



The Effectiveness of Transcutaneous Electrical Nerve Stimulation on Adhesive Capsulitis: A Systematic Review

By

Genista Goorchuran

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Durban University of Technology

Genista Goorchuran
Name of the student

29/09/2025
Date

Signature

Approved for examination

Prof B Chiliza
Name of the supervisor

29/09/2025
Date

Signature

Dr A. van der Meulen
Name of the co-supervisor

29/09/2025
Date

Signature

Declaration

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.....

Signature

Dedication

To my parents, Anil and Nerisha.

With all my love always.

Acknowledgements

I would like to thank my parents, Anil and Nerisha, for being the island of sanity in the sea of insanity called life. You both have always put the best interests of your children first, for this, Nihal and I cannot thank you enough. You have taught us, with the support of our parents, anything is possible.

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Abstract

Background: Adhesive capsulitis, commonly known as frozen shoulder, is a common condition associated with pain, stiffness and reduced mobility. The pathology affects between 2 to 8% of the general population, primarily females aged 40 years and older. Patients diagnosed with diabetes mellitus, hypothyroidism and cardiovascular disease carry a higher risk of the development of adhesive capsulitis. Transcutaneous electrical stimulation (TENS) is a conservative treatment option, the evidence supporting its effectiveness remains inconsistent and varied in methodological quality. Therefore, this systematic review aimed to critically appraise the available literature and summarise the evidence to determine the level of support of the use of TENS in the management of adhesive capsulitis.

Methods: The researcher searched eight electronic databases (Google Scholar, CINAHL, Cochrane databases, Cochrane review databases, PubMed, and SCOPUS). The search terms used were namely, “adhesive capsulitis”, “shoulder adhesive capsulitis”, “frozen shoulder”, “shoulder pain”, “transcutaneous electrical nerve stimulation”, “TENS” and “electrical stimulation”. The inclusion criteria included randomised controlled trials (RCTs), non-randomised controlled trials (nRCTs), and observational studies focused on adhesive capsulitis following the use of TENS as a part of the intervention. The citations and abstracts were filtered based on the relevance to keywords and the full text articles identified based on the inclusion criteria. The final list of articles was reviewed by seven reviewers using PEDro, Newcastle Ottawa and the Liddle Scales (the scales used to evaluate the articles were based on the study design), to establish the methodological rigor of the studies. Once the data collection concluded (viz., full text articles), each article was screened and reviewed by the reviewers. Therefore, the article was evaluated based on the outlined criteria, specified scales, and the limitations of the study reported. The primary outcomes were the effectiveness of TENS in the management of adhesive capsulitis either as a single treatment and/or in combination with other modalities. The data was summarised and presented in tables, illustrating the data found.

Results: The initial database search yielded 4 282 studies (after 148 duplicated articles were removed), of which 23 articles fulfilled the eligibility criteria for inclusion in this systematic review. The studies provided mixed results specifically, with only one study utilized TENS as a single treatment modality, while the majority (n=22) examined TENS as part of a multimodal treatment approach. In addition, one study did not specify whether the evidence was related to TENS as the intervention was broadly described as electrical stimulation. The included studies reported improvements in pain, shoulder range of motion and functional outcomes following the interventions that incorporated TENS. However, these improvements were noted when TENS was used in combination with other treatment interventions, rather than a standalone treatment. There is limited evidence supporting the use of TENS as a single modality in the management of adhesive capsulitis, whereas the evidence supporting the use of TENS in combination therapy was deemed favourable, but the evidence was limited in respect to the contribution of TENS in the multimodal protocols.

Conclusion: The evidence in support of combination therapy with the addition on TENS in the management of adhesive capsulitis was favourable as participants reported improvements in terms of

pain, range of motion and in some cases functionality. Considering the current evidence, it is recommended that future studies investigate the use of TENS in combination therapy and its long-term efficacy.

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Definitions

Allocation bias:	This form of bias occurs when there was no randomisation of participant assignments to their clinical trial group. Nunan, Heneghan and Spencer (2018) reported that this may result if the investigator is familiar with the treatment prescribed to the participant, thus most likely to know the best outcome based on the treatment. In this instance, the researcher was looking to identify the presence of allocation bias in the studies utilized as data.
Allocation concealment:	A process in which information was withheld from the research participants and the investigators regarding the allocation of patients to their intervention groups whilst conducting a randomised controlled trial. The use of allocation concealment is to prevent bias by allocating a participant into a group based on information known (i.e. lack of co-morbidities, handiness and age) (Nagendrababu <i>et al.</i> 2020).
AMSTAR:	A Measurement Tool to Assess systematic Reviews. AMSTAR is an instrument which contains 11 items in a checklist that is used to conduct and critically appraise systematic reviews. The aim of AMSTAR is to improve the methodological quality of the reviews for the benefit of the authors, editors, readers and referees (Nagendrababu <i>et al.</i> 2020).
Arbitrator:	An external party chosen to settle a disagreement between the reviewers involved (Garner 2022).
Avabahuka:	A disorder that usually affects the Amsa sandhi (shoulder joint) (Das <i>et al.</i> 2010). Atri and Wadkar (2022) reported the modern correlation to be adhesive capsulitis. Also referred to “Avabahuka”
Bias:	A systematic error in the study design, recruitment process, data collection and/or under the analysis process which may impact the results by a mistaken estimation of the true population parameter (Glasser 2008).
Case study:	An approach used to generate a multifaceted and comprehensive understanding of an issue in a complex context (Crowe <i>et al.</i> 2011), which is different to studying a broad group of subjects. A case series may be different as it will follow more than one individual (Mathes and Pieper 2017).
Citation bias:	The number of times a study was cited, indicates a predisposition to a positive result outcome associated with the study, henceforth, a study with a higher outcome is likely to recorded and included in systematic reviews (Chan and Altman 2005).
Cochrane:	An international organisation promoting evidence based informed healthcare through the means of systematic reviews and various research evidence (Cochrane 2019).
Confidence interval:	An indication of the correlation between the research and reality or the reliability of the research based on the statistical theory (Morey <i>et al.</i> 2016).
CONSORT:	A protocol designed by researchers which not only identified problems which may arise from conducting randomised control trials, but documenting the results yielded by research, allowing a better assessment of the quality (Falci and Marques 2015).
Design bias:	Higgins, Altman and Sterne (2011) indicated this form of bias will occur in situations when the investigator fails to consider the existing biases which may influence the investigation of the systematic review.
Eligibility criteria:	Detailed requirements, which will define the criteria for either inclusion or exclusion of the studies in the systematic review that one may answer the selected research question (McCrae <i>et al.</i> 2015).
Frequency:	Pulses of electrical energy delivered by the machine per second, this is measured in Hertz (Hz). The range used transcutaneous electrical nerve stimulation ranges between 2-150Hz (Tashani and Johnson 2009; Johnson 2007).

Handedness:	Hand preference used for performing certain tasks (Clerke and Clerke 2001). Handedness can also be referred to as hand dominance.
Hawthorne effect:	This describes the effects of the subject's awareness of their evaluation as the participants of a research study (Merrett 2006). Sedgwick and Greenwood (2015) postulated the Hawthorne effect as a change in the trial participants' behaviour or investigation outcomes that is not a direct effect of the intervention or treatment regimen, caused by the awareness of being in a research study.
Intensity:	The strength of the current utilised by the transcutaneous electrical nerve stimulation machine to stimulate the nerves, often measured in amplitude (mA). The clinical range used by transcutaneous electrical nerve stimulation ranges between 0-100 mA (Tashani and Johnson 2009; Johnson 2007).
Invasive therapy:	Purposeful access to the body by either an incision, percutaneous puncture, where instrumentation is used to introduce a device or fluid into the body. It begins when entry to the body is gained and ends when the instrument is removed, and/or the skin is closed (Cousins, Blencowe and Blazeby 2019).
Kaltenborn manipulation:	"A three-tiered technique that incorporates small amplitude movements with traction to loosen and counteract any compressive forces on the joint (grade one), to gentle mobilizations of joints with oscillations without overriding any tightening of the connective tissues surrounding the joint (grade two), or oscillations followed by additional stretching (grade three) " (Levitsky <i>et al.</i> 2019).
Language bias:	The publication of research findings recorded in a specific language, but is dependent on the nature and direction of the outcomes (Boutron <i>et al.</i> 2019).
Location bias:	The publication of research results is dependent on the accessibility or levels in ordinary databases/search engines. These are associated with the type of results estimated (Boutron <i>et al.</i> 2019).
Meta-analysis:	A statistical technique whereby findings, results and data from independent studies are connected to be included in a systematic review (Haidich 2010). Through this collation, a meta-analysis provides more accuracy in the effects of the healthcare system when compared to the findings of specific studies (Moher <i>et al.</i> 2015).
Non-invasive therapy:	A therapy that is applied to the soma (anything derived from the ectoderm of the embryo) from an external source and does not introduce any form of devices or substances into the body (PubMed MeSH terms, 2016).
Non-randomized study:	An investigation whereby the involved participants are assigned into two or more treatment groups however, the allocation process by which the participant is placed is not random (Boland <i>et al.</i> 2018). These studies are usually more pragmatic in nature and therefore represent clinical practice to a greater degree.
Observational studies:	Investigations in which the researchers observe the effects of risk factors, diagnostic test, treatment protocols and/or interventions without changes those who are exposed and those who aren't. There are two forms of observational studies, cohort studies and case control studies (Song, Hooper and Loke 2013; Work).
Placebo:	Any form of intervention used for a non – specific psychological or psychophysiological effect on an individual (Shapiro 1964).
Placebo effect:	The occurrence of a sham intervention causes improvement to a patient's medical condition due to the patient's perception of the intervention (Dodd <i>et al.</i> 2017).
Prevalence:	The proportion of a population who have a specific characteristic in a specified period. Prevalence can be a measure of the frequency of illness, disease and/or a health condition (Carroll 2013).
Publication bias:	Selective publication or non-publication of research conclusions based on significance, nature and direction of the outcome (Chan and Altman 2005).

PRISMA-P:	Guidelines to enable the development of protocol preceding conducting a systematic review, focussing on the purpose and methodology of the systematic review (Moher <i>et al.</i> 2015).
PRISMA:	Preferred Reporting for Systematic Reviews and Meta-Analyses, provides a minimum set of requirements to ensure the quality of reports describing systematic reviews or meta-analyses. PRISMA entails a checklist of 27 items along with one four-phase flow diagram (Liberati <i>et al.</i> 2009).
PROSPERO:	An international prospective register of systematic reviews with health-related outcomes before it is initiated. The goal of PROSPERO is to avoid duplications of systematic reviews by making them known upon registration along with requesting transparency throughout the reviewing process.
Randomized Clinical Trial:	A prospective experiment that aims to compare the effectiveness of two or more interventions/treatment methods. In this instance, the test intervention is being compared to a standard treatment (known as a gold standard) or no treatment (known as a placebo) (Kendall, 2003, Nagendrababu <i>et al.</i> 2020). The allocation of participants to the groups is structured to ensure the greatest likelihood of similarity between the groups. These studies are usually more clinical, precisely identifying the effect of one intervention therefore does not represent clinical practice well.
Random sampling:	A sample whose participants are chosen at random from a given population in such a way of obtaining any sample can be recorded (Acharya <i>et al.</i> 2013).
Reporting bias:	The systematic differences between reported and unreported findings. In some instances, the significant difference analysis between intervention groups is more likely when compared to that of non-significant differences (Higgins <i>et al.</i> 2020). Chan and Altman (2005) reported “within-study publication bias” is a result of reporting bias or selective reporting bias, often having a significant bias influencing the results from individual studies.
Reviewer bias:	This form of bias may develop from circumstances such as reviewers reviewing their own work or in the instance that the reviewer has a relationship with the authors of the articles being reviewed (Belur <i>et al.</i> 2021).
Scaption:	An abbreviation for elevation in the scapular plane (Alpi and Delgado 2010). Scaption is the defines the motion of a flexed arm by 30 degrees with the thumb in an upward position, whereby the scapular and humerus are in the same plane (Roldán-Jiménez, Cuesta-Vargas and Martín-Martín 2022).
Search terms:	Terms, phrases, or words used on an electronic platform to identify relevant information from various search engines, databases, or information sources (Boland <i>et al.</i> 2018).
Selection Bias:	Boutron <i>et al.</i> (2019) described that this form of bias was reliant on the outcome or analysis, but not others which are closely associated with the results.
Systematic review:	“A review of a clearly formulated question that uses systematic and explicit methods to identify, select and critically appraise relevant research”. Cochrane Library (2011). A collation of relevant eligible evidence and information which fits in pre-specified criteria to answer a specific research question (Moher <i>et al.</i> 2015; Oxman and Guyatt, 1993). A systematic review is a better form of critical literature analysis especially in a context where interventions and the clinical outcome measures vary, or the pathogenesis is unclear negatively affecting the consistency of outcome measures between studies (Lefebvre <i>et al.</i> 2001).
Umbrella Review:	A combination of the published results from both meta-analyses and / or systematic reviews (Fusar-Poli and Radua 2018; Nagendrababu <i>et al.</i> 2020). An umbrella review establishes whether the evidence reported around the research question / topic is consistent, contradictory or presence of discrepancies; if so, will explore into the reasons. A summary of the amalgamation of the existing evidence (Aromataris <i>et al.</i> 2015).

Appendices

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Abbreviations

A	ADL	Activities of Daily Living
B	BMI	Body Mass Index
C	CI	Confidence Interval
	CMA	Constant Murley Assessment
	CNS	Central Nervous System
	CONSORT	Consolidated Standards of Reporting Trials
	CRP	C-reactive proteins
	CS/CR	Case studies/ series/ report
	CVD	Cardiovascular disease
D	DASH	Disability of Arm, Shoulder, and Hand
	DRC	Department Research Committee
	DUT	Durban University of Technology
F	FBC	Full Blood Count
	FRC	Faculty Research Committee
G	GRADE	Grading of recommendations, assessment, development, and evaluations
H	HDL	High-density lipoprotein (cholesterol)
I	IREC	Institutional Research Ethics Committee
L	LDL	Low-density lipoprotein (cholesterol)
	LSST	Lateral Scapular Slide Test
M	MCID	Minimal clinically important differences
	MoA	Memorandum of Agreement
N	No	Number
	NOS	Newcastle-Ottawa Scale
	NPRS	Numerical Pain Rating Scale
	nRCT	Non-randomised controlled study
	NSAIDs	Non-steroidal anti-inflammatory drugs
O	OS	Observational Studies
	OTC	Over the counter
P	PEDro	Physiotherapy Evidence Database
	PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analyses
	PROSPERO	Prospective Register of Systematic Review
	PRS	Pain Rating Scale
	PSFS	Patient Specific Functional Scale questionnaires

Q	QoL	Quality of life
R	RCT	Randomised controlled study
	ROM	Range of motion
S	SD	Standard Deviation
	SDQ	Shoulder Disability Questionnaire
	SF-36	Medical Outcomes Study Questionnaire Short Form 36 Health Survey
	SPADI	Shoulder Pain and Disability Index
	SWD	Short Wave Diathermy
V	VAS	Visual Analogue Scale
W	WHO	World Health Organization

Chapter One: Introduction

1.1. Introduction

Shoulder adhesive capsulitis, also commonly known as “frozen shoulder syndrome”, (which will be referred to as “adhesive capsulitis” throughout this dissertation), is a condition encountered by chiropractors (Rainbow *et al.* 2008; Kazemi 2000; Polkinghorn 1995). The terms adhesive capsulitis and frozen shoulder syndrome are used to describe the presence of a painful and stiff shoulder. Adhesive capsulitis is defined as a condition in which the synovial membrane forms adhesions within the glenohumeral joint due to inflammation, producing shoulder stiffness, reduced motion and pain, ultimately causing dysfunction (Le *et al.* 2017b; Le *et al.* 2017a; Neviaser and Hannafin 2010b; Neviaser and Hannafin 2010a; Manske and Prohaska 2008). St Angelo and Fabiano (2018) postulated when diagnosed and managed in the early stages, adhesive capsulitis is self-limiting and can provide favourable outcomes. Adhesive capsulitis can be classified as either primary, whereby the condition is idiopathic in nature with an unknown cause or, secondary, whereby the condition is produced by a different condition (Maund *et al.* 2012).

The pathology affects between 2 and 5% of the general population and prevalent in individuals between the ages of 40 and 70 years (Hsu *et al.* 2011; Ewald 2011). Tasto and Elias (2007) reported an 11% prevalence in the United States among diabetic patients, with a prevalence of 40% specifically in individuals with type 1 diabetes. Additionally adhesive capsulitis has a high prevalence in those with hypertriglyceridemia (Tasto and Elias 2007), hypertension, thyroid disease, localized trauma, pulmonary tuberculosis and heart disease (Tighe and Oakley 2008; Bridgman 1972). Generally, women are more commonly affected with the peak onset of 56 years of age as compared to men (Kwaees and Charalambous 2015; D'Orsi *et al.* 2012; Dias, Cutts and Massoud 2005). Jones *et al.* (2013) postulated the usual onset of adhesive capsulitis is between the ages of 40 to 60 years, which falls into the working-age of most populations, thus having an economic impact on individuals and society. A one-year prevalence investigation indicated 0.35% of the patients over the age of 65 years on the Medicare system in the United States of America were diagnosed with adhesive capsulitis (this equated to over 140 000 individuals) (Sarasua *et al.* 2021). Jacob *et al.* (2023) reported the one-year and lifetime prevalence of adhesive capsulitis were 0,4% and 2,4% respectively in older adults (≥ 65 years of age) in general practices in Germany. Furthermore, the presence of adhesive capsulitis was associated with co-morbidities, specifically osteoarthritis and trauma of the upper extremity and thorax. Research has highlighted that there is no link between the genetic precursors or racial vulnerability (Tighe and Oakley 2008). The occurrence of bilateral shoulder involvement is rare however, the incidence may increase based on the presence of co-morbid conditions (Robinson *et al.* 2012; Zuckerman and Rokito 2011a).

Without intervention, the condition can last between 1 to 3 years (Ralston, Britton and Davidson 2018; Kwaees and Charalambous 2015), often causing difficulties in carrying out the activities of daily living thus gradually reducing the quality of life. The symptoms of adhesive capsulitis cause the patient debilitating adverse effects which can impact the patients ability to work, often resulting in absenteeism, reduced participation in leisure activities along with the increased use of medical care (Bouaicha *et al.*

2020; Buchbinder *et al.* 2007). Furthermore the prevalence of patients having diabetes and Parkinson's disease was closely linked with the diagnosis of adhesive capsulitis (Sarasua *et al.* 2021).

Sarasua *et al.* (2021) revealed patients diagnosed with adhesive capsulitis had an average annual beneficiary Medicare spend higher than those without adhesive capsulitis. This may indicate patients with adhesive capsulitis could be in poorer health and ultimately requiring additional treatment. The current management methods vary depending on the severity of adhesive capsulitis, from conservative to invasive treatments. Conservative methods include the utilization of oral nonsteroidal anti-inflammatory drugs (NSAIDs) during the early stages to provide pain relief, specifically night pain (Mezian, Coffey and Chang 2021). Whereas Chen *et al.* (2024) reported the use of topical NSAIDs provided significant improvement in range of motion and pain in patients with adhesive capsulitis. Alternative forms of conservative management include electro modalities, temperature therapy, manipulation and mobilization of the joints and soft tissue, stretches, range of motion exercises along with proprioceptive neuromuscular facilitation (Griggs, Ahn and Green 2000). Surgical procedures used to manage adhesive capsulitis are manipulation under anaesthesia and an arthroscopic capsular release (Ramirez 2019). However, prior to the utilization of surgical interventions, the use of hyaluronate or corticosteroid injections can be utilized to offer a form of relief for the patient (Ryans *et al.* 2005).

Transcutaneous electrical nerve stimulation (TENS) is a non-invasive cutaneous stimulus using low frequency pulsed electrical current. TENS has become favoured in the management of pain due to the cost effectiveness. The application provides immediate results with limited adverse effects (Vance *et al.* 2014). The device has a portable option (for home care) and is non-invasive in nature. In clinical practice, practitioners utilize their knowledge of previous treatments in the management of adhesive capsulitis. Research has informed that some practitioners fail to incorporate evidence-based information regarding the treatment of adhesive capsulitis. Levine *et al.* (2007) postulated that the use of conservative treatment in the management of adhesive capsulitis had a similar clinical outcome as to the use of the surgical intervention. Comparatively Souza (2016) outlined and deemed the conservative treatment to be a primary method of care initiated by the chiropractor. Munthe, Sandman and Cutas (2012) identified the discrepancies between the literature and clinical practice which created several ethical concerns; specifically, the inability of the practitioner to provide the patient with adequate information regarding the available treatments for the management of adhesive capsulitis. Therefore, the patient lacks the ability to make an informed judgement subsequently, failure to provide informed consent for the prescribed treatment protocols. As a result of the ineffective treatment for the condition, a financial implication is experienced by the patients, third party payers and companies (Sarasua *et al.* 2021; Munthe, Sandman and Cutas 2012).

The role of this systematic review was thus to collate evidence accurately and reliably, which may offer health providers information of the current treatment protocols using TENS available. The systematic review outcome outlines tools to assist the practitioner to make an educated decision when rendering treatment options to the patient. Information provided by the systematic review may inform the public of the relevant treatments available (Liberati *et al.* 2009). Therefore, the purpose of this study was to examine the use of TENS in the management of adhesive capsulitis, so that the practitioners can be

better informed, patients can receive accurate information during consent, and improved guidelines for the patientcare (Hemingway and Brereton 2009).

1.2. Aims

The *aim* of this systematic review was to evaluate the level and quality of evidence regarding the effectiveness of transcutaneous electrical nerve stimulation (TENS), used either as a standalone intervention or as an axillary to other treatment protocols, in the management of adhesive capsulitis.

1.3. Objectives

The *primary objective* of this systematic review was:

- To evaluate the effects of transcutaneous electrical nerve stimulation (TENS) on clinical outcomes, specifically pain, shoulder range of motion, and functional outcomes, in adults diagnosed with adhesive capsulitis.

The *secondary objectives* of this systematic review were:

- To compare clinical outcomes associated with the use of TENS as a standalone intervention in contrast to its use as part of combination therapy in the management of adhesive capsulitis.
- To assess the methodological quality of the included studies investigating the use of TENS in the management of adhesive capsulitis.
- To determine the overall certainty and strength of the evidence supporting the use of TENS in the management of adhesive capsulitis.

1.4. Rationale and benefits of the study

The purpose of this systematic review was to provide a critical summary of the scientific evidence both supporting and opposing the use of TENS in the management of adhesive capsulitis. This provides the practitioner insight into the use of TENS in the management of adhesive capsulitis, either alone or in a combination therapy.

The rationale outlined was based on the guidelines that underpin a systematic review (Moher *et al.* 2015). This outlines a systematic search for the studies, the manner in which studies are chosen, how each study type is reviewed, the critical review process and lastly the determination of the level of evidence within a given domain (Moher *et al.* 2015; Liberati *et al.* 2009). Therefore, establishing a treatment guideline utilizing TENS in the management of adhesive capsulitis. Thus, development of patient's specific treatment protocol along with resultant patient satisfaction. Within the context of the use of TENS in the management of adhesive capsulitis, there is inconsistency in the literature as the available evidence tends to provide a contradictory picture for clinicians (Hsu *et al.* 2015; Manske and Prohaska 2008; Hannafin and Chiaia 2000; Rizk *et al.* 1983). This negatively impacts on healthcare practitioners as they are required to inform their patients of management protocols based on the current evidence to receive evidence informed consent (Munthe, Sandman and Cutas 2012). Without a clear

guideline as to the protocols regarding the management of adhesive capsulitis by the means of TENS, the practitioner is unable to practice evidence-based treatment and receive evidence-informed consent from the patient to treat (Sundberg *et al.* 2014; Munthe, Sandman and Cutas 2012).

Gibbs and Gambrill (2002) with Plath (2013) outlined guidelines defining evidence based medicine, which are described below. This definition suggests that practitioners are required to provide best treatment protocols, by establishing the patient's complaint, examining the patient to confirm the complaint, and arriving at a diagnosis (collectively referred to as the practitioner's clinical experience). This is followed by the practitioner examining the literature and evaluating the validity, sensitivity, specificity, and clinical efficacy of indicated modalities. Then in discussion with the patient (referred to as the patient preference), a protocol is defined for that patient. When clinical experience, research evidence, and patient preferences misalign, it makes it difficult for practitioners to achieve the best outcomes for patients. Clinical experience grows slowly over time as practitioners encounter different situations and reflect on them. Furthermore, patient preferences are also difficult as they are shaped by many factors, which include culture, background, education level and personal circumstances. These influences are complex and cannot be predicted with certainty. Due to this, research becomes the most reliable area for evaluation, as it allows for careful, structured, and measurable assessment of clinical interventions. This concurs with Sackett *et al.* (2000) who indicates that systematic reviews are a part of evidence-based practice, which results from the collation of the information evidence research and is combined with the best clinical expertise and patient preferences to attain the best patient outcomes (Haby *et al.* 2016; Bowen and Zwi 2005; Sackett *et al.* 2000).

Without clear evidence, there is often a disjuncture between the management of conditions (e.g., adhesive capsulitis) in clinical practice and the published literature (Georgiannos *et al.* 2017; Lefebvre *et al.* 2011; Withrow *et al.* 2010). In accordance with this systematic review, the purpose was to determine the level of evidence available for the use of TENS in clinical practice to reduce the gap between clinical practice and the published literature evidence. Subsequently, the results of this systematic review will provide healthcare providers with a summation of the relevant data to provide evidence informed or evidence based recommendations to patients and may allow fuller informed consent from the patient (Sundberg *et al.* 2014; Krumholz 2010).

1.5. Acknowledged limitations of this systematic review

Systematic reviews are pivotal in translation of research into clinical practice and provide support for evidence-based practices however, there are limitations (Noyes *et al.* 2018), which are briefly discussed in this chapter and in detail in Chapter 3 and 4. This systematic review focused on primary adhesive capsulitis as the source of shoulder pain, excluding cases secondary to pathologies or surgeries, to provide evidence relevant to the management.

Systematic review assess all study types and the individual contribution of each study, before providing a composite evaluation of the literature in terms of the evidence (Liberati *et al.* 2009). This systematic review examined the use of TENS in managing adhesive capsulitis, providing a

holistic view of the available evidence, including its strengths and weaknesses, when compared to a meta-analysis.

Only English-language publications were included, which may have excluded relevant studies, introducing potential language bias (Boutron *et al.* 2019; Balk *et al.* 2013). However, the exclusion of non-English studies generally has a minimal impact on the overall conclusions (Nussbaumer-Streit *et al.* 2020).

Publication bias is another limitation, as studies with positive outcomes are more likely to be published, though randomised controlled trials are less susceptible to this bias (Knobloch, Yoon and Vogt 2011; Easterbrook *et al.* 1991) .

1.6. Outline of the chapter contents

This chapter introduced the research topic and the context of the systematic review. The aims and objectives were emphasised along with the rationale for the study. The forthcoming chapters provide further understanding of the research problem arising from the literature review (Chapter Two) and methodology utilized in this study (Chapter Three). A summarised analysis of the results obtained from this systematic review is provided in the fourth chapter, with a detailed discussion per the use of TENS in the management of adhesive capsulitis provided in Chapter Five. Finally, in conclusion, a summary of the findings and recommendations in the Sixth Chapter.

Chapter Two: Literature Review

2.1. Introduction

The second chapter provides an overview of adhesive capsulitis. It begins with the definition of the condition and outlines the impact of the pathology on the patients affected. Thereafter, the risk factors are reviewed, highlighting the limited pathophysiology along with the diagnostic and management protocols. The chapter also focuses on the use of TENS in the treatment protocol and explains the systematic review used to assess the evidence for or against its effectiveness.

2.2. Anatomy of the Shoulder

The shoulder is one of the largest and most complex structures of the body (Miniato, Anand and Varacallo 2021). Miniato, Anand and Varacallo (2021) noted the shoulder was complex structurally and functionally as it was the most generously mobile region of the human body because of the glenohumeral joint articulation. The shoulder girdle forms a connection between the upper limb to the axial skeleton through the sternoclavicular joint. The intricate relationship of the structures maintains joint stability of the shoulder and allows synergistic motion of the joints. This may result in instability leaving the joint susceptible to dislocation and injury, whereby muscles and joints are discordant in their function (Miniato, Anand and Varacallo 2021; Terry and Chopp 2000).

The pectoral girdle (will be referred to as shoulder girdle) comprised of the clavicle and the scapula, which forms an articulation with the proximal humerus. Within the shoulder girdle, there are four joints present namely; glenohumeral, sternoclavicular (SC), acromioclavicular (AC) and scapulothoracic joint (Miniato, Anand and Varacallo 2021; Goldstein 2004). The movement of the shoulder girdle is an intricate dynamic relationship of muscle forces and ligament constraints along with bony articulations. The homeostatic relationship between the static and dynamic stabilizers allow the shoulder to move optimally and position both the hand and elbow (Terry and Chopp 2000).

2.2.1. Bones of the shoulder girdle

A. The clavicle

The clavicle (also known as the collarbone) is located on the anterior aspect of the shoulder girdle. This S-shaped long bone lies superficially and horizontally through the anatomy. The clavicle acts as the bony connection between the trunk and the shoulder girdle, with the sternoclavicular joint medially and acromioclavicular distally (Moore *et al.* 2015). The clavicle serves as a site of muscular attachment, barrier to protect the neurovascular structures which lie posteriorly and a stabilizer for the shoulder complex (Terry and Chopp 2000). The strong coracoclavicular ligaments prevent inferior migration of the clavicle from the shoulder girdle.

B. The scapula

The scapula (commonly known as the shoulder blade) is a large yet thin triangular bone which anatomically lies on the posterolateral aspect of the thorax, between ribs two to seven. The purpose of the scapula is primarily a site for muscle attachment (Terry and Chopp 2000) and form a main structure in the formation of the scapulothoracic joint complex (Moore *et al.* 2015). The structure has three angles (superior, inferior, and anterior), three borders (superior, lateral/axillary, and medial or vertebral) along with two surfaces (anterior and posterior) (Standring 2021; Gray 2013; Goldstein 2004). The most crucial osseous features of the scapula are the spine, acromion, coracoid process, along with the glenoid cavity (Moore *et al.* 2015).

The spine of the scapula situated on the posterior aspect runs from the medial edge to the superolateral angle of the scapula, dividing the posterior scapula into the infraspinatus fossa and supraspinatus fossa (Standring 2021). The acromion articulates with the distal clavicle forming the acromioclavicular joint which has a significant role in the glenohumeral joint motion occurring. Furthermore, the acromion has a role in the coracoacromial arch which prevents the excessive translation of the humeral head. Arising from the broad base of the neck of the scapula is the coracoid process, the thickening and curved extension of the scapula (Standring 2021). The coracoid process functions as an attachment site for several ligaments and muscles, and contributes to the coracoacromial arch (Frank *et al.* 2013). The coracoid tip serves as the origin of the coracobrachialis muscle, short head of the biceps brachii and the insertion of the pectoralis minor muscle. Furthermore, the coracohumeral and coracoacromial ligaments are situated on the coracoid. Located medial to the base of the coracoid is the scapular notch which comprises of the transverse scapular ligament that lies superior to the suprascapular nerve. The suprascapular nerve innervates the supraspinatus and infraspinatus muscles. The glenoid fossa represents the humeral bony articulating surface which provides a small contribution to glenohumeral stability (Terry and Chopp 2000).

C. The humerus

The humerus is the longest bone of the upper extremity and articulates with the glenoid cavity of the scapula at the glenohumeral joint (Moore *et al.* 2015). The humerus consists of three parts specifically; upper part (humeral head), middle part (shaft) and the lower part (gives rise to the humeral condyles that form an articulation with the ulna and radius at the elbow). The humeral head is ball shaped with articular cartilage covering the medial surface. The humeral head articulates with the glenoid at the glenohumeral joint. Lateral to the articular cartilage comprises of the lesser and greater tuberosities which is separated by the bicipital groove. The greater tuberosity, located on the lateral aspect of the humerus, serves as an attachment site for three of the rotator cuff muscles (supraspinatus, infraspinatus and teres minor). The lesser tuberosity of the humerus provides the insertion site for the subscapularis (Terry and Chopp 2000). The humerus contains two necks described as anatomical and surgical. The anatomical neck is the junction of the humeral head and surrounding bone junction, whereas the surgical neck is located inferiorly and junction between the humeral neck and humeral shaft.

2.2.2. Joints of the shoulder girdle

A. Glenohumeral joint

The formation of a ball and socket joint between the humerus and glenoid cavity of the scapula created the most mobile joint (glenohumeral) of the human body. This permits for motion in multiple planes namely, flexion, extension, shoulder circumduction, rotation in both medial and lateral planes, abduction, and adduction, along with scaption (Roldán-Jiménez, Cuesta-Vargas and Martín-Martín 2022; Moore *et al.* 2015).

The subacromial bursa (commonly called subacromial-subdeltoid bursa) is the synovial cavity located below the acromion and coracoid, and superior to the supraspinatus and infraspinatus tendons. The function of the subacromial bursa is to reduce friction and facilitate the motion between the shoulder structures. In the paragraph to follow the ligaments of the glenohumeral joint will be discussed. In Table 2.1, the glenohumeral joint stabilizers identified according as static and dynamic stabilizers, and the structures stabilized.

Ligaments involved (Moore *et al.* 2015; Terry and Chopp 2000):

- Coracoacromial ligament- reduce the superior displacement of the humeral head from the glenoid cavity.
- Coracohumeral ligament-resists superior and inferior displacement and reinforces the anterior portion of the joint capsule.
- Glenohumeral ligaments-contains superior, middle, and inferior bands, which stabilizes the joint in adduction, abduction, and external rotation.
- Transverse humeral ligament-maintains the long head of the biceps tendon within the bicipital groove.

Table 2. 1: Glenohumeral joint stabilizers.

	Humeral stabilizers	Glenohumeral joint movers	Scapular stabilizers
Passive (static)	Capsule Labrum Coracohumeral ligament Superior glenohumeral ligament	Middle glenohumeral ligament Inferior glenohumeral ligament Geometry of the humeral articular surface Geometry of the glenoid articular surface Coracoacromial ligament Articular cartilage compliance	Joint cohesion
Active (dynamic)	Supraspinatus Infraspinatus Subscapularis Teres minor	Pectoralis major Latissimus dorsi Long head of the biceps Triceps Deltoid Teres major	Serratus anterior Latissimus dorsi Trapezius Rhomboids Levator scapulae Pectoralis minor

Information taken from (Chang, Anand and Varacallo 2022; Miniato, Anand and Varacallo 2021; Curl and Warren 1996) and adapted into table format.

B. Acromioclavicular joint

The formation of a synovial joint between the acromion and the clavicle. The acromioclavicular joint allows smooth motion between the scapula and clavicle during arm motion (Wong and Kiel 2022; Ha, Petscavage-Thomas and Tagoylo 2014). The ligaments involved in the acromioclavicular joint are discussed below.

Ligaments involved:

- Acromioclavicular ligament: reinforces the superior aspect of the joint capsule and resists the anteroposterior displacement at the acromioclavicular joint.
- Coracoclavicular ligament consists of the trapezoid and conoid ligaments and resists vertical and rotational displacement of the clavicle relative to the scapula (Wong and Kiel 2022).

C. Sternoclavicular joint

The saddle synovial joint formed by the sternum and medial aspect of the clavicle allow for motion of the clavicle in multiple planes (Epperson and Varacallo 2019; Dhawan *et al.* 2018). The ligaments involved in the sternoclavicular joint are discussed in terms of attachment, and relationship to the sternoclavicular joint.

Ligaments involved:

- Sternoclavicular ligaments: provides stabilization in an anterior/posterior plane and prevent superior displacement.
- Costoclavicular ligaments: anchored the clavicle to the first rib and resists clavicular elevation.
- Interclavicular ligaments strengthens the capsule and resists the downward displacement of the clavicle (Epperson and Varacallo 2019; Morell and Thyagarajan 2016).

D. Scapulothoracic joint

The scapulothoracic joint is not a true synovial joint, the articulation represents a space between the convex surface of the posterior thoracic cage and concave surface of the anterior scapula. The anatomical purpose of the joint is to provide motion of the scapula on the thorax; a synergic motion is required from both the acromioclavicular and sternoclavicular joints. The serratus anterior muscle is interposed with the subscapularis muscle between the scapula and posterior thorax (Moore *et al.* 2015). The scapula can tilt, glide, and rotate on the thorax allowing normal function of the shoulder joint (Paine and Voight 2013). The presence of abnormalities in the structures can result in pain and disturbance of the arm or scapula movements (Frank *et al.* 2013).

2.2.3. Extracapsular ligaments

A. Coracoacromial ligament

The coracoacromial ligament originates from the lateral aspect of the coracoid process and runs laterally and upwards to the acromion tip. Together with the acromion and the outer end of the clavicle, the coracoacromial roof is formed. The coracoacromial arch provides a strong roof for the shoulder joint on which the rotator cuff tendons glide to provide shoulder motion. The subacromial bursae creates a

surface in which the cuff tendons and proximal humerus glide. The nature of the area is delicate as there usually is no gap between the cuff and the roof thus the presence of superior translation can lead to compression of the cuff tendons and/or bursa between the arch and humeral head (Rothenberg *et al.* 2017).

B. Coracoclavicular ligament

The trapezoid ligament originates from the superior aspect of the coracoid process and inserts into the inferolateral aspect of the clavicle. Medial to the trapezoid ligament lies the conoid ligament which originates on the superomedial aspect of the coracoid process and inserts into the conoid tubercle at the inferior clavicle. Both these ligaments attach to the scapula via the inferior outer side of the clavicle. The conical structure provides the clavicle with the ability to rotate around its axis thus allowing arm elevation (Harris *et al.* 2001).

C. Costocoracoid fascia

Beneath the pectoralis major muscle lies several muscles and ligaments namely, the clavipectoral fascia, subclavius and pectoralis minor muscles. Together they form part of the clavipectoral muscle in the costocoracoid fascia which is located superomedial to the pectoralis minor muscle. The idiopathic loss of elasticity can occur within the fascia, resulting in a structural contracture and limited arm elevation (Netter 2014).

2.2.4. Bursae of the shoulder girdle

The shoulder contains five bursae which namely includes subacromial-subdeltoid (SASD) bursa, subscapular recess, subcoracoid bursa, coracoclavicular bursa, and supra-acromial bursa (Soler, Ezagüi and Calvo 2023; Chang, Anand and Varacallo 2022). In recent studies also identify a sixth bursal space commonly referred to as the medial extension of the subacromial-subdeltoid bursa (Salzman, Lillegard and Butcher 1997).

A. Subacromial-subdeltoid bursa (SASD)

The structure of one bursa is comprised of two portions namely the deep and superficial subacromial parts (Klatte-Schulz *et al.* 2022). The subacromial-subdeltoid bursa is normally not a “space” depicted on diagrams but rather two serosal surfaces in contact with each other, one on the deep surface of the coracoacromial arch (subacromial portion) and deep to the deltoid muscle (subdeltoid portion) extending forward and downward to cover the bicipital groove (Prececutti *et al.* 2010; Martinoli *et al.* 2003). Within the space a small amount of fluid is produced which acts as a lubricant. Within the bursae, the two layers are able to glide in relation to each other thus can be considered to be a synovial portion of the subacromial joint (extension of the glenohumeral joint) (Klatte-Schulz *et al.* 2022; Ombregt 2013).

B. Subscapularis bursa/Subcoracoid bursa

The subscapularis bursa is positioned between the upper aspect of the subscapularis tendon, neck of the scapula and the coracoid process base. Furthermore, it is covered by the pectoralis major muscle. When inflamed, this bursa can limit external rotation of the shoulder. Stretching of the subscapularis

during lateral rotation compresses the bursa, often provoking spasm in the pectoralis major (Ombregt 2013).

2.2.5. Muscles of the shoulder girdle

The human body is comprised of over 600 muscles which are responsible for the production of multiple movements (Brooks, Guzman and Ruiz 2023). The upper limb is comprised of over 60 muscles per arm. The scapula is not anatomically attached to the skeleton thus there are numerous muscles on the posterior aspect of the thorax to hold it in place and allow it to function (McCausland *et al.* 2023). The clavicle is the only direct connection between the upper limb and trunk of the body. Furthermore, the muscles and their attachments assist the arms in functioning. Tortora and Derrickson (2011) reported the muscles are divided into subgroups namely; anterior thoracic muscles, posterior thoracic muscles and the scapulohumeral muscles (extrinsic and intrinsic, which includes rotator cuff muscles) which allows motion of the scapula and humerus respectively (Moore, Dalley and Agur 2010). The muscles of the anterior aspect of the body are responsible for assisting with arm movement along with stabilization and rotation of the shoulder. Anterior axioappendicular muscles that move the pectoral girdle, stabilize the clavicle, and move the upper arm are seen in Table 2.2. The relationship between the muscles and their functions are depicted, long with the nerve supply, origin and insertion of the muscle in relation to each other.

Table 2. 2: The anterior axioappendicular muscles.

Muscle	Pectoralis major	Pectoralis minor	Subclavius	Serratus anterior
Origin	<u>Clavicular head</u> : anterior surface of the medial clavicle. <u>Sternocostal head</u> : sternum and superior 6 costal cartilages.	Ribs 3 to 5.	First rib and the sternal costal cartilage junction.	External surface of the first eight ribs.
Insertion	Lateral lip of the intertubercular sulcus.	Medial border, superior surface of the coracoid process of the scapula.	The inferior aspect of the middle third of the clavicle.	Medial border of the scapula.
Nerve supply	Lateral and medial pectoral nerves. <u>Clavicular head</u> is innervated by C5 and C6. <u>Sternocostal head</u> is innervated by nerves C7 to T1.	Medial border, superior surface of the coracoid process of the scapula.	Nerve to the subclavius (nerve roots C5 and C6).	Long thoracic nerve (nerve roots C6 and C7).
Function	Adducts and medially rotate the shoulder joint. Pulls the scapular in an anteroinferior direction.	Scapular stabilization and pulls in an anteroinferior direction.	Clavicle stabilization and depression.	Protracts the scapula and holds the scapula against the posterior aspect of the thoracic wall.

Table adapted from Moore, Dalley and Agur (2010).

The posterior axioappendicular muscles (comprised of both a superficial and deep layer) attach the superior appendicular skeleton (of the upper limb) to the axial skeleton. The intrinsic back muscles

maintain posture, control the movements of the vertebral column, stabilize and move the scapula (Moore, Dalley and Agur 2010).

Table 2. 3: Muscle of the posterior thoracic wall.

Muscle	Superficial		Deep/intrinsic		
	Trapezius	Latissimus dorsi	Rhomboid major	Rhomboid minor	Levator scapulae
Origin	Medial third of the superior nuchal line, external occipital protuberance, nuchal ligament, spinous process of C7-T12.	Spinous process of T6-T12, thoracolumbar fascia, iliac crest, and ribs 9-12.	Spinal processes of T2-T5.	Spinal processes of C7-T1.	Transverse process of C1-C4.
Insertion	Lateral third of the clavicle and the spine of the scapula.	Floor of the intertubercular groove.	Vertebral border of the scapula, from the spine to the inferior angle of the scapula.	Vertebral border of the scapula superior to the spine.	Superior angle of the scapula.
Nerve supply	Accessory spinal nerve (cranial nerve XI) along with spinal nerves C3 and C4 for proprioception.	Thoracodorsal nerve (C6-C8).	Dorsal scapula nerve (C4-C5).		Dorsal scapula nerve (C5) and cervical spinal nerves (C3-C5).
Function	<u>Descending aspect:</u> elevates the scapula. <u>Transverse part:</u> scapular retraction. <u>Ascending part:</u> scapular depression. <u>Descending and ascending:</u> superior rotation of the scapula.	Humeral adduction, extension, and medial rotation.	Retraction of the scapula, inferior rotation of scapula (depression of the glenoid cavity).	Stabilizes the scapula.	Elevation of the scapula, inferior rotation of scapula (depression of the glenoid cavity).

Table adapted from Moore, Dalley and Agur (2010).

The scapulohumeral (intrinsic shoulder) muscles are short muscles which pass from the scapula to the humerus and the glenohumeral joint (Moore *et al.* 2015).

Table 2. 4: Table of scapulohumeral muscles.

Muscle	Deltoid	Teres major	Coracobrachialis
Origin	<u>Clavicular head:</u> lateral third of the clavicle. <u>Acromial head:</u> acromion. <u>Spinal head:</u> spine of the scapula.	Inferolateral portion of the scapula.	Coracoid process of scapula.
Insertion	Deltoid tuberosity of the humerus.	Medial lip of the intertubercular groove.	Anteromedial aspect of the humeral shaft.
Nerve supply	Axillary nerve (C5).	Lower subscapular nerve (C6).	Musculocutaneous nerve (C5 -C7).
Function	<u>Lateral fibres:</u> arm abduction. <u>Anterior fibres:</u> arm flexion and medial rotation. <u>Posterior fibres:</u> extension and lateral rotation of the arm.	Shoulder joint adduction and medial rotation.	Flexion, adduction, and medial rotation of the shoulder joint.

Table adapted from (Moore, Dalley and Agur 2010).

Rotator cuff muscles comprise of four intrinsic shoulder muscles namely, supraspinatus, infraspinatus, teres minor and the subscapularis muscle. These muscles together form a musculotendinous rotator cuff around the glenohumeral joint. The tendons of the rotator cuff muscle blend with and reinforce the fibrous layer of the joint capsule of the glenohumeral joint, forming the rotator cuff that protects the joint and creates stability (Moore *et al.* 2015).

Table 2. 5: Table of Rotator cuff muscles and the deltoid muscle.

Muscle	Supraspinatus	Infraspinatus	Teres Minor	Subscapularis	Deltoid
Origin	Supraspinatus fossa.	Infraspinatus fossa.	Lateral border of the scapula (middle portion).	Subscapular fossa.	Lateral third of the clavicle, acromion, and the spine of the scapula.
Insertion	Superior facet of the humeral greater tubercle.	Middle facet of the humeral greater tubercle.	Inferior facet of the humeral greater tubercle.	Lesser tubercle of the humerus.	Deltoid tuberosity of the humerus.
Nerve supply	Suprascapular nerve (C5).		Axillary nerve (C6).	Upper and lower branches of the subscapular nerves (C6).	Axillary nerve (C5 and C6).
Function	Initiates and assists the deltoid in abduction.	Shoulder joint lateral rotation and holds the humeral head within the glenoid cavity.		Shoulder joint medial rotation and adduction; holds the humeral head within the glenoid cavity.	Clavicular attachment: flexion and medial rotation of the arm. Acromial attachment: abducts the arm. Scapula: extension and lateral rotation of the arm.

Table adapted from (Moore, Dalley and Agur 2010).

2.2.6. Nerves

A. Suprascapular nerve

Derived from the brachial plexus via the C5 root carrying motor fibres to supply the supraspinatus and infraspinatus muscles (Basta, Sanganerla and Varacallo 2020).

B. Axillary nerve

The axillary nerve originates from the anterior aspect of the brachial plexus. One of the branches supplies the teres minor muscle and the deltoid muscle. In comparison to the terminal branch which becomes the lateral superior brachial cutaneous nerve and supplies the upper and outer aspect of the skin over the deltoid region. The axillary nerve is composed of both motor and sensory fibres (Okwumabua and Thompson 2018). The musculoskeletal system in corporation with the nervous system creates an orchestrated biomechanical system creating a synergistic shoulder motion.

2.3. Biomechanics of the shoulder

The shoulder complex is comprised of four joints namely, glenohumeral joint, acromioclavicular joint, sternoclavicular joint and the scapulothoracic joint. Furthermore, the shoulder complex can be influenced by the sternocostal, costovertebral and sternomanubrial joints along with the muscular connections and the adjoining ligaments (Goetti *et al.* 2020; Lugo, Kung and Ma 2008). The biomechanics of the shoulder girdle, specifically the glenohumeral joint is determined by the relationship between the static and dynamic stabilizing structures (Lugo, Kung and Ma 2008). The synergistic motion of the shoulder can be interrupted by several abnormalities influencing the biomechanics. The abnormalities can be influenced by several factors i.e., overuse, trauma and age-related changes.

2.4. Pathologies of the shoulder

The organization system of shoulder disorders uses a pathoanatomical classification to sub-categorize the shoulder conditions. Codman (1934) defined the pathoanatomical subcategories utilized today specifically, rotator cuff disease, biceps tendon disease, acromioclavicular joint abnormalities, and adhesive capsulitis. In recent years the classification system has been adapted based on the origin of the condition ranging from traumatic, shoulder pain secondary disease along with nonspecific causes of shoulder pain. This specialized classification allows the condition to be treated appropriately (Zuckerman and Rokito 2011a; Lundberg 1969).

2.4.1. Adhesive capsulitis

In 1896, Duplay (1896) described the combination of shoulder pain and restriction as peri-arthritis of the scapulohumeral joint attributing to the condition of subacromial bursitis. Developing on the Duplay (1896) hypothesis, Codman (1934) termed this pathology frozen shoulder believing the condition involved non-calcifying tendinitis of the rotator cuff, and argued the calcification was caused by a different pathology. After treating several patients, Codman (1934) determined the symptoms were namely: slow onset typically insidious in nature, pain at the deltoid insertion, inability to sleep on the affected side, painful and associated with incomplete shoulder elevation, and external rotation (Lewis 2014). Neviaser (1945) suggested the term adhesive capsulitis suited the pathology better as the source of the pathology were fibrotic lesions, inflammation and capsular contracture (Neviaser and Hannafin 2010a). Adhesive capsulitis can be divided into primary or secondary adhesive capsulitis based on the presence of predisposing factors (Hand *et al.* 2007; Lundberg 1969). The secondary classification was further described as intrinsic, extrinsic and systematic categories (Zuckerman and Rokito 2011a) (shown in Figure 2.1). Zuckerman proposed pathways in which the frozen shoulder was developed from secondary factors (seen on the lines containing the stars).

Figure 1.1: Zuckerman classification of adhesive capsulitis.

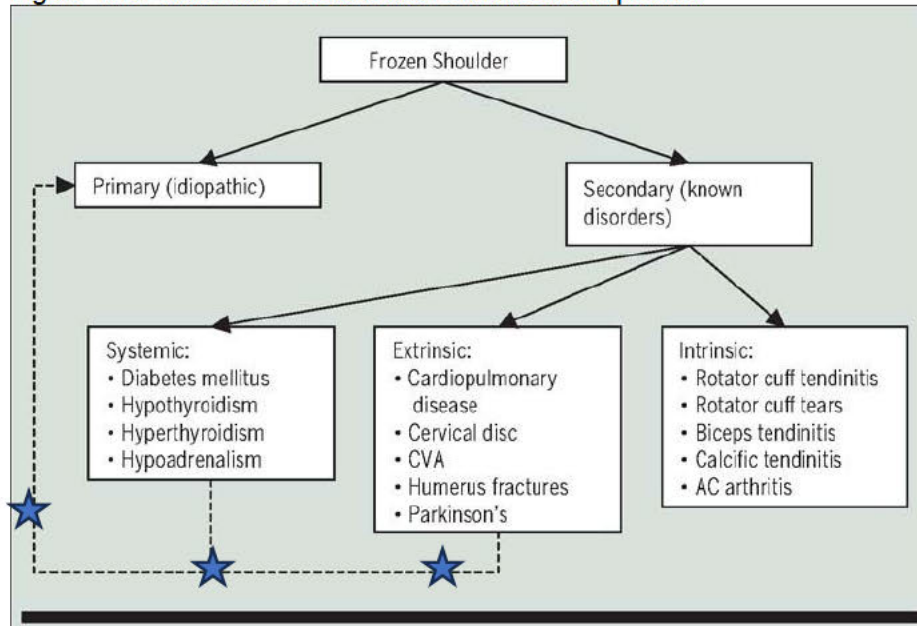


Figure 2.1 supplied by Zuckerman and Rokito (2011a).

Neviaser and Hannafin (2010b) defined adhesive capsulitis as an insidious inflammatory condition which is characterized by the gradual loss of passive and active range of motion in the glenohumeral joint often associated with pain. This is the outcome of advanced fibrosis and contracture of the glenohumeral joint capsule. The most crucial feature in the diagnosis is the loss of passive range of motion (Allen 2018), and yet there are no remarkable radiographic findings associated with diagnosing adhesive capsulitis (Zuckerman and Rokito 2011b).

2.4.1.1. Epidemiology

Adhesive capsulitis affects between two to five percent of the general population (Tighe and Oakley 2008), often affecting females between the ages of 40 to 70 years, with the peak being 56 years of age (Hsu *et al.* 2011; Ewald 2011). Females are more likely to experience this condition when compared to the male population (Mezian, Coffey and Chang 2021). The risk factors which predispose the individual to adhesive capsulitis namely include; female sex, persons over the age of 40 years, history of trauma, diabetes, hypercholesterolemia, hypertension, and positivity for HBLA-B27 (Le *et al.* 2017b; Le *et al.* 2017a; Manske and Prohaska 2008). Additionally, Kingston *et al.* (2018) reported a higher prevalence of adhesive capsulitis in individuals who are Hispanic and African American.

2.4.1.2. Pathophysiology

The exact pathophysiology of adhesive capsulitis is a mystery. Literature indicates the most common hypothesis known is initial inflammation within the joint capsule, followed by reactive fibrosis and adhesions within the joint synovial lining (Le *et al.* 2017a). The patient initially experiences pain, followed by reduced range of motion (Dias, Cutts and Massoud 2005). In this context the hallmark indication of adhesive capsulitis is contracture of the glenohumeral capsule. The pathophysiological findings included the reduction of the synovial membrane within the shoulder capsule accompanied by

adhesions in the humeral neck with a resultant reduction in the general capsular volume (Le *et al.* 2017a; Neviaser 1945).

Additionally, Hutchinson *et al.* (1998) identified a correlation between adhesive capsulitis and elevated serum cytokine levels. Cytokines are polypeptide, non-antigen specific mediators used to communicate signals between the immune system cells, various organs and tissues. The presence of elevated cytokines in individuals diagnosed adhesive capsulitis provides an indication of changes of the cells caused by inflammation and fibrosis. Subsequently, Bunker *et al.* (2000) postulated a mild lesional event could stimulate an inflammatory response thus resulting in an increased production of fibroblasts and consequently the release of collagen type one and three. The fibroblasts can differentiate into myofibroblasts which stimulate the deposited collagen type three to contract forming the adhesions responsible for decreased movement.

2.4.1.3. Aetiology/ Presentation

Table 2.6 depicts the different stages of adhesive capsulitis along with the classic presentation of the disease at the various stages.

Table 2. 6: Depiction of the various stages of Adhesive Capsulitis.

	Stage 1	Stage 2	Stage 3	Stage 4
Stage	Pre-adhesive (Pre-freezing)	Adhesive (Freezing)	Maturation (Frozen)	Chronic (Thawing)
Duration	Variable, normally less than 3 months.	3 to 9 months.	9 to 14 months.	12 to 15 months.
Disease process	Fibrotic inflammatory reaction, without the presence of adhesion.	Proliferation of the synovium and the presence of early adhesion.	Presence of mature adhesions.	Scarring present in the tissue.
Range of motion	Normal (full range of motion).	Mild reduction of the range of motion.	Notable reduction of range of motion.	Limited range of motion.
Symptoms	The presence of night pain, pain is most noticeable when the patients' arm is raised or behind their back, can often be nonspecific symptoms.	Pain is more known with active and passive range of motion.	Reduced pain when compared to the first two stages.	Can be pain free, however pain can occur with sudden movement outside the scarred capsule.

Adapted from Neviaser and Neviaser (1987).

2.4.1.4. Treatment options

The management goals of adhesive capsulitis are primarily to relieve pain, increase motion within the shoulder and restore shoulder function. The management of adhesive capsulitis is based on the stage in which the patient presents with, along with the associated co-morbidities (Floyd *et al.* 2022; Hsu *et al.* 2011). The initial treatment protocol is conservative followed by pharmaceutical and surgical based on pathology progression (Hsu *et al.* 2011). The treatment protocol can be determined by the stage of the pathology diagnosed by the clinicopathological symptoms experiences (Neviaser and Neviaser 1987; Reeves 1975). Hanchard *et al.* (2012) postulated a different classification based on the clinical

presentation of the disease, differentiating the “pain-predominant” and “stiffness-predominant” type. This classification assists in identifying the stage of the pathology and management protocol.

Levine *et al.* (2007) and Vastamäki, Kettunen and Vastamäki (2012) postulated the prognosis of conservative treatment in the management of frozen shoulder to be favourable in patients. Furthermore, the use of operative interventions are required in more severe cases. Patients diagnosed with underlying medical conditions should receive treatment for the co-morbidities, as poorly managed conditions may influence the severity of frozen shoulder (Pandey and Madi 2021).

I. The non-operative treatment of frozen shoulder include:

- A. Nonsteroidal anti-inflammatory drugs (NSAIDs) and analgesics: The primary conservative management in treating frozen shoulder is NSAIDs (D'Orsi *et al.* 2012; Tasto and Elias 2007). The use of NSAIDs reduces the pain experienced without interfering with the natural course of the pathology. The use of analgesics and NSAIDs in addition to physical therapy allow the patient to experience the activities of daily living and painless motion (Leung and Cheing 2008).
- B. Corticosteroids: The use of corticosteroids are the second most common form of conservative therapy for frozen shoulder. Pandey and Madi (2021) reported the use of corticosteroids to have favourable results in the early stages of the pathology as the inflammation will be controlled thus reducing the pain.
 - i. Oral corticosteroid usage for short durations (6-8 week period) were found advantageous in pain reduction along with improvement of range of motion and general functioning (Buchbinder *et al.* 2006).
 - ii. Local injectable corticosteroids can also be referred to as intra-articular corticosteroid injections. Subject to the presentation of the pathology, the use of local corticosteroid injectables in combination therapies can be utilized. Song *et al.* (2014) reported a promising outcome with the use of corticosteroid injections, as there was a notably immediate pain relief after the administration which lasted approximately 6 weeks. Patients diagnosed with diabetes mellitus may experience an increase in their blood glucose levels after receiving the steroid injection. However, the use of steroid injections should be avoided in patients with uncontrolled diabetes (Waterbrook, Balcik and Goshinska 2017). Common adverse effects one may experience include facial flushing, pain in the shoulder, dizziness and nausea due to a vasovagal response to the injection (Sun *et al.* 2017).
- C. Physiotherapy remains the basis for the management of frozen shoulder (Hsu *et al.* 2011), either in combination with pharmacological interventions or alone, provides the patient with beneficial results. The use of physiotherapy can be categorized into pain relieving, strengthening, mobilization and physical therapy (Pandey and Madi 2021), specifically the management will be tailored to the stage of the pathology. Physiotherapy management may incorporate physical therapy, manual therapy, electrotherapy, temperature therapy, taping, hydrotherapy, dry needling, and acupuncture. Page and Labbe (2010) reported the use of

physiotherapy beneficial in patients with frozen shoulder as they experienced pain relief along with increased range of motion. In the early stages of adhesive capsulitis, physiotherapy is the first line treatment. Green, Buchbinder and Hetrick (2003) reported limited evidence supporting the management of adhesive capsulitis by the means of physical therapy alone. However, the combination of physical therapy and other treatment modalities have proven favourable as it incorporates a multifaceted approach (Page and Labbe 2010). Page *et al.* (2014a) reported the use of low-level laser therapy to most effective in pain reduction when comparing several forms of physical therapies. Additionally, ultrasound therapy provided short term improvement of range of motion (Jain and Sharma 2014). Evidence recommending the use of TENS was in combination with other therapies but provided limited evidence (Alsubheen, MacDermid and Faber 2022; Page *et al.* 2014b; Blanchard, Barr and Cerisola 2010). The application of the modality is non-invasive and low cost when compared to the available treatments (Jones and Johnson 2009; Sluka and Walsh 2003).

- D. Hydrodilatation treatment comprises of an injection (steroid and saline solution) into the glenohumeral joint to promote the dilation of the capsule. Buchbinder *et al.* (2008) reported hydrodilatation to provide short term benefits in pain reduction and improvement in function. Complications of hydrodilatation include pain and flushing (Swaroop *et al.* 2023), dizziness and infection at the injection site (Chen, Jiang and Huang 2019).
- E. The use of self-administrated intranasal salmon calcitonin reduced the systemic inflammatory response and facilitated the release of endorphins (Sahin *et al.* 2006). Furthermore, the use of calcitonin in combination with physiotherapy and NSAIDs provides pain relief and improves shoulder range of motion when compared to studies excluding calcitonin (Cho, Bae and Kim 2019). The main source of calcitonin is salmon thus those with a seafood allergy may experience hypersensitivity response, such as bronchospasm, anaphylactic shock, tongue swelling along with urticaria (McLaughlin and Jialal 2019; Waldburger, Meier and Gobelet 1992). Intranasal administration of calcitonin may have varied adverse effects as nasal events increase with the age of the individual. However, the most common symptom reported was nausea (Peña-Rodríguez, Haro-García and Benito-Navarro 2017). The most frequent side effect of parental administration of calcitonin involves the gastrointestinal tract as the individual can experience abdominal pain and discomfort, diarrhoea and appetite loss (McLaughlin and Jialal 2019). Local inflammatory reactions are common at the site of the calcitonin injection along with general flushing and pruritis, and in some cases paraesthesia is reported in the feet and hands (McLaughlin and Jialal 2019).
- F. Extracorporeal shockwave therapy (ESWT) is a non-invasive procedure commonly known as shockwave therapy. This procedure utilizes energy sound waves via cutaneous stimulation. Chen *et al.* (2014) reported a significant improvement in activities of daily living in patients who received ESWT when compared to those who received steroid therapy alone. General complications of ESWT include namely, pain, swelling, tenderness and bruising in the application area (Roerdink *et al.* 2017).

- G. The use of acupuncture in the management of adhesive capsulitis is limited (Rangan, Hanchard and McDaid 2016), yet several studies reported favourable results (Ben-Arie *et al.* 2020; Ramirez 2019; Sun *et al.* 2001). Kim (2021) reported that after 24 sessions of acupuncture, the patient involved experienced full range of motion and absence of pain.

II. Surgical management of frozen shoulder:

- A. Manipulation under anaesthesia (MUA) is reserved for patients who do not respond to conservative management. The procedure involves gentle manipulation of the shoulder joint in planes (Melzer *et al.* 1995) under general anaesthesia (Rymaruk and Peach 2017). This procedure has been used in combination with other modalities namely; local corticosteroid injection, hydrodistension (Mun and Baek 2016) and in some instances limited capsular release (Bidwai *et al.* 2016). Studies have indicated the long term clinical outcome of MUA favourable as the patient will experience a full range of motion and experience painless living (Vastamäki and Vastamäki 2013; Farrell, Sperling and Cofield 2005). Complications of MUA include rotator cuff tear, shoulder dislocation, labral tear, humeral shaft fracture and injury to the brachial plexus nerve structure (Magnussen and Taylor 2011; Buchbinder *et al.* 2008; Hamdan and Al-Essa 2003).

Arthroscopic capsular release is a minimally invasive surgical procedure utilizing general anaesthetic to reduce tight capsular tissue surrounding the shoulder joint. During the procedure the scar tissue is surgically removed and in some instances the inflamed capsule (Kim and Lee 2015). Arthroscopic capsular release is usually used for patients who have not received relief from conservative management for one year. The clinical outcome of arthroscopic capsular release has favourable results as the participants received restoration of function and pain relief (Forsythe *et al.* 2021). Complications of arthroscopic capsular release involve the axillary nerve as the nerve lays close to the inferior glenohumeral joint capsule (Kraal, Hekman and van den Bekerom 2020). When MUA and arthroscopic capsular release were compared, Rangan *et al.* (2020) postulated arthroscopic capsular release to be more costly and present with more complications.

- B. Open capsular release is used in patients with posttraumatic or postsurgical adhesive capsulitis, who present with adhesions and contractures within the capsule (Le *et al.* 2017b). The management of adhesive capsulitis can be a conundrum especially when factors such as co-morbidities, trauma and duration of the condition are considered. It is pivotal for the practitioner to make a concise assessment and diagnosis when planning the management (Manske and Prohaska 2008).

2.5. Transcutaneous electrical nerve stimulation

2.5.1. History of Transcutaneous electrical nerve stimulation

When one injures his or her toe, it is intuitive to rub the site of pain hoping to reduce the pain. Over decades science has created various pain-relieving methods ranging from massage, acupuncture, and electrical stimulation to name a few (Chang 2020; Budh and Lundeberg 2004).

Transcutaneous electrical nerve stimulation known by the acronym TENS is a non-invasive therapeutic modality using electrical impulses to relieve pain (Teoli and An 2021; Johnson 2017). The earliest form of TENS was believed to date back to AD 60 when Scribonius Largus, a Roman physician postulated the use of “electric fish” from the ocean. It was reported that it produces symptomatic relief in patients when exposed and in contact with these fish. Johnson (2007) reported that the Egyptians in approximately 2500 B.C used electrogenic fish on painful parts of the body to relieve pain. Furthermore, historical records report the use of electrical eels being used for pain management and further ideologies of the use of electricity for pain relief (Teoli and An 2021; Johnson 2007). By the 18th century, the use of electrostatic generators assisted in electrotherapy to relieve an array of medical conditions ranging from headaches to cancer (Teoli and An 2021). However, during this time the pharmacological developments began to rise thus leading to the decline in use of the conceptual electrical therapy modalities (Johnson 2007).

In the early 1900s the development of battery powered transcutaneous electrical stimulators were produced in the United States of America. Melzack and Wall (1965) published “Pain mechanisms: a new theory”, which went on to elaborate the Gate Control Theory of pain by providing a physiological explanation of how electrical stimulation on intact skin can relieve pain (Johnson 2017). The development of the theory provided the neural foundation which reconciled the differences between the pattern and specificity theories of pain (Moayed and Davis 2013).

2.5.2. Gate control theory of pain in relation to TENS

The theory revolves around the hypothesis that there is a “gate” through which the impulses are delivered to the brain via the nerves (Treede 2016). According to the theory, the pain stimulation is transferred by fibres which are large and small (A-beta, A-delta and C fibres respectively) to the substantia gelatinosa found in the spinal cord dorsal horn and central transmission cells of the dorsal horn (T-cells). The substantia gelatinosa contains inhibitory interneurons, that act as a “gate” by determining the nerve that will deliver the signal to the T-cells. The small C fibres transfer the impulse and their activation keeps the gate open thus allowing pain signal to pass through and the brain to perceive the pain (Campbell, Johnson and Zernicke 2020). Once the A-beta fibres are activated they exhibit a presynaptic inhibition of pain impulse from the C fibres. Hence the gate is “closed” due to the inhibition of pain impulses transmitted from the T-cells. In the instance of the gate being “closed” the pain signals will be restricted from travelling up to the brain and the sensation of pain will not be felt (Campbell, Johnson and Zernicke 2020).

If the individual experiences a noxious (painful) stimulus, the application of a non-noxious (soothing) stimulus will allow the initiation of the gate control mechanism and reduce the pain perceived (Astokorki and Mauger 2017). Melzack and Wall (1965) noted when TENS was used in the management of active trigger points resulting in pain reduction, accompanied by long lasting effects. This highlighted the TENS overrode the nociceptive response to the painful stimulation. In recent times, the TENS device is a portable, non-invasive, and battery-operated unit. The unit's range between two to four electrode ports which connect the conduction pads to the surface of the patient's skin, transferring the electrical stimulation to the area required (Johnson 2007).

2.5.3. Mechanism of TENS

The various mechanisms of TENS are outlined in Table 2.7 below, along with the various settings associated with the physiological intervention and clinical technique used to obtain the best outcome. There are various forms of TENS which have different physiological interventions based on their respective clinical techniques. The most commonly used technique is conventional TENS. The table below outlines the various types of TENS along with the physiological and clinical application.

Table 2. 7: Table depicting the various types of TENS

	Physiological intention	TENS settings	Electrode placement	Analgesic effect	Patient experience
Conventional TENS	Activation of large diameter non-noxious afferents allowing segmental analgesia, i.e., "close the gate".	<u>Frequency</u> : 50-100 Hz <u>Pulse width</u> : 50-200 μ s. Low intensity (amplitude)/high frequency. To be used when pain is experienced.	Sites of the pain, dermatomes.	Can be an immediate onset and offset.	"A strong but comfortable TENS paraesthesia".
Acupuncture-like TENS	Muscle twitches allow the activation of the small diameter motor afferents to stimulate extra-segmental analgesia.	<u>Frequency</u> : 1-5 Hz <u>Pulse width</u> : 200-400 μ s. High intensity/low frequency. To be used for 20–30-minute sessions.	Acupuncture points, myotomes, affected muscles, motor nerve and site of pain.	Can be a gradual or delayed onset and offset.	"A strong but comfortable muscle contractions".
Intense TENS	Activation of the small diameter noxious afferents to produce peripheral nerve blockade and extra-segmental analgesia.	<u>Frequency</u> : 80-150 Hz <u>Pulse width</u> : 200-250 μ s High intensity/high frequency. To be used in short sessions of 5-15 minutes.	Site of pain, dermatomes, nerves proximal to the pain.	Immediate onset and delayed offset.	"Maximum tolerable (painful) TENS paraesthesia".

The information from above is adapted from Johnson (2007), Vance *et al.* (2014), Johnson and Tabasam (2003).

A. Segmental mechanisms

Animal studies indicated the use of TENS reduced the nociceptive activity and sensitization in the central nervous system when used on the somatic receptive fields. The activation of the A-delta cells was hypothesized to reduce the central nociceptive pain activity for 2 hours (Johnson 2007; Sluka and Walsh 2003).

B. Extra-segmental mechanisms

The use of TENS in the A-delta cells stimulated the descending inhibitory pathways (midbrain periaqueductal grey and rostral ventromedial medulla) along with the inhibition of descending pain facilitatory pathways (Johnson 2007). In participants with adhesive capsulitis, TENS will block the nerve impulses and increase the endorphin level, thus positively influencing the pain perception of the patient (Vance *et al.* 2022).

C. Peripheral mechanisms

The antidromic stimulation of the peripheral nerves by TENS produces impulses hypothesized to collide and extinguish the afferent impulses of the peripheral nerve structures. The peripheral blockade of nociceptive impulses is likely to occur when the TENS stimulates the A-delta fibres (via intense TENS settings). In the application of conventional TENS, the TENS-stimulated activity of the large diameter afferents will inhibit the afferent activity of the large diameter fibres, thus contributing to the reduced pain perception (Johnson 2007). Vance *et al.* (2014) determined the administration of high frequency TENS in animals with tissue injury, resulted in an increase in the dorsal root ganglia neurons following the reduction of Substance P levels. Furthermore, blockage of the peripheral opioid receptors prevents the analgesia produced by the low frequency TENS.

D. Neurochemicals/ neurotransmitters

The application of TENS provides pain relief in individuals through the stimulation of various neurochemical and neurotransmitter pathways of the nervous system. The neurochemicals influenced include opioids, serotonin, acetylcholine, norepinephrine, and gamma-aminobutyric acid (GABA). The physiological response of TENS initiates the activation process of the opioid receptors (mu and delta opioid receptors), followed by the GABAergic and serotonergic systems, and lastly the excitatory neurotransmitters (such as aspartate and glutamate) (Johnson 2007; Sluka and Walsh 2003). The various TENS settings can provide specific physiological responses; these are briefly described below:

- Serotonin and GABA modulation

The application of TENS influences the release and receptor activity of serotonin (5-HTP), specifically 5-HTP2 and 5-HTP3 receptors. Furthermore, the release of GABA occurs in the role of the inhibitory neurotransmitter (Johnson 2007),

The use of low frequency TENS activates the mu-opioid receptors, thus the release of serotonin in the spinal cord activates the GABAergic neurons and reduces the pain transmission or perception (Maeda *et al.* 2007).

- Opioid system involvement

The application of low frequency TENS provides stimulation to the mu-opioid receptors, comparatively the application of high frequency TENS stimulates the delta-opioid receptors. Both the mu and delta-opioid receptors are involved in pain modulation and pain relief when activated by the use of TENS.

- Peripheral and central mechanisms

The peripheral mechanism of TENS activates both the opioid and adrenergic receptors, thus reducing Substance P. In the spinal cord, TENS activates the opioid, GABAergic, serotonergic receptors along with the excitatory neurotransmitters. In the brain, the application of TENS activates the opioid receptors within the pain-modulating regions of the brain, such as the periaqueductal gray (PAG) and rostroventromedial medulla, thus influencing the descending pain inhibitory pathways, resulting in the reduction of pain sensation.

2.5.4. Factors influencing the efficacy of TENS

A. Settings of the TENS

i. Intensity of the stimulation (amplitude)

In order to create an analgesic effect, the amplitude of the TENS needs to be at a sufficient strength (Johnson 2007). The TENS should be at a “strong, but comfortable” setting to provide the best analgesic effect. In comparison to instances when the settings were at or below the sensory threshold the effect was unsuccessful (Sluka *et al.* 2013). Thus, it is postulated that the amplitude be increased to an adequate level allowing analgesic effects. The use of high frequency TENS stimulates non-painful paraesthesia. Comparatively, the use of low frequency TENS is applied at higher intensities which stimulate motor fibres. It is important to note that the use of TENS at a higher intensity may not be well tolerated by some patients (Sluka *et al.* 2013). Pantaleão *et al.* (2011) reported in a single session using the test that the analgesic effect was greater when the TENS intensity was adjusted throughout the session, as it adapted the patients perceptual- sensory of the TENS sensation.

ii. Stimulation of frequency

The use of different stimulation frequencies allow the activation of different mechanisms. Chandran and Sluka (2003) postulated that the repeated use of TENS is likely to produce analgesic tolerance. Therefore, the use of mixed TENS may provide a better outcome. In the instance of the patient taking opioids, modulating the TENS settings between a high and low setting will delay opioid tolerance (Desantana, Santana-Filho and Sluka 2008). Furthermore, the use of only high frequency TENS is more apt to be more effective in patients who are using opioid analgesics when compared to low frequency TENS (Sluka *et al.* 2000).

B. Repeated use

Analgesic tolerance was produced after having a repeated application of TENS at the same frequency, intensity, and pulse duration daily (it can be either high frequency or low frequency) (Liebano *et al.*

2011; Chabal *et al.* 1998a). Chabal *et al.* (1998a) stated the use of low-frequency analgesic tolerance resulted in cross tolerance at mu-opioid receptors in the spinal cord and the use of high-frequency TENS results in cross tolerance of the delta-opioid receptors in the spinal cord in animals (Vance *et al.* 2014).

C. Long term use

Most of the trials viewed evaluated the use of TENS in situations of short-term use (i.e., for a set duration, or a pre/post-test evaluation). There are several studies (Carroll *et al.* 2001; Chabal *et al.* 1998b; Fishbain *et al.* 1996) which have identified the long-term use (approximately over six months) have shown a reduction in pain previously experienced, analgesic use, and pain on activities. An increase in the activities was also noted (Chabal *et al.* 1998a; Fishbain *et al.* 1996).

D. Interactions with pharmacological agents

The use of TENS produces the activation of opioid receptors in the central nervous system. The use of high frequency TENS stimulates the delta-opioid receptors, and the use of the low frequency TENS stimulates the mu-receptors (Sluka *et al.* 2013). Clinically, opioid analgesics require the use of mu-receptors to produce the desired effects. In the instance of the opioid tolerance, a low frequency TENS would be ineffective whereas the use of high frequency TENS will be successful (Sluka *et al.* 2013).

E. Placement of electrodes

The electrodes should be positioned on healthy intact skin. The electrode pads can be placed on dermatomes which will direct paraesthesia to the affected area. A few exceptions may include:

- Aggravation of pain resulting in hyperaesthesia and allodynia (mechanical),
- Phantom limb pain (absence of a body party), damaged or frail skin or,
- Hypoesthesia due to the TENS not being effective and may result in skin irritation due to the high intensity settings used (Johnson 2007).

Vance *et al.* (2014) reported there was a lack of consistency in clinical studies regarding the electrode placement and homogeneity throughout each investigation. The evidence supporting the use of TENS, specifically the electrode placement was limited and inconsistent (Page *et al.* 2014a) when compared to the evidence in support of TENS in generalised shoulder pain (Teoli and An 2021; Lin *et al.* 2019). Lin *et al.* (2019) discussed the application of TENS and Transcutaneous Pulsed Radiofrequency (TPRF) for generalised shoulder pain. The application comprises of two electrodes, one placed proximally at the site of the most tender and the other placed distally close to the inferior margin of the deltoid muscle on the same shoulder. Dewan and Sharma (2011) applied four electrodes on either the acupuncture points of the shoulder or the motor points of the shoulder. However, the names of the acupuncture points were not documented.

2.5.5. Clinical effectiveness of TENS

Johnson (2007) suggested the use of TENS is likely to assist in acute and chronic pain (of either nociceptive, neuropathic, or musculoskeletal conditions). The clinical effectiveness of TENS can be influenced by the dosage administered (via intensity, frequency, pulse, and time). The patients who are new to using the TENS device should be given a supervised trial, to allow for troubleshooting errors and correct guidance in the use of the device based on the condition at hand (Jones and Johnson 2009). However, studies were inconclusive with those investigating adhesive capsulitis, as the use of TENS was done under the supervision of a trained physiotherapist (Faruqui *et al.* 2015; Celik 2010; Carette *et al.* 2003).

Chabal *et al.* (1998b) reported the long-term use of TENS was associated with a significant reduction in the use of pain medication along with health services (physiotherapy and occupational therapy). Furthermore, it was postulated the potential use of TENS in combination with the reduction in medication costs and adverse effects may influence the future of pain management (Chabal *et al.* 1998b). Recently, the manufacturing costs were reported to be lower and have a lower power consumption, allowing the long-term use to be effective in many communities (Tashani and Johnson 2009). With the progression of technology, the devices can be controlled wirelessly via smartphones in the future (Ursache *et al.* 2021). Topuz *et al.* (2004) reported the use of TENS (at both high and low frequency settings) improved physical motion, emotional well-being, and reduced the pain experienced.

The literature in support of the use of TENS in the management of adhesive capsulitis differs. However, most of the evidence utilized TENS as an additional intervention rather than it alone. Carette *et al.* (2003) and Celik (2010) utilized TENS amongst the patients involved in the study along with other modalities such as temperature therapy, soft tissue therapy and pharmaceutical interventions. Calis *et al.* (2006), Maryam *et al.* (2012) and Park, Lee and Kim (2014) included TENS as part of the physiotherapy treatment for the “physiotherapy” intervention allocation; which went on to show promising results. Rizk *et al.* (1983) reported that the use of TENS provided an increased range of motion in patients diagnosed with adhesive capsulitis when compared to those who received combination therapy of heat, exercise, and manipulation. The lack of clinical application in the literature supported the need for this systematic review, as articles provided the use of TENS in the management of adhesive capsulitis favourable (Page *et al.* 2014a; Johnson *et al.* 1989) but lacked the information regarding settings, electrode placement and the use of the modality in combination with other interventions or alone.

2.5.6. Conditions managed by the use of TENS

With the non-invasive and portable design, TENS has been used to manage a variety of conditions regarding pain management. Johnson, Ashton and Thompson (1991) reported the onset of analgesia when using TENS is almost immediate from the initiation of the stimulation, and thereafter last for a few hours (DeJesus *et al.* 2023). In addition, the efficacy of the treatment may vary based on the stimulus preferred by the patient and their rate of compliance.

A. Clinical indications of TENS

Chronic condition management with TENS has been researched to verify the effectiveness of treatment. The use of TENS in the treatment of acute conditions such as pain related to musculoskeletal conditions and dysfunction was deemed effective (Maayah and Al-Jarrah 2010). Several systematic reviews and meta-analyses have evaluated the efficacy of reduction of pain in individuals with chronic neck pain (Martimbianco *et al.* 2019), post-operative pain (Kerai *et al.* 2014), cancer pain (Singh and Chaturvedi 2015; Hurlow *et al.* 2012), labour pain (Francis 2012), acute pain (Johnson *et al.* 2015), low back pain (Binny *et al.* 2019), osteoarthritis pain (Wu *et al.* 2022) and dysmenorrhea (Arik *et al.* 2022).

Examples included in these systematic reviews included the use of TENS in the management of labour pain was deemed to be effective in the first two stages of labour. When the electrodes were applied to the skin superficially next to the lumbar sacroiliac region, the stimulation corresponded to the nociceptive afferents, thus reducing the pain experienced (Francis 2012; Jones and Johnson 2009). Post-operative pain can be managed by TENS, although there are conflicting results regarding the efficacy. Bjordal, Johnson and Ljunggreen (2003) reported reduced postoperative pain along with the analgesic sensation experienced, thus reducing the amount of analgesic medication used. In acute non-postoperative pain, the use of TENS was reported to clinically reduce pain when compared to placebo intervention (Barker *et al.* 2006). Similarly, several studies have reported that TENS can be effective in managing diabetic peripheral neuropathy, as the pain experienced was reduced and the quality of life improved (Jin *et al.* 2010; Jones and Johnson 2009). The reduction of pain with comfortable high frequency TENS is effective for both resting and movement pain in people with fibromyalgia (Carbonario *et al.* 2013; Löfgren and Norrbrink 2009). The cost effective, non-invasive nature of the TENS enables patients to manage their pain without the supervision of a medical practitioner. The analgesic properties of TENS can reduce the patients need for pharmaceutical interventions (Vance *et al.* 2014).

B. Contraindications of TENS

In current times healthcare providers use evidence informed practice whereby the patient is informed of all the available treatment methods and involved in the management of the condition (Kumah *et al.* 2022). In instances whereby the patient is a minor, specifically below the age of four, they should not be advised to use TENS as the child is unable to comprehend the instructions (Jones and Johnson 2009). Similarly, patients who are incoherent, incognizant or incapable of making their own medical decisions, the use of TENS is ill advised (Kluge 2008).

The use of TENS in patients with cardiovascular conditions and cardiovascular implants is not advised. Research has indicated the use of TENS may interfere in the functioning of a pacemaker or implant. Rasmussen *et al.* (1988) indicated the use of TENS in the patients with pacemakers to be safe considering the position of the electrodes should not lie on the side of the pacemaker, rather parallel to it. The use of TENS can be used successfully in the management of angina when the electrodes are placed on the chest under the supervision of a cardiologist (Jones and Johnson 2009). Hsieh *et al.*

(2021) postulated the use of TENS in patients with cardiac conditions to influence the heart rhythm by potentiating the cardiac vagal tone.

There are possibilities of the electrodes causing an irritation or skin dermatitis beneath the electrodes (Johnson 2007). TENS should not be applied to the skin if there is nerve damage or diminished sensation, due to the patient not being able to perceive the impulses sent by the TENS often causing skin irritation (Jones and Johnson 2009; Johnson 2007).

The TENS electrode placement should not be placed on the face or skull, anterior neck or on the chest. Placement of the electrodes on the anterior neck as it may cause a spasm or the hypotensive response (Jones and Johnson 2009). In the instance of the electrodes are placed on the face, especially in the ocular region the intraocular pressure may increase. The intercostal muscles can be compromised with the use of electrode placement on the chest thus influencing pulmonary functioning. Patients diagnosed with epilepsy should not have electrodes placed on the head or neck as the possibility for TENS to induce seizures are likely in those post-stroke (Jones and Johnson 2009).

Searle *et al.* (2009) reported positive outcomes in the management of cancer bone pain using TENS correctly. With the correct patient education/electrode placement, there will be a reduction in pain experienced and analgesic effects beneficial to the patient (Loh and Gulati 2015). The TENS electrodes should not be placed directly over the active malignancies as the stimulation may influence the malignancy growth (Jones and Johnson 2009). The evidence regarding the application of TENS in adhesive capsulitis will be discussed in the Sixth Chapter.

2.6. Systematic review

The purpose of a systematic review is to examine available literature in a structured way so that it can provide a clear and reliable summary of evidence in the field of interest (Liberati *et al.* 2009). The goal of a systematic review is to provide a summary of evidence to health practitioners of high quality and relevant information without bias (Cumpston *et al.* 2019). This is achieved by a well-defined and rigorous approach to evaluating the articles for critical appraisal of available evidence (Moher *et al.* 2009).

2.6.1. The process of conducting a systematic review

A systematic review requires a well-defined protocol in order to gather articles relevant to the topic of interest and the review process. The protocol should be outlined prior to the commencement of the review process, allowing for transparency, accountability and integrity in the research process as the involved parties are in agreement to the process (Moher *et al.* 2015).

Hemingway and Brereton (2009) postulated there are five steps in conducting a systematic review, these steps are in place to maintain the scientific rigor of the investigation and maintain transparency throughout. The steps are discussed briefly below and further elaborated in the third chapter in terms of the methodology followed while conducting the systematic review.

The first step of a systematic review process is to define an appropriate healthcare question. This step may include a list of objectives and aims, population groups, interventions, studies along with the eligibility criteria (Higgins, Altman and Sterne 2011; Higgins and Green 2011).

The second step of the systematic review process is to undergo a review of the relevant literature. To maintain an unbiased investigation several databases should be utilized. In this instance namely, PubMed, CINAHL, Google Scholar and SCOPUS were used. All forms of data were sorted and filtered for relevance relating to the research question. The databases were searched using the key terms to prevent selection bias in the study. In the instance of the researcher's ability to translate non-English articles, the articles would be accepted into the investigation (Harris 2014; Higgins and Green 2011). Should the journal not be electronic, the researcher can undergo hand searching for relevant articles in this step and the references for full text papers further searched. This step has the potential for various biases namely, language bias, publication bias and selection bias (Hemingway and Brereton 2009; Dubben and Beck-Bornholdt 2005; Delgado-Rodriguez and Llorca 2004).

The third step of a systematic review process involves the assessment of the relevant studies which were found in the literature search. This step involves the researcher looking at the relevant studies in the following manner: eligibility criteria and full text articles for those which meet the criteria, the critical appraisal of the framework of the studies, and finally those meeting the requirements to be placed on a separate "master list" which is reviewed by two independent reviewers (Hemingway and Brereton 2009; Delgado-Rodriguez and Llorca 2004).

The fourth step in the systematic review process involves combining the results from the reviewers. The results of the two independent reviewers and the researcher are collated to provide an unbiased evidence-based answer to the research question. The collation of findings in this stage is known as evidence synthesis. This will provide an answer to the research question in terms of clinical effectiveness, feasibility, suitability, and importance regarding its contribution to healthcare (Hemingway and Brereton 2009).

The final step in the systematic review is placing the research findings in a relevant context. This involves the discussion of the results obtained in step four and identification of any inconsistency regarding the results reviewed. The researcher addresses the quality and heterogeneity of the studies included, and the possibility of bias impacting the outcomes. Furthermore, the application of the results pertaining towards the healthcare sector, namely towards the research question (Hemingway and Brereton 2009).

Systematic reviews aim to identify, evaluate, and summarize the findings of the relevant studies, in so doing making the evidence accessible to healthcare professionals and patients alike. Systematic reviews adhere to a specific scientific design based on guidelines, thus providing valid and reliable evidence. Furthermore, when conducted correctly, can provide accurate medical evidence to healthcare practitioners and patients, which will enable evidence informed decision making in the healthcare sector (Higgins, Altman and Sterne 2011; Moher *et al.* 2009).

2.6.2. Levels of evidence

The table (Table 2.8) below illustrates the hierarchy of various studies according to the level of evidence (validity of results) that are produced respectively.

Table 2. 8: Levels of Evidence

Level I	Systematic reviews, meta-analyses, randomised controlled trials
Level II	Two groups, non-randomised studies (i.e., case control and cohort)
Level III	One group, non-randomised studies (i.e., pre-test and post-test)
Level IV	Descriptive studies that include analysis of the outcome (case series)
Level V	Case reports, expert opinions; evidence based on physiology, or bench research

Adapted from Sackett *et al.* (2005) and Burns, Rohrich and Chung (2011).

2.6.2.1. Evaluation of the evidence

Adhesive capsulitis will be discussed and graded according to the grading system. Each of the grading systems rank evidence based on a specific domain:

- A. Foley *et al.* (2003) grading system encompasses a scoring system subdivided into levels of evidence, allowing the evidence gathered to be classified supportive or otherwise. The criteria Foley *et al.* (2003) encompasses a scoring system used in shoulder rehabilitation and post stroke context. The scoring system can only be utilized in the randomised controlled trials.
- B. GRADE system (Guyatt *et al.* 2011) presents a level of complexity in the scoring system. The criteria of the GRADE system contain four levels of evidence (i.e., high, moderate, low and very low), characterising the article in support of the research question or otherwise. The GRADE system domain is for clinical interventions and practice.
- C. Dagenais and Haldeman (2011) comprises of a scoring system divided into six levels of evidence, characterising the article in support of the research question or otherwise. Dagenais and Haldeman (2011) stated the six levels of evidence to be: strong, moderate, limited, consensus, conflicting and no evidence. Due to the nature of the scoring system being allowing, the domain is for manual therapy. The use of the scoring system was utilized in the fifth chapter, whereby the articles were scored based on the Dagenais and Haldeman (2011) as per the study design (i.e., RCT, nRCT and observational studies).

In comparison to the GRADE system, most evidence in healthcare utilise either Foley *et al.* (2003) and Dagenais and Haldeman (2011) due to the simple ranking system. Both Foley *et al.* (2003) and Dagenais and Haldeman (2011) allow the researcher to identify whether the evidence is in support of the research question, therefore highlighting the availability of evidence.

2.6.3. Factors affecting the systematic reviews:

2.6.3.1. Biases

As mentioned above, the possibility of bias can impact the quality of the evidence evaluated and reported. English being a universal language was the primary language when searching for the articles for review, along with the communication protocol used by the researcher to communicate with the reviewers.

A. Publication bias

Publication bias is defined as the selective publication or non-publication of research conclusions based on significant, nature and directions of the outcome (Chan and Altman 2005). Publication bias represents a concern as positive outcome studies tend to have preferential submission for the publication (Callaham *et al.* 1998), and tend to appear more frequently in English journals.

B. Language bias

In a systematic review it is difficult to limit language bias with majority of the publications available being mainly in English (Stern and Kleijnen 2020; Egger *et al.* 1997). The articles included into this investigation were required to be in the English language or translated into the English language. Furthermore, the reviewers involved in the systematic review were required to be English speaking as it would aid in communication.

C. Selection of studies (inclusion criteria-based bias)

The selective reporting of some outcomes or analyses and excluding others depended on the nature and direction of the desired results. Evidence selection bias can occur in a systematic review when all the available data on the topic is not identified. This form of bias can be influenced by publication bias where the information regarded statistically irrelevant is likely to be excluded (Drucker, Fleming and Chan 2016).

D. Reviewer bias

Three reviewers were used in the investigation to reduce the possible occurrence of bias. Belur *et al.* (2018) postulated bias can occur in instances when the selected reviewers review their own articles which may influence their opinion negatively or positively.

E. Mismatch between reviewing tool and study

This systematic review opted to use several tools based on the designs of the studies investigated. Articles noted as randomised controlled trials (RCTs) employed the PEDro Scale (Sherrington *et al.* 2000), non-randomised controlled trials (nRCTs) used the Newcastle-Ottawa Scale (NOS) (Zeng *et al.* 2015). Observational studies (case studies and case reports) made use of the Liddle Scale (Liddle, Williamson and Irwig 1996).

This phenomena was seen with two cohort studies namely; Shetty and Shah (2020) and Metgud, Naik and Heggannavar (2017) whereby the study identified as the methodology of a nRCT study design but

failed to fulfil the criteria of the NOS as it was not the nRCT method followed. In this instance, Metgud, Naik and Heggannavar (2017) was evaluated as per the Liddle Scale and Shetty and Shah (2020) per the NOS. These two studies are discussed in detail in the fourth chapter.

F. Reporting bias

Reporting bias is a misrepresentation of information gathered from the research caused by selective disclosure or concealment of the information (Higgins and Green 2011). When presenting the outcomes, the information is to be stated from the data collection tools and the analyses be consistent in their application of the principles accompanying the reported study limitations (Kirkham *et al.* 2010). The use of several ranking systems will be utilized to allow clear information interpretation along with relevant scales per the allocated articles.

2.6.4. Tools utilised in the systematic review:

2.6.4.1. Systematic analysis of randomised controlled studies (RCT's)

In systematic reviews, which are conducted on randomised controlled trials (RCT's), there are several scales usually used for the analysis namely; Jadad scale, Delphi List, PEDro Scale and the Downs and Blacks (Armijo-Olivo *et al.* 2015; Maher *et al.* 2003). In this dissertation the PEDro Scale was used as it provided "fair to substantial" levels of reliability and "fair to good" levels of validity when evaluating the RCTs (Olivo *et al.* 2008; Maher *et al.* 2003). The PEDro Scale was identified to be a scale that measured the methodical quality of the RCT studies as it was subjected to parametric statistical analysis (de Morton 2009). The PEDro Scale included eleven criterion categories (see Appendix H), each to be applied to appraise the methodological rigour of the RCT under evaluation. A detailed outline of the PEDro Scale can be found on Appendix H and the application seen in the Appendix L.

2.6.4.2. Systematic analysis of non-randomised controlled trials (nRCTs)

There are numerous scales used to evaluate the validity of nRCTs, however in this dissertation the Newcastle-Ottawa Quality Assessment Scale (NOS) was used (Wells, Shea and O'Connell 2003). The Cochrane collaboration accepted and used the NOS in the assessment of cohort and case controlled studies (Higgins and Green 2011).

The scale is divided into three sections-selection, comparability, and exposure. Within the three sections there are subsections (eight in total). Points are awarded for each subsection with a maximum of two points per subsection under the comparability section, and one point for the selection and exposure sections. The study evaluated can be awarded a maximum of nine points in total (Higgins and Green 2011; Wells, Shea and O'Connell 2003). Wells, Shea and O'Connell (2003) reported should the score be nine points in total, the study would have attained a high level in methodological rigour.

2.6.4.3. Systematic analysis of case studies and observational studies

The Method for Evaluating Research and Guideline Evidence (MERGE) was founded by the Cochrane Collaboration, New South Wales Health department along with several practitioners (Liddle, Williamson and Irwig 1996). The Liddle Scale comprises of criteria in a question form which allows the reviewer the

opportunity to identify potential bias in the study design and evaluate the study. The Liddle Scale comprises of twelve individual criteria, which will be ranked according to the requirements (from A to B1, B2, C and I, specifically strongest to weakest) (Liddle, Williamson and Irwig 1996).

2.7. Conclusion

Following the overview of the effort to address adhesive capsulitis along with the description of TENS, this systematic review used the PEDro, NOS and Liddle Scales to assess the use of TENS in the management of adhesive capsulitis. A well-defined and clearly outlined protocol was used to answer the study questions (see Chapter Three).

Chapter Three: Methodology

3.1. The introduction

The third chapter provides insight into the methodology used in this systematic review process. This chapter outlines the research design; permissions and the procedure followed in this systematic review.

3.2. The research design

This study followed the design of a systematic review looking at the effectiveness of TENS therapy in the management of adhesive capsulitis (Higgins and Green 2011). A mixed methodology was utilized in this systematic review, incorporating both qualitative and quantitative data analysis (Seers 2015; Lefebvre *et al.* 2011) which evaluated the methodological rigour (the level of evidence provided an individual article). The systematic review critically evaluated the structure of the studies conducted by reviewing the internal and external validity of the studies (Higgins and Green 2011). This was in line with the PRISMA-P and Cochrane collaboration guidelines for systematic reviews (Lefebvre *et al.* 2011; Liberati *et al.* 2009).

3.3. Permissions:

- Permission to proceed with the study was granted by the Faculty Research Committee (FRC) of the Durban University of Technology (DUT) (see Appendix A).
- Copyright permission was gained from Dramatic, Artistic and Literary Rights Organization (DALRO) for the use and distribution of articles included in the study (see Appendices B and C).
- Registration of the systematic review with the international prospective register of systematic review (PROSPERO) (PROSPERO ID: CRD42021225175) was attained (see Appendix D).
- Agreement from the reviewers to participate in the study was formalized by the means of a Memorandum of Agreement (MoA) (see Appendix E).
- Letter of approach to the reviewers to participate as a reviewer (Appendix F).

3.4. Location of the study:

This systematic review was conducted on the premises of DUT using the journal articles which were acquired from the online databases with the reviewers located at their respective sites.

3.5. Advertising

No advertising was required for this study as there was no need for patients. The participants specifically, the reviewers, were selected and approached by the researcher, after having met the criteria requirements stipulated for reviewer eligibility (Section 3.8).

3.6. Sample

To obtain a data sample a systematic article searches, and review was undertaken. This process is outlined in the following steps and in the PRISMA flow diagram (see Appendix G).

3.7. Literature search

A literature search was conducted on several search engines and databases viz., PubMed, Google Scholar, Cochrane reviews, Cochrane reviews database, the Cumulative Index to Nursing, Allied Health Literature (CINAHL) and SCOPUS.

The initial literature search was conducted between May 2020 and July 2020 and yielded 4120 published articles. The second, updated literature search was conducted between June 2022 and August 2022, which identified 310 additional published articles after excluding all records retrieved from the initial search.

A literature review was conducted on numerous databases and search engines (PubMed, Google Scholar, Cochrane reviews, CINAHL, SCOPUS, Cochrane reviews database) utilising the key search terms to obtain the relevant published articles meeting the established inclusion criteria. The search was conducted on the following keywords: “adhesive capsulitis”, “shoulder adhesive capsulitis”, “frozen shoulder”, “shoulder pain”, “transcutaneous electrical nerve stimulation”, “TENS” and “electrical stimulation”. In accordance with the inclusion/exclusion criteria, the search produced 4 430 citations (Google scholar-128 citations, PubMed-2 628 citations, Cochrane reviews-478 citations, CINAHL-62 citations and SCOPUS-1 134 citations). An illustration of the literature search is documented in the PRISMA flow diagram (Appendix G).

3.7.1. Sample characteristics

3.7.1.1. Inclusion criteria

- Relevant published articles were required to be available in electronic format. This allowed citations to be reflected on the electronic searches (Higgins and Green 2011).
- The published articles were required to be in English or translated into English, in order to reduce translation errors that could affect the outcomes of the review process (Harris 2014).
- The published articles were required to have one or more of the following keywords: “adhesive capsulitis”, “shoulder adhesive capsulitis”, “frozen shoulder”, “shoulder pain”, “transcutaneous electrical nerve stimulation”, “TENS” and “electrical stimulation” in either the title, abstract and/or the contents of the article.
- RCT, nRCT, and CR/CS were included in this study, as well as grey literature that conformed to one of these designs (Moher *et al.* 2015; Hemingway and Brereton 2009; Liberati *et al.* 2009).
- Only articles where the intervention was applied to an adult, human subject(s) were included in the study.

3.7.1.2. Exclusion criteria

- Published articles that were unobtainable through electronic databases or through the available interlibrary loans system, opinion paper, web-based article or unpublished article (Mahood, Van Eerd and Irvin 2014).
- Previously conducted systematic reviews and literature reviews, or articles containing expert opinions, narrative reviews, blogs, gazettes, and guidelines (Harris 2014). Thus, any publication

outside of randomized controlled trials (RCT), non-randomized controlled trials (nRCTs), case studies and case reports (Moher *et al.* 2015; Liberati *et al.* 2009).

- Studies conducted on animal models.
- Non-English language articles due to budgetary constraints (discussed in detail in the sixth chapter).

3.7.2. Steps involved in setting up this systematic review

3.7.2.1. Citation selection

The citations along with the abstracts attached were uploaded to EndNote (the citation manager used for the study) thereafter a duplication search was conducted and resulted in the exclusion of 148 citations, leaving 4 282 citations remaining. See Appendix G for the PRISMA flow diagram.

3.7.2.2. Screening of the selected citations

Screening of the full titles and abstracts of the citations according to the inclusion/exclusion criteria resulted in the exclusion of 2 781 for not meeting the eligibility criteria (among them animal-based studies, clinical guidelines and reviews and analyses). See Appendix G for the PRISMA flow.

3.7.2.3. Articles obtained

Full text articles were obtained for 1 501 articles. However, 1 438 full text articles were excluded for not meeting the eligibility criteria. The total number of full text articles eligible was 63. See Appendix G for the PRISMA flow.

3.7.2.4. Selecting the final number of articles included

The full text articles were analysed according to the eligibility criteria, and 39 articles were excluded as they did not meet the scope of the study. The master list contained 23 articles (see Appendix K for the master list of articles).

3.7.2.5. The Faculty of Research Committee's approval of this study

On the 07 December 2020 FRC gave approval for this study (Appendix A). This represented the starting point of the PROSPERO registration. Once the reviewers signed the MoA (Appendix E) and officially participated in the study, they had the option to advocate for the inclusion or exclusion of articles within the study. Based on their rationale and meeting of the eligibility criteria, the articles were either included or excluded accordingly. A further 2 articles were included as a hand search and reviewer submission. With the input of the reviewers, a total of 23 full text articles were included making the final master list 23 articles. See Appendix G for the PRISMA flow diagram.

3.7.2.6. The reviewers

Upon approval of the PG2a by the Faculty Research Committee (Appendix A), the selected reviewers were contacted by email to establish their interest and availability to participate in this systematic review.

The email contained a covering letter approaching the reviewer personally to participate in the systematic review as a prospective reviewer (see Appendix F: Letter approaching the selected reviewer).

The letter contained the following points:

A point of commonality with the reviewer (e.g., reference to an article the potential reviewer was involved in or the area of interest of the reviewer).

- Introduction to and description of the study.
- The research procedure (the role and expectation of the approached reviewer).
- Procedure of anonymity, confidentiality, and blinding.
- Requirements of the approached reviewer (copy of their curriculum vitae and/or a bio-sketch to verify their qualifications).

Upon confirmation that the potential reviewer agreed to be a reviewer, the researcher emailed the reviewer the memorandum of agreement (see Appendix E: MoA). On receipt of the MoA, the reviewers had an opportunity to read and sign the agreement, which contained the following information:

- Introduction and description of the study.
- The research procedure (the role and expectation of the reviewer).
- Procedure of anonymity, confidentiality, and blinding.
- Procedure for resolution of possible reviewer inconsistencies.
- Projected timelines for the steps in the review process.

With the aim of ensuring the reviewers met the qualification requirements and maintained consistency, upon acceptance of the position the reviewer was requested to attach their curriculum vitae or a bio-sketch to the MoA (Appendix E).

Once the MoA was signed it was required that the document be sent back to the researcher in PDF format and a copy of their curriculum vitae or bio-sketch attached. Once the signed MoA was received by the researcher and PROSPERO registration was attained, the reviewer was sent the allocated articles and corresponding review scales (Peterson *et al.* 2011; Wells, Shea and O'Connell 2003; Liddle, Williamson and Irwig 1996; Williamson 1991).

The reviewers had an 8-week period to review their allocated articles. The reviewers were requested to confirm the receipt of the initial email with the allocated articles. Follow up reminder emails were sent at periodic intervals to remind reviewers of the deadlines and the check in to assist with any questions or queries (at week 3 and 6, with final submissions at week 9).

3.8. Reviewers

The researcher approached potential reviewers who met the study requirements, of which some were accepting, and others declined the invite. This process continued until the required number of 6 reviewers was met. Further details of the reviewers accepting are seen in Table 3.1 and 3.2.

Table 3. 1 :Table of the reviewers (including the researcher).

Article review group	Reviewer	Master's Qualification	PhD Qualification	Academic	Clinical	Research
A1	Reviewer 1		X	X		X
A2	Reviewer 2	X			X	
B1	Reviewer 3		X	X		X
B2	Reviewer 4	X			X	
C1	Reviewer 5		X	X		X
C2	Reviewer 6	X			X	
All	Reviewer 7 (Researcher)	-	-	-	-	-

The profession of the reviewers was either chiropractic, physiotherapy, or physical therapy (participation was dependent on the reviewer agreement based on the MoA (Appendix E) which all reviewers were required to sign).

Table 3. 2: Table of reviewer qualifications.

Reviewer	Qualification	Country/ Region
A1	PhD Chiropractic	United Kingdom
A2	Masters Physiotherapy	South Africa
B1	PhD Musculoskeletal Physiotherapy	Ghana
B2	Masters Chiropractic	United Arab Emirates
C1	PhD (Musculoskeletal Physiotherapy)	South Africa
C2	Masters Chiropractic	United Kingdom

Identification of the reviewers for the study

- Reviewers with an interest in the topic of this systematic review, where identified based on the publications available in the topic are and reviewed as part of the systematic search of the literature (including the excluded publications).
- Special interest groups were contacted to determine possible reviewers with an interest in the topic of this systematic review e.g.: Cochrane collaboration centres.
- Reviewer selection was not limited to persons based at a particular geographical location.
- Reviewer selection was not limited by profession of the reviewer, other than those more likely to have an interest in the application of electrotherapies in the context of adhesive capsulitis (by default the manual therapy professions).

A. Review Process

For the duration of the study, the identity of the reviewers remained confidential as they were required to complete the reviews in a blinded manner to allow objective review of the articles in this study (Suri 2020). Additionally, statements and comments made by anyone particular reviewer associated with this study, was not correlated to any particular reviewer (this was the basis of the MoA between the researcher and the reviewers) (Appendix E) during the reporting process. In the intention of preserving the integrity of the study, it was arranged that any reviewer who was known to have authored any included articles or who were associated with the supervision of the studies that were represented by the included articles were not permitted to review these articles. This limited reviewer bias and the impact on this systematic review (Lefebvre *et al.* 2011).

B. Article allocation

Once all reviewers were appointed, each reviewer group was defined in that each was required to contain one PhD qualified reviewer and one master's level reviewer. This balanced the experience (clinical, research and academic) in each group and ensured variation of the experience in the group improving the level of significance if agreement on the reviews were reached (Higgins and Green 2011). In the event of a reviewer being an author in one of the eligible articles, it was ensured that the author did not review the study. This ensured that no reviewer bias is included in the review process (Moher 2015; Moher *et al.* 2015).

C. Reviewer instructions

Once the reviewer was appointed, the reviewer was paired with fellow reviewer (i.e., one PhD and master's qualification). Each pair of reviewers received allocated articles with corresponding scales to review (da Costa, Hilfiker and Egger 2013; Peterson *et al.* 2011; de Morton 2009; Liddle, Williamson and Irwig 1996), and checklists (Liberati *et al.* 2009) along with the study category to be reviewed.

The scales (Appendices H, I and J) were accompanied by their relevant set of instructions and explanations to clarify the procedures on how to use the scales effectively. In the event where a reviewer required assistance regarding the use of the scales, the researcher was available to assist either to explain the use or clarify questions regarding the scales (Moher 2015). The researcher however, avoided making the decision for the reviewer in terms of the outcomes required by the scale. Furthermore, the reviewers were guided on how to submit the information generated for purposes of efficacy for the researcher's ability to analyse the received data. Each reviewer received their own email, to ensure the review process was blinded to reduce peer pressure compliance and promote independent review by the reviewers (Moher 2015).

During the time when the external reviewers were reviewing the articles/participating in the review process, the researcher conducted their independent reviews of the eligible articles. In the instance where the external reviewers provided their review findings prior to the week eight submission date, the reviewer was requested to submit their outcomes to the researcher's supervisor. This was done to limit review bias on the side of the researcher. After all reviews were completed and in the event of conflict

amongst the reviewer's outcomes, an additional reviewer was asked to review the article providing another independent review for purposes of arbitration (Resnik and Elmore 2018).

3.9. Quality assessment

3.9.1. Study types and measurement tools

There are various scales used to test the validity and reliability of each article in this study (Moher 2015; Liberati *et al.* 2009). Each study type has a specific set of scales used to review a particular field of study. The relevant articles were allocated according to their study type divisions, PEDro Scale (Appendix H), Newcastle Ottawa Scale (NOS) (Appendix I) and the Liddle Scale (Appendix J) (these are outlined and discussed in detail below).

A. PEDro Scale (Appendix H) was used to assess the Randomized Controlled Trials (RCTs). In this study there was a total of 16 RCTs included.

The PEDro Scale is the most frequently used measurement tool to evaluate RCTs and has sustained a fair to good reliability rating (Maher *et al.* 2003). The PEDro Scale was developed in 1999 and based on a variation of the Delphi scale in the context of physical therapy. Furthermore, emphasises on the methodological quality. The purpose of the PEDro Scale is to assist researchers to measure compliance of the trials in terms of their internal validity and allows a measure of whether the stated outcomes are statistically or clinically significant based on the research methodology. The scale considers blinding allocation concealment intention to treat analysis and the follow up assessments (Olivo *et al.* 2008).

The PEDro Scale consists of eleven individual criteria; each section assesses the methodological strength of the study being reviewed. Each fulfilled criteria receives a point and a maximum score of eleven can be awarded and a minimum of 0. For each question or criterion suitably fulfilled, a point was awarded. An average score was then calculated for the three reviewers, and a mean score indicated the methodological rigor of the study. The PEDro scoring tool outlined a total score of 0-3 considered 'poor', 4-5 'fair', 6-8 'good' and 9-10 'excellent' (Scale 1999). A PEDro score of high-quality studies range from 6 upwards, depending on the study context and research question (Moseley and Pinheiro 2022; Sherrington *et al.* 2000).

B. Newcastle Ottawa Scale (NOS) (Appendix I) was used to assess the non-randomized controlled Trials (nRCTs). A total of three nRCTs were included in this study.

The Cochrane Collaboration (Higgins *et al.* 2020) approved and established that the Newcastle-Ottawa Scale was simple and appropriate to use whilst conducting a systematic review. Wells, Shea and O'Connell (2003) reviewed and improved the scale, allowing the inter-rater reliability to be rated being strong.

The Newcastle Ottawa Scale is divided into eight categories, which are further divided into three categories viz: selection, comparability, and exposure. For each of the eight items, there is diversity of the possible responses, however only one response (a, b, or c, etc.) can be selected. The comparability section is the exception whereby one, two or no responses can be selected. The award of one point

can be granted per section, apart from the comparability section which allows for the possible awarding of two points to be granted. A maximum total of nine points can be awarded. For each adequately fulfilled criterion, a point is awarded. Thereafter the average score is calculated from the final score collected from the reviewers. The higher score indicates a methodological rigor study, a mean score of nine points. Comparably, a score of zero indicates lowest level of methodological rigor achieved.

C. Liddle Scale (Appendix J) was used to assess the observational studies. A total of four observational studies (specifically case series and case studies) were included.

The Method for Evaluating Research and Guideline Evidence (MERGE) was established by the Cochrane Collaboration along with the New South Wales Health Department in collaboration with researchers (Liddle, Williamson and Irwig 1996). The MERGE principles were a standardised guideline for the evaluation of case reports, case series and observational studies. Based on the MERGE principle, the Liddle Scale was formed to review observational studies and case studies, in terms of the level of evidence, methodological rigour and the level of bias presence (Liddle, Williamson and Irwig 1996). The Liddle Scale was developed with a standardised method to evaluate the quality of evidence in a consistent manner. The Liddle Scale allows the assessment of the quality by evaluating the separate criteria of each source of bias and the extent to which each influences the overall study results. In combination, the criteria provides an overview assessment in establishing the methodological quality according to epidemiological principles (Harris 2014; Liddle, Williamson and Irwig 1996).

The analysis of cases studies or case series and observational studies are discussed together. The Liddle Scale is used in the assessment of both study types. The Liddle Scale comprises of 12 individual criteria for the case studies or case series and 13 individual criteria for the observational studies. The evaluation coding used for the Liddle Scale indicates the risk of bias in the study (A indicating low risk of bias, B1 indicating a low-moderate risk of bias, B2 indicating a moderate-high risk of bias, and C indicates a high risk of bias). The strongest methodological rigor is indicated by the granting of an "A". When compared to the score of an "I" awarded, the weakest possibility of methodological rigor is determined. The strength of the methodological rigor is graded in descending strength of the following order: A, B1, B2 and I. The use of n/a is used in the event of the criteria not complying with the reviewed study. The summary of evidence is gathered by the collation of the feedback received by the reviewers. The summation of the review is discussed in context of the clinical effectiveness, feasibility, appropriateness of the intervention being tested. In chapter four, the information is collated, discussed in the context of the methodological quality and study outcomes (Hemingway and Brereton 2009).

3.9.2. Data analysis and synthesis

The articles were categorized based on their study design and evaluated according to the relevant scales. The individual articles were analysed along with the individual weaknesses and strengths, which were identified with the use of the scales mentioned above. Upon receiving the review outcomes from the external reviewers, the data was captured on an excel spreadsheet for each study. A compilation of the analysis from the three reviewers, along with the outcome of the review for each study and the discussion of the article is reported in Appendix L. In chapter four, the evidence was ranked, and an

unbiased report was compiled to appropriately describe the evidence gathered. The final results are summarised in the fourth chapter and detailed in Appendix L.

In chapter five, a final overview of the evidence assessing the management of adhesive capsulitis (by the stage of the pathology) by the means of TENS (in the form of application) is further discussed and graded according to the Dagenais and Haldeman (2011), Guyatt *et al.* (2011) or Foley *et al.* (2003). Foley *et al.* (2003) postulated the level of evidence along with the strength of evidence for multiple articles can be established. Similarly, Dagenais and Haldeman (2011) and the GRADE system (Guyatt *et al.* 2011) consists of all levels of evidence. These specific levels are used to indicate the strength or degree of the evidence in a specific group. Foley *et al.* (2003) was a contextually specific study, thus this systematic review utilizes the approach of Dagenais and Haldeman (2011) and the GRADE system (Guyatt *et al.* 2011). Furthermore, the two systems used are complimentary in application and facilitate a balanced grading of the evidence.

3.10. Ethical considerations and Bias

A systematic review did not require the approval of the Institutional Research Ethics Committee (IREC). FRC has been delegated the responsibility of systematic reviews as a level one study indicating studies which do not involve human participants, do not require IREC approval. To protect both the reviewers and the rigor of the study, all the reviewers including the researcher were denied knowledge of who the other external reviewers of a particular article were. The reviews remained confidential and were not discussed unless the arbitration process was required. To maintain the confidentiality and anonymity the reviewers involved did not have their credentials disclosed so to make it impossible to trace a submission (i.e., a review of an article) back to a participant. This was maintained by a central submission point to which the research and the reviewers submitted their evaluations (reviews). In this situation, the supervisor undertook this role withholding the documents from the researcher until all the submissions were accounted for and identifying all the data was removed. In addition, the reviewers involved are not revealed in this dissertation as evidenced in Table 3.2 and noted in the methodology and the critical review only by their qualifications specified.

3.10.1. Compliance with and protection of the four pillars of ethical medical research, in accordance with those defined by Gillon (1994):

A. Autonomy

If one has autonomy, one can make their own decisions based on deliberation. Furthermore, respect for autonomy requires all parties to be honest and adequate communication throughout the process (Coggon and Miola 2011). The reviewer had the right to refuse or choose their own participation treatment. In this research, the reviewer had the right to refuse the opportunity to be involved in the research process and leave at any point during the study.

B. Beneficence

The reviewer should act in the best interest of the patient /practitioner patient interaction. All participating reviewers benefitted through an honorarium (gratitude for their participation), and the opportunity to publish as a co-author on the published study.

C. Non-maleficence and Utility

To not be the cause of harm to any of the reviewers and all the interactions between the reviewers and researcher be guided by mutual consent and respect.

D. Justice

The distribution of scarce resources related to fairness and equality. All the reviewers were treated in the same manner based on mutual agreement (see Appendix E: MoA).

3.11. Conclusion

This chapter detailed the methodology used for setting the parameters of this study and for the process of searching, identifying, and selecting the appropriate literature. In addition, the extraction, analysis, and the synthesis of the data obtained in this study. The chapter went on to provide insights to the reviewing process used when analysing the articles and the criteria needed to fulfil. As such, this chapter laid the foundation on which the forthcoming chapters are structured.

Chapter Four: Results

The purpose of chapter four is to report and synthesize the data collected from the reviewers who evaluated the articles included in the systematic review.

4.1. Commonly used abbreviations in this chapter

ADLs	: Activities of Daily Living
CONSORT	: Consolidated Standard of Reporting Trials
CMA	: Constant Murley Assessment
CS/CR	: Case Series/Studies/Reports
DASH	: Disability of Arm, Shoulder, and Hand
DUT	: Durban University of Technology
LSST	: Lateral Scapular Slide Test
MCID	: Minimal clinically important differences
No	: Number
NPRS	: Numerical Pain Rating Scale
NPS	: Numerical Pain Scale
nRCT	: non-Randomized Controlled/Clinical Trial
PRS	: Pain Rating Scale
PSFS	: Patient Specific Functional Scale questionnaires
QoL	: Quality of Life
RCT	: Randomized Controlled/Clinical Trials
ROM	: Range of Motion
SD	: Standard Deviation
SDQ	: Shoulder Disability Questionnaire
SF-36	: Medical Outcomes Study Questionnaire Short Form 36 Health Survey
SPADI	: Shoulder Pain and Disability Index
SWD	: Short Wave Diathermy
VAS	: Visual Analogue Scale

4.2. Data

4.2.1. Primary Data

A final list of articles was compiled after the primary and secondary searches were completed (see Appendix K: Master list). The study incorporated 23 articles. Table 4.1 indicated the number of articles per article type included.

Table 4.1: Article numbers characterized by study design.

Article Type	Number Of Articles
RCT	16
nRCTs	3
Case series/ reports	4
Total	23

The final articles that were included in this systematic review were reviewed by the reviewers (three reviewers to an article). Thereafter, the feedback data for the articles from each reviewer was collated into a table titled the Tabulated Feedback Data (Table 4.4.1.X.A). A table is allocated per an article (Table 4.4.1.X.B). Each table contained the feedback from the reviewers and the ranking information. Furthermore, the tables went on to calculate the percentage agreement of each criterion and discuss the respective limitations of each article reviewed. The tables of analysis are seen in Appendix L.

4.2.2. The analysis of articles

The included articles are tabulated below according to the order and study design in Table 4.2. The individual analysis of the articles based on the applicable scales are depicted in Appendix L. The forthcoming paragraphs provide the level of methodological rigor of each article along with the application of TENS in the management of adhesive capsulitis (either as a single intervention or as a combination therapy).

Table 4.2. List of included articles according to the order and study design

	<u>Tabulated feedback data:</u>	<u>Analysis of articles:</u>	<u>Author(s):</u>	<u>Year:</u>	<u>Title:</u>	<u>Study design:</u>
1.	Table A1	Table A2	Balci, Yuruk, Zeybek, Gulsen and Tekindal	2016	Acute effect of scapular proprioceptive neuromuscular facilitation (PNF) techniques and classic exercises in adhesive capsulitis: a randomized controlled trial.	RCT
2.	Table B1	Table B2	Carette, Moffet, Tardif, Bessette, Morin, Frémont, Bykerk, Thorne, Bell and Bensen	2003	Intraarticular corticosteroids, supervised physiotherapy, or a combination of the two in the treatment of adhesive capsulitis of the shoulder: A placebo-controlled trial.	
3.	Table C1	Table C2	Celik	2010	Comparison of the outcomes of two different exercise programs on frozen shoulder.	
4.	Table D1	Table D2	Dewan and Sharma	2011	Effectiveness of transcutaneous electrical nerve stimulation and interferential electrotherapy in adhesive capsulitis.	
5.	Table E1	Table E2	Doner, Guven, Atalay and Celiker	2013	Evaluation of Mulligan's technique for adhesive capsulitis of the shoulder.	
6.	Table F1	Table F2	Faruqui, Kazmi, Devi, Naqvi, Kumar, Rizvi and Puri	2015	Effects of mobilization in sub-acute and chronic frozen shoulder (adhesive capsulitis) management.	
7.	Table G1	Table G2	Maryam, Zahra, Adeleh and Morteza	2012	Comparison of corticosteroid injections, physiotherapy, and combination therapy in treatment of frozen shoulder.	
8.	Table H1	Table H2	Patil, Sudha and Sidharth	2018	Comparative efficacy of transcutaneous electrical nerve stimulation [tens] and pendular exercises v/s ultrasound and rhythmic stabilization in clinically diagnosed frozen shoulder [adhesive capsulitis] using SPADI scale." A random study.	
9.	Table I1	Table I2	Rawat, Eapen and Seema	2017	Effect of rotator cuff strengthening as an adjunct to standard care in subjects with adhesive capsulitis: A randomized controlled trial.	
10.	Table J1	Table J2	Reddy and Metgud	2014	A randomized controlled trial to compare the effect of muscle energy technique with conventional therapy in stage ii adhesive capsulitis.	
11.	Table K1	Table K2	Reddy and Metgud	2015	Randomized controlled trial to investigate the effect of mulligan's mwm and conventional therapy in stage ii adhesive capsulitis.	
12.	Table L1	Table L2	Saber, Rashad, Eltnany and Shaat	2022	Does Ultrasound-Guided Continuous Suprascapular Nerve Block Affect Frozen Shoulder Rehabilitation Programme Outcome?	
13.	Table M1	Table M2	Wahyuni, Nurdina and Indasah	2020	Effectiveness Variation Giving SWD, TENS, Manipulation Therapy, Exercise to Reduce Pain, Increase Range of Motion, Improve Functional Ability on Frozen Shoulder in Dr. Soepraen Malang Hospital.	
14.	Table N1	Table N2	Waldburger, Meier and Gobelet	1992	The frozen shoulder: diagnosis and treatment. Prospective study of 50 cases of adhesive capsulitis.	
15.	Table O1	Table O2	Yatheendra Kumar, Sudhakar, Sudhan, Sivajyothi, Senthil Selvam and Deepthi	2017	Effectiveness of active release technique and muscle energy technique in adhesive capsulitis.	
16.	Table P1	Table P2	Yildiz, Kuş, Mustafaoğlu and Argut	2017	The Comparison of The Effectiveness of Physical and Electrotherapy Modalities Versus Home Exercises Program on Frozen Shoulder.	nRCT
17.	Table Q1	Table Q2	Lad and Anandh	2019	Effect of Traction Versus Counter Traction with Conservative Treatment on Adhesive Capsulitis.	
18.	Table R1	Table R2	Mengi	2021	The Effect of Glenohumeral Joint Injection Prior to Physical Therapy on Treatment Outcomes in Adhesive Capsulitis.	
19.	Table S1	Table S2	Shetty and Shah	2020	Effect of Maitland Technique (Posterior Glide) with Muscle Energy Technique for Subscapularis Muscle on Adhesive Capsulitis.	Case studies/ series
20.	Table T1	Table T2	Subramanian	2018	Mobilization Vs Electrotherapy in Adhesive Capsulitis Shoulder.	
21.	Table U1	Table U2	Lilje, Genberg, Aldudjaili and Skillgate	2014	Pain relief in a young woman with adhesive capsulitis after manual manipulation of the acromioclavicular joint for remaining symptoms after mobilisation under anaesthesia.	
22.	Table V1	Table V2	Hui	2016	Effective treatment of adhesive capsulitis utilizing soft tissue and joint manipulation—A case study.	
23.	Table W1	Table W2	Metgud, Naik, and Heggannavar	2017	Randomized controlled trial to investigate the effect of mulligan's mwm and conventional therapy in stage ii adhesive capsulitis.	

4.2.2.1. Overview of the included articles

A total of 23 studies were included in this systematic review. Studies were conducted across multiple countries, with ten studies from India, and others from Turkey, Iran, Pakistan, Canada, Egypt, Switzerland, Sweden, Indonesia, and the United States of America. The majority of the studies recruited the participants from outpatient clinics, with population sample sizes ranging from single case reports to 56 participants per group. The age range of the participants recruited were from 29 to 61 years of age. Female participants were noticeably overrepresented across the studies, reflecting the high prevalence of adhesive capsulitis in women.

i. Pain outcomes

Pain reduction was observed with all interventions in all the studies, although the treatment type varied. TENS alone (Patil, Sudha and Sidharth 2018; Dewan and Sharma 2011) provided modest pain reduction (see in VAS reduction). The exercise-based interventions, such as Glenohumeral ROM or scapulothoracic exercises (Balci *et al.* 2018; Celik 2010) achieved moderate improvements (seen in VAS reduction).

Combination therapies constantly demonstrated the greatest reduction of pain. For example, studies combining physiotherapy with corticosteroid injections (Maryam *et al.* 2012; Carette *et al.* 2003) or TENS combined with exercise/ mobilizations (Rawat, Eapen and Seema 2017; Doner *et al.* 2013) reported pain reduction ranging from 35 to 50% less (seen in the reduced VAS after the intervention). Non-randomised controlled trials, utilizing interventions such as Maitland mobilization, subscapularis muscle energy technique (Shetty and Shah 2020), or suprascapular nerve blocks (Saber *et al.* 2022) also demonstrated favourable pain outcomes, though the effect sizes were harder to quantify due to single-group designs.

ii. Range of motion

Improvement in shoulder ROM was observed in almost all of the studies; however, the degree of improvement depended on the intervention type. Manual therapy and mobilization techniques, including Mulligan's mobilization with movement (Reddy and Metgud 2015), joint mobilization combined with soft tissue therapy (Hui 2016), and early mobilization programs (Faruqui *et al.* 2015; Waldburger, Meier and Gobelet 1992), consistently produced improvements in flexion and abduction; often outperforming electrotherapy alone.

Exercise programs alone, particularly GH ROM and scapulothoracic exercises (Balci *et al.* 2018; Celik 2010), also improved ROM; while TENS or other electrotherapy modalities without exercise (Wahyuni, Nurdina and Indasah 2020; Patil, Sudha and Sidharth 2018) produced smaller improvements. Combination therapy, especially TENS or electrotherapy combined with exercise/mobilization, led to pain reduction and notable ROM improvements, highlighting the synergistic effects of multi-modal therapy.

iii. Functional outcomes

Functional improvements were measured using validated scales such as SPADI, DASH, Constant score, PSFS, and SST. Across studies, exercise and physiotherapy alone achieved moderate functional gains. Interventions incorporating manual therapy, mobilization, or combination approaches consistently produced the greatest improvements (seen in the functional scores). Combination therapies including corticosteroids, TENS, or joint mobilization demonstrated faster and more pronounced improvements in function, supporting the use in clinical practice. Single-case studies reported substantial functional gains individuals (Subramanian 2018; Lilje *et al.* 2014), though these results are limited in generalizability.

4.2.3. Study location

The location of the studies is discussed above. In studies such as Carette *et al.* (2003) and Saber *et al.* (2022) reported the education level along with the occupation of the recruited participants, additionally the study locations Canada and Egypt respectively.

Ten of the twenty-three studies were conducted in India; one study was conducted in Iran and another in Pakistan; emphasising most of the studies were conducted in lower income countries. Higher income countries generally provided higher prevalence of shoulder pain than in those countries of a lower income level (Lucas *et al.* 2022).

The population recruited into the studies provide a representation of the general population of the participants with adhesive capsulitis in accordance with the eligibility criteria, thus providing good external validity (Braga *et al.* 2025). The location of the study influences the access to healthcare due to factors such as socioeconomic disparities and location of the study (commute distance for the participant) (Keanjoom, Toyoda and Nakamura 2024). Atkins and Mukhida (2022) postulated that patients' of a lower socio-economic status were associated with a greater likelihood of opioid prescription to manage chronic pain, and less likely to receive other prescription medications; thus, suggesting socioeconomic factors may provide inequality in pain management.

Chapter Five: Discussion

5.1. Introduction

After reviewing the various study types in chapter four, this chapter will contextualize the level of evidence to support the effectiveness of the use of TENS in the management of adhesive capsulitis.

5.2. A review of the effectiveness of TENS in the management of adhesive capsulitis

The review will be conducted in accordance with:

Review the evidence available for the use of TENS as a single therapy intervention versus the use of TENS in a combination therapy intervention in the management of adhesive capsulitis.

Outlining the listed specifications of TENS and its clinical application, along with the evidence for these situations.

5.3. Discussion of the criteria for grading evidence

The articles included in this systematic review (Table 4.2) were individually graded based on the review of their methodological rigour (internal validity) and external validity. This systematic review utilized the criteria defined by Foley *et al.* (2003), Dagenais and Haldeman (2011) and the GRADE criteria (Brozek *et al.* 2009). To summarize the evidence and determine the level of evidence supporting the use of TENS in the management of adhesive capsulitis.

In comparison, Foley *et al.* (2003) and Dagenais and Haldeman (2011) utilize simpler grading criteria for the evidence along with easy accessibility to those in healthcare, especially those involved in the systematic review. The GRADE (Brozek *et al.* 2009) system utilized by the Cochrane, is deemed complex as additional knowledge is required to fulfil the criteria adequately in the application for clinical practice. However, the AGREE (Dagenais and Haldeman 2011) and Foley *et al.* (2003) provide a practical and detailed application. The additional benefit of both the AGREE (Dagenais and Haldeman 2011) and Foley *et al.* (2003) systems provide the evidence to be categorized according to different levels, described as “strong evidence”, “moderate evidence” and “low or no evidence”. Additionally, Foley *et al.* (2003) further enables the review to account for whether the evidence supports or conflicts in respect of the specified modality.

The AGREE (Dagenais and Haldeman 2011) and Foley *et al.* (2003) grading systems provided a superior criteria when compared to the GRADE system (Brozek *et al.* 2009). The information can collectively establish whether the evidence supporting the clinical outcome is good or bad with respect to specific modality (in this instance TENS). In addition of this information, the outcome of the systematic review is better contextualised.

The Dagenais and Haldeman (2011) and Foley *et al.* (2003) grading systems are as follows:

- Strong Evidence: The findings within a specific area were supported by two or more RCTs which fulfilled a “fair to moderate” quality grading, which constitutes to a strong level of evidence.
- Moderate Evidence: The findings within a specific area were supported by at least one RCT which fulfilled a “fair to moderate” quality grading.
- Limited Evidence: The findings within a specific area were supported by at least one nonexperimental study (i.e. NRCT, case series, cohort, or an observational study).
- No Evidence: The available study or studies were of low or poor quality and thus failed to present evidence in support of the treatment regimen.

The following categories provided by Foley *et al.* (2003) describe whether the results provided additional evidence to the clinical outcome within one specific area. These include:

- Consensus of Evidence: When evidence is lacking, researchers may reach a consensus regarding the potential effectiveness of TENS in managing adhesive capsulitis., Although the consensus opinion represents the lowest level of evidence and is rarely considered true evidence, it may be used when the available studies consistently support the intervention.
- Conflicting Evidence: Conflicting evidence occurs when findings from at least two RCTs are not in agreement (Dagenais and Haldeman 2011). When a minority of studies produce conflicting results, conclusions may be based on the majority of findings-unless the study with divergent results is of superior methodological quality.

The following section will review the outcomes attained in chapter four and present the evidence based on the results of the grading criteria.

5.4. The application of TENS

The methodology of the eligible articles provided a guideline for the use of TENS, the classification of the application can be seen in Table 5.1.

In study designs comprising of a multimodal approach, the participants received numerous interventions and approached the patient based on symptoms. However, Carette *et al.* (2003) utilised two different physiotherapy strategies based on the stage of adhesive capsulitis, specifically patients with 3 or more symptoms were classified as acute, and those with less than 3 symptoms were classified as chronic. The participants with acute symptoms received TENS, mobilization, active range of motion exercises and cryotherapy. In those with chronic symptoms the intervention used was ultrasound, heat to the

joints prior to mobilization, active and assisted range of motion, isometric strengthening exercises along with cryotherapy. Similarly, after the participants received their exercise therapy, Shetty and Shah (2020) utilized either TENS or ultrasound therapy based on the area of pain experienced. In these two cases, the distribution of patients who experienced TENS or ultrasound therapy was not disclosed, thus the results of both lacked clarity of the favourable intervention.

Table 5. 1: The application of TENS outlined in the methodology of the included articles.

TENS used alone	All participants received TENS	TENS included in the physiotherapy protocol- received by all participants	Intervention included TENS as part of protocol	TENS included in physiotherapy protocol group allocation
Dewan and Sharma (2011)	Rawat, Eapen and Seema (2016) Wahyuni, Nurdina and Indasah (2020) Metgud, Naik and Heggannavar (2017) Hui (2016) Lilje <i>et al.</i> (2014) Shetty and Shah (2020) Subramanian (2018)	Balci <i>et al.</i> (2018) Celik (2010) Doner <i>et al.</i> (2013) Faruqui <i>et al.</i> (2015) Lad and Anandh (2019) Mengi (2021) Reddy and Metgud (2014) Reddy and Metgud (2015) Saber <i>et al.</i> (2022) Yatheendra Kumar <i>et al.</i> (2017) Waldburger, Meier and Gobelet (1992)	Patil, Sudha and Sidharth (2018) Yıldız <i>et al.</i> (2017)	Carette <i>et al.</i> (2003) Maryam <i>et al.</i> (2012)

As seen in Table 5.1, Dewan and Sharma (2011) compared two sample groups, TENS and IFC alone, emphasising on the short term effect of the modality on patients with adhesive capsulitis. Hui (2016) was included in the eligible articles as the methodology outlined the use of “electrical stimulation” as part of the multimodal intervention in the management of the case study. In case study designs such as Lilje *et al.* (2014) and Subramanian (2018) whereby the patient underwent multiple treatment interventions prior to the resolution of the condition, thus the true efficiency of TENS was not determined. Subramanian (2018) compared two different treatment interventions administered by two different healthcare providers, specifically, the use of electromodalities compared to exercise only. However, due to the study design, the author emphasised on the second intervention used as more details were provided when compared to the initial intervention received by the participant (i.e., no settings or duration of the sessions were provided). The outcome measurement tools utilised were the shoulder function index for both the initial and secondary intervention, along with the changes in range of motion and range of motion. The patient reported the initial intervention provided no pain relief and the presence of reduced shoulder disability. The favourable intervention was deemed exercise therapy as the participant experienced an improved shoulder function and range of motion.

5.5. A review of TENS as an individual treatment for Adhesive Capsulitis

In the study mentioned in Table 5.2, the study design of Dewan and Sharma (2011) compared the effectiveness of TENS and IFC alone in the management of adhesive capsulitis. The design emphasised on the short-term effect of IFC and TENS on the patient's presenting with adhesive capsulitis.

Table 5. 2: Level of evidence for TENS as an individual treatment for adhesive capsulitis.

Author and Year	Type of study	PEDro Ranking	Clinical Outcomes for TENS	Level of Evidence					
				Strong	Moderate	Limited	No Evidence	Consistent Clinical Outcome	Mixed Clinical Outcome
Dewan, A. and Sharma, R. (2011)	RCT	7/11	Fair					X	

The evidence of TENS as a single intervention was limited as seen in Tables 5.1 and 5.2. Dewan and Sharma (2011) investigated the short-term effect of IFC and TENS on patient's adhesive capsulitis. The use of both modalities provided pain relief and restored shoulder function. However, the use of IFC was reported to be more effective in the individuals with periarthritis than TENS when investigating the short-term effect.

5.6. A review of TENS as part of a combination treatment for Adhesive Capsulitis

Table 5. 3: Level of evidence for TENS as a part of a combination treatment

Author and Year	Type of study	Ranking	Clinical Outcomes for TENS	Level of evidence					
				Strong	Moderate	Limited	No evidence	Consistent clinical outcome	Mixed clinical outcome
Balci <i>et al.</i> (2018)	RCT	8/11	Moderate			X			
Carette <i>et al.</i> (2003)	RCT	10/11	Moderate						
Celik, D. (2010)	RCT	5/11	Limited						
Doner <i>et al.</i> (2013)	RCT	7/11	Favourable		X				
Faruqui <i>et al.</i> (2015)	RCT	5/11	Favourable	X					
Hui (2016)	Case study	A:0 B1:4 B2:0 C:0 N/A:7	Limited				X		X
Lad and Anandh (2019)	nRCT	3/10	Moderate to limited			X			
Lilje <i>et al.</i> (2014)	Case report	A:1 B1:3 B2:0 C:0 N/A:7	Limited						
Maryam <i>et al.</i> (2012)	RCT	6/11	Favourable		X				
Mengi (2021)	nRCT	7/10	Moderate to limited			X			X
Metgud, Naik and Heggannavar (2017)	Case series	A: 0 B1: 2 B2: 1 C: 1 I: 2 N/A: 2	Favourable						
Patil, Sudha and Sidharth (2018)	RCT	4/11	Favourable		X				
Rawat, Eapen and Seema (2016)	RCT	9/11	Favourable						
Reddy and Metgud (2014)	RCT	6/11	Favourable						
Reddy and Metgud (2015)	RCT	7/11	Favourable						
Saber <i>et al.</i> (2022)	RCT	9/11	Favourable						
Shetty and Shah (2020)	nRCT	1/10	Limited			X			X
Subramanian (2018)	Case study	A:1 B1:0 B2:0 C:3 N/A:7	Limited						
Wahyuni, Nurdina and Indasah (2020)	RCT	7/11	Favourable						
Waldburger, Meier and Gobelet (1992)	RCT	7/11	Moderate						
Yatheendra Kumar <i>et al.</i> (2017)	RCT	7/11	Limited						
Yıldız <i>et al.</i> (2017)	RCT	5/11	Moderate		X				

Based on the evidence from Table 5.1, TENS was utilized in various methods. In study designs comprised of standard treatment, the application of TENS was provided to all the participants as seen in Wahyuni, Nurdina and Indasah (2020); Metgud, Naik and Heggannavar (2017); Rawat, Eapen and Seema (2016). In the experimental pre-post study conducted by Metgud, Naik and Heggannavar (2017), the participants recruited were in the second stage of adhesive capsulitis, thus revealed the multimodal approach provided favourable short-term results. In both Wahyuni, Nurdina and Indasah (2020) and Rawat, Eapen and Seema (2016) incorporated TENS into the interventions received by all the participants recruited, thus the effectiveness of TENS was not determined.

Yildiz *et al.* (2017) compared the effects of standard care and electrotherapy, versus standard care and home care utilising both ultrasound and TENS as the electrotherapy component. Supporting data for the use of TENS was limited as the study conducted by Yildiz *et al.* (2017) did not identify the superior modality. Whereas, Carette *et al.* (2003) utilised ultrasound or TENS as part of a physiotherapy modality based on the number of symptoms the participant experienced. However, the evidence did not identify the superior modality nor the frequently chosen modality, thus deeming “physiotherapy favourable”. A similar study design was utilised in Patil, Sudha and Sidharth (2018) where the experimental groups were both a combination of electrical modalities and mobilizations, specifically TENS combined with pendular exercises, and ultrasound combined with rhythmic stabilization. As a result, the clinical effectiveness of both treatment interventions was deemed effective in the reduction of pain and disability in those with adhesive capsulitis, however the superior intervention was not reported. Hui (2016) followed the case study design and provided adequate information, and parameters of the interventions used. However, it did not provide the type of electrical stimulation used.

In study designs such as Maryam *et al.* (2012) where the intervention used corticosteroid injections as an experimental group, the true clinical effect of the intervention may not be measured as the participant may experience adverse effects such as pain in the injection site or bruising (Hodgens and Sharman 2023; Yasir, Goyal and Sonthalia 2018) prior to experiencing the effects of the intervention. The use of a combination therapy was deemed effective. However, the treatment parameters were not provided along with the superior treatment modality. Comparatively, Waldburger, Meier and Gobelet (1992) incorporated subcutaneous salmon calcitonin as the experimental intervention. However, the two participants dropped out of the study due to the adverse effects of the salmon calcitonin. Waldburger, Meier and Gobelet (1992) reported the use of salmon calcitonin in addition to the conventional therapy to provide a favourable effect as salmon calcitonin provided analgesic effects (Lyritis and Trovas 2002).

5.7. The effect of the TENS settings and placement on clinical outcomes

Based on the evidence gathered from the settings and electrode placement when TENS was used as part of the treatment (Tables 5.5 and 5.6), 13 of the 23 articles included had not reported the settings used in the study. Furthermore, the majority of the studies utilized high frequency settings providing favourable outcomes as opposed to low frequency TENS settings, as seen in studies by Dewan and Sharma (2011) to Yatheendra Kumar *et al.* (2017). The evidence gathered from Tables 5.4 and 5.5 revealed conflicting findings regarding the efficacy of TENS, alongside inconsistent reporting of frequency settings, prohibiting a definitive conclusion on the most effective frequency.

The sites of electrode placement were reported as vague anatomical locations or in some cases did not report on this. Therefore, this systematic review was unable to draw any conclusions regarding whether specific or different electrode placement positions influenced the clinical effectiveness of TENS along with the participants response to TENS.

Table 5.4: Evidence of TENS settings and electrode placement for TENS used as an individual treatment.

Author and Year	Type of Study	TENS settings reported	TENS settings	Electrode placement specified	PEDro ranking	Clinical outcome for TENS
Dewan, A. and Sharma, R. (2011)	RCT	Reported	20-minute duration of 0.2ms at 100Hz, for 10 sessions in total	Yes	7/11	Fair

Table 5. 5: Evidence of TENS settings and electrode placement for TENS used as part of a combination treatment intervention

Author and Year	Study Type	TENS Settings reported in study	TENS settings	Electrode placement specified	Clinical outcome for TENS
Balci <i>et al.</i> (2018)	RCT	Reported	100Hz, 60µsn	No	Moderate-all groups received TENS
Carette <i>et al.</i> (2003)	RCT	Not reported	-	No	Favourable
Celik (2010)	RCT	Not reported	-	No	Not in favour
Doner <i>et al.</i> (2013)	RCT	Reported	100Hz, 0.05-0.07ms 20-minute duration	No	Favourable-all groups received TENS
Faruqui <i>et al.</i> (2015)	RCT	Not reported	-	No	Moderate-all groups received TENS
Hui (2016)	Case study	Setting given for electrical stimulation, not indicated if TENS was used.	-	Yes	Limited
Lad and Anandh (2019)	nRCT	Reported	Burst mode for a 15-minute duration	Yes	Moderate to limited
Lilje <i>et al.</i> (2014)	Case report	Not reported	-	No	Limited
Maryam <i>et al.</i> (2012)	RCT	Not reported	-	No	Favourable
Mengi (2021)	nRCT	Reported	100Hz, 100µs 25-minute duration	Yes	Moderate to limited
Metgud, Naik and Heggannavar (2017)	Case study	Reported	100Hz, 200µs 15-minute duration	Yes	Moderate to limited
Patil, Sudha and Sidharth (2018)	RCT	Reported	100Hz, 0.2ms 20-minute duration	Yes	Favourable
Rawat, Eapen and Seema (2016)	RCT	Reported	150Hz, 25-35mA 15-minute duration	Yes	Favourable
Reddy and Metgud (2014)	RCT	Not reported	-	No	Favourable
Reddy and Metgud (2015)	RCT	Not reported	-	No	Favourable
Saber <i>et al.</i> (2022)	RCT	Reported	100Hz, 15mA, 100m.s 20-minute duration	Yes	Favourable
Shetty and Shah (2020)	nRCT	Not reported	-	No	Limited
Subramanian (2018)	Case study	Not reported	-	No	Limited
Wahyuni, Nurdina and Indasah (2020)	RCT	Not reported	-	No	Favourable
Waldburger, Meier and Gobelet (1992)	RCT	Not reported	-	No	Favourable
Yatheendra Kumar <i>et al.</i> (2017)	RCT	Reported	4-8Hz 8-minute duration	No	Moderate-all groups received TENS
Yildiz <i>et al.</i> (2017)	RCT	Not reported	-	No	Favourable

5.8. Stage-specific treatment for adhesive capsulitis

Table 5. 6: Table depicting the included articles based the stage of adhesive capsulitis.

<u>Stage 1</u>	<u>Stage 1 and 2</u>	<u>Stage 2</u>	<u>Stage 2 and 3</u>	<u>Stage 3</u>	<u>Unknown stage</u>
Doner <i>et al.</i> (2013) Lilje <i>et al.</i> (2014) Rawat, Eapen and Seema (2017) Saber <i>et al.</i> (2022) Waldburger, Meier and Gobelet (1992) Yatheendra Kumar <i>et al.</i> (2017)	Shetty and Shah (2020)	Balcı <i>et al.</i> (2016) Carette <i>et al.</i> (2003) Metgud, Naik and Heggannavar (2017) Reddy and Metgud (2014) Reddy and Metgud (2015) Subramanian (2018)	Faruqui <i>et al.</i> (2015) Maryam <i>et al.</i> (2012) Mengi (2021)	-	Celik (2010) Dewan and Sharma (2011) Hui (2016) Lad and Anandh (2019) Patil, Sudha and Sidharth (2018) Wahyuni, Nurdina and Indasah (2020) Yıldız <i>et al.</i> (2017)

The design of several studies addressed the pathology in relation to a specific stage, as seen in Shetty and Shah (2020) which identified participants with the first two stages of adhesive capsulitis (early stages) by outlining definitive inclusion criteria. However, Faruqui *et al.* (2015) identified and investigated patients with acute symptoms and chronic symptoms, utilising early and late mobilisation based on the symptoms experienced. The identification of early-stage mobilizations along with the conventional therapy (including TENS) was deemed effective. The studies designed to include participants of a specific stage were conducted, however the evidence supporting the use of TENS along with the effectiveness was not determined.

5.9. Discussion of the articles

5.9.1 Assessment of bias and confounding factors on the articles reviewed in this systematic review.

With reference to this systematic review and the imparted risk it carried, Randomised Controlled Trials (RCTs) are considered the gold standard of research evidence. Hariton and Locascio (2018) reported the application of randomisation reduced the risk of bias and provided a rigorous tool to examine the cause-effect relationship between the intervention and its outcome. Samaan *et al.* (2013) reported that the use of the Consolidated Standards of Reporting Trials (CONSORT) provided a clear outline for the investigation along with the quality of the results required. Both non-randomised controlled trials and observational studies acknowledge a better representation of the clinical application. The internal validity of observational study designs is low, and the external validity is high. The opposite is noted for the randomised control trial or experimental study designs (Carlson and Morrison 2009). In observational studies and non-randomised controlled trials, the element of randomisation is removed thus there is precision in the methodological process. There are numerous factors influencing the study designs of RCTS, nRCTs and case series, along with their impact on this systematic review discussed below.

5.9.2. External influencers:

The presence of these factors, unless addressed and controlled for during the methodological design, introduces confounding biases that could compromise the validity of the clinical results (Wells, Shea and O'Connell 2003). These factors include the following:

- i. Medication use and monitoring should be reviewed, including how the patients follow their prescriptions, how long they take their medication, changes made before or during the study, the type and dose of the medication, administration method, potential drug interactions, and if required wash-out periods. The consideration of the factors are important because they can affect how the patients respond to the interventions being investigated.
- ii. Other interventions used simultaneously by the participant could alter the desired outcome and may interfere with the intervention tested. The use of self-administered medication or over the counter (OTC) medication can influence the participants experience as the pharmacological effects can reduce the pain experienced. Therefore, not indicating the true influence of the intervention tested. Carette *et al.* (2003) recorded the intake of acetaminophen and other medication along with other treatment utilised at each follow-up visit. Furthermore, the participants compliance with the home exercises were recorded daily on the standardised agenda form during the initial three months of the investigation. Lilje *et al.* (2014) conducted a case study of a young woman who underwent several treatments to manage adhesive capsulitis. Health practitioners prescribed the use of analgesics, hypnotics, along with anticonvulsant medication known as Gabapentin Hexal. The side effects of the medications used to manage the

patient's pain was not considered as the patient referred to various practitioners. Maryam *et al.* (2012) permitted the use of acetaminophen for pain relief in addition to shoulder home care exercise program. The incorporation of intervention diaries can be useful as well as limiting the number of analgesics taken, along with documentation of medication controlling other co-morbidities if present.

- iii. Occupation and shoulder pathologies are closely linked. Linaker and Walker-Bone (2015) reported the combination of workplace strains such as overhead activities, heavy lifting, forceful work along with an awkward working posture is likely to increase the risk of shoulder disorders. The incidence of adhesive capsulitis is linked to occupational factors, performing manual labour, operating heavy machinery or objects and in some instances, working at a high altitude are likely to experience adhesive capsulitis (Cao *et al.* 2022; Mezian, Coffey and Chang 2021). Development of secondary adhesive capsulitis can be attributed to the development of work-related musculoskeletal disorders as individuals are likely to develop rotator cuff conditions, along with degenerative joint disorders (Aptel, Aublet-Cuvelier and Cnockaert 2002). Saber *et al.* (2022) considered the participants occupation and residence in the baseline measurements and characteristics of the recruitments.
- iv. Hand-dominance of the participants may influence the efficacy of the intervention. Nalcaci *et al.* (2001) reported females appeared to be more asymmetric with regards to motor functioning, while right-handed males have more bilateral motor function. Kingston *et al.* (2018) postulated the non-dominant shoulder to be more prone to the development of adhesive capsulitis. Jason, Ganesh Sundaram and Vengata Subramani (2015) reported significant improvements in participants who utilised the affected arm in the activities of daily living along with the physiotherapy treatment. Tanaka *et al.* (2010) the observation of improvement in the participants who experienced adhesive capsulitis in the dominant-handed group, as the participants were likely to use the affected shoulder in daily life. Celik (2010) reported the number of participants presenting with an affected dominant side in the baseline characteristics, yet the relationship was not identified. Toda (2018) observed a higher prevalence in the non-dominant shoulder of participants with adhesive capsulitis, furthermore the left shoulder was significantly more affected than the right shoulder. Doner *et al.* (2013) supported the previous statement as the experimental group baseline characteristics reported right side dominance, however the affected extremities were split equally between left and right side. From the studies included in this systematic review, a correlation can be seen between the affected side and dominance (Saber *et al.* 2022; Mengi 2021).

- v. Comorbidities attributing to the development of adhesive capsulitis. The prevalence of diabetes mellitus and hypothyroidism increases the likelihood of the development of adhesive capsulitis from 10% to 38% (Huang *et al.* 2013; Kelley, McClure and Leggin 2009). Cohen and Ejnisman (2015) postulated that the presence of comorbidities occurred in 85% of adhesive capsulitis patients and approximately 37.5% will have more than three comorbidities simultaneously. Kingston *et al.* (2018) reported that obesity and diabetes are significantly associated with adhesive capsulitis. The use of stratified randomisation would be likely to reduce variations within the groups. Furthermore, stratified randomisation allows the participants allocated to have similar characteristics and sociodemographic information; therefore, allowing the researcher to identify the prognostic outcomes of the intervention (Kahan and Morris 2012). Faruqi *et al.* (2015) utilized a quasi-experimental study where the participants were allocated into the groups based on their diagnosis into either subacute or chronic adhesive capsulitis. Similarly, the design utilised by Waldburger, Meier and Gobelet (1992) comprised of two groups, of which one received the intervention and the other the control. However, the group characteristics included the aetiology of the disease (i.e., idiopathic, post-traumatic and neurological). The analyses were not only done inter-group but also sub-group (aetiological causes). Furthermore, the disclosure of the neurological aetiology as a result of cerebrovascular accident provided the information of a participant dropped out due to a coma rather than adverse effects of the intervention as experienced by another participant. Doner *et al.* (2013) disclosed in the baseline characteristic of the participants accompanied medical disorder but did not report the disease present. Saber *et al.* (2022) provided the number of participants recruited in each group that experienced trauma which may or may not have attributed to the aetiology of adhesive capsulitis.
- vi. The endocrine status of the patient is important in the diagnosis and prevalence of adhesive capsulitis. Schiefer *et al.* (2017) reported the prevalence of adhesive capsulitis is significantly higher in participants without hypothyroidism. Furthermore, the higher the thyroid stimulating hormone (TSH) levels, the greater the prevalence of bilateral cases and severe cases (SW *et al.* 2014). Cakir *et al.* (2003) reported that the presence of musculoskeletal disorders are closely accompanied by thyroid dysfunction. Le *et al.* (2017a) stated that the general population of individuals diagnosed with adhesive capsulitis is between 3 to 5%, however approximately 20% of those with adhesive capsulitis have diabetes mellitus. The systematic review focused on idiopathic adhesive capsulitis. However, the data procurement process could not exclude articles investigating adhesive capsulitis and those participants diagnosed with diabetes mellitus (Subramanian 2018; Metgud, Naik and Heggannavar 2017; Maryam *et al.* 2012; Sharad 2011; Celik 2010; Carette *et al.* 2003).

- vii. The participants response to pain is influenced by several factors related to the personality, social and cultural background, age and gender (Kröner-Herwig *et al.* 2012) along with the severity of the condition (Fillingim 2017). Saber *et al.* (2022) provided patient characteristics of the participants in the allocated groups, specifically their socioeconomic status, i.e., working, housewife or retired. Similarly, Saber *et al.* (2022) and Maryam *et al.* (2012) reported an increased presence of females diagnosed with adhesive capsulitis than males. Maryam *et al.* (2012) included the level of education of the participants along with the type of employment in the characteristics for each group. Carette *et al.* (2003) included the participants education and employment level in the baseline characteristics; furthermore, the participant completed the 36-Item Short Form Health Survey (SF-36 questionnaire) upon each re-evaluation. The use of the SF-36 questionnaire provided a practical and effective measurement tool, which compared the health status of the individual participants along with the treatment effectiveness (Barnett 2014).
- viii. The recruitment process in which participants were recruited to be involved in the research process is vital. For instance, recruiting participants from a single site (such as one hospital, outpatient facility, or a geographic site), limits the diversity of the individuals with adhesive capsulitis. To minimize recruitment bias, eligibility criteria should manage confounding variables and ensure participant homogeneity, aligning the sample with the global population of adhesive capsulitis patients (Wells, Shea and O'Connell 2003). Carette *et al.* (2003) utilised seven recruitment sites (i.e., outpatient rheumatology clinics), the methodology provided the protocols followed at the sites along with the training the therapists underwent to maintain homogeneity amongst sites.

An example of maintaining homogeneity can be seen when the participants recruited are diagnosed with adhesive capsulitis and have knowledge of the stage in which they are currently in. This will allow the homogeneity amongst the participants in the studies and provide better representation of the global population with adhesive capsulitis and their possible outcome based on the intervention. Patients diagnosed with the same stage of adhesive capsulitis allows the outcome measure to be directly linked to the intervention investigated. Taking these complexities into consideration allows the study's findings to be better understood in relation to the various stages of adhesive capsulitis. Therefore, enabling a greater application in the clinical setting (Kendall 2003b). However, this may not represent the general population diagnosed with adhesive capsulitis and may be seen in nRCT studies. Faruqui *et al.* (2015) tailored the study design to stage specific treatment for patients with adhesive capsulitis by means of non-probability, purposive sampling. The methodology utilised early mobilizations for those diagnosed with acute symptoms and late mobilizations for those with chronic symptoms; however, the criteria for diagnosis was not disclosed. Waldburger, Meier and Gobelet (1992) recruited participants with symptoms of three months or less into the study, furthermore the recruits were classified into three etiological groups (viz, idiopathic, post-traumatic and neurological) for the two allocated groups. The results were discussed in relation to the aetiology classification within the group allocation, providing the clinical effect of the intervention on the participants specific

aetiology. An example of reported limited eligibility criteria was seen in Yildiz *et al.* (2017) due to the format being a conference paper, thus information provided was restricted. Consideration regarding the eligibility criteria of the study needs to be noted as participants may present with contraindications to the intervention (Ruchat *et al.* 2018). In addition, the participants may experience difficulty in compliance with the required interventions (Kendall 2003b).

- ix. An appropriate sample size and study power are essential for drawing valid conclusion. These should be determined at the beginning of the study to ensure that each group, and the overall sample, is large enough to detect both statistical and clinical significance (Kendall 2003b). Statistically, sample size is usually calculated using 95 or 99% confidence interval (0.05/0.01 significance level) and a power of around 80%. Clinically, the minimally clinically important difference (MCID), which represents the smallest change that is meaningful to participants (Hemming and Taljaard 2021). The MCID baseline is the starting point of the investigation and creates a definitive clinical conclusion to be drawn with regards to testing interventions (Hemming and Taljaard 2021). For example on the 11 point NRS, a change of 2 points in an acute patient or 3 points in a chronic patient indicates that there is a change in the patient's condition, that is clinically relevant to that patient (Salas Apaza *et al.* 2021) even in the absence of statistical significance. It is also possible that there is statistically significant change, but this does not imply that there is indeed a clinically impactful change for the patient. In studies such as Patil, Sudha and Sidharth (2018); Wahyuni, Nurdina and Indasah (2020), the number of participants allocated per group were 8 participants and 6 participants respectively, thus provided limited results.
- x. Given the calculation of the sample size, it is important that the recruitment process should leave adequate room for the lack of participation adherence and participant dropout. The "intention to treat" analysis provides an outcome based on the original random treatment allocation subsequently reducing the risk of potential bias (McCoy 2017). In study designs requiring follow-up measurements, after some time noticed a reduction in follow-up visits from the participants as seen in Maryam *et al.* (2012) and Carette *et al.* (2003). On this crucial aspect participants could experience adverse effects from the intervention or experience a coma, thus unable to continue participation in the study (Waldburger, Meier and Gobelet 1992).
- xi. In a RCT design, the randomized participant group allocation is crucial in the methodology. Furthermore, the method of randomization along with the concealed allocation may present with bias challenges (Clark, Fairhurst and Torgerson 2016; Akobeng 2005). Doig and Simpson (2005) postulated that the purpose of randomisation was to prevent prediction and influence of the treatment received by the participants, along with the outcome attributed to the intervention. By randomisation occurring, the possibility of bias is reduced as the allocation is concealed from both participants and researchers. In RCT scenarios, participants are treated in their group allocation irrespective of whether they are to receive the intended intervention. Furthermore, the analysis focuses on the size estimation of the predefined outcomes between the groups (Sibbald and Roland 1998). In designs utilizing purposeful sampling such as Faruqui *et al.* (2015), whereby the participants were allocated into groups based on the stage of pathology, i.e., acute symptoms

and chronic symptoms; the inter-group comparability created a discrepancy as the groups were different, thus increasing the potential for bias (Kim and Shin 2014). The introduction of patient consent, limits the randomisation process as the participant may deny treatment as seen in Mengi (2021); whereby the recruits unwilling to receive an intra-articular injection were allocated into a “non-injection group”. In design such as Carette *et al.* (2003) the hospital pharmacist at each of the centres managed the randomisation process, along with the preparation of the injection which was covered in aluminium foil. The design permitted a double blinding of both the patient and radiographer administering the intervention. Karunarathna *et al.* (2024) postulated that a study design comprising of a placebo-controlled and double-blinded randomised controlled trial will provide a high internal validity subsequently reducing the bias.

- xii. To ensure effective randomisation and reduce researcher influence, allocation should be either computer-generated or use concealed allocation methods (Kendall 2003a). In addition, researchers must consider various randomisation methods, such as block, cluster and stratified randomisation, to reduce the impact of external factors, even when the participants are randomly assigned (Lai *et al.* 2021; Lim and In 2019; Viera and Bangdiwala 2007). As illustrated in Waldburger, Meier and Gobelet (1992) the participants are randomly allocated into two groups. However, the sub-group identifying the aetiology of the disease was also utilised to further investigate the effect of the intervention. The use of stratified random sampling at the recruitment sites, as seen in Carette *et al.* (2003), involved the division of a population into smaller subgroups; thus providing homogeneity amongst the recruits at each site (Kernan *et al.* 1999).
- xiii. Prior to the initial intervention, a baseline measurement and comparison between the groups occurs, in doing so, variations between the groups is noted (Viera and Bangdiwala 2007). The baseline measurements should include the influence of external factors which may influence the clinical outcome whilst undergoing the intervention. In the instance of discrepancy of the baseline measurement amongst the groups being present, the clinical outcome will allow the possibility of error and poor clinical representation (Kendall 2003b). Should this occur, it can be statistically controlled, minimising the influence of different baseline measures between the groups that can affect the outcome measures. The age range of the participants, disease stage or duration of symptoms are factors which pose an influence (Roberts and Torgerson 1999b). The reporting of baseline measurements is crucial. However, not always possible as seen in Subramanian (2018) whereby a patient received treatment elsewhere prior to seeking treatment from the investigator. Therefore, the baseline measures were reported but the means of how the measurements were obtained is unknown. The absence of baseline characteristics and measurements, indicates the lack of information pertaining to the recruits at the starting point, furthermore the results may not fully depict the results of the intervention (Wahyuni, Nurdina and Indasah 2020; Lad and Anandh 2019; Patil, Sudha and Sidharth 2018; Yatheendra Kumar *et al.* 2017).
- xiv. Systematic differences between baseline characteristics of the participants of the groups may indicate selection bias (Higgins *et al.* 2019). The use of the RoB 2 tool considers the situation through which the baseline characteristics may be imbalanced during the randomisation process.

Baseline imbalances are deemed consistent in this situation and not interpreted as bias. In circumstances where the baseline characteristics and measurements are not reported or disclosed, the reader cannot completely gauge the clinical effectiveness of the intervention (Dewan and Sharma 2011). The absence of baseline measurements and characteristics of participants can provide a misrepresentation of the outcome measures of the intervention (Roberts and Torgerson 1999a).

5.9.3. Patient-related factors that may influence the outcomes of the articles include the following:

- a. The Hawthorne effect occurs when individuals change their behaviour when they are aware of being observed. The effect has the potential to influence the study results as the participants may alter their normal habits or withhold information to impress the observers. Carette *et al.* (2003) utilized seven recruitment sites, therefore the methodology outlined the protocols to maintain homogeneity, and the participant randomisation was stratified at each recruitment site. Furthermore, both the participants and the radiologist administering the intervention was blinded, thus minimizing the researcher bias and participant expectation of the treatment.
- b. The placebo effect needs to be considered in all the intervention groups. Placebo is based on the belief the patient has attached to the intervention and the perceived outcome. The use of placebo is best used in blinded studies whereby the participants, intervention administrator along with the assessor are unaware of the treatment received. By this, the placebo effect is isolated (Misra 2012; Linde, Fässler and Meissner 2011). In some cases, manual therapy is unable to be blinded as the individual administering the intervention is aware of the treatment thus the participant perception can be influenced along with the expectation from both the participant and administrator (Colloca 2019; Hróbjartsson, Kaptchuk and Miller 2011). Participant consent in the investigation and the intervention administered plays a vital role in the placebo effect as there are invasive interventions such as manipulation under anaesthesia, intravenous injections and in some cases blood tests. Participant consent can negatively influence the recruitment and enrolment of participants as it is part of their informed consent. The participants of Carette *et al.* (2003) were allocated into four groups, whereby one of the groups was a placebo (*viz.*, saline injection alone). The study design outlined the use of a double blinding protocol as the hospital pharmacist at each site managed the patient allocation into groups and the preparation of the injection for the administering radiologist.

- c. Memory recall can influence the participant's ability to report clinical improvement. In cases where subjective clinical outcomes are utilised, participants involved are likely to recall previous outcomes and may alter their responses based on their perception of improvement compared to the actual clinical presentation or response. Chen, Wang and Xu (2023) reported poor cognitive performance in patients with chronic pain. Furthermore, elderly patients with chronic pain present with memory deficits, cognitive impairments, and dysfunction (van der Leeuw *et al.* 2018; Oosterman *et al.* 2011). Lilje *et al.* (2014) discussed the case report of a young woman diagnosed with adhesive capsulitis, who received treatment for a duration of two years. The patient received various treatments from healthcare providers prior to experiencing relief of symptoms; furthermore, the patient was required to recall the treatments and outcome measurement tools.
- d. The use of touch therapy is vital in many manual therapies as there is physical contact, which facilitates the interoceptive awareness of the patient and influencing the pain threshold (Keel and Caviglia 2023). Melzack and Wall (1965) postulated that patients were more likely to respond better to treatment interventions involving physical therapy when compared to non-contact interventions, therefore having a better satisfaction rate. The increase in normal touch sensory information allows an inhibition of pain fibres, subsequently reducing pain perception (Ropero Peláez and Taniguchi 2016). Geri *et al.* (2019) postulated the blinding of therapist and participant when manual therapy or touch therapy was involved in the intervention process. Furthermore, the release of oxytocin can be stimulated by touch therapy thus, may contribute to the patients experiences (D'Alessandro *et al.* 2022). Touch therapy can be interpreted into various categories, such as stretching, Proprioceptive Neuromuscular Facilitation (PNF), and assisting the participant in the general movements; furthermore, the application can be identified in several of the studies included in this systematic review. The human touch can be interpreted as a form of communication by the participant and may alter the pain perception experienced.
- e. Pain tolerance and pain threshold plays a crucial role in measuring the subjective clinical outcomes. Factors such as age, gender, and previous history of pain-related conditions are likely to impact the pain outcome measures (Lobo *et al.* 2017; Lund *et al.* 2005; Chesterton *et al.* 2003). Edwards *et al.* (2003) postulated sex-related differences, specifically that females are at a higher risk for the development of chronic pain conditions and sensitivity to noxious stimulation. The choice of measurement tools played a significant role in the outcome measure of the study, specifically the measurement tools were selected in relation to the objectives of the study. The most common outcome measurement tools used for pain measurement were VAS, NPRS and the Constant Murley Assessment Score. Both the VAS and NPRS were measurement tools aimed to identify the pain intensity experienced by the participant, which is impacted by the individuals' pain tolerance and threshold.

- f. Treatment naïve refers to an individual that has not received any treatment for a specific pathology (Lee *et al.* 2024) or a participant who experienced a long wash-out period (known as “secondary naïve”) (Biggioggero *et al.* 2015). Mouton (2001) postulated the ideal study design to identify the true result of an intervention and the clinical effectiveness, was to include participants naïve to the intervention tested. In studies investigating the later stages of adhesive capsulitis, along with the studies assessing the long-term treatment effects (by the means of a prolonged follow-up period) were limited regarding patient naivety as the external influencers are likely to be present and influence the effects of the treatment (Carette *et al.* 2003).

5.9.4. The researcher-related factors that may influence the outcomes of the articles include the following:

- a. Schulz and Grimes (2018) hypothesized that some researchers may have a “for or against” attitude regarding the intervention, thus this may be projected to the study participants if the investigators are not blinded. Blinding of the researcher screening the patients in terms of the participant allocation to their groups reduces the possibility of researcher bias. When the researcher is blinded to the participant's specific group allocation (and therefore treatment), there will be reduced bias that impacts on the outcomes (Moustgaard *et al.* 2014). Previous research regarding patient informed consent and the “for or against” attitude is limited; however in studies such as Mengi (2021), whereby the participants were allocated to their respective groups based on their consent to the treatment, may perceive the received treatment differently, furthermore the subjective outcome measures may be reported differently.
- b. Blinding of the outcome measurer (also known as an assessor). The assessor should not be privy to the patient group allocation to reduce the potential for bias . Renjith (2017) postulated blinding of the outcome assessor will ensure impartial assessment of the outcome variable whereas unblinded assessors are likely to report favourable responses for the outcome variables of subjects in the intervention group (Schulz and Grimes 2018). Saber *et al.* (2022); Rawat, Eapen and Seema (2017); Carette *et al.* (2003) reported the use the assessors involved in the studies were blinded to the participants group allocation, thus reducing the bias in subjective outcome assessments (van der Ende *et al.* 2023).
- c. Blinding of the person administering the intervention (i.e. therapist) is important in a blinded RCT, especially in pharmacological investigations. Carette *et al.* (2003) conducted a double-blinded trial in which both participants and radiologist were blinded to the group allocations. However, blinding of a manual therapist was not feasible as they were the individuals administering the intervention for the participants.
- d. Protocol consistency throughout the investigation is rarely reported in RCTs but could easily be achieved by the use of manuals, meetings and specific training within the context of the given investigation. Therefore, creating a standardized methodology each researcher has to follow throughout the process and consequently improving the quality of clinical outcomes (Kendall 2003a; Carette *et al.* 2003).

5.9.5. Information related to the intervention that may interfere with the outcomes of the articles include the following:

- a. Duration of the study is an important factor especially in the design of a trial. In the instance of the intervention providing an immediate clinical effect. The design of pre-post study design can be applied but if the study requires changes in the fascial structures or histological changes, then a minimum of three months is needed for the clinical outcomes to be accurately measured (Fraser 2008). The duration of the study measurement protocol (i.e., the duration a participant is recruited into the study) may vary as the process of participant enrolment may take time or need to occur at different sites. However, the research needs to maintain a rigorous methodology in this situation to prevent bias from occurring. Maryam *et al.* (2012) experienced difficulty in participant recruitment thus the trial was stopped before each group comprised of 35 participants each. The statement was ambiguous as it was not clear if the participants were recruited at the same time of the study duration or at different stages of the study duration as seen in Patil, Sudha and Sidharth (2018). Nair (2019) reported several factors which influenced the design of the study along with the outcomes. The duration of the study was closely linked to the dropout rate, as a longer follow-up period led to less patients completing the study resulting in a compromised study power.
- b. Treatment protocols are required to be clearly documented. The details of the treatment protocol are crucial in the fulfilment of the intervention requirements. Furthermore, should there be an adjustment to the original protocol a record of the amendment is included in the study. The details are important as the variation of the applications can influence the clinical outcomes along with the identification of weak protocols to be rectified in further investigation thus preventing attrition bias (Jüni, Altman and Egger 2001). Changes to the pre-approved design of the RCT can be seen as a necessity in unforeseen circumstances. However, the changes are likely to increase the risk of bias if utilized with knowledge of the group allocation. Furthermore, the alterations need to be documented to provide transparency (Coskinas *et al.* 2020). Carette *et al.* (2003) indicated two different physiotherapy strategies was utilized based on the stage of adhesive capsulitis, which was determined by the number of symptoms present. The participants presenting with acute capsulitis received TENS, mobilization, active range of motion and cryotherapy. Comparatively, those with chronic capsulitis received ultrasound, heat, mobilization, range of motion techniques, isometric strengthening exercises and ice application. Two of the four groups were allocated to receive physiotherapy treatment; however, the stage of capsulitis was not reported along with the physiotherapy strategies used. In studies such as Yildiz *et al.* (2017), Wahyuni, Nurdina and Indasah (2020); Shetty and Shah (2020), the reported methodology and treatment protocol was limited, thus the overall representation of the clinical effectiveness may be misrepresented; thus a high likelihood for reporting bias.

- c. A wash-out period refers to the time period in which a prospective participant should not receive treatment for the condition prior to being involved in the investigation (Roberts, Dusetzina and Farley 2015). The wash-out period can be referred to as a run-in period if the treatment used by the participants were discontinued prior to the investigation. The use of a wash-out period eliminates potential external factors which may influence the outcome measures. Waldburger, Meier and Gobelet (1992) reported the evidence based on the aetiology of adhesive capsulitis (specifically groups classified into-idiopathic, post traumatic and neurological). Furthermore, two participants recruited into the study failed to complete the study as one passed away and the other experienced adverse effects of the salmon calcitonin injections. The evidence failed to provide the medications utilised by the participants in the post-traumatic and neurological subgroups.
- d. The stage of the disease in relation to the treatment received. The stage of adhesive capsulitis amongst the participant group allocation was required to be unanimous, to identify the effect of the desired intervention. The design of Carette *et al.* (2003) outlined two of the four groups were to receive physiotherapy interventions based on the symptoms the participant experienced, however the stage capsulitis of the participants was not disclosed. Faruqui *et al.* (2015) utilised purposeful sampling to allocate the participants into two groups of acute and chronic symptoms in order identify the intervention. However, the interventions utilised were two different interventions. Based on the evidence gathered in this systematic review, the evidence in support of stage specific treatment. This statement will be discussed in the sixth chapter.

5.9.6. The relationship between the intervention and measurement/data collection points may influence the outcomes of the included articles. Key factors include the following :

- a. Timing of the measurement protocols. The timing of data collection in relation to the intervention is crucial for accurately reflecting the treatment effects. The use of a pre-post study design provides the immediate effect of the intervention (Shetty and Shah 2020; Metgud, Naik and Heggannavar 2017). However, the measurement at the baseline and end of the treatment protocol provides the long-term result (Celik 2010; Carette *et al.* 2003).
- b. The clinical effect of the intervention must be given sufficient time to manifest. Literature indicates that the measurable muscular adaptations typically require at least six to eight weeks to develop (Del Vecchio *et al.* 2019). Therefore, assessments of muscle strength will only provide an accurate reflection of the intervention's effect after this period has passed. In designs utilising a corticosteroid injection often take a few days to experience some form of relief, and in some instances the relief may last up to six weeks (Chesterton *et al.* 2018). The measurement frequency should be on par with this as seen in Maryam *et al.* (2012) and Carette *et al.* (2003) where the second measurement was conducted six weeks after the intervention treatment began. Waldburger, Meier and Gobelet (1992) utilised the salmon calcitonin injections daily for 21 days, McLaughlin, Awosika and Jialal (2023) reported the intramuscular injections reached peak plasma concentrations within 15 to 30 minutes after administration. However, the effects of

calcitonin were less effective after 24 to 48 hours. The frequency of measurement utilised by Waldburger, Meier and Gobelet (1992) were at baseline days; 7, 21, 60 and 180 but the immediate effect of the salmon calcitonin injection was not clearly investigated.

- c. The choice of control in the investigations. The use of unilateral verses bilateral measurements in the context of single-sided intervention can influence the outcomes. Evidence suggests that treating one side may affect both sides due to systemic and neurologically mediated effects (Villafañe, Cleland and Fernandez-De-Las-Penas 2013). . Using the untreated limb as a control may therefore compromise the comparison, as both limbs may respond to the intervention. The use of placebo as a control in RCTs is justified when determining clinical efficiency and in some instances safety profiles of new drugs (Ovosi, Ibrahim and Bello-Ovosi 2017). Carette *et al.* (2003) utilised saline injections as a control. However, both the administrator of the injection and patient were blinded as the syringes were covered in foil and prepared by an impartial individual. The participants received their allocated treatment and the control utilised was saline injections alone. Whereas, Faruqi *et al.* (2015) did not have a control group as both the groups were experimental and received a different intervention with the addition of physiotherapy interventions and Maitland mobilizations. In some cases, the controls utilised physiotherapy treatments in all the groups and in relation to the TENS, the participants received TENS therapy.

5.9.7. Statistical considerations that may influence the outcomes of the articles may include:

- a. Intention to treat analysis is a statistical analysis which suggests an outcome based on either the calculated clinical trajectory or the changes seen in the group to which the participant was allocated. The concept of intention to treat includes the analysis of all subjects involved in the randomization. However, it fails to acknowledge the possibility of noncompliance, variation of the protocol, participant withdrawal or dropout along with any bias which may occur after the allocation process (Gupta 2011; Montori and Guyatt 2001). In a RCT design, the use of CONSORT diagram depicts the relationship of the participants in relation to the study duration and design, depicting the participant dropouts and loss in the process. The use of the CONSORT diagram allows the data to be analysed as per intention to treat, per protocol or as treated.
- b. Participant dropouts from the investigation should be considered in the protocol design, as some of the designs do not have enough data to compute and intention to treat analysis, which will result in dropouts. The concept of dropouts in the context of a clinical trial refers to the state in which the observation is suspended or lost as a result of the participant not attending the scheduled visits of the investigation, or in some situations death (Jeon, Nam and Kim 2021). In clinical trials the data is usually collected longitudinally, however when data collection occurs periodically over time, a proportion of the data will be lost in the instance of participant dropouts (Lee 2008). Bell *et al.* (2013) reported the occurrence of dropouts in RCTs is common and may often influence the validity of the results, i.e. dropouts usually happen when they perceive that the intervention is not effective or that their clinical status is getting worse, so in essence the noted clinical outcomes of the study only represent the best-case scenario (as the dropout data is not included). Furthermore, the variation between dropout rates between treatment arms can

be referred to as differential dropout or attrition, which can also provide a form of bias to the results in some circumstances. Moher *et al.* (2010) went on to postulate the commonality of dropout is higher in those receiving interventions with potentially negative effects and can often lead to an inaccurate representation of the intervention effects. In study designs that compromised of numerous follow up sessions, the dropout rate increased as seen in Maryam *et al.* (2012); Carette *et al.* (2003) and Waldburger, Meier and Gobelet (1992).

- c. Parametric statistics are based on the assumptions made regarding the parameters (i.e., properties) of the population used. The concept development is based on the distribution shape in the underlying population (i.e., the assumption of a normal distribution and the parameters of the assumed distribution (i.e., mean, and standard deviations). The parametric statistical analysis used varies between the standard t-tests and analysis of variance (ANOVA). However, this is based on the assumption of the normal distribution mean and not of the data (Nordstokke 2014; Gattiker 2013). Comparatively, nonparametric statistics and tests are distribution free of the inferential statistics, making no assumptions. This is used when the test of normality indicates variables used are not normally distributed. The tests used for non-parametric testing are the Mann Whitney U-Test, paired t-test better known as the Wilcoxon Signed Rank Test (Gattiker 2013). The use of parametric statistics are more accurate in being able to draw conclusions in terms of statistical significance (usually more than 20 patients per group) non-parametric (usually less than 20 patients per group) can usually only comment on trends without the ability to reach significance (Kim 2015; Vickers 2005). Patil, Sudha and Sidharth (2018) utilized non-parametric statistics as the group allocation comprised of 8 participants each, furthermore SPADI was the outcome measurement tool used. The reported results of the study were based on the statistical analysis, with no elaboration of the baseline characteristics or measurements attributed to the study.

5.9.8. Outcome measure-related factors that may influence the articles include the following:

- a. Choice of outcome measures. The outcome measures utilised need to be appropriate for measuring the change in the clinical presentation of the patient based on the effects of the intervention. An outcome is a measurement of the effect of an intervention on the participants functional and clinical status (Wang and Bakhai 2006). Furthermore, in an RCT, the outcome measurement provides information regarding the effect of the intervention investigated. The possibility of bias can occur in the situation where the method of measuring the outcome was inappropriate-e.g. using ROM to measure effects of a thermal intervention. The measurement of the outcome varied between the allocated groups (Higgins, Altman and Sterne 2011) as seen in Faruqui *et al.* (2015) where the allocated groups were two different pathological stages of adhesive capsulitis, yet the same measurement tools were utilised for both groups. Comparatively, Wahyuni, Nurdina and Indasah (2020) reported pain experienced by the participant yet the measurement tool was not reported. Similar instances of standardised outcome measures was identified in Hui (2016) whereby the range of motion was measured by

anatomical landmarks, yet the results discussed pain and activities of daily living (ADLs) with no mention of the measurement tool used.

- b. Validity, reliability, and sustainability describe how well a measurement tool captures true change in a patient's condition. These concepts indicate whether the tool measures what it is supposed to measure, produces consistent results, and remains useful over time. Together, they indicate how accurately the outcome measure reflects clinical change (Bahreini *et al.* 2020). However, the use of a valid and reliable tool in measuring range of motion when the intervention is a thermal intervention negates the validity and reliability in being able to measure accurate clinical effect. Wahyuni, Nurdina and Indasah (2020) utilised the goniometer for the measurement of ROM of the shoulder and reported the measurement of pain along with the functional activity capability without the measurement tool use. In instances such as these, the production of the results in the future would be difficult.
- c. The outcome measures must align with the study's objectives to allow accurate conclusions about the effectiveness of the interventions being investigated (Kapoor and Goyal 2023). Outcome measures utilised in this systematic review included; self-reported measures (Kyte *et al.* 2015), performance-based measures (Bean *et al.* 2011), and clinician-reported measures (Powers *et al.* 2017). Waldburger, Meier and Gobelet (1992) provided a good illustration for the use of both subjective objective outcome measurement tools, as the measurement tools included imaging studies, blood work along with pain and range of motion. The use of various outcome measurement tools reported the clinical efficacy of salmon calcitonin on the participants recruited into the study. Comparatively, Hui (2016) limited the outcome measurement tools as anatomical landmarks was used to measure the change in range in motion. The results of the case study reported changes in pain, ADLs and range of motion, yet all the tools utilized were not disclosed.
- d. The equilibrium of both objective and subjective outcome measurements is vital in the representation of the clinical outcomes (Moustgaard *et al.* 2014). Mobbs (2021) postulated objective outcome assessments overcome the shortcomings of the subjective measures, which are measures reported by the patient and can have poor reliability, recollection and may report bias along with the lack of capacity for continuous assessment (Chang, Gillespie and Shaverdian 2019). The SPADI demonstrated favourable validity and reliability properties in a study focused on idiopathic adhesive capsulitis (Venturin *et al.* 2023), supporting the use of SPADI as a single outcome measure in Patil, Sudha and Sidharth (2018). However, the use of SPADI was deemed a subjective outcome measurement tool Breckenridge and McAuley (2011), as the questionnaire measured the patient's perception of shoulder pain and disability.

Calibration of the outcome measurement tool is vital in reporting the clinical outcomes accurately. The calibration is not only important for the equipment used but for the researchers and participants involved in the investigation. The researchers involved in the investigation are to be trained as to how to conduct themselves whilst involved in the investigation, interaction with the participants and how to use the intervention administered. In addition, to note the measurement

outcomes along with how to analyse the received information. The participants involved in the investigation are to be taught how to report their symptoms accurately to the assessor. Treister *et al.* (2018) postulated participants who received training regarding their pain reporting, presented with lower variability scores and discrimination of drug use (active or placebo) compared to those who did not undergo training. The information discussed in the above points were used in the analysis of the articles included in this systematic review.

5.10. Conclusion

The various applications of TENS were depicted in Table 5.1, emphasising the limited evidence the use of TENS as a single treatment intervention, as only one article was noted. The single treatment intervention reported favourable results; however, the study did not evaluate the long-term effects of the modalities.

Given the review of the treatment options available and the evidence provided by the articles in Tables 5.2 and 5.3 indicated the application of TENS as a single treatment intervention and multimodal treatment protocols including TENS, provided moderate evidence for favourable clinical outcomes. Due to the multimodal design of these studies, the results were reported based on the overall treatment protocols received by the participants, rather than detailing the specific involvement of TENS. The inclusion of TENS in a multimodal treatment protocol provided limited information regarding the favourable interventions, due to numerous modalities included in the various interventions.

In addition, the application of TENS in the articles were reported in Tables 5.4 and 5.5. The TENS settings, session duration and electrode placement were limited as the information was not provided by all of the included articles. The evidence was inconclusive due to the conflicting protocols reported, thus the evidence in support of a specific electrode placement and settings was limited for both TENS alone and as a combination treatment.

The stage of adhesive capsulitis played a pivotal role in the clinical effectiveness of the interventions, as seen in Table 5.6. The majority of studies were conducted on participants diagnosed in the early stages (i.e., the first two stages). The generalised protocol utilised in the management of the early stages comprised of all the participants receiving TENS either as the part of the physiotherapy protocol or as an additional modality in the treatment.

Based on the evidence, the addition of TENS to the physiotherapy protocol provided favourable results, however the clinical effectiveness of specifically TENS in the protocol was unclear; thus, recommendations are suggested to investigate this phenomenon.

Chapter Six: Conclusion and Recommendations

6.1. Introduction

To conclude this systematic review, this chapter blends the findings of chapters four and five to present future recommendations for practitioners utilizing TENS.

6.2. Conclusions

As outlined in Chapter One, this study aimed to evaluate the current evidence supporting the use of TENS in the management of adhesive capsulitis. A systematic search identified 23 eligible articles, which were assessed using appropriate measurement scales by the researcher and appointed reviewers. In Chapter Four, the studies were ranked based on internal validity (reviewer assessments) and external validity, with both forms considered in relation to their impact on clinical outcomes. These evaluations revealed that while TENS was frequently used in combination with other interventions, the evidence supporting its standalone effectiveness remains limited.

Using the AGREE criteria (Dagenais & Haldeman, 2011) and GRADE evidence profiles (Guyatt et al., 2011) in Chapter Five, it became clear that combination therapies did not allow the therapeutic effect of TENS to be isolated, highlighting a significant gap in the literature. This underscores the need for further high-quality research to strengthen the evidence base, inform clinical decision-making, and support the informed consent process.

6.3. Additional recommendations

6.3.1. Recommendations to improve this systematic review

In future systematic reviews, the reviewers should be familiarised with the relevant measurement scales before the review begins. A mock review using an article not included in the final analysis would be beneficial, as it allows the reviewers to practice the application of the scales, thereby reducing the variability and potential bias. The reviewers should also receive clear documentation outlining the requirements of each scale (Appendices H, I; and J), as was done in this systematic review.

Future projects could allocate a larger research budget to allow the inclusion of non-English articles (to employ a translator), which would increase the number of eligible studies and enhance the overall value of the review.

Furthermore, two independent researchers should conduct the initial database searches to minimise bias and ensure all the potentially relevant studies are identified and included.

6.3.2. Recommendations for future studies

Future studies in this domain should use the prescribed guidelines in respect to the studies published (i.e. CONSORT for the RCT studies) (Moher *et al.* 2010), STROBE guidelines for nRCTs (Cuschieri 2019), and the CARE guidelines for case series or case reports (Gagnier *et al.* 2013). By utilizing the

prescribed guidelines, one will ensure the methodological rigour of the studies were of a high standard and would consider factors such as homogeneity of the participants and environment, recruitment and randomisation of the participants, along with relevant outcome measurement tools in respect to the interventions tested.

Considering the limitations discussed in chapters four and five, the lack of information pertaining to the parameters of TENS and the use of TENS alone failed to provide the ideal treatment protocol for one to follow when managing a patient with adhesive capsulitis. Furthermore, paired with the lack of information regarding the electrode placement, frequency or duration of the treatment, practitioners are provided with inconsistent and limited information. Future studies should be more specific with this as the main objective. The patient homogeneity of the participants varied, as discussed in chapter four. Future studies should outline a strict eligibility criterion to prevent a large, generalised recruitment of participants. Consequently, this may skew the data as the potential for bias and external influences increases and not provide a true clinical result.

6.3.3. Recommendations for practitioners

Based on the conclusions noted in chapter six, along with the limitations outlined in both chapter four and five, the evidence in support of TENS in treating adhesive capsulitis was limited. Therefore, healthcare practitioners should consider the limited evidence when applying the use of TENS in the management of adhesive capsulitis, particularly with regards to evidence-based practice and patient informed consent.

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Appendices

Appendix A: FRC Approval

	
7 December, 2020 Ms G Goorchuran Student No: 21214159 34 Swapo Road Broadway Durban North 4051 Dear Ms Goorchuran <u>MASTER OF TECHNOLOGY: CHIROPRACTIC</u> I am pleased to advise that: 1. The Faculty Research Committee approved the following: (i) Your research proposal and dissertation title, being: The effectiveness of transcutaneous electrical nerve stimulation on Adhesive Capsulitis: A systematic review. Please note: <u>ANY PROPOSED CHANGES</u> in the <u>DISSERTATION TITLE</u> require the approval of your supervisor and the Faculty Research Committee. (ii) Supervisor – Dr C Korporaal Co-supervisor – Dr A van der Meulen 2. Your request for funding totalling R 8 000.00 subject to any literature referred to in Section A of the PG 4a form being accessioned by this University, and any equipment purchased shall become the property of the department. NOTE: - This funding is not paid directly to you but is controlled by the Faculty Office. Any proposed changes to this funding allocation needs the approval of your supervisor, and Faculty Research Committee The University Research Committee has stipulated that: (a) Ownership of any patent registered in respect of the results of your Master's studies is	

retained by you as the initiator of the project;

(b) Should you make any drift from the results of your Master's studies, you will be required to repay pro rata, the **R 8 000.00** investment which the University Research Committee has made in approving your request for funding;

(c) If the Durban University of Technology provided the equipment/materials for the creation of artefacts, this cost would be refunded to the University if such artefacts were sold and

(d) Durban University of Technology is given first refusal in respect of any possible future sale by you of any patent that may be registered in respect of your said project.

(e) All journal articles, referenced in your dissertation, are to accompany your ring-bound copies when submitting for examination purposes.

Should you experience any problems relating to your research studies, your supervisor must be informed as soon as possible. If the difficulty persists, you must then approach your Head of Department and thereafter the Executive Dean of the Faculty.

Yours sincerely



Ms S Perumal
FACULTY RESEARCH OFFICER

Student's signature in acceptance
of the conditions contained herein.

Date:

Appendix B: DALRO Letter 1



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Durban University of Technology
P O Box 1334
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REPROGRAPHIC REPRODUCTION RIGHTS QUOTATION: 12/11/2020

QUOTATION NUMBER: 0000010643/01

LICENSING ENTITY: DURBAN UNIVERSITY OF TECHNOLOGY
 LECTURER: GENISTA GOORCHURAN
 DEPARTMENT: CHIROPRACTIC
 DISSEMINATION: COURSEPACK
 USAGE PERIOD: 01/06/2020 - 31/12/2020



Item	Title	Units	Pages	Copies	Rate	VAT Excl.	VAT	VAT Incl.
001/ 001	ARTHRITIS AND RHEUMATISM INTRAARTICULAR CORTICOSTEROIDS, SUPERVISED PHYSIOTHERAPY, OR A COMBINATION OF THE TWO IN THE TREATMENT OF ADHESIVE CAPSULITIS OF THE SHOULDER: A PLACEBOCONTROLLED TRIAL (CARETTE Simon (et al.)) 160283	3	10	30	R1.07	R42.63 *	R6.39	R49.02
002/ 002	JOURNAL OF PHYSICAL THERAPY SCIENCE ACUTE EFFECT OF SCAPULAR PROPRIOCEPTIVE NEUROMUSCULAR FACILITATION (PNF) TECHNIQUES AND CLASSIC EXERCISES IN ADHESIVE CAPSULITIS: A RANDOMIZED CONTROLLED TRIAL (BALCI Nilay (et al.)) 160286	3	9	27	R1.07	R42.63 *	R6.39	R49.02
003/ 003	SPINAL CORD COMPARISON OF THE OUTCOMES OF TWO DIFFERENT EXERCISE PROGRAMS ON FROZEN SHOULDER (CELIK Derya) 160288	3	4	12	R1.07	R42.63 *	R6.39	R49.02
004/ 004	JOURNAL OF ORTHOPAEDICS EFFECTIVENESS OF TRANSCUTANEOUS ELECTRICAL NERVE STIMULATION AND INTERFERENTIAL ELECTROTHERAPY IN ADHESIVE CAPSULITIS (DEWAN Anil, SHARMA R.) 160290	3	8	24	R1.07	R42.63 *	R6.39	R49.02

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005/ 005	PLOS ONE ADDITION OF LIDOCAINE INJECTION IMMEDIATELY BEFORE PHYSIOTHERAPY FOR FROZEN SHOULDER: A RANDOMIZED CONTROLLED TRIAL (HSU Wei-Chun (et al.)) 160292	3	15	45	R1.07	R48.15	R7.22	R55.37
006/ 006	JOURNAL OF ADVANCES IN MEDICINE AND MEDICAL RESEARCH EFFECTIVE TREATMENT OF ADHESIVE CAPSULITIS UTILIZING SOFT TISSUE AND JOINT MANIPULATION—A CASE STUDY (Hui Timothy) 160294	3	5	15	R1.07	R42.63 *	R6.39	R49.02
007/ 007	INDIAN JOURNAL OF PUBLIC HEALTH RESEARCH AND DEVELOPMENT EFFECT OF TRACTION VERSUS COUNTER TRACTION WITH CONSERVATIVE TREATMENT ON ADHESIVE CAPSULITIS (ANANDH S., LAD Divya) 160297	3	5	15	R1.07	R42.63 *	R6.39	R49.02
008/ 008	BMJ CASE REPORTS PAIN RELIEF IN A YOUNG WOMAN WITH ADHESIVE CAPSULITIS AFTER MANUAL MANIPULATION OF THE ACROMIOCLAVICULAR JOINT FOR REMAINING SYMPTOMS AFTER MOBILISATION UNDER ANAESTHESIA (LILJE Sina (et al.)) 160299	3	4	12	R1.07	R42.63 *	R6.39	R49.02
009/ 009	JOURNAL OF HAND THERAPY EFFECT OF ROTATOR CUFF STRENGTHENING AS AN ADJUNCT TO STANDARD CARE IN SUBJECTS WITH ADHESIVE CAPSULITIS: A RANDOMIZED CONTROLLED TRIAL (RAWAT Pallavi (et al.)) 160301	3	7	21	R1.07	R42.63 *	R6.39	R49.02
010/ 010	INDIAN JOURNAL OF PHYSICAL THERAPY AND RESEARCH RANDOMIZED CONTROLLED TRIAL TO COMPARE THE EFFECT OF MUSCLE ENERGY TECHNIQUE WITH CONVENTIONAL THERAPY IN STAGE II ADHESIVE CAPSULITIS (METGUD Santosh, REDDY B. Chakradhar) 160302	3	6	18	R1.07	R42.63 *	R6.39	R49.02

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011/ 011	JOURNAL OF NOVEL PHYSIOTHERAPIES EFFECTIVENESS OF MULLIGAN'S MWN VERSUS MUSCLE ENERGY TECHNIQUE IN STAGE II ADHESIVE CAPSULITIS- A RANDOMIZED CLINICAL TRIAL (METGUD Santosh) 160304	3	7	21	R1.07	R42.63*	R6.39	R49.02
012/ 012	WORLD WIDE JOURNAL OF MULTIDISCIPLINARY RESEARCH AND DEVELOPMENT MOBILIZATION VS ELECTROTHERAPY IN ADHESIVE CAPSULITIS SHOULDER (SUBRAMANIAN S.) 160305	3	3	9	R1.07	R42.63*	R6.39	R49.02
013/ 013	CLINICAL RHEUMATOLOGY FROZEN SHOULDER: DIAGNOSIS AND TREATMENT. PROSPECTIVE STUDY OF 50 CASES OF ADHESIVE CAPSULITIS (WALDBURGER M, MEIER J -L, Gobelet C) 160312	3	5	15	R1.07	R42.63*	R6.39	R49.02
014/ 014	INTERNATIONAL JOURNAL OF RESEARCH IN PHARMACEUTICAL SCIENCES EFFECTIVENESS OF ACTIVE RELEASE TECHNIQUE AND MUSCLE ENERGY TECHNIQUE IN ADHESIVE CAPSULITIS (YATHEENDRA Kumar) 160316	3	6	18	R1.07	R42.63*	R6.39	R49.02
015/ 015	ORTHOPAEDIC JOURNAL OF SPORTS MEDICINE COMPARISON OF THE EFFECTIVENESS OF PHYSICAL AND ELECTROTHERAPY MODALITIES VERSUS HOME EXERCISES PROGRAM ON FROZEN SHOULDER (YILDIZ Abdurrahim (et al)) 160318	3	1	3	R1.07	R42.63*	R6.39	R49.02
TOTALS:		45	95	285		R644.97	R96.68	R741.65

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002/ 002	King Edward Medical University, Lahore. Annals PAIN MODULATION IN FROZEN SHOULDER -ELECTROTHERAPY VERSUS EXERCISE THERAPY	DALRO DOES NOT CONTROL COPYRIGHT IN WORK	NO AGREEMENT WITH TERRITORY
003/ 003	EVALUATION OF MULLIGAN'S TECHNIQUE FOR ADHESIVE CAPSULITIS OF THE SHOULDER	DALRO DOES NOT CONTROL COPYRIGHT IN WORK	NO AGREEMENT WITH TERRITORY
004/ 004	Pakistan Journal of Medical Sciences Quarterly COMPARISON OF CORTICOSTEROID INJECTIONS, PHYSIOTHERAPY, AND COMBINATION THERAPY IN TREATMENT OF FROZEN SHOULDER	DALRO DOES NOT CONTROL COPYRIGHT IN WORK	NO AGREEMENT WITH TERRITORY

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Appendix C: DALRO Letter 2



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002/ 002	EUROPEAN INTERNATIONAL JOURNAL OF SCIENCE AND TECHNOLOGY: ELUST EFFECTS OF MOBILIZATION IN SUB-ACUTE AND CHRONIC FROZEN SHOULDER (ADHESIVE CAPSULITIS) MANAGEMENT (FARUQUI M. (et al)) 166821	2	10	20	R1.16	R46.50 *	R6.98	R53.48
003/ 003	INTERNATIONAL JOURNAL OF APPLIED RESEARCH EFFECT OF MCKENZIE METHOD OF MECHANICAL DIAGNOSIS AND THERAPY (MDT) VERSUS MAILAND MOBILIZATION IN INDIVIDUALS WITH STAGE II ADHESIVE CAPSULITIS: A RANDOMIZED CLINICAL TRIAL (NAIK S., METGUD S., HEGGANNANAVAR A.) 166823	2	5	10	R1.16	R46.50 *	R6.98	R53.48

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005/ 005	INDIAN JOURNAL OF PHYSIOTHERAPY AND OCCUPATIONAL THERAPY COMPARITIVE STUDY ON THE EFFICACY OF END RANGE MOBILIZATION TECHNIQUES IN TREATMENT OF ADHESIVE CAPSULITIS OF SHOULDER, A (SHARAD K.S.) 166826	2	4	8	R1.16	R46.50 *	R6.98	R53.48
006/ 006	INDIAN JOURNAL OF PHYSIOTHERAPY AND OCCUPATIONAL THERAPY EFFECT OF MAITLAND TECHNIQUE (POSTERIOR GLIDE) WITH MUSCLE ENERGY TECHNIQUE FOR SUBSCAPULARIS MUSCLE ON ADHESIVE CAPSULITIS (SHETTY S.S., SHAH R.R.) 166827	2	6	12	R1.16	R46.50 *	R6.98	R53.48
007/ 007	INTERNATIONAL JOURNAL OF CURRENT RESEARCH AND REVIEW STUDY PROTOCOL OF COMPARATIVE STUDY ON EFFICACY OF NARMA CHIKITSA, AGNIKARMA AND PHYSIOTHERAPY IN AVABAHUKA (FROZEN SHOULDER). THE (DESHIPANDE A. (et al)) 166831	2	5	10	R1.16	R46.50 *	R6.98	R53.48
TOTALS:		14	49	98		R325.50	R48.86	R374.36

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002/ 002	EGYPTIAN JOURNAL OF HOSPITAL MEDICINE DOES ULTRASOUND-GUIDED CONTINUOUS SUPRASCAPULAR NERVE BLOCK AFFECT FROZEN SHOULDER REHABILITATION PROGRAMME OUTCOME?	DALRO DOES NOT CONTROL COPYRIGHT IN WORK	NO AGREEMENT WITH TERRITORY
003/ 003	EFFECTIVENESS VARIATION GIVING SWID, TENS, MANIPULATION THERAPY, EXERCISE TO REDUCE PAIN, INCREASE RANGE OF MOTION, IMPROVE FUNCTIONAL ABILITY ON FROZEN SHOULDER IN DR. SOEPRAOEN MALANG HOSPITAL	DALRO DOES NOT CONTROL COPYRIGHT IN WORK	NO AGREEMENT WITH TERRITORY

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Appendix D: PROSPERO Registration

12/7/24, 12:00 PM

PROSPERO

You have 1 records

My other records

These are records that have either been published or rejected and are not currently being worked on.

ID	Title	Status	Last edited
CRD42021225175	The effectiveness of transcutaneous electrical nerve stimulation on Adhesive Capsulitis: A systematic review To enable PROSPERO to focus on COVID-19 registrations during the 2020 pandemic, this registration record was automatically published exactly as submitted. The PROSPERO team has not checked eligibility.	Registered	20/01/2021

Appendix E: Memorandum of Agreement

Memorandum Agreement

Title of Research Study: The effectiveness of transcutaneous electrical nerve stimulation on Adhesive Capsulitis: A systematic review

Principle investigators: Miss Genista Goorchuran (Researcher)

Co-investigators: Dr C. Korporaal (Supervisor); Dr A van der Meulen (co-supervisor)

Brief Introduction and Purpose of the Study:

This study is a systematic review of literature pertaining to the management of adhesive capsulitis using transcutaneous electrical nerve stimulation. Articles are collected electronically via databases by the researcher, the articles included into the study are divided into different study types, of those randomised controlled clinical trials, non-randomized clinical trials and observational studies are included in this study. Grouped articles are to be reviewed by a panel of three of five blinded reviewers, using rating scales (specific to the study types listed above) and feedback from reviewers is collated and presented in a statistical presentation.

Outline of Procedures:

Reviewers will receive articles which have been grouped according to study type (Randomized clinical trials, Nonrandomised clinical trials, Observational studies) as well as the corresponding scale rating sheet (Randomized clinical trials – PEDro scale, Non-randomised clinical trials – Newcastle-Ottawa scale or Observational studies – Liddle scale) as well as an explanation sheet for each scale. The reviewer will then individually rate the articles according to its corresponding scale. Rating sheets are collected and collated for statistical analysis. A determined time period (9 weeks) will be recommended for each article/group of articles review for feedback.

Benefits:

Publication of the study: Should this study be published, all persons participating in the study will be included in the publication. Should the reviewer wish to be exempt from this, please strike through the paragraph and initial alongside.

Remuneration:

An honorarium of R1, 000.00 will be awarded to each reviewer in appreciation of their time and dedication to this project. This will be made at the conclusion of this research project once submission for final marking has been completed. Contact persons: Please do not hesitate to contact either the supervisor and/or researcher regarding any questions or queries via the following methods:

Dr. Charmaine Korporaal (Supervisor):
Telephone: 031 373 2611
Cell no.: 083 463 3562
E-mail: charmak@du.ac.za

Miss Genista Goorchuran (Researcher)
Cell No.: 072 614 0014
E-mail: genistag@gmail.com

Dr. Anthony van der Meulen (Supervisor):
E-mail: anthony@vukukhanye.org
Telephone no: 0832332924

Statement of Agreement to Participate in the Research Study:

I (Subject's full name), (Identity number), have read this document in its entirety and understand its contents. Where I have had any questions or queries, these have been explained to me by to my satisfaction. Furthermore, I voluntarily agree to participate in this study as a reviewer.

Reviewer's name: Reviewer's signature: Date:

Supervisor name: Supervisor signature: Date:

Co-supervisor name: Supervisor signature: Date:

Researcher name: Researcher signature: Date:

Appendix F: Letter approaching reviewer

Dear (reviewer name)

Re: The effectiveness of transcutaneous electrical nerve stimulation on Adhesive Capsulitis: A systematic review

My name is Genista Goorchuran, I am currently conducting a systematic review as part of my master's studies at the Durban University of Technology. I have been referred to you by your colleague regarding your interest in the field of research, shoulder adhesive capsulitis, upper extremity disorders, shoulder pain, transcutaneous electrical nerve stimulation, electrical nerve stimulation and/or systematic reviews.

I read your work on... And your interest in (insert here)

Brief Introduction and Purpose of the Study:

This study is a systematic review of literature pertaining to the management of adhesive capsulitis using transcutaneous electrical nerve stimulation. Articles are collected electronically via databases by the researcher, the articles included into the study are divided into different study types, of those randomised controlled clinical trials, non-randomized clinical trials along with observational studies are included in this study. Grouped articles are to be reviewed by a panel of three of five blinded reviewers, using rating scales (specific to the study types listed above) and feedback from reviewers is collated and presented in a statistical presentation.

Outline of Procedures:

Reviewers will receive articles which have been grouped according to study type (Randomized clinical trials, Nonrandomised clinical trials and observational studies) as well as the corresponding scale rating sheet (Randomized clinical trials – PEDro scale, Non-randomised clinical trials – Newcastle-Ottawa scale, Observational studies – Liddle scale) as well as an explanation sheet for each scale. The reviewer will then individually rate the articles according to its corresponding scale. Rating sheets are collected and collated for statistical analysis. A determined time period will be recommended for each article/group of articles review for feedback.

Benefits:

The reviewer's identity will remain anonymous throughout the reviewing process.

In the instance of this study be published, all persons participating in the study have the option of being included in the publication as authors. Should the reviewer wish to be exempt from this, please strike through the paragraph and initial alongside.

Remuneration:

An honorarium of R1, 000.00 will be awarded to each reviewer in appreciation of their time and dedication to this project. This will be made at the conclusion of this research project once submission for final marking has been completed.

In the instance of acceptance of the position of reviewer, the researcher will send the reviewer a Memorandum of agreement to sign and fax/ scan or email a secure pdf version to the researcher along with a copy of the reviewers curriculum vitae or a bio-sketch.

Please do not hesitate to contact either the supervisor and/or researcher regarding any questions or queries via the following methods:

Dr. Charmaine Korporaal (Supervisor):
Telephone: 031 373 2611
Cell no.: 083 463 3562
E-mail: charmak@dut.ac.za

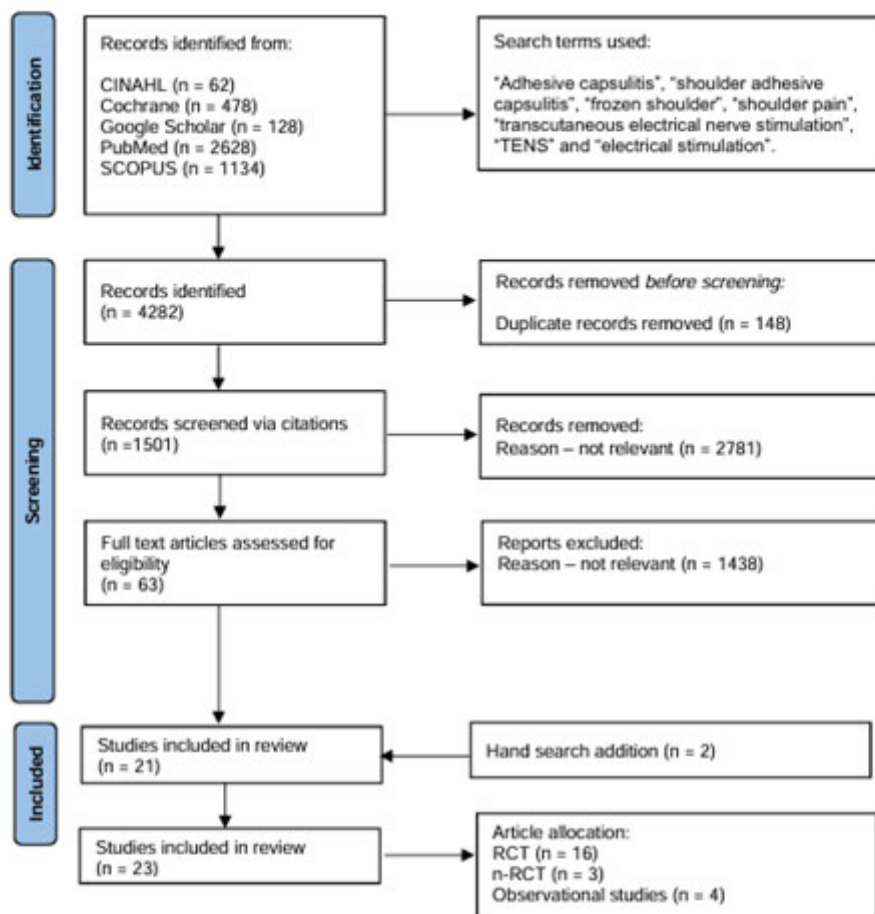
Miss Genista Goorchuran (Researcher)
Cell No.: 072 614 0014
E-mail: genistag@gmail.com

Dr. Anthony van der Meulen (Supervisor):
E-mail:
Telephone no: 0832332924

I look forward I would appreciate your assistance in the systematic review and look forward to hearing from you.

Kind regards,
Genista Goorchuran

Appendix G: PRISMA flow diagram



Source: Page MJ, et al. BMJ 2021;372:n71. doi: 10.1136/bmj.n71.

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Appendix H: PEDro Scale

PEDro scale

1. eligibility criteria were specified	no ☐ yes ☐ where:
2. subjects were randomly allocated to groups (in a crossover study, subjects were randomly allocated an order in which treatments were received)	no ☐ yes ☐ where:
3. allocation was concealed	no ☐ yes ☐ where:
4. the groups were similar at baseline regarding the most important prognostic indicators	no ☐ yes ☐ where:
5. there was blinding of all subjects	no ☐ yes ☐ where:
6. there was blinding of all therapists who administered the therapy	no ☐ yes ☐ where:
7. there was blinding of all assessors who measured at least one key outcome	no ☐ yes ☐ where:
8. measures of at least one key outcome were obtained from more than 85% of the subjects initially allocated to groups	no ☐ yes ☐ where:
9. all subjects for whom outcome measures were available received the treatment or control condition as allocated or, where this was not the case, data for at least one key outcome was analysed by "intention to treat"	no ☐ yes ☐ where:
10. the results of between-group statistical comparisons are reported for at least one key outcome	no ☐ yes ☐ where:
11. the study provides both point measures and measures of variability for at least one key outcome	no ☐ yes ☐ where:

The PEDro scale is based on the Delphi list developed by Verhagen and colleagues at the Department of Epidemiology, University of Maastricht (Verhagen AP et al (1998). *The Delphi list: a criteria list for quality assessment of randomised clinical trials for conducting systematic reviews developed by Delphi consensus. Journal of Clinical Epidemiology*, 51(12):1235-41). The list is based on "expert consensus" not, for the most part, on empirical data. Two additional items not on the Delphi list (PEDro scale items 8 and 10) have been included in the PEDro scale. As more empirical data comes to hand it may become possible to "weight" scale items so that the PEDro score reflects the importance of individual scale items.

The purpose of the PEDro scale is to help the users of the PEDro database rapidly identify which of the known or suspected randomised clinical trials (ie RCTs or CCTs) archived on the PEDro database are likely to be internally valid (criteria 2-9), and could have sufficient statistical information to make their results interpretable (criteria 10-11). An additional criterion (criterion 1) that relates to the external validity (or "generalisability" or "applicability" of the trial) has been retained so that the Delphi list is complete, but this criterion will not be used to calculate the PEDro score reported on the PEDro web site.

The PEDro scale should not be used as a measure of the "validity" of a study's conclusions. In particular, we caution users of the PEDro scale that studies which show significant treatment effects and which score highly on the PEDro scale do not necessarily provide evidence that the treatment is clinically useful. Additional considerations include whether the treatment effect was big enough to be clinically worthwhile, whether the positive effects of the treatment outweigh its negative effects, and the cost-effectiveness of the treatment. The scale should not be used to compare the "quality" of trials performed in different areas of therapy, primarily because it is not possible to satisfy all scale items in some areas of physiotherapy practice.

Last amended June 21st, 1999

Notes on administration of the PEDro scale:

- All criteria **Points are only awarded when a criterion is clearly satisfied.** If on a literal reading of the trial report it is possible that a criterion was not satisfied, a point should not be awarded for that criterion.
- Criterion 1 This criterion is satisfied if the report describes the source of subjects and a list of criteria used to determine who was eligible to participate in the study.
- Criterion 2 A study is considered to have used random allocation if the report states that allocation was random. The precise method of randomisation need not be specified. Procedures such as coin-tossing and dice-rolling should be considered random. Quasi-randomisation allocation procedures such as allocation by hospital record number or birth date, or alternation, do not satisfy this criterion.
- Criterion 3 *Concealed allocation* means that the person who determined if a subject was eligible for inclusion in the trial was unaware, when this decision was made, of which group the subject would be allocated to. A point is awarded for this criteria, even if it is not stated that allocation was concealed, when the report states that allocation was by sealed opaque envelopes or that allocation involved contacting the holder of the allocation schedule who was "off-site".
- Criterion 4 At a minimum, in studies of therapeutic interventions, the report must describe at least one measure of the severity of the condition being treated and at least one (different) key outcome measure at baseline. The rater must be satisfied that the groups' outcomes would not be expected to differ, on the basis of baseline differences in prognostic variables alone, by a clinically significant amount. This criterion is satisfied even if only baseline data of study completers are presented.
- Criteria 4, 7-11 *Key outcomes* are those outcomes which provide the primary measure of the effectiveness (or lack of effectiveness) of the therapy. In most studies, more than one variable is used as an outcome measure.
- Criterion 5-7 *Blinding* means the person in question (subject, therapist or assessor) did not know which group the subject had been allocated to. In addition, subjects and therapists are only considered to be "blind" if it could be expected that they would have been unable to distinguish between the treatments applied to different groups. In trials in which key outcomes are self-reported (eg, visual analogue scale, pain diary), the assessor is considered to be blind if the subject was blind.
- Criterion 8 This criterion is only satisfied if the report explicitly states *both* the number of subjects initially allocated to groups *and* the number of subjects from whom key outcome measures were obtained. In trials in which outcomes are measured at several points in time, a key outcome must have been measured in more than 85% of subjects at one of those points in time.
- Criterion 9 An *intention to treat* analysis means that, where subjects did not receive treatment (or the control condition) as allocated, and where measures of outcomes were available, the analysis was performed as if subjects received the treatment (or control condition) they were allocated to. This criterion is satisfied, even if there is no mention of analysis by intention to treat, if the report explicitly states that all subjects received treatment or control conditions as allocated.
- Criterion 10 A *between-group* statistical comparison involves statistical comparison of one group with another. Depending on the design of the study, this may involve comparison of two or more treatments, or comparison of treatment with a control condition. The analysis may be a simple comparison of outcomes measured after the treatment was administered, or a comparison of the change in one group with the change in another (when a factorial analysis of variance has been used to analyse the data, the latter is often reported as a group $\times$ time interaction). The comparison may be in the form hypothesis testing (which provides a "p" value, describing the probability that the groups differed only by chance) or in the form of an estimate (for example, the mean or median difference, or a difference in proportions, or number needed to treat, or a relative risk or hazard ratio) and its confidence interval.
- Criterion 11 A *point measure* is a measure of the size of the treatment effect. The treatment effect may be described as a difference in group outcomes, or as the outcome in (each of) all groups. *Measures of variability* include standard deviations, standard errors, confidence intervals, interquartile ranges (or other quantile ranges), and ranges. Point measures and/or measures of variability may be provided graphically (for example, SDs may be given as error bars in a Figure) as long as it is clear what is being graphed (for example, as long as it is clear whether error bars represent SDs or SEs). Where outcomes are categorical, this criterion is considered to have been met if the number of subjects in each category is given for each group.

Explanation for the use of PEDro scale for Randomised control trials (RCTs):

For the RCTs the most appropriate scale to use in order to assess it was the PEDro Scale. This scale focuses on eleven (11) criteria, each used to evaluate the strength of the methodology used in the studies to which the scale is applied. Each of the criteria filled contribute a single point, to a maximum of eleven (11) points and a minimum of zero (0) points. An average between the three (3) submissions (from the researcher and the 2 participants) per article were calculated. The mean score correlates with the strength of the methodological rigor. Should the article have received the highest score; eleven (11) across the 3 reviews, the highest methodological rigour can be assumed. In contrast, should the article have received the lowest score; zero (0) across the 3 reviews, the lowest methodological rigour can be assumed.

Appendix I: NOS Scale

NEWCASTLE - OTTAWA QUALITY ASSESSMENT SCALE NON-RANDOMISED CONTROL TRIALS

Note: A study can be awarded a maximum of one star for each numbered item within the Selection and Exposure categories. A maximum of two stars can be given for Comparability.

Selection

- 1) Is the case definition adequate?
 - a) yes, with independent validation *
 - b) yes, eg record linkage or based on self reports
 - c) no description
- 2) Representativeness of the cases
 - a) consecutive or obviously representative series of cases *
 - b) potential for selection biases or not stated
- 3) Selection of Controls
 - a) community controls *
 - b) hospital controls
 - c) no description
- 4) Definition of Controls
 - a) no history of disease (endpoint) *
 - b) no description of source

Comparability

- 1) Comparability of cases and controls on the basis of the design or analysis
 - a) study controls for _____ (Select the most important factor.) *
 - b) study controls for any additional factor * (This criteria could be modified to indicate specific control for a second important factor.)

Exposure

- 1) Ascertainment of exposure
 - a) secure record (eg surgical records) *
 - b) structured interview where blind to case/control status *
 - c) interview not blinded to case/control status
 - d) written self report or medical record only
 - e) no description
- 2) Same method of ascertainment for cases and controls
 - a) yes *
 - b) no
- 3) Non-Response rate
 - a) same rate for both groups *
 - b) non respondents described
 - c) rate different and no designation

The Newcastle-Ottawa Scale (NOS) for non-randomised control trials

Non-Randomised control trials (nRCTs):

For the nRCTs the most appropriate scale to use in order to assess it was the Newcastle-Ottawa Scale. The scale contains three headings: Selection, Comparability and Exposure. These headings had a variable number of questions (four, one and three respectively). Each question with a set of answers, to which the participant must select the answer most appropriate to the article being reviewed. Points are awarded accordingly; headings "selection" and "exposure" can each be awarded a maximum of one (1) point per question. The heading "comparability" may obtain a maximum of two (2) points. With all headings and questions completed a maximum total of nine (9) points may be awarded. An average between the three (3) submissions (from the researcher and the 2 participants) per article where calculated. The mean score correlates with the strength of the methodological rigor. Should the article have received the highest score; nine (9) across the 3 reviews, the highest methodological rigour can be assumed. In contrast, should the article have received the lowest score; zero (0) across the 3 reviews, the lowest methodological rigour can be assumed.

Appendix J: Liddle Scale

Liddle Scale Explanation

Case Reports/Series and Observational Studies

Codes for evaluation criteria:

<u>Evaluation criteria are coded according to the extent to which the criteria are fulfilled</u>	<u>Code</u>
Criterion entirely fulfilled	A
Criterion mostly fulfilled	B1
Criterion mostly not fulfilled	B2
Criterion not at all fulfilled	C
Criterion not described adequately to classify as a,b1,b2 or c	I
Criterion not applicable	n/a

Codes for overall assessment of quality of study checklists:

Low risk of bias	A	All or most evaluation criteria from the checklist are fulfilled. Where evaluation criteria are not fulfilled, the conclusions of the study are thought very unlikely to alter.
Low-moderate risk of bias	B1	Some evaluation criteria from the checklist are fulfilled. Where evaluation criteria are not fulfilled or are not adequately described, the conclusions of the study are thought unlikely to alter.
Moderate to high risk of bias	B2	Some evaluation criteria from the checklist are fulfilled. Where evaluation criteria are not fulfilled or are not adequately described, the conclusions of the study are thought likely to alter.
High risk of bias	C	Few or no evaluation criteria fulfilled. Where evaluation criteria are not fulfilled or are not adequately described, the conclusions of the study are thought very likely to alter.

Adapted from: Liddle, J., Williamson, M. and Irwig, I. 1996. Method for evaluating research and guideline evidence. New South Wales Department of Health, Sydney, Australia.

Liddle Scale: Case Report/Series

Reviewer:			
Article Title:			
EVALUATION CRITERIA FOR THE STUDY:		Comments:	Code Option: A, B1, B2, C, or I
1. Are the study participants well-defined in terms of time, place and person?			
2. What percentage of individuals refused to participate?			
3. Are outcomes measured in a standard, valid and reliable way?			
4. Are outcomes measured in the same way for both intervention and control groups?			
5. Are factors other than the intervention e.g. confounding factors, comparable between intervention and control groups and if not comparable, are they adjusted for in the analysis?			
6. What percentage of individuals recruited into the study are not included in the analysis? (loss to follow-up).			
7. Is the analysis by intention to intervene (treat)?			
8. Are results homogeneous between sites? (multicentre/multisite studies only).			
OVERALL ASSESSMENT OF THE STUDY:			
1. How well was the study done to minimise bias? IF coded as B1, B2 or C, what is the likely direction in which bias might affect the study results?			
2. Is the overall effect of the study due to the study intervention?			
3. Explain if there is any practical/ethical reason why an RCT cannot be done.			
4. Include any other comments			

Adapted from: Liddle, J., Williamson, M., and Inwig, L. 1996. Method for evaluating research and guideline evidence. New South Wales Department of Health, Sydney, Australia.

Appendix K: Master List of articles

<u>Author(s):</u>	<u>Year:</u>	<u>Title:</u>	<u>Study design:</u>
Balci, Yuruk, Zeybek, Gulsen and Tekindal	2016	Acute effect of scapular proprioceptive neuromuscular facilitation (PNF) techniques and classic exercises in adhesive capsulitis: a randomized controlled trial.	RCT
Carette, Moffet, Tardif, Bessette, Morin, Frémont, Bykerk, Thorne, Bell and Bensen	2003	Intraarticular corticosteroids, supervised physiotherapy, or a combination of the two in the treatment of adhesive capsulitis of the shoulder: A placebo-controlled trial.	
Celik	2010	Comparison of the outcomes of two different exercise programs on frozen shoulder.	
Dewan and Sharma	2011	Effectiveness of transcutaneous electrical nerve stimulation and interferential electrotherapy in adhesive capsulitis.	
Doner, Guven, Atalay and Celiker	2013	Evaluation of Mulligan's technique for adhesive capsulitis of the shoulder.	
Faruqui, Kazmi, Devi, Naqvi, Kumar, Rizvi and Puri	2015	Effects of mobilization in sub-acute and chronic frozen shoulder (adhesive capsulitis) management.	
Maryam, Zahra, Adeleh and Morteza	2012	Comparison of corticosteroid injections, physiotherapy, and combination therapy in treatment of frozen shoulder.	
Patil, Sudha and Sidharth	2018	Comparative efficacy of transcutaneous electrical nerve stimulation [TENS] and pendular exercises v/s ultrasound and rhythmic stabilization in clinically diagnosed frozen shoulder [adhesive capsulitis] using SPADI scale." A random study.	
Rawat, Eapen and Seema	2017	Effect of rotator cuff strengthening as an adjunct to standard care in subjects with adhesive capsulitis: A randomized controlled trial.	
Reddy and Metgud	2014	A randomized controlled trial to compare the effect of muscle energy technique with conventional therapy in stage ii adhesive capsulitis.	
Reddy and Metgud	2015	Randomized controlled trial to investigate the effect of mulligan's mwm and conventional therapy in stage ii adhesive capsulitis.	
Saber, Rashad, Eltnany and Shaat	2022	Does Ultrasound-Guided Continuous Suprascapular Nerve Block Affect Frozen Shoulder Rehabilitation Programme Outcome?	
Wahyuni, Nurdina and Indasah	2020	Effectiveness Variation Giving SWD, TENS, Manipulation Therapy, Exercise to Reduce Pain, Increase Range of Motion, Improve Functional Ability on Frozen Shoulder in Dr. Soepraoen Malang Hospital.	
Waldburger, Meier and Gobelet	1992	The frozen shoulder: diagnosis and treatment. Prospective study of 50 cases of adhesive capsulitis.	
Yatheendra Kumar, Sudhakar, Sudhan, Sivajyothi, Senthil Selvam and Deepthi	2017	Effectiveness of active release technique and muscle energy technique in adhesive capsulitis.	
Yildiz, Kuş, Mustafaoğlu and Argut	2017	The Comparison of The Effectiveness of Physical and Electrotherapy Modalities Versus Home Exercises Program on Frozen Shoulder.	
Lad and Anandh	2019	Effect of Traction Versus Counter Traction with Conservative Treatment on Adhesive Capsulitis.	nRCT
Mengi	2021	The Effect of Glenohumeral Joint Injection Prior to Physical Therapy on Treatment Outcomes in Adhesive Capsulitis.	
Shetty and Shah	2020	Effect of Maitland Technique (Posterior Glide) with Muscle Energy Technique for Subscapularis Muscle on Adhesive Capsulitis.	
Hui	2016	Effective treatment of adhesive capsulitis utilizing soft tissue and joint manipulation—A case study.	Case studies/ series
Lilje, Genberg, Aldudjaili and Skillgate	2014	Pain relief in a young woman with adhesive capsulitis after manual manipulation of the acromioclavicular joint for remaining symptoms after mobilisation under anaesthesia.	
Metgud, Naik, and Heggannavar	2017	Randomized controlled trial to investigate the effect of mulligan's mwm and conventional therapy in stage ii adhesive capsulitis.	
Subramanian	2018	Mobilization Vs Electrotherapy in Adhesive Capsulitis Shoulder.	

Appendix L: Table of analyses of the included articles

Table A1. Tabulated feedback of reviewer data for Balci *et al.* (2016) (according to the Pedro Scale).

Author(s)	Balci, N. C., Yuruk, Z. O., Zeybek, A., Gulsen, M. and Tekindal, M. A.					
Year	2016					
Title	Acute effect of scapular proprioceptive neuromuscular facilitation (PNF) techniques and classic exercises in adhesive capsulitis: a randomized controlled trial.					
Criterion		Reviewer 1	Reviewer 2	Reviewer 3	Ranking	Total Percentage Agreement (%)
1	Eligibility criteria were specified	1	1	1	1	100%
2	Subjects were randomly allocated to groups (in a crossover study, subjects were randomly allocated an order in which treatments were received)	1	1	1	1	100%
3	Allocation was concealed	0	0	0	0	100%
4	The groups were similar at baseline regarding the most important prognostic indicators	0	1	1	1	67%
5	There was blinding of all subjects	0	0	0	0	100%
6	There was blinding of all therapists who administered the therapy	0	0	0	0	100%
7	There was blinding of all assessors who measured at least on key outcome	1	0	1	1	67%
8	Measures of at least on key outcome were obtained from more than 85% of the subjects initially allocated to groups	1	1	1	1	100%
9	All subjects for whom outcome measures were available received the treatment or control condition as allocated or, where this was not the case, data for at least one key outcome was analysed by "intention to treat"	0	1	1	1	67%
10	The results of between-group statistical comparisons are reported for at least one key outcome	1	1	1	1	100%
11	The study provides both point measures and measures of variability for at least one key outcome	1	1	1	1	100%
Total score		6/11	7/11	8/11	8/11	
Overall percentage agreement						88%

Table A1. Properties of the study, outcome, and discussion for Balci *et al.* (2016).

Author (s)	Balci, N. C., Yuruk, Z. O., Zeybek, A., Gulsen, M. and Tekindal, M. A.							
Year	2016							
Title	Acute effect of scapular proprioceptive neuromuscular facilitation (PNF) techniques and classic exercises in adhesive capsulitis: a randomized controlled trial.							
Study properties:								
Form of measurement	Frequency of measurement	Duration of study	Number of participants	Assessors blinded	Control used	Randomisation of participants	Ranking	Total Percentage Agreement
VAS, LSST, Goniometer, Simple shoulder test	Pre-test/post-test.	Not identified as the study was to identify the immediate effect of the interventions (thus a pre-post protocol).	53 participants	Not disclosed.	Control group comprised of physiotherapy modalities (TENS, ultrasound and heat pack)	Simple randomization and a random number table were used as a method as sequence generation for patients	8/11	88%
Limitations	The participants were recruited from the outpatient clinic at Baskent University of Physical Medicine and Rehabilitation in Ankara, Turkey. The eligibility criteria defined was vague yet required the participants to experience shoulder pain for more than three months and diagnosis by a doctor with stage two adhesive capsulitis by the means of an MRI by a doctor. The inclusion criteria did not restrict age and gender, furthermore the presence of pre-existing conditions restricted to exclude neurological deficits, and pathological conditions affected the shoulder. The recruitment strategy and inclusion criteria of a controlled trial design is to limit the population, preventing missing data and population generalisation (Kendall 2003a). The eligibility criteria did not accurately represent the population with stage two adhesive capsulitis as the inclusion criteria was not specific regarding the participants age range, the co-morbidities present with the patient, medication use (current and previous) of the participant and/or history of previous medical treatment received for the complaint. The age variation between the groups did not take into consideration for the age related changes which may impact the outcomes, the older the participant the more likely to have age related conditions (Navaratnarajah and Jackson 2017). The duration of the study lasted five months, however the study duration lasted one session as the design was a pre-test/post-test. Simple randomisation techniques were utilized, failing to disclose whether blinding techniques were utilized by the participant. The evaluation on the participants was conducted by the same therapist, whilst the intervention utilised was applied by the same therapist. The lack of blinding knowledge fails to allow the reader to identify whether the therapists involved were aware of the participant group allocation. The Hawthorne effect is a non-specific effect of a treatment, it can change the beliefs of those receiving, administering, and evaluating an intervention based on the interest received through administration and evaluation. In the instance that the administrator and evaluator were not blinded by the group allocation, they would be aware as to the expectations of the study thus can influence the patients belief thus impact the outcome (McCarney <i>et al.</i> 2007). Based on the stage of adhesive capsulitis, the patient would have likely received previous treatment for the condition, thus leaving room for patient naivety to treatment interventions to be negated (Silva Junior <i>et al.</i> 2015). This may have influenced the subject outcome measures (viz. VAS) also of which can be influenced by the Hawthorne effect or the observer effect; thus, may undermine the articles' ability to report accurate clinical changes. At the baseline, all three groups comprised of more women than men and the age average of Group C were higher than the other two groups. Furthermore, the hand dominance and affected side were varied, seen in table one (Balci <i>et al.</i> 2016) where Groups A and C had participants with more right hand dominance and majority affected on the right hand side, whereas Group B had more participants with right hand dominance and majority affected on the							

	left hand side. Lemos <i>et al.</i> (2011) postulated the handedness of the participant influenced the outcomes as those who were affected on the non-dominant side would have not experienced the same disability as the participants who experienced the condition on the dominant side. This could indicate those with non-dominant affected extremities could experience better results than those with dominant affected sides. The hand dominance and the extremity affected was reported, however it was not equally represented throughout the groups. The methodology clearly outlined the treatment protocols used by the therapist administering the interventions. The settings of the electrotherapy modalities utilised were reported, however the specific location of the ultrasound probe and electrode pads was not reported, merely stated "painful sites of the shoulder" (Balci <i>et al.</i> 2016). The effects of proprioceptive neuromuscular facilitation (PNF) stretching has an immediate effect (Zaidi <i>et al.</i> 2023) but in some instances can take up to 8 weeks to show the full progression of muscle strength (Hindle <i>et al.</i> 2012). The frequency of measurement was conducted at baseline and one hour after the intervention was conducted, with no follow up thereafter. The frequency of measurement was pre-test and post-test, however there was no clear disclosure as to the recruitment methods used along with participant recruitment or bias. The sample size utilized in this study was small, comprising of 53 participants (with a minimum of 17 participants per group allocation) leading a potential risk of type two error (Akobeng 2005) thus through the statistical analysis (non-parametric) reduce the ability to reduce particular outcome measures. Statistical power analysis required 13 subjects per group to conduct the investigation, however with a smaller sample size, a weaker clinical effect was measured.
Outcome	PNF, classic exercise and physiotherapy modalities provided immediate effects on adhesive capsulitis.
Discussion	The study design investigated the immediate effect of PNF, classic exercises and physiotherapy; thus provided a limitation of in the long-term effect clinical effect of the intervention. The patient homogeneity was unclear as the eligibility criteria utilised was vague thus not limiting the population recruited. The population recruited into the study may have not clearly depicted the general population of individuals diagnosed with stage two adhesive capsulitis, due to the lack of information regarding the recruited participants (i.e., age limit, gender, co-morbidities and current medication used). The blinding of the participants, therapists and assessors was not disclosed, along with mention concealed allocation into the groups. The Hawthorne effect in an RCT can influence the subjective outcome measures. Balci <i>et al.</i> (2018) utilized one therapist in the evaluation process and another therapist administered the intervention which intended to reduce the chance of bias, contradicted Kendall (2003a) postulated the use of a single therapist may identify the differences between the groups and identify the intervention, thus inadvertently convey the information to the participants involved. The methodology utilised by the therapist administering the intervention was clearly outlined as noted above, however the placement of the ultrasound probe and TENS electrode pads was not. The placement of the electrode pads was required to be homogeneous amongst the participants to provide a true clinical effect result. Vance <i>et al.</i> (2014) reported the previous clinical studies regarding the specifications of electrode placement and whether it was consistent amongst the participants. Whereas, Sluka and Walsh (2003) postulated the electrode placement in either at the site of injury or at the affected dermatome to be effect; similarly Somers and Clemente (2006) postulated favourable results when electrodes were placed on the acupuncture points. The baseline characteristics, specifically the sociodemographic information of the participants was limited. The patient homogeneity was unknown as the eligibility criteria was not specified thus generalisation of the population likely. The reporting of pre-existing medical conditions, current medication used, and treatment used was not mentioned, and may play a vital role in the immediate clinical effect of the intervention. The disclosure of analgesics in prior to receiving the intervention was pivotal as the outcome measure may be altered if used. The reporting of previous treatment received by the participants was absent, especially since the inclusion criteria required the participants to be in the second stage of adhesive capsulitis.

	Given the limitations mentioned above, the future studies would be required to include evaluation of the shoulder in all ranges of motion, follow up evaluations to see whether there was change since the post-intervention reading along with blinding the of the evaluators and participants. Blinding of the therapist administering the intervention may be difficult, however this may be required to eliminate future biases. The design of including participants in the second stage of adhesive capsulitis, limited the previous treatment utilised by the participants involved but failed to include past medical treatment in the baseline characteristics. The use of physiotherapy modalities used were a combination of TENS, ultrasound and heat, and received by all three groups, thus the clinical effectiveness of TENS alone was not determined.
Conclusion	Based on Table A1 above the reviewers agreed that there was a good internal validity (a measure of the research structure of the study), with an 88% agreement between the reviewers. By contrast the impact of factors that affect the external validity of the study. Table A2, indicated that there are flaws in the study, not necessarily related to the research structure, but related to the human element of participants, researchers, therapists and assessors that may have resulted in negative consequences on attaining accurate outcomes for the programmes. Therefore, this study provides limited evidence for the treatment programmes received by both groups one and two when compared to the third group, who received the physiotherapy modalities alone. The study provides no evidence for or against the use of TENS in patients with stage 2 adhesive capsulitis.

Table B1.Tabulated feedback of reviewer data for Carrette *et al.* (2003)(according to the Pedro Scale).

Author (s)	Carrette, S., Moffet, H., Tardif, J., Bessette, L., Morin, F., Frémont, P., Bykerk, V., Thorne, C., Bell, M. and Bensen, W					
Year	2003					
Title	Intraarticular corticosteroids, supervised physiotherapy, or a combination of the two in the treatment of adhesive capsulitis of the shoulder: A placebo-controlled trial.					
Criterion		Reviewer 1	Reviewer 2	Reviewer 3	Ranking	Total Percentage Agreement (%)
1	Eligibility criteria were specified	1	1	1	1	100%
2	Subjects were randomly allocated to groups (in a crossover study, subjects were randomly allocated an order in which treatments were received)	1	1	1	1	100%
3	Allocation was concealed	1	1	1	1	100%
4	The groups were similar at baseline regarding the most important prognostic indicators	1	1	1	1	100%
5	There was blinding of all subjects	0	0	1	0	67%
6	There was blinding of all therapists who administered the therapy	1	0	1	1	67%
7	There was blinding of all assessors who measured at least on key outcome	1	1	1	1	100%
8	Measures of at least on key outcome were obtained from more than 85% of the subjects initially allocated to groups	1	1	0	1	67%
9	All subjects for whom outcome measures were available received the treatment or control condition as allocated or, where this was not the case, data for at least one key outcome was analysed by "intention to treat"	1	1	1	1	100%
10	The results of between-group statistical comparisons are reported for at least one key outcome	1	1	1	1	100%
11	The study provides both point measures and measures of variability for at least one key outcome	1	1	1	1	100%
Total score		10/11	9/11	10/11	10/11	
Overall percentage agreement						91%

Table B2.Properties of the study, outcome, and discussion Carette *et al.* (2003).

Author (s)	Carette, S., Moffet, H., Tardif, J., Bessette, L., Morin, F., Frémont, P., Bykerk, V., Thorne, C., Bell, M. and Bensen, W							
Year	2003							
Title	Intraarticular corticosteroids, supervised physiotherapy, or a combination of the two in the treatment of adhesive capsulitis of the shoulder: A placebo-controlled trial.							
Study properties:								
Form of measurement	Frequency of measurement	Duration of study	Number of participants	Assessors blinded	Control used	Randomisation of participants	Ranking	Total Percentage Agreement
SPADI, SF-36, Goniometer	After 6 weeks, 3 months, 6 months and 1 year	Four years	93 subjects	Therapists administering the intervention, and the participant was blinded to the injection administered. Assessors were unaware of the group allocation and not normally employed in the facility administering the intervention.	Yes	Assignment scheme was generated from a table of random numbers	10/11	91%
Limitations	The participants were recruited from seven different outpatient facilities in Canada, and the recruitment was conducted between November 1996 to June 2000. The patients recruited were required to be symptomatic for more than one year and the use of the SPADI index as part of the inclusion criteria. The minimum age was 18 years; however no maximum age was outlined. Furthermore, the eligibility criteria initially excluded participants diagnosed with secondary adhesive capsulitis and those diagnosed with diabetes mellitus, but due to poor participant recruitment, those diagnosed with diabetes mellitus were later included. The group allocation was overseen by the hospital pharmacists at the respective locations. The random assignments for the treatment groups were stratified and balance after every 12 assignments in opaque prenumbered envelopes kept by the hospital pharmacist at each location, thus an adequate representation from all the strata in the population. The physiotherapists involved in the investigation were trained as to the protocol and recorded the results on a standardized form. The syringes containing the placebo and intervention were prepared by the pharmacist and covered in foil to blind both the therapist administering the intervention and participant receiving the intervention. The effect of double blinding, prevented the occurrence of performance bias and detection bias as therapists, assessors and the participants were unaware of the injection administered along with the participant group allocation (Devereaux <i>et al.</i> 2001). Probst <i>et al.</i> (2016) postulated the outcome assessors who are aware of the treatment received are likely to alter their assessment, specifically in subjective outcome measurements of the assessor. Prior to the randomisation, all the participants were taught a simple homecare regime to be done twice daily for three months, the regime was taught by the physiotherapist conducting the assessments. Advice regarding homecare management and suitable exercise adaptations (intensity, frequency, exercise progression along with suitable shoulder positions. The home exercise program was recorded daily on an agenda form for the first three months of the study. The participants were prescribed to only take acetaminophen and form a record of each tablet taken, furthermore a record of the medication taken were obtained at each follow up.							

	The same physiotherapist assessed each subject throughout the investigation. The physiotherapists were not familiar with the location sites and unaware of the group allocations of the participants. Patient compliance throughout the intervention was well documented along with the protocols utilized at all the sites regarding the injections. At the baseline group one according to Table 1 (Carette <i>et al.</i> 2003), was older than the other groups along with a higher percentage of participants not working because of the adhesive capsulitis and a higher percentage of duration of the pain experienced. The SPADI total score was higher in the fourth group when compared to the other groups. Although the baselines were similar amongst the groups, there were more males in the physiotherapy group. Due to the eligibility criteria, the participants included experienced symptoms for over one year, thus the pathology not homogenous. Based on the stage of adhesive capsulitis, the clinical practice was altered due to the treatment goals, however Carette <i>et al.</i> (2003) identified the treatment strategies to "pursue complementary goals but differ in the nature and intensity of the modality used". The outlined criteria (Carette <i>et al.</i> 2003) identified those whom experienced three or more of the five symptoms to be in an acute stage, thus receive TENS followed by active ROM, mobilizations and cryotherapy. Whereas those experienced less than three of the outlined criteria diagnosed with chronic stage, received ultrasound, heat prior to mobilizations, ROM exercises, isometric strengthening exercises and the use of cryotherapy. The number of participants in either the acute or chronic stage was not reported, thus the clinical effect of the two treatment methods not clearly disclosed. The settings and duration of either treatment was not reported, furthermore homogeneity at all seven sites regarding the treatment was not reported. Upon enrolment and randomisation, there were 97 participants, however due to the eligibility criteria, the participant numbers reduced to 93. Carette <i>et al.</i> (2003) reported 16 participants failed to return for the follow up visits, thus reducing the sample size to 77 participants (group 1-19 participants, group 2-14 participants, group 3-23 participants, group 4-22 participants). Based on the physiotherapy compliance, of the 47 participants allocated to receive physiotherapy interventions (group 1 and group 3), 38 participants attended the 12 prescribed physiotherapy sessions, whereas 2 attended 10 and 11 sessions, and 1 participant refused to participate in the physiotherapy program. Furthermore, the physiotherapy files of 6 participants were missing, thus information withheld. Five of the recruited participants received an additional corticosteroid injection after randomisation above the interventions administered, however the justification for this action was not reported. The participant in the fourth group underwent a rotator cuff repair, but there was no indication whether the participant remained in the study or failed to meet the eligibility due to the repair. The statistical analysis considers the initial number of participants recruited; however, the data did not identify whether those who dropped out were represented in the results. Based on Table 6 (Carette <i>et al.</i> 2003) the total SPADI score was calculated for the dropped out participants based on the data from the last visit, taking into consideration no improvement occurred after the previous visit. The potential for bias may have occurred when the data was imputed and calculated regarding the drop off participants and were likely to favour the participants in the combination and placebo groups as the dropout rates were less than the other groups.
Outcome	The authors outcomes and statistics identify the support the use of a corticosteroid injection combined with a simple home exercise program was shown to improve shoulder pain and disability in patients with adhesive capsulitis. The addition of supervised physiotherapy provides an improved shoulder range of motion.
Discussion	This study identified favourable results when utilizing a combination treatment in the management of adhesive capsulitis to improve the range of motion and reduce pain experienced. Furthermore, the recommendation of increasing the number of participants in the allocated groups would statistically assist in the results should there be several participants dropout due to the study follow up period. The initial criterion of excluding those diagnosed with diabetes mellitus should be adjusted in future recommendations of this study and documented whether the participant manages the condition and other co-morbidities.

	The representation of participants in the acute and chronic stages of adhesive capsulitis was not present; thus, the clinical effect of the physiotherapy modalities utilised to treat both groups were wasted. The lack of information regarding the settings utilized, frequency of activities along with the duration and placements, limited the reproduction of this study in the future. Thus, the effectiveness of TENS in the management of adhesive capsulitis was poorly reported and the resulted inconclusive.
Conclusion	With the ranking score of 10/11 and a total percentage agreement of 91%, the methodological rigour of Carette <i>et al.</i> (2003) high. However, the study failed to identify which physiotherapeutic modality was effective in the management of adhesive capsulitis as the information was not disclosed adequately.

Table C1. Tabulated feedback of reviewer data for Celik (2010) (according to the Pedro Scale).

Author (s)	Celik, D.					
Year	2010					
Title	Comparison of the outcomes of two different exercise programs on frozen shoulder.					
Criterion		Reviewer 1	Reviewer 2	Reviewer 3	Ranking	Total Percentage Agreement (%)
1	Eligibility criteria were specified	1	1	1	1	100%
2	Subjects were randomly allocated to groups (in a crossover study, subjects were randomly allocated an order in which treatments were received)	1	1	1	1	100%
3	Allocation was concealed	0	0	0	0	100%
4	The groups were similar at baseline regarding the most important prognostic indicators	1	0	0	0	67%
5	There was blinding of all subjects	0	0	0	0	100%
6	There was blinding of all therapists who administered the therapy	0	0	0	0	100%
7	There was blinding of all assessors who measured at least on key outcome	0	0	0	0	100%
8	Measures of at least on key outcome were obtained from more than 85% of the subjects initially allocated to groups	0	0	1	0	67%
9	All subjects for whom outcome measures were available received the treatment or control condition as allocated or, where this was not the case, data for at least one key outcome was analysed by "intention to treat"	1	1	1	1	100%
10	The results of between-group statistical comparisons are reported for at least one key outcome	1	1	1	1	100%
11	The study provides both point measures and measures of variability for at least one key outcome	1	1	1	1	100%
Total score		6/11	5/11	6/11	5/11	
Overall percentage agreement						94%

Table C2.Properties of the study, outcome and discussion for Celik (2010).

Author (s)	Celik, D.							
Year	2010							
Title	Comparison of the outcomes of two different exercise programs on frozen shoulder.							
Study properties:								
Form of measurement	Frequency of measurement	Duration of study	Number of participants	Assessors blinded	Control used	Randomisation of participants	Ranking	Total Percentage Agreement
Visual Analogue Scale (VAS), Modified constant score, Goniometer	At baseline, 6 and 12 weeks	6 weeks compiled of 30 sessions	29 participants	No blinding	Yes	Yes	5/11	94%
Limitations	The location of the study was based at a department of orthopaedics and trauma in Istanbul, specialising in the shoulder. The recruitment methods utilised in this study was not disclosed, however Celik (2010) reported the participants recruited were examined by different orthopaedists for the first time at the location of the study. The eligibility criteria required the participant to undergo imaging studies, specifically an x-ray and MRI. The inclusion criteria outlined was vague regarding the sociodemographic information, duration of the symptoms along with diagnosed co-morbidities and previous treatment received. However, the baseline characteristics of Table 1 (Celik 2010) outlined the distribution of the participants in the groups based on age, co-morbidities (diabetes mellitus and thyroid disease), along with the classification of adhesive capsulitis (primary or secondary adhesive capsulitis). The recruitment method utilised along with the randomisation technique failed to stratify the sample population, thus not representing the general population of individuals diagnosed with adhesive capsulitis. Considering, individuals diagnosed with diabetes mellitus (Kim <i>et al.</i> 2023) and thyroid disease (Cohen <i>et al.</i> 2020) have an increased risk of developing adhesive capsulitis, the inclusion of participants with secondary adhesive capsulitis was well depicted. The participants enrolled were randomly allocated into the two groups, group one received glenohumeral ROM exercises, whereas group two received glenohumeral ROM and scapulothoracic exercises. The allocation method utilized was unknown and no indication of concealed allocation. The participants and therapists involved were not blinded to the treatment, as manual therapy is impossible to blind the therapists involved. The participant enrolment, included 22 female and 7 male participants, ranging from 38-65 years of age. The group participant allocation consisted of 14 and 15 participants respectively and the number of females drastically outnumbering the male participants. The participants of group two were significantly younger than those in group one and more participants were diagnosed with secondary adhesive capsulitis. The groups at the baseline were similar, however the handedness, side treated and involved, along with the co-morbidities were not similar. The participants in group two had double the prevalence of group one regarding secondary adhesive capsulitis (Celik 2010), with no mention of $p =$ values in Table 1. There was no indication of a wash out period due to the result of the treatment outside of the investigation which could alter the study outcome. The baselines measured in Tables 2 and 3 (Celik 2010) are not similar, as the intergroup VAS, modified constant score and range of motion valued differed between the two groups. The data reported that Group 2 (the experimental group) experienced more pain and less range of motion whilst doing internal rotation comparison to the control group (Group 1). There was no mentioning of blinding of the participant allocation, nor was there mention of the individual administrating the intervention and the individual undergoing the assessor being blinded to the group of the participant. The bias increases in this instance, as the interaction between the							

	participants if in contact with each other, or the participants with the intervention administrators or the assessors may influence each other (Schulz and Grimes 2002). Whilst the participants were in clinic, they were prescribed 20 minutes of TENS and a cold pack. As homecare, depending on the pain status experienced, active ROM exercises were given and cold application (for a period of 15 minutes, thrice daily) and prescribed nonsteroidal anti-inflammatory drugs (NSAIDs), Gandhi <i>et al.</i> (2004) suggested the pharmacodynamic and pharmacokinetic properties of medication (specifically those pertaining to pain management) have varied efficiency and adverse effects on genders. Furthermore, there was no mention of the participants using a homework diary or medication diary to record if /and when the participant conducted the exercises, utilized the ice pack, and medicated with NSAIDs. The researcher is unable to draw whether the patient's outcome is due to the complete treatment, the treatment conducted whilst under supervision or the intervention without the homecare. Tanaka <i>et al.</i> (2010) postulated patients with better compliance in the home exercise program resulted in more improvement of the adhesive capsulitis; however, in Celik (2010) the onus falls on the patient to adhere to the home program but there is no record of the patient doing the exercises at home. The location of the TENS electrodes placements was not recorded, nor was the settings of the TENS machine, along with the affected side in relation to the dominant side. There was no mention whether the side affected was the dominant limb of the patient. Furthermore, there was no indication if the administrator was the same individual applying the interventions for all the research groups along with an indifferent individual taking the measurements. The diagnosis of primary or secondary adhesive capsulitis was not made prior to the participants randomized allocation into the two groups, which may alter the outcome of the intervention as the participants are not at the same stage of the condition. reported the progression from stage one to stage two of adhesive capsulitis was the develop of stiffness from pain and early adhesion formation.
Outcome	The addition of glenohumeral ROM exercises and scapulothoracic exercises contribute to pain reduction and increasing the ROM of patients with frozen shoulder.
Discussion	The eligibility criteria outlined by Celik (2010) was limited and in combination with the lack of information regarding the recruitment methods, created a generalised sample of participants, thus the participant homogeneity and condition homogeneity lacked. The inclusion criteria failed to control the confounding variables along with the patient specific population with adhesive capsulitis; this ensures homogeneity amongst the groups receiving the interventions (Zabor, Kaizer and Hobbs 2020; Wells <i>et al.</i> 2012). The inclusion criteria did not outline the age range, gender, duration of the symptoms along with the presence of co-morbidities; thus, the stage of pathology amongst the recruited participants are less likely to be consistent. The efficiency of the intervention used on the participants may not measure the clinical outcome of the intervention. The application of the interventions used was not clearly outlined, specifically the settings, duration along with the placement of the electrodes was not reported. The lack of information regarding the application, left potential for bias as the application amongst the participants and therapists were not clearly detailed thus homogeneous intergroup. The use of NSAIDs and cryotherapy were used in both groups, and promising results found. At the 5th week, the use of NSAIDs and TENS were terminated, but the stretching exercises increased in both groups (dependant on the patient pain, and the use of cryotherapy used when the patient experienced pain). The scapulothoracic exercises were increased in those in group two. The patient compliance regarding homecare was not reported as the presence of a homecare diary not reported.
Conclusion	Based on the points mentioned in the limitations, outcomes, and discussion above, this article was ranked with a 94% agreement as seen above. The consensus regarding the reviewer outcome was that the study lacked methodological rigour, which can result in a questionable outcome and should be applied with caution. The conclusion can be made that the study has poor methodologic rigour and a poor clinical outcome.

Table D1.Tabulated feedback of reviewer data for the RCT studies of Dewan and Sharma (2011) (according to the Pedro Scale).

Author (s)	Dewan and Sharma					
Year	2011					
Title	Effectiveness of transcutaneous electrical nerve stimulation and interferential electrotherapy in adhesive capsulitis					
Criterion		Reviewer 1	Reviewer 2	Reviewer 3	Ranking	Total Percentage Agreement (%)
1	Eligibility criteria were specified	1	1	1	1	100%
2	Subjects were randomly allocated to groups (in a crossover study, subjects were randomly allocated an order in which treatments were received)	1	1	1	1	100%
3	Allocation was concealed	1	0	0	0	67%
4	The groups were similar at baseline regarding the most important prognostic indicators	1	1	1	1	100%
5	There was blinding of all subjects	0	0	0	0	100%
6	There was blinding of all therapists who administered the therapy	0	0	0	0	100%
7	There was blinding of all assessors who measured at least on key outcome	0	0	0	0	100%
8	Measures of at least on key outcome were obtained from more than 85% of the subjects initially allocated to groups	1	0	1	1	67%
9	All subjects for whom outcome measures were available received the treatment or control condition as allocated or, where this was not the case, data for at least one key outcome was analysed by "intention to treat"	0	1	1	1	67%
10	The results of between-group statistical comparisons are reported for at least one key outcome	1	1	1	1	100%
11	The study provides both point measures and measures of variability for at least one key outcome	1	1	1	1	100%
Total score		7/11	6/11	7/11	7/11	
Overall percentage agreement						91%

Table D2.Properties of the study, outcome and discussion of Dewan and Sharma (2011).

Author (s)	Dewan and Sharma							
Year	2011							
Title	Effectiveness of transcutaneous electrical nerve stimulation and interferential electrotherapy in adhesive capsulitis							
Study properties:								
Form of measurement	Frequency of measurement	Duration of study	Number of participants	Assessors blinded	Control used	Randomisation of participants	Ranking	Total Percentage Agreement
Goniometer, CMA, VAS	Pre and post treatment measurement	4 weeks	50 Participants	No mention of blinding	TENS group in comparison to an IFC group	Yes	7/11	91%
Limitations	The location utilised in Dewan and Sharma (2011) was the site of participant recruitment. The participants were recruited on a volunteer basis; however, the method of advertisement was unknown. Of the 70 participants who volunteered, 50 met the inclusion criteria and enrolled into the study. The eligibility criteria were age specific, along location of the pain and functionality specific, however failed to into the duration of the symptoms along with preexisting co-morbidities. Based on the duration of the study along with the number of participants included in the study, there was no clear indication of participant interaction inter and intra groups thus patient naivety void in the circumstance of interaction. There was no mention in the methodology regarding the participant randomization method, along with concealment of the allocation in an opaque envelope. The lack of transparency with the allocation paired with the absence of blinding of either participant, assessor and/or therapist allows the influence of bias to be effective. Moustgaard <i>et al.</i> (2014) noted blinding of the assessor and the therapist administering the intervention reduced the possibility of bias based on the treatment outcome. The lack of blinding among the participants, evaluators and therapists may lead to a variation of the intended interventions (Higgins <i>et al.</i> 2020). The Hawthorne effect may influence the outcome measures as the participants may be influenced. The group baseline characteristics was not depicted thus there was no indication whether the allocation of the participants in the two groups were similar. The lack of information regarding the gender, age allocation, co-morbidities, handedness and affected limb, medication use along with previous treatment does not equally represent the general population. Burgess, Gebiski and Keech (2003) reported the knowledge of baseline characteristics allow the randomisation to be assessed, furthermore fair baseline characteristics amongst the groups provide a true clinical efficacy of the intervention (influencing internal validity). The CONSORT checklist requires reporting of the demographic and clinical characteristics of the participants recruited. There was no indication that the participants included were in the same stage of adhesive capsulitis as the inclusion criteria was vague and did not verify previous treatment acquired thus did not rule out the possibility for the lack of patient nativity. The clinical efficiency of the intervention cannot be clearly determined should the participants recruited not be in the same stage of the pathology, in combination with the lack of baseline characteristics and measurements, the clinical outcome cannot be deemed valid as there were not initial measurements to base the result on. The frequency of treatment for the participants who received IFC treatment was unclear per week for the four-week study duration, whereas those who received TENS received two to three sessions per week for four weeks. Furthermore, there was no mention of the patient being blinded; thus, the patient naivety can be influenced. The setting of the IFC group received 10 sessions during the four-week duration as did those in the TENS group, however those in the TENS group received between two to three sessions per week. The setting of the IFC was 80-120 Hz current swept with the use of a four-pole electrode placement (location not known) for 20 minutes. The TENS setting was set at 0.2 ms at 100 Hz applied to the acupoints with a four-pole electrode							

	placement for 20 minutes. The results and discussion did not include gender or age comparisons between the groups, nor was there mentioned if the participants continued to take their medication (if any) throughout the study.
Outcome	This study investigated the effects of TENS and interferential therapy on patients diagnosed with adhesive capsulitis, furthermore Balci <i>et al.</i> (2018) reported both TENS and interferential therapy effective in pain reduction and improving shoulder function in patients diagnosed with adhesive capsulitis.
Discussion	The participants recruited and stage of the pathology lacked homogeneity. The recruitment process utilized a volunteer method whereby the participants volunteered to be enrolled into the study. The eligibility criteria outlined by Dewan and Sharma (2011) failed to specify inclusion criteria to represent the general population of participants diagnosed with adhesive capsulitis (i.e., a specific stage of the pathology, presence of co-morbidities). McDonagh <i>et al.</i> (2013) postulated the purpose of inclusion criteria was to minimise ambiguity, as vague inclusion criteria increase the potential for poor reproduction. This phenomenon occurs due to the lack of subjective decisions regarding the participants to include, thus may result in random error in the study selection. Blinding of the participants, therapists administering the intervention and the evaluator was not reported thus, was unclear whether the involved parties were aware of the allocation and possessed the potential for bias such as the Hawthorne effect, patient naivety or intergroup/intragroup communication. The study did not state whether the participants had never experienced this form of therapy before, and in the instance they did, would they be able to identify the possible outcome based on their past experiences (Torgerson, Torgerson and Director 2013). Dewan and Sharma (2011) provided a clear depiction of the intervention application, however the placement of the electrodes was vague, i.e., IFC electrode placement was around the shoulder in a quadripolar pattern, whereas the TENS electrode placement varied between the acupuncture points but varied to the motor points of the shoulder. The Fifth Chapter of this dissertation discussed the efficiency of electrode placement in detail. Teoli and An (2021) postulated the placement of electrodes are to be precise when used, furthermore the electrode pad placement should within a close proximity to the appropriate dermatomal region of the targeted pain. In lieu with the absence of baseline characteristics, the results depicted by Dewan and Sharma (2011) failed to provide intergroup comparisons proving the superior intervention. Furthermore, the frequency of measurement was unclear as it was reported pre/post but not details whether it was pre-intervention/post-intervention or at baseline and at the end of the four-week duration. The results depicted illustrated the pre-treatment and post-treatment, but no details were provided.
Conclusion	Based on the points mentioned in the limitations, discussion, and outcome above, and the article overall 91% viewer agreement and 7/11 ranking. The consensus regarding the reviewer outcome was that the study lacked methodological rigour, which can result in a questionable outcome and should be applied with caution. The conclusion can be made that the study has poor methodologic rigour and a poor clinical outcome. With no evidence of blinding and the certainty of similar baselines between the groups, it is inconclusive whether the results represent the population who experience adhesive capsulitis. Furthermore, the use of analgesics or alternative medication whilst participating in the investigation was not mentioned.

Table E1. Tabulated feedback of reviewer data for Doner *et al.* (2013)(according to the Pedro Scale).

Author (s)	Doner, G., Guven, Z., Atalay, A. and Celiker, R					
Year	2013					
Title	Evaluation of Mulligan's technique for adhesive capsulitis of the shoulder.					
Criterion		Reviewer 1	Reviewer 2	Reviewer 3	Ranking	Total Percentage Agreement (%)
1	Eligibility criteria were specified	1	1	1	1	100%
2	Subjects were randomly allocated to groups (in a crossover study, subjects were randomly allocated an order in which treatments were received)	1	1	1	1	100%
3	Allocation was concealed	1	0	0	0	67%
4	The groups were similar at baseline regarding the most important prognostic indicators	1	1	0	1	67%
5	There was blinding of all subjects	0	0	0	0	100%
6	There was blinding of all therapists who administered the therapy	0	0	0	0	100%
7	There was blinding of all assessors who measured at least on key outcome	0	0	0	0	100%
8	Measures of at least on key outcome were obtained from more than 85% of the subjects initially allocated to groups	1	0	1	1	67%
9	All subjects for whom outcome measures were available received the treatment or control condition as allocated or, where this was not the case, data for at least one key outcome was analysed by "intention to treat"	0	1	1	1	67%
10	The results of between-group statistical comparisons are reported for at least one key outcome	1	1	1	1	100%
11	The study provides both point measures and measures of variability for at least one key outcome	1	1	1	1	100%
Total score		7/11	6/11	6/11	7/11	
Overall percentage agreement						88%

Table E2. Properties of the study, outcome and discussion for Doner *et al.* (2013).

Author (s)	Doner, G., Guven, Z., Atalay, A. and Celiker, R							
Year	2013							
Title	Evaluation of Mulligan's technique for adhesive capsulitis of the shoulder.							
Study properties:								
Form of measurement	Frequency of measurement	Duration of study	Number of participants	Assessors blinded	Control used	Randomisation of participants	Ranking	Total Percentage Agreement
VAS, Constant score, Shoulder disability questionnaire (SDQ)	Baseline, after the completion of the treatment sessions and at the end of the 3 months follow up. The participants were treated five times per week for three weeks.	Three months	40 participants allocate into two groups of 20 each.	There was no blinding of the therapist or the assessor	Group 1 received treatment with a hot pack, TENS and, passive stretching in four directions. Group 2 received treatment with a hot pack, TENS, and mulligans manipulation	The participants were randomly allocated by the use if a table of random numbers	7/11	88%
Limitations	The inclusion criteria were not clear as to what the participant requirements were to be accepted into the study. The eligibility criteria excluded those participants with coexisting neck pain and radiculopathies, according to Mezian, Coffey and Chang (2020) the occurrence of neck pain concomitantly with adhesive capsulitis is common due to the compensatory overuse of the cervical spine muscles. There was no age range was specified in the criteria, thus the older the patient was the more likelihood of co-morbidities increased which were likely to cause a reduction in the quality in life of the patient (Siebens 2007). The previous medical history of the patients including the use of medication whilst participating in the investigation was not documented. The participants recruited were required to have at least three months duration of shoulder pain and were required to be diagnosed in the stiffness phase by the practitioners of the outpatient department, along with imaging studies to confirm the diagnosis. The investigation included participants were diagnosed with primary adhesive capsulitis. The gender ratio of the participants was not homogeneous in the group allocation, with the female allocation being 77.5% whereas the male was 22.5% in total. Wolf <i>et al.</i> (2015) found when the genders were compared, there was a higher age-adjusted prevalence of musculoskeletal pain in females when compared to males in those aged over 72 years. Treaster and Burr (2004) reported the prevalence of upper extremity musculoskeletal disorders were significantly higher in females than males. The participant socioeconomic status was not taken into consideration, which did not include the occupation of the participant and literacy status of the patient. De Zwart, Frings-Dresen and Kilbom (2000) found an association between the complaints in the upper extremities amongst the general working population and gender; furthermore, the female workers were identified to have a higher risk at the development of the complaints. Participants who received pharmacological assistance to manage adhesive capsulitis were included in the study however there was no mention the type of medication which was utilized. Those participants who utilized the pharmacological methods to manage adhesive capsulitis could have experienced adverse effects, which may influence the study outcome (Konarski <i>et al.</i> 2020). The therapist administering the intervention was not blinded, nor were the participants. The attitude of the therapist could influence the experience of the participant, which may influence the participants subjective outcome. Furthermore, the patients were not blinded to the treatment intervention, this may be							

	influencing the patient perception of the treatment and overall altering the outcome. There was no mention whether the groups interacted or whether the therapist influenced the participants' perception regarding the treatment. Each group was allocated 20 participants which allowed the authors to use parametric statistics to evaluate the participants. The baseline characteristics differed between the groups as there were more males in group two when compared to group one. Furthermore, the handedness and side effected were not equal, table one illustrates the participants of group two were right side dominant and the affected shoulder was 50% right and 50% left, whereas the participants in group one was majority right hand dominant (19:1), however in the affected shoulder was majority left side (15:5). Both groups received similar treatment (hot pack and TENS), however Group 1 received passive stretching and Group 2 received mulligans manipulation. The participants received treatment five times per week for 3 weeks and, received homecare exercises to conduct twice daily. There was no mention of the use of a "homework diary" which could have recorded if the patient complied with the instructions. The TENS session lasted 20 minutes at the frequency of 100Hz and pulse of 0.05-0.07ms. The electrode placement was not specified in the methodology, thus does not stipulate whether this was continuous between all participants, nor was it identified whether the electrode used two pole or four pole. The study duration was three months and did not include a follow up with the participants thereafter.
Outcome	The use of Mulligan's technique and passive stretching exercises was effective in both pain reduction and restoration of functional motion. However, Mulligan's technique provided better improvements in comparison to passive stretching.
Discussion	There were several limitations noted in the Doner <i>et al.</i> (2013) which influenced the validity of the investigation, these are discussed below. The participants recruited were randomised via a table of random number, however there was not mention of concealed allocation along with blinding of either participants or therapists. The recruited participants underwent examination by the same therapist regarding the inclusion criteria. Furthermore, the inclusion criteria required the participants to undergo a radiographic examination. The inclusion criteria required the participants to be in the stiffness phase, thus the pathology homogeneous. The interventions utilised by both groups was TENS and heat pack, the first group received passive stretching in four directions and second group received Mulligan's technique. The treatment methodology was clearly outlined along with the settings of the modalities utilized; however, the electrode placement was not outlined. The participants were instructed to perform homecare exercises twice daily and educated about daily care for the shoulders, however there was no indication of a homework diary or record measuring participant compliance. Due to the intervention design utilized, the efficiency of TENS was not clearly outlined. Due to the lack of allocation stratification, the participant distribution was not homogenous amongst the groups. The participants of the second group were older than those of the in the first group, along with the presence of co-morbidities were higher in the second group when compared to the first. The gender ratio in both groups comprised of more female participants than male. The outcome measurement tools used were the VAS, goniometer, constant score, SDQ along with satisfaction of both the participant and therapist. The frequency of measurement reported were conducted at baseline, after the interventions and at the end of the three month follow up. There was not mention of participant dropout along with the participant loss at the three month follow up period.
Conclusion	Based on the overall ranking of 7/11 and total reviewer percentage agreement of 88%. The methodological rigor of Doner <i>et al.</i> (2013) was deemed good. The evidence provided supported the use of Mulligan's technique in combination with heat therapy and TENS. The study presented with good internal validity; however, the external factors posed a risk thus failed to provide a true representation of the general population of those with adhesive capsulitis. The evidence gathered by Doner <i>et al.</i> (2013) proved effective, but should the study need to be reproduced, the design changed to identify the superior intervention.

Table F1. Tabulated feedback of reviewer data for Faruqui *et al.* (2015) (according to the PEDro Scale).

Author (s)	Faruqui, Z., Kazmi, S. A. M., Devi, J., Naqvi, I. H., Kumar, S., Rizvi, A. S. and Puri, J.					
Year	2015					
Title	Effects of mobilization in sub-acute and chronic frozen shoulder (adhesive capsulitis) management					
Criterion		Reviewer 1	Reviewer 2	Reviewer 3	Ranking	Total Percentage Agreement (%)
1	Eligibility criteria were specified	1	1	1	1	100%
2	Subjects were randomly allocated to groups (in a crossover study, subjects were randomly allocated an order in which treatments were received)	0	0	0	0	100%
3	Allocation was concealed	1	0	0	0	67%
4	The groups were similar at baseline regarding the most important prognostic indicators	0	0	1	0	67%
5	There was blinding of all subjects	0	0	0	0	100%
6	There was blinding of all therapists who administered the therapy	0	0	0	0	100%
7	There was blinding of all assessors who measured at least on key outcome	0	1	0	0	67%
8	Measures of at least on key outcome were obtained from more than 85% of the subjects initially allocated to groups	1	1	1	1	100%
9	All subjects for whom outcome measures were available received the treatment or control condition as allocated or, where this was not the case, data for at least one key outcome was analysed by "intention to treat"	1	1	1	1	100%
10	The results of between-group statistical comparisons are reported for at least one key outcome	1	1	1	1	100%
11	The study provides both point measures and measures of variability for at least one key outcome	1	1	1	1	100%
Total score		5/11	5/11	6/11	5/11	
Overall percentage agreement						91%

Table F2. Properties of the study, outcome and discussion for Faruqi *et al.* (2015).

Author (s)	Faruqui, Z., Kazmi, S. A. M., Devi, J., Naqvi, I. H., Kumar, S., Rizvi, A. S. and Puri, J.							
Year	2015							
Title	Effects of mobilization in sub-acute and chronic frozen shoulder (adhesive capsulitis) management							
Study properties:								
Form of measurement	Frequency of measurement	Duration of study	Number of participants	Assessors blinded	Control used	Randomisation of participants	Ranking	Total Percentage Agreement
VAS, SPADI	Pretest, post test	6 weeks	85 participants	No record	No	No.	5/11	91%
Limitations	The study was conducted at an outpatient facility. The participants recruited were required to be diagnosed with sub-acute and chronic adhesive capsulitis, with a history of impaired activities of daily living (ADLs). The study design of the research was a quasi-experimental study (White and Sabarwal 2014), aims to evaluate interventions which don't require randomisation; and the sampling technique a non-probability, purposive sampling technique refer to the participants to be included as they meet the eligibility criteria (Vehovar, Toepoel and Steinmetz 2016). The purposeful sampling technique identified those who fulfilled the criteria required for each group, furthermore the inclusion criteria was not clearly outlined thus posing ambiguous results. Faruqui <i>et al.</i> (2015) reported the participants recruited were randomised upon enrolment and divided into two group, contradicting the purposeful sampling technique. The eligibility criteria specified to individuals aged between 40-60 years of age, diagnosed was adhesive capsulitis along with reduced range of motion, and the compromised activities of daily living (ADLs). The ADLs are assessed with the Katz index, which is a self-administered thus the patient is subjectively answering the question. The inclusion criteria outlined did not disclose the tools used to diagnose the stage of pathology (sub-acute or chronic stage), thus the potential for selection bias was possible. The baseline characteristics amongst the groups were not clearly outlined, except the gender distribution and number of the participants presenting in the sub-acute and chronic group. The lack of information regarding the duration of symptoms, existing co-morbidities and the history of previous treatment; the participant homogeneity was not clearly identified. The number of females recruited outweighed the number of male recruits (female participants recruited were 60 whereas male recruits were 25). The age distribution was based on the total participants recruited and not per the allocated group. The treatment utilized amongst both groups remained uniform including the mobilizations used for the respective groups. The treatment used by both groups was TENS, cold pack, heat pack, ROM exercises along with Maitland mobilizations grade four and five. The settings along with the TENS electrode settings was not disclosed, furthermore the treatment protocol followed omitted details, thus the homogeneity amongst the treatment protocol was not clear. The frequency of measurement was conducted pre and post intervention for six weeks. The measurement tools utilized was VAS and SPADI, thus the use for subjective tools outweighed the use of objective tools. The use of medication/medication related to pre-existing conditions was not reported.							
Outcome	Earlier mobilization technique was found to be more effective when compared to late mobilization techniques by restoration of range of motion in the restricted joint.							

Discussion	The use of purposeful sampling allowed the investigators to identify and recruit participants of a particular sample group. The diagnostic tools used to diagnose the participants was not clearly outlined along, in combination with the vague inclusion criteria disclosed, the potential for selection bias occurred. The use of two outcome measurement tools failed to provide objective outcome measures thus the efficiency of the interventions was not clearly reported. The six-week duration of study allowed initiated the initial physiological response, however the long-term efficiency if the intervention was not reported since there was no follow up period beyond six weeks. The outcome of the study identified the earlier mobilization techniques provided favourable results when compared to late mobilization techniques regarding the ROM of the joint, however no measurement tools were utilized to measure the ROM of the joint. The inconsistency of measurement tools and results reported created the potential for bias. The absence of settings and intervention protocol prevented the homogeneity of treatment amongst the participants. The replication of the study may not be possible in the future due to the lack of information regarding the inclusion criteria. Interventions used along with the measurement tools use.
Conclusion	Based on the ranking of 5/11 and total agreement percentage of 91%. Faruqi <i>et al.</i> (2015) provided a fair methodological rigour, however with based on the limitations discussed above, the investigation lacked internal and external validity. The data provided from Faruqi <i>et al.</i> (2015) was limited thus the replication of the study for the future should be adapted and more detailed thus providing a detailed, yet true representation of the population diagnosed with adhesive capsulitis.

Table G1. Tabulated feedback of reviewer data for Maryam *et al.* (2012) studies (according to the Pedro Scale).

Author (s)	Maryam, M., Zahra, K., Adeleh, B. and Morteza, Y.					
Year	2012					
Title	Comparison of corticosteroid injections, physiotherapy, and combination therapy in treatment of frozen shoulder.					
Criterion		Reviewer 1	Reviewer 2	Reviewer 3	Ranking	Total Percentage Agreement (%)
1	Eligibility criteria were specified	1	1	1	1	100%
2	Subjects were randomly allocated to groups (in a crossover study, subjects were randomly allocated an order in which treatments were received)	1	1	1	1	100%
3	Allocation was concealed	0	0	0	0	100%
4	The groups were similar at baseline regarding the most important prognostic indicators	1	1	1	1	100%
5	There was blinding of all subjects	0	0	0	0	100%
6	There was blinding of all therapists who administered the therapy	0	0	0	0	100%
7	There was blinding of all assessors who measured at least on key outcome	0	1	0	0	67%
8	Measures of at least on key outcome were obtained from more than 85% of the subjects initially allocated to groups	0	0	1	0	67%
9	All subjects for whom outcome measures were available received the treatment or control condition as allocated or, where this was not the case, data for at least one key outcome was analysed by "intention to treat"	1	1	1	1	100%
10	The results of between-group statistical comparisons are reported for at least one key outcome	1	1	1	1	100%
11	The study provides both point measures and measures of variability for at least one key outcome	1	1	1	1	100%
Total score		6/11	7/11	7/11	6/11	
Overall percentage agreement						94%

Table G2. Properties of the study, outcome and discussion Maryam *et al.* (2012).

Author (s)	Maryam, M., Zahra, K., Adeleh, B. and Morteza, Y.							
Year	2012							
Title	Comparison of corticosteroid injections, physiotherapy, and combination therapy in treatment of frozen shoulder.							
Study properties:								
Form of measurement	Frequency of measurement	Duration of study	Number of participants	Assessors blinded	Control used	Randomisation of participants	Ranking	Total Percentage Agreement
SPADI, VAS, Goniometer	Baseline, 6 weeks and 24 weeks	Initially 6 weeks, follow up of 24 weeks	87 participants initially, however at 6 weeks 21 participants dropped out from the investigation. At 24 weeks, only 36 participants were evaluated	Yes	Yes	Yes	6/11	94%
Limitations	The location of participant recruitment was conducted at a rheumatology clinic situated in Sari, Iran. The inclusion criteria required the participants to experience the frozen shoulder symptoms for less than a year and SPADI score of greater than equals to 30. Based on the duration of the symptoms and the location of recruitment, treatment novelty and participant naivety are factors accompanying prior exposure to the range of interventions that could influence the clinical outcomes of the investigation (Mouton 2001). Maryam <i>et al.</i> (2012) excluded participants who underwent treatment consisting of physiotherapy and injections in the last 6 months, however patient naivety may present a greater risk of bias when determining the clinical effect of the intervention (Harbour and Miller 2001). The inclusion criteria included participants diagnosed with diabetes mellitus in the study and distributed the participants to the treatment groups. The interventions utilized by Maryam <i>et al.</i> (2012) was physiotherapy, corticosteroid injections and the combination therapy of physiotherapy and corticosteroid injections. The limitation experienced in this study revolved around participant consent, specifically participants willingness to receive the corticosteroid injection or physiotherapy treatment. Informed consent and evidence-based consent in the health care is vital regarding participant treatment, however manual therapy influences patient naivety and the determination of clinical efficiency (Boucher, Brousseau and Chahine 2016; Harbour and Miller 2001). To be included in the investigation participants were required to have a total SPADI score of ≥ 30 to be included, however according to the baseline in Table 1 (Maryam <i>et al.</i> 2012) within each group more than 50% of the participants has a low level of education. Mandalia <i>et al.</i> (2022) postulated female gender, co-morbidities, lower educational level along with low-income place of residence were likely to contribute to a delay in health access and more progressed state of disease upon presentation. Furthermore, those from a lower education level produced poor patient-reported outcomes as well as increased pain and poor satisfaction. Dunn <i>et al.</i> (2014) reported that high levels of pain were associated with comorbidity, race and low education level. The participant was required to fill in the SPADI questionnaire, however it was not clear whether a researcher assisted the participants, should they not be literate or require assistance. The randomisation methods utilized was not disclosed along with the if the allocation was concealed. Considering the interventions utilized and need for participant informed consent, participant blinding was not possible. The evaluation of the SPADI score was conducted by an observer blind to the treatment allocation. The study design outlined the ideal sample size required in each group was 35 participants, however due to difficulty recruiting participants who							

	fulfilled the eligibility criteria, the trial was stopped. The dosage of the corticosteroid injections and site of the injection was reported, however the physiotherapy modalities utilised was mentioned but no detailed provided. The physiotherapy sessions received was reported to be ten sessions, however it was not clearly defined. The number of corticosteroid injections received was not reported. The baseline characteristics noted more female participants than males, and majority of the participants involved experienced a low level of education. The participants involved were taught a simple shoulder exercise program and allowed to take acetaminophen for pain relief, however a record of the pain medication and home care via journal was not reported. The number of participants recruited were 87, however 36 participants completed the trial (24-week period), thus the true clinical effect of the intervention could not be measured, however the physiotherapy group provided a more subjective improvement.
Outcome	The use of combination therapy was more effective than physiotherapy alone. The use of physiotherapy alone can offer limited efficiency in the management of adhesive capsulitis.
Discussion	Based on the evidence discussed above limitations in Maryam <i>et al.</i> (2012) were noted and discussed below. The randomisation methods utilized was not clearly disclosed along with the concealed allocation. The ambiguous eligibility criteria created the population generalizability and true representation of the population with adhesive capsulitis. The number of females to males recruited were more than double in ratio, and the level of education of the participants recruited low. The interventions used in the trial were mentioned, but the details pertaining to treatment were not reported. The number of sessions received was reported to be ten, however the frequency of the sessions was not mentioned. Should the trial design need to be replicated, the lack of information may fail to provide a true effectiveness of the clinical intervention. The follow up period utilized in the trial resulted in a substantial drop out of the participants, failing to provide a long-term outcome of the intervention and presenting attrition bias.
Conclusion	Based on a ranking of 6/11 and total percentage agreement of 91%, Maryam <i>et al.</i> (2012) provided a good level of evidence. The methodological rigour provided was fair however the internal and external validity of the study was limited as the information provided was ambiguous and design of the trial poorly described thus the replication of the design unlikely.

Table H1. Tabulated feedback of reviewer data for Patil, Sudha and Sidharth (2018)(according to the Pedro Scale).

Author (s)	Patil, S. N., Sudha, B. R. and Sidharth, D.					
Year	2018					
Title	Comparative efficacy of transcutaneous electrical nerve stimulation [TENS] and pendular exercises v/s ultrasound and rhythmic stabilization in clinically diagnosed frozen shoulder [adhesive capsulitis] using SPADI scale. A random study					
Criterion		Reviewer 1	Reviewer 2	Reviewer 3	Ranking	Total Percentage Agreement (%)
1	Eligibility criteria were specified	1	1	1	1	100%
2	Subjects were randomly allocated to groups (in a crossover study, subjects were randomly allocated an order in which treatments were received)	1	1	1	1	100%
3	Allocation was concealed	0	0	0	0	100%
4	The groups were similar at baseline regarding the most important prognostic indicators	1	0	0	0	67%
5	There was blinding of all subjects	0	0	0	0	100%
6	There was blinding of all therapists who administered the therapy	0	0	0	0	100%
7	There was blinding of all assessors who measured at least on key outcome	0	0	0	0	100%
8	Measures of at least on key outcome were obtained from more than 85% of the subjects initially allocated to groups	1	0	0	0	67%
9	All subjects for whom outcome measures were available received the treatment or control condition as allocated or, where this was not the case, data for at least one key outcome was analysed by "intention to treat"	1	1	0	1	67%
10	The results of between-group statistical comparisons are reported for at least one key outcome	1	1	0	1	67%
11	The study provides both point measures and measures of variability for at least one key outcome	1	0	0	0	67%
Total score		7/11	4/11	2/11	4/11	
Overall percentage agreement						85%

Table H2. Properties of the study, outcome and discussion Patil, Sudha and Sidharth (2018).

Author (s)	Patil, S. N., Sudha, B. R. and Sidharth, D.							
Year	2018							
Title	Comparative efficacy of transcutaneous electrical nerve stimulation [TENS] and pendular exercises v/s ultrasound and rhythmic stabilization in clinically diagnosed frozen shoulder [adhesive capsulitis] using SPADI scale. A random study							
Study properties:								
Form of measurement	Frequency of measurement	Duration of study	Number of participants	Assessors blinded	Control used	Randomisation of participants	Ranking	Total Percentage Agreement
SPADI	Pre-test and post-test	1 month/ 1 year	24	Unknown	Yes	Yes	4/11	85%
Limitations	The participants involved were recruited from two outpatient facilities. The participants were enrolled for the investigation for approximately a one-year period at each site, whereas the duration of each study conducted was one month. The eligibility criteria utilized by Patil, Sudha and Sidharth (2018) was based on evidence provided by Kelley, McClure and Leggin (2009), however the onset of symptoms was not clearly defined, and the inclusion criteria in this particular study not clearly outlined. Based on the inclusion criteria, the participant was required to undergo a radiograph to exclude pathological processes influencing the diagnosis of adhesive capsulitis, however it was inconclusive whether the imaging studies was conducted upon initial visit to the facility or upon recruitment into the investigation. The stage of the pathology investigated was not disclosed, furthermore the use of the radiograph imaging excluded pathological processes causing the adhesive capsulitis, however, did not confirm blinding of the participants, therapists or assessors. The ambiguous eligibility criteria did not include the duration of symptoms experienced by the participants, along with presence of co-morbidities and previous treatment/ current medication used. Patil, Sudha and Sidharth (2018) provided thorough methodology and processes followed by the participants and therapists, however the use of the same assessors at both locations was not disclosed. Based on the design of the investigation, blinding was impossible due to the nature of the investigations utilized. The relationship between the location of the investigation and participant visits were not discussed thus was unclear whether the participant received the intervention at both locations and one specific location. Furthermore, the therapists training was unknown and undisclosed where the consistent between both locations. The group allocation was random, but the method of randomisation and concealment not clear along with the confirmation the same protocols were followed in both locations. The number of participants per group were 8 individuals each, into three groups respectively, deducing non-parametric statistics were utilized in the analysis. The small group in combination with the vague eligibility criteria, questionable naivety and the lack of information regarding blinding provides an increased variance between the groups. The greater the variance, the more difficult group comparison becomes (Nahm 2016; Vickers 2005). The intervention utilized in the groups were TENS and pendular exercises (Group A), ultrasound and rhythmic stabilization (Group B), and the control consisting of a heat pack and shoulder active therapy (Group C). The parameters of the interventions used were clearly outlined along with the duration and placement of the modalities. Due to the nature of the interventions, i.e., manual therapy, blinding of the therapist administering the intervention was unable to be blinded. The absence of baseline characteristics of the participants makes the interpretation of the results misleading. The presence of baseline characteristics and measures provides a comparison and analysis of data either in support or against the intervention. The data provided in the results establishes and compares the two experimental groups verses the control, whereas the intervention intragroup was not present. The vague eligibility criteria and absent							

	information regarding the sociodemographic details of the participants recruited into their respective groups, failed to provide the true clinical effectiveness of the interventions tested, furthermore the participant distribution was not clearly reported as the allocation method was not disclosed. The measurement tool utilized was the SPADI, which provided subjective information supplied by the participant, however the frequency of measurement was unclear as Patil, Sudha and Sidharth (2018) provided pretest values and post-test values suggesting the SPADI was conducted at the outset of the investigation and at the end of the investigation. The use of one outcome measurement tool may create a threat to the validity as the analyses between the groups may differ and not clearly be measured, thus bias occur due to the outcome measure (Sterne <i>et al.</i> 2019). The results reported, discussed statistical analysis between the groups, but the absence of information of the data analysed/ data captured, created ambiguity and no clear outcome. Furthermore, the Patil, Sudha and Sidharth (2018) reported after a year of conducting the study on 24 participants, a further three groups of participants received the intervention for a month; thus it was unclear whether the study was repeated or if the study was continued for a year. The lack of information regarding the participant recruitment and if the same participants were involved was not disclosed.
Outcome	Both the experimental groups, utilizing TENS and ultrasound, provided favourable results when compared to the control. The pain and disability experienced was significantly reduced in the two experimental groups.
Discussion	The absence of information pertaining to the recruitment methods used, along with the eligibility criteria provided the potential for selection bias along with allocation bias. The stage of pathology diagnosed and treated was not disclosed, furthermore the patient homogeneity was not clearly disclosed. The lack of information regarding the participant characteristics, previous treatment and current medical conditions failed to present a homogenous distribution. The use of one outcome measurement tool, and absence of corresponding data prevented the clinical effectiveness to be measured; in combination with no baseline measurements corresponding to the statistical analysis, the lack of comparative information was provided. The use of SPADI failed to provide an objective outcome measurement tool as the participant may be influenced by the therapists and participants involved. Patient naivety plays a vital role along with the presence of the Hawthorne effect, as the participants are likely to be influenced by their surroundings as blinding was not disclosed. The parameters and duration of the interventions utilized were clearly outlined, thus providing adequate information regarding homogeneity amongst the treatment. As discussed above the lack of comparative data from the results, prevents one from identifying the true clinical effectiveness of the intervention.
Conclusion	Based on the ranking of 4/11 and total percentage agreement of 85%, Patil, Sudha and Sidharth (2018) provided limited information. Considering vague eligibility criteria combined with the lack of information regarding patient homogeneity, the participant distribution between the groups was unknown. The use of non-parametric statistics provided a vague comparison of the intergroup results and failed to identify the superior intervention. The validity of the study was poor and failed to provide adequate information.

Table I1. Tabulated feedback of reviewer data for Rawat, Eapen and Seema (2017)(according to the Pedro Scale).

Author (s)	Rawat, P., Eapen, C. and Seema, K. P.					
Year	2017					
Title	Effect of rotator cuff strengthening as an adjunct to standard care in subjects with adhesive capsulitis: A randomized controlled trial.					
Criterion		Reviewer 1	Reviewer 2	Reviewer 3	Ranking	Total Percentage Agreement (%)
1	Eligibility criteria were specified	0	1	1	1	67%
2	Subjects were randomly allocated to groups (in a crossover study, subjects were randomly allocated an order in which treatments were received)	1	1	1	1	100%
3	Allocation was concealed	1	1	1	1	100%
4	The groups were similar at baseline regarding the most important prognostic indicators	1	1	0	1	67%
5	There was blinding of all subjects	0	1	0	0	67%
6	There was blinding of all therapists who administered the therapy	0	0	0	0	100%
7	There was blinding of all assessors who measured at least on key outcome	1	1	1	1	100%
8	Measures of at least on key outcome were obtained from more than 85% of the subjects initially allocated to groups	1	1	1	1	100%
9	All subjects for whom outcome measures were available received the treatment or control condition as allocated or, where this was not the case, data for at least one key outcome was analysed by "intention to treat"	1	1	1	1	100%
10	The results of between-group statistical comparisons are reported for at least one key outcome	1	1	1	1	100%
11	The study provides both point measures and measures of variability for at least one key outcome	1	1	1	1	100%
Total score		8/11	10/11	8/11	9/11	
Overall percentage agreement						91%

Table 12. Properties of the study, outcome and discussion Rawat, Eapen and Seema (2017).

Author (s)	Rawat, P., Eapen, C. and Seema, K. P.							
Year	2017							
Title	Effect of rotator cuff strengthening as an adjunct to standard care in subjects with adhesive capsulitis: A randomized controlled trial.							
Study properties:								
Form of measurement	Frequency of measurement	Duration of study	Number of participants	Assessors blinded	Control used	Randomisation of participants	Ranking	Total Percentage Agreement
VAS, SPADI, PSFS, goniometer, handheld dynamometer	Measured at baseline and after 4 weeks after the intervention (after the 12 th session)	4 weeks	42 participants randomly allocated into groups of 21 participants each.	Blinding of the assessors but no mention of participant allocation.	Yes	Yes	9/11	91%
Limitations	The participants recruited were referred upon diagnosis with adhesive capsulitis from both inpatient and outpatient facilities of the Kasturba Medical College, however the location of the study was not disclosed. The eligibility criteria outlined was vague and focused on functionality, range of motion, and 1-3-month onset of the symptoms. The lack of requirements pertaining to the sociodemographic characteristics along with the age range and presence of co-morbidities; thus allowed a broader generalised population to be recruited. Based on the duration of symptoms, the assumption was made that the participants recruited were in the first stage of adhesive capsulitis. The screening process excluded those with secondary adhesive capsulitis and the history of trauma. Based on the baseline characteristics provided (Rawat, Eapen and Seema 2017) the lack of participant homogeneity was noted as the participants in group two were older and experienced symptoms for a longer duration when compared to group one. The randomized group allocation did not equally represent the patient gender, age, hand dominance and the limb affected. The socioeconomic status of the patient, including if the patient was literate. Furthermore, the lack of information regarding the recruitment method utilized along with previous treatment utilised for the symptoms. The total number of participants meeting the requirements to be 42. The participants were randomly allocated though the block randomization. The number of the participants in each group allowed the researcher to utilize parametric statistics, providing more definitive conclusions based on the outcome measured utilized). The study design followed an intention to treat analysis, however no participants dropped out of the study and a total of 42 participants were analysed at week 4, staying within the study design of intention to treat analysis. The Hawthorne effect (McCarney <i>et al.</i> 2007) can play a vital role in the participants in both groups. The patient perception of the intervention received can be influenced by the belief of the therapist administering the intervention. The intervention was administered by a postgraduate student under the supervision of an experienced therapist with over 15 years of experience and a doctorate qualification, however there was no indication if the supervisor was an author in the study. The therapist administering the intervention conducted the treatment for all the participants throughout the study. The use of a novice therapist administering the intervention can impact the overall patient perception, based on if the therapist was confident in administration of the intervention, the age of the therapist, and the interaction between the therapist and the participant. Based on the therapist administering the intervention on the participant, the therapist was not blinded thus the attitude of the therapist towards the patient and not the intervention can influence the participants subjective outcome. Throughout the study there is no mention of an environmental variation, however based on the recruitment process of the patients being inpatient and outpatients, the environment in which the intervention was administered can influence the participants subjective outcome. The measurements were taken twice, before and after the completion of the treatment sessions by another assessor physiotherapist who was not involved in the assessment or intervention of the study. The participants underwent subjective measurements and objective measurements. The eligibility criteria did							

not outline whether the participants were required to be literate to be included in the study, the means the participants completed the subjective measurements could have varied if the participant was literate versus illiterate. The participant would require assistance in the completion of the questionnaires with the assistance of the assessor, which may influence the outcome through communication bias and or the participants understanding of the questionnaire.

The participant nativity was needed to be taken into consideration based on the recruitment process from the inpatient and outpatient departments of the hospitals. There is no indication of the ratio of inpatient and outpatient participants in the study, as well as the participant allocation into the two groups. The patients who were recruited from the inpatient facilities were likely to have serious conditions and might have been exposed to the interventions used. The study does not mention whether the participants were blinded throughout the study to the interventions utilized, thus with the assumption there was no blinding the patient perception can alter the subjective outcome, furthermore there was no mention of interaction of the groups and if this was prevented. Participants with co-morbidities, systemic diseases and secondary causes of adhesive capsulitis were excluded from the study, furthermore, the exclusion criteria noted if participants reproduced the reported symptoms and shoulder pain altered with nerve tension positions and/or shoulder pain was produced during palpation of the peripheral nerve root entrapment site, the participant would be excluded. Participants in the acute phase of adhesive capsulitis will experience the reduction in motion specifically in abduction and external rotation, thus the use of nerve root entrapment tests are likely to produce a false positive in some instances (Schmid, Fundaun and Tampin 2020). The patient allocation into the groups did not mention of there was homogeneity between the two groups, specifically were the groups equal according to the participant age, gender, hand dominance, limb affected and whether the patient was an inpatient or outpatient recruit. The participants lifestyle and/or socioeconomic state was not taken into consideration or mentioned in the study; however, it is empirical to note this information can influence the subjective outcomes of the participants. The practitioners were blinded throughout the study. Each author was allocated definitive roles throughout the study- the second author randomised the allocation of participants. The assessors were blinded to the group allocation and conducted the measurements at baseline and week 4. The same therapist administered the treatments to all the participants throughout the study duration. The practitioner can influence the participants outcome with their perception rather than the intervention administered based on the level of confidence whilst administering the intervention, the age of the therapist, professionalism of the therapist and the influence of the supervisor on the intervention protocols towards each participant (if the supervisor was present throughout each participants treatment session). The projection of the perceptions of the therapists administering the intervention regarding the treatment onto the participants was unknown, furthermore it was unclear whether the participants were blinded.

Both the groups underwent shoulder mobilization exercises and TENS, whereas Group 2 included strengthening exercises of the rotator cuff muscles. The shoulder mobilization techniques the rotator cuff muscle strengthening exercises given to the experimental group (Group 2) were isometric and isotonic exercise, dynamic muscle strengthening of the rotator cuff muscle through eccentric exercises using a TheraBand and dynamic muscle strengthening of the rotator cuff concentrically by the means of dumbbells. All the participants were given pendular, free ROM and stretching exercises for the shoulder were taught as a homecare program, however there is no record of a "homework diary" which reported if the patient completed the homecare exercises and there was no indication of there was consistency between the participants in each group with regards to completion of the homecare exercises.

The TENS electrodes were placed over the site where the most intense pain was felt, or the greatest tenderness was elicited, indicating the placement of the electrodes was not consistent between participants. There is no mention if the electrodes were placed on the affected limb or the dominant limb between the participants. Reporting of the hand dominance and the affected extremity are not included; this can influence both the subjective and objective outcomes if the participants non-dominant limb is affected when compared to that a participant having the affected arm being the dominant limb. The stimulation was set at 15 minutes at the frequency of 15. The intensity of the current was set at a comfortable level as determined by the subjects which ranged between 25-35 mA. The current was increased when the participant accommodated to the stimulation (paraesthesia and mild twitches subsided) within 5 minutes.

	The baseline and 4 th week measurement (after the 12 th session) were taken by a blinded assessor, however the measurements before and after each session was taken by a blinded assessor not involved in the study.
Outcome	Statistical changes were noted in pain and function in both groups. The participants who received the additional rotator cuff strengthening exercises experienced significant increase in the shoulder ROM.
Discussion	Based on the information above, the vague eligibility criteria and the outlined recruitment methods utilized enabled a diffuse general population to be included in the study. The criteria excluded secondary adhesive capsulitis and trauma. The population included may not represent the general population of participants diagnosed with adhesive capsulitis, in addition the lack of information regarding the stage of adhesive capsulitis investigated failed to identify patient homogeneity. The clinical efficiency of the intervention may not fully be identified as the pathology homogeneity amongst participants was inconsistent. The lack of information regarding blinding, specifically the participant blinding, and previous treatment used to manage the pathology, excluded potential bias through patient naivety and the Hawthorne effect. The design of the study utilised a duration of four weeks, however based on evidence a minimum of six weeks was required to provide a physiological response(Wohlann <i>et al.</i> 2023; Murlasits, Reed and Wells 2012). Both groups received TENS and mobilization, thus the clinical efficacy of TENS was not completely identified.
Conclusion	With a ranking of 9/11 and overall percentage agreement of 91%, Rawat, Eapen and Seema (2017) provided excellent quality. The limitations discussed above identified the study provided the lack of internal validity as the structure of the study lacked significant information and potential for attrition bias, furthermore the information may be misinterpreted due to the lack of participant information.

Table J1. Tabulated feedback of reviewer data for Reddy and Metgud (2014) according to the Pedro Scale).

Author (s)	Reddy, B. C. and Metgud, S.					
Year	2014					
Title	A randomized controlled trial to compare the effect of muscle energy technique with conventional therapy in stage ii adhesive capsulitis.					
Criterion		Reviewer 1	Reviewer 2	Reviewer 3	Ranking	Total Percentage Agreement (%)
1	Eligibility criteria were specified	1	1	1	1	100%
2	Subjects were randomly allocated to groups (in a crossover study, subjects were randomly allocated an order in which treatments were received)	1	1	1	1	100%
3	Allocation was concealed	0	0	0	0	100%
4	The groups were similar at baseline regarding the most important prognostic indicators	1	0	0	0	67%
5	There was blinding of all subjects	0	0	0	0	100%
6	There was blinding of all therapists who administered the therapy	0	0	0	0	100%
7	There was blinding of all assessors who measured at least on key outcome	0	0	0	0	100%
8	Measures of at least on key outcome were obtained from more than 85% of the subjects initially allocated to groups	1	1	1	1	100%
9	All subjects for whom outcome measures were available received the treatment or control condition as allocated or, where this was not the case, data for at least one key outcome was analysed by "intention to treat"	1	1	1	1	100%
10	The results of between-group statistical comparisons are reported for at least one key outcome	1	1	1	1	100%
11	The study provides both point measures and measures of variability for at least one key outcome	1	1	1	1	100%
Total score		7/11	6/11	6/11	6/11	
Overall percentage agreement						97%

Table J2. Properties of the study, outcome and discussion for Reddy and Metgud (2014).

Author (s)	Reddy, B. C. and Metgud, S.							
Year	2014							
Title	A randomized controlled trial to compare the effect of muscle energy technique with conventional therapy in stage ii adhesive capsulitis.							
Study properties:								
Form of measurement	Frequency of measurement	Duration of study	Number of participants	Assessors blinded	Control used	Randomisation of participants	Ranking	Total Percentage Agreement
VAS, DASH, Goniometer	Pre and post intervention session	Patients were recruited from the 15 th of March 2013 to 30 th of January 2014. The protocol duration was 15 days	30 participants divided into 2 groups of 15 each	No.	Yes	No indication of the allocation method used.	6/11	97%
Limitations	The eligibility criteria indicated the minimum age requirement, however, does not mention the maximum age limit. As the participants age increases, the rate of healing reduces, which can limit the outcomes. Singh <i>et al.</i> (2017) noted in participants over the age of 60 years there is a notable reduction in the range of motion and reported function. The patient recruitment procedure lasted from 15th of March 2013 to 30th of January 2014, with the patient inclusion criteria being diagnosed with stage 2 adhesive capsulitis at the time of recruitment. The date of the study procession was not indicated, thus can impact the subjective and objective outcomes as the participant can progress from stage 2 to stage 3 of adhesive capsulitis which will further reduce the pain experienced, range of motion and increase the stiffness in the affected joint (Fields <i>et al.</i> 2019). The lack of homogeneity between the patients was further noted with the allocation of the participants based on the limb affected, there were 8 participants with left limb affected and 7 right limbs in Group 1, whereas in Group 2 there was 2 left limbs affected, and 13 right limbs affected. The method of random patient allocation into the two groups was not specified, however it mentioned in the abstract the study followed a randomized control trial design but there was not further explanation provided. The Hawthorne effect can influence in the participants perception which may alter the subjective outcome negatively. The environment of the study was contacted between the KLES Dr Prabhakar Kore Hospital and MRC, Belgaum, Karnataka. The variation of the environment can alter the participants subjective outcome as there is no homogeneity between the participants, furthermore, there was no indication of the same therapists and assessors conducting the investigation in both environments. There was no indication whether the participants underwent previous treatment for adhesive capsulitis and/or other shoulder conditions. There was no blinding of either assessors, therapists and/or the research participants throughout the study. The attitude of the therapist administering the intervention could have influenced the participants subjective measurements based on the lack of blinding, furthermore the assessor was aware of the group allocation of the participant which can influence the efficiency of the measurements and altered the attitude of the assessor towards the patient, sequentially influencing the participants subjective outcome. The socioeconomic status of the participants, co-morbidities and hand dominance was not considered.							

	The sample size was 15 participants in each group thus non-parametric statistics were utilized by the authors. The use on non-parametric statistics used for smaller groups, which analyse by data by the process of median statistics. Nonparametric statistics might not provide accurate results when variability differs between the groups (Nahm 2016). There were no participant dropouts in the study. There was no blinding of the participants, therapists, and assessors throughout the study, thus can be create various bias and influence the measurement outcomes negatively. There was no stipulation whether there was a change in the environment and/or the therapists administering the intervention along with the assessors. The measurement outcomes can be prejudiced as the participants perception can be influenced by the therapists/assessor's perception projected unto the participant based on their beliefs on the intervention. Comparatively, the participant cand be influenced based on the appearance, age, knowledge and interaction with the therapist administering the intervention. Group A received conventional therapy, whereas Group B received MET and conventional therapy. The conventional therapy comprised of a hot moist pack, TENS, shoulder mobility exercises. Those in Group A were given on treatment session per a day for 15 days. The participants in Group B received 15 repetitions, three sets per session and one session per day for 15 sessions. The protocol setting of TENS and the placement of the electrodes was not disclosed, thus can identify whether the treatment was homogeneous between the participants.
Outcome	The use of conventional therapy alone (Group A) and the combination of conventional therapy and MET (Group B) were both equally effective in the management of adhesive capsulitis.
Discussion	The recruitment and enrolment period utilized was 11 months, however the duration of the study was 15 days. The recruitment method used by Reddy and Metgud (2014) was not disclosed, thus the influence for patient naivety may provide bias, along with the potential of participant word-of-mouth recruitment strategies. The eligibility criteria provided, allowed a specific population of participants with adhesive capsulitis to be recruited, also excluding secondary adhesive capsulitis. The lack of blinding of all parties involved, provided the potential for bias in the form of patient naivety and the Hawthorne effect, as with manual therapy blinding was impossible. The allocation method and randomisation technique utilised by Reddy and Metgud (2014) was not reported. The parameters of the interventions used was not clear and the details of the modalities (i.e., settings, electrode placement and duration) not reported. The study design failed to identify the clinical effectiveness of TENS on the management of adhesive capsulitis and merely identified the use of TENS in the form of combination therapy to manage adhesive capsulitis. The study duration of 15 days, identified the immediate effect of the intervention on the affected joint as seen in Moore <i>et al.</i> (2011) where the single application of MET provided immediate improvement in the glenohumeral joint of the affected individuals. The lack of information regarding the intervention may influence the replication of the study in future investigations.
Conclusion	Based on the ranking of 6/11 and total percentage average of 97%, Reddy and Metgud (2014) provided a good methodological rigour. However, considering the limitations mentioned above, the internal and external validity of the study were poor as the replication of the study based on the information provided may not fulfil the same outcome was reached in this design due to the structure of the study along with the findings provided.

Table K1. Tabulated feedback of reviewer data for Reddy and Metgud (2015) (according to the Pedro Scale).

Author (s)	Reddy, B. C. and Metgud, S.					
Year	2015					
Title	Randomized controlled trial to investigate the effect of mulligan's mwm and conventional therapy in stage ii adhesive capsulitis.					
Criterion		Reviewer 1	Reviewer 2	Reviewer 3	Ranking	Total agreement percentage (%)
1	Eligibility criteria were specified	1	1	0	1	67%
2	Subjects were randomly allocated to groups (in a crossover study, subjects were randomly allocated an order in which treatments were received)	1	1	1	1	100%
3	Allocation was concealed	1	0	0	0	67%
4	The groups were similar at baseline regarding the most important prognostic indicators	1	1	1	1	100%
5	There was blinding of all subjects	0	0	0	0	100%
6	There was blinding of all therapists who administered the therapy	0	0	0	0	100%
7	There was blinding of all assessors who measured at least on key outcome	0	0	0	0	100%
8	Measures of at least on key outcome were obtained from more than 85% of the subjects initially allocated to groups	1	1	1	1	100%
9	All subjects for whom outcome measures were available received the treatment or control condition as allocated or, where this was not the case, data for at least one key outcome was analysed by "intention to treat"	0	1	1	1	67%
10	The results of between-group statistical comparisons are reported for at least one key outcome	1	1	1	1	100%
11	The study provides both point measures and measures of variability for at least one key outcome	0	1	1	1	67%
Total score		6/11	7/11	7/11	7/11	
Overall percentage agreement						88%

Table K2. Properties of the study, outcome and discussion for Reddy and Metgud (2015).

Author (s)	Reddy, B. C. and Metgud, S.							
Year	2015							
Title	Randomized controlled trial to investigate the effect of mulligan's mwm and conventional therapy in stage ii adhesive capsulitis.							
Study properties:								
Form of measurement	Frequency of measurement	Duration of study	Number of participants	Assessors blinded	Control used	Randomisation of participants	Ranking	Total Percentage Agreement
VAS, Goniometer, DASH	Pre and post the 15 th day of the intervention for all the interventions	15 days	30 participants, split into 15 participants per a group	No blinding indicated	Group A used conventional therapy (hot moist pack, TENS, shoulder mobility exercises)	Participants were randomly allocated into groups	7/11	88%
Limitations	The participants were recruited from one location from the 15th of March 2013 to the 30th of January 2014. The location of the study was reported to be a hospital and medical research centre, subsequently, the patient recruitment method was not disclosed along with the manner of information disbursement to the participant. The eligibility criteria required the participants to be diagnosed with stage two adhesive capsulitis, over the age of 40 years along with reduced range of motion in the shoulder. With the purpose of excluding those participants who did not fulfil the inclusion criteria, the exclusion criteria excluded those diagnosed with secondary adhesive capsulitis along with factors influencing the pathology. The eligibility criteria failed to outline an age limit to the participants recruited along with previous treatment used to manage adhesive capsulitis. The method of randomisation was not disclosed along with information of allocation concealment, furthermore Reddy and Metgud (2015) reported no assessors involved were blinded, not clarifying whether the assessors were involved in administration of the intervention and along with clarification of blinding amongst the participants. Due to the randomised allocation the gender ratio between the groups were not equal, along with the age distribution of the participants. The distribution of gender provided more males than females, specifically in the control group. The outcome measures utilized in this study (Reddy and Metgud 2015) was the VAS, goniometer and DASH, to measure pain experienced, shoulder range of motion and the functional index experienced by the participant respectively. The measurements were done at the initial visit and at the end of the 15th day of the intervention. The use of three measurement tools provided subjective and objective validity tools. The lack of information pertaining to the relationship the participants (intergroup and intragroup communication) and the therapists and assessors provided the potential for bias as patient naivety, and the Hawthorne effect may influence the outcome. Furthermore, the recruitment duration utilized was over an 11-month period, and the lack of information regarding the participant recruitment, may influence the validity and provide potential bias as the participants may have recruited by word of mouth.							

	Based on the absence of information regarding the sociodemographic characteristics of the participants involved, the previous medical history and treatment used to manage the condition was not documented. With the participants being in the same stage of the disease and location of recruitment a hospital, the participants were aware of the diagnosis and may have utilized previous interventions. The interventions utilized were Group A conventional therapy (i.e., hot moist pack, TENS and shoulder mobility exercises) and Group B received conventional therapy and Mulligan's MWM. The sessions received were once daily for 15 days and 3 sets of 10 repetitions of Mulligan's MWM for 15 sessions respectively; however, the parameters for the interventions specifically the conventional therapy was not provided. The dosage of the settings, duration, electrode placement and intervention duration were absent. The interventions utilized did not identify the clinical effectiveness of TENS in the management of adhesive capsulitis, merely the use of TENS in a combination treatment protocol.
Outcome	The use of Mulligan's MWM in combination with conventional therapy was effective in the treatment of adhesive capsulitis.
Discussion	The location of the study was based at a hospital, however the lack of information pertaining to the recruitment process provided potential for bias as patient naivety was possible. The lack of age limitation in the eligibility criteria, broadened the population and may provide a generalised population/ representation of participants with adhesive capsulitis. The lack of blinding amongst all the involved parties, allowed the Hawthorne effect and naivety to influence the outcome. The lack of information regarding previous medical interventions and current treatment/ homecare influenced the internal validity of the study. Furthermore, the lack of information regarding the interventions, specifically the settings, duration and placement parameters allowed the replication of the study to be impossible thus results justified.
Conclusion	Based on the ranking of 7/11 and total percentage agreement of 88%, Reddy and Metgud (2015) provided a good methodological ranking. However, based on the limitations noted above, the internal and external validity was poor, and the information provided unreproducible for future investigations. The use of TENS was identified as part of a combination therapy and not alone.

Table L1. Tabulated feedback of reviewer data for Saber *et al.* (2022) (according to the Pedro Scale).

Author (s)	Saber, H. I., Rashad, A., Eltnany, E. and Shaat, R. M.					
Year	2022					
Title	Does Ultrasound-Guided Continuous Suprascapular Nerve Block Affect Frozen Shoulder Rehabilitation Programme Outcome?					
Criterion		Reviewer 1	Reviewer 2	Reviewer 3	Ranking	Total agreement percentage (%)
1	Eligibility criteria were specified	0	1	1	1	67%
2	Subjects were randomly allocated to groups (in a crossover study, subjects were randomly allocated an order in which treatments were received)	1	1	1	1	100%
3	Allocation was concealed	1	1	1	1	100%
4	The groups were similar at baseline regarding the most important prognostic indicators	1	1	1	1	100%
5	There was blinding of all subjects	0	0	0	0	100%
6	There was blinding of all therapists who administered the therapy	0	0	0	0	100%
7	There was blinding of all assessors who measured at least on key outcome	1	1	1	1	100%
8	Measures of at least on key outcome were obtained from more than 85% of the subjects initially allocated to groups	0	1	1	1	67%
9	All subjects for whom outcome measures were available received the treatment or control condition as allocated or, where this was not the case, data for at least one key outcome was analysed by "intention to treat"	1	1	1	1	100%
10	The results of between-group statistical comparisons are reported for at least one key outcome	1	1	1	1	100%
11	The study provides both point measures and measures of variability for at least one key outcome	1	1	1	1	100%
Total score		7/11	9/11	9/11	9/11	
Overall percentage agreement						94%

Table L2. Properties of the study, outcome and discussion for Saber *et al.* (2022).

Author (s)	Saber, H. I., Rashad, A., Eltnany, E. and Shaat, R. M.							
Year	2022							
Title	Does Ultrasound-Guided Continuous Suprascapular Nerve Block Affect Frozen Shoulder Rehabilitation Programme Outcome?							
Study properties:								
Form of measurement	Frequency of measurement	Duration of study	Number of participants	Assessors blinded	Control used	Randomisation of participants	Ranking	Total Percentage Agreement
Constant score	Before physical therapy, immediately after and one month after	One month	76 participants	Yes	Yes	Yes	9/11	94%
Limitations	The recruitment location utilized was unspecific but reported patients were recruited from a pain clinic or outpatient physical therapy and rehabilitation clinics of Mansoura University. The recruitment process was unknown, but the eligibility criteria required the participants to be diagnosed with adhesive capsulitis and experience symptoms for at least a month. The eligibility criteria outlined was vague thus allowing a larger general population of participants to be recruited and the recruiters involved focused on the presence of diabetes and history of shoulder trauma when identifying secondary adhesive capsulitis. Furthermore, the inclusion criteria excluded participants with secondary adhesive capsulitis (but included trauma and diabetes participants) and further excluded those who received intraarticular drug injections three months prior. The allocation concealed in closed envelopes and the participants randomised equally into two groups: Group A (injection group) received the suprascapular nerve block (SSNB) prior to physical therapy, whereas Group B (control group) did not receive a SSNB prior to physical therapy. Based on the design of the study and nature of the interventions along with the participant consent, blinding of the participants was not possible; however, the assessor involved was blinded to the participant groups and completed assessments on all participants using the constant score. Saber <i>et al.</i> (2022) provided a detailed description of the protocols followed when administering the SSNB, along with the physical therapy program followed by both groups. The physical therapy program included ultrasound, heat therapy, mobilizations, TENS, ROM exercises and stretching exercises. The parameters, electrode placement and duration and frequency of treatment was also reported. In addition, the participants were given a homecare programme to do twice daily but not record of patient compliance was noted for this. Based on the vague eligibility criteria, the baseline characteristics of the recruited participants were broad, specifically more females were recruited than males, and high prevalence of participants with secondary diabetes caused by diabetes and trauma amongst the groups. The participant homogeneity amongst the groups lacked, as the duration of symptoms between the groups varied, as most participants in Group A were in the early stage of adhesive capsulitis, whereas Group B had an even distribution of participants in all the stages of adhesive capsulitis. The sociodemographic characteristics considered the employment status of the participants, the participant distribution between groups comprised of both majority housewives and working individuals, whereas Group A comprised of a significant number of retired folk when compared to Group B. The patient characteristics also reported the handedness and affected side; noting most participants' dominant side was affected.							
Outcome	The addition of suprascapular nerve blocks in physical therapy provided a better improvement in shoulder function.							

Discussion	External validity of the study negatively influenced as the inclusion criteria was vague and prevented limitations (Rothwell 2006), thus the population recruited not homogeneous and the clinical effectiveness of the intervention not identified. The use of both TENS and ultrasound therapy in the physiotherapy intervention, failed to identify the effectiveness of TENS in the management of adhesive capsulitis. Furthermore, the participants recruited were provided homecare exercises, but no record of participant compliance was provided. The participants recruited presenting with secondary adhesive capsulitis caused by diabetes and/or trauma, the history of current and past medical treatment was not reported and medication taken during the time of the study. Based on the evidence provided, the replication of the results would be likely based on the methodology provided, thus internal validity was fair.
Conclusion	Based on the ranking of 9/11 and a total percentage agreement of 94%, an excellent level of evidence was reported. However, the external validity of the study was left vulnerable as vague inclusion criteria, allowed a generalised population to be recruited into the study, failing to identify a specific sample group and participants in varied stages of the disease to be recruited; thus, the clinical effectiveness of the intervention not identified.

Table M1. Tabulated feedback of reviewer data for Wahyuni, Nurdina and Indasah (2020)(according to the Pedro Scale).

Author (s)	Wahyuni, R., Nurdina, N. and Indasah, I.					
Year	2020					
Title	Effectiveness Variation Giving SWD, TENS, Manipulation Therapy, Exercise to Reduce Pain, Increase Range of Motion, Improve Functional Ability on Frozen Shoulder in Dr. Soepraoen Malang Hospital.					
Criterion		Reviewer 1	Reviewer 2	Reviewer 3	Ranking	Total Percentage Agreement (%)
1	Eligibility criteria were specified	0	0	0	0	100%
2	Subjects were randomly allocated to groups (in a crossover study, subjects were randomly allocated an order in which treatments were received)	0	0	1	0	100%
3	Allocation was concealed	0	0	0	0	100%
4	The groups were similar at baseline regarding the most important prognostic indicators	1	0	0	0	67%
5	There was blinding of all subjects	0	0	0	0	100%
6	There was blinding of all therapists who administered the therapy	0	0	0	0	100%
7	There was blinding of all assessors who measured at least on key outcome	0	0	0	0	100%
8	Measures of at least on key outcome were obtained from more than 85% of the subjects initially allocated to groups	0	0	1	0	67%
9	All subjects for whom outcome measures were available received the treatment or control condition as allocated or, where this was not the case, data for at least one key outcome was analysed by "intention to treat"	1	1	1	1	100%
10	The results of between-group statistical comparisons are reported for at least one key outcome	0	1	1	1	67%
11	The study provides both point measures and measures of variability for at least one key outcome	1	1	0	1	67%
Total score		3/11	3/11	4/11	3/11	
Overall percentage agreement						88%

Table M2. Properties of the study, outcome and discussion for Wahyuni, Nurdina and Indasah (2020).

Author (s)	Wahyuni, R., Nurdina, N. and Indasah, I.							
Year	2020							
Title	Effectiveness Variation Giving SWD, TENS, Manipulation Therapy, Exercise to Reduce Pain, Increase Range of Motion, Improve Functional Ability on Frozen Shoulder in Dr. Soepraoen Malang Hospital.							
Study properties:								
Form of measurement	Frequency of measurement	Duration of study	Number of participants	Assessors blinded	Control used	Randomisation of participants	Ranking	Total Percentage Agreement
Goniometer	Pre-test, post-test	Two weeks	24	Unknown	Yes	Yes	3/11	88%
Limitations	The location of the study was located at Tk II Hospital Dr Soepraoen Malang; however, the method of participant recruitment was not disclosed. The study design utilised by Wahyuni, Nurdina and Indasah (2020) was a pre/post-test randomised controlled trial. The eligibility criteria along with the exclusion criteria was not reported, thus the homogeneity of participant recruitment was unclear, specifically the stage of the pathology, sociodemographic details and the previous treatment experienced. The baseline characteristics of the participants allocated into the four groups were not outlined, thus the basis to compare the treatments amongst the groups limited. The method of randomisation and concealment method not reported, thus the risk for recruitment bias high. The sampling method used in this particular study was purposeful sampling, as it was to identify the participants diagnosed with adhesive capsulitis (Wahyuni, Nurdina and Indasah 2020). The number of participants initially recruited into the study and failed to fulfil the inclusion criteria were not disclosed. The patients were randomly allocated into four groups of 6 participants respectively. The treatment design of each group was: Group 1 – SWD (Short Wave Diathermy), TENS intervention, manipulation and exercise therapy up to 6 therapy 2 times a week twice. Group 2 – SWD, TEN intervention, manipulation therapy up to 6 times a week twice. Group 3 – SWD, TENS, exercise therapy up to 6 times a week twice. Group 4 – SWD, TENS without the addition of up to 6 times therapy a week twice. The treatment protocols used for each group were outlined, barring the parameters of the interventions, duration and the settings of the interventions used. The use of exercise therapy based on literature requires a minimum of six weeks to be effective (Silveira <i>et al.</i> 2024), thus the study duration of two weeks may provide limited results. The restricted information pertaining to the treatment protocols increased the potential for bias as the patient compliance with treatment, the interaction between the therapist and participants along with blinding of both parties involved. At the outset of the investigation, baseline measurements were conducted on the participants, specifically for range of motion (ROM), measurement of pain and the functional activity capability before each treatment. The documented measurement tool used in this investigation was a goniometer to measure the ROM, subsequently the measurement of pain experienced was discussed but not measurement tool utilized not discussed. The results discussed were based on pain level, area of motion of the joints and the functional capabilities of the participants, despite the lack of baseline measures of the participants. The results of the interventions were analysed with the use of the Kruskal-Wallis and Mann-Whitney tests, in terms of range of motion, functionality and pain; yet the intergroup and intragroup analysis lacked substantial evidence. The results and discussion of Wahyuni, Nurdina and Indasah (2020) provided an indication of favourable outcomes of the first group as the results were improved; although the information provided was limited.							
Outcome	Improved functionality and increased range of motion was noted in group 2 (SWD intervention, TENS, manipulation therapy). The group that reported the most notable reduction in pain was group 1 (SWD, TENS intervention, manipulation therapy and exercise therapy).							

Discussion	The limitations discussed above highlighted the lack of information regarding the methodology followed in conducting said study. The lack of eligibility criteria provided a generalised population to be recruited thus increasing the potential for external influences. The details provided cannot provide sufficient information to support the results out the outcome measures as the reproduction of the results not possible and supporting the outcomes found in said study impossible. Based on the above, it was unclear whether all the four groups received TENS as the treatment of the fourth group was not clear. The use of one measurement tool and ambiguous scoring tools for the pain experienced, provided poor results. The clinical efficacy of TENS was not clearly reported. The information provided were vague and based on the evidence provided, should the methodology prescribed by Wahyuni, Nurdina and Indasah (2020) be used to reproduce a future study, the results may vary due to the poorly reported processes followed, along with the poor internal and external validity.
Conclusion	Based on the evidence gathered from above, the ranking of 3/11 and total percentage agreement of 88%, provided poor quality and a high risk for bias. Both internal and external validity of the study was poor as the risk for bias was high and the application of the treatment interventions tested into a generalised population of adhesive capsulitis patients unfavourable. The limited information and lack of data in support of the interventions used, along with parameters followed prevented the study from providing an unbiased report.

Table N1. Tabulated feedback of reviewer data for Waldburger, Meier and Gobelet (1992)(according to the Pedro Scale).

Author (s)	Waldburger, M., Meier, J.-L. and Gobelet, C.					
Year	1992					
Title	The frozen shoulder: diagnosis and treatment. Prospective study of 50 cases of adhesive capsulitis.					
Criterion		Reviewer 1	Reviewer 2	Reviewer 3	Ranking	Total Percentage Agreement (%)
1	Eligibility criteria were specified	0	1	1	1	67%
2	Subjects were randomly allocated to groups (in a crossover study, subjects were randomly allocated an order in which treatments were received)	1	1	1	1	100%
3	Allocation was concealed	1	0	0	0	67%
4	The groups were similar at baseline regarding the most important prognostic indicators	1	0	1	1	67%
5	There was blinding of all subjects	0	0	0	0	100%
6	There was blinding of all therapists who administered the therapy	0	0	0	0	100%
7	There was blinding of all assessors who measured at least on key outcome	0	0	0	0	100%
8	Measures of at least on key outcome were obtained from more than 85% of the subjects initially allocated to groups	1	1	1	1	100%
9	All subjects for whom outcome measures were available received the treatment or control condition as allocated or, where this was not the case, data for at least one key outcome was analysed by "intention to treat"	0	1	1	1	67%
10	The results of between-group statistical comparisons are reported for at least one key outcome	1	1	1	1	100%
11	The study provides both point measures and measures of variability for at least one key outcome	0	1	1	1	67%
Total score		5/11	6/11	7/11	7/11	
Overall percentage agreement						85%

Table N2. Properties of the study, outcome and discussion for Waldburger, Meier and Gobelet (1992).

Author (s)	Waldburger, M., Meier, J.-L. and Gobelet, C.							
Year	1992							
Title	The frozen shoulder: diagnosis and treatment. Prospective study of 50 cases of adhesive capsulitis.							
Study properties:								
Form of measurement	Frequency of measurement	Duration of study	Number of participants	Assessors blinded	Control used	Randomisation of participants	Ranking	Total Percentage Agreement
ROM, pain, radiographs, bone scans, blood tests	Day 1,7, 21, 60 and 180	180 days	50 participants	Not disclosed	Yes	Yes	7/11	85%
Limitations	The study was conducted at three Swiss medical centres over a duration of 180 days. Both in-patients and out-patients fulfilling the eligibility criteria were recruited into the study, however the participant enrolment period was not reported. The study design utilized was a randomised controlled trial, despite the limited information regarding the group allocation, randomisation method along with consistent protocols followed in all three sites. The initial clinical assessments included ROM, pain experienced, radiographs, isotopic bone scans along with blood tests; were conducted prior to the randomisation. The radiograph imaging was used to identify and confirm the diagnosis of the participants pathology. The eligibility criteria failed to include gender, age and general characteristics as prescribed in previous investigations, thus allowing the possibility for selection bias and recruitment bias. The participants recruited were classified into three different aetiological groups: post-traumatic, neurological, idiopathic; yet the aetiological distribution of the participants was not reported per the group allocation. There were two intervention groups, group one utilised active mobilization, TENS and cryotherapy four times per week, whereas group two underwent the same physical therapy along with subcutaneous injections of salmon calcitonin for 21 days. The use of protocols used in the physiotherapy did not outline the parameters or settings used, thus the risk for bias was likely as the procedure may vary based on the sites. Two participants dropped out of the study, one due to the adverse effects of calcitonin and another went into a coma. The lack of baseline characteristics and sociodemographic data per group allocation was not provided, rather a general group demographic provided for the participants recruited. The results were reported per the aetiological groups, yet the results indicated the use of salmon calcitonin to be favourable in the improvement of function.							
Outcome	Physical therapy, early mobilization and the subcutaneous administration of salmon calcitonin for 21 days increased the effect on pain when compared to physiotherapy treatment alone.							
Discussion	Based on the points discussed in the limitations above, the study conducted by Waldburger, Meier and Gobelet (1992) provided poor internal validity, however due to the inability to apply the findings into the general population, poor external validity. The limited information regarding the participant homogeneity as the stage of the participants recruited were not reported. Furthermore, the lack of baseline characteristics and measurements of the participants limited the true clinical effectiveness of the interventions, thus the homogeneity of the population recruited was unclear. The publication date of the study was 1992 yet was still included into the systematic review as it fulfilled the eligibility criteria. The information was limited and dated, yet when compared to other articles in the systematic review provided well documented data.							

Conclusion	Based on 7/11 ranking and total percentage agreement of 85%, provided good outcomes. The internal and external validity of the study was poor, due to the lack of application of the study into other situations. The information provided, though limited provided insight into the favourable outcomes of the use of salmon calcitonin as part of a management protocol for adhesive capsulitis.
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Table O1. Tabulated feedback of reviewer data for Yatheendra Kumar *et al.* (2017)(according to the Pedro Scale).

Author (s)	Yatheendra Kumar, G., Sudhakar, S., Sudhan, S. G., Sivajyothi, N., Senthil Selvam, P. and Deepthi, K. V. S. R.					
Year	2017					
Title	Effectiveness of active release technique and muscle energy technique in adhesive capsulitis.					
Criterion		Reviewer 1	Reviewer 2	Reviewer 3	Ranking	Total Percentage Agreement (%)
1	Eligibility criteria were specified	1	1	1	1	100%
2	Subjects were randomly allocated to groups (in a crossover study, subjects were randomly allocated an order in which treatments were received)	0	0	1	0	67%
3	Allocation was concealed	0	0	0	0	100%
4	The groups were similar at baseline regarding the most important prognostic indicators	0	0	1	0	67%
5	There was blinding of all subjects	0	0	0	0	100%
6	There was blinding of all therapists who administered the therapy	0	0	0	0	100%
7	There was blinding of all assessors who measured at least on key outcome	0	0	0	0	100%
8	Measures of at least on key outcome were obtained from more than 85% of the subjects initially allocated to groups	1	1	1	1	100%
9	All subjects for whom outcome measures were available received the treatment or control condition as allocated or, where this was not the case, data for at least one key outcome was analysed by "intention to treat"	1	1	1	1	100%
10	The results of between-group statistical comparisons are reported for at least one key outcome	1	1	1	1	100%
11	The study provides both point measures and measures of variability for at least one key outcome	1	1	1	1	100%
Total score		5/11	5/11	7/11	5/11	
Overall percentage agreement						94%

Table O2. Properties of the study, outcome and discussion for Yatheendra Kumar *et al.* (2017).

Author (s)	Yatheendra Kumar, G., Sudhakar, S., Sudhan, S. G., Sivajyothi, N., Senthil Selvam, P. and Deepthi, K. V. S. R.							
Year	2017							
Title	Effectiveness of active release technique and muscle energy technique in adhesive capsulitis.							
Study properties:								
Form of measurement	Frequency of measurement	Duration of study	Number of participants	Assessors blinded	Control used	Randomisation of participants	Ranking	Total Percentage Agreement
VAS, Goniometer, SPADI	The measurements were conducted pre- and post-hoc	Participants were recruited between August 2016 and July 2017. The duration of the study was 4 weeks	60 participants divided into 20 participants into 3 groups	There is no mention if blinding of the assessors or therapists	A control group of only conventional therapy was used as a baseline	Convenient sampling method	511	94%
Limitations	The patients were recruited from the outpatient department of Susrutha institute of physical medicine and rehabilitation from August 2016 to July 2017, however the duration of the study of the study was four weeks. There was no mention whether the interventions ran simultaneously or at different times between the three groups. furthermore, there was no location disclosed in the methodology along with whether the participants received treatments at the same location along with whether there was intergroup communication. The Hawthorne effect can play an impact in the participants results based on influence of those around them, for example participants from the other groups, therapists or evaluators (Sedgwick and Greenwood 2015; Richardson 2007). There was no mention of the concealment of the participant allocation along with no blinding of the either the assessor, therapist and/or patient. The inconsistency can alter the perception of the patient and the assessor if no blind took place thus altering the measurements negatively. The lack of blinding allowed room for bias to be formed amongst the therapists and assessors, which may influence the patient perception and influence the measurement outcomes. The lack of blinding and concealment could create bias (Boutron <i>et al.</i> 2006). The participants were required to be diagnosed with idiopathic unilateral adhesive capsulitis of more than three months duration with the presence of subscapularis muscle trigger points; yet there was no mention whether the patient received treatment for the complaint previously. The participant's nativity was not considered if there was previous treatment, the participants subjective measurements can be altered (Moore and Picou 2018). The participant-group allocation based on the socioeconomic status of the participants and the participants past/ current medical history was not disclosed. The participants were allocated into three groups of 20 participants each. The groups received the following intervention: Group A-active release technique (ART) and conventional therapy, Group B-muscle energy technique (MET) and conventional therapy, Group C-conventional therapy (TENS, pendulum exercises, Maitland mobilizations, wand and towel exercises, coracohumeral ligament stretch, capsular stretches, home program and patient education). The inconsistency between the reported treatment protocol between the three groups, allowed room for the alteration of the measurement outcomes. There was a specific protocol outlined for Group B, however when compared to Groups A and C, there were discrepancies. This can indicate							

	favourable results to Group B as the participants received muscle energy technique (MET) performed in three repetitions per day thrice a week for 5 weeks, whereas there is no treatment duration protocol mentioned for Group A and Group C. The duration of the study was inconsistent, this was seen in the measurement intervals were outlined to be pre-hoc and post-hoc at baseline and four weeks, however the Group B participants received treatment for 5 weeks. The lack of homogeneity between group treatments and the measurement timeframes, created room for treatment bias between the groups which will alter the measurement outcomes. There were no dropouts reported between the study; thus, each group consisted of 20 participants in each group which allowed the assessors to use parametric statistics were utilized. The use of parametric statistics allowed the researcher to analyse the data by the average as the sample size is larger and stronger when compared to those of non-parametric statistics. The comparison between hand dominance and the affected side was not disclosed, along with the participant allocation based on age and gender. The lack of homogeneity between the groups created inconsistent representation of patients with adhesive capsulitis and the intervention results. The conventional TENS setting was applied at the frequency of 4-8 Hz for a period of 8 minutes. The participants in Group C were given instructions to perform daily exercises as homecare to reduce the symptoms, however there was no mention of a "homework diary" which may have outlined if the participants completed the daily activities and/or only participants in Group C were provided with the stretches. This may influence the patient perception, which may influence the measurement outcomes.
Outcome	Immediate results were seen in Group A when compared the other two groups. However, mixed clinical outcomes occurred in all three groups.
Discussion	This study identified the use of TENS as part of a conventional therapy in combination with MET has been effective in treatment with adhesive capsulitis, however, these results need to be read with cautions as the following was noted: The lack of blinding amongst the participants, assessors and/or therapists. No mention of significant co-morbidities, medication use, handedness, socioeconomic factors which may influence the outcome of the study. The lack of consistency in which the measurements were conducted between the groups and treatment protocol received by the participants. The lack of control for bias between the therapists, assessors, and participants. The authors do not stipulate the duration of the study and the intervals in which the measurements were conducted at pre-test and post-test assessment. The TENS settings used in the study was stated as being set at a frequency of 4-8 Hz for a period of 8 minutes. There was no statement regarding the location of the electrodes in terms of the placement along with if there was homogeneous amongst the participants. Moreover, the study does not identify whether all the participants received homecare exercises to complete or if it was only prescribed to those in Group C. The absent of the use of a "homework diary" indicated there is no verification whether the participant completed the relevant exercises.
Conclusion	Based on the evidence gathered above the total percentage agreement of 94% and ranking of 5/11 provided evidence of a low risk of bias. The addition of either ARTs or METs provided a baseline for the groups to compare. However, the evidence failed to identify the superior modality and the clinical effectiveness,

Table P1. Tabulated feedback of reviewer data for Yildiz *et al.* (2017) (according to PEDro).

Author (s)	Yildiz, A., Kuş, G., Mustafaoglu, R. and Karaborklu Argut, S					
Year	2017					
Title	The Comparison of The Effectiveness of Physical and Electrotherapy Modalities Versus Home Exercises Program on Frozen Shoulder.					
Criterion		Reviewer 1	Reviewer 2	Reviewer 3	Ranking	Total Percentage Agreement (%)
1	Eligibility criteria were specified	0	0	0	0	100%
2	Subjects were randomly allocated to groups (in a crossover study, subjects were randomly allocated an order in which treatments were received)	1	1	1	1	100%
3	Allocation was concealed	0	0	0	0	100%
4	The groups were similar at baseline regarding the most important prognostic indicators	0	0	0	0	100%
5	There was blinding of all subjects	0	0	0	0	100%
6	There was blinding of all therapists who administered the therapy	0	0	0	0	100%
7	There was blinding of all assessors who measured at least on key outcome	0	0	0	0	100%
8	Measures of at least on key outcome were obtained from more than 85% of the subjects initially allocated to groups	1	1	1	1	100%
9	All subjects for whom outcome measures were available received the treatment or control condition as allocated or, where this was not the case, data for at least one key outcome was analysed by "intention to treat"	1	1	1	1	100%
10	The results of between-group statistical comparisons are reported for at least one key outcome	1	1	1	1	100%
11	The study provides both point measures and measures of variability for at least one key outcome	0	1	1	1	67%
Total score		4/11	5/11	5/11	5/11	
Overall percentage agreement						97%

Table P2.Properties of the study, outcome and discussion for Yildiz *et al.* (2017).

Author (s)	Yıldız, A., Kuş, G., Mustafaoglu, R. and Karaborklu Argut, S							
Year	2017							
Title	The Comparison of The Effectiveness of Physical and Electrotherapy Modalities Versus Home Exercises Program on Frozen Shoulder.							
Study properties:								
Form of measurement	Frequency of measurement	Duration of study	Number of participants	Assessors blinded	Control used	Randomisation of participants	Ranking	Total Percentage Agreement
VAS, DASH, BDI, PSQI	Pre-post treatment	3 weeks	22 participants	No indication	No	Yes	5/11	97%
Limitations	The information gained was limited due to the article received being in the form of a conference report rather than a journal article. However, the information provided was discussed below within the restrictions related to the form of literature. 24 participants were recruited into the study, however the method of recruitment utilised by the authors was not disclosed along with the location of the study thus the potential for bias was likely in the form of selection or recruitment bias. The participants were randomly assigned into the two group allocations; however, the methodology does not include if blinding of both the participants and researcher, nor the method of randomisation. At the baseline, 24 participants were recruited however the study was completed by 22 participants (Groups A and B comprised of 12 and 10 participants respectively), the reason for participant dropout was not reported. The potential for attrition bias was likely, since the participant dropout occurred in one of the two groups but falls within the acceptable range of less than 20% (Babic <i>et al.</i> 2019). The baseline characteristics of both groups were not disclosed; however, the baselines of each group were reported for the VAS-resting, VAS-activity, BDI and DASH scores respectively. Both groups received a standard treatment program comprising of shoulder joint mobilization, shoulder muscle stretching and strengthening for a 30-minute duration. Group A received the standard therapy in combination with electrotherapy for 30 minutes, the electrotherapy comprised of a heat pack, ultrasound therapy and TENS (the settings of the modalities were undisclosed). Group B received the standard treatment in combination with the home exercise program for 30 minutes. The home care exercises included wand exercises, isometric strengthening, and self-stretching on top of the standard program. There was no mention of a record of the homecare exercises, indicating the participants compliance with the treatment protocol. Thus, the patient compliance pertaining to homecare and medication used not reported, as this may influence the outcome of the interventions investigated.							
Outcome	The VAS (night) and sleep quality improved in electrotherapy in terms of intra group change, there was no significant difference between the groups in any parameter. Consequently, the choice of home exercise program applied in addition to the exercise program would be more advantageous in terms of cost-effectiveness and time instead of electrotherapy modalities.							
Discussion	Taking into consideration the limited information presented by the methodological rigour of the investigation was deemed poor, thus the evidence was limited.							
Conclusion	With the ranking of 5/11 along with the total percentage agreement of 97%, the methodological rigour was deemed poor due to the lack of information received. The internal validity was deemed low risk, however the evidence outlined regarding the use as TENS was limited.							

Table Q1. Tabulated feedback of reviewer data for Lad and Anandh (2019) (according to the NOS).

Author/s	Lad, D. N. and Anandh, S.					
Year	Effect of traction versus counter traction with conservative treatment on adhesive capsulitis					
Title	2019					
Criteria		Reviewer 1	Reviewer 2	Reviewer 3	Ranking	Total Percentage Agreement (%)
Selection	Is the case definition adequate? a. Yes, with independent validation * b. Yes, e.g., record linkage or based on self-reports. c. No description.	0	0	0	0	100%
	Representativeness of the case a) Consecutive or obviously representative series of cases * b) Potential for selection biases or not stated	0	1	0	0	66%
	Selection of controls a) Community control * b) Hospital control c) No description	1	0	0	0	66%
	Definition of controls a) No history of disease (endpoint) * b) No description of source	0	1	0	0	66%
Comparability	Comparability of cohorts based on design or analysis a) Study controls for _____ (select the most important factor.) * b) Study controls for any additional factor * (This criterion could be modified to indicate specific control for a second important factor.)	0	1	0	0	66%
Exposure	Ascertainment of exposure a) Secure record (e.g., surgical records) * b) Structured interview where blind to case/control status * c) Interview not blinded to case/control status. d) Written self-report or medical record only. e) No description	1	1	1	1	100%
	Same method of ascertainment for cases and controls a) Yes * b) No	0	1	1	1	66%
	Non-response rate a) Same rate for both groups * b) Non respondents described c) Rate different and no designation	1	1	1	1	100%
Total score		3/10	6/10	3/10	3/10	
Overall percentage agreement						79%

Table Q2. Properties of the study, outcome and discussion for Lad and Anandh (2019).

Author/s	Lad, D. N. and Anandh, S.							
Year	Effect of traction versus counter traction with conservative treatment on adhesive capsulitis							
Title	2019							
Study properties:								
Form of measurement	Frequency of measurement	Duration of study	Number of participants	Assessors blinded	Control used	Randomisation of participants	Ranking	Total Percentage Agreement
Goniometer, VAS, SPADI	Pre-treatment and post-treatment	2 weeks	40 participants	No	No	No	3/9	79%
Limitations	The location where the participants were recruited was not disclosed along with the recruitment process utilised. The study design was an experimental pre-treatment and post-treatment design implemented in this study. The participants recruited were between the ages of 40-60 years of age, shoulder pain and restriction of an unknown duration irrespective of handedness and gender. Patients diagnosed with diabetes mellitus are more likely to develop adhesive capsulitis (Dyer <i>et al.</i> 2021) and may experience worse outcomes of frozen shoulder (Dyer <i>et al.</i> 2023), which may influence the study outcomes as the participants diagnosis of diabetes mellitus was not considered since patients with or without diabetes were included (Lad and Anandh 2019). Random sampling allocation method was used to divide the participants into two groups, one of which received traction and the other counter traction; both groups received conventional therapy (comprising of ultrasound therapy, TENS, hot moist pack and free exercises). The method of randomisation was not disclosed, along with the allocation method, thus the study design was assumed to be a non-randomised controlled trial. The participants recruited received an education and home exercise booklet as a reference, however no mention of a homework diary to ensure compliance with the homecare treatment protocol. The baseline characteristics were limited as the group allocation only mentioned the age average of the participants for each group (average of 60 in Group A and 59.3 for Group B), the gender and side effected were generalised to the overall study population, specifically majority of the participants were diagnosed with left side affected and more men involved in the study. The limited baseline characteristics failed to provide the reader with comparable results, depicting the clinical efficiency of the interventions tested along with the long-term clinical effect as the study duration was two weeks. There was no mention of blinding amongst either the participants, therapists, or the assessors, nor indication of concealed allocation.							
Outcome	The use counter traction (Group B) shown significant reduction in pain and improvement in range of motion for shoulder flexion and abduction							
Discussion	The authors indicated the use of counter traction to be more favourable when compared to traction when combined with conventional therapy. The investigation was limited, in the following manners: the short duration of investigation limited the short-term results, the lack of blinding amongst the participants and assessors provided potential bias as the therapist administering the intervention may influence participants outcome along with bias when recording the outcome measurements. The limited baseline characteristics amongst the groups prevented the representation of the adhesive capsulitis population along with the influence of the co-morbidities on the treatment outcome. The researchers provided limited parameters pertaining to the treatment protocol utilized in the study, thus the reproduction of the results in future studies may not be possible.							
Conclusion	Lad and Anandh (2019) highlighted the short-term management of the patients diagnosed with adhesive capsulitis, however due to the limitations mentioned above made the long-term results uncertain with the treatment interventions used. The average reviewers ranking was 3/9, indicating the presence of methodological flaws in the investigation, limitations in the population used and limited duration of the investigation. The promising outcome measures contradicted the flaws in the methodological rigour.							

Table R1.Tabulated feedback of reviewer data for Mengi (2021) (according to NOS)

Author/s	Mengi, A.					
Year	2021					
Title	The Effect of Glenohumeral Joint Injection Prior to Physical Therapy on Treatment Outcomes in Adhesive Capsulitis.					
Criteria		Reviewer 1	Reviewer 2	Reviewer 3	Ranking	Total Percentage Agreement (%)
Selection	Is the case definition adequate? a) Yes, with independent validation * b) Yes, e.g., record linkage or based on self-reports. c) No description.	1	1	0	1	66%
	Representativeness of the case a) Consecutive or obviously representative series of cases * b) Potential for selection biases or not stated	1	1	1	1	100%
	Selection of controls a) Community control * b) Hospital control c) No description	1	1	0	1	66%
	Definition of controls a) No history of disease (endpoint) * b) No description of source	0	0	1	0	66%
Comparability	Comparability of cohorts based on design or analysis a) Study controls for _____ (select the most important factor.) * b) Study controls for any additional factor * (This criterion could be modified to indicate specific control for a second important factor.)	2	2	2	2	100%
Exposure	Ascertainment of exposure a) Secure record (e.g., surgical records) * b) Structured interview where blind to case/control status * c) Interview not blinded to case/control status. d) Written self-report or medical record only. e) No description	1	1	1	1	100%
	Same method of ascertainment for cases and controls a) Yes * b) No	1	1	1	1	100%
	Non-response rate a) Same rate for both groups * b) Non respondents described c) Rate different and no designation	0	0	1	0	66%
Total score		7/10	7/10	7/10	7/10	
Overall percentage agreement						83%

Table R2. Properties of the study, outcome and discussion for Mengi (2021).

Author/s	Mengi, A.							
Year	2021							
Title	The Effect of Glenohumeral Joint Injection Prior to Physical Therapy on Treatment Outcomes in Adhesive Capsulitis.							
Study properties:								
Form of measurement	Frequency of measurement	Duration of study	Number of participants	Assessors blinded	Control used	Randomisation of participants	Ranking	Total Percentage Agreement
Goniometer, VAS, SPADI	Baseline and day 21	3 weeks	41 participants	No	Yes	No	7/10	83%
Limitations	The participants were recruited from one location, a hospital physical therapy and rehabilitation outpatient clinic. The participants were recruited by the means of recent medical records of 93 participants who received physical therapy and rehabilitation treatment over a six-month period at the location. The eligibility criteria and completion of the previous program were part of the inclusion criteria for the participants, reducing the sample size to 41 participants. Due to the invasive nature of the intervention, the participants involved were required to provide consent to either receive the injection or not receive the injection; subsequently creating the design of a nonrandomised controlled trial. Those who agreed to receive the injection application, were referred to Group one (containing 19 participants) and those who did not were referred to as Group two (containing 22 participants). The allocation distribution created an unequal baseline of characteristics, when compared the participants in the second group (non-injection group) contained more female participants, older participants and duration of symptoms were longer than the one group (Mengi 2021). The injection group received the injection by an experienced physiatrist four days prior to commencement of the physical and rehabilitation program, the administration process followed was clearly outlined, with the same individual administering the injection to all the injection group participants, thus bias was minimised. The duration of symptoms experienced by the participants varied, thus the stage of the pathology lacking consistency amongst the participants. Both groups received the same physical therapy program (TENS, ultrasound, infrared therapy), and exercise program under the supervision of the same physiotherapist throughout the investigation. The setting of the modalities used along with the placement was described, consequently the program consistent amongst both groups and throughout the duration of the investigation (Mengi 2021). The frequency of measurement was conducted on the first and last day of the physiotherapy program. The duration of the investigation lasted 21 days, however evidence suggests favourable outcomes when the physiotherapy and rehabilitation program last between 6 to 8 weeks (Shahidi <i>et al.</i> 2022; Rachel <i>et al.</i> 2018). In addition to the physical therapy program received five sessions per week for three weeks, the participants were required to complete home care exercises daily; however, there was no record of compliance from the participants by the means of a journal, diary, or record. The use of a record may deem favourable to note consistency, presence of the co-morbidities and medication used through the duration of the investigation. The data was statistically analysed for parametric statistics and nonparametric statistics; however, the number of participants recorded at the end of the physical therapy program was not provided. The lack of knowledge regarding participant dropouts and intention to treat analysis, limited the knowledge of participant compliance. With the detailed methodology provided by Mengi (2021), the investigation may be replicated with the addition of a follow up period thus to investigate the longevity of the intervention. Mengi (2021) cited some limitations of this investigation was attributed to the limited outcome measurement tools and instruments, along with the patient consent pertaining to the injection.							

Outcome	The use of ultrasound-guided glenohumeral IA injection therapy prior to physical therapy and exercise therapy program may be beneficial in adhesive capsulitis patients experiencing pain.
Discussion	The overall methodology utilized was clearly followed, thus the probability of bias was limited. The methodology outlined by Mengi (2021) provided detailed information to replicate the investigation with adjustments to investigate the longevity of the intervention. The participant group allocation was non-randomised as the participants were required to provide consent the treatment (either injection or non-injection) to be allocated into the group. The combination of modalities utilized in the physical therapy program, limits the efficiency of the modality which may provide the most effective method in the management of adhesive capsulitis. A potential modification of this investigation may be to use different physical therapy modalities in separate groups; this will provide a control group to compare the data from the intervention groups.
Conclusion	With an 83% total percentage agreement, the reviewers agreed the methodological rigour of Mengi (2021) was reported to be of a high standard and presented a low risk of bias. The addition of an ultrasound-guided glenohumeral intraarticular injection prior to the physical and exercise therapy were deemed beneficial.

Table S1. Tabulated feedback of reviewer data for Shetty and Shah (2020) (according to NOS).

Author/s	Shetty and Shah					
Year	Effect of Maitland Technique (Posterior Glide) with Muscle Energy Technique for Subscapularis Muscle on Adhesive Capsulitis.					
Title	2020					
Criteria		Reviewer 1	Reviewer 2	Reviewer 3	Ranking	Total Percentage Agreement (%)
Selection	Is the case definition adequate? a) Yes, with independent validation * b) Yes, e.g., record linkage or based on self-reports. c) No description.	0	0	0	0	100%
	Representativeness of the case a) Consecutive or obviously representative series of cases * b) Potential for selection biases or not stated	1	1	1	1	100%
	Selection of controls a) Community control * b) Hospital control c) No description	0	0	0	0	100%
	Definition of controls a) No history of disease (endpoint) * b) No description of source	0	0	0	0	100%
Comparability	Comparability of cohorts based on design or analysis a) Study controls for _____ (select the most important factor.) * b) Study controls for any additional factor * (This criterion could be modified to indicate specific control for a second important factor.)	0	0	0	0	100%
Exposure	Ascertainment of exposure a) Secure record (e.g., surgical records) * b) Structured interview where blind to case/control status * c) Interview not blinded to case/control status. d) Written self-report or medical record only. e) No description	0	0	0	0	100%
	Same method of ascertainment for cases and controls a) Yes * b) No	0	0	0	0	100%
	Non-response rate a) Same rate for both groups * b) Non respondents described c) Rate different and no designation	0	0	0	0	100%
Total score		1/10	1/10	1/10	1/10	
Overall percentage agreement						100%

Table S2. Properties of the study, outcome and discussion for Shetty and Shah (2020).

Author/s	Shetty and Shah							
Year	Effect of Maitland Technique (Posterior Glide) with Muscle Energy Technique for Subscapularis Muscle on Adhesive Capsulitis.							
Title	2020							
Study properties:								
Form of measurement	Frequency of measurement	Duration of study	Number of participants	Assessors blinded	Control used	Randomisation of participants	Ranking	Total Percentage Agreement
VAS, SPADI, Goniometer	Baseline and the end of the intervention	3 days	40 participants	No	No	No	1/9	100%
Limitations	Forty eligible participants were recruited from an outpatient physiotherapy facility in Karak, India. The participants were diagnosed with primary adhesive capsulitis of more than three months duration and were a mean age of 49.4 years of age. The design was a pre-test and post-test experimental study which utilised a consecutive sampling method. The study duration was reported to be 6 months, but the intervention duration reported was for three days, as the participants underwent measurements at baseline and on the third day post-intervention (Shetty and Shah 2020). Polit (2010) postulated consecutive sampling to be a reliable nonprobability sampling method as it includes all available eligible subjects, nevertheless, consecutive sampling is not immune to sampling bias, as commonalities amongst the participants recruited from the specific clinic may occur (Thewes <i>et al.</i> 2018). Shetty and Shah (2020) reported the participants living in rural areas are less likely to seek healthcare, unless the condition impacts the functions of daily living, furthermore, given the duration of the study and location of the hospital in a rural area, the possibility of snowball sampling may occur as the participants may share their experiences and refer their community to the investigation (Johnson). The group comprised of more men than women and did not take into consideration the disease duration, however the limited information pertaining to the participant baseline characteristics prevented the reader from identifying the clinical efficiency of the interventions. The participants received a hot moist pack prior to the treatment protocol, along with pre-test measurements. The participants received Maitland's mobilization technique (posterior glide) with subscapularis MET, followed by conventional exercises, and electromodalities (ultrasound or TENS) depending on the area of pain. The physical therapy occurred daily and concluded with a post-test measurement done on the third day. The use of ultrasound and TENS was mentioned; however, the settings of the modalities were not disclosed along with the placement of the probe and TENS pads. The protocol followed was limited, therefore the replication of the study or results may be impossible as the evidence was limited. Blinding of the participants, therapists and assessors was unknown but based on the study design could not be done.							
Outcome	The combination of Maitland technique (posterior glide), subscapularis MET, and conventional treatment was effective in the management of adhesive capsulitis.							
Discussion	The outcome of the study proved the use of a combination treatment protocol was effective in the management of adhesive capsulitis, however this study has numerous limitations, which are discussed below. The participant baseline characteristics were not disclosed along with the baseline measurements pre-test were not provided; thus, the clinical effectiveness of the intervention was not clear. The intervention duration of three days was deemed short as it could not provide a long-term outcome for the condition. The lack of information regarding the modality settings and placement prevents the execution of this intervention into new treatment protocols, furthermore the lack of a control group prevented the researcher from having a comparison to the intervention used.							
Conclusion	With the ranking of 1/10 and a 100% overall percentage agreement, the methodological rigour was deemed of a poor quality. Due to the significant limitation listed above, it is not surprising the rating using the NOS criteria, by the reviewers was low. The clinical outcome of the study was positive; however, the low rating is recommended due to the limited evidence in support of the use of Maitland technique (posterior glide), subscapularis MET and conventional therapy in practice, and that more rigorous studies are required.							

Table T1. Tabulated feedback of reviewer data for Subramanian (2018) (according to the Liddle Scale).

Author (s)	Subramanian, S					
Year	2018					
Title	Mobilization Vs Electrotherapy in Adhesive Capsulitis Shoulder					
Criteria		Reviewer 1	Reviewer 2	Reviewer 3	Ranking	Total Percentage Agreement (%)
Evaluation criteria for the study:	1. Are the study participants well-defined in terms of time, place and person?	A	A	A	A	100%
	2. What percentage of individuals refused to participate?	N/A	N/A	N/A	N/A	100%
	3. Are outcomes measured in a standard, valid and reliable way?	C	C	C	C	100%
	4. Are outcomes measured in the same way for both intervention and control groups?	N/A	N/A	N/A	N/A	100%
	5. Are factors other than the intervention e.g. confounding factors, comparable between intervention and control groups and if not comparable, are they adjusted for in the analysis?	N/A	N/A	N/A	N/A	100%
	6. What percentage of individuals recruited into the study are not included in the analysis? (loss to follow-up).	N/A	N/A	N/A	N/A	100%
	7. Is the analysis by intention to intervene (treat)?	N/A	N/A	N/A	N/A	100%
	8. Are results homogeneous between sites? (multicentre/multisite studies only).	N/A	N/A	N/A	N/A	100%
Overall assessment of the stud:	1. How well was the study done to minimise bias? IF coded as B1, B2 or C, what is the likely direction in which bias might affect the study results?	C	The participant involved received two different interventions from two different healthcare providers in different locations. The lack of information regarding symptoms onset and the initial intervention was not disclosed. The outcome measures utilized by Subramanian (2018) was assumed to be used by the initial practitioner, however the lack of baseline measures was noted.			
	2. Is the overall effect of the study due to the study intervention?	C	Based on the information above, this cannot be concluded. A further elaboration of this point is seen the table below.			
	3. Explain if there is any practical/ethical reason why an RCT cannot be done.	N/A	There was not ethical or practical reason for this investigation to be a RCT as the design utilised by Subramanian (2018) was a case study. To conduct a RCT design, more participants would be required along with a defined methodology to be followed by the potential assessors.			
Overall percentage agreement						100%

Table T2. Properties of the study, outcome and discussion for Subramanian (2018).

Author (s)	Subramanian, S							
Year	2018							
Title	Mobilization Vs Electrotherapy in Adhesive Capsulitis Shoulder							
Study properties:								
Form of measurement	Frequency of measurement	Duration of study	Number of participants	Assessors blinded	Control used	Randomisation of participants	Ranking	Total Percentage Agreement
Shoulder function index	Pre-test/post-test	6 months	One	Unknown	No	No	A:1 B1:0 B2:0 C:3 N/A:7	100%
Limitations	The participant recruited was a 61-year-old female, with a history of type two diabetes (management by the means of medication was not reported). The participants medical history revealed "a fall in June 2017", however the relationship of the fall and onset adhesive capsulitis symptoms was not established. The information regarding the onset of initial adhesive capsulitis symptoms was vague as the participant experienced the fall and subsequently received three months of treatment at the first healthcare provider. The stage of the disease nor the symptom duration was absent from the report, in addition to the absence of baseline measurements from the first healthcare provider. The presence of information bias posed a potential influence on the information provided by Subramanian (2018) as the information reported was distorted and may prevent accurate measurements of the clinical efficacy of the interventions (Alexander <i>et al.</i> 2015). Subramanian (2018) reported the use of electromodalities (TENS and ultrasound therapy) and NSAIDs as interventions received by healthcare provider one, however without settings of the intervention, dosage and frequency of the interventions; the assumption was made the information regarding treatment was provided by the patient. The influence of memory decay and memory decay are subject to influence the information provided by the participant. The interventions and outcomes experienced by the first healthcare provider, were reported by the participant, thus memory recollection and decay may influence the information provided and may be distorted based on the response of the patient in terms of what they should be reporting opposed to the clinical reality (Mouton 2001). The participant went on to receive treatment from the second healthcare provider, the author (Subramanian) for three months consisting of a heat pack, Maitland's manual therapy, strengthening of the shoulder and scapula muscles along with kinetic exercises thrice weekly for 20-25 minutes per session. The specifics of the interventions received was not disclosed along with medication used by the patient (prescribed or over the counter). The shoulder functional index was utilized as an outcome measurement tool in this study at pre-intervention (at the onset of the intervention) and post intervention (after the three-month intervention duration) for each healthcare provider. The results of the pre and post shoulder function index were recorded and analysed by the student t test for electromodalities and exercise respectively. The presentation of the shoulder functional index results was provided for the electromodalities (received by the initial healthcare provider) but the lack of information regarding how the results were obtained by the author created the potential for bias as it was not disclosed if the patient was either referred by the author to the initial healthcare provider or potential communications amongst the involved healthcare providers. The author referred to the patient's pain experienced along with the improvement of the range of motion; however, no measurement tools were used to prove the statements made. The lack of measurement tools used by the author illustrated a poor depiction of the intervention results. The discussion of the article did not discuss the findings of the investigation, rather provided evidence to support the use of electrotherapy and exercise therapy in the management of adhesive capsulitis.							

Outcome	Subramanian (2018) reported a positive result with the exercise only treatment when compared to the electrotherapy treatment.
Discussion	The lack of information regarding the treatment the patient received from the initial doctor along with the inconsistencies with the shoulder function index readings left potential for outcome bias (Viswanathan <i>et al.</i> 2018) along with reporting bias. Two different healthcare providers with supervision or documentation to correlate the treatment and results of said treatment fails to present a clear case presentation. The absence of baseline characteristics, statistical analysis along with the additional outcome measurement tools; may have not influenced the final result of the intervention but merely provided reliability and validity tools. In a patient who experienced a fall which may have influenced the onset of the symptoms, especially with co-morbidities, the use of imaging studies to identify potential secondary causes and/or pathologies which may influence the interventions used. In the instance such as this case, where a case study was conducted, a detailed medical history should be provided, with the interest of identifying the favourable intervention without potential bias hampering the results. The lack of information reported by Subramanian (2018) failed to represent the general population of patients with adhesive capsulitis, furthermore the reproduction of results was not possible due to the ambiguous methodology utilized. The study design provided poor internal and external validity, with high risk for bias. The evidence gathered by the author supported the use of electrotherapy, however due to the lack of information provided, the clinical efficiency was inconclusive. The study failed to identify the long-term clinical effectiveness of the interventions as there was no follow up period noted. The influence of TENS in the management of adhesive capsulitis was not identified as the electrotherapy used was a combination of TENS and ultrasound, thus the clinical effectiveness of TENS not identified.
Conclusion	Based on the evidence gathered, the reviewers' results (100% total agreement). The article was deemed high risk of bias due to the evaluation criteria not being adequately fulfilled or reported. Should treatment protocols need to be utilized in future studies, the evidence would not support it as there was inadequate information provided and reproduction of the results impossible.

Table U1. Tabulated feedback of reviewer data for Lilje *et al.* (2014) (according to the Liddle Scale).

Author (s)	Lilje, S., Genberg, M., Aldudjaili, H. and Skillgate, E.					
Year	2014					
Title	Pain relief in a young woman with adhesive capsulitis after manual manipulation of the acromioclavicular joint for remaining symptoms after mobilisation under anaesthesia.					
Criteria		Reviewer 1	Reviewer 2	Reviewer 3	Ranking	Total Percentage Agreement (%)
Evaluation criteria for the study:	1. Are the study participants well-defined in terms of time, place and person?	A	A	B1	A	67%
	2. What percentage of individuals refused to participate?	N/A	N/A	N/A	N/A	100%
	3. Are outcomes measured in a standard, valid and reliable way?	B1	B1	A	B1	67%
	4. Are outcomes measured in the same way for both intervention and control groups?	N/A	N/A	N/A	N/A	100%
	5. Are factors other than the intervention e.g. confounding factors, comparable between intervention and control groups and if not comparable, are they adjusted for in the analysis?	N/A	N/A	N/A	N/A	100%
	6. What percentage of individuals recruited into the study are not included in the analysis? (loss to follow-up).	N/A	N/A	N/A	N/A	100%
	7. Is the analysis by intention to intervene (treat)?	N/A	N/A	A	N/A	67%
	8. Are results homogeneous between sites? (multicentre/multisite studies only).	N/A	N/A	B2	N/A	67%
Overall assessment of the study:	4. How well was the study done to minimise bias? IF coded as B1, B2 or C, what is the likely direction in which bias might affect the study results?	B1	There are numerous possibilities for bias as the patient underwent various interventions for approximately 20 months by numerous health care providers. The presence of variable control was non-existent due to the nature of the interventions received.			
	Is the overall effect of the study due to the study intervention?	B1	Yes, there was a single application of a specific intervention which provided a positive outcome.			
	Explain if there is any practical/ethical reason why an RCT cannot be done.	N/A	There would be no ethical reason for conducting an RCT, as the intervention group would need to receive manipulation of the acromioclavicular joint (ACJ) and mobilization under anaesthesia. The participants involved are required to provide consent to undergo the procedures, thus due to the nature of the interventions, randomisation and blinding was not possible. The non-intervention group would not receive the intervention as the intervention group receives.			

Overall percentage agreement

79%

Table U2. Properties of the study, outcome and discussion Lilje *et al.* (2014).

Author (s)	Lilje, S., Genberg, M., Aldudjaili, H. and Skillgate, E.							
Year	2014							
Title	Pain relief in a young woman with adhesive capsulitis after manual manipulation of the acromioclavicular joint for remaining symptoms after mobilisation under anaesthesia.							
Study properties:								
Form of measurement	Frequency of measurement	Duration of study	Number of participants	Assessors blinded	Control used	Randomisation of participants	Ranking	Total Percentage Agreement
Xray imaging studies, VAS, SF-36	Months-3,6,8,9,12,24	2 years	One	No	No	No	A:1 B1:3 B2:0 C:0 N/A:7	79%
Limitations	The patient recruited was a 29-year-old female of a previously healthy medical history, the participant experienced the symptoms insidiously. The participant was employed as a sedentary office worker and had a stressful occupation; furthermore, the participant travelled for prolonged periods to and from work. The information reported was not evident whether the patient experienced difficulties whilst sitting at her desk and while conducting general activities of daily function prior to the onset of the disease or after the onset of the disease. Lilje <i>et al.</i> (2014) reported the participant sought medical assistance three months after the onset of the disease, however no mention of past medical treatment such as pharmacological interventions or manual therapy (such as massage therapy) was reported. Mello <i>et al.</i> (2023) postulated those individuals diagnosed with depression and anxiety, increased a higher risk of developing adhesive capsulitis. Due to the nature of the interventions the participant undergoes, the location of the interventions was not consistent as the participant consulted with several healthcare providers. The outcome measures were measured by the means of x-ray imaging, visual analogue scale (VAS), SF36 health survey, accompanied by the secondary outcomes were sleep pattern, medication usage and patient perceived recovery. The intervention protocol utilized was through a referral pattern via healthcare providers whereby the healthcare practitioners provided interventions based on the symptoms, however when unsuccessful in improving the condition an alternative approach/ intervention was used. With the numerous healthcare practitioners involved, the settings used for the modalities, injection site location, medication dosage and homecare exercises were mentioned but the details not disclosed. During this time, 11 months after the onset of the disease, the participant agreed to be included in a randomised controlled trial as part of the control group thus received standard orthopaedic care for 107 weeks. However, no information was provided as to the other participants involved in the RCT along with the outcome the RCT provided. The patient was referred between medical practitioners seeking resolution; however the forms of measurement was not disclosed, prior to the involvement in the RCT, thus the stage of the pathology progressed to chronic, as seen in the Table 1 of Lilje <i>et al.</i> (2014) indicating the baseline readings were taken 11 months after the onset of the pathology. The potential for bias throughout the investigation was noted as the various health care providers did not disclose information regarding the treatment, along with protocols used. The participants received inconsistent interventions based on the symptom's severity, however the use of Naprapathic treatment was deemed to be the successful.							

	Based on the information provided, the study design utilised by the authors was a case study format, however the lack of information regarding the treatment protocols utilised prior to the involvement in a RCT (where results were provided whilst enrolled), failed to provide a true outline of the methodology followed.
Outcome	Manual manipulation by the Naprapathy provided favourable results as the patient experienced reduced symptoms of adhesive capsulitis.
Discussion	The failure to include all forms of conservative manual therapy prior referral to an orthopaedic surgeon was clearly indicated throughout the investigation, further highlighting the need for medical practitioners to seek the patient's best interest in mind. The journal article included the patients' perspective which supported the above statement. The participant was treated by several medical practitioners based on the care the primary healthcare provider deemed necessary. Lilje <i>et al.</i> (2014) provided a patient perspective in the article write up, in the interest of transparency the participant revealed she was compliant with the interventions used along with the homecare, since there was no previous mention of a record kept. The patient reported she seldomly complained of the pain she experienced to her healthcare providers as she questioned the importance in the investigation. The recent information paired with the use of the SF-36 health survey and the VAS, provided a subjective outcome measure that may have not reflected to true experience of the patient since it was self-administered, thus a higher risk of potential for reporting bias was noted. Furthermore, the referral to healthcare providers was done with the consent of the patient, under the guidance of the physiotherapist, and based on the symptoms experienced. The lack of information based on the methodology utilized, indicated both internal and external validity of the study to be of a poor to moderate ranking. The design outline was tailored for this particular participant and may not be applicable to the general population of participants with adhesive capsulitis, furthermore the design may not be replicated in the future to prove the results reported. The interventions utilised provided no evidence in support of the use of TENS in the management of adhesive capsulitis, furthermore, the clinical effectiveness of the intervention of the intervention utilized was deemed effective as there was a one year follow up on the patient.
Conclusion	In conclusion for Lilje <i>et al.</i> (2014), it is evident from the reviewers' responses (total percentage agreement of 79%) that this study was able to mostly fulfil one criterion, barely fulfil another criterion and barely fulfil the applicable criteria of the Liddle Scale. The combination of ranking and total percentage agreement suggests that there is a high agreement for moderate to low rigour, and moderate to high bias. In addition to the limitations discussed above and the lack of validity tools listed, resulted the study being ranked as subject to as high degree of bias, suggesting the replication of a similar outcome unlikely due to the interventions alone. The evidence in support of TENS was absent thus the provided no supporting evidence to this systematic review.

Table V1. Tabulated feedback of reviewer data for (Hui 2016)(according to the Liddle Scale).

Author/s	Hui, T					
Year	Effective treatment of adhesive capsulitis utilizing soft tissue and joint manipulation – A case study					
Title	2016					
Criteria		Reviewer 1	Reviewer 2	Reviewer 3	Ranking	Total Percentage Agreement
Evaluation Criteria for the Study:	1. Are the study participants well-defined in terms of time, place and person?	B1	B2	B1	B1	67%
	2. What percentage of individuals refused to participate?	N/A	N/A	N/A	N/A	100%
	3. Are outcomes measured in a standard, valid and reliable way?	B1	B1	A	B1	67%
	4. Are outcomes measured in the same way for both intervention and control groups?	N/A	N/A	N/A	N/A	100%
	5. Are factors other than the intervention e.g. confounding factors, comparable between intervention and control groups and if not comparable, are they adjusted for in the analysis?	N/A	N/A	N/A	N/A	100%
	6. What percentage of individuals recruited into the study are not included in the analysis? (loss to follow-up).	N/A	N/A	N/A	N/A	100%
	7. Is the analysis by intention to intervene (treat)?	N/A	A	N/A	N/A	67%
	8. Are results homogeneous between sites? (multicentre/multisite studies only).	N/A	N/A	N/A	N/A	100%
Overall Assessment of the study	1. How well was the study done to minimise bias? IF coded as B1, B2 or C, what is the likely direction in which bias might affect the study results?	B1	There is potential bias presence regarding the selection of participants along with the treatment methodology.			
	2. Is the overall effect of the study due to the study intervention?	B1	The patient was referred by an orthopaedist. The previous treatment in the “several months” of disease onset was not disclosed, thus the overall effect of the intervention not fully reported.			
	3. Explain if there is any practical/ethical reason why an RCT cannot be done.	It would be unethical to subject participants two different treatments, i.e. the control group receive either no treatment or sham intervention whereas the intervention group would receive the intervention. The purpose of a RCT would be to identify the effect of two interventions rather than the previously mentioned. In the instance that a RCT were to be done, the number of participants were to be increased to provide adequate data.				
	4. Include any other comments	Although the outcome of the investigation was favourable, there were numerous limitations noted (see the table below).				
Overall percentage agreement						82%

Table V2. Properties of the study, outcome and discussion for Hui (2016).

Author (s)	Hui, T							
Year	2016							
Title	Effective treatment of adhesive capsulitis utilizing soft tissue and joint manipulation—A case study.							
Study properties:								
Form of measurement	Frequency of measurement	Duration of study	Number of participants	Assessors blinded	Control used	Randomisation of participants	Ranking	Total Percentage Agreement
ADLs, NPRS, ROM, microcurrent injury detection	Infrequently-not disclosed	12 weeks	One	Unknown	N/A	N/A	A:0 B1:4 B2:0 C:0 N/A:7	82%
Limitations	The 48 year old female was referred by an orthopaedic surgeon after experiencing left sided shoulder pain for “several months” (Hui 2016). Even though the patients past medical history was reported unremarkable, the previous treatment utilized by the participant was not reported and the onset of symptoms vague. The absence of information regarding the sociodemographic and baseline characteristics of the participant, such as hand dominance, occupation, general activities of daily living. The study design utilised was a case study, however the ambiguity of information pertaining to the participant recruited suggested the influence of selection bias as the participant was selected based on the treatments utilized by the specialist. The location of the investigation was not disclosed along with the environment administered the intervention. There was no indication of the researchers’ presence whilst the intervention was conducted along with the potential influence of the researcher on the participant. The number of researchers involved in the investigation was not disclosed, thus the assumption was Hui (2016) was the only individual involved. The duration of study was reported to be 12 weeks; however, this did not consider previous treatment utilized by the participant prior to the investigated. The participant experienced symptoms for several months prior to the involvement in the study, patient naivety and homecare were not considered thus may have influenced the clinical outcome. The frequency of measurement was not reported along with the measurement tools used. The use of an “electrical stimulation” was reported, and the settings provided with the pad’s placement, however the type of the modality not disclosed. The use of microcurrent injury detection was utilized, however the settings of microcurrent detection modality along with the placement of the probe or electrode was no reported. The range of motion was measured, but the measurement tool was not disclosed, as the measurements were based on anatomical landmarks (i.e., vertebral bodies). The duration of the interventions and sessions was not disclosed along with information regarding homecare activities or medications used. The activities of daily living were a form of measurement used, however this tool was self-care specific as the patient experienced difficulty dressing, bathing and reaching shelves (Hui 2016).The aetiology of adhesive capsulitis fulfilled the prescribed criteria for the activities of daily living scale as the disease outcome would have prevented certain actions. The measurement of range of motion was utilized as a form of measurement, however the ROM was based on anatomical landmarks and not by goniometer, however Hui (2016) reported range of motion of the joint in degrees but no mention of the tools used. The lack of information pertaining to the study design and methodology used, resulted in a poor internal and external validity. The reproduction of the study and the results would not be possible based on the evidence provided.							
Outcome	The patient experiencing no pain along with full recovery of functional activities of daily living, furthermore external rotation of the left shoulder improved within 8 weeks.							

Discussion	The investigator customised the treatment based on the needs of the patient, specifically the pain experienced and the range of motion. The lack of information regarding the measurement tools for the range of motion, left inconsistencies, however the investigator used landmarks to identify such as vertebral bodies. The use of a validated questionnaire, for example the DASH tool or the SPADI tool, may have provided a reliability tool to the intervention outcome without influencing the intervention results. In addition to the measurement tools, the use of a goniometer to measure the range of motion instead of using anatomical structures as measurement scale, would have not influenced the results of the intervention, but provided a reliability/validity tool to monitor the patient recovery by measuring ROM adequately. Although the use of the numerical pain rating scale (NPRS) was widely used in research, the scale can often provide subjective outcome measures. The need for objective measurement tools would allow an unbiased and reliable result. Furthermore, should the study need to be replicated in the future, the use of either the DASH tool, SPADI or goniometer would provide the researchers with a clear methodology. The lack of information with regards to the disease onset in relation to the treatment duration of three months left the reviewers in the lurch as the disease was reported to be self-limiting in some circumstances and self-resolving in others (Le <i>et al.</i> 2017b; Le <i>et al.</i> 2017a; Manske and Prohaska 2008). Given this information, the duration of the onset of the symptoms was deemed somewhat important as it may alter the conclusion of the results. Based on the duration of the study, the natural history of the disease may have overshadowed or boosted the effect of the real intervention as the participant may experience self-resolution in the same 12 week duration (Barbosa <i>et al.</i> 2019). The ambiguity of the interventions used, specifically the “therapeutic exercises” and “electrical stimulation” illustrated a poorly designed study as the replication of the results cannot be fulfilled should the design be used in future studies. The intervention design utilized a combination therapy thus the identification of a superior therapy could not be reported and the clinical efficiency of the protocols followed not be identified, leaving the level of evidence provided poor.
Conclusion	In conclusion, this particular study, Hui (2016), it is evident from the reviewers' responses (82% collective agreement) that this study was able to mostly fulfil one criterion, and subsequently another unfulfilled applicable criterion of the Liddle Scale. This indicates that there is a high agreement for moderate to low rigour and moderate to high bias. As a result, the study was influenced by bias and the outcomes of the study cannot be determined to be better than chance or natural history of the disease alone, when compared to results. The evidence provided in this study was limited in support of the program used as the measurement tools and outcomes used was poorly validated in relation to other measurement tools and outcomes that would have provided a more specific outcome measure.

Table W1. Tabulated feedback of reviewer data for Metgud, Naik and Heggannavar (2017)(according to Liddle Scale).

Author (s)	Metgud, S., Naik, S. and Heggannavar, A.					
Year	2017					
Title	Effect of McKenzie method of Mechanical Diagnosis and Therapy (MDT) on pain, range of motion and shoulder functions using Penn shoulder score in individuals with stage ii adhesive capsulitis: A pre-post experimental study.					
Criteria		Reviewer 1	Reviewer 2	Reviewer 3	Ranking	Total Percentage Agreement (%)
Evaluation criteria for the study:	9. Are the study participants well-defined in terms of time, place and person?	B1	A	B1	B1	66%
	10. What percentage of individuals refused to participate?	C	C	C	C	100%
	11. Are outcomes measured in a standard, valid and reliable way?	B1	A	B1	B1	66%
	12. Are outcomes measured in the same way for both intervention and control groups?	N/A	N/A	N/A	N/A	100%
	13. Are factors other than the intervention e.g. confounding factors, comparable between intervention and control groups and if not comparable, are they adjusted for in the analysis?	B2	N/A	B2	B2	66%
	14. What percentage of individuals recruited into the study are not included in the analysis? (loss to follow-up).	I	B1	I	I	66%
	15. Is the analysis by intention to intervene (treat)?	I	A	I	I	66%
	16. Are results homogeneous between sites? (multicentre/multisite studies only).	N/A	N/A	N/A	N/A	100%
Overall assessment of the stud:	5. How well was the study done to minimise bias? IF coded as B1, B2 or C, what is the likely direction in which bias might affect the study results?	B1	The study considered and reported the limitations in the report. The methodology used in the study as clearly outlined and procedure parameters provided for the interventions.			
	6. Is the overall effect of the study due to the study intervention?	B2	The data provided was limited thus it was unclear of the intervention effect. The researchers of the article attempted to minimise the bias; however certain variables were unable to be controlled.			
	7. Explain if there is any practical/ethical reason why an RCT cannot be done.	N/A	With exception of financial and timeframe limitations, there was no reason to not design this study as an RCT.			
Overall percentage agreement						79%

Table W2. Properties of the study, outcome and discussion for Metgud, Naik and Heggannavar (2017).

Author (s)	Metgud, S., Naik, S. and Heggannavar, A.							
Year	2017							
Title	Effect of McKenzie method of Mechanical Diagnosis and Therapy (MDT) on pain, range of motion and shoulder functions using Penn shoulder score in individuals with stage ii adhesive capsulitis: A pre-post experimental study.							
Study properties:								
Form of measurement	Frequency of measurement	Duration of study	Number of participants	Assessors blinded	Control used	Randomisation of participants	Ranking	Total Percentage Agreement
VAS, NPRS, Penn Shoulder score	Pre-post intervention (first and last day)	5 days	20 participants	No	No	No	A: 0 B1: 2 B2: 1 C: 1 N/A: 2 I: 2	79%
Limitations	The participants were recruited from a tertiary health care facility and the investigation conducted onsite for five days. The eligibility criteria required the participants to be clinically diagnosed with stage two adhesive capsulitis, and a brief medical history taken. The medical history included the presence of comorbidities, such as diabetes, however absence of symptoms duration and previous treatment noted. The recruitment procedure and sample procedure utilized was not disclosed, along with the number of participants whom refused to participate in the investigation (Metgud, Naik and Heggannavar 2017). The sample demographics and the participant homogeneity were similar as the baselines were equal in the gender ratio and the presence of comorbidities (specifically diabetes mellitus). The study reported the assessors were not blinded along with the participants. A quasi-experimental design was utilized in the investigation, with the no control present as the participants involved received the same intervention, limiting Metgud, Naik and Heggannavar (2017) from determining the true effect of the program interventions. The participants received the same intervention for 5 consecutive days and were assessed on the first and last day. The outcome measurement tools utilized were the numerical pain rating scale (NPRS), Penn Shoulder Score and a Goniometer, however the goniometer was listed but not discussed in depth when compared to the other measurement tools. The limited details regarding the goniometer regarding the placement of the tool and training knowledge on the users behalf, created the question of measurement consistency. The data gathered from the results was not stratified nor the number of participants included in the presented results. The lack of information including loss of follow up and intention to treat, limits the analysis outcomes and consistency throughout the investigation.							
Outcome	The McKenzie Method of Mechanical Diagnosis and Therapy (MDT) treatment was highly effective in the improvement of range of motion, reduction of shoulder joint pain along with improvement of the shoulder functions using the Penn score in participants with stage two adhesive capsulitis.							
Discussion	Metgud, Naik and Heggannavar (2017) considered provided positive results regarding the McKenzie Method of Mechanical Diagnosis and Therapy (MDT), however the investigation did not have a follow-up period, thus limiting the longevity of the intervention.							

	The study design was clearly depicted, therefore making replication of investigation possible. A suggestion for the investigation modification would be to change the design into a randomised controlled trial with a larger sample size, with more than one group containing more than 15 participants each. This modification may provide a true representation of the affected population and the addition of results pertaining to a follow up period to identify the capacity of the intervention longevity. The absence of participant recruitment process and the outcome measurement tools utilized increases the potential for bias as it was unclear whether the protocol was followed.
Conclusion	Given the pre-test post-test quasi-experimental design, the use of the Newcastle Ottawa Scale (NOS) (Wells, Shea and O'Connell 2003) was not applicable, thus the decision made to use the Liddle Scale (Liddle, Williamson and Irwig 1996) was made. With a total percentage agreement of 79%, the investigation conducted by Metgud, Naik and Heggannavar (2017) provided a positive outcome however with modifications discussed above, the longevity of the investigation may be extended, and functionality restored to those diagnosed with stage two adhesive capsulitis, preventing disease progression and reduce the reoccurrence of the pathology.