The effectiveness of combined spinal manipulation and patella mobilization compared to patella mobilization alone in the conservative management of patellofemoral pain syndrome.

By

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Dissertation submitted in partial compliance with the requirements for the Master's Degree in Technology:

Chiropractic in the Faculty of Health at Technikon Natal.

I, Neil Osmond Stakes, do hereby declare that this dissertation is representative of my own work.

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31/07/2000

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APPROVED FOR FINAL SUBMISSION

31. 7. 2000

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DR C. MYBURGH

Dedication

I dedicate this work to the Blessed Trinity, all the angels and saints in heaven and on earth on whose constant intercession I rely for help.

To my mother, undoubtedly the strongest influence in my life, my counsellor and my good friend. Her selfless sacrifice and tireless devotion, as well as her willingness to listen to me in my time of need meant the world to me. I would like to thank her for always believing in me, encouraging my potential and doing everything in her power to keep me on track.

To Chelsey, my daughter, without the prospect of her in my life I would not have achieved this. She was the light at the end of the tunnel and the motivation for my success. Even though we were not together physically, you were always in my heart.

I wish to thank the rest of my family, as well as those who have also supported me in prayer and those whom I may have not directly mentioned. May the Lord bless you and keep revealing his blessings to you!
Acknowledgements

I wish to acknowledge the special friendships throughout my years at Technikon Natal... Gary, Maureen, Justin and Hayden, and there so many more, are far too many to mention here...I think of the Ross family, my numerous flat-mates, my home-cell group, just to mention a few.

A very special word of thanks to Lilly Leong and her family for their support during the arduous task of putting the thesis together...and dealing with me too!

Finally, a word of thanks to my supervisor Dr. Myburgh.
ABSTRACT.

Purpose.

Patellofemoral pain syndrome (PFPS) refers to a syndrome associated with the following signs and symptoms: anterior knee pain, inflammation, imbalance, instability, or any combination thereof (Wood 1998). The purpose of this investigation was to evaluate whether spinal manipulation, as an adjunct to patella mobilization, contributed significantly to the improvement of patients diagnosed with PFPS.

Method.

A prospective trial using convenient sampling was implemented using the first 60 volunteers that met the requirements. These were randomly divided into two groups. Participants in group 2 received combined patella mobilization and spinal manipulative therapy, while those in group 1 received patella mobilization only.

Each patient selected for the study was required to complete an informed consent form. The selected patients underwent a general medical case history, lower back and knee orthopaedic regional examinations.

8 clinical experiments were done: pain threshold (ALG1), pain tolerance (ALG2), the mean least pain experienced (NRS1), the mean worst pain experienced (NRS2), the mean pain experienced (NRS3), pain quality (McGill), patellofemoral joint evaluation scale (PFJE) and a patient specific functional scale (PSFS). All were continuous variables except McGill, which was a categorical variable. For each clinical experiment, readings were taken 3 times, i.e. at the first, third and sixth consultations.
Continuous variables were analysed using Levene's test to compare the 2 population variances, and the two-sample paired t-test was used to compare results from related samples. Categorical variables were analysed using the Mann-Whitney U-test to compare Groups 1 and 2, and the Wilcoxon's signed rank test was used to compare results from related samples. The data was presented in the form of bar charts and tables.

Parametric methods were used for continuous variables and non-parametric methods were used for categorical variables, as each group consisted of thirty patients. The null hypothesis was rejected at the $\alpha = 0.05$ level of significance if $p < \alpha$, where $p$ was the observed significance level or probability value. Where the results were significantly different, i.e. $p < \alpha$, the two-tailed $p$ value was converted to a one-tailed value with $\alpha = 0.025$. Otherwise, the null hypothesis was accepted at the same level.

Continuous variables were analysed using Levene's test to compare the 2 population variances, and the two-sample paired t-test was used to compare results from related samples. Categorical variables were analysed using the Mann-Whitney U-test to compare Groups 1 and 2, and the Wilcoxon's signed rank test was used to compare results from related samples. The data was presented in the form of bar charts and tables.

Results.
The two treatment groups improved significantly, however the study failed to show that there was any statistically significant benefit to combining lumbar spinal manipulation to the mobilization treatment protocol when treating PFPS. In addition, it may not be possible to draw accurate representative conclusions from this study as this sample was not a reflection of the patellofemoral population in terms of age and gender distribution.
Conclusions.

The two treatment groups improved significantly, however there were no significant differences in improvement between the two groups. The study failed to show that there was any overall statistically significant benefit to combining lumbar spinal manipulation to the mobilization treatment protocol when treating PFPS. In future studies it may be possible to note clinically significant improvements by determining a decreased muscle inhibition. I believe that such a decrease occurred in the spinal manipulation group but no tests were performed to assess such an improvement.

Evidence of this may be found in the improved functional ability as reported in the patient specific functional scale (group 2 improved by 2.7 points compared to 2.2 points for group 1), as well as the lower pain quality reported in the McGill pain questionnaire. The slightly improved patient specific functional improvements may have been more clearly elucidated had a muscle inhibition test been performed.
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Definition of Terms.

ADJUSTMENT
Specific form of direct articular manipulation utilizing either long or short leverage techniques with specific contacts, characterised by a dynamic thrust of controlled velocity, amplitude and direction. (Gatterman 1990: 405)

CHIROPRACTIC
A discipline of the scientific healing arts concerned with the pathogenesis, diagnostic, therapeutics, and prophylaxis of functional disturbances, pathomechanical states, pain syndromes, and neurophysiological effects related to the statics and dynamics of the locomotor system, especially of the spine and pelvis. (Haldeman 1991: 622)

FIXATION
Absence of motion of a joint in a position of motion, usually at the extremity of such motion. (Gatterman 1990: 409)

JOINT DYSFUNCTION
Joint dysfunction showing area disturbances of function. (Gatterman 1990: 409)

MANIPULATION
Passive manoeuvre in which specifically directed manual forces are applied to vertebral and extravertebral articulations of the body, with the object of restoring mobility to restricted areas. (Gatterman 1990: 410)
PATELLOFEMORAL PAIN SYNDROME

A syndrome associated with the following signs and symptoms: anterior knee pain, inflammation, imbalance, instability, or any combination thereof (Wood 1998).

Also,

Retro-or peri-patellar pain aggravated by knee flexion activities such as stair climbing/descending and squatting activities (Rowlands 1998).
CHAPTER ONE

1. INTRODUCTION.

1.1 The problem of patellofemoral pain syndrome.

Patellofemoral pain syndrome (PFPS) has gone by many descriptions which include patellalgia, gonalgia paraesthetica, anterior knee pain syndrome, retropatellar arthralgia, the patellar syndrome, and patellar tracking problems (Reid 1992:349.). Although often described in the literature as retro- or peri-patellar pain aggravated by knee flexion activities, for the purpose of this study, PFPS refers to a syndrome associated with the following signs and symptoms: anterior knee pain, inflammation, imbalance, instability, or any combination thereof (Wood 1998).

Meyer et al. (1990) reported that PFPS was a common problem in adolescents and young adults. Bockrath (1993) stated that anterior knee pain syndrome was a common problem for the athlete, and Reid (1992:349) reported that the incidence was as high as 25% of the athletic population. In a study done on 196 consecutive injuries at a runners' clinic, Pinshaw et al. (1984) reported a 22% incidence of 'runner's knee' (peripatella pain syndrome).

The aetiology of PFPS, according to Galantly et al. (1994), generally result from an overuse injury to the extensor/decelerator mechanism of the knee. Amongst the various theories on PFPS aetiology, Chadwick (1987), Reid (1992:351), Dryburgh
(1998), Gelfound and DeVore (1995), and Wood (1998) all report third lumbar (L3) sclerotomal dysfunction as a possible cause of PFPS. Referred pain from skeletal structures was first outlined by Inman and Saunders (1944), who showed that L2, L3, and L4 refer pain to the knee. Haldeman (1980:72-73) reinforced this.

Suter et al. (1998) showed that muscle inhibition was closely associated with the anterior knee pain syndrome. The study concluded that there was substantial muscle inhibition of the uninvolved leg in addition to the involved leg. Therefore the opposite leg may not be used as a control when assessing muscle inhibition. Hurley et al. (1994) shared the same view and points to a possible neurological mechanism as the cause. Furthermore, the study by Suter et al. (1998) showed that a one-week administration of non-steroidal anti-inflammatory drugs (NSAIDS) did not affect the muscle inhibition, despite a reduction in pain. Suter et al. (1999), in a randomised controlled trial, showed significant reduction in muscle inhibition after sacroiliac manipulation.

According to Fulkerson (1989), the aetiology of PFPS was perceived to be primarily retinacular in origin. Furthermore, it was recommended that treatment be directed to correcting a tight retinaculum. With this consideration, Rowlands (1999) concluded that patella mobilization was an effective treatment for PFPS.

This study attempted to show whether the combination of patella mobilization and lumbar spinal manipulation served as an effective treatment. However, no tests for muscle inhibition were conducted as the symptomatic improvement was seen as an indication of improvement in muscle inhibition.
1.2 Aims and objectives.

1.2.1 The aim.

The aim of the investigation was to evaluate the effectiveness of combined spinal manipulation and patella mobilization compared to the effectiveness of patella mobilization alone, in terms of subjective and objective measures in the conservative management of patellofemoral pain syndrome.

1.2.2 The objectives.

a) The first objective was to determine the effectiveness of combined spinal manipulation and patella mobilization compared to the effectiveness of patella mobilization alone, in terms of objective measures in the conservative management of patellofemoral pain syndrome.

b) The second objective was to determine the effectiveness of combined spinal manipulation and patella mobilization compared to the effectiveness of patella mobilization alone, in terms of subjective measures in the conservative management of patellofemoral pain syndrome.

1.3 The potential benefits of this study.
A ten-minute patella mobilization has been shown to be more effective than placebo (Rowlands 1999). The results of the two-minute mobilization will be of interest to compare to the aforementioned study. Rowlands (1999) recommended that the treatment time be reduced, this may enable a less time consuming, yet an effective treatment for PFPS.

Chiropractors have traditionally used spinal manipulation as an adjunct to extremity care (Brantingham 1999). Suter et al. (1999), have shown decreased muscle inhibition in those patients with anterior knee pain after sacroiliac manipulation. Lumbar spinal manipulation may prove to be a useful adjunct when treating PFPS. This study attempted to show whether the added effect of lumbar spinal manipulation benefits in the treatment of PFPS. This fact may translate into improved patient management as well as possible decreased treatment time.

The decreased treatment time may be of value to both the patient and the practitioner. This is as evidenced by a decrease in the cost to the patient in terms of lost productivity at work and for professional athletes. Practitioners with a time efficient method of care may be able to treat more patients, more efficiently and effectively.
CHAPTER TWO

2. THE REVIEW OF THE RELATED LITERATURE.

2.1 INTRODUCTION.

2.1.1 Definition and History

Patellofemoral pain syndrome (PFPS) refers to any combination of the following: anterior knee pain, inflammation, imbalance, and instability (Wood 1998).

Synonyms for patellofemoral pain syndrome include chondromalacia patella; patella subluxation, patellofemoral chondritis; anterior knee pain; and quadriceps or vastus medialis obliquus insufficiency. Others include patellofemoral dysfunction; patella compression syndrome; lateral hypercompression syndrome; excessive lateral pressure syndrome; patellalgia; gonalgia paraesthetica; retropatellar arthralgia; the patellar syndrome, and patellar tracking problems (Boucher et al. 1992, Davidson 1993, DeLee & Drez 1994{1169}, Reid 1992:348, Scaringe 1994, Shelton 1992).

2.1.2 Incidence

Scaringe (1994), stated in a review article that the incidence of patellofemoral pain syndrome was between 11.3% and 25% of all findings in sports medicine; and that this condition made up 30% of all knee injuries. Reid (1992: 349) reported that the incidence may be as high as 25% of the athletic population. In a study done on 196 consecutive injuries at a runner’s clinic, Pinshaw et al. (1984) reported a 22% incidence of ‘runner’s
knee' (patellofemoral pain). The incidence in army personnel ranges from 15% to 30% (BenGal et al. 1997). PFPS is a common finding which affects a significant part of the population.

According to Tria et al. (1992) patients are mostly between the ages of 10 to 20, with a predominance of teenage females. Meyer et al. (1990) supports this stating that PFPS is common in adolescents and young adults. Davidson (1993) attributed the increased incidence of patellofemoral pain syndrome in women to the wider gynaecoid pelvic structure, which increases the Q-angle. This is plausible in that the Q-angle would increase if the pelvis were wider, as the anterior superior iliac spine would be more lateral compared to males. However the use of the Q-angle has not been established as a method for predicting or assessing the severity of PFPS. According to Fitzgerald & McClure (1995), the Q-angle was not a reliable indication when assessing PFPS.

2.1.3 Natural History

In a study by Sandow and Goodfellow (1985) on 62 adolescent girls, between the age of 14 and 16 years old, a follow-up between 2 to 8 years after initial consultation was performed.

Participants were offered physiotherapy and occasionally plaster immobilisation for short periods. Other interventions, which may have impacted on the outcome, included arthroscopy and double-contrast arthrograms on selected cases, all findings were within normal limits. 30% of the participants were only seen once, others were seen at regular intervals sometimes for several years. After a period of between 2 to 8 years, questionnaires were submitted to 62 participants, of which 54 were returned. Results
were based on an 86% response, as one participant was deceased and another had emigrated [Sandow and Goodfellow (1985)].

94.4% of respondents continued to experience some pain, however 46.3% reported diminished severity while only 13% reported worse symptoms. 81.5% reported a pain frequency of once a week or less, which corresponds with the 87% of patients which rarely or never used analgesics. 48.1% reported knee pain that did not interfere with sport at all, however 16.7% had knee pain which severely restricted sporting activities [Sandow and Goodfellow (1985)].

The study, by Sandow and Goodfellow (1985), suggests that PFPS, therefore is a benign condition, which affects the individual for many years after the initial onset causing residual pain in most cases. The pain was less intense in nature and tended to occur less frequently in the majority as compared to the initial visit. Only a small percentage experienced increased pain, which may have severely restricted sporting activities in some cases.

2.2 PATELLOFEMORAL JOINT ANATOMY AND BIOMECHANICS.

2.2.1 Anatomy.

The patella is a sesamoid bone that exists within the quadriceps tendon proximally and within the patellar tendon distally. The patella acts as a guide for the quadriceps mechanism, sliding between the femoral condyles, which hold it in place. It also increases the efficiency of the quadriceps muscle in extending the knee (Davidson, 1993.)
The patellofemoral articulation consists of the facets of the patella in contact with the sulcus of the anterior femur. The surface anatomy of each side, the overall rotational anatomy of the entire lower extremity, and the relationship of the surrounding muscles affect the contact between the two surfaces. The patella surface can include up to seven facets, with three on the medial and lateral surfaces and an extra ("odd") facet on the medial side (Tria et al., 1992.)

Davidson (1993) states that proper tracking of the knee during flexion and extension of the knee is influenced by: height of the femoral condyles and hence depth of the femoral groove, keeping the patella "seated". The shape of the facets on the undersurface determines the "fit"; the medial and lateral retinacula which keep the patella "centred" in the femoral sulcus; the relative strength of the individual muscles composing the quadriceps group; and the Q-angle. It is the author’s opinion that an increased Q-angle may not necessarily precipitate PFPS as the pull of the quadriceps may compensate for the altered structure. However, when the abnormal Q-angle is combined with an atrophic vastus medialis obliquus, PFPS may occur.

2.2.2 Biomechanical Functions.

The patella serves a significant biomechanical function as part of the extensor mechanism of the knee. The patella increases the distance of the extensor pull from the centre of rotation of the knee and, therefore increases the mechanical advantage of the quadriceps group (Tria et al., 1992.) Davidson (1993) echoes this view.

2.3 AETIOLOGY OF PFPS.

2.3.1 Patellofemoral Articulation.
Davidson (1993) states that patellofemoral pain syndrome seems to develop under one of two circumstances: anatomic abnormalities or repetitive microtrauma (overuse). Anatomic abnormalities i.e. shallow femoral condyles, are implicated as a cause of abnormal tracking of the patella during knee movement. Abnormal patella shape and size (Wiberg types 1 to 3; Baumgarti; Patella parva; Alpine hunter’s cap, Pebble; Half-moon; and Patella magna) led investigators to believe that abnormal facet anatomy caused incomplete facet contact which resulted in patellofemoral pain (Tria et al. 1992). There is no endemic linking between PFPS and the aforementioned abnormal patella shapes and sizes.

Furthermore, pathologies of the patellofemoral joint are considered to be a major cause of anterior knee pain Scaringe (1994). Numerous authors namely Shelton (1992), Davidson (1993) and DeLee & Drez (1994:1169) share these views.

According to Fulkerson (1982, 1987), a tight lateral retinaculum may cause chronic strain, inflammation and pain, in addition to chronic strain. Biedert et al. (1992) found a high occurrence of free nerve endings in the peripatellar tissues. The combination of the above may contribute to the pain that those with PFPS experience. In a randomised, placebo controlled clinical trial on 30 patients in which a tight retinaculum (as well as other patellofemoral restrictions were stretched by mobilization) Rowlands (1999) found a significant difference between the study group and the control group. The results showed significant improvements ($p<\alpha$, where $\alpha = 0.05$) in terms of objective measures, i.e. algometer readings for pain tolerance, between the first and the fourth treatments, the first and the eighth treatments, as well as the first and the one-month follow-up. Results also indicated significantly higher pain tolerance measurements at the various treatments. Significant improvements were also found in terms of subjective measures, i.e.
Numerical pain rating scale 101 and the Patient Specific Functional Scale, between the first and the eighth treatments, as well as the first and the one-month follow-up (Numerical pain rating scale 101 only) [Rowlands 1999].

2.3.2 Neuromuscular.

Bose et al. (1980) concluded that insufficiency of the vastus medialis oblique muscle was of clinical significance in the aetiology and treatment of patellofemoral instability. The results of a study by Boucher et al. (1992) demonstrate that an important neuromuscular imbalance between vastus medialis obliquus (VMO) and vastus lateralis (VL) is associated with patellofemoral pain syndrome and that it can be investigated through VMO: VL ratio of activity. In a study by Gillettard et al. (1998) patella taping changed the timing of the VMO and VL activity as measured by electromyography and decreased pain in subjects with PFPS. 14 female subjects with a mean age of 22.7 were used. Earlier activation of VMO and delayed activation of VL was observed which were thought to optimally place the patella in the femoral trochlea.

Hurley et al. (1994) showed that muscle inhibition was closely associated with extensive traumatic knee injuries. The study concluded that there was substantial muscle inhibition of the uninvolved leg in addition to the involved leg. This mechanism was thought to be as a result of abnormal afferent neurological impulses, from articular mechanoreceptors, which are perceived to be bilateral. As the spinal neurons receive a convergent bilateral input from articular mechanoreceptors, any unilateral injury in perceived as bilateral. This decreases the excitability of spinal neurons controlling the quadriceps activity. Therefore the opposite leg may not be used as a control when assessing muscle inhibition.
Suter et al. (1998) concluded that articular muscle inhibition occurs in PFPS and that the opposite leg was also inhibited. Furthermore, this study showed that a one-week administration of non-steroidal anti-inflammatory drugs (NSAIDS) did not affect the muscle inhibition, despite a reduction in pain. However, in a randomised controlled trial, Suter et al. (1999) showed significant reduction in muscle inhibition after sacroiliac manipulation in those patients with anterior knee pain. Vicenzino et al. (1996), in a randomised controlled trial showed that cervical spine manipulation has been shown to be useful in the treatment of lateral epicondylitis. Lumbar adjusting may improve segmental nerve function and help overcome muscle inhibition. However, no research has been performed to validate lumbar spinal manipulation as a useful adjunct while treating PFPS.

In a study by Puniello (1993) on ilio-tibial band tightness and medial patellar glide in patients with patellofemoral dysfunction, the results showed 70% with decreased medial glide with ilio-tibial tightness, 12% with had decreased medial glide with a normal Ober's Test, and 18% with normal patella mobility and Ober's Test. This study had only 17 participants, 16 of which were female therefore accurate conclusions cannot be drawn from this, as the sample was too small and not representative of the normal population distribution. However, the condition is more common in women (Davidson, 1993).

2.3.3. Referred pain

- Increased excitability (facilitation) of internucial neuronal pools at the involved cord levels, presumably incited by aberrant sensory input from the injured site. Sensory, motor and sympathetic pathways are thought to be affected by the enhanced central excitatory state. The increased sympathetic discharges produce changes in the periphery, which incite secondary afferent discharges, thus initiating and sustaining vicious, autogenic cycles of impulses.

- Excitation of ectopic impulses in pain fibres by impulses passing in neighbouring sympathetic postganglionic fibres (interaxonal “cross-talk”, lateral or ephaptic transmission, “artificial synapse”). The antidromic (as well as orthodromic, afferent) impulses triggered in this manner are thought by some to release vasoactive agents and irritants at the endings.

- Various adaptations of the gate-control theory of pain.

Korr (1977:255-256) believes the first to be the most plausible in explaining sympatheticotonia or its trophic manifestations and he outlines how spinal manipulation serves to decrease this overactivity and normalise function. Relief after injection of a small amount of anaesthetic into the retinacula area confirms extra-articular source of pain (Davidson, 1993). The high occurrence of free nerve endings, as described by Biedert et al. (1992), are inhibited. Therefore Korr’s theory on the release of vasoactive and irritants at the free nerve endings in the retinaculum may have some value.

Korr’s aforementioned theories also explain the phenomenon of reflex sympathetic dystrophy and trigeminal neuralgia, as well as phantom limb pain.
2.3.4 Miscellaneous Views.

The cause of PFPS appears to be an enigma and a variety of diverse aetiologies have been suggested. Scarringe (1994) states that currently, no convincing proof exists as to exact cause of patellofemoral pain syndrome. The author describes intrinsic and extrinsic causes, as well as an altered balance of the relationship of muscles, ligaments, and/or bones. Intrinsic causes include: abnormalities of subchondral bone (increasing intraosseous pressure); and poor healing after trauma. Extrinsic causes include: wasting of the VMO; tight lateral structures; tight hamstrings and gastrocnemius; excessive pronation; increased Q-angle; patellar position; femoral rotation; femoral neck rotation; variation in patellar shape; genu valgum; tibial torsion; patellar instability; and medial facet overuse. This is a broad overview of almost every local structure capable of producing the pain but does not provide any clarity or offer any explanation.

2.3.5 Hyperpronation.

The foot may also play a role in the aetiology of PFPS. Zappala et al. (1992) implicates excessive pronation of the subtalar joint as a causative factor of patellofemoral pain and that foot orthotics may help alleviate the condition, but concedes that this has not been researched fully.

2.3.6 Author's View.

The lower back may also be involved especially since the third lumbar nerve innervates the anterior knee. Inman and Saunders (1944) implicated the second, third, and fourth lumbar spinal levels as those responsible for innervating the knee. The writings of Grieve (1981) in which the sclerotomal levels implicate the third lumbar nerve level, as
the source of referred pain to the anterior knee, is corroborated by Schafer & Faye (1990:247), as well as Haldeman (1980:72).

Chadwick (1987) stated that the blame for anterior knee pain and groin pain could be laid at the doorstep of the lumbar and lower thoracic spines. This author agrees with the above authors that treatment should be directed at these areas (which is adjacent to and may influence the lumbar spine). In a randomised controlled study by Suter et al. (1999) sacroiliac adjusting was shown to decrease muscle inhibition in those patients with anterior knee pain. The study consisted of 28 subjects with 14 controls and 14 experimental subjects. It is the opinion of this author that lumbar spinal manipulation may improve the neuromuscular control of the knee, thereby improving the symptoms of PFPS.

2.4 PRESENTATION

2.4.1 The Clinical History.

Tria et al. (1992) believes that the history is of paramount importance in diagnosis of PFPS. The complaint is of a non-specific anterior knee discomfort, which may be bilateral (DeLee & Drez 1994:1170, Tria et al. 1992). DeLee & Drez (1994:1170) state that the pain may occur spontaneously although there may have been some direct trauma to the anterior knee. The condition may begin gradually and is not commonly related to an injury (Tria et al. 1992).

Tria et al. (1992) notes five groups in which patellofemoral pain syndrome occurs:

- the first group, a non-specific anterior knee discomfort in a teenage girl is a common finding;
- second group, patella instability with patella subluxations or dislocations occurs;
• third group, direct trauma to the anterior aspect of the knee may also be found;
• fourth group, athletic overactivity may also be found; and
• fifth group, arthritis of the patellofemoral joint may also occur.

2.4.2 The Symptoms.

According to Davidson (1993) presenting symptoms include retropatellar or peripatellar knee pain. DeLee & Drez (1994:1170) describe the pain as diffuse; or centred along the medial or lateral patellofemoral joint or retinaculum; crepitations are also implicated even if they occur before the onset of pain or in the opposite knee. Davidson (1993) states that crepitus is extremely common in young patients, generally does not always imply patellofemoral pathology. The latter also describes the pain as having a dull, aching nature, occasionally becoming sharp during activities that increase the pressure over the kneecap.

2.4.2.1 Aggravating factors.


Subtle differences in the literature are common, e.g. Davidson (1993) refers to the pain after prolonged sitting with knee flexion as the "theatre" sign, whereas Scaringe (1994) refers to it as the movie sign. The same idea is being described using slightly different terms.

Repetitive strain from vigorous activities and overuse is a common finding. Activities which aggravate the pain include running, jumping, and cycling (Scaringe, 1994).
During these activities there is repetitive knee flexion and extension. In a study by Miller et al. (1997), it was found that during flexion of the knee from 20° to 80° of flexion the patellofemoral force increased from 75% of the quadriceps tendon force to its maximum level. The increased patellofemoral force explains why knee flexion activities aggravate PFPS.

2.4.2.2 Relieving factors.
Rest relieves the pain (Scaringe, 1994), especially when seated with the knee in the extended position. This is due possibly to the decreased patellofemoral force in the extended position.

2.5 ASSESSMENT.
2.5.1 The Physical Assessment.
2.5.1.1 The Q-angle.
The Q-angle is believed to be a "relevant clinical measurement" indicating patellofemoral problem, i.e. useful measure of the direction of the quadriceps tendon force. An increased Q-angle causing lateral displacement of the patella was believed to predispose, cause, or aggravate PFPS. Research has shown that the actual tendon force was more laterally displaced than the Q-angle measurement led the researchers to believe (Schulthies et al. 1995). Problems in this study were the use of male cadavers only and the small sample consisting of only seven specimens. In addition, the reliability of Q-angle measurements was questioned and found to be unreliable in a study done by Fitzgerald & McClure (1995). In this study the showed that the tests alone lacked reliability as a method of determining the direction of taping. In the past the increased Q-angle was used as a justification for PFPS surgery a great deal of useless and harmful
procedures were performed. At most it appears that an increased Q-angle may be an indication of PFPS problem (Reid 1992: 349).

2.5.1.2 Physical testing.

2.5.1.2 a) PATELLA APPREHENSION: As the examiner attempts to displace the patella laterally, if the patient senses the possibility of dislocation and there is apprehension and discomfort (DeLee & Drez 1994:1179). A positive test may indicate serious injury or patellofemoral disorder.

2.5.1.2 b) FACET TENDERNESS: Palpation of the medial or lateral patella facets may produce pain (Davidson 1993).

2.5.1.2 c) CLARKE'S SIGN: The supine patient extends the knee and relaxes the quadriceps. The examiner places the web of the hand against the superior pole of the patella and depresses it distally. The patient then contracts the quadriceps as the examiner compresses the patella against the condyles of the distal femur. The sign is positive if the patient cannot maintain contraction without producing a sharp pain (Schafer & Faye 1990.) This test must be performed bilaterally, repeatedly and gradually. The involved side should be more painful than the normal side and indicates the possibility of a number of patellofemoral problems including PFPS (Reid 1992: 348).

2.5.2 The Radiographic Assessment.

According to Yochum & Rowe (1996:181): the use of the tangential knee or "skyline" projection and the combined use of measurements derived are important in evaluating contributing causes of patellofemoral pain syndromes; the use of the lateral knee projection is valuable in assessing patella alta or patella baja. However, none of these measurements have been used to show a conclusive relationship with the diagnosis or
severity of PFPS. Radiographs were used primarily to rule out pathology and where indicated by the history and clinical findings.

2.5.2.1 Tangential Knee (Skyline) Projection:
The relationship of the patella to the femoral condyles can be measured including Patella apex; Sulcus angle; Lateral Patellofemoral Joint Index; Lateral Patellofemoral Angle; and Lateral Patellar Displacement (Yochum & Rowe 1996:181).

2.5.2. Lateral Projection:
Measurement of the patella and patella tendon lengths, as described by Yochum & Rowe (1996:181) are:

2.5.2.1 Patella length.
The greatest diagonal dimension between the superior and inferior poles.

2.5.2.2 Patella Tendon length.
The distance measured is between the insertion points of the posterior surface at the inferior patella pole and the notch at the tibial tubercle.

Patella length to patella tendon length is usually equal to or within 20% variation of each other. When patella tendon length is more than 20% greater, patella alta is present. This is found in association with chondromalacia patellae. Patella baja, a low-riding patella, may be seen in poliomyelitis, achondroplasia, juvenile rheumatoid arthritis and tibial tubercle transposition (Yochum & Rowe 1996:181.)

2.6 TREATMENT.
Very few controlled studies on PFPS exist, what follows is a summary of the various literature reviews. Patients with anterior knee pain present a challenge due to the
perplexing problems presented by the patellofemoral joint and its components. Therefore, according to Cailliet (1991:143) appropriate and effective treatment remains an enigma.

Treatment for patellofemoral pain syndrome is varied Tria et al. (1992) and includes various forms of therapeutic exercise, oral medication, rest, external support, physical modalities, modification of contributing factors. Zappala et al. (1992) advocates in addition correction of excessive pronation of the subtalar joint, using orthotics. Chadwick (1987) prefers manipulation of the thoracic and lumbar spines. Scaringe (1994) adds manipulation of the subtalar joint to this list. In a condition with such a variety of possible causes the treatment list is varied and every option needs to be evaluated thoroughly so that the best treatment protocols can be derived.

2.6.1 Medication

Tria et al. (1992) advocates the use of steroids and NSAIDS. Medications should be viewed as adjunctive, however, and are not nearly of the same importance as rehabilitative exercise (DeLee & Drez 1994:1194).

2.6.1.1 Non-steroidal anti-inflammatory drugs (NSAIDS)

2.6.1.1 a) General.


Tria et al. (1992) recommend that the choice of NSAID be based on safety margin, potential side effects, individual medical history, other drugs the patient may be taking, and ease of dosing schedule.
These drugs (NSAIDS) should not be prescribed for all patients but should be used judiciously when symptoms interfere with activities of daily living. Their use has also been beneficial when the patient experiences an acute exacerbation of symptoms (Zappala et al. 1992.)

Suter et al. (1998) showed that a one-week administration of non-steroidal anti-inflammatory drugs (NSAIDS) did not affect the muscle inhibition, despite a reduction in pain.

2.6.1.1 b) Side Effects.

All NSAIDS cause gastric irritation and can exacerbate peptic ulcers. Further complications of ulcers are due to decreased platelet aggregation and adversely affecting bleeding time. Other complications include decreased renal blood flow, hypersensitivity, adverse cutaneous reactions, and hematologic disorders (Tria et al. 1992.)

2.6.1.2 Steroids.

Steroids do not have a role in the conservative therapeutic approach (Tria et al. 1992). Injection of steroids has generally been discouraged because of the resultant articular cartilage degradation and the physical damage to tendon resulting in a high degree of subsequent tendon ruptures (Shelton 1992).

2.6.2 Physical modalities and rest.

2.6.2.1 Physical modalities.

Davidson (1993) recommends the use of cryotherapy through its effects on both pain and inflammation for patellofemoral pain syndrome. Ice packs and ice massage are described and their use over the affected area for 15 to 20 minutes is advised. Furthermore, treatment up to six times per day initially, but later only after activity is prescribed.
2.6.2.2 Rest.

Patellofemoral pain syndrome is caused by repetitive microtrauma (overuse) according to Davidson (1993). Shelton (1992) recommends rest because of overuse either partial rest through activity modification; or complete rest only if all other conservative measures fail.

2.6.3 Activity modification.

Since virtually every patient with patellofemoral pain syndrome presents in a situation of overuse, it only makes sense to prescribe some modification of the overuse (DeLee & Drez 1994:1194).

A change in activity - from one that seems to aggravate the problem to one that causes less pressure over the knee - should decrease the symptoms and allow the patient to continue exercising. The patient should be advised to avoid activities that aggravate the problem, including deep knee bends, stair climbing and twisting or lateral movements (Davidson 1993). DeLee & Drez (1994: 1194) recommend that it is wiser and more acceptable to the patient to suggest modification of activity such as the substitution of brisk walking for running, or bicycling and swimming for weight bearing activities.

2.6.4 External support.

2.6.4.1 Bracing.

The basic choice in patellofemoral bracing is between those that utilise some passive lateral buttress to realign the patella and those that use some active elastic strap
component to provide a dynamic pull medially on the patella (DeLee & Drez 1994: 1194). Tria et al. (1992) describes three types of braces: Palumbo cut-out braces, straps beneath the patella (Levine strap), and newer techniques of taping the knee.

The prophylactic use of bracing was shown to be efficacious in preventing patellofemoral pain syndrome in male individuals undergoing intensive physical training (BenGal et al. 1997). The study consisted of 60 athletes with 27 in the brace group (21 men, 6 women) and 33 (22 men, 11 women) in the non-brace group. Women are more affected than men are in general, but in this study, women constituted less than 50% of the population and unequal sex distribution within and between the groups. There were more women in the nonbrace group (11) compared to the braced group (6).

Davidson (1993) reports that several studies demonstrated decreased symptoms and increased strength as a result of patellar bracing. However, patients have good relief while wearing the support but complain of increased pain at night after brace use (Tria et al. 1992). The nocturnal symptoms may be due to inactivity and the resulting absence of mechanoreceptor stimulation, which usually dampens afferent pain impulses.

2.6.4.2 Orthotics

Shoe orthotic devices are also employed in the treatment of patellofemoral pain syndrome (Davidson 1993, Scaringe 1994, and Zappala 1992). This approach has minimal support in the literature and has been only occasionally successful in their experience (Tria et al. 1992).

2.6.4.3 Taping
Taping techniques are another attempt to force the patella to track medially and to decrease pain. Skin compromise and allergic reaction must both be considered (Tria et al. 1992).

Shelton (1992) advises the use of the McConnel taping technique to correct faulty patellar postures. This approach involves the use of various tests, which were found to lack reliability (Fitzgerald & McClure 1995).

According to Gilleard et al. (1998) abnormal VMO and VL activation occurs in PFPS patients. This phenomenon is thought to be a neurological mechanism and with patella taping there was earlier VMO activation during step-down tasks. The earlier VMO activation, which results from patella taping procedures, may improve patella tracking and alter the retropatellar force distribution on a structural level. However, the increased proprioceptive feedback may, neurologically, improve the altered firing. Currently no controlled trial exists using the McConnell or any other taping technique to treat PFPS (Rowlands 1998).

2.6.5 Adjusting protocols.

2.6.5.1 Spinal adjusting.

It is accepted that many chiropractors advocate and make use of spinal manipulation therapy (SMT) when treating extremity conditions. Scaringe (1994) in the literature review prescribes adjusting between the third lumbar level and the first sacral level.

Chadwick (1987) points to the use of detection of "joint signs" from T8/9 to the lumbosacral junction. The author states no matter how minimal the spinal signs may appear to be, it is necessary to abolish these signs first, and assesses the effect, both on the spinal signs and the peripheral signs. Chadwick (1987) describes the need for quite
vigorous end-of-range pressure. The technique used appears analogous to the static and motion palpation and adjustment which chiropractors use.

Chadwick (1987) mentions that it is possible that treatment of the spinal sign will completely abolish both the spinal and the peripheral signs and symptoms.

In a single subject experiment consisting of four treatments of the lumbar spine and upper thoracics over two weeks with quadriceps strengthening, Dryburgh (1998) reported no low back pain and a marked decrease in disability in a patient with PFPS. However there were no objective outcome measures of pain or disability in this case report. It still remains unclear as to whether the exercise or the spinal manipulation was responsible for the improvements.

In a single case study Gelfound and DeVore (1998) manipulated the lumbar spine, hip and pelvic joints, including the symphysis pubis three times per week over three weeks on a patient with PFPS. A three-week wash out period, consisting of no treatment, was then followed by an identical three-week adjusting period combined with McConnell taping and rehabilitation procedure. Improvements were noted in both manipulation periods, but the second manipulation period produced more significant improvement. However, it is unclear as to whether the manipulation or the McConnell taping and rehabilitation protocol was solely responsible for the improvements. Although the authors felt that the significant improvements were due to the cumulative effect of manipulation over the two manipulation periods, this remains unclear. Manipulations were delivered to all mentioned joints and motion palpation was not used to isolate a lesion.
In a randomised controlled study by Suter et al. (1999) sacroiliac adjusting was shown to decrease quadriceps muscle inhibition in patients with anterior knee pain, significantly improving overall strength in lower limb muscle groups. The improvements were compared to a control group and the results appear to be very encouraging. However, whether the mechanism was neurological or biomechanical remains unclear.

In a randomised single blinded, placebo controlled study done on fifteen patients with lateral epicondylitis cervical manipulation produced hypoalgesia at the elbow as manifest by increased grip strength, improved neurodynamics and reduced pain over a 24 hour period (Vicenzino et al. 1996). This study supports the belief that spinal manipulation may be beneficial in treating extremity conditions. This also provides evidence that there may be a neurological link involved which may be affected through the use of spinal manipulative therapy.

The author is therefore of the opinion that adjusting the lumbar spine may restore aberrant neurological signals, and possibly correct the timing and firing of the VMO and VL muscle contractions. Adjustments may also increase overall lower limb muscle strength and by overcoming muscle inhibition, restore normal patella tracking. However, the benefit and extent of lumbar spine manipulations may or may not be enhanced by cumulative treatments.

2.6.5.2 Peripheral adjusting.

Scaringe (1994) advocates adjusting of the Ankle Mortise joint and many chiropractors use this approach. Adjusting improves lower limb mechanics by increasing dorsiflexion and decreases pronation and internal tibial rotation. These form part of the extrinsic causes of patellofemoral pain syndrome as outlined earlier by Scaringe (1994).
Wilson (1990) found in a prospective uncontrolled case study treated 47 patients with a specific knee manipulative procedure, that 43 patients were completely asymptomatic after 6 treatments. There were no valid or reliable outcome measures in this study.

2.6.6 Therapeutic exercise.

2.6.6.1 Exercises.

Therapeutic exercise for PFD (patellofemoral dysfunction) patients has taken on many forms from the very traditional to the very innovative. Most studies reported therapeutic exercise techniques for PFD have met with at least some measure of success. Currently, the trend is toward functionally orientated activities performed with good VMO control, as well as, maximising muscular and retinacula flexibility to improve patellofemoral tracking. Adjusting the mode and intensity of the therapeutic exercise program helps keep the intensity at a level tolerable to the patient (Shelton 1992.)

Boucher et al. (1992) found that isometric contractions at 90 degrees of knee extension may enhance not only the activity of the vastus medialis obliquus fibres relative to the vastus lateralis, but may also assist in retropatellar articular cartilage repair.

Retraining for sport is something that usually comes at the end of a rehabilitation programme (Chadwick 1987). Other authors echo this view but it is recognised that partial rather than complete rest is taken, i.e. activity modification, where fitness is maintained.

2.6.6.2 Aquatic therapy

Zappala et al. (1992) refers to the work done by McNeal, who found that patients using aquatic therapy for lower limb rehabilitation were able to return to normal activities sooner than patients using conventional methods. The advantages of the McNeal
(aquatic) technique include isolated exercises for strengthening and range of motion, ambulatory activities for re-education, proprioception, and initiation of weight bearing, and the ability to do complex movement patterns with decreased joint reactive forces.

2.6.6.3 Stretching.

Scaringe (1994) recommends stretching of abductors and hamstrings to facilitate quadriceps femoris activity, piriformis because of its importance in eccentric hip control during gait; iliotibial band and lateral retinaculum. The latter structures have been found to be closely associated with patellofemoral pain syndrome, namely 70% with iliotibial band tightness (Puniello 1993). Routinely testing for iliotibial band tightness may be useful in the diagnosis and treatment of PFPS.

2.6.7 Surgery.

Nonsurgical treatment is the cornerstone of dealing with patellofemoral pain syndrome. Every effort must be made to avoid surgery in a syndrome in which the cause of pain is so poorly understood (DeLee & Drez 1994: 1193.)

According to numerous authors patellofemoral joint surgery is fraught with adverse complications (Scaringe 1994, Davidson 1993, Shelton 1992). The lateral release technique is most often used in treating patellofemoral pain syndrome (DeLee & Drez 1994: 1194). Studies from 1974 to 1990 on the poor outcomes after surgery range between 3% and 24.5%, while those for poor outcomes vary between 9% and 74% (DeLee & Drez 1994:1197).

2.7 SUMMARY.
The condition of patellofemoral pain syndrome must first be differentiated from other conditions affecting the knee and once the diagnosis is confirmed, immediate conservative care implemented. Due to the high success rate of non-invasive techniques, conservative therapy remains the best treatment for patellofemoral pain syndrome. Conservative measures are varied and include medications, external support, therapeutic exercise, activity modification, physical modalities and adjusting.

The role of adjusting has not been fully examined in the literature and it is the view of this author that this aspect deserves attention and should be examined. In a randomised controlled study by Suter et al. (1999) sacroiliac adjusting was shown to decrease muscle inhibition in patients with anterior knee pain. In lateral epicondylitis patients, cervical manipulation produced hypoalgesia at the elbow as manifest by increased grip strength, improved neurodynamics and reduced pain over a 24 hour period (Vicenzino et al. 1996). The aforementioned trials produced results in a relatively short period of time, as present treatment and management plans may last up to six months. Spinal, specifically lumbar adjusting, may be the key to decreasing treatment time and therefore overall costs involved to both the patient and practitioner.
CHAPTER 3

3. MATERIALS AND METHODS.

3.1 Methodology.

3.1.1 The Sample.

The public was informed of the study via advertisements placed at local schools, secondary and tertiary campuses, churches, sports clubs and posters placed running events. Convenient sampling was implemented using the first 60 patients that met the requirements. The selected patients were then be randomly allocated into two groups as decided by each patient drawing a number from a hat containing numbers 1 to 60. Numbers 1 to 30 were placed into group 1 while numbers 31 to 60 were placed into group 2. Once one group had 30 patients the ensuing participants were admitted to the other group. If there were any drop outs from the full group (containing 30 patients), new participants were automatically admitted to this group. Participants in group 2 would receive combined patella mobilisation and spinal manipulative therapy, while those in group 1 would receive patella mobilization only.

3.1.2 Inclusion criteria.

For a diagnosis of PFPS to be made, patients must have presented with:

1) Localised pain originating from the peripatellar tissue or the patellofemoral joint, and

2) Pain must have been reproduced with at least two of the following:
   - Squatting
   - Stair climbing
- Kneeling
- Prolonged sitting
- Isometric quadriceps femoris contraction (Powers et al. 1996).

3.1.3 **Exclusion criteria.**

a) **General.**
- Age less than 10 years old, or greater than 65
- Pregnancy

b) **Knee.**
- A history of traumatic patella dislocation
- Any neurological involvement that would affect their gait
- Any knee surgery in the past two years
- Bursitis
- Plical syndrome
- Fat pad syndrome
- Ligament instability
- Internal derangement
- Patella tendonitis
- Systemic arthritides, if they have affected the knee (Powers et al. 1996).
- Any patient performing a quadratus femoris strengthening or rehabilitation program.

c) **Lumbar spine conditions.**
Disc herniation with increasing signs and symptoms of neurological deficit (Gatterman, 1990:142),

- Aortic aneurysms
- Lumbar spine tumours
- Lumbar spine infections
- Lumbar spine traumatic injuries
- Systemic arthritides, if they have affected the lumbar spine (Gatterman, 1990:58-63)

3.1.4 The Method.

Both groups had the procedure explained, using a covering letter (APPENDIX A).

Patients were not allowed any medication for their knees during the period of treatment. If a subject were taking medication for an unrelated disorder a pharmacist would have been consulted to exclude possible drug interaction.

Each patient selected for the study was required to complete an informed consent form (APPENDIX B). The selected patients underwent a general medical history (APPENDIX C), lower back (APPENDIX D) and knee regional (APPENDIX E) examinations. Radiographic examination was performed, only where indicated by the history and examination findings, to exclude pathology of either the lumbar spine or the knee. Views of the lumbar spine included anterior, lateral and anterior obliques, while those of the knee included anterior, lateral and sunrise.
Each patient was treated six times within a four-week period. Wilson (1990) found in a prospective uncontrolled case study treated 47 patellofemoral pain syndrome patients over two years with a specific knee manipulation, that 43 patients were completely asymptomatic after 6 treatments. If patients became asymptomatic prior to the eighth consultation, they would be required to return for all remaining treatments as a means of observation of results.

8 clinical experiments were done: pain threshold (ALG1), pain tolerance (ALG2), average least pain experienced (NRS1), average worst pain experienced (NRS2), average pain experienced (NRS3), pain quality (McGill), patellofemoral joint evaluation scale (PFJE) and a patient specific functional scale (PSFS). All were continuous variables except McGill, which was a categorical variable. For each clinical experiment, readings were taken 3 times, i.e. at the first, third and sixth consultations (beginning, middle and end). Parametric methods were used for continuous variables and non-parametric methods were used for categorical variables, as each group consisted of thirty patients.

3.2 Treatment protocols.

Patient’s in-group 1 will have their patella assessed for restricted movement in the following directions, medial to lateral, lateral to medial, superior to inferior and inferior to superior. Bergman et al. (1993:676-677) describes contacting the borders of the patella with the thumb, and using the thumb to apply stress in the various directions. The operator feels for a comparative loss of degree of movement as well as springing for quality of movement.
Patients will be seated with the knee extended while the patella is mobilised using a thumb-web contact and applying a stress in the direction of restricted movement as described by Bergman et al. (1993:686). In a personal interview Dr. J. Brantingham (1999), senior lecturer at Technikon Natal, recommended that repeated oscillatory mobilization of the patella should be followed by an adjustment repeated 3 times into the direction of restricted movement. This will constitute the entire treatment for members within group 1.

Patients in group 2, in addition to the above, received lumbar spinal adjustments between L1-L5. Spinal subluxations were detected using the technique described by Schafer and Faye (1990:213-216). Initially the seated patient is analysed by using a proximal phalanx contact on the spinous process and a wiggle motion is imparted to assess joint play. Normal joint play motion should be of a springy quality. An abnormal segment usually feels hard or blocked. The segment is then analysed further using motion palpation by contacting a) the zygapophyseal joint and stressing it into: extension, while extending the lumbar spine simultaneously; rotation, while the lumbar spine is rotated away from the contact point. Further analysis is performed by contacting: b) the spinous process: inferiorly and stressing it inferior to superior while stressing the lumbar spine into flexion; laterally and stressing it lateral to medial while laterally flexing the spine to the ipsilateral side relative to the contact.

The subluxations were reduced using a typical side posture chiropractic adjustment, viz. a low amplitude, high velocity thrust delivered at the point of restriction, into the direction of lost motion. The patient was positioned in a lateral recumbent posture.
with the lumbar fixation up and the doctor in a square stance facing the patient. The lower limb on the uninvolved side was kept straight as the involved side limb was flexed until resistance was felt. A pisiform contact was then taken up on the involved segment, i.e. either on the zygapophyseal joint or the spinous process, as the patient’s flexed knee was adducted. A fencer’s stance was initiated at this point to hold the adducted limb in position. The thrust was then delivered into the direction of lost motion, i.e. either into extension, rotation (contacting the facet joint), or into flexion (inferior aspect of the spinous process), or lateral flexion (lateral aspect of the spinous process) [Schafer and Faye 1990:222]. The levels and direction of restricted movement were recorded at every treatment.

3.3 Subjective Measurements.

Subjective measurements were taken on the first, third and sixth consultations, using the following scales:

i. A Short-Form McGill Pain Questionnaire (APPENDIX F)

The above questionnaire was developed to assess the patients sensory dimension of the pain experienced in limited time. It was derived from the McGill Long-form Questionnaire and contains 15 representative words (descriptors). These descriptors were selected based on the frequency of their use by patients. Each was ranked on an intensity scale of: 0 = none; 1 = mild; 2 = moderate; 3 = severe (Melzack 1987). This questionnaire is designed to assess the multi-dimensional nature of pain experienced by patients. It is a reliable, consistent and valid measuring tool (Melzack 1987).
ii. **The Numerical Pain Rating Scale 101 (APPENDIX G)**

The participants were required to indicate by means of a percentage the maximum and the minimum intensity of their pain experienced over the past few days, on the appropriate lines. This questionnaire aids in assessing the average pain intensity as perceived by the participant. In a study by Jensen et al. (1986:117), comparing six methods of evaluating pain intensity and assessed them according to five criteria, i.e.:

1. Ease of administration of scoring.
2. Relative rates or incorrect responding.
3. Sensitivity as defined by the statistical power.
4. The magnitude of the relationship between each scale; and
5. The linear combination of the pain indices.

Jensen et al. (1986:125) mentioned that the NRS-101 has an advantage over other measuring techniques because:

a) It is simple to administer and score
b) Oral and written responses may be utilised
c) Age does not affect the scale

Jensen et al. (1986:125) claim that the NRS-101 is the questionnaire of choice when assessing pain intensity in chronic pain patients at different points in their lives. The NRS was used to determine the average worst pain NRS1, average least pain NRS 2 and average pain NRS 3 as perceived by the patient.

iii. **The Patient Specific Functional Scale (PSFS), (APPENDIX H)**
According to Chatman et al. (1997) the results suggest that it is a time-efficient and appropriate tool when the goal the assessment of change in knee and low back dysfunction. The study by Chatman et al. (1997) showed that for knee dysfunction at the individual activity level a change in 3 or more PFPS points provides reliability at a 90% confidence interval, and that validity in terms of within-patient decision making exists.

iv. **The Patellofemoral Rating Scale, (APPENDIX I)**

Magee (1997:532) recommends this scale as an effective tool for measuring improvement in PFPS patients. Although there have been no studies on the reliability and/or validity of the PFPS, it has been used as an outcome measure by Karlsson et al. (1996) and by Shea and Fulkerson (1992). In both of these studies the scale has never been applied before the initiation of treatment and only applied after the post-operative period, i.e. after the treatment at the end of the study.

According to Shea and Fulkerson (1992), the PFPS is currently in place at the Department of Orthopaedic Surgery, Division of Sports Medicine, University of Connecticut School of Medicine, Farmington, Connecticut, U.S.A. Functional improvements are reported on a scale and scored out of 100, excellent results equal 90 - 100 points, good 80 - 89, fair 60 - 79, and poor <60 points. However, the patellofemoral rating scale has only been used as a long term follow-up in previous studies, therefore the value of results cannot be ascertained.

3.4 Objective Measurements.
Objective measurements were taken using two types of algometers, one to measure pain threshold while the other measures pain tolerance. Pain threshold was measured at the point where the pain was first perceived on application of the algometer pressure, whereas pain tolerance was measured at the point where the pain was perceived as being too much to bear. Fischer (1986) reported on the reliability and use of the algometer to quantify tenderness in hypersensitive spots. According to Fischer (1987) these hypersensitive spots, or areas of focal tenderness may be due to pain originating from ligaments, joint capsules, tendons and periosteum. Nussbaum and Downes (1998) reported that the algometer is a reliable tool for measuring day-to-day changes in delayed onset muscle soreness, especially when one examiner is used. The readings were recorded and used to obtain the objective data at the first, third and sixth consultations (APPENDIX J).

A reading was be taken before the first treatment had been delivered thereafter the readings would follow the treatment. Permanent ink was used to mark the point of pain and ensure that the same point is used to assess the pain threshold and pain tolerance on consequent visits.

3.5 The Data.

Demographics included the following information: average age of the two groups and the ratio of males to females in each group.

The data was collected at the first, third and sixth visits and was analysed, according to the principles laid out by Fisher et al. (1993: 315-319), using the SPSS statistical package and presented in the form of bar graphs and tables.
Decision rule:

The null hypothesis was rejected at the $\alpha = 0.05$ level of significance if $p < \alpha$, where $p$ was the observed significance level or probability value. Otherwise, the null hypothesis was accepted at the same level.

3.5.1 The use of parametric and non-parametric tests for statistical data analyses.

Continuous variables were analysed using parametric methods, while categorical variables were analysed using non-parametric methods regardless of the sample size per group.

3.5.1.1 Parametric tests: Comparison between groups 1 and 2 with respect to continuous variables.

a) The two-sample unpaired t-test was used to compare 2 independent groups with continuous variables. Levene's test was used to compare 2 population variances. The null hypothesis states that there was no significant difference between Groups 1 and 2 with respect to the variable of comparison at the $\alpha = 0.05$ level of significance. The alternative hypothesis states that there is a significant difference at the same level of significance.
b) The two-sample unpaired t-test for continuous variables was used to compare the difference of the means of the 2 independent groups. A 95% confidence interval for \( \mu_1 - \mu_2 \) gives lower and upper limits for the difference between 2 means or averages.

Results:
The 95% confidence interval was accepted because \( \mu_1 - \mu_2 = 0 \). This showed that the 2 means are equal at the \( \alpha = 5\% \) level of significance.

3.5.1.2 Non-parametric tests: Comparison between groups 1 and 2 with respect to categorical variables.

a) The Mann-Whitney U-test was used to compare Groups 1 and 2 with respect to each categorical variable. The null hypothesis states that there is no significant difference between Groups 1 and 2 with respect to the variable of comparison at the \( \alpha = 0.05 \) level of significance. The alternative hypothesis states that there is a significant difference at the same level of significance.

3.5.2 The use of parametric and non-parametric tests for statistical data analyses - group 1 analysis.

3.5.2.1 Parametric tests: Comparison between related samples within Group 1 with respect to continuous variables.
a) The two-sample paired t-test was used to compare results from related samples. In each test, the null hypothesis stated that there was no significant improvement between the 2 related samples being compared, at the $\alpha$ level of significance. The alternative hypothesis states that there was a significant difference between the 2 groups.

3.5.2.2 Non-parametric tests: Comparison between related samples within Group 1 with respect to categorical variables.

a) Wilcoxon's signed rank test was used to compare results from related samples. In each test, the null hypothesis states that there was no significant improvement between the 2 related samples being compared at the $\alpha$ level of significance. The alternative hypothesis states that there is a significant improvement.

3.5.3 The use of parametric and non-parametric tests for statistical data analyses - group 2 analysis.

3.5.3.1 Parametric tests: Comparison between related samples within Group 2 with respect to continuous variables.

a) The two-sample paired t-test was used to compare results from related samples. In each test, the null hypothesis stated that there was no significant improvement between the 2 related samples being compared, at the $\alpha$ level of significance. The alternative hypothesis states that there was a significant difference between the 2 groups.
3.5.3.2 Non-parametric tests: Comparison between related samples within Group 2 with respect to categorical variables.

a) Wilcoxon's signed rank test was used to compare results from related samples. In each test, the null hypothesis states that there was no significant improvement between the 2 related samples being compared at the $\alpha$ level of significance. The alternative hypothesis states that there is a significant improvement.
CHAPTER FOUR

4. THE RESULTS.

4.1 The sample size of study.

The sample size of the study was 30 patients per group. Purposive sampling was used to ensure subjects were selected that satisfied the study criteria. Group 1 consists of 30 patients who made up the first treatment group. Group 2 consists of the remaining 30 patients who made up the second treatment group.

4.2 Demographics.

The mean age for group 1 was 34.20 years old, for group 2 was 29.23 years old, and the entire sample was 31.72 years old.

![Figure 4.1 Average age distribution.](Image)

The age ranges for group 1 was 16 - 61 years old, for group 2 was 14 - 57 years old, and the entire sample was 14 - 61 years old.
Those with a history of knee trauma included for group 1 were 7 (23.3%), for group 2 were 12 (40%), and the entire sample were 19 (31.67%). The trauma was felt to be a contributing factor in the development or aggravation of the condition in some cases.

Those with a history of knee surgery included for group 1 were 2 (6.67%), for group 2 were 2 (6.67%), and the entire sample were 4 (6.667%). The knee surgery was more than two years prior to the onset of the study in all cases.

The following bar charts illustrate the sex distribution for each group as well as the entire sample.

The mobilization group (group 1) consisted of more males than females. This is not apparently representative of the population with PFPS, as the literature reports that more females are usually affected than males. The increased number of males may
have resulted in a distorted outcome, resulting from an increase in overuse syndromes and traumatically induced aetiology.

According to a review article by Davidson (1993), he believes that PFPS in females is due to, in addition to the aforementioned, the altered Q-angle. Therefore improvements made from the treatments given to this group (of increased males) may have had a sustained benefit due to the lack of perpetuating factors, i.e. the lack of an increased Q-angle in a predominantly male sample. The increased Q-angle in females would likely only give temporary relief as a result of the treatment. Yet the validity and reliability of the Q-angle remains in doubt and therefore may reflect a more normal population.

![Sex Distribution](image)

**Figure 4.3 Group 2 - Sex distribution.**

The combined mobilization and lumbar spine adjustments (group 2) consisted of more females than males. This is more representative of the population with PFPS and accurate results may be drawn from this group.
The entire sample consisted of more males than females. This is not representative of the population with PFPS, as more females are usually affected than males. The increased number of males may result in a distorted outcome, resulting from an increase in overuse syndromes and traumatically induced aetiology.

According to a review article by Davidson (1993), PFPS in females was due to, in addition to the aforementioned, the altered Q-angle. Therefore improvements made from the treatments given to group 1 may have had a sustained benefit due to the lack of perpetuating factors, i.e. the lack of an increased Q-angle in a predominantly male sample. The increased Q-angle in females would likely only give temporary relief as a result of the treatment.

However the above results may be more representative of the type of profile seen at a runner's clinic or a sports clinic. The results may be more applicable to the latter situation than to the classic PFPS profile.
4.3 Analysis of the data.

All the p-values were represented as two tailed, except where \( p < \alpha \). Here the results were converted to a one tailed value and \( \alpha < 0.025 \) was the level of significance to assess a significance.

4.3.1 Parametric tests: Comparison between groups 1 and 2 with respect to continuous variables.

4.3.1.1 The two-sample unpaired t-test was used to compare 2 independent groups with continuous variables.

Table 4.1 Inter-group analysis at the first treatment a comparison of variances for continuous variables.

<table>
<thead>
<tr>
<th>Test</th>
<th>Treatment Group 1 (Mobilization)</th>
<th>Treatment Group 2 (Mobilization and spinal adjustment)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>S.D.</td>
</tr>
<tr>
<td>ALG1</td>
<td>3.643</td>
<td>1.290</td>
</tr>
<tr>
<td>ALG2</td>
<td>4.967</td>
<td>1.54</td>
</tr>
<tr>
<td>NRS1</td>
<td>69.367</td>
<td>18.083</td>
</tr>
<tr>
<td>NRS2</td>
<td>16.733</td>
<td>18.359</td>
</tr>
<tr>
<td>NRS 3</td>
<td>43.567</td>
<td>14.564</td>
</tr>
<tr>
<td>PFJE</td>
<td>67.400</td>
<td>16.531</td>
</tr>
<tr>
<td>PSFS</td>
<td>4.112</td>
<td>1.537</td>
</tr>
</tbody>
</table>
The standard deviation (S.D.) were evenly distributed around the mean in all cases except the ALG 1, and NRS 2. The null hypothesis was accepted because $p > \alpha$, therefore the 2 variances were equal in all cases.

Table 4.2 Inter-group analysis at the third treatment a comparison of variances for continuous variables.

<table>
<thead>
<tr>
<th>Test</th>
<th>Treatment Group 1 (Mobilization)</th>
<th>Treatment Group 2 (Mobilization and spinal adjustment)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>S.D.</td>
</tr>
<tr>
<td>ALG1</td>
<td>4.323</td>
<td>1.607</td>
</tr>
<tr>
<td>ALG2</td>
<td>6.030</td>
<td>1.960</td>
</tr>
<tr>
<td>NRS1</td>
<td>47.267</td>
<td>27.634</td>
</tr>
<tr>
<td>NRS2</td>
<td>12.133</td>
<td>13.011</td>
</tr>
<tr>
<td>NRS3</td>
<td>30.867</td>
<td>19.492</td>
</tr>
<tr>
<td>PFJE</td>
<td>77.667</td>
<td>17.492</td>
</tr>
<tr>
<td>PSFS</td>
<td>5.411</td>
<td>1.883</td>
</tr>
</tbody>
</table>

The standard deviation (S.D.) were evenly distributed around the mean in all cases except the ALG 1, NRS 1, and NRS 2. The null hypothesis was accepted because $p > \alpha$, therefore the 2 variances were equal in all cases.
Table 4.3 Inter-group analysis at the sixth treatment a comparison of variances for continuous variables.

<table>
<thead>
<tr>
<th>Inter-group Analysis 6th visit a comparison of variances</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment Group 1 (Mobilization)</td>
</tr>
<tr>
<td>Test</td>
</tr>
<tr>
<td>ALG1</td>
</tr>
<tr>
<td>ALG2</td>
</tr>
<tr>
<td>NRS1</td>
</tr>
<tr>
<td>NRS2</td>
</tr>
<tr>
<td>NRS 3</td>
</tr>
<tr>
<td>PFJE</td>
</tr>
<tr>
<td>PSFS</td>
</tr>
</tbody>
</table>

The standard deviation (S.D.) were evenly distributed around the mean in all cases except the ALG1, NRS 1, and NRS 2. The null hypothesis was accepted because $p > \alpha$, therefore the 2 variances were equal.

The null hypothesis was rejected because $p = 0.0195$ where $\alpha = 0.025$, hence $p < \alpha$, therefore the 2 variances were unequal for the PSFS for the one tailed $p$-value.
4.3.1.2 The two-sample unpaired t-test for continuous variables was used to compare the difference of the means of the 2 independent groups.

Table 4.4 Inter-group analysis at the first treatment a comparison for the equality of means for continuous variables.

<table>
<thead>
<tr>
<th>Inter-group Analysis 1st visit for Equality of means</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment Group 1 (Mobilization)</td>
</tr>
<tr>
<td>Test</td>
</tr>
<tr>
<td>ALG1</td>
</tr>
<tr>
<td>ALG2</td>
</tr>
<tr>
<td>NRS1</td>
</tr>
<tr>
<td>NRS2</td>
</tr>
<tr>
<td>NRS 3</td>
</tr>
<tr>
<td>PFJE</td>
</tr>
<tr>
<td>PSFS</td>
</tr>
</tbody>
</table>

The standard deviation (S.D.) were evenly distributed around the mean in all cases except the ALG 1, NRS 1, and NRS 2. The 95% confidence interval was accepted because \( \mu_1 - \mu_2 = 0 \). This showed that the 2 means are equal at the \( \alpha = 5\% \) level of significance.
Table 4.5 Inter-group analysis at the third treatment a comparison for the equality of means for continuous variables.

<table>
<thead>
<tr>
<th>Test</th>
<th>Treatment Group 1 (Mobilization)</th>
<th>Treatment Group 2 (Mobilization and spinal adjustment)</th>
<th>P-Value</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>ALG1</td>
<td>Mean 4.323, S.D. 1.607, S.E. 0.293</td>
<td>Mean 4.387, S.D. 1.498, S.E. 0.274</td>
<td>0.875</td>
<td>4.378</td>
</tr>
<tr>
<td>ALG2</td>
<td>Mean 6.030, S.D. 1.960, S.E. 0.358</td>
<td>Mean 6.160, S.D. 1.655, S.E. 0.302</td>
<td>0.782</td>
<td>6.160</td>
</tr>
<tr>
<td>NRS1</td>
<td>Mean 47.267, S.D. 27.634, S.E. 5.045</td>
<td>Mean 54.633, S.D. 23.820, S.E. 4.349</td>
<td>0.273</td>
<td>5.273</td>
</tr>
<tr>
<td>NRS2</td>
<td>Mean 12.133, S.D. 13.011, S.E. 2.376</td>
<td>Mean 15.267, S.D. 17.156, S.E. 3.132</td>
<td>0.429</td>
<td>4.291</td>
</tr>
<tr>
<td>NRS 3</td>
<td>Mean 30.867, S.D. 19.492, S.E. 3.559</td>
<td>Mean 36.117, S.D. 14.882, S.E. 2.717</td>
<td>0.246</td>
<td>2.461</td>
</tr>
<tr>
<td>PFJE</td>
<td>Mean 77.667, S.D. 17.492, S.E. 3.194</td>
<td>Mean 75.700, S.D. 12.890, S.E. 2.353</td>
<td>0.622</td>
<td>6.221</td>
</tr>
<tr>
<td>PSFS</td>
<td>Mean 5.411, S.D. 1.883, S.E. 0.341</td>
<td>Mean 5.659, S.D. 1.559, S.E. 0.285</td>
<td>0.191</td>
<td>1.911</td>
</tr>
</tbody>
</table>

The standard deviation (S.D.) were evenly distributed around the mean in all cases except the ALG 1, NRS 1, and NRS 2. The 95% confidence interval was accepted because \( \mu_1 - \mu_2 = 0 \). This showed that the 2 means are equal at the \( \alpha = 5\% \) level of significance.
Table 4.6 Inter-group analysis at the sixth treatment a comparison for the equality of means for continuous variables.

<table>
<thead>
<tr>
<th>Test</th>
<th>Treatment Group 1 (Mobilization)</th>
<th>Treatment Group 2 (Mobilization and spinal adjustment)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>S.D.</td>
</tr>
<tr>
<td>ALG1</td>
<td>5.220</td>
<td>1.654</td>
</tr>
<tr>
<td>ALG2</td>
<td>7.100</td>
<td>2.152</td>
</tr>
<tr>
<td>NRS1</td>
<td>40.833</td>
<td>30.543</td>
</tr>
<tr>
<td>NRS2</td>
<td>11.233</td>
<td>18.110</td>
</tr>
<tr>
<td>NRS 3</td>
<td>25.700</td>
<td>20.213</td>
</tr>
<tr>
<td>PFJE</td>
<td>82.033</td>
<td>15.982</td>
</tr>
<tr>
<td>PSFS</td>
<td>6.385</td>
<td>2.508</td>
</tr>
</tbody>
</table>

The standard deviation (S.D.) were evenly distributed around the mean in all cases except the NRS 1, and NRS 2. The 95% confidence interval was accepted because $μ_1 - μ_2 = 0$. This showed that the 2 means are equal at the $α = 5\%$ level of significance.
4.3.2 Non-parametric tests: for inter-group analysis: Comparison between groups 1 and 2 with respect to categorical variables.

4.3.2.1 The Mann-Whitney U-test was used to compare Groups 1 and 2 with respect to each categorical variable.

Table 4.7 Inter-group analysis at the first treatment a comparison of means for categorical variables.

<table>
<thead>
<tr>
<th>Inter-group Analysis Treatment 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment Group 1 (Mobilization)</td>
</tr>
<tr>
<td>Test</td>
</tr>
<tr>
<td>McGill</td>
</tr>
</tbody>
</table>

The null hypothesis was accepted because $p > \alpha$. Therefore, there was no significant improvement between the two groups at treatment 1.
Table 4.8 Inter-group analysis at the third treatment a comparison of means for categorical variables.

<table>
<thead>
<tr>
<th>Test</th>
<th>Mean</th>
<th>P-Value</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>McGill</td>
<td>28.73</td>
<td>0.432</td>
<td>32.27</td>
</tr>
</tbody>
</table>

The null hypothesis was accepted because $p > \alpha$. Therefore, there was no significant improvement between the two groups at treatment 3.

Table 4.9 Inter-group analysis at the sixth treatment a comparison of means for categorical variables.

<table>
<thead>
<tr>
<th>Test</th>
<th>Mean</th>
<th>P-Value</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>McGill</td>
<td>32.35</td>
<td>0.409</td>
<td>28.65</td>
</tr>
</tbody>
</table>

The null hypothesis was accepted because $p > \alpha$. Therefore, there was no significant improvement between the two groups at treatment 6.
4.3.2 Non-parametric tests: for inter-group analysis: Comparison between groups 1 and 2 with respect to categorical variables.

4.3.2.1 The Mann-Whitney U-test was used to compare Groups 1 and 2 with respect to each categorical variable.

Table 4.7 Inter-group analysis at the first treatment a comparison of means for categorical variables.

<table>
<thead>
<tr>
<th>Test</th>
<th>Treatment Group 1 (Mobilization)</th>
<th>Treatment Group 2 (Mobilization and spinal adjustment)</th>
</tr>
</thead>
<tbody>
<tr>
<td>McGill</td>
<td>29.38</td>
<td>31.62</td>
</tr>
</tbody>
</table>

The null hypothesis was accepted because $p>\alpha$. Therefore, there was no significant improvement between the two groups at treatment 1.
Table 4.8 Inter-group analysis at the third treatment a comparison of means for categorical variables.

<table>
<thead>
<tr>
<th>Test</th>
<th>Mean</th>
<th>P- Value</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>McGill</td>
<td>28.73</td>
<td>0.432</td>
<td>32.27</td>
</tr>
</tbody>
</table>

The null hypothesis was accepted because $p > \alpha$. Therefore, there was no significant improvement between the two groups at treatment 3.

Table 4.9 Inter-group analysis at the sixth treatment a comparison of means for categorical variables.

<table>
<thead>
<tr>
<th>Test</th>
<th>Mean</th>
<th>P- Value</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>McGill</td>
<td>32.35</td>
<td>0.409</td>
<td>28.65</td>
</tr>
</tbody>
</table>

The null hypothesis was accepted because $p > \alpha$. Therefore, there was no significant improvement between the two groups at treatment 6.
4.3.3 Comparison between related samples within Group 1 with respect to continuous variables.

4.3.3.1 The two-sample paired t-test was used to compare results from related samples.

Table 4.10 Intra-group analysis between the first and the third treatments a comparison of variances for continuous variables.

<table>
<thead>
<tr>
<th>Treatment 1</th>
<th>Treatment 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test</td>
<td>Mean</td>
</tr>
<tr>
<td>ALG1</td>
<td>3.643</td>
</tr>
<tr>
<td>ALG2</td>
<td>4.967</td>
</tr>
<tr>
<td>NRS1</td>
<td>69.367</td>
</tr>
<tr>
<td>NRS2</td>
<td>16.733</td>
</tr>
<tr>
<td>NRS3</td>
<td>43.567</td>
</tr>
<tr>
<td>PFJE</td>
<td>67.400</td>
</tr>
<tr>
<td>PSFS</td>
<td>4.112</td>
</tr>
</tbody>
</table>

The null hypothesis was rejected because $p<\alpha$, except for NRS 2. The other groups therefore showed significant improvement between the 1st and the 3rd treatments at the $p<0.05$ level of significance.
The null hypothesis was rejected because \( p = 0.0185 \) where \( \alpha = 0.025 \), hence \( p < \alpha \), therefore the 2 variances were unequal for the ALG 1 for the one tailed \( p \)-value.

The null hypothesis was rejected because \( p = 0.00005 \) where \( \alpha = 0.025 \), hence \( p < \alpha \), therefore the 2 variances were unequal for the ALG 2 for the one tailed \( p \)-value.

The null hypothesis was rejected because \( p = 0.00005 \) where \( \alpha = 0.025 \), hence \( p < \alpha \), therefore the 2 variances were unequal for the NRS 1 for the one tailed \( p \)-value.

The null hypothesis was rejected because \( p = 0.002 \) where \( \alpha = 0.025 \), hence \( p < \alpha \), therefore the 2 variances were unequal for the NRS 3 for the one tailed \( p \)-value.

The null hypothesis was rejected because \( p = 0.0005 \) where \( \alpha = 0.025 \), hence \( p < \alpha \), therefore the 2 variances were unequal for the PFJE for the one tailed \( p \)-value.

The null hypothesis was rejected because \( p = 0.00005 \) where \( \alpha = 0.025 \), hence \( p < \alpha \), therefore the 2 variances were unequal for the PSFS for the one tailed \( p \)-value.
Table 4.11 Intra-group analysis between the first and the sixth treatments a

comparison of variances for continuous variables.

<table>
<thead>
<tr>
<th>Test</th>
<th>Treatment 1</th>
<th>Treatment 6</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>S.D.</td>
</tr>
<tr>
<td>ALGI</td>
<td>3.643</td>
<td>1.289</td>
</tr>
<tr>
<td>ALG2</td>
<td>4.967</td>
<td>1.654</td>
</tr>
<tr>
<td>NRS1</td>
<td>69.367</td>
<td>18.083</td>
</tr>
<tr>
<td>NRS2</td>
<td>16.733</td>
<td>18.358</td>
</tr>
<tr>
<td>NRS3</td>
<td>43.567</td>
<td>14.564</td>
</tr>
<tr>
<td>PFJE</td>
<td>67.400</td>
<td>16.531</td>
</tr>
<tr>
<td>PSFS</td>
<td>4.112</td>
<td>1.537</td>
</tr>
</tbody>
</table>

The null hypothesis was rejected because $p<\alpha$, except for NRS 2. The other groups therefore showed significant improvement between the 3rd and the 6th treatments at the $p<0.05$ level of significance.

The null hypothesis was rejected because $p = 0.00005$ where $\alpha = 0.025$, hence $p<\alpha$, therefore the 2 variances were unequal for the ALG 1 for the one tailed $p$-value.

The null hypothesis was rejected because $p = 0.00005$ where $\alpha = 0.025$, hence $p<\alpha$, therefore the 2 variances were unequal for the ALG 2 for the one tailed $p$-value.
The null hypothesis was rejected because $p = 0.00005$ where $\alpha = 0.025$, hence $p < \alpha$, therefore the 2 variances were unequal for the NRS 1 for the one tailed $p$-value.

The null hypothesis was rejected because $p = 0.00005$ where $\alpha = 0.025$, hence $p < \alpha$, therefore the 2 variances were unequal for the NRS 3 for the one tailed $p$-value.

The null hypothesis was rejected because $p = 0.00005$ where $\alpha = 0.025$, hence $p < \alpha$, therefore the 2 variances were unequal for the PFJE for the one tailed $p$-value.

The null hypothesis was rejected because $p = 0.00005$ where $\alpha = 0.025$, hence $p < \alpha$, therefore the 2 variances were unequal for the PSFS for the one tailed $p$-value.

Table 4.12 Intra-group analysis between the third and the sixth treatments a comparison of variances for continuous variables.

<table>
<thead>
<tr>
<th>Test</th>
<th>Treatment 3</th>
<th>Treatment 6</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>S.D.</td>
</tr>
<tr>
<td>ALG1</td>
<td>4.323</td>
<td>1.607</td>
</tr>
<tr>
<td>ALG2</td>
<td>6.030</td>
<td>1.960</td>
</tr>
<tr>
<td>NRS1</td>
<td>47.267</td>
<td>27.634</td>
</tr>
<tr>
<td>NRS2</td>
<td>12.133</td>
<td>13.011</td>
</tr>
<tr>
<td>NRS 3</td>
<td>30.867</td>
<td>19.492</td>
</tr>
<tr>
<td>PFJE</td>
<td>77.667</td>
<td>17.492</td>
</tr>
<tr>
<td>PSFS</td>
<td>5.412</td>
<td>1.883</td>
</tr>
</tbody>
</table>
The null hypothesis was rejected because $p<\alpha$, except for NRS 1, NRS 2 and NRS 3. The other groups therefore showed significant improvement between the 3rd and the 6th treatments at the $p<0.05$ level of significance.

The null hypothesis was rejected because $p = 0.002$ where $\alpha = 0.025$, hence $p<\alpha$, therefore the 2 variances were unequal for the ALG 1 for the one tailed $p$-value.

The null hypothesis was rejected because $p = 0.002$ where $\alpha = 0.025$, hence $p<\alpha$, therefore the 2 variances were unequal for the ALG 2 for the one tailed $p$-value.

The null hypothesis was rejected because $p = 0.00005$ where $\alpha = 0.025$, hence $p<\alpha$, therefore the 2 variances were unequal for the PSFS for the one tailed $p$-value.

4.3.4 Non-parametric tests: Comparison between related samples within Group 1 with respect to categorical variables.

4.3.4.1 Wilcoxon's signed rank test was used to compare results from related samples.

Table 4.13 Intra-group analysis between the first and the third treatments a comparison of means for categorical variables.

<table>
<thead>
<tr>
<th>Group 1: Patella Mobilisation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment 1</td>
</tr>
<tr>
<td>Test</td>
</tr>
<tr>
<td>McGill</td>
</tr>
</tbody>
</table>
Between treatment number 1 and 3, the null hypothesis was rejected because $p = 0.00005$ where $\alpha = 0.025$, indicating significant improvement between these consultations.

Table 4.14 Intra-group analysis between the first and the sixth treatments a comparison of means for categorical variables.

<table>
<thead>
<tr>
<th>Group1: Patella Mobilisation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment 1</td>
</tr>
<tr>
<td>Test</td>
</tr>
<tr>
<td>McGill</td>
</tr>
</tbody>
</table>

Between treatment number 1 and 6, the null hypothesis was rejected because $p = 0.00005$ where $\alpha = 0.025$, indicating significant improvement between these consultations.

Table 4.14 Intra-group analysis between the third and the sixth treatments a comparison of means for categorical variables.

<table>
<thead>
<tr>
<th>Group1: Patella Mobilisation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment 3</td>
</tr>
<tr>
<td>Test</td>
</tr>
<tr>
<td>McGill</td>
</tr>
</tbody>
</table>
Between treatment number 3 and 6, the null hypothesis was accepted because $p > \alpha$, indicating no significant improvement between these consultations.

4.3.5 **Parametric tests: Comparison between related samples within Group 2 with respect to continuous variables.**

4.3.5.1 The two-sample paired t-test was used to compare results from related samples.

**Table 4.16 Intra-group analysis between the first and the third treatments a comparison of variances for continuous variables.**

<table>
<thead>
<tr>
<th>Test</th>
<th>Treatment 1</th>
<th>Treatment 3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>S.D.</td>
</tr>
<tr>
<td>ALG1</td>
<td>3.633</td>
<td>1.285</td>
</tr>
<tr>
<td>ALG2</td>
<td>5.363</td>
<td>1.560</td>
</tr>
<tr>
<td>NRS1</td>
<td>73.633</td>
<td>14.545</td>
</tr>
<tr>
<td>NRS2</td>
<td>18.067</td>
<td>18.948</td>
</tr>
<tr>
<td>NRS 3</td>
<td>45.767</td>
<td>11.663</td>
</tr>
<tr>
<td>PFJE</td>
<td>67.233</td>
<td>13.708</td>
</tr>
<tr>
<td>PSFS</td>
<td>4.403</td>
<td>1.515</td>
</tr>
</tbody>
</table>

The standard deviation (S.D.) were evenly distributed around the mean in all cases except the ALG 1 and NRS 2. In the other tests the null hypothesis was rejected.
because $p<\alpha$ thus the tests showed the significant difference implicating a significant improvement.

The null hypothesis was rejected because $p = 0.004$ where $\alpha = 0.025$, hence $p<\alpha$, therefore the 2 variances were unequal for the ALG 1 for the one tailed $p$-value.

The null hypothesis was rejected because $p = 0.024$ where $\alpha = 0.025$, hence $p<\alpha$, therefore the 2 variances were unequal for the ALG 2 for the one tailed $p$-value.

The null hypothesis was rejected because $p = 0.0005$ where $\alpha = 0.025$, hence $p<\alpha$, therefore the 2 variances were unequal for the NRS 1 for the one tailed $p$-value.

The null hypothesis was rejected because $p = 0.0045$ where $\alpha = 0.025$, hence $p<\alpha$, therefore the 2 variances were unequal for the NRS 3 for the one tailed $p$-value.

The null hypothesis was rejected because $p = 0.0005$ where $\alpha = 0.025$, hence $p<\alpha$, therefore the 2 variances were unequal for the PFJE for the one tailed $p$-value.

The null hypothesis was rejected because $p = 0.00005$ where $\alpha = 0.025$, hence $p<\alpha$, therefore the 2 variances were unequal for the PSFS for the one tailed $p$-value.
Table 4.17 Intra-group analysis between the first and the sixth treatments a comparison of variances for continuous variables.

<table>
<thead>
<tr>
<th>Group2: Patella Mobilisation and Spinal Adjustment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment 1</td>
</tr>
<tr>
<td>Test</td>
</tr>
<tr>
<td>ALG1</td>
</tr>
<tr>
<td>ALG2</td>
</tr>
<tr>
<td>NRS1</td>
</tr>
<tr>
<td>NRS2</td>
</tr>
<tr>
<td>NRS 3</td>
</tr>
<tr>
<td>PFJE</td>
</tr>
<tr>
<td>PSFS</td>
</tr>
</tbody>
</table>

The standard deviation (S.D.) were evenly distributed around the mean in all cases except the ALG1, NRS 1, and NRS 2. In the other tests the null hypothesis was rejected because \( p < \alpha \) thus the tests showed the significant difference implicating a significant improvement.

The null hypothesis was rejected because \( p = 0.00005 \) where \( \alpha = 0.025 \), hence \( p < \alpha \), therefore the 2 variances were unequal for the ALG 1 for the one tailed \( p \)-value.

The null hypothesis was rejected because \( p = 0.00005 \) where \( \alpha = 0.025 \), hence \( p < \alpha \), therefore the 2 variances were unequal for the ALG 2 for the one tailed \( p \)-value.
The null hypothesis was rejected because $p = 0.00005$ where $\alpha = 0.025$, hence $p<\alpha$, therefore the 2 variances were unequal for the NRS 1 for the one tailed $p$-value.

The null hypothesis was rejected because $p = 0.00005$ where $\alpha = 0.025$, hence $p<\alpha$, therefore the 2 variances were unequal for the NRS 3 for the one tailed $p$-value.

The null hypothesis was rejected because $p = 0.00005$ where $\alpha = 0.025$, hence $p<\alpha$, therefore the 2 variances were unequal for the PFJE for the one tailed $p$-value.

The null hypothesis was rejected because $p = 0.00005$ where $\alpha = 0.025$, hence $p<\alpha$, therefore the 2 variances were unequal for the PSFS for the one tailed $p$-value.
Table 4.18 Intra-group analysis between the third and the sixth treatments a comparison of variances for continuous variables.

<table>
<thead>
<tr>
<th></th>
<th>Group2: Patella Mobilisation and Spinal Adjustment</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Treatment 3</td>
</tr>
<tr>
<td>Test</td>
<td>Mean</td>
</tr>
<tr>
<td>ALG1</td>
<td>4.387</td>
</tr>
<tr>
<td>ALG2</td>
<td>6.160</td>
</tr>
<tr>
<td>NRS1</td>
<td>54.633</td>
</tr>
<tr>
<td>NRS2</td>
<td>15.267</td>
</tr>
<tr>
<td>NRS 3</td>
<td>36.117</td>
</tr>
<tr>
<td>PFJE</td>
<td>75.700</td>
</tr>
<tr>
<td>PSFS</td>
<td>5.658</td>
</tr>
</tbody>
</table>

The standard deviation (S.D.) were evenly distributed around the mean in all cases except the ALG 1, NRS 1, NRS 2 and NRS 3. In the other tests the null hypothesis was rejected because \( p<\alpha \) thus the tests showed the significant difference implicating a significant improvement.

The null hypothesis was rejected because \( p = 0.006 \) where \( \alpha = 0.025 \), hence \( p<\alpha \), therefore the 2 variances were unequal for the ALG 1 for the one tailed \( p \)-value.

The null hypothesis was rejected because \( p = 0.00005 \) where \( \alpha = 0.025 \), hence \( p<\alpha \), therefore the 2 variances were unequal for the ALG 2 for the one tailed \( p \)-value.
The null hypothesis was rejected because $p = 0.0085$ where $\alpha = 0.025$, hence $p < \alpha$, therefore the 2 variances were unequal for the NRS 1 for the one tailed $p$-value.

The null hypothesis was rejected because $p = 0.0025$ where $\alpha = 0.025$, hence $p < \alpha$, therefore the 2 variances were unequal for the PFJE for the one tailed $p$-value.

The null hypothesis was rejected because $p = 0.00005$ where $\alpha = 0.025$, hence $p < \alpha$, therefore the 2 variances were unequal for the PSFS for the one tailed $p$-value.

4.3.6 Non-parametric tests: Comparison between related samples within Group 2 with respect to categorical variables.

4.3.6.1 Wilcoxon's signed rank test was used to compare results from related samples.

Table 4.19 Intra-group analysis between the first and the third treatments a comparison of means for categorical variables.

<table>
<thead>
<tr>
<th></th>
<th>Group 2: Patella Mobilisation and Spinal Adjustments</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Treatment 1</td>
</tr>
<tr>
<td>Test</td>
<td>Mean</td>
</tr>
<tr>
<td>McGill</td>
<td>15.48</td>
</tr>
</tbody>
</table>

Between treatment number 1 and 3, the null hypothesis was rejected because $p = 0.00005$ where $\alpha = 0.025$, hence $p < \alpha$, indicating significant improvement between these consultations.
Table 4.20 Intra-group analysis between the first and the sixth treatments a comparison of means for categorical variables.

<table>
<thead>
<tr>
<th>Group 2: Patella Mobilisation and Spinal Adjustments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment 1</td>
</tr>
<tr>
<td>Test</td>
</tr>
<tr>
<td>------</td>
</tr>
<tr>
<td>McGill</td>
</tr>
</tbody>
</table>

Between treatment number 1 and 6, the null hypothesis was rejected because $p = 0.00005$ where $\alpha = 0.025$, hence $p < \alpha$, indicating significant improvement between these consultations.

Table 4.21 Intra-group analysis between the third and the sixth treatments a comparison of means for categorical variables.

<table>
<thead>
<tr>
<th>Group 2: Patella Mobilisation and Spinal Adjustments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment 3</td>
</tr>
<tr>
<td>Test</td>
</tr>
<tr>
<td>------</td>
</tr>
<tr>
<td>McGill</td>
</tr>
</tbody>
</table>

Between treatment number 3 and 6, the null hypothesis was rejected because $p = 0.008$ where $\alpha = 0.025$, hence $p < \alpha$, indicating significant improvement between these consultations.
CHAPTER FIVE

5. THE DISCUSSION OF THE RESULTS.

5.1 Demographics.

Meyer et al. (1990) stated that PFPS was common in adolescents and young adults. The mean age for group 1 was 34.20 years old, for group 2 was 29.23 years old, and the entire sample was 31.72 years old (figure 4.1). The sample does not represent the normal PFPS population in terms of the age distribution, as the average age is far greater than that of adolescence.

According to Tria et al. (1992) patients are mostly between the ages of 10 to 20, with a predominance of teenage females. Both group 1 (figure 4.2) as well as the entire sample (figure 4.4) consisted of more males than females. These were not representative of the population with PFPS, in terms of gender distribution either, as more females were usually affected than males. However, group 2 consisted of more females than males (figure 4.3).

The sample therefore did, unfortunately, not resemble the affected population in terms of age and gender distribution. Hence, accurate conclusions may not be drawn from this study and applied to the patellofemoral population with a classic textbook presentation. However, PFPS was found in this distribution as a result of the patient's accessibility to transport and availability for treatment, these factors may have ruled many would be participants. PFPS may also be prevalent in other age groups as a
result of activities undertaken, for example runners, which would account for the difference in presentation.

5.2 THE OBJECTIVE MEASUREMENTS.

5.2.1 The algometer readings.

5.2.1.1 Pain threshold measurements (ALG 1).

This measurement indicated the level at which pain was first perceived when applying an algometer. The inter-group comparison revealed no significant difference between the two groups at the first, third and sixth visits (tables 4.1, 4.2, 4.3, respectively). The standard deviation did not vary greatly between the two groups at the various consultations, which indicated a degree of reliability. However, the intra-group evaluation revealed statistically significant improvements between the first and the third, the first and the sixth as well as the third and the sixth treatments in both group 1 (tables 4.10, 4.11, 4.12, respectively) and group 2 (tables 4.16, 4.17, 4.18, respectively).

5.2.1.2 Pain tolerance measurements (ALG 2).

This measurement indicated the level at which pain was perceived as being too much when applying an algometer. The inter-group comparison revealed no significant difference between the two groups at the first, third and sixth visits (tables 4.1, 4.2, 4.3, respectively). The standard deviation did not vary greatly between the two groups at the various consultations, which indicated a degree of reliability. However, the intra-group evaluation revealed statistically significant improvements between the first and the third, the first and the sixth as well as the third and the sixth treatments in
both group 1 (tables 4.10, 4.11, 4.12, respectively) and group 2 (tables 4.16, 4.17, 4.18, respectively).

5.3 THE SUBJECTIVE MEASUREMENTS

a) Continuous Variables

5.3.1 Numerical pain rating scale 101

5.3.1.1 Numerical pain rating scale 101 - worst pain experienced (NRS 1)

The test recorded the average worst pain perceived. The results indicated no significant differences in the inter-group analysis at the first, third and sixth visits (tables 4.1, 4.2, 4.3, respectively). However, the intra-group analysis revealed statistically significant improvements between the first and the third, the first and the sixth in both group 1 (tables 4.10, 4.11, respectively) and group 2 (tables 4.16, 4.17, respectively). The intra-group analysis revealed that between the third and the sixth treatments group 2 (table 4.18) showed statistically significant improvements, whereas group 1 (table 4.12) did not.

5.3.1.2 Numerical pain rating scale 101 - least pain experienced (NRS 2)

The test recorded the average least pain perceived. The results indicated no significant differences in the inter-group analysis at the first, third and sixth visits (tables 4.1, 4.2, 4.3, respectively). However, the intra-group analysis revealed no statistically significant improvements between the first and the third, the first and the sixth as well as the third and the sixth treatments in both group 1 (tables 4.10, 4.11, 4.12, respectively) and group 2 (tables 4.16, 4.17, 4.18, respectively).

5.3.1.3 Numerical pain rating scale 101 - average pain experienced (NRS 3)
The test recorded the average pain perceived. The results indicated no significant differences in the inter-group analysis at the first, third and sixth visits (tables 4.1, 4.2, 4.3 respectively). However, the intra-group analysis revealed statistically significant improvements between the first and the third, the first and the sixth in both group 1 (tables 4.10, 4.11, respectively) and group 2 (tables 4.16, 4.17, respectively). Between the third and the sixth treatments no statistically significant improvements were noted. Although the p value for group 2 ($p = 0.087$) [table 4.18] was significantly lower than group 1 [$p = 0.189$ table 4.10], indicating a clinically significant difference between the groups. This may provide further evidence for greater clinical improvements in the manipulation group, i.e. group 2.

5.4.1 *Patellofemoral pain joint evaluation scale (PFJE).*

The test was used to record the degree of disability or pain the subjects experienced.

The results indicated no significant differences in the inter-group analysis at the first, third and sixth visits (tables 4.1, 4.2, 4.3 respectively). Both groups improved from fair (60%-79%) to good (80%-89%), i.e., by about 15 points. The standard deviation did not vary greatly between the two groups at the various consultations, which indicated a degree of reliability. However, the intra-group analysis revealed statistically significant improvements between the first and the third, the first and the sixth as well as the third and the sixth treatments in both group 1 (tables 4.10, 4.11, 4.12 respectively) and group 2 (tables 4.16, 4.17, 4.18 respectively).

5.5.1 *Patient Specific Functional Scale (PSFS).*

The test was used to record the degree of disability or pain the subjects experienced for specific activities as reported by the patient. The results indicated no significant
improvement. This may indicate a slight improvement in the spinal manipulation

inter-group difference at visit one the manipulation group showed greater
improvements than the mobilization group by the sixth visit. The overall improvement
was slightly less than the three points required (viz., group 1 = 2.2; group 2 = 2.7
points), by Chatman et al. (1997), that were needed to indicate a 90% chance of
improvement. This may indicate a slight improvement in the spinal manipulation
group over the mobilization group. The intra-group analysis revealed statistically
significant improvements between the first and the third, the first and the sixth as well
as the third and the sixth treatments in both group 1 (tables 4.10, 4.11, 4.12,
respectively) and group 2 (tables 4.16, 4.17, 4.18, respectively).

b) Categorical Variables.

5.6 The Short-Form McGill Pain Questionnaire (McGill).

The test was used to ascertain pain quality. The results indicate no significant
differences in the inter-group analysis at the first, third and sixth visits (tables 4.7, 4.8,
4.9 respectively). However, the intra-group analysis revealed statistically significant
improvements between the first and the third, the first and the sixth in both group 1
(tables 4.13, 4.14, respectively) and group 2 (tables 4.19, 4.20, respectively). Between
the third and the sixth treatments group 2 (table 4.21) showed statistically significant
improvements, whereas group 1 (table 4.15) did not. This finding is consistent with
the finding of Gelfound and DeVore (1995) who proposed that improvements might
be cumulative after receiving spinal manipulative therapy. In other words the improvement may accrue after application of spinal manipulative therapy and be evident at a later stage.
CHAPTER SIX

6. CONCLUSIONS AND RECOMMENDATIONS.

6.1 Conclusions.

The two treatment groups improved significantly, however there were no significant differences in improvement between the two groups. The study failed to show that there was any overall statistically significant benefit to combining lumbar spinal manipulation to the mobilization treatment protocol when treating PFPS. In future studies it may be possible to note clinically significant improvements by determining a decreased muscle inhibition. I believe that such a decrease occurred in the spinal manipulation group but no tests were performed to assess such an improvement. Evidence of this may be found in the improved functional ability as reported in the patient specific functional scale (group 2 improved by 2.7 points compared to 2.2 points for group 1), as well as the lower pain quality reported in the McGill pain questionnaire. The slightly improved patient specific functional improvements may have been more clearly elucidated had a muscle inhibition test been performed.

6.2 Recommendations.

The author recommends the following for future studies:

- To improve the statistical significance of the study in terms of sample selection:
  1. The participants should be limited to the most common age and gender population group, i.e. adolescent females [Meyer et al. (1990)],
  2. Alternatively, the population needs to be limited to a specific activity, i.e. runners with PFPS. Therefore, the results may be applied to the PFPS population at large.
The study design may be improved by:

1. Regimented treatment application, i.e. two treatments in the first week with a third treatment in the following week so that bruising from the algometer application does not occur. This would enable a clearer understanding of how often treatments should be administered.

2. The inclusion of a long-term follow-up, i.e. about six weeks after the study to assess the benefit, if any, of lumbar spinal manipulation.

The use of more reliable objective outcome measures, for example:

1. An automated digital algometer so that pressure is applied at a constant rate of 1kg per centimetre squared per second.

2. The use, instead, of a cybex or a similar unit to measure the quadriceps muscle group strength to assess the effect, if any, of lumbar adjustments, on muscle inhibition.

The reliability of the data may be strengthened by:

1. The use of an unbiased colleague in the selection process according to the previously mentioned inclusion criteria in order to eliminate bias.

2. The recording of the subjective and objective data by blinded, unbiased colleague would increase the reliability of the data in order to eliminate bias.

3. Conducting the study with practising chiropractors and comparing the results. The manipulative procedure is a motor skill and as an undergraduate, with relatively little experience may not be as proficient as compared to someone with more experience.
The study was prone to the Hawthorne effect as the selection was based on adverts. Therefore only those with a high degree of interest and time to volunteer were able to participate in this study and no attempt was made to determine how their results would have differed from those patients recruited to participate from practices.

A total of eight outcomes were utilised in this study. This increases the risk of a type 2 error, finding a positive result by chance alone, or in this case, failing to find evidence of effectiveness when evidence exists. This could be overcome by selecting one or two measures to determine a positive result.
References


Dear Participant

Welcome to this research study. You have been selected to participate in a clinical trial comparing two treatment forms for your knee pain. The condition you have is known as patellofemoral pain syndrome. The condition is fairly common but very little research has been done in this field.

The aim of this study is to compare the effectiveness of two widely used treatment approaches in the management of patellofemoral pain syndrome.

There are two treatment groups, each consisting of 30 people and you will be allocated to a specific group. Members of both groups will receive recognized chiropractic treatments. Those participants in the same group will receive identical treatment.

The treatment will entail eight treatments spread over four weeks. Your full co-operation in this study will enable the chiropractic profession to design more cost-effective and less time consuming form of treatment.

During the study you will not be able to receive any other form of treatment (chiropractic or otherwise) and you are further asked to refrain from any new or unaccustomed activities.

Treatment is free of charge and will be performed under the supervision of a qualified chiropractor.

Thank you.

Sincerely yours,

Neil Stakes

6th year Chiropractic Resident
APPENDIX B

INFORMED CONSENT FORM

(To be completed in duplicate by patient/subject) Delete whichever is not applicable

TITLE OF THE RESEARCH PROJECT: To determine the effectiveness of combined spinal manipulation and patella mobilisation compared to patella mobilisation alone

NAME OF SUPERVISOR: Dr C. Myburgh

NAME OF RESEARCH STUDENT: Neil Stakes

DATE: ____________________

PLEASE CIRCLE THE APPROPRIATE ANSWER

1. Have you read the research information sheet? YES/NO

2. Have you had an opportunity to ask questions regarding this study? YES/NO

3. Have you received satisfactory answers to your questions? YES/NO

4. Have you had an opportunity to discuss this study? YES/NO

5. Have you received enough information about this study? YES/NO

6. Who have you spoken to? _______________________________________

7. Do you understand the implications of your involvement in this study? YES/NO

8. Do you understand that you are free to withdraw from this study?
   a) at any time
   b) without having to give a reason for withdrawing, and
   c) without affecting your future health care.

   YES/ NO

9. Do you agree to voluntarily participate in the study? YES/NO

PATIENT NAME: ___________________________ SIGNATURE: ___________________________

PARENT/GUARDIAN: ___________________________ SIGNATURE: ___________________________

WITNESS: ___________________________ SIGNATURE: ___________________________

RESEARCH STUDENT: ___________________________ SIGNATURE: ___________________________
# APPENDIX C

## TECHNIKON NATAL CHIROPRACTIC DAY CLINIC

### CASE HISTORY

<table>
<thead>
<tr>
<th>Patient:</th>
<th>Date:</th>
</tr>
</thead>
<tbody>
<tr>
<td>file #:</td>
<td>X-Ray#:</td>
</tr>
<tr>
<td>Age:</td>
<td>Sex:</td>
</tr>
<tr>
<td>Intern:</td>
<td>Occupation:</td>
</tr>
<tr>
<td></td>
<td>Signature:</td>
</tr>
</tbody>
</table>

### FOR CLINICIAN'S USE ONLY

<table>
<thead>
<tr>
<th>Initial visit clinician:</th>
<th>Signature:</th>
</tr>
</thead>
</table>

**Case History:**

**Examination:**
- Previous: |
- Current:  |

**X-Ray Studies:**
- Previous: |
- Current:  |

**Clinical Path. lab:**
- Previous: |
- Current:  |

**Case Status:**
- PTT: Conditional: |
- Signed Off: |
- Final Sign out: |

**Recommendations:**

---

**Intern's Case History**

1. **Source of History:**
2. **Chief Complaint: (patient's own words)**
3. **Present Illness:**
   - Location
   - Onset
   - Duration
   - Frequency
   - Pain (Character)
   - Progression
   - Aggravating Factors
   - Relieving Factors
   - Associated S & S
   - Previous Occurrences
   - Past Treatment and Outcome

4. **Other Complaints:**

5. **Past Medical History:**
   - General Health Status
   - Childhood Illnesses
   - Adult Illnesses
   - Psychiatric Illnesses
   - Accidents/Injuries
   - Surgery
   - Hospitalizations
6. Current health status and life-style:
   - Allergies
   - Immunizations
   - Screening Tests
   - Environmental Hazards (Home, School, Work)
   - Safety Measures (seat belts, condoms)
   - Exercise and Leisure
   - Sleep Patterns
   - Diet
   - Current Medication
   - Tobacco
   - Alcohol
   - Social Drugs

7. Immediate Family Medical History:
   - Age
   - Health
   - Cause of Death
   - DM
   - Heart Disease
   - TB
   - Stroke
   - Kidney Disease
   - CA
   - Arthritis
   - Anaemia
   - Headaches
   - Thyroid Disease
   - Epilepsy
   - Mental Illness
   - Alcoholism
   - Drug Addiction
   - Other
8. Psychosocial history:
   - Home Situation and daily life
   - Important experiences
   - Religious Beliefs

9. Review of Systems:
   - General
   - Skin
   - Head
   - Eyes
   - Ears
   - Nose/Sinuses
   - Mouth/Throat
   - Neck
   - Breasts
   - Respiratory
   - Cardiac
   - Gastro-intestinal
   - Urinary
   - Genital
   - Vascular
   - Musculoskeletal
   - Neurologic
   - Haematologic
   - Endocrine
   - Psychiatric
APPENDIX D

TECHNIKON NATAL CHIROPRACTIC DAY CLINIC
REGIONAL EXAMINATION - LUMBAR SPINE AND PELVIS.

PATIENT: ________________________________

FILE #: ___________________ DATE: _________________

INTERN/RESIDENT: ________________________________

SUPERVISING CLINICIAN: ________________________________

STANDING:

Posture
Minor's Sign
Skin
Scars
Discoloration
Muscle Tone
Bony & Soft Tissue Contours

Spinous Percussion
Schober's Test (6cm)
Treadmill
Body Type
Attitude

RANGE OF MOTION

Forward Flexion = 40-60° (15cm from floor)
Extension = 20-35°
L/R Rotation = 3-18°
L/R Lateral Flexion = 15-20°

SUPINE:

Skin
Hair
Nails
Palpate Abdomen/groin
Pulses (abdomen)

Observe abdomen
Fasciculations
Abdominal Reflexes
Pulses (extremities)
SLR
Bowstring
Plantar Reflex
Circumference (thigh, calf)
Leg Length:
  actual
  apparent
Sciatic Notch
Patrick FABERE
Gaenslen's Test
Gluteus Maximus Stretch
Hip Medial rotation
Psoas Test
Thomas' Test:
  hip joint
  Rectus Femoris

LATERAL RECUMBENT

S-I Compression
Ober's Test
Femoral Nerve stretch
Myotomes:
  QL
  Gluteus Medius

PRONE

Gluteal skyline
Skin rolling
Iliac crest compression
Facet joint challenge
S-I tenderness
Erichson's Test
Pheasant's Test
Myotome:
  Glut. Max
Active MF Trigger Pts:
  QL
  Glut. Med
  Glut. Min
  Glut. Max
  Piriformis
  Hamstrings
  TFL

NON ORGANIC SIGNS

Pin Point Pain
Axial Compression
Trunk Rotation
Burn's Bench Test
Flip Test
Hoover's Test
Ankle Dorsiflexion Test.

GAIT

Rhythm
On toes (standing)
On Heels (standing)
Half squat on one leg
### NEUROLOGICAL EXAMINATION

<table>
<thead>
<tr>
<th>DERMATOMES</th>
<th>MYOTOMES</th>
<th>REFLEXES</th>
</tr>
</thead>
<tbody>
<tr>
<td>L R</td>
<td>L R</td>
<td>L R</td>
</tr>
<tr>
<td>T12</td>
<td>Hip Flex</td>
<td>Pat.</td>
</tr>
<tr>
<td>L1</td>
<td>Hip int rot</td>
<td>Achil</td>
</tr>
<tr>
<td>L2</td>
<td>Hip ext rot</td>
<td>H/S</td>
</tr>
<tr>
<td>L3</td>
<td>Hip abd</td>
<td></td>
</tr>
<tr>
<td>L4</td>
<td>Hip add</td>
<td></td>
</tr>
<tr>
<td>L5</td>
<td>Knee flex</td>
<td></td>
</tr>
<tr>
<td>S1</td>
<td>Knee ext</td>
<td></td>
</tr>
<tr>
<td>S2</td>
<td>Dorsiflex</td>
<td></td>
</tr>
<tr>
<td>S3</td>
<td>Plantarflex</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Eversion</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ext.hal.long</td>
<td></td>
</tr>
</tbody>
</table>

Tripod  
Kemp's Test

### MOTION PALPATION and JOINT PLAY:

**LEFT:**  
Upper Thoracics:  
Lumbar Spine:  
Sacroiliac Joint:  

**RIGHT:**  
Upper Thoracics:  
Lumbar Spine:  
Sacroiliac Joint:  

**Basic Exam:** Hip  
Case History:  

**ROM:** Active:  
Passive:  
RIM:  
Orthopedic/Neuro/  
Vascular:  

**Observ/Palpation:**

**Basic Exam:** Thoracic Spine  
Case History:  

**ROM:** Motion Palp:  
Active:  
Passive:  
Orthopedic/Neuro/  
Vascular:  

**Observ/Palpation:**

3 of 3
**Knee regional examination**

- **Patient:** [Name]  
  - **File #:** [File Number]  
  - **Date:** [Date]

- **Intern:** [Name]  
  - **Signature:** [Signature]

- **Clinician:** [Name]  
  - **Signature:** [Signature]

**Observation (Standing, Seated and during gait cycle).**

<table>
<thead>
<tr>
<th>Observation</th>
<th>Standing</th>
<th>Seated</th>
<th>Gait Cycle</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Anterior view.</td>
<td>[Details]</td>
<td>[Details]</td>
<td>[Details]</td>
</tr>
<tr>
<td>B. Lateral view</td>
<td>[Details]</td>
<td>[Details]</td>
<td>[Details]</td>
</tr>
<tr>
<td>Genu Varum:</td>
<td>[Details]</td>
<td>[Details]</td>
<td>[Details]</td>
</tr>
<tr>
<td>Genu Recurvatum:</td>
<td>[Details]</td>
<td>[Details]</td>
<td>[Details]</td>
</tr>
<tr>
<td>Genu Valgum:</td>
<td>[Details]</td>
<td>[Details]</td>
<td>[Details]</td>
</tr>
<tr>
<td>Patella Alta:</td>
<td>[Details]</td>
<td>[Details]</td>
<td>[Details]</td>
</tr>
<tr>
<td>Patellar position:</td>
<td>[Details]</td>
<td>[Details]</td>
<td>[Details]</td>
</tr>
<tr>
<td>Patella Baja:</td>
<td>[Details]</td>
<td>[Details]</td>
<td>[Details]</td>
</tr>
<tr>
<td>Tibial Torsion:</td>
<td>[Details]</td>
<td>[Details]</td>
<td>[Details]</td>
</tr>
<tr>
<td>Skin:</td>
<td>[Details]</td>
<td>[Details]</td>
<td>[Details]</td>
</tr>
<tr>
<td>Swelling:</td>
<td>[Details]</td>
<td>[Details]</td>
<td>[Details]</td>
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<table>
<thead>
<tr>
<th>Observation</th>
<th>Standing</th>
<th>Seated</th>
<th>Gait Cycle</th>
</tr>
</thead>
<tbody>
<tr>
<td>C. Posterior view.</td>
<td>[Details]</td>
<td>[Details]</td>
<td>[Details]</td>
</tr>
<tr>
<td>Swelling:</td>
<td>[Details]</td>
<td>[Details]</td>
<td>[Details]</td>
</tr>
<tr>
<td>Skin:</td>
<td>[Details]</td>
<td>[Details]</td>
<td>[Details]</td>
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</table>

**Active movements:**

<table>
<thead>
<tr>
<th>Movement</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>Flexion (0 - 135°)</td>
<td>Tissue approx</td>
</tr>
<tr>
<td>Extension (0 - 15°)</td>
<td>Bone-bone</td>
</tr>
<tr>
<td>Medial Rotation (20 - 30°)</td>
<td>Tissue stretch</td>
</tr>
<tr>
<td>Lateral rotation (30 - 40°)</td>
<td>Tissue stretch</td>
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**Passive movements:**

<table>
<thead>
<tr>
<th>Movement</th>
<th>Description</th>
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**Resisted isometric movements:**

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<th>Movement</th>
<th>Description</th>
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<tr>
<td>Knee: Flexion:</td>
<td>Ankle: Plantarflexion</td>
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<tr>
<td>Extension:</td>
<td>Dorsiflexion</td>
</tr>
<tr>
<td>Internal rotation:</td>
<td>[Details]</td>
</tr>
<tr>
<td>External rotation:</td>
<td>[Details]</td>
</tr>
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</table>

**Ligamentous assessment:**

<table>
<thead>
<tr>
<th>Instability</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>One-Plane Medial Instability:</td>
<td>One-Plane Lateral Instability:</td>
</tr>
<tr>
<td>Valgus stress (abduction)</td>
<td>Varus stress (adduction)</td>
</tr>
<tr>
<td>- Extended</td>
<td>- Extended</td>
</tr>
<tr>
<td>- Resting Position</td>
<td>- Resting Position</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Instability</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>One-Plane Anterior Instability</td>
<td>One-Plane Posterior Instability</td>
</tr>
<tr>
<td>Lachman Test (0-30°)</td>
<td>Posterior &quot;sag&quot; Sign</td>
</tr>
<tr>
<td>Anterior Drawer Sign</td>
<td>Posterior Drawer Test</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Instability</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anterolateral Rotatory Instability</td>
<td>Anteromedial Rotatory Instability</td>
</tr>
<tr>
<td>Slocum Test</td>
<td>Slocum Test</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Instability</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Macintosh Test</td>
<td></td>
</tr>
</tbody>
</table>
Tests for meniscus injury:
- McMurray
- "Bounce Home"
- Anderson med-lat grind
- Apley’s

Tests for swelling:
- Brush/Stroke Test
- Patellar Tap Test

Tests for patella femoral pain syndrome:
- Clarke’s Sign
- Passive patella tilt test
- Waldron test

Other tests:
- Wilson’s
- Quadriceps Contusion Test
- Fairbank’s
- Leg Length Discrepancy
- Noble Compression

Joint play:
- P-A movement of the tibia on the femur
- A-p movement of the tibia on the femur
- Medial translation of the tibia on the femur
- Lateral translation of the tibia on the femur
- Inf, sup, lat, + med glide of the patella
- A-P movement of the inf. tibiofibular joint
- A-P movement of the sup. tibiofibular joint
- Inf-sup movement of the sup tibiofibular joint
- Long axis distraction of the tibiofemoral joint

Palpation:
- Tenderness
- Swelling
- Joint line pain
- Nodules/exostoses

Reflexes and cutaneous distribution:
- Patellar Reflex (L3,L4) R____L____
- Medial Hamstring Reflex (L5,S1) R____L____

Dermatomes
- L2 R____L____ S1 R____L____
- L3 R____L____ S2 R____L____
- L4 R____L____ S3 R____L____
- L5 R____L____
APPENDIX F

THE SHORT-FORM McGILL PAIN QUESTIONNAIRE

Patient Name: ________________________________

File number: ____________________ Date: ________________

<table>
<thead>
<tr>
<th>Serves</th>
<th>None</th>
<th>Mild</th>
<th>Moderate</th>
<th>Severe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Throbbing</td>
<td>0)</td>
<td>1)</td>
<td>2)</td>
<td>3)</td>
</tr>
<tr>
<td>Shooting</td>
<td>0)</td>
<td>1)</td>
<td>2)</td>
<td>3)</td>
</tr>
<tr>
<td>Stabbing</td>
<td>0)</td>
<td>1)</td>
<td>2)</td>
<td>3)</td>
</tr>
<tr>
<td>Sharp</td>
<td>0)</td>
<td>1)</td>
<td>2)</td>
<td>3)</td>
</tr>
<tr>
<td>Cramping</td>
<td>0)</td>
<td>1)</td>
<td>2)</td>
<td>3)</td>
</tr>
<tr>
<td>Gnawing</td>
<td>0)</td>
<td>1)</td>
<td>2)</td>
<td>3)</td>
</tr>
<tr>
<td>Hot-burning</td>
<td>0)</td>
<td>1)</td>
<td>2)</td>
<td>3)</td>
</tr>
<tr>
<td>Aching</td>
<td>0)</td>
<td>1)</td>
<td>2)</td>
<td>3)</td>
</tr>
<tr>
<td>Heavy</td>
<td>0)</td>
<td>1)</td>
<td>2)</td>
<td>3)</td>
</tr>
<tr>
<td>Tender</td>
<td>0)</td>
<td>1)</td>
<td>2)</td>
<td>3)</td>
</tr>
<tr>
<td>Splitting</td>
<td>0)</td>
<td>1)</td>
<td>2)</td>
<td>3)</td>
</tr>
<tr>
<td>Exhausting</td>
<td>0)</td>
<td>1)</td>
<td>2)</td>
<td>3)</td>
</tr>
<tr>
<td>Sickenig</td>
<td>0)</td>
<td>1)</td>
<td>2)</td>
<td>3)</td>
</tr>
<tr>
<td>Fearful</td>
<td>0)</td>
<td>1)</td>
<td>2)</td>
<td>3)</td>
</tr>
<tr>
<td>Punishing-cruel</td>
<td>0)</td>
<td>1)</td>
<td>2)</td>
<td>3)</td>
</tr>
</tbody>
</table>
APPENDIX G

NUMERICAL PAIN RATING SCALE 101

PATIENT NAME: _________________________  FILE NO.: __________
DATE: _________________________  TREATMENT NO.: _______

Please indicate on the line below the number between 0 and 100 that best describes the pain of your major problem at this point, when it is at its WORST. A zero (0) would mean "no pain at all" and one hundred (100) would mean "pain as bad as it could be".

Please write only one number.

0 _____________________________________ 100

Please indicate on the line below the number between 0 and 100 that best describes the pain of your major problem at this point, when it is at its LEAST. A zero (0) would mean "no pain at all" and one hundred (100) would mean "pain as bad as it could be".

Please write only one number.

0 _____________________________________ 100
APPENDIX H

CLINICIAN TO READ AND FILL IN BELOW: Complete at the end of the history and prior to physical examination.

Initial assessment:

I am going to ask you to identify up to three important activities that you are unable to do or are having difficulty with as a result of your \_\_\_\_ problem. Today, are there any activities that you are unable to do or having difficulty with because of your \_\_\_\_ problem? (Clinician: show scale to patient and have the patient rate each activity.)

Follow-up assessments:

When I assessed you on (state previous assessment date), you told me that you had difficulty with (read all activities from list at a time). Today, do you still have difficulty with: (read and have patient score each item in the list)?

PATIENT-SPECIFIC ACTIVITY SCORING SCHEME (Point to one number):

<table>
<thead>
<tr>
<th></th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Unable to perform activity.</td>
<td>Able to perform activity at same level as before injury or problem.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(Date and Score)

Activity | Initial
---|---
1
2
3
4
5
Additional
Additional
# APPENDIX I

## Patello-femoral joint evaluation scale

Please indicate the appropriate finding with a tick.

<table>
<thead>
<tr>
<th></th>
<th>None</th>
<th>Slight/episodic</th>
<th>Severe</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Limp</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Assistive devices</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>None</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cane or brace</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Unable to bear weight</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Stair climbing</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>No problem</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Slight impairment</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Very slowly</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>One step at a time, always same leg first</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Unable</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Crepitation</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>None</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Annoying</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Limits activities</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Severe</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Instability, &quot;giving way&quot;</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Never</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Occasionally with vigorous activities</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Frequently with vigorous activities</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Occasionally with daily activities</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Frequently with daily activities</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Every day</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Swelling</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>None</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>After vigorous activities only</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>After walking or mild activities</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Constant</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Pain</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>None</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Occasionally with vigorous activities</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Marked with vigorous activities</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Marked after walking 1 mile or mild or moderate rest pain</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Marked with walking &lt; 1 mile</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Constant and severe</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1 of 1
APPENDIX J

Patient name: ___________________  File #: ______

Age: _____  Male/ Female: ______

Group #: ___

<table>
<thead>
<tr>
<th>Reading</th>
<th>INITIAL VISIT</th>
<th>3&lt;sup&gt;rd&lt;/sup&gt; VISIT</th>
<th>6&lt;sup&gt;th&lt;/sup&gt; VISIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>ALG 1 (Pain threshold)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ALG 2 (Pain tolerance)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>