The Inter-examiner Reliability of Motion Palpation to Detect Joint Dysfunction in Hindfoot and Midfoot Joints.

By

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I, Lisa Jane Williams, do declare that this dissertation is representative of my own work in both conception and execution.

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DEDICATION

To my parents and my fiancé, thank you.

Your continuous love and support has made me who I am today.

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ABSTRACT

The aim of this study was to determine the inter-examiner reliability of motion palpation to detect joint dysfunction in hindfoot and midfoot joints of asymptomatic feet and feet with chronic ankle instability syndrome. The rationale for this study was that motion palpation is a commonly used assessment tool that is used by the chiropractic profession to detect the need for manipulation of the spine and extremities. Also until the reliability of motion palpation is known, other studies using motion palpation as an assessment tool to detect the need for manipulation in the hindfoot and midfoot are questionable.

The study was conducted at Durban University of Technology (DUT). Patients that responded to the adverts were then screened via telephonic interview. The researcher performed a case history, physical examination and a foot and ankle regional examination on each patient. Three masters chiropractic students then independently assessed both the symptomatic and asymptomatic feet of each patient and recorded their results. The data was then statistically analysed using SPSS version 15.

It was found that the inter-examiner reliability of motion palpation for detecting restrictions in feet with chronic ankle instability syndrome was fair and for detecting instability, there was moderate reliability. In the asymptomatic group the examiners showed to have poor reliability in detecting restrictions and moderate reliability in detecting instability. Inter-examiner reliability was better in the symptomatic group and in this group examiners had more agreement on detecting instability as opposed to restrictions.

This study has showed that inter-examiner reliability ranged from poor to moderate in the symptomatic and asymptomatic group with the reliability ranging from poor to moderate. Therefore, one can conclude that motion palpation can be used as an assessment tool to detect joint dysfunction in hindfoot and midfoot joints. However, further studies are warranted to address other subjective and objective measurements such as tenderness and range of motion together with motion palpation.

Key terms:
Motion palpation, Chronic ankle instability syndrome, Inter-examiner reliability.

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DEFINITION OF TERMS

Palpation

"The act of feeling with your hands. The application of variable manual pressure through the surface of the body for the purpose of determining the shape, size consistency, position, inherent motility and health of the tissues beneath." (Bergmann, Peterson and Lawrence, 1993:762)

Motion Palpation

"Palpatory diagnosis of passive and active segmental joint range of motion." (Bergmann, Peterson and Lawrence, 1993:762)

End Feel

"Discrete, short range movements of a joint independent of the action of voluntary muscles, determined by springing each vertebrae at the limit of its passive range of motion." (Bergmann, Peterson and Lawrence, 1993:757)

Joint Play

"Discrete, short range movements of a joint independent of the action of voluntary muscles, determined by springing each vertebrae in the neutral position." (Bergmann, Peterson and Lawrence, 1993:759)

Joint Dysfunction

"Joint mechanics showing area disturbances of function without structural change. Subtle joint dysfunction affecting quality and range of joint movement. They are diagnosed with the aid of motion palpation, and stress and motion radiography investigation." (Bergmann, Peterson and Lawrence, 1993:759)

Inter-examiner Reliability

The degree to which the results between examiners correspond, when using the same procedure and patient. It shows how much homogeneity there is between examiners results and is useful to evaluate specific diagnostic procedures, such as motion palpation (Bergmann, Peterson and Lawrence, 1993)

Restriction/Fixation/Hypomobility

“**Fixation**: The state whereby an articulation has become temporarily immobilized in a position which it may normally occupy during any phase of physiologic movement. The immobilization of an articulation in a position of movement when the joint is at rest, or in a position of movement when the joint is at rest, or in a position of rest when the joint is in movement.” (Bergmann, Peterson and Lawrence, 1993:758)

“Restriction: Limitation of movement. Describes the direction of limited movement in subluxated and /or dysfunctional joints.” (Bergmann, Peterson and Lawrence, 1993:764)

Instability

“Quality or condition of being unstable; not firm, fixed or constant.” (Bergmann, Peterson and Lawrence, 1993:759)

CHAPTER ONE

1.1 INTRODUCTION

Motion palpation (MP) is important in the diagnosis, manipulative treatment and prognosis of musculoskeletal disorders (Beal, 1989). It is a method used to assess the status of a joint by assessing the quality of movement between articular structures (Bergmann, Peterson and Lawrence, 1993) to determine if a joint has normal range of movement (Ames, 1987). This assessment tool is used by chiropractors and other disciplines such as osteopathy (Beal, 1989) and physiotherapy (Keating, Matyas and Bach, 1993). A survey carried out in Australia on the most commonly used methods to detect joint dysfunction in the spine, showed that chiropractors regarded motion palpation as the most reliable method to detect joint dysfunction (Walker, 1998). Because motion palpation is highly regarded as an effective assessment tool (Beal, 1989), it is important to determine its reliability in assessing common clinical conditions.

Huijbregts (2002) and Hestbaek and Leboeuf-Yde (2000) stated that inter-examiner reliability studies on MP have primarily concentrated on the spine and that research in this context has shown that spinal MP has inadequate levels of reliability. They also suggest that there have been methodological flaws in the research design of inter-examiner reliability studies performed on the spine, and therefore one cannot categorically state that motion palpation of the spine is not reliable. Because there have been numerous inter-examiner reliability studies on MP of the spine (Stochkendahl, Christensen, Hartvigsen, Vach, Haas, Hestbaek, Adams and Bronfort, 2006), and few performed on extremities, this dissertation aims to investigate the inter-examiner reliability of motion palpation to detect joint dysfunction in hindfoot and midfoot joints.

Inter-examiner reliability of motion palpation to detect joint dysfunction in the hindfoot and midfoot joints has not been investigated. Chronic ankle instability syndrome (CAIS) is a common condition that occurs in 10% to 20% of people following an acute ankle sprain (de Vries, Krips, Sierevelt, Blankevoort and van Dijk, 2006). Numerous studies have highlighted the presence of joint dysfunction (hypermobility or hypomobility) within the hindfoot (mortise, subtalar and distal tibiofibular joints) in patients with CAIS

(Meadows, 2002; Dananberg Shearstone and Guillano, 2000; Lewit, 1999; Kavanagh, 1999; O'Brien and Vicenzino, 1998; Hetherington, 1996; Greenman, 1996 and Mulligan, 1995). But, fewer studies have investigated the effect chronic ankle instability may have on the midfoot (talo-calcaneonavicular, cuneonavicular, intercuneiform, cuneicuboid, cuboideonavicular and calcaneocuboid joint). However, according to Schafer and Faye (1990) the lower leg, ankle and foot work as a unit, therefore this dissertation investigated both hindfoot and midfoot joints in patients with one asymptomatic (pain free and fully functional) and one foot with CAIS. By investigating a condition the sample was more homogenous and one could compare inter-examiner reliability between the symptomatic and asymptomatic groups.

To date there have been two inter-examiner reliability studies performed on the foot. In the one study, the reliability of the circumduction test to detect joint mobility was assessed in symptomatic and asymptomatic feet (Brantingham, Wood, Parkin-Smith, Van der Muelen and Weston, 2003). The inclusion criteria stated that each patient had to have an asymptomatic and symptomatic foot. Symptomatic was defined as unilateral, pain in the foot, ankle or lower leg. Two qualified chiropractors independently graded the mobility of the feet of 17 patients. This study showed to have substantial inter-examiner agreement between examiners because there was moderate reliability in symptomatic feet and excellent reliability when assessing asymptomatic feet (Brantingham, *et al*., 2003). This indicates that the levels of agreement of the circumduction motion palpation technique seems to rate higher than spinal motion palpation technique which had inadequate levels of reliability (Huijbregts, 2002 andHestbaek and Leboeuf-Yde, 2000). The other study assessed the inter-examiner reliability of palpation to detect tenderness in the foot and ankle. Their results were in keeping with previous studies that had evaluated the reliability of palpation for tenderness in the cervical and lumbar spine and was shown to be reliable (Brantingham, Hubka, Snyder, Diballa, Wilke and Biedebach, 1995).

No study has researched the reliability of motion palpation of the individual joints of the hinfoot and midfoot. Therefore, this study investigated motion palpation of the individual joints of both asymptomatic and symptomatic foot changes with CAIS.

1.2 AIMS/OBJECTIVES OF THIS STUDY

The aim of this study was to determine the inter-examiner reliability of motion palpation in the hindfoot and midfoot joints in asymptomatic feet and in feet with CAIS.

Objective 1: To determine the inter-examiner reliability of motion palpation of the hindfoot and midfoot joints in patients with chronic ankle instability syndrome.

Objective 2: To determine the inter-examiner reliability of motion palpation of the hindfoot and midfoot joints in asymptomatic feet.

Objective 3: To determine if motion palpation is reliable irrespective of Chronic ankle instability syndrome.

Objective 4: To determine the presence or absence of joint dysfunction in both groups and then compare findings between groups.

1.3 RATIONALE FOR THE STUDY

MP is an assessment tool that is commonly used by the chiropractic profession to detect the need for manipulation (Walker, 1998).

To date many inter-examiner reliability motion palpation studies have been conducted on the spine (Stochkendahl *et al*., 2006). But there is a lack of inter-examiner reliability studies of MP performed on the hindfoot and midfoot joints of asymptomatic and symptomatic feet.

1.4 BENEFITS OF THE STUDY

This study will help the chiropractic profession in expanding its knowledge on the reliability of motion palpation as an assessment tool. This could result in improved clinical assessment of patients.

1.5 LIMITATIONS

Studies have shown that clinical experience does not influence the reliability of manual examinations (Stochkendahl, *et al*., 2006). However, the reliability of students carrying out manual examinations is considered a limitation as they do not have the clinical experience of a qualified chiropractor. Yet, this study used students as the examiners due to time and practical constraints. However, every attempt was made to overcome this limitation by virtue of using masters students who underwent seven specialized training sessions and have five years of teaching education, which includes many hours of clinical experience under the guidance of a qualified chiropractor.

1.6 CONCLUSION

While motion palpation is a commonly used assessment tool, there has been a lack of inter-examiner reliability studies performed to detect joint dysfunction in hindfoot and midfoot joints, of asymptomatic and chronic ankle instability syndrome feet. This, however, is in contrast to the increasing use of manipulation for the lower extremity (Brantingham, Globe, Pollard, Pollard, Hicks, Korporaal and Hoskins, 2009), which therefore necessitates that this modality be evaluated for its use in the lower extremity.

CHAPTER 2

2.1 INTRODUCTION

This chapter aims to discuss literature on motion palpation (MP), inter-examiner reliability studies on motion palpation and joint dysfunction associated with chronic ankle instability syndrome (CAIS) as well as the anatomy and biomechanics of the joints in the hindfoot and midfoot.

2.2 MOTION PALPATION

Palpation:

"*The application of variable manual pressure through the surface of the body for the purpose of determining the shape, size, consistency, position, inherent motility, and health of the tissues beneath*" (Bergmann, Peterson and Lawrence, 1993).

Motion Palpation:

"Palpatory diagnosis of passive and active segmental joint range of motion" (Bergmann, Peterson and Lawrence, 1993)

Motion palpation (MP) is the method used to assess the status of a joint by assessing the quality of movement between articular structures (Bergmann, Peterson and Lawrence, 1993). It can be used to determine whether the joint has a normal anatomical range of movement or if the movement is increased or decreased, (Ames 1987).

According to Bergmann, Peterson and Lawrence (1993), MP includes techniques to assess active, passive and accessory joint movements. They explain that passive joint movement is performed with the patient sitting or lying in a relaxed position as the examiner stabilizes and carries out particular voluntary (active physiological range of movement) movements. In contrast, during active movement the patient voluntarily moves the joint being examined without the help of the examiner, while the examiner palpates for the opening and closing movement between the joint surfaces. Accessory joint movement is an involuntary movement that is necessary for normal function of a joint. It is a small range of movement that is achieved by the examiner passively moving the joint (Magee, 2002). This movement includes the small give or play within a joint that can be assessed by motion palpatory procedures of joint play (the resistance felt in the neutral position) and end feel (the resistance felt at the end range of motion) (Schafer and Faye, 1990).

Joint Play

Bergmann, Peterson and Lawrence (1993) stated that when assessing joint play, one evaluates the joints resistance to movement when the joint is in a neutral position. They also suggested that joint play could be used in the evaluation of joint instability.

Joint play should be painless and is performed by the examiner placing the joint into its loose-packed position, contacting the relevant surfaces and inducing gentle springing movement (Bergmann, Peterson and Lawrence, 1993). These are small movements and are different in the spine and extremities (Bergmann, Peterson and Lawrence, 1993).

End-Feel

The examiner assesses end-feel by applying extra pressure to the joint at the end range of passive movement, at this point the examiner applies a gentle springing force (Bergmann, Peterson and Lawrence, 1993). In the assessment of joint function, end-feel is vital as a change of end-feel resistance suggests joint dysfunction (Bergmann, Peterson and Lawrence, 1993). End-feel is also important as it can assist the examiner in establish the type of pathology present and determine a prognosis for the condition (Magee, 2002).

Magee (2002) stated that there are five “abnormal” end-feels namely:

Muscle spasm

This occurs suddenly and is often accompanied by pain. The muscle spasm occurs as a result of the subconscious efforts of the body to protect the injured joint.

Capsular

A hard, firm springy end-feel, similar to the tissue stretch except the range of motion is reduced.

Bone-to-bone

This occurs where “normal” bone-to-bone movement is not expected. It has a similar end-feel except the range of motion is reduced.

Empty

This occurs when the movement is not possible due to extreme pain. There is no muscle spasm associated with this “abnormal” end-feel.

Springy block

Similar to normal tissue stretch however, it occurs where you would not expect it to occur. It is usually found in joints with menisci.

If there is an increase or decrease in joint play it is termed a joint dysfunction (Magee, 2002). Schafer and Faye (1990), describe joint dysfunction as the loss of one or more movements within the joints normal range of motion, it is associated with pain.

Joint Dysfunction

Clinical features of joint dysfunction include:

Pain over the area, the severity often changes with activity.
The local tissue may be hypersensitive
Altered alignment between the joint surfaces
Joint movement is decreased, increased or unusual
Change in normal joint play
End-feel resistance is altered
The local muscle feels rigid to palpation
(Bergmann, Peterson and Lawrence, 1993)

Motion palpation in this study was used to determine whether the hindfoot and midfoot joints assessed had normal anatomical range of motion. The examiners assessed each joint with passive joint movement and accessory joint movement.

2.2.1 History of Motion Palpation

Provided by Gillet, (1995):

Motion palpation was first introduced in 1906 by Smith, Gillet acknowledged his idea and went on to introduce MP to the world. However, it took fifty years for MP to gain access to the chiropractic profession. Since then it has become a component of the syllabus in most colleges as a required topic in chiropractic examination (Gillet, 1995).

The above article on the history of MP was based on spinal motion palpation. This is in keeping with an article by Nelson, Lawrence, Triano, Bronfort, Perle, Metz, Hegetschweiler and LaBrot, (2005) who suggested that the chiropractic profession has focussed primarily on spinal conditions, as these were thought to be the model for the future of the profession. This has led to a perception that the scope of chiropractic is limited to the management of spinal conditions (Stump and Redwood, 2002). However, according to Palmer (Brantingham and Snyder, 1992) a pioneer of the profession, chiropractic techniques exist for the management of extremity conditions. At most colleges chiropractors are trained to diagnose and treat neuromusculoskeletal conditions associated with both the extremities and the spine (Hoskins, McHardy, Pollard, Windsham and Onley, 2006). This means that the chiropractic graduate is qualified to manage clinical conditions of the extremities (Hoskins *et al*., 2006) and also qualified to carry out MP as an assessment tool.

2.2.2 Inter-examiner reliability of motion palpation

To date motion palpation research has been primarily based on reliability studies (Haas, Panzer, Peterson and Raphael, 1995). Research carried out by Stochkendahl *et al*., (2006) on reproducibility of manual techniques of the spine between 1980 and 2005 found that motion palpation of the spine was the most frequently investigated procedure. They indicated that even though motion palpation is a widely used procedure to diagnose joint dysfunction, previous literature shows poor levels of inter-examiner reliability. Poor reliability results in previous studies have led to motion palpation of the spine being questioned whether it should be used as a diagnostic tool. (Huijbregts, 2002 and Hestbaek, and Leboeuf-Yde, 2000).

Although the reliability of motion palpation in the spine has been investigated in depth, there is limited literature on the reliability of motion palpation of extremities. It is important to assess the reliability of MP in common extremity conditions such as CAIS. As the evaluation of the foot and ankle includes MP of the joints to determine the presence of joint dysfunction (Bergmann, Peterson and Lawrence, 1993). Also an overview of chiropractic practice in America conducted by Christensen and Kollasch (2005) showed that 95.4% of chiropractors manipulate extremities and that 46.8% of patients attending chiropractic practices undergo extremity manipulation. There is therefore a need for research studies on extremities to assess the reliability and validity of chiropractic assessment techniques such as MP (Hoskins, *et al*., 2006). Untill the reliability of MP is known, any research that uses MP as a tool to find the presence or absence of joint dysfunction will be subject to question (Bergmann, Peterson and Lawrence, 1993).

In the literature search for this dissertation, there were two inter-examiner reliability studies performed on the foot and ankle. Brantingham *et al*. (1995) investigated the inter-examiner reliability of palpation for foot and ankle joint tenderness. Their results indicated good inter-examiner reliability, which was in keeping with other studies that investigated the reliability of palpation for tenderness in the cervical and lumbar spine. However, Brantingham *et al*. (2003) investigated the reliability of the circumduction test to detect joint mobility in asymptomatic and symptomatic feet. Two qualified chiropractors independantly assessed seventeen patients that were experiencing pain in the foot, lower leg or ankle, and graded the mobility of the foot according to the grid provided by the researcher. Unlike the literature on spinal motion palpation, which showed to have poor inter-examiner reliability, Brantingham, *et al*., (2003) results showed that there was substantial inter-examiner reliability. Also, the inter-examiner reliability was higher in the asymptomatic group whereas Boline, Haas, Meyer, Kassek, Nelson and Keating (1993) study on the inter-examiner reliability of eight evaluative dimensions of lumbar segmental abnormality stated that previous palpatory studies have shown to have higher inter-examiner reliability in the symptomatic group.

Although the results of Brantingham *et al*., (2003) study suggest that inter-examiner reliability is higher when assessing extremities, there have not been enough studies performed to support this finding. This dissertation will therefore be assessing the inter-examiner reliability of motion palpation to assess for specific joint dysfunction in the hindfoot and midfoot to determine if the results concur with Brantingham *et al*., (2003) study. But, the sample will include symptomatic as well as asymptomatic feet to see if the inter-examiner reliability was the same for both groups. For the purpose of this study CAIS was the condition chosen to represent the symptomatic feet.

2.3 ANATOMY AND BIOMECHANICS OF THE HINDFOOT AND MIDFOOT

2.3.1 Introduction

Motion palpation of the foot and ankle requires a thorough understanding of its anatomy and biomechanics of the foot and ankle. Each joint has a normal range of movement that is determined by the orientation of the joint and surrounding structures (Magee, 2002). Without an understanding of these features the examiner will not have accurate motion palpation findings. The following section will explain the movements, function and related structures of each joint in the midfoot and hindfoot that was examined in this study.

2.3.2 The Hindfoot

The hindfoot comprises of the tibiofibular, mortise and subtalar joint each with their own planes of movement (Magee, 2002).

2.3.2.1 The Mortise Joint

The mortise joint, also known as the ankle, tibiotalar or talocrural joint is a hinge type of synovial joint that allows motions of plantarflexion and dorsiflexion (Moore and Dalley, 1999). It is formed by the articulation of the talar dome with the distal ends of the fibula and tibia (Hertel, 2002). The function of the shape of this joint is to allow transmission of torque from the lower leg to the foot during weight bearing (Hertel, 2002).

The stability of the tibiotalar joint depends on the following three factors;

- Joint congruency (Hockenbury and Sammarco, 2001)
- Supporting ligaments (Hockenbury and Sammarco, 2001) and
- Musculotendinous support (Hertel, 2002).

According to Baker and Todd (1995) during dorsiflexion of the foot, the talus moves from anterior to posterior and becomes “locked” into the mortise. When the ankle is dorsiflexed, the ankle joint is considered stable (Baker and Todd, 1995) and very strong (Moore and Dalley, 1999). On the other hand, when the foot is plantarflexed the talus is “unlocked” (Baker and Todd, 1995) and the ankle is considered unstable (Moore and Dalley, 1999) and therefore higher chance of an ankle sprain occurring in this position.

The articular capsule surrounding the mortise joint is thin anteriorly and posteriorly and is supported by strong collateral ligaments on each side (Moore and Dalley, 1999). The collateral ligaments include the medial or deltoid ligament and the lateral ligament. The lateral ligament is made up of three parts namely: the anterior talofibular ligament (ATFL), posterior talofibular ligament (PTFL) and the calcaneofibular ligament (CFL).

The ATFL is a flat weak band that runs anteromedially from the lateral malleolus to the neck of the talus (Moore and Dalley, 1999). The ATFL has shown to prevent anterior displacement of the talus from the mortise joint and extreme internal rotation and inversion of the talus on the tibia (Hollis, Blasier and Flahiff, 1995). It is the most frequently injured ligament of the lateral ligaments (Renstro¨m and Konradsen, 1997).

The PTFL, is a thick, strong band that runs from the lateral malleolus posteriorly to the lateral tubercle of the talus (Moore and Dalley, 1999). The PTFL limits supination when the talocrural joint is loaded (Stormont, Morrey, An and Cass, 1985) and is the least commonly sprained ankle ligament (Renstro¨m and Konradsen, 1997).

The CFL is a round cord that passes from the lateral malleolus posteroinferiorly to the lateral surface of the calcaneus (Moore and Dalley, 1999). It limits supination (inversion and internal rotation) of the mortise as well as the subtalar joints and is under the most stress when the ankle is dorsiflexed (Hollis, Blasier and Flahiff, 1995).

The medial ligament is strong and reinforces the articular capsule. This ligament runs inferiorly from the medial malleolus to the talus, navicular and calcaneus forming a broad base (Moore and Dalley, 1999).

2.3.2.2 The Distal Tibiofibular Joint

The distal tibiofibular joint is one of two joints that connects the tibia and fibula. It is a fibrous joint that plays an essential role in the stability of the ankle joint because it holds the lateral malleolus firmly against the lateral surface of the talus (Moore and Dalley, 1999). There is little movement between these two bones (Mulligan, 1995). However, gliding movement at this joint is important for normal movement in the ankle complex

(Mulligan, 1995) as the structure of this fibrous joint forms a stable roof for the mortise joint (Hertel, 2002).

2.3.2.3 The Subtalar Joint

The subtalar joint is the joint between the talus and the calcaneus and is responsible for pronation and supination of the foot and ankle (Hertel, 2002). The subtalar joint consists of two separate joint cavities, the posterior subtalar joint and the anterior subtalar joint:

- The posterior subtalar joint is formed by the inferior posterior facet of the talus and the superior posterior facet of the calcaneus.
- The anterior subtalar joint is formed by the head of the talus, the anterior-superior facets, the sustentaculum tali of the calcaneus, and the concave proximal surface of the navicular (Hertel, 2002).

2.3.3 The Midfoot

The midfoot is made up of midtarsal joints which include the talo-calcaneonavicular joint, cuneonavicular joint, intercuneiform joints, cuneicuboid joint, cuboideonavicular joint and the calcaneocuboid joint (Magee, 2002). For ease of reference the following table summarises all the midfoot joints.

Table 1.1: Classification of midfoot joints.

Joint:	**Talo-calcaneonavicular Joint**	• **Cuneonavicular Joint** • **Intercuneiform Joints** • **Cuneicuboid Joint**	**Cuboideonavicular Joint**	**Calcaneocuboid Joint**
Type:	Ball and socket synovial joint	Plane synovial joint	Fibrous joint	Saddle-shaped joint
Degrees of freedom:	3 degrees of freedom			
Closed-pack position:	Supination	Supination	Supination	Supination
Supporting ligaments:	Dorsal talonavicular ligament, Bifurcated ligament, Plantar calcaneo-navicular ligament			Bifurcated ligament, Calcaneocuboid ligament, Long plantar ligament
Movement:	Gliding and rotation	Gliding and rotation	Slight gliding and rotation	Slight gliding and rotation

(Magee, 2002)

2.4 CHRONIC ANKLE INSTABILITY SYNDROME

2.4.1 Introduction

Chronic ankle instability is one of many terms used to describe the existence of an unstable ankle due to numerous repetitive ankle sprains (Renstro¨m and Konradsen, 1997). Symptoms include chronic ankle sprains, recurrent “giving way” of the ankle followed by pain and swelling (Hertling and Kessler, 1996), instability, crepitus, weakness and stiffness (Pellow and Brantingham, 2001). CAIS was selected for investigation in this dissertation as it has certain criteria the patients have to fit into which ensured a homogenous symptomatic group, this allowed for more accurate results. Also studies have shown that manipulation is an effective treatment for CAIS (Pellow and Brantingham, 2001), and that there is a presence of joint dysfunction in hindfoot joints (Meadows, 2002; Dananberg Shearstone and Guillano, 2000; Lewit, 1999; Kavanagh, 1999; O’Brien and Vicenzino, 1998; Hetherington, 1996; Greenman, 1996 and Mulligan, 1995). However, there has been no study performed to assess whether motion palpation is an effective assessment tool to detect joint dysfunction in hindfoot and midfoot joints associated with CAIS.

2.4.2 Incidence and prevalence

After an acute ankle sprain 10% to 20% of patients will develop CAIS (de Vries *et al.*, 2006), it is therefore important to investigate the incidence and prevalence of ankle sprains in order to understand the incidence and prevalence of CAIS. Lysens, Steverlyncky, Van den Auweele, Lefevre, Renson, Claessens, and Ostyn (1984) performed a study on the predictability of sports injuries and found that students with a previous history of injury were at a higher risk of re-injury. Lysens *et al.* (1984) also found that out of 162 reported ankle sprains, 72 (44.5%) were re-injured within the 4-year study. In keeping with these findings Smith and Reischl, (1986) reported that the re-injury rate after lateral ankle sprain has been as high as 80% among athletes.

According to Fallat, Grimm and Saracco (1998), the ankle is one of the most commonly injured joints in the body and lateral ankle sprains are among the most common injuries that occur at the ankle joint (Hertel, 2002).

A systemic review on ankle sprain and ankle injury in sports performed by Fong, Hong, Chan, Yung and Chan, (2007) showed that ankle sprains were the most common ankle injury in 33 of 43 sports investigated. In sports injuries throughout the countries studied in this systemic review, their results showed that the ankle was the second most commonly injured body structure after the knee, with the ankle sprain being the most common type of ankle injury. Fong et al., (2007) also stated that ankle sprains were especially found in court games and team sports, such as rugby, soccer, volleyball and basketball (Fong *et al*., 2007). Karlsson, Rolf and Orava (2003) agreed that running and jumping sports e.g.: soccer, basketball and volleyball, are high risk activities for ankle sprain injuries. They also added that different profiles of sporting activities within a population results in a varying incidence of ankle ligament injuries (Karlsson, Rolf and Orava, 2003).

Previous literature shows varied gender distribution of ankle sprains. According to Louwerens and Snijders (1999) the incidence of ankle injuries in the young male population is higher than the female population, but after 40 years of age the incidence for females increases more than males. Beynnon, Murphy and Alosa (2002), however, propose that gender does not appear to be a risk factor for experiencing an ankle sprain.

It was estimated that in the UK there were 302 000 new ankle sprains and 42 000 new, severe, ankle sprains reported every year (Bridgman, Clement, Downing, Walley, Phair and Maffulli, 2003). Kannus and Renstro¨m (1991), estimated that in the United States more than 23 000 ankle sprains occur per day which equates to one sprain per 10 000 people daily. A profile of ankle injuries in South Africa was not available.

2.4.3 Cause of CAI

Hertel, (2002) proposes that there are two major causes of CAIS namely: mechanical instability and functional instability (Hertel, 2002).

2.4.3.1 Mechanical instability

Hertel, (2002) explained that mechanical instability is caused when various factors such as impaired arthrokinematics, degenerative changes, synovial inflammation and impingement alter the mechanics of the joints within the ankle (Hertel, 2002). Denegar and Miller, (2002) defined mechanical instability as an increase in the accessory movements at a joint. Tropp, Odenrick and Gillquist (1985) suggested that after ankle ligament injury, the ligaments that normally function to stabilize the ankle complex may be torn and therefore result in pathologic laxity of the ankle complex.

2.4.3.2 Functional instability

Functional instability was first described as a cause of CAI by Freeman, (1965) who suggested CAI is a result of proprioceptive deficits that remain after ligament injury. Hertel (2000) subsequently modified this definition of functional instability to "the occurrence of recurrent ankle instability and the sensation of joint instability due to the contributions of proprioceptive and neuromuscular deficits". Functional instability is a complex syndrome, and the exact cause is unknown however, it has been suggested that possible causes include; increased ligamentous laxity, inhibition of proprioceptive function and peroneal muscle weakness (Karlsson*,* Rolf and Orava, 2003). The patient may present with a feeling of "looseness" or "giving way" of the ankle more frequently than pain and they may have a history of recurring inversion injuries to the ankle (Patel and Warren, 1999).

2.4.3.3 Risk factors for ankle sprains include the following:

- Previous ankle sprain: Beynnon *et al*. (2002), suggest that ankle ligament sprains result in disruption of a ligament, these ligaments function as important biomechanical stabilizer. Tropp*,* Odenrick and Gillquist, (1985) found that sportsmen with a history of ankle problems experienced more sprains than those with no previous history.
- Height and weight: Beynnon *et al*. (2002), included these two risk factors because an increase in either factor proportionally increases the amount of inversion torque that needs to be resisted by the ligaments and muscles that span the ankle complex.
- Tight Achilles tendon: According to Reid (1992), the gastrocnemius and soleus tendons pull on the ankle joint via the calcaneus which pulls the calcaneus into slight inversion therefore increasing the likelihood of landing on the outside of the foot during jumping (Reid, 1992).
- Crossover gait: This position results in the foot being excessively supinated during heel strike (Forcum, 1997).

- Muscle imbalances: If the everters are weak (Fibularis muscles) or if the inverters (tibialis anterior and posterior) are tight an ankle sprain may result (Vizniak and Carnes, 2004).
- Anatomical variation: A genu varum, tibia varum or rearfoot varum can contribute to improper foot landing, which may result in an ankle sprain (Vizniak and Carnes, 2004). Reid (1992), added that a varus heel or tarsal coalition may also predispose to ankle injuries.
- Generalized ligament laxity may contribute to ankle instability (Reid, 1992).
- Shoes: According to Reid (1992), low profile boots and narrow, long cleats can contribute to ankle sprains.
- Terrain: Uneven surfaces or potholes may increase the risk of having an ankle sprain (Reid, 1992).
- Limb dominance: Beynonn *et al*. (2002), stated that the literature is divided with regards to limb dominance as a risk factor for ankle sprains, however, it could be implicated as a risk factor as most athletes tend to place a greater demand on their dominant limb (Beynnon *et al*., 2002).

2.4.4 Mechanism of injury

The most common mechanism of injury to the ankle involves extreme inversion or supination of the foot and ankle complex, which results in injury to the lateral ligaments of the ankle (Wolfe, Uhl, Mattacola and McCluskey, 2001 and Kannus and Renstro¨m, 1991).

Results from Denegar, Hertel and Fonseca (2002) research highlight that the lateral joint capsule along with the ligaments that support the lateral talocrural, subtalar, and distal and proximal tibiofibular joints, function to limit the degree of inversion and supination of the ankle complex. They also point out that joint dysfunction (hypermobility or hypomobility) may result in one or more joints in the ankle complex if these structures are overloaded.

2.4.5 Clinical Presentation of ankle sprains

Denegar, Hertel and Fonseca, (2002); Pellow and Brantingham (2001) and Patel and Warren (1999) explain that after an acute ankle injury, tissue injury results in pain, swelling and joint dysfunction. Pain and swelling resolve with time, but joint dysfunction may be longer lasting and indicate residual dysfunction of the ankle complex. Residual symptoms following an ankle ligamentous injury include: swelling, pain, instability, crepitus, weakness and stiffness. The swelling in chronic functional instability is generally more diffuse and ecchymosis is not present (Baker and Todd, 1995).

2.4.5.1 Hypermobility

According to Denegar and Miller (2002), hypermobility is usually associated with mechanical instability. They also stated that many patients suffer from ligamentous laxity, or mechanical instability, after lateral ankle sprain which is an increase in the accessory movements at a joint. An increase in accessory movement indicates an enlarged neutral zone of the joint which is the area of accessory movement the joint allows without ligamentous tensioning (Panjabi, 1992). Furthermore Denegar and Miller (2002) highlighted that lasting mechanical instability suggests an unfavourable healing process and usually results from a tear or lengthening of one of the ligaments that support the ankle joint.

In a clinical trial performed by Bernier, Perrin and Rijke, (1997) it was found that seven of nine subjects with functional ankle instability showed to have laxity in the anterior talofibular ligament. In congruence with these findings Hertel, Denegar, Monroe and Stokes, (1999) found that 75% of subjects with a history of ankle sprains showed to have laxity of the talocrural joint on stress fluoroscopy, and two thirds of those who had talocrural laxity also showed to have subtalar joint laxity. This dissertation investigated whether motion palpation was a reliable assessment tool to detect laxity of the above joints.

2.4.5.3 Hypomobility

Hypomobility after lateral ankle sprain, has been attributed to subluxation, which occurs as a result of altered arthrokinematics, in the ankle-joint complex (Meadows, 2002, Lewit, 1999 and Kavanagh, 1999). Also after a lateral ankle sprain, damage to the proprioceptive organs may occur (Anderson, 2002).

It has been reported that after a lateral ankle sprain, the following joints may be hypomobile:

- Subtalar (Meadows, 2002 and Greenman 1996),

- Talocrural joint (Denegar, Hertel and Fonseca, 2002; Green, Refshauge, Crosbie and Adams, 2001. and Dananberg, Shearstone and Guillano, 2000).
- Distal tibiofibular joint (Kavanagh, 1999; O'Brien and Vicenzino, 1998; Hetherington, 1996. and Mulligan,1995), or
- Proximal tibiofibular joint (Meadows, 2002; Dananberg, Shearstone and Guillano, 2000. and Greenman 1996).

This study will investigate whether motion palpation as an assessment tool can detect hypomobility in the above joints in patients with CAIS.

Research has highlighted that hypomobility in the hindfoot has been reported in many studies (Meadows, 2002; Dananberg Shearstone and Guillano, 2000; Lewit, 1999; Kavanagh, 1999; O'Brien and Vicenzino, 1998; Hetherington, 1996; Greenman, 1996 and Mulligan, 1995). Such references include Denegar, Hertel, and Fonseca (2002), who reported restricted movement in posterior talar glide in a group of college athletes who had returned to sport after an ankle sprain. Also, Mulligan (1995), stated that anterior subluxation of the fibula on the tibia at the distal tibiofibular joint may be the cause of painfully limited inversion after a lateral ankle sprain. Mulligan, (1995) results were supported by Kavanagh (1999) who found that there were differences in mobility at the tibiofibular joint between subjects with and without ankle sprains. But Denegar and Miller (2002), assert that the link between ligamentous sprain and the resultant joint dysfunctions is not fully understood and is likely to differ among individual patients.

Dorsiflexion has also been found to be limited after a lateral ankle sprain. It has been suggested that this limitation of movement is due to tightness in the gastrocnemius-soleus complex, (Wolfe *et al*., 2001). Dananberg, Shearstone and Guillano (2000), suggested that hypomobility at the proximal tibiofibular joint can also limit ankle dorsiflexion. Many rehabilitation guidelines include exercises to restore dorsiflexion after a lateral ankle sprain (Wolfe *et al*., 2001). Although dorsiflexion has been reported to have limited range of motion in the above studies, it was excluded in this dissertation as it did not fall under the motion palpation procedures explained by Bergmann, Peterson and Lawrence, (1993) or Schafer and Faye, (1990).

The relationships among hypomobility, ankle injury, and CAIS have not been the focus of previous studies (Denegar, Hertel and Fonseca, 2002). Taking the above literature into consideration this study aims to investigate if motion palpation, as an assessment tool, can identify joint dysfunction in asymptomatic and symptomatic (CAIS) feet.

2.4.6 Diagnosis

Grading of ankle injuries

Ankle sprains are divided into three grades to classify the degree of inversion sprain (Reid, 1992):

Grade I (mild): There is no bruising, very little swelling, point tenderness, negative anterior drawer sign and no varus laxity.

Grade II (moderate): some bruising, the swelling is localized, the achilles tendon margins are not clear, anterior drawer sign may be positive, and no varus laxity.

Grade III (severe): Achhiles tandon margins have no definition due to the severity of the swelling on either side of the tendon, early haemorrhage, tenderness may be present medially and laterally, positive anterior drawer sign and positive varus laxity.

Grade I injuries result in a single ligament being mildly stretched yet despite this injury, patients are still capable of immediately bearing their weight on the (Forcum, 1997. and Garrick and Schelkun, 1997). These researchers continue to explain that in a grade II injury some tearing of the ligaments occurs, however, there is more swelling than a grade I injury and the patient can generally bear some weight. Furthermore they indicate that a grade III injury involves the complete tearing of one or more of the ligaments. The patient presents with significant swelling and bruising and may show functional and clinical instability of the ankle reducing their ability fully weight bear because of the resultant pain. From the above research it can be noted that differences exist in the grading of ankle sprains and sometimes the margins that delineate different grades can be blurred.

The diagnosis of CAIS in this dissertation was based on the history of the most recent grade I or II inversion ankle sprain and at least four of the six residual symptoms of instability, pain, crepitus, weakness, stiffness or edema (Pellow and Brantingham, 2001 and Patel and Warren, 1999) for at least six weeks.

2.4.7 Treatment

The treatment of acute lateral ankle sprains is initially aimed at controlling pain and swelling followed by range of motion exercises, stretching of musculotendinous tissues, improvement of neuromuscular control, and strengthening exercises (Denegar and Miller, 2002). Chronic ankle instability syndrome is treated with various regimes and modalities. These include; manipulation (Pellow and Brantingham, 2001), mobilization, cryotherapy (Hockenbury and Sammarco, 2001), range of motion and strengthening exercises (Anderson, 2002. and Reid, 1992) and deep transverse friction (Hertling and Kessler, 1996). But Denegar and Miller (2002) assert that treatment of CAIS is difficult and so the reliability of assessment tools of the acutely injured ankle should be evaluated in attempt to appropriately manage CAIS.

2.4.8 Conclusion

In conclusion the literature points out that motion palpation is an important assessment tool, used by chiropractors to determine the need for manipulative treatment. In addition to this, previous studies have shown that patients with CAI have a presence of joint dysfunction. However, there have been a lack of studies investigating the reliability of motion palpation in the hindfoot and midfoot joints in asymptomatic and symptomatic feet. The following chapters will discuss how the reliability of motion palpation was assessed in this study. The results will follow and will be discussed in terms of the review of the literature.

CHAPTER 3

3.1 INTRODUCTION

This chapter is comprised of a detailed description of the study design, objectives, the patients selected to participate in the study as well as the intervention used. It also includes the statistical methods used to analyse the data.

3.2 THE RESEARCH DESIGN

This was an inter-examiner reliability study.

3.3 ADVERTISING

Advertisements (Appendix B) were placed in public places, sport clubs and notice boards around the Durban University of Technology.

3.4 SAMPLE

3.4.1 Method

A consecutive convenience sampling method was used. Patients were selected from those who responded to advertisements and word of mouth. Initially the patients were screened via a telephonic interview, by the researcher, to determine their suitability for the research. The following qualifying questions were asked:

1. What is your name and age?
2. Have you sprained your ankle in the past?
3. Did you sprain your ankle more than six weeks ago?
4. Are you experiencing any ankle discomfort, swelling or giving way?
5. Are the above symptoms present in one or both feet?

The study was available to any person who arrived for a consultation at the Chiropractic Day Clinic at the Durban University of Technology.

3.4.2 Sample size

A sample size of 20 patients was used (Esterhuizen, 2009). The sample size was not established according to a power calculation but by improving on the number of patients used in similar inter-examiner reliability studies. The study only included those patients who experienced chronic ankle instability syndrome in one foot and was asymptomatic in the other foot. The patient needed to meet the following criteria:

a.) Inclusion:

- Patients qualified for the research based on their suitability. This was confirmed during the telephone interview.

- Patients had to be between the ages of 18 and 50 years to increase the reliability of the study.

- The patients had to have one symptomatic foot with the other foot free of pain and fully functional (asymptomatic) (Reid, 1992).

- Patients symptomatic foot had to fit the criteria of CAIS as stated below:

The diagnosis for this study was based on the history of the most recent inversion ankle sprain and at least four of the six continuing symptoms of instability, pain, crepitus, weakness, stiffness or edema (Pellow and Brantingham, 2001 and Patel and Warren, 1999) for at least six weeks.

- Subjectively the patient should have experienced the following clinical picture:

An acute sprain at least six weeks prior to the assessment (Wolfe *et al.*, 2001; Hertel, 2002 and Hertling and Kessler, 1996).

Currently ‘giving way’ during activities such as jumping or quick side-side movements (Hertling and Kessler, 1996).

- Patients numerical pain rating scale (Williamson and Hoggart, 2005) must be between 3 and 8 to keep the group homogenous in terms of pain.

b.) Exclusion:

- Patients with signs of gross mechanical ankle instability (grade III ankle sprain) and syndesmosis injury (Pellow and Brantingham, 2001).
- Patients below the age of 18 needs parental consent and were therefore excluded from the study.
- To avoid altered joint movement due to osteoarthritis patients over the age of 50 were excluded (Flaherty, 2007).
- Patients with a history of ankle surgery or fracture.
- Patients who did not sign the Letter of Information and Consent (APPENDIX A).
- Patients whose foot was painful when partially or fully weight bearing or if there was excessive swelling of the foot.

3.5 DATA COLLECTION

3.5.1 Patient Procedure

An appointment was scheduled for those patients that were included in the study after the telephonic interview. At the first consultation the patient was given a Letter of Information and Consent (Appendix A), which explained the research procedure to the patient. The Letter of Information and Consent detailed that they were allowed to withdraw from the study at any point if they did not wish to further participate in the study. If a patient did withdraw from the study their results were excluded from the study.

The consultation, carried out by the researcher, included a full history (Appendix E), physical examination (Appendix F), foot and ankle regional examination (Appendix G). These above examinations as well as the exclusion and inclusion criteria further determined the patient suitability.

If the patient was suitable for the study, they were reminded that three independent examiners would be assessing their feet. The patient was encouraged not to communicate with the examiners and not to inform the examiners of which foot was painful. A screen was placed between the examiner and the patient so that the examiner could not see the patients' facial expression while palpating their foot. The researcher remained in the examination room throughout the consultation to ensure all examination procedures were carried out correctly.

Once the three examiners completed their assessments (explained in Appendix C), they handed the two completed forms (2 Appendix D) to the researcher. At this stage the research component was finished and the patient could receive one free treatment for chronic ankle instability syndrome, should they so wish.

3.5.2 Examiner Procedure

Three chiropractic masters students were approached to be examiners in this study. They then underwent seven-sessions of training and practice of motion palpation of the foot and ankle joints, an eighth session included a proficiency test supervised by the research supervisor. Mootz, Keating, Kontz, Milus and Jacobs, (1989) and Currier, Froehlich, Carow, McAndrew, Cliborne, Boyles, Mansfield and Wainner, (2007) recommend that preparatory lessons are important so as to ensure sensitivity and consistency of the technique. A motion palpation instruction sheet was given to the three examiners at the practice sessions (Appendix C). The methods practised included clear specifications on the exact position of the examiners' hands (this included determining the dominant hand of the examiner), after which the details on the positioning of each of the fingers were specified and lastly the amount of pressure that should be administered when motion palpating the ankle complex. The examiners were remunerated to ensure they were compliant during the study.

All examiners motion palpated the midfoot and hindfoot joints of both the symptomatic foot as well as the asymptomatic foot of 20 patients. The palpatory technique used was the method explained by Schafer, and Faye, (1990) and Bergmann, Peterson and Lawrence, (1993). The hindfoot was evaluated because of the literature showing the involvement of the mortise joint in CAIS, (Meadows, 2002; Denegar, Hertel and Fonsesca, 2002; Green, Refshauge, Crosbie and Adams, 2001; Dananberg, Shearstone and Guillano, 2000; Lewit, 1999; Kavanagh, 1999; O'Brien and Vicenzino, 1998; Hetherington, 1996; Greenman, 1996 and Mulligan, 1995). And the midfoot was assessed because Scafer and Faye (1990) suggest that the lower leg, foot and ankle work as a unit.

Each examiner assessed both the symptomatic and asymptomatic ankles independently with the researcher in the room to ensure the procedure was carried out correctly. The examiner recorded his/her results for both ankles on separate forms (Appendix D) and once completed handed the forms to the researcher. The researcher put the forms in the patients file so that the other examiners could not see the previous examiners' results. The examiners were blinded to any pathology present. For the purpose of this study the examiners were not allowed to communicate during the research procedure to ensure they did not influence each others findings.

According to Cooperstein and Gleberzon, (2004) the palpatory procedure resembles mobilisation and therefore the first examiner may find different restrictions to the second. As motion palpation may improve end feel in a joint, the three examiners randomly alternated who palpated the patients' feet first. Each examiner drew a number (1, 2 or 3) out of an envelope to decide the order in which they would palpate. (This too was recorded on their data sheet). By alternating the order of palpation any differences in palpatory findings could only be attributed to the examiner performance and not any change in the patient (Lakhani, Nook, Haas and Docrat, 2009). Also the examiners' were advised to motion palpate each direction of the joints twice only, this limited the number of times a particular movement was felt and therefore decrease the mobilisation effect motion palpation potentially may have had.

3.6 STATISTICAL METHODOLOGY

SPSS version 15.0 (SPSS Inc., Chicago, Illinois) was used to analyse the data. Kappa statistics and p values, as well as percentage agreement were calculated in symptomatic and asymptomatic hindfoot and midfoot joints separately by comparing the ratings between examiners 1 and 2, examiners 1 and 3 and examiners 2 and 3.

To compare the kappa values between symptomatic and asymptomatic feet, paired non parametric Wilcoxon signed ranks tests were used. The kappa values used were the 25 measurements where both a symptomatic and asymptomatic group kappa measurement was obtained.

The presence of restrictions and instability between symptomatic and asymptomatic feet were compared using Pearson's chi square tests.

Cohens Kappa is the most used statistical method to detect reproducibility (Stochkendahl *et al.* 2006). However, there has been criticism of its use (Lantz, 1997), these include that Kappa is not entirely a chance corrected measure of agreement, it does not distinguish between different types and sources of disagreements and that Kappa may be low even though percentage agreement is high (Brantingham *et al*., 2003). Taking this criticism into consideration, this study has used Kappa as the primary data along with percentage agreement as the secondary data to assess the inter-examiner reliability of motion palpation to detect joint dysfunction.

Percentage of agreement between all three examiners was calculated for each individual by assessing if all three examiners agreed on the absence or presence of restriction or instability (in which case 100% agreement was recorded). It was also calculated on whether two of the three examiners agreed on either the presence or absence of a restriction or instability, assuming the majority rule (in which case 66.6% agreement was recorded). For example, if two examiners reported restriction and one reported no restriction, then it was assumed due to majority rule that that participant had restriction (and thus 66.6% agreement was recorded), but if one examiner reported restriction while the other two reported no restriction, then it was assumed using the same logic that that participant had no restriction present (and similarly, 66.6% agreement was recorded). The mean agreement across all participants for each movement was calculated and reported for symptomatic and asymptomatic feet separately.

McNemar's chi square tests were performed to assess the significance of the percentage of correctly identified symptomatic feet by each of the examiners.
A p value <0.05 was considered as statistically significant.

3.6.1 Statistical Analysis

A reliability study aims to quantitatively express the reliability level by indicating the level of agreement (Huijbregts, 2002). According to Portney and Watkins, (1993) the most straightforward indicator of agreement is the percentage agreement value. The percentage agreement value is defined as the proportion of the number of agreements to the total number of evaluations made (Haas, 1991). This percentage does not correct for chance agreement, therefore it could provide a deceptively high level of reliability (Maher and Adams, 1994; Portney and Watkins, 1993. and Haas, 1991).

The *kappa statistic* (κ) on the other hand, is a chance-corrected index of agreement and can be inclined to underestimate reliability (Portney and Watkins, 1993). Therefore, if agreement is worse than chance the kappa value will be negative. The kappa statistic does not set apart disagreements, it assumes that all disagreements have equal clinical significance (Portney and Watkins, 1993). Lantz (1997), suggested that kappa should not be interpreted without percentage agreement values or the contingency tables from which it was derived. Results with a high percentage agreement but a low kappa value indicate limited variation (Haas, 1991). One situation where limited variation may take place is when there is a large proportion of agreement (Haas, 1991). This can be the result of a study population that is highly homogenous on the variable of interest (Lantz, 1997). This study used both kappa statistic and percentage agreement values to interpret the data obtained. The following Table from Landis and Koch (1977) was used as guidelines interpret the kappa statistics:

0.81-1.0	Almost perfect
0.61-0.80	Substantial
0.41-0.60	Moderate
0.21-0.40	Fair
0.00-0.20	Slight
<0.00	Poor

CHAPTER 4

4.1 KEY TO ABBREVIATIONS

Abbreviation	Words in full
AP Dtj	Anterior-posterior distal tibiofibular joint
PA dtj	Posterior –anterior distal tibiofibular joint
LA-Distraction	Long axis distraction Tibiotalar joint
AP Ttj	Anterior-posterior tibiotalar joint
PA Ttj	Posterior –anterior Tibiotalar joint
ML Ttj	Medial-lateral tibiotalar joint
LM Ttjr	Lateral-medial tibiotalar joint
AP Stj	Anterior-posterior subtalar joint
PA Stj	Posterior–anterior subtalar joint
ML Stj	Medial-lateral subtalar joint
LM Stj	Lateral-medial subtalar joint
AP Cub	Anterior-posterior cuboid
PA Cub	Posterior–anterior cuboid
AP Nav	Anterior-posterior navicular
PA Nav	Posterior–anterior navicular
AP Cun	Anterior-posterior cuneiforms
PA Cun	Posterior–anterior cuneiforms
AP Tarso met joint	Anterior-posterior tarsometatarsal joint
PA Tarso met joint	Posterior–anterior tarsometatarsal joint
Restric	Restriction
Instab	Instability

4.2 RESULTS

4.2.1 Demographics

a. Number of patients

Twenty participants with one symptomatic and one asymptomatic foot were enrolled into the study (n=40 feet).

b. Age

Their mean age was 29.4 years (standard deviation 5.7 years) with a range from 22 to 44 years.

Table 1: Age of patients.

N	Valid	20
	Missing	0
Mean		29.40
Std. Deviation		5.734
Minimum		22
Maximum		44

c. Order of examination

Each patient was examined by the examiners in different orders. Table 2 shows examination order of each of the participants.

Table 2: Order of examination

		Frequency	Percent
Valid	1,2,3	5	25.0
	2,1,3	1	5.0
	3,2,1	3	15.0
	3,1,2	5	25.0
	2,3,1	5	25.0
	1,3,2	1	5.0
	Total	20	100.0

The order of examination was determined by picking a number out of an envelope, this method was chosen to alternate examiner order so that any difference in motion palpation findings could not be due to the order in which the examiners palpated. Cooperstein and Gleberzon, (2004) supports this method because motion palpation is a form of mobilisation and can result in altered findings between examiners. The order of examination showed that the most frequent orders of examination were examiner order

1, 2, 3; examiner order 3, 1, 2; and examiner order 2, 3, 1 which occurred 25% each next was examiner order 3, 2, 1 which made up 15% and then examiner orders 2,1,3 and 1,3,2 both made up 5% each.

Asymptomatic

Examiner 2 vs. examiner 3 had the worst inter-examiner reliability and examiner 1 vs. 3 had the best inter-examiner reliability in detecting restrictions in the asymptomatic foot and ankle joints. Examiners 2 vs. 3 had the highest inter-examiner reliability and examiners 1 vs. 2 had the lowest inter-examiner reliability when detecting instability in symptomatic feet.

Symptomatic

The examiner combinations each had different inter-examiner reliability. Examiner 1 vs. examiner 2 had the worst inter-examiner reliability and examiner 2 vs. examiner 3 had the best inter-examiner reliability in detecting restrictions in the symptomatic group. Examiners 1 vs. 3 had the highest inter-examiner reliability and examiners 2 vs. 3 had the lowest when detecting the presence of instability in symptomatic foot and ankle joints

d. Gender

Gender was predominantly male (85%). Previous literature shows varied gender distribution. According to Louwerens and Snijders (1999) the incidence of ankle injuries in the young male population is higher, but after 40 years of age the incidence for females increases more than males. Beynnon *et al*. (2002), however, propose that gender does not appear to be a risk factor for experiencing an ankle sprain. This study was not in keeping with previous literature on gender distribution of ankle sprains, as there was a significant difference in gender distribution. Majority of the patients that qualified for this study were patients who responded to the advertisement that was placed in the Natal indoor soccer arena and this could be one of the factors that affected the gender distribution in this study.

Figure 1 shows that their gender was mainly male (n=17, 85%).

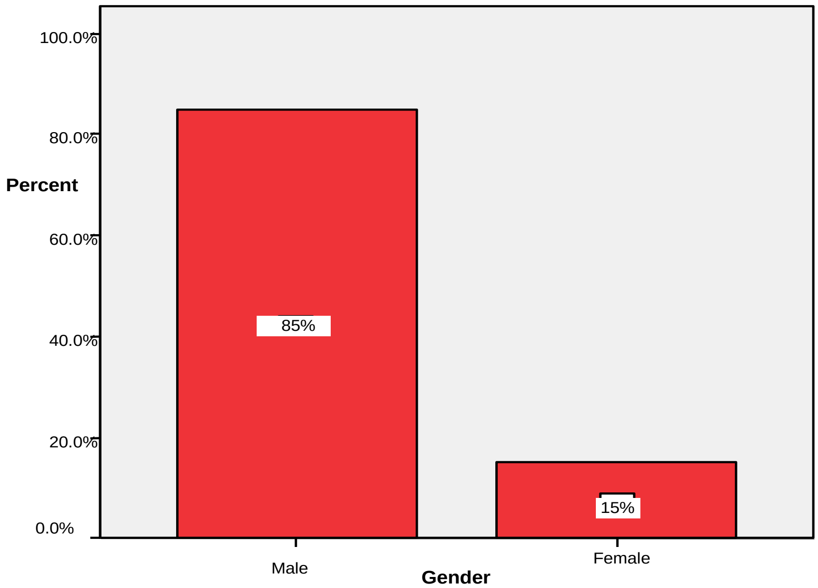

Figure 1: Gender of the sample participants (n=20)

e. Symptomatic foot

Figure 2 shows that 75% of participants had symptomatic right feet and in only 25% the left foot was affected.

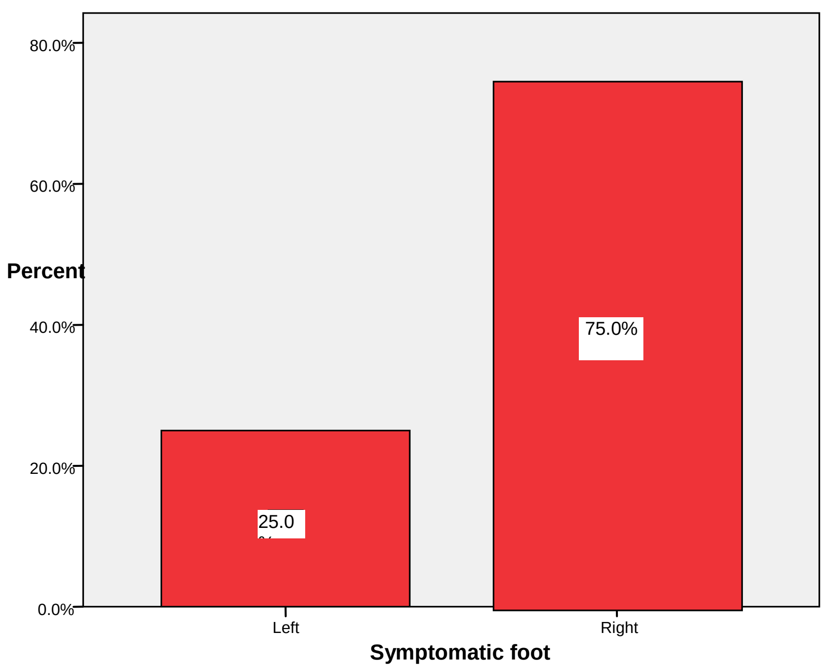

Figure 2: Percentage of right and left foot symptomatic (n=20)

4.2.2 To determine the inter-examiner reliability of motion palpation of the foot and ankle joints in symptomatic feet

The inter-examiner comparisons in symptomatic feet are shown here.

4.2.2.1 Examiner 1 vs. examiner 2

Restriction

Table 3 shows the comparison of examiner 1 and examiner 2's results for the presence of restriction showed the highest kappa value being 0.35 indicating fair agreement. Most of the kappa values were low and several were negative, indicating worse agreement than expected by chance. Percentage agreement showed an average of 87% agreement between these two examiners with 100% being their best agreement and 55% being their worst percentage agreement.

Instability

Table 4 shows that examiner 1 and examiner 2 highest kappa score was 0.400 indicating fair agreement when assessing instability. Their average percentage agreement was 83% with 100% being the highest agreement value and 50% being the worst agreement value.

4.2.2.2 Examiner 1 vs Examiner 3

Restriction

Table 5 shows that examiner 1 vs 3 had better agreement than1 vs 2 with a perfect kappa score of 1 being recorded for one measurement. However, there were still negative and low kappa values for some measurements. Percentage agreement showed an average of 87% with their highest score being 100% and their lowest being 55% agreement.

Instability

Table six shows that examiner 1 vs 3 had better agreement than1 vs 2 with the highest kappa score being 0.814 indicating almost perfect agreement. Percentage agreement showed 100% to be the highest and 50% the lowest with an average of 83% agreement.

4.2.2.3 Examiner 2 vs. Examiner 3

Restriction

Table seven shows that examiner 2 vs. 3 had good agreement with a highest kappa score of 0.643 for one measurement. There were only two negative kappa values. Their average percentage agreement was 90%.

Instability

Table eight shows that examiner 2 vs. 3 had an average percentage agreement of 90%. Their highest kappa score was 0.286 indicating fair agreement.

Table 3: **The inter-examiner reliability of examiner 1 vs. examiner 2 to detect restrictions in symptomatic feet.**

			Examiner 2		Kappa	P value	% agreement
			No	Yes			
AP Dtj Restric	Examiner 1	No	19	1	-		95%
		Yes	0	0			
PA dtj Restric	Examiner 1	No	19	1	-		95%
		Yes	0	0			
LA-Distraction Restric	Examiner 1	No	18	0	-		90%
		Yes	2	0			
AP Ttj Restric	Examiner 1	No	20	0	-		100%
		Yes	0	0			
PA Ttj Restric	Examiner 1	No	20	0	-		100%
		Yes	0	0			
ML Ttj Restric	Examiner 1	No	16	3	0.348	0.040	85%
		Yes	0	1			
LM Ttj Restric	Examiner 1	No	18	1	-0.053	0.814	90%
		Yes	1	0			
AP Stj Restric	Examiner 1	No	19	0	-		95%
		Yes	1	0			
PA Stj Restric	Examiner 1	No	20	0	-		100%
		Yes	0	0			
ML Stj Restric	Examiner 1	No	16	4	-		80%
		Yes	0	0			
LM Stj Restric	Examiner 1	No	20	0	-		100%
		Yes	0	0			
AP Cub Restric	Examiner 1	No	11	1	-0.098	0.402	55%
		Yes	8	0			
PA Cub Restric	Examiner 1	No	10	2	0.091	0.648	60%
		Yes	6	2			
AP Nav Restric	Examiner 1	No	14	1	-0.091	0.554	70%
		Yes	5	0			
PA Nav Restric	Examiner 1	No	13	3	-0.207	0.308	65%
		Yes	4	0			
AP Cun Restric	Examiner 1	No	20	0	-		100%
		Yes	0	0			
PA Cun Restric	Examiner 1	No	20	0	-		100%
		Yes	0	0			
AP Tarso met joint Restric	Examiner 1	No	17	3	-		85%
		Yes	0	0			
PA Tarso met joint Restric	Examiner 1	No	19	1	-		95%
		Yes	0	0			

Table 4: **The inter-examiner reliability of examiner 1 vs. examiner 2 to detect instability in symptomatic feet.**

			Examiner 2		Kappa	P value	% agreement
			No	Yes			
AP Dtj Instab	Examiner 1	No	14	4	-0.154	0.456	70%
		Yes	2	0			
PA dtj Instab	Examiner 1	No	15	3	0.231	0.264	80%
		Yes	1	1			
LA-Distraction Instab	Examiner 1	No	10	0	0.400	0.025	70%
		Yes	6	4			
AP Ttj Instab	Examiner 1	No	11	0	-		55%
		Yes	9	0			
PA Ttj Instab	Examiner 1	No	17	0	-		85%
		Yes	3	0			
ML Ttj Instab	Examiner 1	No	13	2	0.077	0.718	70%
		Yes	4	1			
LM Ttjr Instab	Examiner 1	No	19	0	-		95%
		Yes	1	0			
AP Stj Instab	Examiner 1	No	19	0	-		95%
		Yes	1	0			
PA Stj Instab	Examiner 1	No	10	0	-		50%
		Yes	10	0			
ML Stj Instab	Examiner 1	No	12	5	0.241	0.212	70%
		Yes	1	2			
LM Stj Instab	Examiner 1	No	10	0	-		50%
		Yes	10	0			
AP Cub Instab	Examiner 1	No	19	0	-		95%
		Yes	1	0			
PA Cub Instab	Examiner 1	No	19	0	-		95%
		Yes	1	0			
AP Nav Instab	Examiner 1	No	20	0	-		100%
		Yes	0	0			
PA Nav Instab	Examiner 1	No	20	0	-		100%
		Yes	0	0			
AP Cun Instab	Examiner 1	No	20	0	-		100%
		Yes	0	0			
PA Cun Instab	Examiner 1	No	20	0	-		100%
		Yes	0	0			
AP Tarso met joint Instab	Examiner 1	No	20	0	-		100%
		Yes	0	0			
PA Tarso met joint Instab	Examiner 1	No	20	0	-		100%
		Yes	0	0			
Sympti	Examiner 1	No	3	2	0.222	0.292	65%
		Yes	5	10			

Table 5: **The inter-examiner reliability of examiner 1 vs. examiner 3 to detect restrictions in symptomatic feet.**

			Examiner 3		Kappa	P value	% agreement
			No	Yes			
AP Dtj Restric	Examiner 1	No	18	2	-		90%
		Yes	0	0			
PA dtj Restric	Examiner 1	No	20	0	-		100%
		Yes	0	0			
LA-Distraction Restric	Examiner 1	No	15	3	-0.136	0.531	75%
		Yes	2	0			
AP Ttj Restric	Examiner 1	No	20	0	-		100%
		Yes	0	0			
PA Ttj Restric	Examiner 1	No	19	1	-		95%
		Yes	0	0			
ML Ttj Restric	Examiner 1	No	19	0	1.000	<0.001	100%
		Yes	0	1			
LM Ttjr	Examiner 1	No	18	1	-0.053	0.814	90%
		Yes	1	0			
AP Stj Restric	Examiner 1	No	19	0	-		95%
		Yes	1	0			
PA Stj Restric	Examiner 1	No	20	0	-		100%
		Yes	0	0			
ML Stj Restric	Examiner 1	No	17	3	-		85%
		Yes	0	0			
LM Stj Restric	Examiner 1	No	17	3	-		85%
		Yes	0	0			
AP Cub Restric	Examiner 1	No	9	3	-0.279	0.125	45%
		Yes	8	0			
PA Cub Restric	Examiner 1	No	11	1	-0.098	0.814	55%
		Yes	8	0			
AP Nav Restric	Examiner 1	No	15	0	-		75%
		Yes	5	0			
PA Nav Restric	Examiner 1	No	16	0	-		80%
		Yes	4	0			
AP Cun Restric	Examiner 1	No	20	0	-		100%
		Yes	0	0			
PA Cun Restric	Examiner 1	No	20	0	-		100%
		Yes	0	0			
AP Tarso met joint Restric	Examiner 1	No	17	3	-		85%
		Yes	0	0			
PA Tarso met joint Restric	Examiner 1	No	18	2	-		90%
		Yes	0	0			
symptr	Examiner 1	No	17	2	0.459	0.015	90%
		Yes	0	1			

Table 6: **The inter-examiner reliability of examiner 1 vs. examiner 3 to detect instability in symptomatic feet.**

			Examiner 3		Kappa	P value	% agreement
			No	Yes			
AP Dtj Instab	Examiner 1	No	13	5	0.118	0.151	70%
		Yes	1	1			
PA dtj Instab	Examiner 1	No	16	2	0.318	0.144	85%
		Yes	1	1			
LA-Distraction Instab	Examiner 1	No	8	2	0.100	0.606	55%
		Yes	7	3			
AP Ttj Instab	Examiner 1	No	9	2	-0.075	0.660	50%
		Yes	8	1			
PA Ttj Instab	Examiner 1	No	16	1	0.318	0.144	85%
		Yes	2	1			
ML Ttj Instab	Examiner 1	No	14	1	0.167	0.389	75%
		Yes	4	1			
LM Ttjr Instab	Examiner 1	No	19	0	-		95%
		Yes	1	0			
AP Stj Instab	Examiner 1	No	19	0	-		95%
		Yes	1	0			
PA Stj Instab	Examiner 1	No	9	1	0.100	0.531	55%
		Yes	8	2			
ML Stj Instab	Examiner 1	No	17	0	0.459	0.015	90%
		Yes	2	1			
LM Stj Instab	Examiner 1	No	8	2	-0.100	0.531	45%
		Yes	9	1			
AP Cub Instab	Examiner 1	No	18	1	-0.053	0.814	90%
		Yes	1	0			
PA Cub Instab	Examiner 1	No	19	0	-		95%
		Yes	1	0			
AP Nav Instab	Examiner 1	No	20	0	-		100%
		Yes	0	0			
PA Nav Instab	Examiner 1	No	20	0	-		100%
		Yes	0	0			
AP Cun Instab	Examiner 1	No	20	0	-		100%
		Yes	0	0			
PA Cun Instab	Examiner 1	No	20	0	-		100%
		Yes	0	0			
AP Tarso met joint Instab	Examiner 1	No	20	0	-		100%
		Yes	0	0			
PA Tarso met joint Instab	Examiner 1	No	20	0	-		100%
		Yes	0	0			
Sympti	Examiner 1	No	3	2	0.222	0.292	65%
		Yes	5	10			

Table 7: The inter-examiner reliability of examiner 2 vs. examiner 3 to detect restrictions in symptomatic feet.

			Examiner 3		Kappa	P value	% agreement
			No	Yes			
AP Dtj Restric	Examiner 2	No	18	1	0.643	0.002	95%
		Yes	0	1			
PA dtj Restric	Examiner 2	No	19	0	-		95%
		Yes	1	0			
LA-Distraction Restric	Examiner 2	No	17	3	-		85%
		Yes	0	0			
AP Ttj Restric	Examiner 2	No	20	0	-		100%
		Yes	0	0			
PA Ttj Restric	Examiner 2	No	19	1	-		95%
		Yes	0	0			
ML Ttj Restric	Examiner 2	No	16	0	0.348	0.040	85%
		Yes	3	1			
LM Ttjr	Examiner 2	No	18	1	0.053	0.814	90%
		Yes	1	0			
AP Stj Restric	Examiner 2	No	20	0	-		100%
		Yes	0	0			
PA Stj Restric	Examiner 2	No	20	0	-		100%
		Yes	0	0			
ML Stj Restric	Examiner 2	No	13	3	-0.207	0.308	65%
		Yes	4	0			
LM Stj Restric	Examiner 2	No	17	3			85%
		Yes	0	0			
AP Cub Restric	Examiner 2	No	16	3	0.018	0.666	80%
		Yes	1	0			
PA Cub Restric	Examiner 2	No	16	0	0.348	0.040	85%
		Yes	3	1			
AP Nav Restric	Examiner 2	No	19	0	-		95%
		Yes	1	0			
PA Nav Restric	Examiner 2	No	17	0	-		85%
		Yes	3	0			
AP Cun Restric	Examiner 2	No	20	0	-		100%
		Yes	0	0			
PA Cun Restric	Examiner 2	No	20	0	-		100%
		Yes	0	0			
AP Tarso met joint Restric	Examiner 2	No	17	3	-		85%
		Yes	0	0			
PA Tarso met joint Restric	Examiner 2	No	17	2	0.071	0.372	85%
		Yes	0	0			
symptr	Examiner 2	No	15	2	0.216	0.335	80%
		Yes	2	1			

Table 8: **The inter-examiner reliability of examiner 2 vs. examiner 3 to detect instability in symptomatic feet.**

			Examiner 3		Kappa		% agreement
			No	Yes			
AP Dtj Instab	Examiner 2	No	12	4	0.211	0.329	70%
		Yes	2	2			
PA dtj Instab	Examiner 2	No	14	2	0.138	0.531	75%
		Yes	3	1			
LA-Distraction Instab	Examiner 2	No	13	3	0.286	0.197	75%
		Yes	2	2			
AP Ttj Instab	Examiner 2	No	17	3	-		85%
		Yes	0	0			
PA Ttj Instab	Examiner 2	No	18	2	-		90%
		Yes	0	0			
ML Ttj Instab	Examiner 2	No	15	2	-0.136	0.531	75%
		Yes	3	0			
LM Ttjr Instab	Examiner 2	No	20	0	-		100%
		Yes	0	0			
AP Stj Instab	Examiner 2	No	20	0	-		100%
		Yes	0	0			
PA Stj Instab	Examiner 2	No	17	3	-		85%
		Yes	0	0			
ML Stj Instab	Examiner 2	No	13	0	0.178	0.162	70%
		Yes	6	1			
LM Stj Instab	Examiner 2	No	17	3	-		85%
		Yes	0	0			
AP Cub Instab	Examiner 2	No	19	1	-		95%
		Yes	0	0			
PA Cub Instab	Examiner 2	No	20	0	-		100%
		Yes	0	0			
AP Nav Instab	Examiner 2	No	20	0	-		100%
		Yes	0	0			
PA Nav Instab	Examiner 2	No	20	0	-		100%
		Yes	0	0			
AP Cun Instab	Examiner 2	No	20	0	-		100%
		Yes	0	0			
PA Cun Instab	Examiner 2	No	20	0	-		100%
		Yes	0	0			
AP Tarso met joint Instab	Examiner 2	No	20	0	-		100%
		Yes	0	0			
PA Tarso met joint Instab	Examiner 2	No	20	0	-		100%
		Yes	0	0			
Sympti	Examiner 2	No	6	2	0.583	0.009	80%
		Yes	2	10			

4.2.3 To determine the inter-examiner reliability of motion palpation of the foot and ankle joints in asymptomatic feet

The inter-examiner comparisons in asymptomatic feet are shown here.

4.2.3.1 Examiner 1 vs. examiner 2

Restriction

Table 9 shows that the agreement was generally poor for asymptomatic feet between these 2 examiners. The highest kappa value was 0.219 indicating slight agreement. The average percentage agreement was 87%.

Instability

Table 10 shows these two examiners had poor agreement with -0.071 being their highest kappa value. Their percentage agreement however, had an average of 93% agreement.

4.2.3.2 Examiner 1 vs Examiner 3

Restriction

Table 11 shows that the highest kappa recorded was 0.318 between these 2 examiners but on the whole the agreement was poor. Their percentage agreement was 87% average.

Instability

Table 12 shows that the highest kappa recorded was 0.459 between these 2 examiners but on the whole the agreement was poor. The average percentage agreement was 84%.

4.2.3.3 Examiner 2 vs Examiner 3

Restriction

Table 13 shows agreement was mostly worse than expected by chance, with the highest kappa value being -0.053. However, their average percentage agreement was 87%.

Instability

Table 14 shows that Kappa values were generally poor except for two measures where perfect agreement was recorded. Percentage agreement had an average of 96%.

Table 9: The inter-examiner reliability of examiner 1 vs. examiner 2 to detect restrictions in asymptomatic feet.

			Examiner 2		Kappa	P value	% agreement
			No	Yes			
AP Dtj Restric	Examiner 1	No	20	0	-		100%
		Yes	0	0			
PA dtj Restric	Examiner 1	No	18	2	-		90%
		Yes	0	0			
LA-Distraction Restric	Examiner 1	No	10	3	0.059	0.787	60%
		Yes	5	2			
AP Ttj Restric	Examiner 1	No	20	0	-		100%
		Yes	0	0			
PA Ttj Restric	Examiner 1	No	19	1	-		95%
		Yes	0	0			
ML Ttj Restric	Examiner 1	No	14	6	-		70%
		Yes	0	0			
LM Ttjr	Examiner 1	No	20	0	-		100%
		Yes	0	0			
AP Stj Restric	Examiner 1	No	18	2	-		90%
		Yes	0	0			
PA Stj Restric	Examiner 1	No	18	1	-0.053	0.814	90%
		Yes	1	0			
ML Stj Restric	Examiner 1	No	12	6	-0.176	0.329	60%
		Yes	2	0			
LM Stj Restric	Examiner 1	No	16	4	-		80%
		Yes	0	0			
AP Cub Restric	Examiner 1	No	14	0	0.219	0.117	75%
		Yes	5	1			
PA Cub Restric	Examiner 1	No	11	3	0.125	0.573	65%
		Yes	4	2			
AP Nav Restric	Examiner 1	No	17	1	-0.71	0.732	85%
		Yes	2	0			
PA Nav Restric	Examiner 1	No	17	1	-0.071	0.732	85%
		Yes	2	0			
AP Cun Restric	Examiner 1	No	20	0	-		100%
		Yes	0	0			
PA Cun Restric	Examiner 1	No	20	0	-		100%
		Yes	0	0			
AP Tarso met joint Restric	Examiner 1	No	20	0	-		100%
		Yes	0	0			
PA Tarso met joint Restric	Examiner 1	No	20	0	-		100%
		Yes	0	0			
symptr	Examiner 1	No	17	2	-0.017	0.732	85%
		Yes	1	0			

Table 10: The inter-examiner reliability of examiner 1 vs. examiner 2 to detect instability in asymptomatic feet.

			Examiner 2		Kappa	P value	% agreement
			No	Yes			
AP Dtj Instab	Examiner 1	No	18	2	-		90%
		Yes	0	0			
PA dtj Instab	Examiner 1	No	19	1	-		95%
		Yes	0	0			
LA-Distraction Instab	Examiner 1	No	16	3			80%
		Yes	1	0			
AP Ttj Instab	Examiner 1	No	19	0	-		95%
		Yes	1	0			
PA Ttj Instab	Examiner 1	No	19	0	-		95%
		Yes	0	0			
ML Ttj Instab	Examiner 1	No	19	0	-		95%
		Yes	1	0			
LM Ttjr Instab	Examiner 1	No	19	0	-		95%
		Yes	1	0			
AP Stj Instab	Examiner 1	No	19	0	-		95%
		Yes	1	0			
PA Stj Instab	Examiner 1	No	20	0	-		100%
		Yes	0	0			
ML Stj Instab	Examiner 1	No	17	1	-0.071	0.732	85%
		Yes	2	0			
LM Stj Instab	Examiner 1	No	17	1	-0.071	0.732	85%
		Yes	2	0			
AP Cub Instab	Examiner 1	No	16	0	-		80%
		Yes	4	0			
PA Cub Instab	Examiner 1	No	16	0	-		80%
		Yes	4	0			
AP Nav Instab	Examiner 1	No	20	0	-		100%
		Yes	0	0			
PA Nav Instab	Examiner 1	No	20	0	-		100%
		Yes	0	0			
AP Cun Instab	Examiner 1	No	20	0	-		100%
		Yes	0	0			
PA Cun Instab	Examiner 1	No	20	0	-		100%
		Yes	0	0			
AP Tarso met joint Instab	Examiner 1	No	20	0	-		100%
		Yes	0	0			
PA Tarso met joint Instab	Examiner 1	No	20	0	-		100%
		Yes	0	0			
Sympti	Examiner 1	No	14	3	-0.176	0.430	70%
		Yes	3	0			

Table 11: The inter-examiner reliability of examiner 1 vs. examiner 3 to detect restrictions in asymptomatic feet.

			Examiner 3		Kappa	P value	% agreement
			No	Yes			
AP Dtj Restric	Examiner 1	No	20	0	-		100%
		Yes	0	0			
PA dtj Restric	Examiner 1	No	19	1	-		95%
		Yes	0	0			
LA-Distraction Restric	Examiner 1	No	12	1	-0.96	0.452	60%
		Yes	7	0			
AP Ttj Restric	Examiner 1	No	20	0	-		100%
		Yes	0	0			
PA Ttj Restric	Examiner 1	no	19	1	-		95%
		yes	0	0			
ML Ttj Restric	Examiner 1	No	18	2	-		90%
		Yes	0	0			
LM Ttjr	Examiner 1	No	20	0	-		100%
		Yes	0	0			
AP Stj Restric	Examiner 1	No	18	0	-		90%
		Yes	2	0			
PA Stj Restric	Examiner 1	No	17	2	0.071	0.732	85%
		Yes	1	0			
ML Stj Restric	Examiner 1	No	16	2	0.318	0.144	80%
		Yes	1	1			
LM Stj Restric	Examiner 1	No	15	1	0.231	0.264	80%
		Yes	3	1			
AP Cub Restric	Examiner 1	No	13	1	-0.094	0.502	65%
		Yes	6	0			
PA Cub Restric	Examiner 1	No	12	2	0.176	0.329	60%
		Yes	6	0			
AP Nav Restric	Examiner 1	No	16	2	-0.111	0.619	80%
		Yes	2	0			
PA Nav Restric	Examiner 1	No	16	1	-0.071	0.732	80%
		Yes	2	0			
AP Cun Restric	Examiner 1	No	20	0	-		100%
		Yes	0	0			
PA Cun Restric	Examiner 1	No	20	0	-		100%
		Yes	0	0			
AP Tarso met joint Restric	Examiner 1	No	19	1	-		95%
		Yes	0	0			
PA Tarso met joint Restric	Examiner 1	No	20	0	-		100%
		Yes	0	0			
symptr	Examiner 1	No	17	2	-0.071	0.732	85%
		Yes	1	0			

Table 12: **The inter-examiner reliability of examiner 1 vs. examiner 3 to detect instability in asymptomatic feet.**

			Examiner 3		Kappa	P value	% Agreement
			No	Yes			
AP Dtj Instab	Examiner 1	No	19	1	-		95%
		Yes	0	0			
PA dtj Instab	Examiner 1	No	20	0	-		100%
		Yes	0	0			
LA-Distraction Instab	Examiner 1	No	17	2	0.459	0.015	90%
		Yes	0	1			
AP Ttj Instab	Examiner 1	No	18	1	-0.053	0.814	90%
		Yes	1	0			
PA Ttj Instab	Examiner 1	No	19	1	-		95%
		Yes	0	0			
ML Ttj Instab	Examiner 1	No	19	0	0.1000	0.000	100%
		Yes	0	1			
LM Ttjr Instab	Examiner 1	No	19	1	-		95%
		Yes	0	0			
AP Stj Instab	Examiner 1	No	19	0	0.1000	0.000	100%
		Yes	0	1			
PA Stj Instab	Examiner 1	No	19	1	-		95%
		Yes	0	0			
ML Stj Instab	Examiner 1	No	17	1	-0.071	0.732	85%
		Yes	2	0			
LM Stj Instab	Examiner 1	No	18	0	-		90%
		Yes	2	0			
AP Cub Instab	Examiner 1	No	16	0	-		80%
		Yes	4	0			
PA Cub Instab	Examiner 1	No	16	0	-		80%
		Yes	4	0			
AP Nav Instab	Examiner 1	No	20	0	-		100%
		Yes	0	0			
PA Nav Instab	Examiner 1	No	20	0	-		100%
		Yes	0	0			
AP Cun Instab	Examiner 1	No	20	0	-		100%
		Yes	0	0			
PA Cun Instab	Examiner 1	No	19	1	-		95%
		Yes	0	0			
AP Tarso met joint Instab	Examiner 1	No	20	0	-		100%
		Yes	0	0			
PA Tarso met joint Instab	Examiner 1	No	20	0	-		100%
		Yes	0	0			
Sympti	Examiner 1	No	16	1	0.318	0.144	85%
		Yes	2	1			

Table 13: The inter-examiner reliability of examiner 2 vs. examiner 3 to detect restrictions in asymptomatic feet.

			Examiner 3		Kappa	P value	% Agreement
			No	Yes			
AP Dtj Restric	Examiner 2	No	20	0	-		100%
		Yes	0	0			
PA dtj Restric	Examiner 2	No	17	1	-0.071	0.732	85%
		Yes	2	0			
LA-Distraction Restric	Examiner 2	No	14	1	-0.091	0.554	70%
		Yes	5	0			
AP Ttj Restric	Examiner 2	No	20	0	-		100%
		Yes	0	0			
PA Ttj Restric	Examiner 2	No	18	1	-0.053	0.814	90%
		Yes	1	0			
ML Ttj Restric	Examiner 2	No	12	2	-0.176	0.329	60%
		Yes	6	0			
LM Ttjr	Examiner 2	No	20	0	-		100%
		Yes	0	0			
AP Stj Restric	Examiner 2	No	20	0	-		100%
		Yes	0	0			
PA Stj Restric	Examiner 2	No	17	2	-0.071	0.732	85%
		Yes	1	0			
ML Stj Restric	Examiner 2	No	11	3	-0.250	0.219	55%
		Yes	6	0			
LM Stj Restric	Examiner 2	No	16	0	-		80%
		Yes	4	0			
AP Cub Restric	Examiner 2	No	18	1	-0.053	0.814	90%
		Yes	1	0			
PA Cub Restric	Examiner 2	No	13	2	-0.167	0.39	65%
		Yes	5	0			
AP Nav Restric	Examiner 2	No	17	2	-0.071	0.732	85%
		Yes	1	0			
PA Nav Restric	Examiner 2	No	18	1	-0.053	0.814	90%
		Yes	1	0			
AP Cun Restric	Examiner 2	No	20	0	-		100%
		Yes	0	0			
PA Cun Restric	Examiner 2	No	20	0	-		100%
		Yes	0	0			
AP Tarso met joint Restric	Examiner 2	No	19	1	-		95%
		Yes	0	0			
PA Tarso met joint Restric	Examiner 2	No	20	0	-		100%
		Yes	0	0			
symptr	Examiner 2	No	16	2	-0.111	0.619	80%
		Yes	2	0			

Table 14: **The inter-examiner reliability of examiner 2 vs. examiner 3 to detect instability in asymptomatic feet.**

			Examiner 3		Kappa	P value	% Agreement
			No	Yes			
AP Dtj Instab	Examiner 2	No	17	1	-0.071	0.732	85%
		Yes	2	0			
PA dtj Instab	Examiner 2	No	19	0	-		95%
		Yes	1	0			
LA-Distraction Instab	Examiner 2	No	16	3	-0.081	0.666	80%
		Yes	1	0			
AP Ttj Instab	Examiner 2	No	19	1	-		95%
		Yes	0	0			
PA Ttj Instab	Examiner 2	No	19	0	1.000	0.000	95%
		Yes	0	1			
ML Ttj Instab	Examiner 2	No	19	1	-		95%
		Yes	0	0			
LM Ttj Instab	Examiner 2	No	20	0	-		100%
		Yes	0	0			
AP Stj Instab	Examiner 2	No	19	1	-		95%
		Yes	0	0			
PA Stj Instab	Examiner 2	No	19	1	-		95%
		Yes	0	0			
ML Stj Instab	Examiner 2	No	19	0	1.000	<0.001	100%
		Yes	0	1			
LM Stj Instab	Examiner 2	No	19	0	-		95%
		Yes	1	0			
AP Cub Instab	Examiner 2	No	20	0	-		100%
		Yes	0	0			
PA Cub Instab	Examiner 2	No	20	0	-		100%
		Yes	0	0			
AP Nav Instab	Examiner 2	No	20	0	-		100%
		Yes	0	0			
PA Nav Instab	Examiner 2	No	20	0	-		100%
		Yes	0	0			
AP Cun Instab	Examiner 2	No	20	0	-		100%
		Yes	0	0			
PA Cun Instab	Examiner 2	No	19	1	-		95%
		Yes	0	0			
AP Tarso met joint Instab	Examiner 2	No	20	0	-		100%
		Yes	0	0			
PA Tarso met joint Instab	Examiner 2	No	20	0	-		100%
		Yes	0	0			
Sympti	Examiner2	No	16	1	0.318	0.144	85%
		Yes	2	1			

4.2.4 To determine the percentage of agreement between all 3 examiners in symptomatic feet

The mean percentage of agreement between all three examiners simultaneously was calculated as reported in the methodology section. The percentages are ranked from lowest to highest in the following tables.

4.2.4.1 Restriction

Table 15: Percentage agreement between examiners

	Mean
Agreement AP Cub	79.96
Agreement PA Cub	83.30
Agreement ML Stj	88.31
Agreement PA Nav	88.31
Agreement AP Nav	89.98
Agreement LA-Distraction	91.65
Agreement ML Ttj	93.32
Agreement LM Ttj	94.99
Agreement LM Stj	94.99
Agreement AP Tarso met joint	94.99
Agreement PA Tarso met joint	94.99
Agreement AP Dtj	96.66
Agreement PA Dtj	98.33
Agreement PA Ttj	98.33
Agreement AP Stj	98.33
Agreement AP Ttj	100.00
Agreement PA Stj	100.00
Agreement AP Cun	100.00
Agreement PA Cun	100.00

4.2.4.2 Instability

Table 16: Percentage agreement between examiners

	Mean
Agreement LA-Distraction	79.96
Agreement LM Stj	79.96
Agreement AP Ttj	81.63
Agreement PA Stj	81.63
Agreement AP Dtj	84.97
Agreement ML Ttj	86.64
Agreement ML Stj	86.64
Agreement PA Dtj	88.31
Agreement PA Ttj	93.32
Agreement AP Cub	96.66
Agreement LM Ttj	98.33
Agreement AP Stj	98.33
Agreement PA Cub	98.33
Agreement AP Nav	100.00
Agreement PA Nav	100.00
Agreement AP Cun	100.00
Agreement PA Cun	100.00
Agreement AP Tarso met joint	100.00
Agreement PA Tarso met joint	100.00

4.2.5 To determine the inter-examiner percentage of agreement between all 3 examiners in asymptomatic feet

The mean percentage of agreement between all three examiners simultaneously was calculated as reported in the methodology section. The percentages are ranked from lowest to highest in the following tables.

4.2.5.1 Restriction

Table 17: Percentage agreement between examiners

	Mean
Agreement LA-Distraction	81.63
Agreement PA Cub	81.63
Agreement ML Stj	83.30
Agreement ML Ttj	86.64
Agreement AP Cub	88.31
Agreement LM Stj	91.65
Agreement AP Nav	91.65
Agreement PA Stj	93.32
Agreement PA Nav	93.32
Agreement PA Dtj	94.99
Agreement PA Ttj	96.66
Agreement AP Stj	96.66
Agreement AP Tarso met joint	98.33
Agreement AP Dtj	100.00
Agreement AP Ttj	100.00
Agreement LM Ttj	100.00
Agreement AP Cun	100.00
Agreement PA Cun	100.00
Agreement PA Tarso met joint	100.00

4.2.5.2 Instability

Table 18: Percentage agreement between examiners

	Mean
Agreement LA-Distraction	89.98
Agreement AP Cub	93.32
Agreement PA Cub	93.32
Agreement AP Dtj	94.99
Agreement ML Stj	94.99
Agreement LM Stj	94.99
Agreement AP Ttj	96.66
Agreement PA Dtj	98.33
Agreement PA Ttj	98.33
Agreement ML Ttj	98.33
Agreement LM Ttj	98.33
Agreement AP Stj	98.33
Agreement PA Stj	98.33
Agreement PA Cun	98.33
Agreement AP Nav	100.00
Agreement PA Nav	100.00
Agreement AP Cun	100.00
Agreement AP Tarso met joint	100.00
Agreement PA Tarso met joint	100.00

4.2.6 To compare motion palpation findings in symptomatic and asymptomatic feet

4.2.6.1 Comparison of reliability between symptomatic and asymptomatic feet

Kappa values were extracted from the tables 3 to 14, and compared between the symptomatic and asymptomatic feet. Only those measurements in which valid kappa values from both symptomatic and asymptomatic feet were obtained were used in the analysis (n=25). Non parametric testing was used since the kappa values were non normally distributed. Paired Wilcoxon signed ranks test was used since the symptomatic and asymptomatic feet were paired.

The table below shows that there was a borderline non significant difference in Kappa values between the two groups (p=0.074). There were a greater number of negative ranks than positive ranks, suggesting a trend towards the asymptomatic kappa values being lower than the symptomatic values. Figure 3 also shows that the general distribution of kappa values was lower in the asymptomatic group.

Table 19: Wilcoxon signed ranks test to compare the kappa values between symptomatic and asymptomatic feet

		N	Mean Rank	Sum of Ranks
Asymptomatic - symptomatic	Negative Ranks	15(a)	15.27	229.00
	Positive Ranks	10(b)	9.60	96.00
	Ties	0(c)		
	Total	25		

a asymptomatic < symptomatic
b asymptomatic > symptomatic
c asymptomatic = symptomatic

Test Statistics(b)

	asymptomatic - symptomatic
Z	-1.789(a)
Asymp. Sig. (2-tailed)	0.074

a Based on positive ranks.
b Wilcoxon Signed Ranks Test

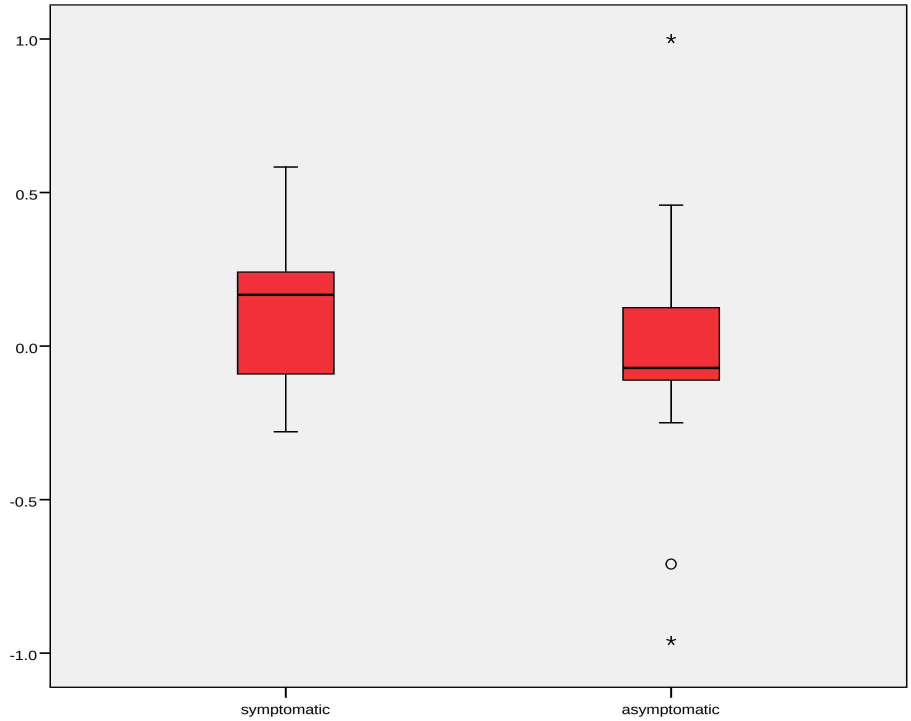

Figure 3: Boxplot of the distribution of Kappa values between the symptomatic and asymptomatic feet

4.2.6.2 Comparison of restrictions between symptomatic and asymptomatic feet

Table 20 shows that there was a borderline non significant difference in long axis distraction restriction between symptomatic and asymptomatic feet (p=0.058). More restrictions were found in asymptomatic feet. No other difference reached statistical significance.

Table 20: Comparison of restrictions between symptomatic and asymptomatic feet

		Actual foot symptomatic				P value
		No		Yes		
		Count	Column %	Count	Column %	
AP Dtj Restric	No	20	100.0%	20	100.0%	-
	Yes	0	.0%	0	.0%	
PA dtj Restric	No	20	100.0%	20	100.0%	-
	Yes	0	.0%	0	.0%	
LA-Distraction Restric	No	13	65.0%	18	90.0%	0.058
	Yes	7	35.0%	2	10.0%	
AP Ttj Restric	No	20	100.0%	20	100.0%	-
	Yes	0	.0%	0	.0%	
PA Ttj Restric	No	20	100.0%	20	100.0%	-
	Yes	0	.0%	0	.0%	
ML Ttj Restric	No	20	100.0%	19	95.0%	0.311
	Yes	0	.0%	1	5.0%	
LM Ttjr	No	20	100.0%	19	95.0%	0.311
	Yes	0	.0%	1	5.0%	
AP Stj Restric	No	18	90.0%	19	95.0%	0.548
	Yes	2	10.0%	1	5.0%	
PA Stj Restric	No	19	95.0%	20	100.0%	0.311
	Yes	1	5.0%	0	.0%	
ML Stj Restric	No	18	90.0%	20	100.0%	0.147
	Yes	2	10.0%	0	.0%	
LM Stj Restric	No	16	80.0%	20	100.0%	0.035
	Yes	4	20.0%	0	.0%	
AP Cub Restric	No	14	70.0%	12	60.0%	0.507
	Yes	6	30.0%	8	40.0%	
PA Cub Restric	No	14	70.0%	12	60.0%	0.507
	Yes	6	30.0%	8	40.0%	

AP Nav Restric	No	18	90.0%	15	75.0%	0.212
	Yes	2	10.0%	5	25.0%	
PA Nav Restric	No	18	90.0%	16	80.0%	0.376
	Yes	2	10.0%	4	20.0%	
AP Cun Restric	No	20	100.0%	20	100.0%	-
	Yes	0	.0%	0	.0%	
PA Cun Restric	No	20	100.0%	20	100.0%	-
	Yes	0	.0%	0	.0%	
AP Tarso met joint Restric	No	20	100.0%	20	100.0%	-
	Yes	0	.0%	0	.0%	
PA Tarso met joint Restric	No	20	100.0%	20	100.0%	-
	Yes	0	.0%	0	.0%	

4.2.6.3 Comparison of instability between symptomatic and asymptomatic feet

Table 21 shows that long axis distraction (p=0.001), anterior to posterior glide of the tibiotalar joint (p=0.003), posterior to anterior glide of the subtalar joint (p<0.001), and lateral to medial tilt of the subtalar joint (p=0.006) instability were significantly more common in symptomatic feet.

Table 21: Comparison of instability between symptomatic and asymptomatic feet

		Actual foot symptomatic				P value
		No		Yes		
		Count	Column %	Count	Column %	
AP Dtj Instab	No	20	100.0%	18	90.0%	0.147
	Yes	0	.0%	2	10.0%	
PA dtj Instab	No	20	100.0%	18	90.0%	0.147
	Yes	0	.0%	2	10.0%	
LA-Distraction Instab	No	19	95.0%	10	50.0%	0.001
	Yes	1	5.0%	10	50.0%	
AP Ttj Instab	No	19	95.0%	11	55.0%	0.003
	Yes	1	5.0%	9	45.0%	
PA Ttj Instab	No	20	100.0%	17	85.0%	0.072
	Yes	0	.0%	3	15.0%	
ML Ttj Instab	No	19	95.0%	15	75.0%	0.077
	Yes	1	5.0%	5	25.0%	
LM Ttjr Instab	No	19	95.0%	19	95.0%	1
	Yes	1	5.0%	1	5.0%	
AP Stj Instab	No	19	95.0%	19	95.0%	1
	Yes	1	5.0%	1	5.0%	
PA Stj Instab	No	20	100.0%	10	50.0%	<0.001
	Yes	0	.0%	10	50.0%	
ML Stj Instab	No	18	90.0%	17	85.0%	0.633
	Yes	2	10.0%	3	15.0%	
LM Stj Instab	No	18	90.0%	10	50.0%	0.006
	Yes	2	10.0%	10	50.0%	
AP Cub Instab	No	16	80.0%	19	95.0%	0.151
	Yes	4	20.0%	1	5.0%	
PA Cub Instab	No	16	80.0%	19	95.0%	0.151
	Yes	4	20.0%	1	5.0%	
AP Nav Instab	No	20	100.0%	20	100.0%	-
	Yes	0	.0%	0	.0%	
PA Nav Instab	No	20	100.0%	20	100.0%	-
	Yes	0	.0%	0	.0%	

AP Cun Instab	No	20	100.0%	20	100.0%	-
	Yes	0	.0%	0	.0%	
PA Cun Instab	No	20	100.0%	20	100.0%	-
	Yes	0	.0%	0	.0%	
AP Tarso met joint Instab	No	20	100.0%	20	100.0%	-
	Yes	0	.0%	0	.0%	
PA Tarso met joint Instab	No	20	100.0%	20	100.0%	-
	Yes	0	.0%	0	.0%	

4.2.7 To ascertain whether each examiner correctly identified the symptomatic foot

5.2.7.1 Examiner 1

a.) Restriction

There was a very significant difference between the actual symptomatic foot and those assessed by examiner 1 to be symptomatic (p<0.001). Examiner 1 only identified 5% of the symptomatic feet for restriction. Sensitivity was therefore 5% but specificity was 95% meaning examiner 1 correctly excluded restriction in 95% of the non symptomatic feet.

Table 22: To ascertain whether examiner 1 correctly identified the symptomatic foot

Examiner 1			Actual foot symptomatic		Total
			No	Yes	
1	No	Count	19	19	38
		% within Actual foot symptomatic	95.0%	95.0%	95.0%
	Yes	Count	1	1	2
		% within Actual foot symptomatic	5.0%	5.0%	5.0%
Total		Count	20	20	40
		% within Actual foot symptomatic	100.0%	100.0%	100.0%

McNemar's chi square p <0.001

b.) Instability

There was no difference between the actual symptomatic foot and those assessed by examiner 1 to be symptomatic (p=0.727). Examiner 1 identified 75% of the symptomatic feet for instability. Sensitivity was therefore 75% and specificity was 85% meaning examiner 1 correctly excluded instability in 85% of the non symptomatic feet.

Table 23: To ascertain whether examiner 1 correctly identified the symptomatic foot

Examiner 1			Actual foot symptomatic		Total
			No	Yes	
1	No	Count	17	5	22
		% Within Actual foot symptomatic	85.0%	25.0%	55.0%
	Yes	Count	3	15	18
		% Within Actual foot symptomatic	15.0%	75.0%	45.0%
Total		Count	20	20	40
		% Within Actual foot symptomatic	100.0%	100.0%	100.0%

McNemar's chi square p=0.727

5.2.7.2 Examiner 2

c.) Restriction

There was a very significant difference between the actual symptomatic foot and those assessed by examiner 2 to be symptomatic (p=0.001). Examiner 2 only identified 15% of the symptomatic feet for restriction. Sensitivity was therefore 15% but specificity was 90% meaning examiner 2 correctly excluded restriction in 90% of the non symptomatic feet.

Table 24: **To ascertain whether examiner 2 correctly identified the symptomatic foot**

Examiner 2			Actual foot symptomatic		Total
			No	Yes	
2	No	Count	18	17	35
		% Within Actual foot symptomatic	90.0%	85.0%	87.5%
	Yes	Count	2	3	5
		% Within Actual foot symptomatic	10.0%	15.0%	12.5%
Total		Count	20	20	40
		% Within Actual foot symptomatic	100.0%	100.0%	100.0%

McNemar's chi square p=0.001

d.) Instability

There was no difference between the actual symptomatic foot and those assessed by examiner 2 to be symptomatic (p=0.227). Examiner 2 identified 60% of the symptomatic feet for instability. Sensitivity was therefore 60% and specificity was 85% meaning examiner 2 correctly excluded instability in 85% of the non symptomatic feet.

Table 25: To ascertain whether examiner 2 correctly identified the symptomatic foot

Examiner 2			Actual foot symptomatic		Total
			No	Yes	No
2	No	Count	17	8	25
		% within Actual foot symptomatic	85.0%	40.0%	62.5%
	Yes	Count	3	12	15
		% within Actual foot symptomatic	15.0%	60.0%	37.5%
Total		Count	20	20	40
		% within Actual foot symptomatic	100.0%	100.0%	100.0%

McNemar's chi square p=0.227

5.2.7.3 Examiner 3

e.) Restriction

There was a very significant difference between the actual symptomatic foot and those assessed by examiner 3 to be symptomatic (p=0.001). Examiner 3 only identified 15% of the symptomatic feet for restriction. Sensitivity was therefore 15% but specificity was 90% meaning examiner 3 correctly excluded restriction in 90% of the non symptomatic feet.

Table 26: To ascertain whether examiner 3 correctly identified the symptomatic foot

Examiner 3			Actual foot symptomatic		Total
			No	Yes	No
3	No	Count	18	8	26
		% Within Actual foot symptomatic	90.0%	40.0%	65.0%
	Yes	Count	2	12	14
		% Within Actual foot symptomatic	10.0%	60.0%	35.0%
Total		Count	20	20	40
		% Within Actual foot symptomatic	100.0%	100.0%	100.0%

McNemar's chi square p=0.109

f.) Instability

There was no significant difference between the actual symptomatic foot and those assessed by examiner 3 to be symptomatic (p=0.109). Examiner 3 identified 60% of the symptomatic feet for instability. Sensitivity was therefore 60% and specificity was 90% meaning examiner 3 correctly excluded instability in 90% of the non symptomatic feet.

Table 27: To ascertain whether examiner 3 correctly identified the symptomatic foot

Examiner 3			Actual foot symptomatic		Total
			No	Yes	
3	No	Count	18	17	35
		% within Actual foot symptomatic	90.0%	85.0%	87.5%
	Yes	Count	2	3	5
		% within Actual foot symptomatic	10.0%	15.0%	12.5%
Total		Count	20	20	40
		% within Actual foot symptomatic	100.0%	100.0%	100.0%

McNemar's chi square p=0.001

CHAPTER 5

5.1 INTRODUCTION

This chapter will discuss all results obtained in the previous chapter.

A sample size of twenty patients was used who presented with one symptomatic foot and one asymptomatic foot. Each patient received the same assessment of both feet by three examiners independently, to determine the inter-examiner reliability of motion palpation in the hindfoot and midfoot joints to detect joint dysfunction. Cohens Kappa along with percentage agreement statistical methods were used. Cohens Kappa, the most used statistical method used to detect reproducibility (Stochkendahl *et al.* 2006) has become increasingly used in clinical research to assess the validity and reliability of diagnostic procedures. However, there has been criticism of its use (Lantz, 1997). Taking this criticism into consideration, Kappa should not be used as the 'gold' standard to interpret agreement and when using Kappa in a study one should not use it in isolation or as the sole method for statistical analysis (Brantingham *et al*., 2003). Taking the above criticism into consideration this dissertation used Cohens Kappa as the primary data along with percentage agreement as secondary data to support the primary data.

In this study a Kappa value could not be established in a considerable number of movements in the foot and ankle joints because there were too many zero values. This meant that the examiners did not find joint dysfunction within each of the 19 directions of movement that were investigated. According to Haas (1991), results with a high percentage agreement but a low kappa value indicate limited variation. One situation where limited variation may take place is when there is a large proportion of agreement (Haas, 1991). The results of this study were in keeping with this as they had low kappa values and high percentage agreement. This could have been the result of a high proportion of agreement that no joint dysfunction was present.

For ease of reference this Table has been repeated.

Table 27: Scale for the interpretation of Kappa

0.81-2.0	Almost perfect
0.61-0.81	Substantial
0.41-0.61	Moderate
0.21-0.41	Fair
0.00-0.21	Slight
<0.00	Poor

(Landis and Koch, 1977)

5.2 DISCUSSION

Objective 1: To determine the inter-examiner reliability of motion palpation of the foot and ankle joints in patients with chronic ankle instability syndrome.

5.2.1.1. Inter examiner reliability to determine the presence of restrictions (tables 3,5, 7) in terms of Kappa statistical analysis:

The inter-examiner reliability ranged from poor to almost perfect with Kappa values ranging from -0,279 to a perfect Kappa value of 1 when looking at all three-examiner combinations (ie. Examiner 1 vs. 2, 1 vs. 3 and 2 vs. 3) in Tables 3, 5 and 7. The mean Kappa values for each Table were added together and divided by the 3 to find the mean Kappa for all three-examiner combinations. The mean Kappa was 0.267 indicating fair agreement.

Previous inter-examiner reliability studies done primarily on motion palpation of the spine, showed poor inter-examiner reliability (Stochkendahl *et al.* 2006). Stochkendahl *et al*., (2006) study was a review of inter-examiner reliability studies performed on the spine and does not specify whether the patients assessed were symptomatic or asymptomatic. However, an inter-examiner reliability study performed on the cervical spine using both symptomatic and asymptomatic patients showed that inter-examiner reliability among the symptomatic population of the study had a statistically significant inter-examiner reliability between them (Lakhani *et al*., 2009). Similarly an extremity study performed to assess the inter-examiner reliability of the circumduction test for general joint mobility in the foot, revealed a moderate (K=0.452) agreement between examiners in the symptomatic foot (Brantingham, 2003).

Motion palpation as an assessment tool to detect specific restrictions in the joints in the foot and ankle in patients with CAIS, showed to have more inter-examiner reliability than spinal motion palpation but less inter-examiner reliability than the circumduction test to detect general foot mobility. One reason why extremity motion palpation studies could have higher inter-examiner reliability than spinal, is that the examiner has the other extremity to compare their findings.

5.2.1.2. Inter examiner reliability to determine the presence of instability (tables 4, 6, 8) in terms of Kappa statistical analysis:

The inter-examiner reliability ranged from –0.154 to 0.459 between the three examiner combinations and the average Kappa value was 0.419 indicating moderate (Landis and Koch, 1977) agreement between the examiners. There has been a lack of inter-examiner-reliability studies performed to investigate whether motion palpation is a reliable assessment tool to detect instability. But, despite the lack of inter-examiner reliability studies, the literature states that mechanical instability (an increased accessory movement at the joint) is a cause of CAIS and that mechanical instability is associated with hypermobility (Denegar and Miller, 2002). Also, studies performed by Bernier, Perrin and Rijke (1997) and Hertel *et al*. (1999) found that there was ligament laxity and instability of the mortise and subtalar joints. Therefore, a moderate agreement between examiners to detect instability is a positive finding as it shows that motion palpation is capable of detecting mechanical instability of the hindfoot and midfoot in patients with CAIS.

5.2.2 Objective 2: To determine the inter-examiner reliability of motion palpation of the foot and ankle joints in asymptomatic feet.

5.2.2.1 Inter examiner reliability to determine the presence of restrictions (tables 8,10,12) in asymptomatic feet in terms of Kappa statistical analysis:

In the asymptomatic group, the Kappa values ranged from –0.250 to 0.318 indicating poor to fair inter-examiner reliability. The mean Kappa value for detecting restrictions in asymptomatic foot and ankle joints was –0.248 indicating poor inter-examiner reliability. This is not in keeping with Brantingham *et al*., (2003) study that assessed the inter-examiner reliability of the circumduction test to detect general joint mobility in asymptomatic and symptomatic feet. They found that examiners had excellent agreement when assessing the circumduction test in asymptomatic feet (Brantingham *et al.*, 2003). One possible reason why the Kappa values were low compared to Brantingham *et al.,* (2003) could be because the examiners were required to palpate each individual joint as opposed to the general mobility of the foot. The percentage agreement was high between examiners indicating that although the examiners had low agreement between them with regards to the restrictions present they did agree when no restriction was present.

5.2.2.2 Inter examiner reliability to determine the presence of instability (tables 9, 11, 13) in asymptomatic feet in terms of Kappa statistical analysis:

Kappa values ranged from –0.081 to a perfect score of one, resulting in the average Kappa score being 0,478. This indicated that there was moderate inter-examiner reliability (Landis and Koch, 1977). Only one movement was reported to have instability in all three-examiner combinations namely; medial to lateral subtalar joint instability.

5.2.3 Objective 3: To determine if motion palpation is reliable irrespective of pathology.

The mean Kappa values for the symptomatic and asymptomatic groups were calculated by adding the mean Kappa value for the inter examiner reliability of motion palpation to detect restrictions and instability and divided by two to find the mean Kappa value for the symptomatic group as a whole and the asymptomatic group as a whole. It was found that the mean Kappa value for the symptomatic group was 0.343 and asymptomatic group was 0.115, showing that the symptomatic group had higher inter-examiner reliability. This was contrary to Brantingham *et al*., (2003) study where the inter examiner agreement to assess for decreased mobility, using the circumduction test, was higher in the asymptomatic feet with a Kappa value of 0.85. However, this was similar to finding of Lakhani *et al*. (2009) who found that the motion palpation findings were statistically significantly higher in the symptomatic group. From a clinical point this is a positive finding as this indicates that the examiners have more inter-examiner reliability when assessing the symptomatic foot, which in practice is the foot being assessed.

The comparison of inter-examiner reliability between symptomatic and asymptomatic feet for detecting instability was better than the inter examiner reliability when detecting restrictions. As no previous inter-examiner reliability studies have investigated the inter-examiner reliability of motion palpation to detect instability, no comparisons can be drawn.

Overall percentage agreement was high in both the symptomatic and asymptomatic groups when detecting joint dysfunction, although percentage agreement includes agreement between examiners when listing that no joint dysfunction was present.

5.2.4 To determine the presence or absence of joint dysfunction in both groups and then compare findings between groups.

5.2.4.1 Symptomatic:

The examiners had the highest inter-examiner agreement when detecting restrictions in the talocrural joint in a medial to lateral direction and posterior to anterior movement of the cuboid.

Previous research on chronic ankle instability syndrome showed that the following joints were found to be hypomobile in patients with CAIS:

- Subtalar, (Meadows, 2002)

- Talocrural joint, (Denegar, Hertel and Fonseca, 2002; Green *et al*., 2001; Dananberg, Shearstone and Guillano, 2000 and Crosbie, Green and Refshauge, 1999),
- Distal tibiofibular joint, (Kavanagh, 1999; O'Brien and Vicenzino, 1998), or
- Proximal tibiofibular joint (Meadows, 2002; Dananberg, Shearstone and Guillano, 2000).

Motion palpation findings in this dissertation were in keeping with recent literature on hypomobilty of the talocrural joint. Even though the Kappa values only showed fair agreement. The presence of specific joint dysfunctions in the midfoot with CAI has not yet been investigated.

More movements were reported to have instability in the symptomatic group (tables 4, 6, 8) than the asymptomatic group. Instability was found in the following movements:

- Anterior to posterior and posterior to anterior glide of the distal tibiofibular joint,
- Long axis distraction and medial to lateral movements of the talocrural joint and
- Medial to lateral movement of the subtalar joint.

The above results were similar to Hertel, Denegar, Monroe and Stokes, (1999) who found that 75% of subjects with a history of ankle sprains showed to have laxity of the talocrural joint on stress fluoroscopy, and two thirds of those who had talocrural laxity also showed to have subtalar joint laxity.

5.2.4.2 Asymptomatic:

The examiners had the highest inter-examiner reliability when detecting restrictions in the subtalar joint in a medial to lateral position as well as a posterior to anterior direction, and the cuboid in an anterior to posterior direction. The presence of the above restrictions in the asymptomatic foot could suggest that secondary restrictions occur as a result of compensating for the symptomatic foot. However, one cannot categorically state this until further research is performed on an asymptomatic population group.

Only one movement was reported to have instability in all three-examiner combinations namely medial to lateral subtalar joint instability.

5.2.4.3 Conclusion:

The asymptomatic group showed to have more restrictions reported by the examiners, however, their inter-examiner reliability was poor. No other difference reached statistical significance between symptomatic and asymptomatic feet. It was found that instability in long axis distraction (p=0.001), anterior to posterior glide of the tibiotalar joint (p=0.003), posterior to anterior glide of the subtalar joint (p<0.001), and lateral to medial tilt of the subtalar joint (p=0.006) was significantly more common in symptomatic feet. This supports previous research that suggests the presence of joint dysfunction prior to manipulation in patients with chronic ankle instability syndrome (Pellow and Brantingham, 2001).

5.2.5 To determine the percentage of agreement between all 3 examiners in symptomatic feet

The percentage agreement between the three examiners was high, however it includes agreement that there was no restriction or instability present. This is a positive finding for the use of motion palpation because the examiners showed a high (above 80%) percentage of agreement. It was noted that the joints that had the highest percentage agreement were those joints that the examiners did not find to be restricted or unstable in any of the patients. It is therefore assumed that no joint dysfunction was present.

CHAPTER 6

6.1 CONCLUSION

The objectives that were outlined in Chapter 1 will be revisited in this chapter now that the results of the study have been recorded and discussed.

The purpose of this study was to determine the inter-examiner reliability of motion palpation to detect joint dysfunction in asymptomatic feet and in feet with chronic ankle instability syndrome (CAIS).

Objective 1: To determine the inter-examiner reliability of motion palpation of the hindfoot and midfoot joints in patients with chronic ankle instability syndrome.

It was found that the inter examiner reliability of motion palpation for detecting restrictions in feet with chronic ankle instability syndrome showed to have fair Kappa agreement, whereas to detect instability they had moderate Kappa agreement.

Objective 2: To determine the inter-examiner reliability of motion palpation of the hindfoot and midfoot joints in asymptomatic feet.

Inter-examiner reliability in the asymptomatic feet showed to have poor Kappa agreement in detecting restrictions and moderate Kappa agreement in detecting instability.

Objective 3: To determine if motion palpation is reliable irrespective of pathology.

Inter-examiner reliability was higher in the symptomatic group and the examiners had more agreement when detecting instability then restrictions.

Objective 4: To determine the presence or absence of restrictions and instability in both groups and then compare findings between groups.

Instability in long axis distraction ($p=0.001$), anterior to posterior glide of the tibiotalar joint ($p=0.003$), posterior to anterior glide of the subtalar joint ($p<0.001$), and lateral to medial tilt of the subtalar joint ($p=0.006$) were more common in the symptomatic group. A statistical comparison showed that asymptomatic feet showed to have more agreement that restrictions were present. However, no other difference reached statistical significance between symptomatic and asymptomatic feet. The examiners had high specificity when detecting which foot was the symptomatic foot.

Motion palpation of the midfoot and hindfoot joints showed to have higher inter-examiner reliability when detecting instability and when assessing the symptomatic foot. Although motion palpation was not reliable enough to detect joint dysfunction in all the joints in the hindfoot and midfoot, the examiners were able to detect which foot was symptomatic. Also the examiners had a high percentage agreement with respect to when no joint dysfunction was present. The latter has not been investigated or included in previous motion palpation studies and is of importance as it showed that although the examiners did not always agree on the direction of the joint dysfunction. They did still have a high percentage agreement between them.

To conclude it is important to note that even though motion palpation may not be a specific assessment tool it can still be used as a sensitive tool that can be used with a variety of assessment tools to make clinical decisions with respect to instability in CAI.

6.2 RECOMMENDATIONS

- This study consisted of 85% males and 15% females, the examiners found that the females were easier to palpate, future motion palpation studies should ensure equal distribution of males and females in the sample group.

- When using Kappa one must ensure that the outcomes are not too similar (as discussed in the methodology) as this results in too many zero Kappa values and therefore, less statistics for comparison.

- The comparison of inter examiner reliability between symptomatic and asymptomatic feet in detecting instability was better than the inter examiner reliability when detecting restrictions. In the literature found for the purpose of this study, no previous inter-examiner reliability studies have investigated the inter-examiner reliability of motion palpation to detect instability. The above findings suggest that future inter-examiner reliability studies should investigate joint dysfunction that encompasses both restrictions and instability individually.

- It has been shown in many studies that dorsiflexion is a movement that is limited in CAIS, (Wolfe *et al*., 2001; Liu, Siegler and Techner, 2001 and Garrick and Webb, 1990) this movement was not investigated in this study as it does not form part of the motion palpatory procedures discussed in Schafer and Faye (1989) and Bergmann, Peterson and Lawrence, (1993). Future studies should include dorsiflexion range of motion when investigating patients with CAI.

- Future studies should investigate the inter-examiner reliability of motion palpation in other extremity joints. A comparison between previous spinal motion palpation inter-examiner reliability studies and extremity joint motion palpation studies could then be performed to assess whether the results differ.

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APPENDIX A

Letter of Information and Consent

Title of the Research Study:
The inter-examiner reliability of motion palpation to detect restrictions in hindfoot and midfoot joints.

Principle Investigator/s:
Lisa Williams,
Contact number: 0723351312

Co-Investigator/s:
Dr. H. Kretzmann, M Dip Chiropractic.
Contact number: (031) 2055520

Brief Introduction and Purpose of the Study:
You have been selected to take part in a study investigating the reliability of motion palpation as an assessment tool in detecting restrictions in the hindfoot and midfoot joints.

20 People will be required to complete this study.

Outline of the Procedures:
At the first consultation you will read this information sheet and ask any questions about the research. If you agree to take part in this research, you will sign this form. The researcher will take a case history and do a physical examination as well as an exam of both your feet and ankles. Three examiners will then enter the room, one at a time, and motion palpate your feet, recording any restrictions they find. You are encouraged not to communicate with these examiners. Once these examiners have assessed your feet the research component is complete and you may receive one free treatment if you so wish. All procedures will be performed under the supervision of a qualified chiropractor.

Risks or Discomforts to the Subject:
The examination procedure is unlikely to be painful or cause any side effects.

Benefits:
Your full co-operation will assist the Chiropractic profession in expanding its knowledge on the reliability of motion palpation as an assessment tool. Results will be made available in the form of a dissertation at the Durban University of Technology library. You will have the option to have a free treatment for chronic ankle instability syndrome.

Subjects may withdraw from the study:
You are free to leave the study at any time.

Remuneration:
You will not be offered any form of remuneration for taking part in the study

Costs of the Study:
There will be no costs involved for the subjects. The treatments are free.

Confidentiality:
All your medical records will be kept confidential and will be stored in the Chiropractic Day Clinic for 5 years, after which it will be shredded. Your name will not appear on any of the data sheets or the thesis.

Research-related Injury:
The risk of injury is minimal, however, if you do sustain any injuries or have any side effects to the treatment, free treatment will be offered to you at the chiropractic day clinic if the side effect falls into the scope of chiropractic.

Persons to Contact in the Event of Any Problems or Queries:
Please don't hesitate to ask questions on any aspect of this study. Should you have any complaints or queries, please do not hesitate to contact my research supervisor at the above details or the Faculty of Health officer for Faculty of Health Sciences at (031) 373 2701.

Statement of Agreement to Participate in the Research Study:
(I,……………………………………………subject's full name, ID number…………………………………………….., have read this document in its entirety and understand its contents. Where I have had any questions or queries, these have been explained to me by ……………………………………………….to my satisfaction. Furthermore, I fully understand that I may withdraw from this study at any stage without any adverse consequences and my future health care will not be compromised. I, therefore, voluntarily agree to participate in this study.

Subject's name (print) ……………………………
Subject's signature: ………………………….. Date: ……………..
Researcher's name (print): ……………………...
Researcher's signature: ………………………..Date: ....
Witness name (print): ....
Witness signature: ……….................................Date: ………………
Supervisor's name (print): ...…………………….
Supervisor's signature: ………………………Date: ……………….

APPENDIX B

Are you between the ages of 18-50?

Do you suffer with recurrent ankle sprains?

**Research is currently being conducted at the Chiropractic Day Clinic
Durban University of Technology
where you can receive a free assessment of your ankle should you qualify for this study.**

**For further information please contact Lisa on
(031) 373 2205**

APPENDIX C:

Method of Motion Palpation

Distal Tibiofibular joint

Anterior-posterior (A-P) glide / Posterior-anterior (P-A) glide:

Patient is in lateral recumbent position, the ankle being tested is the upper one. The examiner stands perpendicular to the ankle, A-P glide is tested by grabbing the patients heel with the caudal hand and the distal part of the patients leg with the cephalid hand. Placing both the thumbs against the anterior surface of of the lateral malleolus and push foreward to test A-P glide. To test P-A glide place the finger tips against the posterior aspect of the lateral malleolus and pull foreward (Schafer,RC. and Faye, LJ. 1990).

The Ankle Mortise

Long-axis extension:

Patient lies in lateral recumbent position with their hip and knee flexed at 90' angle. The examiner sits with their back against the patients thigh, gripping the patients heel and talus by placing web contacts over the talar dome and superior aspect of the calcaneus (Bergmann. TF. *et al.*, 1993. pp 702) The patients foot is pushed away with both hands so as to distract the mortise joint (Schafer,RC. and Faye, LJ. 1990).

Anterior-posterior glide / Posterior-anterior glide:

Patient is supine, hip and knee flexed and the foot at right angle to the patients leg (Schafer,RC. and Faye, LJ. 1990). Standing at the side of the bed the examiner places their cephalad hand over anterior aspect of the distal tibia and their caudal hand over the anterior aspect of the dome of the talus. Each hand has a web contact with their respective structures and must grasp the structures to preserve the joint in its neutral position. With equal pressure apply an anterior to posterior and posterior to anterior force with the hands working in opposite directions (Bergmann. TF. *et al.,* 1993. pp 702).

Medial to lateral and lateral to medial glide:

Patient is supine and examiner is at the foot of the table. The examiner places their fingers over the dome of the talus and their thumbs grasp the plantar surface of the foot. Move the talus in a medial to lateral and lateral to medial direction (Bergmann. TF. *et al*., 1993. pp 702).

Subtalar

Talar rock

The patient is supine. The examiner supports the plantar surface of the foot with one hand while the other hand is used to push the tibia downward to produce full plantarflexion. Pushing further to increase plantarflexion produces Talar rock (Schafer,RC. and Faye, LJ. 1990).

Long-axis extension

Contact over the subtalar joint and carry out the same procedure as long-axis extension of the mortise joint (Schafer,RC. and Faye, LJ. 1990).

Medial and lateral side tilt

Patient is supine while the examiner cups the heel in his/her hands, inversion and eversion forces are applied (Schafer,RC. and Faye, LJ. 1990).

Talo-calcaneal glide

Examiner stands perpendicular to the ipsilateral limb, he/she uses their cephalad facing hand to stabilize the distal aspect of the patients leg. The examiners caudad hand cups the patients heel and pulls upwards to test P-A glide of the calcaneus and reverse to test A-P glide (Schafer,RC. and Faye, LJ. 1990).

Tarsals

Cuboid, navicular and cuneiforms

Examiner grasps the specific tarsal bone and stabilizes the proximal tarsal while applying anterior to posterior and posterior to anterior glide (Schafer,RC. and Faye, LJ. 1990).

Tarsometatarsals

A-P / P-A Tarsometatarsal Glide

The patient is supine. The examiner is perpendicular to the foot being tested. The examiners caudad hand is placed over the top of the patients forefoot and caudal hand over the tarsals, allowing the curve of the foot to fit within the webs of both hands. The caudal hand stabilizes the bases of the patients metatarsals and the cephalid hand pushes downward and then upward to create an A-P and P-A motion (Schafer,RC. and Faye, LJ. 1990).

APPENDIX D:

Motion Palpation Results

Patient code: ____________________

Foot assessed: Left ☐
Right ☐

	Restriction	Instability
Distal tibiofibular joint		
Anterior to posterior glide	☐	☐
Posterior to anterior glide	☐	☐
Tibiotalar joint		
Long axis distraction	☐	☐
Anterior to posterior glide	☐	☐
Posterior to anterior glide	☐	☐
Medial to lateral tilt (inversion)	☐	☐
Lateral to medial tilt (eversion)	☐	☐
Subtalar joint		
Anterior to posterior glide	☐	☐
Posterior to anterior glide	☐	☐
Medial to lateral tilt (inversion)	☐	☐
Lateral to medial tilt (eversion)	☐	☐
Tarsals		
Cuboid		
Anterior to posterior glide	☐	☐
Posterior to anterior glide	☐	☐
Navicular		
Anterior to posterior glide	☐	☐
Posterior to anterior glide	☐	☐
Cuneiforms		
Anterior to posterior glide	☐	☐
Posterior to anterior glide	☐	☐
Tarsometatarsal joint		
Anterior to posterior glide	☐	☐
Posterior to anterior glide	☐	☐

Which foot, on the patient, do you think was the symptomatic?

Left ☐

Right ☐

APPENDIX E:

DURBAN INSTITUTE OF TECHNOLOGY
CHIROPRACTIC DAY CLINIC
CASE HISTORY

Patient: ______________________________ Date: __________

File # : __________ Age: __________

Sex : __________ **Occupation:** ______________________________

Intern : ______________________________ Signature ____________________

FOR CLINICIANS USE ONLY:
Initial visit
Clinician: Signature :

Case History:

Examination:
Previous: Current:

X-Ray Studies:
Previous: Current:

Clinical Path. lab:
Previous: Current:

CASE STATUS:

PTT:	Signature:	Date:

CONDITIONAL:
Reason for Conditional:

Signature: Date:

Conditions met in Visit No:	Signed into PTT:	Date:
Case Summary signed off:		Date:

Intern's Case History:

1. Source of History:

2. Chief Complaint : (patient's own words):

3. Present Illness:

	Complaint 1	**Complaint 2**
< Location < Onset : Initial: Recent: 1. Cause: < Duration < Frequency < Pain (Character) < Progression < Aggravating Factors < Relieving Factors < Associated S & S < Previous Occurrences < Past Treatment (a) **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 incl. xrays

< Environmental Hazards (Home, School, Work)

< Exercise and Leisure

< Sleep Patterns

< Diet

< Current Medication

Analgesics/week:

< 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 F

Durban University of Technology

PHYSICAL EXAMINATION: SENIOR

Patient Name : ______________________ **File no :** ______ **Date :** ______ __________

Student : **Signature :**

VITALS:

Pulse rate:			Respiratory rate:		
Blood pressure:	R	L	Medication if hypertensive:		
Temperature:			Height:		
Weight:	Any recent change? Y / N		If Yes: How much gain/loss	Over what period	

GENERAL EXAMINATION:

General Impression		
Skin		
Jaundice		
Pallor		
Clubbing		
Cyanosis (Central/Peripheral)		
Oedema		
Lymph nodes	Head and neck	
	Axillary	
	Epitrochlear	
	Inguinal	
Pulses		
Urinalysis		

SYSTEM SPECIFIC EXAMINATION:

CARDIOVASCULAR EXAMINATION

RESPIRATORY EXAMINATION

ABDOMINAL EXAMINATION

NEUROLOGICAL EXAMINATION

COMMENTS

Clinician: **Signature :**

APPENDIX G:

DURBAN INSTITUTE of TECHNOLOGY

Foot and ankle regional examination

Patient:______________________________________File no:____________Date:_____

Intern / Resident ______________________Signature:____________________________

Clinician:____________________________Signature:____________________________

Observation
Gait analysis (antalgic limp,toe off, arch, foot alignment, tibial alignment).

____

____

Swelling____
Heloma dura / molle____
Skin____
Nails____
Shoes____
Contours (achilles tendon, bony prominences)_____________________________________

Active movements

Weight bearing:	Ⓡ	Ⓛ	***Non weight bearing:***	Ⓡ	Ⓛ
Plantar flexion			50°		
Dorsiflexion			20°		
Supination					
Pronation					
Toe dorsiflexion			40°(mtp)		
Toe plantar flexion			40° (mtp)		
		Big toe dorsiflexion (mtp) (65-70°)			
		Big toe plantar flexion (mtp) 45°			
		Toe abduction + adduction			
		5° first ray dorsiflexion			
		5° first ray plantar flexion			

Passive movement motion palpation (Passive ROM quality, ROM overpressure, joint play)

	Ⓡ	Ⓛ		Ⓡ	Ⓛ
Ankle joint: *Plantarflexion*			Subtalar joint: *Varus*		
Dorsiflexion			*Valgus*		
Talocrural: *Long axis distraction*			Midtarsal:*A-P glide*		
First ray: *Dorsiflexion*			*P-A glide*		
Plantarflexion			*rotation*		
Circumduction of forefoot on fixed rearfoot			Intermetatarsal glide		
			Tarso metatarsal joints: *A-P*		
Interphalangeal joints: *L / A dist*			Metatarsophalangeal		

A-P glide			dorsiflexion (with associated plantar flexion of each toe		
lat and med glide					
rotation					

Resisted Isometric movements

	R	L		R	L
Knee flexion			Pronation (eversion)		
Plantar flexion			Toe extension (dorsiflexion)		
Dorsiflexion			Toe flexion (plantar flexion)		
Supination (inversion)					

Neurological

	R	L
Dermatomes		
Myotomes		
Reflexes		
Balance/proprioception		

Special tests

	R	L
Anterior drawer test		
Talar tilt		
Thompson test		
Homan sign		
Tinel's sign		
Test for rigid/flexible flatfoot		
Kleiger test (med. deltoid)		

Alignment

	R	L
Heel to ground		
Feiss line		
Tibial torsion		
Heel to leg (subtalar neutral)		
Subtalar neutral position:		
Forefoot to heel (subtalar & Midtarsal neutral)		
First ray alignment		
Digital deformities		
Digital deformity flexible		

Palpation

Anteriorly

	R	L
Medial maleoli		
Med tarsal bones, tibial (post) artery		
Lat.malleolous, calcaneus, sinus tarsi, and cuboid bones		
Inferior tib/fib joint, tibia, mm of leg		
Anterior tibia, neck of talus, dorsalis pedis artery		

Posteriorly

Calcaneus, Achilles tendon, Musculotendinous junction		

Plantarily

Plantar muscles and fascia		
Sesamoids		

21/10/2002

APPENDIX H:

DURBAN INSTITUTE OF TECHNOLOGY

Patient Name: ***File #:*** ***Page:***

Date: ***Visit:*** ***Intern:***
Attending Clinician: ***Signature:***

S: ***Numerical Pain Rating Scale (Patient)*** ***Intern Rating*** ***A:***
Least 0 1 2 3 4 5 6 7 8 9 10 Worst

0: ***P:***

E:

Special attention to: ***Next appointment:***

Date: ***Visit:*** ***Intern:***
Attending Clinician: ***Signature:***

S: ***Numerical Pain Rating Scale (Patient)*** ***Intern Rating*** ***A:***
Least 0 1 2 3 4 5 6 7 8 9 10 Worst

O: ***P:***

E:

Special attention to: ***Next appointment:***

Date: ***Visit:*** ***Intern:***
Attending Clinician: ***Signature***

S: ***Numerical Pain Rating Scale (Patient)*** ***Intern Rating*** ***A:***
Least 0 1 2 3 4 5 6 7 8 9 10 Worst

O: ***P:***

E:

Special attention to: ***Next appointment:***

Patient Name: ***File #:*** ***Page:***

Date: ***Visit:*** ***Intern:***
Attending Clinician: ***Signature:***

S: ***Numerical Pain Rating Scale (Patient)*** ***Intern Rating*** ***A:***
Least 0 1 2 3 4 5 6 7 8 9 10 Worst

0: ***P:***

E:

Special attention to: ***Next appointment:***

Date: ***Visit:*** ***Intern:***
Attending Clinician: ***Signature:***

S: ***Numerical Pain Rating Scale (Patient)*** ***Intern Rating*** ***A:***
Least 0 1 2 3 4 5 6 7 8 9 10 Worst

O: ***P:***

E:

Special attention to: ***Next appointment:***

Date: ***Visit:*** ***Intern:***
Attending Clinician: ***Signature***

S: ***Numerical Pain Rating Scale (Patient)*** ***Intern Rating*** ***A:***
Least 0 1 2 3 4 5 6 7 8 9 10 Worst

O: ***P:***

E:

Special attention to: ***Next appointment:***

CHAPTER ONE

1.1 INTRODUCTION

Motion palpation (MP) is important in the diagnosis, manipulative treatment and prognosis of musculoskeletal disorders (Beal, 1989). It is a method used to assess the status of a joint by assessing the quality of movement between articular structures (Bergmann, Peterson and Lawrence, 1993) to determine if a joint has normal range of movement (Ames, 1987). This assessment tool is used by chiropractors and other disciplines such as osteopathy (Beal, 1989) and physiotherapy (Keating, Matyas and Bach, 1993). A survey carried out in Australia on the most commonly used methods to detect joint dysfunction in the spine, showed that chiropractors regarded motion palpation as the most reliable method to detect joint dysfunction (Walker, 1998). Because motion palpation is highly regarded as an effective assessment tool (Beal, 1989), it is important to determine its reliability in assessing common clinical conditions.

Huijbregts (2002) and Hestbaek and Leboeuf-Yde (2000) stated that inter-examiner reliability studies on MP have primarily concentrated on the spine and that research in this context has shown that spinal MP has inadequate levels of reliability. They also suggest that there have been methodological flaws in the research design of inter-examiner reliability studies performed on the spine, and therefore one cannot categorically state that motion palpation of the spine is not reliable. Because there have been numerous inter-examiner reliability studies on MP of the spine (Stochkendahl, Christensen, Hartvigsen, Vach, Haas, Hestbaek, Adams and Bronfort, 2006), and few performed on extremities, this dissertation aims to investigate the inter-examiner reliability of motion palpation to detect joint dysfunction in hindfoot and midfoot joints.

Inter-examiner reliability of motion palpation to detect joint dysfunction in the hindfoot and midfoot joints has not been investigated. Chronic ankle instability syndrome (CAIS) is a common condition that occurs in 10% to 20% of people following an acute ankle sprain (de Vries, Krips, Sierevelt, Blankevoort and van Dijk, 2006). Numerous studies have highlighted the presence of joint dysfunction (hypermobility or hypomobility) within the hindfoot (mortise, subtalar and distal tibiofibular joints) in patients with CAIS

(Meadows, 2002; Dananberg Shearstone and Guillano, 2000; Lewit, 1999; Kavanagh, 1999; O'Brien and Vicenzino, 1998; Hetherington, 1996; Greenman, 1996 and Mulligan, 1995). But, fewer studies have investigated the effect chronic ankle instability may have on the midfoot (talo-calcaneonavicular, cuneonavicular, intercuneiform, cuneicuboid, cuboideonavicular and calcaneocuboid joint). However, according to Schafer and Faye (1990) the lower leg, ankle and foot work as a unit, therefore this dissertation investigated both hindfoot and midfoot joints in patients with one asymptomatic (pain free and fully functional) and one foot with CAIS. By investigating a condition the sample was more homogenous and one could compare inter-examiner reliability between the symptomatic and asymptomatic groups.

To date there have been two inter-examiner reliability studies performed on the foot. In the one study, the reliability of the circumduction test to detect joint mobility was assessed in symptomatic and asymptomatic feet (Brantingham, Wood, Parkin-Smith, Van der Muelen and Weston, 2003). The inclusion criteria stated that each patient had to have an asymptomatic and symptomatic foot. Symptomatic was defined as unilateral, pain in the foot, ankle or lower leg. Two qualified chiropractors independently graded the mobility of the feet of 17 patients. This study showed to have substantial inter-examiner agreement between examiners because there was moderate reliability in symptomatic feet and excellent reliability when assessing asymptomatic feet (Brantingham, *et al*., 2003). This indicates that the levels of agreement of the circumduction motion palpation technique seems to rate higher than spinal motion palpation technique which had inadequate levels of reliability (Huijbregts, 2002 andHestbaek and Leboeuf-Yde, 2000). The other study assessed the inter-examiner reliability of palpation to detect tenderness in the foot and ankle. Their results were in keeping with previous studies that had evaluated the reliability of palpation for tenderness in the cervical and lumbar spine and was shown to be reliable (Brantingham, Hubka, Snyder, Diballa, Wilke and Biedebach, 1995).

No study has researched the reliability of motion palpation of the individual joints of the hinfoot and midfoot. Therefore, this study investigated motion palpation of the individual joints of both asymptomatic and symptomatic foot changes with CAIS.

1.2 AIMS/OBJECTIVES OF THIS STUDY

The aim of this study was to determine the inter-examiner reliability of motion palpation in the hindfoot and midfoot joints in asymptomatic feet and in feet with CAIS.

Objective 1: To determine the inter-examiner reliability of motion palpation of the hindfoot and midfoot joints in patients with chronic ankle instability syndrome.

Objective 2: To determine the inter-examiner reliability of motion palpation of the hindfoot and midfoot joints in asymptomatic feet.

Objective 3: To determine if motion palpation is reliable irrespective of Chronic ankle instability syndrome.

Objective 4: To determine the presence or absence of joint dysfunction in both groups and then compare findings between groups.

1.3 RATIONALE FOR THE STUDY

MP is an assessment tool that is commonly used by the chiropractic profession to detect the need for manipulation (Walker, 1998).

To date many inter-examiner reliability motion palpation studies have been conducted on the spine (Stochkendahl *et al*., 2006). But there is a lack of inter-examiner reliability studies of MP performed on the hindfoot and midfoot joints of asymptomatic and symptomatic feet.

1.4 BENEFITS OF THE STUDY

This study will help the chiropractic profession in expanding its knowledge on the reliability of motion palpation as an assessment tool. This could result in improved clinical assessment of patients.

1.5 LIMITATIONS

Studies have shown that clinical experience does not influence the reliability of manual examinations (Stochkendahl, *et al*., 2006). However, the reliability of students carrying out manual examinations is considered a limitation as they do not have the clinical experience of a qualified chiropractor. Yet, this study used students as the examiners due to time and practical constraints. However, every attempt was made to overcome this limitation by virtue of using masters students who underwent seven specialized training sessions and have five years of teaching education, which includes many hours of clinical experience under the guidance of a qualified chiropractor.

1.6 CONCLUSION

While motion palpation is a commonly used assessment tool, there has been a lack of inter-examiner reliability studies performed to detect joint dysfunction in hindfoot and midfoot joints, of asymptomatic and chronic ankle instability syndrome feet. This, however, is in contrast to the increasing use of manipulation for the lower extremity (Brantingham, Globe, Pollard, Pollard, Hicks, Korporaal and Hoskins, 2009), which therefore necessitates that this modality be evaluated for its use in the lower extremity.

CHAPTER 2

2.1 INTRODUCTION

This chapter aims to discuss literature on motion palpation (MP), inter-examiner reliability studies on motion palpation and joint dysfunction associated with chronic ankle instability syndrome (CAIS) as well as the anatomy and biomechanics of the joints in the hindfoot and midfoot.

2.2 MOTION PALPATION

Palpation:

"*The application of variable manual pressure through the surface of the body for the purpose of determining the shape, size, consistency, position, inherent motility, and health of the tissues beneath*" (Bergmann, Peterson and Lawrence, 1993).

Motion Palpation:

"Palpatory diagnosis of passive and active segmental joint range of motion" (Bergmann, Peterson and Lawrence, 1993)

Motion palpation (MP) is the method used to assess the status of a joint by assessing the quality of movement between articular structures (Bergmann, Peterson and Lawrence, 1993). It can be used to determine whether the joint has a normal anatomical range of movement or if the movement is increased or decreased, (Ames 1987).

According to Bergmann, Peterson and Lawrence (1993), MP includes techniques to assess active, passive and accessory joint movements. They explain that passive joint movement is performed with the patient sitting or lying in a relaxed position as the examiner stabilizes and carries out particular voluntary (active physiological range of movement) movements. In contrast, during active movement the patient voluntarily moves the joint being examined without the help of the examiner, while the examiner palpates for the opening and closing movement between the joint surfaces. Accessory joint movement is an involuntary movement that is necessary for normal function of a joint. It is a small range of movement that is achieved by the examiner passively moving the joint (Magee, 2002). This movement includes the small give or play within a joint that can be assessed by motion palpatory procedures of joint play (the resistance felt in the neutral position) and end feel (the resistance felt at the end range of motion) (Schafer and Faye, 1990).

Joint Play

Bergmann, Peterson and Lawrence (1993) stated that when assessing joint play, one evaluates the joints resistance to movement when the joint is in a neutral position. They also suggested that joint play could be used in the evaluation of joint instability.

Joint play should be painless and is performed by the examiner placing the joint into its loose-packed position, contacting the relevant surfaces and inducing gentle springing movement (Bergmann, Peterson and Lawrence, 1993). These are small movements and are different in the spine and extremities (Bergmann, Peterson and Lawrence, 1993).

End-Feel

The examiner assesses end-feel by applying extra pressure to the joint at the end range of passive movement, at this point the examiner applies a gentle springing force (Bergmann, Peterson and Lawrence, 1993). In the assessment of joint function, end-feel is vital as a change of end-feel resistance suggests joint dysfunction (Bergmann, Peterson and Lawrence, 1993). End-feel is also important as it can assist the examiner in establish the type of pathology present and determine a prognosis for the condition (Magee, 2002).

Magee (2002) stated that there are five “abnormal” end-feels namely:

Muscle spasm

This occurs suddenly and is often accompanied by pain. The muscle spasm occurs as a result of the subconscious efforts of the body to protect the injured joint.

Capsular

A hard, firm springy end-feel, similar to the tissue stretch except the range of motion is reduced.

Bone-to-bone

This occurs where “normal” bone-to-bone movement is not expected. It has a similar end-feel except the range of motion is reduced.

Empty

This occurs when the movement is not possible due to extreme pain. There is no muscle spasm associated with this “abnormal” end-feel.

Springy block

Similar to normal tissue stretch however, it occurs where you would not expect it to occur. It is usually found in joints with menisci.

If there is an increase or decrease in joint play it is termed a joint dysfunction (Magee, 2002). Schafer and Faye (1990), describe joint dysfunction as the loss of one or more movements within the joints normal range of motion, it is associated with pain.

Joint Dysfunction

Clinical features of joint dysfunction include:

Pain over the area, the severity often changes with activity.

The local tissue may be hypersensitive

Altered alignment between the joint surfaces

Joint movement is decreased, increased or unusual

Change in normal joint play

End-feel resistance is altered

The local muscle feels rigid to palpation

(Bergmann, Peterson and Lawrence, 1993)

Motion palpation in this study was used to determine whether the hindfoot and midfoot joints assessed had normal anatomical range of motion. The examiners assessed each joint with passive joint movement and accessory joint movement.

2.2.1 History of Motion Palpation

Provided by Gillet, (1995):

Motion palpation was first introduced in 1906 by Smith, Gillet acknowledged his idea and went on to introduce MP to the world. However, it took fifty years for MP to gain access to the chiropractic profession. Since then it has become a component of the syllabus in most colleges as a required topic in chiropractic examination (Gillet, 1995).

The above article on the history of MP was based on spinal motion palpation. This is in keeping with an article by Nelson, Lawrence, Triano, Bronfort, Perle, Metz, Hegetschweiler and LaBrot, (2005) who suggested that the chiropractic profession has focussed primarily on spinal conditions, as these were thought to be the model for the future of the profession. This has led to a perception that the scope of chiropractic is limited to the management of spinal conditions (Stump and Redwood, 2002). However, according to Palmer (Brantingham and Snyder, 1992) a pioneer of the profession, chiropractic techniques exist for the management of extremity conditions. At most colleges chiropractors are trained to diagnose and treat neuromusculoskeletal conditions associated with both the extremities and the spine (Hoskins, McHardy, Pollard, Windsham and Onley, 2006). This means that the chiropractic graduate is qualified to manage clinical conditions of the extremities (Hoskins *et al*., 2006) and also qualified to carry out MP as an assessment tool.

2.2.2 Inter-examiner reliability of motion palpation

To date motion palpation research has been primarily based on reliability studies (Haas, Panzer, Peterson and Raphael, 1995). Research carried out by Stochkendahl *et al*., (2006) on reproducibility of manual techniques of the spine between 1980 and 2005 found that motion palpation of the spine was the most frequently investigated procedure. They indicated that even though motion palpation is a widely used procedure to diagnose joint dysfunction, previous literature shows poor levels of inter-examiner reliability. Poor reliability results in previous studies have led to motion palpation of the spine being questioned whether it should be used as a diagnostic tool. (Huijbregts, 2002 and Hestbaek, and Leboeuf-Yde, 2000).

Although the reliability of motion palpation in the spine has been investigated in depth, there is limited literature on the reliability of motion palpation of extremities. It is important to assess the reliability of MP in common extremity conditions such as CAIS. As the evaluation of the foot and ankle includes MP of the joints to determine the presence of joint dysfunction (Bergmann, Peterson and Lawrence, 1993). Also an overview of chiropractic practice in America conducted by Christensen and Kollasch (2005) showed that 95.4% of chiropractors manipulate extremities and that 46.8% of patients attending chiropractic practices undergo extremity manipulation. There is therefore a need for research studies on extremities to assess the reliability and validity of chiropractic assessment techniques such as MP (Hoskins, *et al*., 2006). Untill the reliability of MP is known, any research that uses MP as a tool to find the presence or absence of joint dysfunction will be subject to question (Bergmann, Peterson and Lawrence, 1993).

In the literature search for this dissertation, there were two inter-examiner reliability studies performed on the foot and ankle. Brantingham *et al*. (1995) investigated the inter-examiner reliability of palpation for foot and ankle joint tenderness. Their results indicated good inter-examiner reliability, which was in keeping with other studies that investigated the reliability of palpation for tenderness in the cervical and lumbar spine. However, Brantingham *et al*. (2003) investigated the reliability of the circumduction test to detect joint mobility in asymptomatic and symptomatic feet. Two qualified chiropractors independantly assessed seventeen patients that were experiencing pain in the foot, lower leg or ankle, and graded the mobility of the foot according to the grid provided by the researcher. Unlike the literature on spinal motion palpation, which showed to have poor inter-examiner reliability, Brantingham, *et al*., (2003) results showed that there was substantial inter-examiner reliability. Also, the inter-examiner reliability was higher in the asymptomatic group whereas Boline, Haas, Meyer, Kassek, Nelson and Keating (1993) study on the inter-examiner reliability of eight evaluative dimensions of lumbar segmental abnormality stated that previous palpatory studies have shown to have higher inter-examiner reliability in the symptomatic group.

Although the results of Brantingham *et al*., (2003) study suggest that inter-examiner reliability is higher when assessing extremities, there have not been enough studies performed to support this finding. This dissertation will therefore be assessing the inter-examiner reliability of motion palpation to assess for specific joint dysfunction in the hindfoot and midfoot to determine if the results concur with Brantingham *et al*., (2003) study. But, the sample will include symptomatic as well as asymptomatic feet to see if the inter-examiner reliability was the same for both groups. For the purpose of this study CAIS was the condition chosen to represent the symptomatic feet.

2.3 ANATOMY AND BIOMECHANICS OF THE HINDFOOT AND MIDFOOT

2.3.1 Introduction

Motion palpation of the foot and ankle requires a thorough understanding of its anatomy and biomechanics of the foot and ankle. Each joint has a normal range of movement that is determined by the orientation of the joint and surrounding structures (Magee, 2002). Without an understanding of these features the examiner will not have accurate motion palpation findings. The following section will explain the movements, function and related structures of each joint in the midfoot and hindfoot that was examined in this study.

2.3.2 The Hindfoot

The hindfoot comprises of the tibiofibular, mortise and subtalar joint each with their own planes of movement (Magee, 2002).

2.3.2.1 The Mortise Joint

The mortise joint, also known as the ankle, tibiotalar or talocrural joint is a hinge type of synovial joint that allows motions of plantarflexion and dorsiflexion (Moore and Dalley, 1999). It is formed by the articulation of the talar dome with the distal ends of the fibula and tibia (Hertel, 2002). The function of the shape of this joint is to allow transmission of torque from the lower leg to the foot during weight bearing (Hertel, 2002).

The stability of the tibiotalar joint depends on the following three factors;

- Joint congruency (Hockenbury and Sammarco, 2001)
- Supporting ligaments (Hockenbury and Sammarco, 2001) and
- Musculotendinous support (Hertel, 2002).

According to Baker and Todd (1995) during dorsiflexion of the foot, the talus moves from anterior to posterior and becomes “locked” into the mortise. When the ankle is dorsiflexed, the ankle joint is considered stable (Baker and Todd, 1995) and very strong (Moore and Dalley, 1999). On the other hand, when the foot is plantarflexed the talus is “unlocked” (Baker and Todd, 1995) and the ankle is considered unstable (Moore and Dalley, 1999) and therefore higher chance of an ankle sprain occurring in this position.

The articular capsule surrounding the mortise joint is thin anteriorly and posteriorly and is supported by strong collateral ligaments on each side (Moore and Dalley, 1999). The collateral ligaments include the medial or deltoid ligament and the lateral ligament. The lateral ligament is made up of three parts namely: the anterior talofibular ligament (ATFL), posterior talofibular ligament (PTFL) and the calcaneofibular ligament (CFL).

The ATFL is a flat weak band that runs anteromedially from the lateral malleolus to the neck of the talus (Moore and Dalley, 1999). The ATFL has shown to prevent anterior displacement of the talus from the mortise joint and extreme internal rotation and inversion of the talus on the tibia (Hollis, Blasier and Flahiff, 1995). It is the most frequently injured ligament of the lateral ligaments (Renstro¨m and Konradsen, 1997).

The PTFL, is a thick, strong band that runs from the lateral malleolus posteriorly to the lateral tubercle of the talus (Moore and Dalley, 1999). The PTFL limits supination when the talocrural joint is loaded (Stormont, Morrey, An and Cass, 1985) and is the least commonly sprained ankle ligament (Renstro¨m and Konradsen, 1997).

The CFL is a round cord that passes from the lateral malleolus posteroinferiorly to the lateral surface of the calcaneus (Moore and Dalley, 1999). It limits supination (inversion and internal rotation) of the mortise as well as the subtalar joints and is under the most stress when the ankle is dorsiflexed (Hollis, Blasier and Flahiff, 1995).

The medial ligament is strong and reinforces the articular capsule. This ligament runs inferiorly from the medial malleolus to the talus, navicular and calcaneus forming a broad base (Moore and Dalley, 1999).

2.3.2.2 The Distal Tibiofibular Joint

The distal tibiofibular joint is one of two joints that connects the tibia and fibula. It is a fibrous joint that plays an essential role in the stability of the ankle joint because it holds the lateral malleolus firmly against the lateral surface of the talus (Moore and Dalley, 1999). There is little movement between these two bones (Mulligan, 1995). However, gliding movement at this joint is important for normal movement in the ankle complex

(Mulligan, 1995) as the structure of this fibrous joint forms a stable roof for the mortise joint (Hertel, 2002).

2.3.2.3 The Subtalar Joint

The subtalar joint is the joint between the talus and the calcaneus and is responsible for pronation and supination of the foot and ankle (Hertel, 2002). The subtalar joint consists of two separate joint cavities, the posterior subtalar joint and the anterior subtalar joint:

- The posterior subtalar joint is formed by the inferior posterior facet of the talus and the superior posterior facet of the calcaneus.
- The anterior subtalar joint is formed by the head of the talus, the anterior-superior facets, the sustentaculum tali of the calcaneus, and the concave proximal surface of the navicular (Hertel, 2002).

2.3.3 The Midfoot

The midfoot is made up of midtarsal joints which include the talo-calcaneonavicular joint, cuneonavicular joint, intercuneiform joints, cuneicuboid joint, cuboideonavicular joint and the calcaneocuboid joint (Magee, 2002). For ease of reference the following table summarises all the midfoot joints.

Table 1.1: Classification of midfoot joints.

Joint:	**Talo-calcaneonavicular Joint**	• **Cuneonavicular Joint** • **Intercuneiform Joints** • **Cuneicuboid Joint**	**Cuboideonavicular Joint**	**Calcaneocuboid Joint**
Type:	Ball and socket synovial joint	Plane synovial joint	Fibrous joint	Saddle-shaped joint
Degrees of freedom:	3 degrees of freedom			
Closed-pack position:	Supination	Supination	Supination	Supination
Supporting ligaments:	Dorsal talonavicular ligament, Bifurcated ligament, Plantar calcaneo-navicular ligament			Bifurcated ligament, Calcaneocuboid ligament, Long plantar ligament
Movement:	Gliding and rotation	Gliding and rotation	Slight gliding and rotation	Slight gliding and rotation

(Magee, 2002)

2.4 CHRONIC ANKLE INSTABILITY SYNDROME

2.4.1 Introduction

Chronic ankle instability is one of many terms used to describe the existence of an unstable ankle due to numerous repetitive ankle sprains (Renstro¨m and Konradsen, 1997). Symptoms include chronic ankle sprains, recurrent “giving way” of the ankle followed by pain and swelling (Hertling and Kessler, 1996), instability, crepitus, weakness and stiffness (Pellow and Brantingham, 2001). CAIS was selected for investigation in this dissertation as it has certain criteria the patients have to fit into which ensured a homogenous symptomatic group, this allowed for more accurate results. Also studies have shown that manipulation is an effective treatment for CAIS (Pellow and Brantingham, 2001), and that there is a presence of joint dysfunction in hindfoot joints (Meadows, 2002; Dananberg Shearstone and Guillano, 2000; Lewit, 1999; Kavanagh, 1999; O’Brien and Vicenzino, 1998; Hetherington, 1996; Greenman, 1996 and Mulligan, 1995). However, there has been no study performed to assess whether motion palpation is an effective assessment tool to detect joint dysfunction in hindfoot and midfoot joints associated with CAIS.

2.4.2 Incidence and prevalence

After an acute ankle sprain 10% to 20% of patients will develop CAIS (de Vries *et al.*, 2006), it is therefore important to investigate the incidence and prevalence of ankle sprains in order to understand the incidence and prevalence of CAIS. Lysens, Steverlyncky, Van den Auweele, Lefevre, Renson, Claessens, and Ostyn (1984) performed a study on the predictability of sports injuries and found that students with a previous history of injury were at a higher risk of re-injury. Lysens *et al.* (1984) also found that out of 162 reported ankle sprains, 72 (44.5%) were re-injured within the 4-year study. In keeping with these findings Smith and Reischl, (1986) reported that the re-injury rate after lateral ankle sprain has been as high as 80% among athletes.

According to Fallat, Grimm and Saracco (1998), the ankle is one of the most commonly injured joints in the body and lateral ankle sprains are among the most common injuries that occur at the ankle joint (Hertel, 2002).

A systemic review on ankle sprain and ankle injury in sports performed by Fong, Hong, Chan, Yung and Chan, (2007) showed that ankle sprains were the most common ankle injury in 33 of 43 sports investigated. In sports injuries throughout the countries studied in this systemic review, their results showed that the ankle was the second most commonly injured body structure after the knee, with the ankle sprain being the most common type of ankle injury. Fong et al., (2007) also stated that ankle sprains were especially found in court games and team sports, such as rugby, soccer, volleyball and basketball (Fong *et al*., 2007). Karlsson, Rolf and Orava (2003) agreed that running and jumping sports e.g.: soccer, basketball and volleyball, are high risk activities for ankle sprain injuries. They also added that different profiles of sporting activities within a population results in a varying incidence of ankle ligament injuries (Karlsson, Rolf and Orava, 2003).

Previous literature shows varied gender distribution of ankle sprains. According to Louwerens and Snijders (1999) the incidence of ankle injuries in the young male population is higher than the female population, but after 40 years of age the incidence for females increases more than males. Beynnon, Murphy and Alosa (2002), however, propose that gender does not appear to be a risk factor for experiencing an ankle sprain.

It was estimated that in the UK there were 302 000 new ankle sprains and 42 000 new, severe, ankle sprains reported every year (Bridgman, Clement, Downing, Walley, Phair and Maffulli, 2003). Kannus and Renstro¨m (1991), estimated that in the United States more than 23 000 ankle sprains occur per day which equates to one sprain per 10 000 people daily. A profile of ankle injuries in South Africa was not available.

2.4.3 Cause of CAI

Hertel, (2002) proposes that there are two major causes of CAIS namely: mechanical instability and functional instability (Hertel, 2002).

2.4.3.1 Mechanical instability

Hertel, (2002) explained that mechanical instability is caused when various factors such as impaired arthrokinematics, degenerative changes, synovial inflammation and impingement alter the mechanics of the joints within the ankle (Hertel, 2002). Denegar and Miller, (2002) defined mechanical instability as an increase in the accessory movements at a joint. Tropp, Odenrick and Gillquist (1985) suggested that after ankle ligament injury, the ligaments that normally function to stabilize the ankle complex may be torn and therefore result in pathologic laxity of the ankle complex.

2.4.3.2 Functional instability

Functional instability was first described as a cause of CAI by Freeman, (1965) who suggested CAI is a result of proprioceptive deficits that remain after ligament injury. Hertel (2000) subsequently modified this definition of functional instability to "the occurrence of recurrent ankle instability and the sensation of joint instability due to the contributions of proprioceptive and neuromuscular deficits". Functional instability is a complex syndrome, and the exact cause is unknown however, it has been suggested that possible causes include; increased ligamentous laxity, inhibition of proprioceptive function and peroneal muscle weakness (Karlsson*,* Rolf and Orava, 2003). The patient may present with a feeling of "looseness" or "giving way" of the ankle more frequently than pain and they may have a history of recurring inversion injuries to the ankle (Patel and Warren, 1999).

2.4.3.3 Risk factors for ankle sprains include the following:

- Previous ankle sprain: Beynnon *et al*. (2002), suggest that ankle ligament sprains result in disruption of a ligament, these ligaments function as important biomechanical stabilizer. Tropp*,* Odenrick and Gillquist, (1985) found that sportsmen with a history of ankle problems experienced more sprains than those with no previous history.
- Height and weight: Beynnon *et al*. (2002), included these two risk factors because an increase in either factor proportionally increases the amount of inversion torque that needs to be resisted by the ligaments and muscles that span the ankle complex.
- Tight Achilles tendon: According to Reid (1992), the gastrocnemius and soleus tendons pull on the ankle joint via the calcaneus which pulls the calcaneus into slight inversion therefore increasing the likelihood of landing on the outside of the foot during jumping (Reid, 1992).
- Crossover gait: This position results in the foot being excessively supinated during heel strike (Forcum, 1997).

- Muscle imbalances: If the everters are weak (Fibularis muscles) or if the inverters (tibialis anterior and posterior) are tight an ankle sprain may result (Vizniak and Carnes, 2004).
- Anatomical variation: A genu varum, tibia varum or rearfoot varum can contribute to improper foot landing, which may result in an ankle sprain (Vizniak and Carnes, 2004). Reid (1992), added that a varus heel or tarsal coalition may also predispose to ankle injuries.
- Generalized ligament laxity may contribute to ankle instability (Reid, 1992).
- Shoes: According to Reid (1992), low profile boots and narrow, long cleats can contribute to ankle sprains.
- Terrain: Uneven surfaces or potholes may increase the risk of having an ankle sprain (Reid, 1992).
- Limb dominance: Beynonn *et al*. (2002), stated that the literature is divided with regards to limb dominance as a risk factor for ankle sprains, however, it could be implicated as a risk factor as most athletes tend to place a greater demand on their dominant limb (Beynnon *et al*., 2002).

2.4.4 Mechanism of injury

The most common mechanism of injury to the ankle involves extreme inversion or supination of the foot and ankle complex, which results in injury to the lateral ligaments of the ankle (Wolfe, Uhl, Mattacola and McCluskey, 2001 and Kannus and Renstro¨m, 1991).

Results from Denegar, Hertel and Fonseca (2002) research highlight that the lateral joint capsule along with the ligaments that support the lateral talocrural, subtalar, and distal and proximal tibiofibular joints, function to limit the degree of inversion and supination of the ankle complex. They also point out that joint dysfunction (hypermobility or hypomobility) may result in one or more joints in the ankle complex if these structures are overloaded.

2.4.5 Clinical Presentation of ankle sprains

Denegar, Hertel and Fonseca, (2002); Pellow and Brantingham (2001) and Patel and Warren (1999) explain that after an acute ankle injury, tissue injury results in pain, swelling and joint dysfunction. Pain and swelling resolve with time, but joint dysfunction may be longer lasting and indicate residual dysfunction of the ankle complex. Residual symptoms following an ankle ligamentous injury include: swelling, pain, instability, crepitus, weakness and stiffness. The swelling in chronic functional instability is generally more diffuse and ecchymosis is not present (Baker and Todd, 1995).

2.4.5.1 Hypermobility

According to Denegar and Miller (2002), hypermobility is usually associated with mechanical instability. They also stated that many patients suffer from ligamentous laxity, or mechanical instability, after lateral ankle sprain which is an increase in the accessory movements at a joint. An increase in accessory movement indicates an enlarged neutral zone of the joint which is the area of accessory movement the joint allows without ligamentous tensioning (Panjabi, 1992). Furthermore Denegar and Miller (2002) highlighted that lasting mechanical instability suggests an unfavourable healing process and usually results from a tear or lengthening of one of the ligaments that support the ankle joint.

In a clinical trial performed by Bernier, Perrin and Rijke, (1997) it was found that seven of nine subjects with functional ankle instability showed to have laxity in the anterior talofibular ligament. In congruence with these findings Hertel, Denegar, Monroe and Stokes, (1999) found that 75% of subjects with a history of ankle sprains showed to have laxity of the talocrural joint on stress fluoroscopy, and two thirds of those who had talocrural laxity also showed to have subtalar joint laxity. This dissertation investigated whether motion palpation was a reliable assessment tool to detect laxity of the above joints.

2.4.5.3 Hypomobility

Hypomobility after lateral ankle sprain, has been attributed to subluxation, which occurs as a result of altered arthrokinematics, in the ankle-joint complex (Meadows, 2002, Lewit, 1999 and Kavanagh, 1999). Also after a lateral ankle sprain, damage to the proprioceptive organs may occur (Anderson, 2002).

It has been reported that after a lateral ankle sprain, the following joints may be hypomobile:

- Subtalar (Meadows, 2002 and Greenman 1996),

- Talocrural joint (Denegar, Hertel and Fonseca, 2002; Green, Refshauge, Crosbie and Adams, 2001. and Dananberg, Shearstone and Guillano, 2000).
- Distal tibiofibular joint (Kavanagh, 1999; O'Brien and Vicenzino, 1998; Hetherington, 1996. and Mulligan,1995), or
- Proximal tibiofibular joint (Meadows, 2002; Dananberg, Shearstone and Guillano, 2000. and Greenman 1996).

This study will investigate whether motion palpation as an assessment tool can detect hypomobility in the above joints in patients with CAIS.

Research has highlighted that hypomobility in the hindfoot has been reported in many studies (Meadows, 2002; Dananberg Shearstone and Guillano, 2000; Lewit, 1999; Kavanagh, 1999; O'Brien and Vicenzino, 1998; Hetherington, 1996; Greenman, 1996 and Mulligan, 1995). Such references include Denegar, Hertel, and Fonseca (2002), who reported restricted movement in posterior talar glide in a group of college athletes who had returned to sport after an ankle sprain. Also, Mulligan (1995), stated that anterior subluxation of the fibula on the tibia at the distal tibiofibular joint may be the cause of painfully limited inversion after a lateral ankle sprain. Mulligan, (1995) results were supported by Kavanagh (1999) who found that there were differences in mobility at the tibiofibular joint between subjects with and without ankle sprains. But Denegar and Miller (2002), assert that the link between ligamentous sprain and the resultant joint dysfunctions is not fully understood and is likely to differ among individual patients.

Dorsiflexion has also been found to be limited after a lateral ankle sprain. It has been suggested that this limitation of movement is due to tightness in the gastrocnemius-soleus complex, (Wolfe *et al*., 2001). Dananberg, Shearstone and Guillano (2000), suggested that hypomobility at the proximal tibiofibular joint can also limit ankle dorsiflexion. Many rehabilitation guidelines include exercises to restore dorsiflexion after a lateral ankle sprain (Wolfe *et al*., 2001). Although dorsiflexion has been reported to have limited range of motion in the above studies, it was excluded in this dissertation as it did not fall under the motion palpation procedures explained by Bergmann, Peterson and Lawrence, (1993) or Schafer and Faye, (1990).

The relationships among hypomobility, ankle injury, and CAIS have not been the focus of previous studies (Denegar, Hertel and Fonseca, 2002). Taking the above literature into consideration this study aims to investigate if motion palpation, as an assessment tool, can identify joint dysfunction in asymptomatic and symptomatic (CAIS) feet.

2.4.6 Diagnosis

Grading of ankle injuries

Ankle sprains are divided into three grades to classify the degree of inversion sprain (Reid, 1992):

Grade I (mild): There is no bruising, very little swelling, point tenderness, negative anterior drawer sign and no varus laxity.

Grade II (moderate): some bruising, the swelling is localized, the achilles tendon margins are not clear, anterior drawer sign may be positive, and no varus laxity.

Grade III (severe): Achhiles tandon margins have no definition due to the severity of the swelling on either side of the tendon, early haemorrhage, tenderness may be present medially and laterally, positive anterior drawer sign and positive varus laxity.

Grade I injuries result in a single ligament being mildly stretched yet despite this injury, patients are still capable of immediately bearing their weight on the (Forcum, 1997. and Garrick and Schelkun, 1997). These researchers continue to explain that in a grade II injury some tearing of the ligaments occurs, however, there is more swelling than a grade I injury and the patient can generally bear some weight. Furthermore they indicate that a grade III injury involves the complete tearing of one or more of the ligaments. The patient presents with significant swelling and bruising and may show functional and clinical instability of the ankle reducing their ability fully weight bear because of the resultant pain. From the above research it can be noted that differences exist in the grading of ankle sprains and sometimes the margins that delineate different grades can be blurred.

The diagnosis of CAIS in this dissertation was based on the history of the most recent grade I or II inversion ankle sprain and at least four of the six residual symptoms of instability, pain, crepitus, weakness, stiffness or edema (Pellow and Brantingham, 2001 and Patel and Warren, 1999) for at least six weeks.

2.4.7 Treatment

The treatment of acute lateral ankle sprains is initially aimed at controlling pain and swelling followed by range of motion exercises, stretching of musculotendinous tissues, improvement of neuromuscular control, and strengthening exercises (Denegar and Miller, 2002). Chronic ankle instability syndrome is treated with various regimes and modalities. These include; manipulation (Pellow and Brantingham, 2001), mobilization, cryotherapy (Hockenbury and Sammarco, 2001), range of motion and strengthening exercises (Anderson, 2002. and Reid, 1992) and deep transverse friction (Hertling and Kessler, 1996). But Denegar and Miller (2002) assert that treatment of CAIS is difficult and so the reliability of assessment tools of the acutely injured ankle should be evaluated in attempt to appropriately manage CAIS.

2.4.8 Conclusion

In conclusion the literature points out that motion palpation is an important assessment tool, used by chiropractors to determine the need for manipulative treatment. In addition to this, previous studies have shown that patients with CAI have a presence of joint dysfunction. However, there have been a lack of studies investigating the reliability of motion palpation in the hindfoot and midfoot joints in asymptomatic and symptomatic feet. The following chapters will discuss how the reliability of motion palpation was assessed in this study. The results will follow and will be discussed in terms of the review of the literature.

CHAPTER 3

3.1 INTRODUCTION

This chapter is comprised of a detailed description of the study design, objectives, the patients selected to participate in the study as well as the intervention used. It also includes the statistical methods used to analyse the data.

3.2 THE RESEARCH DESIGN

This was an inter-examiner reliability study.

3.3 ADVERTISING

Advertisements (Appendix B) were placed in public places, sport clubs and notice boards around the Durban University of Technology.

3.4 SAMPLE

3.4.1 Method

A consecutive convenience sampling method was used. Patients were selected from those who responded to advertisements and word of mouth. Initially the patients were screened via a telephonic interview, by the researcher, to determine their suitability for the research. The following qualifying questions were asked:

1. What is your name and age?
2. Have you sprained your ankle in the past?
3. Did you sprain your ankle more than six weeks ago?
4. Are you experiencing any ankle discomfort, swelling or giving way?
5. Are the above symptoms present in one or both feet?

The study was available to any person who arrived for a consultation at the Chiropractic Day Clinic at the Durban University of Technology.

3.4.2 Sample size

A sample size of 20 patients was used (Esterhuizen, 2009). The sample size was not established according to a power calculation but by improving on the number of patients used in similar inter-examiner reliability studies. The study only included those patients who experienced chronic ankle instability syndrome in one foot and was asymptomatic in the other foot. The patient needed to meet the following criteria:

a.) Inclusion:

- Patients qualified for the research based on their suitability. This was confirmed during the telephone interview.

- Patients had to be between the ages of 18 and 50 years to increase the reliability of the study.

- The patients had to have one symptomatic foot with the other foot free of pain and fully functional (asymptomatic) (Reid, 1992).

- Patients symptomatic foot had to fit the criteria of CAIS as stated below:

The diagnosis for this study was based on the history of the most recent inversion ankle sprain and at least four of the six continuing symptoms of instability, pain, crepitus, weakness, stiffness or edema (Pellow and Brantingham, 2001 and Patel and Warren, 1999) for at least six weeks.

- Subjectively the patient should have experienced the following clinical picture:

An acute sprain at least six weeks prior to the assessment (Wolfe *et al.*, 2001; Hertel, 2002 and Hertling and Kessler, 1996).

Currently ‘giving way’ during activities such as jumping or quick side-side movements (Hertling and Kessler, 1996).

- Patients numerical pain rating scale (Williamson and Hoggart, 2005) must be between 3 and 8 to keep the group homogenous in terms of pain.

b.) Exclusion:

- Patients with signs of gross mechanical ankle instability (grade III ankle sprain) and syndesmosis injury (Pellow and Brantingham, 2001).

- Patients below the age of 18 needs parental consent and were therefore excluded from the study.

- To avoid altered joint movement due to osteoarthritis patients over the age of 50 were excluded (Flaherty, 2007).

- Patients with a history of ankle surgery or fracture.

- Patients who did not sign the Letter of Information and Consent (APPENDIX A).

- Patients whose foot was painful when partially or fully weight bearing or if there was excessive swelling of the foot.

3.5 DATA COLLECTION

3.5.1 Patient Procedure

An appointment was scheduled for those patients that were included in the study after the telephonic interview. At the first consultation the patient was given a Letter of Information and Consent (Appendix A), which explained the research procedure to the patient. The Letter of Information and Consent detailed that they were allowed to withdraw from the study at any point if they did not wish to further participate in the study. If a patient did withdraw from the study their results were excluded from the study.

The consultation, carried out by the researcher, included a full history (Appendix E), physical examination (Appendix F), foot and ankle regional examination (Appendix G). These above examinations as well as the exclusion and inclusion criteria further determined the patient suitability.

If the patient was suitable for the study, they were reminded that three independent examiners would be assessing their feet. The patient was encouraged not to communicate with the examiners and not to inform the examiners of which foot was painful. A screen was placed between the examiner and the patient so that the examiner could not see the patients' facial expression while palpating their foot. The researcher remained in the examination room throughout the consultation to ensure all examination procedures were carried out correctly.

Once the three examiners completed their assessments (explained in Appendix C), they handed the two completed forms (2 Appendix D) to the researcher. At this stage the research component was finished and the patient could receive one free treatment for chronic ankle instability syndrome, should they so wish.

3.5.2 Examiner Procedure

Three chiropractic masters students were approached to be examiners in this study. They then underwent seven-sessions of training and practice of motion palpation of the foot and ankle joints, an eighth session included a proficiency test supervised by the research supervisor. Mootz, Keating, Kontz, Milus and Jacobs, (1989) and Currier, Froehlich, Carow, McAndrew, Cliborne, Boyles, Mansfield and Wainner, (2007) recommend that preparatory lessons are important so as to ensure sensitivity and consistency of the technique. A motion palpation instruction sheet was given to the three examiners at the practice sessions (Appendix C). The methods practised included clear specifications on the exact position of the examiners' hands (this included determining the dominant hand of the examiner), after which the details on the positioning of each of the fingers were specified and lastly the amount of pressure that should be administered when motion palpating the ankle complex. The examiners were remunerated to ensure they were compliant during the study.

All examiners motion palpated the midfoot and hindfoot joints of both the symptomatic foot as well as the asymptomatic foot of 20 patients. The palpatory technique used was the method explained by Schafer, and Faye, (1990) and Bergmann, Peterson and Lawrence, (1993). The hindfoot was evaluated because of the literature showing the involvement of the mortise joint in CAIS, (Meadows, 2002; Denegar, Hertel and Fonsesca, 2002; Green, Refshauge, Crosbie and Adams, 2001; Dananberg, Shearstone and Guillano, 2000; Lewit, 1999; Kavanagh, 1999; O'Brien and Vicenzino, 1998; Hetherington, 1996; Greenman, 1996 and Mulligan, 1995). And the midfoot was assessed because Scafer and Faye (1990) suggest that the lower leg, foot and ankle work as a unit.

Each examiner assessed both the symptomatic and asymptomatic ankles independently with the researcher in the room to ensure the procedure was carried out correctly. The examiner recorded his/her results for both ankles on separate forms (Appendix D) and once completed handed the forms to the researcher. The researcher put the forms in the patients file so that the other examiners could not see the previous examiners' results. The examiners were blinded to any pathology present. For the purpose of this study the examiners were not allowed to communicate during the research procedure to ensure they did not influence each others findings.

According to Cooperstein and Gleberzon, (2004) the palpatory procedure resembles mobilisation and therefore the first examiner may find different restrictions to the second. As motion palpation may improve end feel in a joint, the three examiners randomly alternated who palpated the patients' feet first. Each examiner drew a number (1, 2 or 3) out of an envelope to decide the order in which they would palpate. (This too was recorded on their data sheet). By alternating the order of palpation any differences in palpatory findings could only be attributed to the examiner performance and not any change in the patient (Lakhani, Nook, Haas and Docrat, 2009). Also the examiners' were advised to motion palpate each direction of the joints twice only, this limited the number of times a particular movement was felt and therefore decrease the mobilisation effect motion palpation potentially may have had.

3.6 STATISTICAL METHODOLOGY

SPSS version 15.0 (SPSS Inc., Chicago, Illinois) was used to analyse the data. Kappa statistics and p values, as well as percentage agreement were calculated in symptomatic and asymptomatic hindfoot and midfoot joints separately by comparing the ratings between examiners 1 and 2, examiners 1 and 3 and examiners 2 and 3.

To compare the kappa values between symptomatic and asymptomatic feet, paired non parametric Wilcoxon signed ranks tests were used. The kappa values used were the 25 measurements where both a symptomatic and asymptomatic group kappa measurement was obtained.

The presence of restrictions and instability between symptomatic and asymptomatic feet were compared using Pearson's chi square tests.

Cohens Kappa is the most used statistical method to detect reproducibility (Stochkendahl *et al.* 2006). However, there has been criticism of its use (Lantz, 1997), these include that Kappa is not entirely a chance corrected measure of agreement, it does not distinguish between different types and sources of disagreements and that Kappa may be low even though percentage agreement is high (Brantingham *et al*., 2003). Taking this criticism into consideration, this study has used Kappa as the primary data along with percentage agreement as the secondary data to assess the inter-examiner reliability of motion palpation to detect joint dysfunction.

Percentage of agreement between all three examiners was calculated for each individual by assessing if all three examiners agreed on the absence or presence of restriction or instability (in which case 100% agreement was recorded). It was also calculated on whether two of the three examiners agreed on either the presence or absence of a restriction or instability, assuming the majority rule (in which case 66.6% agreement was recorded). For example, if two examiners reported restriction and one reported no restriction, then it was assumed due to majority rule that that participant had restriction (and thus 66.6% agreement was recorded), but if one examiner reported restriction while the other two reported no restriction, then it was assumed using the same logic that that participant had no restriction present (and similarly, 66.6% agreement was recorded). The mean agreement across all participants for each movement was calculated and reported for symptomatic and asymptomatic feet separately.

McNemar's chi square tests were performed to assess the significance of the percentage of correctly identified symptomatic feet by each of the examiners.
A p value <0.05 was considered as statistically significant.

3.6.1 Statistical Analysis

A reliability study aims to quantitatively express the reliability level by indicating the level of agreement (Huijbregts, 2002). According to Portney and Watkins, (1993) the most straightforward indicator of agreement is the percentage agreement value. The percentage agreement value is defined as the proportion of the number of agreements to the total number of evaluations made (Haas, 1991). This percentage does not correct for chance agreement, therefore it could provide a deceptively high level of reliability (Maher and Adams, 1994; Portney and Watkins, 1993. and Haas, 1991).

The *kappa statistic* (κ) on the other hand, is a chance-corrected index of agreement and can be inclined to underestimate reliability (Portney and Watkins, 1993). Therefore, if agreement is worse than chance the kappa value will be negative. The kappa statistic does not set apart disagreements, it assumes that all disagreements have equal clinical significance (Portney and Watkins, 1993). Lantz (1997), suggested that kappa should not be interpreted without percentage agreement values or the contingency tables from which it was derived. Results with a high percentage agreement but a low kappa value indicate limited variation (Haas, 1991). One situation where limited variation may take place is when there is a large proportion of agreement (Haas, 1991). This can be the result of a study population that is highly homogenous on the variable of interest (Lantz, 1997). This study used both kappa statistic and percentage agreement values to interpret the data obtained. The following Table from Landis and Koch (1977) was used as guidelines interpret the kappa statistics:

0.81-1.0	Almost perfect
0.61-0.80	Substantial
0.41-0.60	Moderate
0.21-0.40	Fair
0.00-0.20	Slight
<0.00	Poor

CHAPTER 4

4.1 KEY TO ABBREVIATIONS

Abbreviation	**Words in full**
AP Dtj	Anterior-posterior distal tibiofibular joint
PA dtj	Posterior –anterior distal tibiofibular joint
LA-Distraction	Long axis distraction Tibiotalar joint
AP Ttj	Anterior-posterior tibiotalar joint
PA Ttj	Posterior –anterior Tibiotalar joint
ML Ttj	Medial-lateral tibiotalar joint
LM Ttjr	Lateral-medial tibiotalar joint
AP Stj	Anterior-posterior subtalar joint
PA Stj	Posterior–anterior subtalar joint
ML Stj	Medial-lateral subtalar joint
LM Stj	Lateral-medial subtalar joint
AP Cub	Anterior-posterior cuboid
PA Cub	Posterior–anterior cuboid
AP Nav	Anterior-posterior navicular
PA Nav	Posterior–anterior navicular
AP Cun	Anterior-posterior cuneiforms
PA Cun	Posterior–anterior cuneiforms
AP Tarso met joint	Anterior-posterior tarsometatarsal joint
PA Tarso met joint	Posterior–anterior tarsometatarsal joint
Restric	Restriction
Instab	Instability

4.2 RESULTS

4.2.1 Demographics

a. Number of patients

Twenty participants with one symptomatic and one asymptomatic foot were enrolled into the study (n=40 feet).

b. Age

Their mean age was 29.4 years (standard deviation 5.7 years) with a range from 22 to 44 years.

Table 1: Age of patients.

N	Valid	20
	Missing	0
Mean		29.40
Std. Deviation		5.734
Minimum		22
Maximum		44

c. Order of examination

Each patient was examined by the examiners in different orders. Table 2 shows examination order of each of the participants.

Table 2: Order of examination

		Frequency	Percent
Valid	1,2,3	5	25.0
	2,1,3	1	5.0
	3,2,1	3	15.0
	3,1,2	5	25.0
	2,3,1	5	25.0
	1,3,2	1	5.0
	Total	20	100.0

The order of examination was determined by picking a number out of an envelope, this method was chosen to alternate examiner order so that any difference in motion palpation findings could not be due to the order in which the examiners palpated. Cooperstein and Gleberzon, (2004) supports this method because motion palpation is a form of mobilisation and can result in altered findings between examiners. The order of examination showed that the most frequent orders of examination were examiner order

1, 2, 3; examiner order 3, 1, 2; and examiner order 2, 3, 1 which occurred 25% each next was examiner order 3, 2, 1 which made up 15% and then examiner orders 2,1,3 and 1,3,2 both made up 5% each.

Asymptomatic

Examiner 2 vs. examiner 3 had the worst inter-examiner reliability and examiner 1 vs. 3 had the best inter-examiner reliability in detecting restrictions in the asymptomatic foot and ankle joints. Examiners 2 vs. 3 had the highest inter-examiner reliability and examiners 1 vs. 2 had the lowest inter-examiner reliability when detecting instability in symptomatic feet.

Symptomatic

The examiner combinations each had different inter-examiner reliability. Examiner 1 vs. examiner 2 had the worst inter-examiner reliability and examiner 2 vs. examiner 3 had the best inter-examiner reliability in detecting restrictions in the symptomatic group. Examiners 1 vs. 3 had the highest inter-examiner reliability and examiners 2 vs. 3 had the lowest when detecting the presence of instability in symptomatic foot and ankle joints

d. Gender

Gender was predominantly male (85%). Previous literature shows varied gender distribution. According to Louwerens and Snijders (1999) the incidence of ankle injuries in the young male population is higher, but after 40 years of age the incidence for females increases more than males. Beynnon *et al*. (2002), however, propose that gender does not appear to be a risk factor for experiencing an ankle sprain. This study was not in keeping with previous literature on gender distribution of ankle sprains, as there was a significant difference in gender distribution. Majority of the patients that qualified for this study were patients who responded to the advertisement that was placed in the Natal indoor soccer arena and this could be one of the factors that affected the gender distribution in this study.

Figure 1 shows that their gender was mainly male (n=17, 85%).

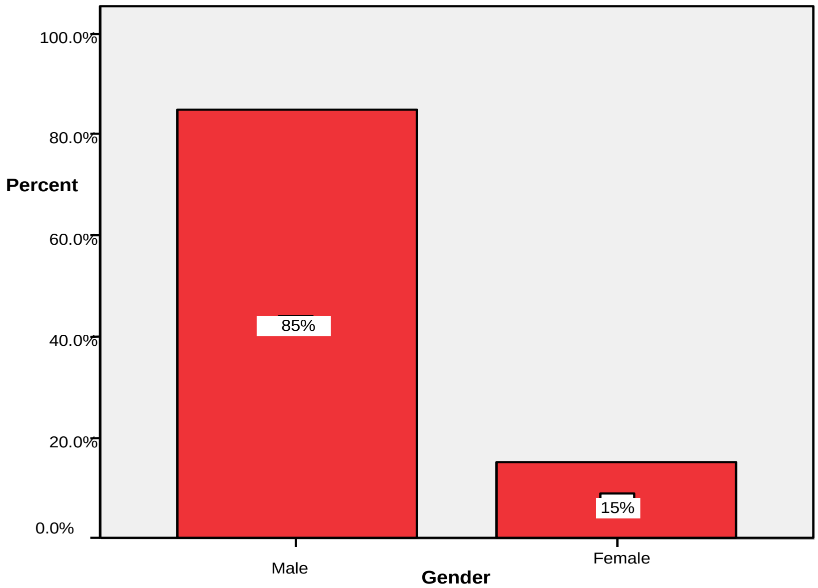

Figure 1: Gender of the sample participants (n=20)

e. Symptomatic foot

Figure 2 shows that 75% of participants had symptomatic right feet and in only 25% the left foot was affected.

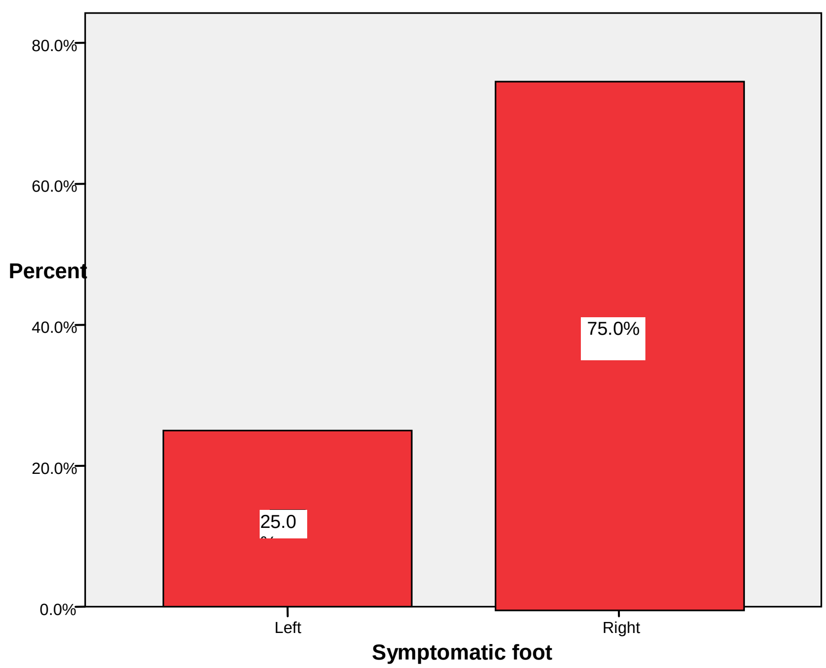

Figure 2: Percentage of right and left foot symptomatic (n=20)

4.2.2 To determine the inter-examiner reliability of motion palpation of the foot and ankle joints in symptomatic feet

The inter-examiner comparisons in symptomatic feet are shown here.

4.2.2.1 Examiner 1 vs. examiner 2

Restriction

Table 3 shows the comparison of examiner 1 and examiner 2's results for the presence of restriction showed the highest kappa value being 0.35 indicating fair agreement. Most of the kappa values were low and several were negative, indicating worse agreement than expected by chance. Percentage agreement showed an average of 87% agreement between these two examiners with 100% being their best agreement and 55% being their worst percentage agreement.

Instability

Table 4 shows that examiner 1 and examiner 2 highest kappa score was 0.400 indicating fair agreement when assessing instability. Their average percentage agreement was 83% with 100% being the highest agreement value and 50% being the worst agreement value.

4.2.2.2 Examiner 1 vs Examiner 3

Restriction

Table 5 shows that examiner 1 vs 3 had better agreement than1 vs 2 with a perfect kappa score of 1 being recorded for one measurement. However, there were still negative and low kappa values for some measurements. Percentage agreement showed an average of 87% with their highest score being 100% and their lowest being 55% agreement.

Instability

Table six shows that examiner 1 vs 3 had better agreement than1 vs 2 with the highest kappa score being 0.814 indicating almost perfect agreement. Percentage agreement showed 100% to be the highest and 50% the lowest with an average of 83% agreement.

4.2.2.3 Examiner 2 vs. Examiner 3

Restriction

Table seven shows that examiner 2 vs. 3 had good agreement with a highest kappa score of 0.643 for one measurement. There were only two negative kappa values. Their average percentage agreement was 90%.

Instability

Table eight shows that examiner 2 vs. 3 had an average percentage agreement of 90%. Their highest kappa score was 0.286 indicating fair agreement.

Table 3: **The inter-examiner reliability of examiner 1 vs. examiner 2 to detect restrictions in symptomatic feet.**

			Examiner 2		Kappa	P value	% agreement
			No	Yes			
AP Dtj Restric	Examiner 1	No	19	1	-		95%
		Yes	0	0			
PA dtj Restric	Examiner 1	No	19	1	-		95%
		Yes	0	0			
LA-Distraction Restric	Examiner 1	No	18	0	-		90%
		Yes	2	0			
AP Ttj Restric	Examiner 1	No	20	0	-		100%
		Yes	0	0			
PA Ttj Restric	Examiner 1	No	20	0	-		100%
		Yes	0	0			
ML Ttj Restric	Examiner 1	No	16	3	0.348	0.040	85%
		Yes	0	1			
LM Ttj Restric	Examiner 1	No	18	1	-0.053	0.814	90%
		Yes	1	0			
AP Stj Restric	Examiner 1	No	19	0	-		95%
		Yes	1	0			
PA Stj Restric	Examiner 1	No	20	0	-		100%
		Yes	0	0			
ML Stj Restric	Examiner 1	No	16	4	-		80%
		Yes	0	0			
LM Stj Restric	Examiner 1	No	20	0	-		100%
		Yes	0	0			
AP Cub Restric	Examiner 1	No	11	1	-0.098	0.402	55%
		Yes	8	0			
PA Cub Restric	Examiner 1	No	10	2	0.091	0.648	60%
		Yes	6	2			
AP Nav Restric	Examiner 1	No	14	1	-0.091	0.554	70%
		Yes	5	0			
PA Nav Restric	Examiner 1	No	13	3	-0.207	0.308	65%
		Yes	4	0			
AP Cun Restric	Examiner 1	No	20	0	-		100%
		Yes	0	0			
PA Cun Restric	Examiner 1	No	20	0	-		100%
		Yes	0	0			
AP Tarso met joint Restric	Examiner 1	No	17	3	-		85%
		Yes	0	0			
PA Tarso met joint Restric	Examiner 1	No	19	1	-		95%
		Yes	0	0			

Table 4: **The inter-examiner reliability of examiner 1 vs. examiner 2 to detect instability in symptomatic feet.**

			Examiner 2		Kappa	P value	% agreement
			No	Yes			
AP Dtj Instab	Examiner 1	No	14	4	-0.154	0.456	70%
		Yes	2	0			
PA dtj Instab	Examiner 1	No	15	3	0.231	0.264	80%
		Yes	1	1			
LA-Distraction Instab	Examiner 1	No	10	0	0.400	0.025	70%
		Yes	6	4			
AP Ttj Instab	Examiner 1	No	11	0	-		55%
		Yes	9	0			
PA Ttj Instab	Examiner 1	No	17	0	-		85%
		Yes	3	0			
ML Ttj Instab	Examiner 1	No	13	2	0.077	0.718	70%
		Yes	4	1			
LM Ttjr Instab	Examiner 1	No	19	0	-		95%
		Yes	1	0			
AP Stj Instab	Examiner 1	No	19	0	-		95%
		Yes	1	0			
PA Stj Instab	Examiner 1	No	10	0	-		50%
		Yes	10	0			
ML Stj Instab	Examiner 1	No	12	5	0.241	0.212	70%
		Yes	1	2			
LM Stj Instab	Examiner 1	No	10	0	-		50%
		Yes	10	0			
AP Cub Instab	Examiner 1	No	19	0	-		95%
		Yes	1	0			
PA Cub Instab	Examiner 1	No	19	0	-		95%
		Yes	1	0			
AP Nav Instab	Examiner 1	No	20	0	-		100%
		Yes	0	0			
PA Nav Instab	Examiner 1	No	20	0	-		100%
		Yes	0	0			
AP Cun Instab	Examiner 1	No	20	0	-		100%
		Yes	0	0			
PA Cun Instab	Examiner 1	No	20	0	-		100%
		Yes	0	0			
AP Tarso met joint Instab	Examiner 1	No	20	0	-		100%
		Yes	0	0			
PA Tarso met joint Instab	Examiner 1	No	20	0	-		100%
		Yes	0	0			
Sympti	Examiner 1	No	3	2	0.222	0.292	65%
		Yes	5	10			

Table 5: **The inter-examiner reliability of examiner 1 vs. examiner 3 to detect restrictions in symptomatic feet.**

			Examiner 3		Kappa	P value	% agreement
			No	Yes			
AP Dtj Restric	Examiner 1	No	18	2	-		90%
		Yes	0	0			
PA dtj Restric	Examiner 1	No	20	0	-		100%
		Yes	0	0			
LA-Distraction Restric	Examiner 1	No	15	3	-0.136	0.531	75%
		Yes	2	0			
AP Ttj Restric	Examiner 1	No	20	0	-		100%
		Yes	0	0			
PA Ttj Restric	Examiner 1	No	19	1	-		95%
		Yes	0	0			
ML Ttj Restric	Examiner 1	No	19	0	1.000	<0.001	100%
		Yes	0	1			
LM Ttjr	Examiner 1	No	18	1	-0.053	0.814	90%
		Yes	1	0			
AP Stj Restric	Examiner 1	No	19	0	-		95%
		Yes	1	0			
PA Stj Restric	Examiner 1	No	20	0	-		100%
		Yes	0	0			
ML Stj Restric	Examiner 1	No	17	3	-		85%
		Yes	0	0			
LM Stj Restric	Examiner 1	No	17	3	-		85%
		Yes	0	0			
AP Cub Restric	Examiner 1	No	9	3	-0.279	0.125	45%
		Yes	8	0			
PA Cub Restric	Examiner 1	No	11	1	-0.098	0.814	55%
		Yes	8	0			
AP Nav Restric	Examiner 1	No	15	0	-		75%
		Yes	5	0			
PA Nav Restric	Examiner 1	No	16	0	-		80%
		Yes	4	0			
AP Cun Restric	Examiner 1	No	20	0	-		100%
		Yes	0	0			
PA Cun Restric	Examiner 1	No	20	0	-		100%
		Yes	0	0			
AP Tarso met joint Restric	Examiner 1	No	17	3	-		85%
		Yes	0	0			
PA Tarso met joint Restric	Examiner 1	No	18	2	-		90%
		Yes	0	0			
symptr	Examiner 1	No	17	2	0.459	0.015	90%
		Yes	0	1			

Table 6: **The inter-examiner reliability of examiner 1 vs. examiner 3 to detect instability in symptomatic feet.**

			Examiner 3		Kappa	P value	% agreement
			No	Yes			
AP Dtj Instab	Examiner 1	No	13	5	0.118	0.151	70%
		Yes	1	1			
PA dtj Instab	Examiner 1	No	16	2	0.318	0.144	85%
		Yes	1	1			
LA-Distraction Instab	Examiner 1	No	8	2	0.100	0.606	55%
		Yes	7	3			
AP Ttj Instab	Examiner 1	No	9	2	-0.075	0.660	50%
		Yes	8	1			
PA Ttj Instab	Examiner 1	No	16	1	0.318	0.144	85%
		Yes	2	1			
ML Ttj Instab	Examiner 1	No	14	1	0.167	0.389	75%
		Yes	4	1			
LM Ttjr Instab	Examiner 1	No	19	0	-		95%
		Yes	1	0			
AP Stj Instab	Examiner 1	No	19	0	-		95%
		Yes	1	0			
PA Stj Instab	Examiner 1	No	9	1	0.100	0.531	55%
		Yes	8	2			
ML Stj Instab	Examiner 1	No	17	0	0.459	0.015	90%
		Yes	2	1			
LM Stj Instab	Examiner 1	No	8	2	-0.100	0.531	45%
		Yes	9	1			
AP Cub Instab	Examiner 1	No	18	1	-0.053	0.814	90%
		Yes	1	0			
PA Cub Instab	Examiner 1	No	19	0	-		95%
		Yes	1	0			
AP Nav Instab	Examiner 1	No	20	0	-		100%
		Yes	0	0			
PA Nav Instab	Examiner 1	No	20	0	-		100%
		Yes	0	0			
AP Cun Instab	Examiner 1	No	20	0	-		100%
		Yes	0	0			
PA Cun Instab	Examiner 1	No	20	0	-		100%
		Yes	0	0			
AP Tarso met joint Instab	Examiner 1	No	20	0	-		100%
		Yes	0	0			
PA Tarso met joint Instab	Examiner 1	No	20	0	-		100%
		Yes	0	0			
Sympti	Examiner 1	No	3	2	0.222	0.292	65%
		Yes	5	10			

Table 7: The inter-examiner reliability of examiner 2 vs. examiner 3 to detect restrictions in symptomatic feet.

			Examiner 3		Kappa	P value	% agreement
			No	Yes			
AP Dtj Restric	Examiner 2	No	18	1	0.643	0.002	95%
		Yes	0	1			
PA dtj Restric	Examiner 2	No	19	0	-		95%
		Yes	1	0			
LA-Distraction Restric	Examiner 2	No	17	3	-		85%
		Yes	0	0			
AP Ttj Restric	Examiner 2	No	20	0	-		100%
		Yes	0	0			
PA Ttj Restric	Examiner 2	No	19	1	-		95%
		Yes	0	0			
ML Ttj Restric	Examiner 2	No	16	0	0.348	0.040	85%
		Yes	3	1			
LM Ttjr	Examiner 2	No	18	1	0.053	0.814	90%
		Yes	1	0			
AP Stj Restric	Examiner 2	No	20	0	-		100%
		Yes	0	0			
PA Stj Restric	Examiner 2	No	20	0	-		100%
		Yes	0	0			
ML Stj Restric	Examiner 2	No	13	3	-0.207	0.308	65%
		Yes	4	0			
LM Stj Restric	Examiner 2	No	17	3			85%
		Yes	0	0			
AP Cub Restric	Examiner 2	No	16	3	0.018	0.666	80%
		Yes	1	0			
PA Cub Restric	Examiner 2	No	16	0	0.348	0.040	85%
		Yes	3	1			
AP Nav Restric	Examiner 2	No	19	0	-		95%
		Yes	1	0			
PA Nav Restric	Examiner 2	No	17	0	-		85%
		Yes	3	0			
AP Cun Restric	Examiner 2	No	20	0	-		100%
		Yes	0	0			
PA Cun Restric	Examiner 2	No	20	0	-		100%
		Yes	0	0			
AP Tarso met joint Restric	Examiner 2	No	17	3	-		85%
		Yes	0	0			
PA Tarso met joint Restric	Examiner 2	No	17	2	0.071	0.372	85%
		Yes	0	0			
symptr	Examiner 2	No	15	2	0.216	0.335	80%
		Yes	2	1			

Table 8: **The inter-examiner reliability of examiner 2 vs. examiner 3 to detect instability in symptomatic feet.**

			Examiner 3		Kappa		% agreement
			No	Yes			
AP Dtj Instab	Examiner 2	No	12	4	0.211	0.329	70%
		Yes	2	2			
PA dtj Instab	Examiner 2	No	14	2	0.138	0.531	75%
		Yes	3	1			
LA-Distraction Instab	Examiner 2	No	13	3	0.286	0.197	75%
		Yes	2	2			
AP Ttj Instab	Examiner 2	No	17	3	-		85%
		Yes	0	0			
PA Ttj Instab	Examiner 2	No	18	2	-		90%
		Yes	0	0			
ML Ttj Instab	Examiner 2	No	15	2	-0.136	0.531	75%
		Yes	3	0			
LM Ttjr Instab	Examiner 2	No	20	0	-		100%
		Yes	0	0			
AP Stj Instab	Examiner 2	No	20	0	-		100%
		Yes	0	0			
PA Stj Instab	Examiner 2	No	17	3	-		85%
		Yes	0	0			
ML Stj Instab	Examiner 2	No	13	0	0.178	0.162	70%
		Yes	6	1			
LM Stj Instab	Examiner 2	No	17	3	-		85%
		Yes	0	0			
AP Cub Instab	Examiner 2	No	19	1	-		95%
		Yes	0	0			
PA Cub Instab	Examiner 2	No	20	0	-		100%
		Yes	0	0			
AP Nav Instab	Examiner 2	No	20	0	-		100%
		Yes	0	0			
PA Nav Instab	Examiner 2	No	20	0	-		100%
		Yes	0	0			
AP Cun Instab	Examiner 2	No	20	0	-		100%
		Yes	0	0			
PA Cun Instab	Examiner 2	No	20	0	-		100%
		Yes	0	0			
AP Tarso met joint Instab	Examiner 2	No	20	0	-		100%
		Yes	0	0			
PA Tarso met joint Instab	Examiner 2	No	20	0	-		100%
		Yes	0	0			
Sympti	Examiner 2	No	6	2	0.583	0.009	80%
		Yes	2	10			

4.2.3 To determine the inter-examiner reliability of motion palpation of the foot and ankle joints in asymptomatic feet

The inter-examiner comparisons in asymptomatic feet are shown here.

4.2.3.1 Examiner 1 vs. examiner 2

Restriction

Table 9 shows that the agreement was generally poor for asymptomatic feet between these 2 examiners. The highest kappa value was 0.219 indicating slight agreement. The average percentage agreement was 87%.

Instability

Table 10 shows these two examiners had poor agreement with -0.071 being their highest kappa value. Their percentage agreement however, had an average of 93% agreement.

4.2.3.2 Examiner 1 vs Examiner 3

Restriction

Table 11 shows that the highest kappa recorded was 0.318 between these 2 examiners but on the whole the agreement was poor. Their percentage agreement was 87% average.

Instability

Table 12 shows that the highest kappa recorded was 0.459 between these 2 examiners but on the whole the agreement was poor. The average percentage agreement was 84%.

4.2.3.3 Examiner 2 vs Examiner 3

Restriction

Table 13 shows agreement was mostly worse than expected by chance, with the highest kappa value being -0.053. However, their average percentage agreement was 87%.

Instability

Table 14 shows that Kappa values were generally poor except for two measures where perfect agreement was recorded. Percentage agreement had an average of 96%.

Table 9: The inter-examiner reliability of examiner 1 vs. examiner 2 to detect restrictions in asymptomatic feet.

			Examiner 2		Kappa	P value	% agreement
			No	Yes			
AP Dtj Restric	Examiner 1	No	20	0	-		100%
		Yes	0	0			
PA dtj Restric	Examiner 1	No	18	2	-		90%
		Yes	0	0			
LA-Distraction Restric	Examiner 1	No	10	3	0.059	0.787	60%
		Yes	5	2			
AP Ttj Restric	Examiner 1	No	20	0	-		100%
		Yes	0	0			
PA Ttj Restric	Examiner 1	No	19	1	-		95%
		Yes	0	0			
ML Ttj Restric	Examiner 1	No	14	6	-		70%
		Yes	0	0			
LM Ttjr	Examiner 1	No	20	0	-		100%
		Yes	0	0			
AP Stj Restric	Examiner 1	No	18	2	-		90%
		Yes	0	0			
PA Stj Restric	Examiner 1	No	18	1	-0.053	0.814	90%
		Yes	1	0			
ML Stj Restric	Examiner 1	No	12	6	-0.176	0.329	60%
		Yes	2	0			
LM Stj Restric	Examiner 1	No	16	4	-		80%
		Yes	0	0			
AP Cub Restric	Examiner 1	No	14	0	0.219	0.117	75%
		Yes	5	1			
PA Cub Restric	Examiner 1	No	11	3	0.125	0.573	65%
		Yes	4	2			
AP Nav Restric	Examiner 1	No	17	1	-0.71	0.732	85%
		Yes	2	0			
PA Nav Restric	Examiner 1	No	17	1	-0.071	0.732	85%
		Yes	2	0			
AP Cun Restric	Examiner 1	No	20	0	-		100%
		Yes	0	0			
PA Cun Restric	Examiner 1	No	20	0	-		100%
		Yes	0	0			
AP Tarso met joint Restric	Examiner 1	No	20	0	-		100%
		Yes	0	0			
PA Tarso met joint Restric	Examiner 1	No	20	0	-		100%
		Yes	0	0			
symptr	Examiner 1	No	17	2	-0.017	0.732	85%
		Yes	1	0			

Table 10: The inter-examiner reliability of examiner 1 vs. examiner 2 to detect instability in asymptomatic feet.

			Examiner 2		Kappa	P value	% agreement
			No	Yes			
AP Dtj Instab	Examiner 1	No	18	2	-		90%
		Yes	0	0			
PA dtj Instab	Examiner 1	No	19	1	-		95%
		Yes	0	0			
LA-Distraction Instab	Examiner 1	No	16	3			80%
		Yes	1	0			
AP Ttj Instab	Examiner 1	No	19	0	-		95%
		Yes	1	0			
PA Ttj Instab	Examiner 1	No	19	0	-		95%
		Yes	0	0			
ML Ttj Instab	Examiner 1	No	19	0	-		95%
		Yes	1	0			
LM Ttjr Instab	Examiner 1	No	19	0	-		95%
		Yes	1	0			
AP Stj Instab	Examiner 1	No	19	0	-		95%
		Yes	1	0			
PA Stj Instab	Examiner 1	No	20	0	-		100%
		Yes	0	0			
ML Stj Instab	Examiner 1	No	17	1	-0.071	0.732	85%
		Yes	2	0			
LM Stj Instab	Examiner 1	No	17	1	-0.071	0.732	85%
		Yes	2	0			
AP Cub Instab	Examiner 1	No	16	0	-		80%
		Yes	4	0			
PA Cub Instab	Examiner 1	No	16	0	-		80%
		Yes	4	0			
AP Nav Instab	Examiner 1	No	20	0	-		100%
		Yes	0	0			
PA Nav Instab	Examiner 1	No	20	0	-		100%
		Yes	0	0			
AP Cun Instab	Examiner 1	No	20	0	-		100%
		Yes	0	0			
PA Cun Instab	Examiner 1	No	20	0	-		100%
		Yes	0	0			
AP Tarso met joint Instab	Examiner 1	No	20	0	-		100%
		Yes	0	0			
PA Tarso met joint Instab	Examiner 1	No	20	0	-		100%
		Yes	0	0			
Sympti	Examiner 1	No	14	3	-0.176	0.430	70%
		Yes	3	0			

Table 11: **The inter-examiner reliability of examiner 1 vs. examiner 3 to detect restrictions in asymptomatic feet.**

			Examiner 3		Kappa	P value	% agreement
			No	Yes			
AP Dtj Restric	Examiner 1	No	20	0	-		100%
		Yes	0	0			
PA dtj Restric	Examiner 1	No	19	1	-		95%
		Yes	0	0			
LA-Distraction Restric	Examiner 1	No	12	1	-0.96	0.452	60%
		Yes	7	0			
AP Ttj Restric	Examiner 1	No	20	0	-		100%
		Yes	0	0			
PA Ttj Restric	Examiner 1	no	19	1	-		95%
		yes	0	0			
ML Ttj Restric	Examiner 1	No	18	2	-		90%
		Yes	0	0			
LM Ttjr	Examiner 1	No	20	0	-		100%
		Yes	0	0			
AP Stj Restric	Examiner 1	No	18	0	-		90%
		Yes	2	0			
PA Stj Restric	Examiner 1	No	17	2	0.071	0.732	85%
		Yes	1	0			
ML Stj Restric	Examiner 1	No	16	2	0.318	0.144	80%
		Yes	1	1			
LM Stj Restric	Examiner 1	No	15	1	0.231	0.264	80%
		Yes	3	1			
AP Cub Restric	Examiner 1	No	13	1	-0.094	0.502	65%
		Yes	6	0			
PA Cub Restric	Examiner 1	No	12	2	0.176	0.329	60%
		Yes	6	0			
AP Nav Restric	Examiner 1	No	16	2	-0.111	0.619	80%
		Yes	2	0			
PA Nav Restric	Examiner 1	No	16	1	-0.071	0.732	80%
		Yes	2	0			
AP Cun Restric	Examiner 1	No	20	0	-		100%
		Yes	0	0			
PA Cun Restric	Examiner 1	No	20	0	-		100%
		Yes	0	0			
AP Tarso met joint Restric	Examiner 1	No	19	1	-		95%
		Yes	0	0			
PA Tarso met joint Restric	Examiner 1	No	20	0	-		100%
		Yes	0	0			
symptr	Examiner 1	No	17	2	-0.071	0.732	85%
		Yes	1	0			

Table 12: **The inter-examiner reliability of examiner 1 vs. examiner 3 to detect instability in asymptomatic feet.**

			Examiner 3		Kappa	P value	% Agreement
			No	Yes			
AP Dtj Instab	Examiner 1	No	19	1	-		95%
		Yes	0	0			
PA dtj Instab	Examiner 1	No	20	0	-		100%
		Yes	0	0			
LA-Distraction Instab	Examiner 1	No	17	2	0.459	0.015	90%
		Yes	0	1			
AP Ttj Instab	Examiner 1	No	18	1	-0.053	0.814	90%
		Yes	1	0			
PA Ttj Instab	Examiner 1	No	19	1	-		95%
		Yes	0	0			
ML Ttj Instab	Examiner 1	No	19	0	0.1000	0.000	100%
		Yes	0	1			
LM Ttjr Instab	Examiner 1	No	19	1	-		95%
		Yes	0	0			
AP Stj Instab	Examiner 1	No	19	0	0.1000	0.000	100%
		Yes	0	1			
PA Stj Instab	Examiner 1	No	19	1	-		95%
		Yes	0	0			
ML Stj Instab	Examiner 1	No	17	1	-0.071	0.732	85%
		Yes	2	0			
LM Stj Instab	Examiner 1	No	18	0	-		90%
		Yes	2	0			
AP Cub Instab	Examiner 1	No	16	0	-		80%
		Yes	4	0			
PA Cub Instab	Examiner 1	No	16	0	-		80%
		Yes	4	0			
AP Nav Instab	Examiner 1	No	20	0	-		100%
		Yes	0	0			
PA Nav Instab	Examiner 1	No	20	0	-		100%
		Yes	0	0			
AP Cun Instab	Examiner 1	No	20	0	-		100%
		Yes	0	0			
PA Cun Instab	Examiner 1	No	19	1	-		95%
		Yes	0	0			
AP Tarso met joint Instab	Examiner 1	No	20	0	-		100%
		Yes	0	0			
PA Tarso met joint Instab	Examiner 1	No	20	0	-		100%
		Yes	0	0			
Sympti	Examiner 1	No	16	1	0.318	0.144	85%
		Yes	2	1			

Table 13: **The inter-examiner reliability of examiner 2 vs. examiner 3 to detect restrictions in asymptomatic feet.**

			Examiner 3		Kappa	P value	% Agreement
			No	Yes			
AP Dtj Restric	Examiner 2	No	20	0	-		100%
		Yes	0	0			
PA dtj Restric	Examiner 2	No	17	1	-0.071	0.732	85%
		Yes	2	0			
LA-Distraction Restric	Examiner 2	No	14	1	-0.091	0.554	70%
		Yes	5	0			
AP Ttj Restric	Examiner 2	No	20	0	-		100%
		Yes	0	0			
PA Ttj Restric	Examiner 2	No	18	1	-0.053	0.814	90%
		Yes	1	0			
ML Ttj Restric	Examiner 2	No	12	2	-0.176	0.329	60%
		Yes	6	0			
LM Ttjr	Examiner 2	No	20	0	-		100%
		Yes	0	0			
AP Stj Restric	Examiner 2	No	20	0	-		100%
		Yes	0	0			
PA Stj Restric	Examiner 2	No	17	2	-0.071	0.732	85%
		Yes	1	0			
ML Stj Restric	Examiner 2	No	11	3	-0.250	0.219	55%
		Yes	6	0			
LM Stj Restric	Examiner 2	No	16	0	-		80%
		Yes	4	0			
AP Cub Restric	Examiner 2	No	18	1	-0.053	0.814	90%
		Yes	1	0			
PA Cub Restric	Examiner 2	No	13	2	-0.167	0.39	65%
		Yes	5	0			
AP Nav Restric	Examiner 2	No	17	2	-0.071	0.732	85%
		Yes	1	0			
PA Nav Restric	Examiner 2	No	18	1	-0.053	0.814	90%
		Yes	1	0			
AP Cun Restric	Examiner 2	No	20	0	-		100%
		Yes	0	0			
PA Cun Restric	Examiner 2	No	20	0	-		100%
		Yes	0	0			
AP Tarso met joint Restric	Examiner 2	No	19	1	-		95%
		Yes	0	0			
PA Tarso met joint Restric	Examiner 2	No	20	0	-		100%
		Yes	0	0			
symptr	Examiner 2	No	16	2	-0.111	0.619	80%
		Yes	2	0			

Table 14: **The inter-examiner reliability of examiner 2 vs. examiner 3 to detect instability in asymptomatic feet.**

			Examiner 3		Kappa	P value	% Agreement
			No	Yes			
AP Dtj Instab	Examiner 2	No	17	1	-0.071	0.732	85%
		Yes	2	0			
PA dtj Instab	Examiner 2	No	19	0	-		95%
		Yes	1	0			
LA-Distraction Instab	Examiner 2	No	16	3	-0.081	0.666	80%
		Yes	1	0			
AP Ttj Instab	Examiner 2	No	19	1	-		95%
		Yes	0	0			
PA Ttj Instab	Examiner 2	No	19	0	1.000	0.000	95%
		Yes	0	1			
ML Ttj Instab	Examiner 2	No	19	1	-		95%
		Yes	0	0			
LM Ttj Instab	Examiner 2	No	20	0	-		100%
		Yes	0	0			
AP Stj Instab	Examiner 2	No	19	1	-		95%
		Yes	0	0			
PA Stj Instab	Examiner 2	No	19	1	-		95%
		Yes	0	0			
ML Stj Instab	Examiner 2	No	19	0	1.000	<0.001	100%
		Yes	0	1			
LM Stj Instab	Examiner 2	No	19	0	-		95%
		Yes	1	0			
AP Cub Instab	Examiner 2	No	20	0	-		100%
		Yes	0	0			
PA Cub Instab	Examiner 2	No	20	0	-		100%
		Yes	0	0			
AP Nav Instab	Examiner 2	No	20	0	-		100%
		Yes	0	0			
PA Nav Instab	Examiner 2	No	20	0	-		100%
		Yes	0	0			
AP Cun Instab	Examiner 2	No	20	0	-		100%
		Yes	0	0			
PA Cun Instab	Examiner 2	No	19	1	-		95%
		Yes	0	0			
AP Tarso met joint Instab	Examiner 2	No	20	0	-		100%
		Yes	0	0			
PA Tarso met joint Instab	Examiner 2	No	20	0	-		100%
		Yes	0	0			
Sympti	Examiner2	No	16	1	0.318	0.144	85%
		Yes	2	1			

4.2.4 To determine the percentage of agreement between all 3 examiners in symptomatic feet

The mean percentage of agreement between all three examiners simultaneously was calculated as reported in the methodology section. The percentages are ranked from lowest to highest in the following tables.

4.2.4.1 Restriction

Table 15: Percentage agreement between examiners

	Mean
Agreement AP Cub	79.96
Agreement PA Cub	83.30
Agreement ML Stj	88.31
Agreement PA Nav	88.31
Agreement AP Nav	89.98
Agreement LA-Distraction	91.65
Agreement ML Ttj	93.32
Agreement LM Ttj	94.99
Agreement LM Stj	94.99
Agreement AP Tarso met joint	94.99
Agreement PA Tarso met joint	94.99
Agreement AP Dtj	96.66
Agreement PA Dtj	98.33
Agreement PA Ttj	98.33
Agreement AP Stj	98.33
Agreement AP Ttj	100.00
Agreement PA Stj	100.00
Agreement AP Cun	100.00
Agreement PA Cun	100.00

4.2.4.2 Instability

Table 16: Percentage agreement between examiners

	Mean
Agreement LA-Distraction	79.96
Agreement LM Stj	79.96
Agreement AP Ttj	81.63
Agreement PA Stj	81.63
Agreement AP Dtj	84.97
Agreement ML Ttj	86.64
Agreement ML Stj	86.64
Agreement PA Dtj	88.31
Agreement PA Ttj	93.32
Agreement AP Cub	96.66
Agreement LM Ttj	98.33
Agreement AP Stj	98.33
Agreement PA Cub	98.33
Agreement AP Nav	100.00
Agreement PA Nav	100.00
Agreement AP Cun	100.00
Agreement PA Cun	100.00
Agreement AP Tarso met joint	100.00
Agreement PA Tarso met joint	100.00

4.2.5 To determine the inter-examiner percentage of agreement between all 3 examiners in asymptomatic feet

The mean percentage of agreement between all three examiners simultaneously was calculated as reported in the methodology section. The percentages are ranked from lowest to highest in the following tables.

4.2.5.1 Restriction

Table 17: Percentage agreement between examiners

	Mean
Agreement LA-Distraction	81.63
Agreement PA Cub	81.63
Agreement ML Stj	83.30
Agreement ML Ttj	86.64
Agreement AP Cub	88.31
Agreement LM Stj	91.65
Agreement AP Nav	91.65
Agreement PA Stj	93.32
Agreement PA Nav	93.32
Agreement PA Dtj	94.99
Agreement PA Ttj	96.66
Agreement AP Stj	96.66
Agreement AP Tarso met joint	98.33
Agreement AP Dtj	100.00
Agreement AP Ttj	100.00
Agreement LM Ttj	100.00
Agreement AP Cun	100.00
Agreement PA Cun	100.00
Agreement PA Tarso met joint	100.00

4.2.5.2 Instability

Table 18: Percentage agreement between examiners

	Mean
Agreement LA-Distraction	89.98
Agreement AP Cub	93.32
Agreement PA Cub	93.32
Agreement AP Dtj	94.99
Agreement ML Stj	94.99
Agreement LM Stj	94.99
Agreement AP Ttj	96.66
Agreement PA Dtj	98.33
Agreement PA Ttj	98.33
Agreement ML Ttj	98.33
Agreement LM Ttj	98.33
Agreement AP Stj	98.33
Agreement PA Stj	98.33
Agreement PA Cun	98.33
Agreement AP Nav	100.00
Agreement PA Nav	100.00
Agreement AP Cun	100.00
Agreement AP Tarso met joint	100.00
Agreement PA Tarso met joint	100.00

4.2.6 To compare motion palpation findings in symptomatic and asymptomatic feet

4.2.6.1 Comparison of reliability between symptomatic and asymptomatic feet

Kappa values were extracted from the tables 3 to 14, and compared between the symptomatic and asymptomatic feet. Only those measurements in which valid kappa values from both symptomatic and asymptomatic feet were obtained were used in the analysis (n=25). Non parametric testing was used since the kappa values were non normally distributed. Paired Wilcoxon signed ranks test was used since the symptomatic and asymptomatic feet were paired.

The table below shows that there was a borderline non significant difference in Kappa values between the two groups (p=0.074). There were a greater number of negative ranks than positive ranks, suggesting a trend towards the asymptomatic kappa values being lower than the symptomatic values. Figure 3 also shows that the general distribution of kappa values was lower in the asymptomatic group.

Table 19: Wilcoxon signed ranks test to compare the kappa values between symptomatic and asymptomatic feet

		N	Mean Rank	Sum of Ranks
Asymptomatic - symptomatic	Negative Ranks	15(a)	15.27	229.00
	Positive Ranks	10(b)	9.60	96.00
	Ties	0(c)		
	Total	25		

a asymptomatic < symptomatic
b asymptomatic > symptomatic
c asymptomatic = symptomatic

Test Statistics(b)

	asymptomatic - symptomatic
Z	-1.789(a)
Asymp. Sig. (2-tailed)	0.074

a Based on positive ranks.
b Wilcoxon Signed Ranks Test

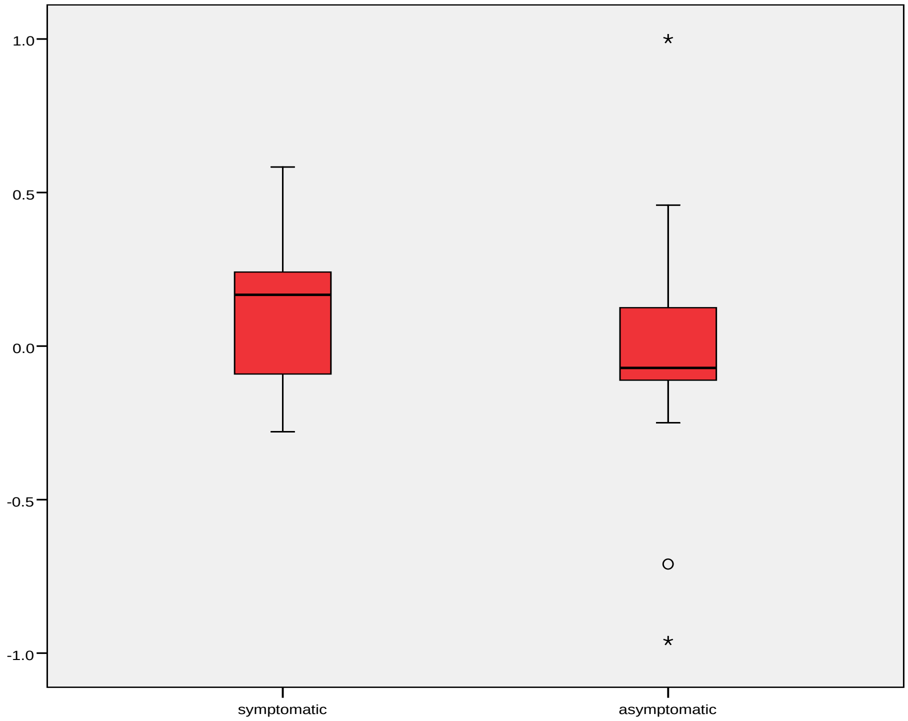

Figure 3: Boxplot of the distribution of Kappa values between the symptomatic and asymptomatic feet

4.2.6.2 Comparison of restrictions between symptomatic and asymptomatic feet

Table 20 shows that there was a borderline non significant difference in long axis distraction restriction between symptomatic and asymptomatic feet (p=0.058). More restrictions were found in asymptomatic feet. No other difference reached statistical significance.

Table 20: Comparison of restrictions between symptomatic and asymptomatic feet

		Actual foot symptomatic				P value
		No		Yes		
		Count	Column %	Count	Column %	
AP Dtj Restric	No	20	100.0%	20	100.0%	-
	Yes	0	.0%	0	.0%	
PA dtj Restric	No	20	100.0%	20	100.0%	-
	Yes	0	.0%	0	.0%	
LA-Distraction Restric	No	13	65.0%	18	90.0%	0.058
	Yes	7	35.0%	2	10.0%	
AP Ttj Restric	No	20	100.0%	20	100.0%	-
	Yes	0	.0%	0	.0%	
PA Ttj Restric	No	20	100.0%	20	100.0%	-
	Yes	0	.0%	0	.0%	
ML Ttj Restric	No	20	100.0%	19	95.0%	0.311
	Yes	0	.0%	1	5.0%	
LM Ttjr	No	20	100.0%	19	95.0%	0.311
	Yes	0	.0%	1	5.0%	
AP Stj Restric	No	18	90.0%	19	95.0%	0.548
	Yes	2	10.0%	1	5.0%	
PA Stj Restric	No	19	95.0%	20	100.0%	0.311
	Yes	1	5.0%	0	.0%	
ML Stj Restric	No	18	90.0%	20	100.0%	0.147
	Yes	2	10.0%	0	.0%	
LM Stj Restric	No	16	80.0%	20	100.0%	0.035
	Yes	4	20.0%	0	.0%	
AP Cub Restric	No	14	70.0%	12	60.0%	0.507
	Yes	6	30.0%	8	40.0%	
PA Cub Restric	No	14	70.0%	12	60.0%	0.507
	Yes	6	30.0%	8	40.0%	

AP Nav Restric	No	18	90.0%	15	75.0%	0.212
	Yes	2	10.0%	5	25.0%	
PA Nav Restric	No	18	90.0%	16	80.0%	0.376
	Yes	2	10.0%	4	20.0%	
AP Cun Restric	No	20	100.0%	20	100.0%	-
	Yes	0	.0%	0	.0%	
PA Cun Restric	No	20	100.0%	20	100.0%	-
	Yes	0	.0%	0	.0%	
AP Tarso met joint Restric	No	20	100.0%	20	100.0%	-
	Yes	0	.0%	0	.0%	
PA Tarso met joint Restric	No	20	100.0%	20	100.0%	-
	Yes	0	.0%	0	.0%	

4.2.6.3 Comparison of instability between symptomatic and asymptomatic feet

Table 21 shows that long axis distraction (p=0.001), anterior to posterior glide of the tibiotalar joint (p=0.003), posterior to anterior glide of the subtalar joint (p<0.001), and lateral to medial tilt of the subtalar joint (p=0.006) instability were significantly more common in symptomatic feet.

Table 21: Comparison of instability between symptomatic and asymptomatic feet

		Actual foot symptomatic				P value
		No		Yes		
		Count	Column %	Count	Column %	
AP Dtj Instab	No	20	100.0%	18	90.0%	0.147
	Yes	0	.0%	2	10.0%	
PA dtj Instab	No	20	100.0%	18	90.0%	0.147
	Yes	0	.0%	2	10.0%	
LA-Distraction Instab	No	19	95.0%	10	50.0%	0.001
	Yes	1	5.0%	10	50.0%	
AP Ttj Instab	No	19	95.0%	11	55.0%	0.003
	Yes	1	5.0%	9	45.0%	
PA Ttj Instab	No	20	100.0%	17	85.0%	0.072
	Yes	0	.0%	3	15.0%	
ML Ttj Instab	No	19	95.0%	15	75.0%	0.077
	Yes	1	5.0%	5	25.0%	
LM Ttjr Instab	No	19	95.0%	19	95.0%	1
	Yes	1	5.0%	1	5.0%	
AP Stj Instab	No	19	95.0%	19	95.0%	1
	Yes	1	5.0%	1	5.0%	
PA Stj Instab	No	20	100.0%	10	50.0%	<0.001
	Yes	0	.0%	10	50.0%	
ML Stj Instab	No	18	90.0%	17	85.0%	0.633
	Yes	2	10.0%	3	15.0%	
LM Stj Instab	No	18	90.0%	10	50.0%	0.006
	Yes	2	10.0%	10	50.0%	
AP Cub Instab	No	16	80.0%	19	95.0%	0.151
	Yes	4	20.0%	1	5.0%	
PA Cub Instab	No	16	80.0%	19	95.0%	0.151
	Yes	4	20.0%	1	5.0%	
AP Nav Instab	No	20	100.0%	20	100.0%	-
	Yes	0	.0%	0	.0%	
PA Nav Instab	No	20	100.0%	20	100.0%	-
	Yes	0	.0%	0	.0%	

AP Cun Instab	No	20	100.0%	20	100.0%	-
	Yes	0	.0%	0	.0%	
PA Cun Instab	No	20	100.0%	20	100.0%	-
	Yes	0	.0%	0	.0%	
AP Tarso met joint Instab	No	20	100.0%	20	100.0%	-
	Yes	0	.0%	0	.0%	
PA Tarso met joint Instab	No	20	100.0%	20	100.0%	-
	Yes	0	.0%	0	.0%	

4.2.7 To ascertain whether each examiner correctly identified the symptomatic foot

5.2.7.1 Examiner 1

a.) Restriction

There was a very significant difference between the actual symptomatic foot and those assessed by examiner 1 to be symptomatic (p<0.001). Examiner 1 only identified 5% of the symptomatic feet for restriction. Sensitivity was therefore 5% but specificity was 95% meaning examiner 1 correctly excluded restriction in 95% of the non symptomatic feet.

Table 22: To ascertain whether examiner 1 correctly identified the symptomatic foot

Examiner 1			Actual foot symptomatic		Total
			No	Yes	
1	No	Count	19	19	38
		% within Actual foot symptomatic	95.0%	95.0%	95.0%
	Yes	Count	1	1	2
		% within Actual foot symptomatic	5.0%	5.0%	5.0%
Total		Count	20	20	40
		% within Actual foot symptomatic	100.0%	100.0%	100.0%

McNemar's chi square p <0.001

b.) Instability

There was no difference between the actual symptomatic foot and those assessed by examiner 1 to be symptomatic (p=0.727). Examiner 1 identified 75% of the symptomatic feet for instability. Sensitivity was therefore 75% and specificity was 85% meaning examiner 1 correctly excluded instability in 85% of the non symptomatic feet.

Table 23: To ascertain whether examiner 1 correctly identified the symptomatic foot

Examiner 1			Actual foot symptomatic		Total
			No	Yes	
1	No	Count	17	5	22
		% Within Actual foot symptomatic	85.0%	25.0%	55.0%
	Yes	Count	3	15	18
		% Within Actual foot symptomatic	15.0%	75.0%	45.0%
Total		Count	20	20	40
		% Within Actual foot symptomatic	100.0%	100.0%	100.0%

McNemar's chi square p=0.727

5.2.7.2 Examiner 2

c.) Restriction

There was a very significant difference between the actual symptomatic foot and those assessed by examiner 2 to be symptomatic (p=0.001). Examiner 2 only identified 15% of the symptomatic feet for restriction. Sensitivity was therefore 15% but specificity was 90% meaning examiner 2 correctly excluded restriction in 90% of the non symptomatic feet.

Table 24: **To ascertain whether examiner 2 correctly identified the symptomatic foot**

Examiner 2			Actual foot symptomatic		Total
			No	Yes	
2	No	Count	18	17	35
		% Within Actual foot symptomatic	90.0%	85.0%	87.5%
	Yes	Count	2	3	5
		% Within Actual foot symptomatic	10.0%	15.0%	12.5%
Total		Count	20	20	40
		% Within Actual foot symptomatic	100.0%	100.0%	100.0%

McNemar's chi square p=0.001

d.) Instability

There was no difference between the actual symptomatic foot and those assessed by examiner 2 to be symptomatic (p=0.227). Examiner 2 identified 60% of the symptomatic feet for instability. Sensitivity was therefore 60% and specificity was 85% meaning examiner 2 correctly excluded instability in 85% of the non symptomatic feet.

Table 25: To ascertain whether examiner 2 correctly identified the symptomatic foot

Examiner 2			Actual foot symptomatic		Total
			No	Yes	No
2	No	Count	17	8	25
		% within Actual foot symptomatic	85.0%	40.0%	62.5%
	Yes	Count	3	12	15
		% within Actual foot symptomatic	15.0%	60.0%	37.5%
Total		Count	20	20	40
		% within Actual foot symptomatic	100.0%	100.0%	100.0%

McNemar's chi square p=0.227

5.2.7.3 Examiner 3

e.) Restriction

There was a very significant difference between the actual symptomatic foot and those assessed by examiner 3 to be symptomatic (p=0.001). Examiner 3 only identified 15% of the symptomatic feet for restriction. Sensitivity was therefore 15% but specificity was 90% meaning examiner 3 correctly excluded restriction in 90% of the non symptomatic feet.

Table 26: To ascertain whether examiner 3 correctly identified the symptomatic foot

Examiner 3			Actual foot symptomatic		Total
			No	Yes	No
3	No	Count	18	8	26
		% Within Actual foot symptomatic	90.0%	40.0%	65.0%
	Yes	Count	2	12	14
		% Within Actual foot symptomatic	10.0%	60.0%	35.0%
Total		Count	20	20	40
		% Within Actual foot symptomatic	100.0%	100.0%	100.0%

McNemar's chi square p=0.109

f.) Instability

There was no significant difference between the actual symptomatic foot and those assessed by examiner 3 to be symptomatic (p=0.109). Examiner 3 identified 60% of the symptomatic feet for instability. Sensitivity was therefore 60% and specificity was 90% meaning examiner 3 correctly excluded instability in 90% of the non symptomatic feet.

Table 27: To ascertain whether examiner 3 correctly identified the symptomatic foot

Examiner 3			Actual foot symptomatic		Total
			No	Yes	
3	No	Count	18	17	35
		% within Actual foot symptomatic	90.0%	85.0%	87.5%
	Yes	Count	2	3	5
		% within Actual foot symptomatic	10.0%	15.0%	12.5%
Total		Count	20	20	40
		% within Actual foot symptomatic	100.0%	100.0%	100.0%

McNemar's chi square p=0.001

CHAPTER 5

5.1 INTRODUCTION

This chapter will discuss all results obtained in the previous chapter.

A sample size of twenty patients was used who presented with one symptomatic foot and one asymptomatic foot. Each patient received the same assessment of both feet by three examiners independently, to determine the inter-examiner reliability of motion palpation in the hindfoot and midfoot joints to detect joint dysfunction. Cohens Kappa along with percentage agreement statistical methods were used. Cohens Kappa, the most used statistical method used to detect reproducibility (Stochkendahl *et al.* 2006) has become increasingly used in clinical research to assess the validity and reliability of diagnostic procedures. However, there has been criticism of its use (Lantz, 1997). Taking this criticism into consideration, Kappa should not be used as the 'gold' standard to interpret agreement and when using Kappa in a study one should not use it in isolation or as the sole method for statistical analysis (Brantingham *et al*., 2003). Taking the above criticism into consideration this dissertation used Cohens Kappa as the primary data along with percentage agreement as secondary data to support the primary data.

In this study a Kappa value could not be established in a considerable number of movements in the foot and ankle joints because there were too many zero values. This meant that the examiners did not find joint dysfunction within each of the 19 directions of movement that were investigated. According to Haas (1991), results with a high percentage agreement but a low kappa value indicate limited variation. One situation where limited variation may take place is when there is a large proportion of agreement (Haas, 1991). The results of this study were in keeping with this as they had low kappa values and high percentage agreement. This could have been the result of a high proportion of agreement that no joint dysfunction was present.

For ease of reference this Table has been repeated.

Table 27: Scale for the interpretation of Kappa

0.81-2.0	Almost perfect
0.61-0.81	Substantial
0.41-0.61	Moderate
0.21-0.41	Fair
0.00-0.21	Slight
<0.00	Poor

(Landis and Koch, 1977)

5.2 DISCUSSION

Objective 1: To determine the inter-examiner reliability of motion palpation of the foot and ankle joints in patients with chronic ankle instability syndrome.

5.2.1.1. Inter examiner reliability to determine the presence of restrictions (tables 3,5, 7) in terms of Kappa statistical analysis:

The inter-examiner reliability ranged from poor to almost perfect with Kappa values ranging from -0,279 to a perfect Kappa value of 1 when looking at all three-examiner combinations (ie. Examiner 1 vs. 2, 1 vs. 3 and 2 vs. 3) in Tables 3, 5 and 7. The mean Kappa values for each Table were added together and divided by the 3 to find the mean Kappa for all three-examiner combinations. The mean Kappa was 0.267 indicating fair agreement.

Previous inter-examiner reliability studies done primarily on motion palpation of the spine, showed poor inter-examiner reliability (Stochkendahl *et al.* 2006). Stochkendahl *et al*., (2006) study was a review of inter-examiner reliability studies performed on the spine and does not specify whether the patients assessed were symptomatic or asymptomatic. However, an inter-examiner reliability study performed on the cervical spine using both symptomatic and asymptomatic patients showed that inter-examiner reliability among the symptomatic population of the study had a statistically significant inter-examiner reliability between them (Lakhani *et al*., 2009). Similarly an extremity study performed to assess the inter-examiner reliability of the circumduction test for general joint mobility in the foot, revealed a moderate (K=0.452) agreement between examiners in the symptomatic foot (Brantingham, 2003).

Motion palpation as an assessment tool to detect specific restrictions in the joints in the foot and ankle in patients with CAIS, showed to have more inter-examiner reliability than spinal motion palpation but less inter-examiner reliability than the circumduction test to detect general foot mobility. One reason why extremity motion palpation studies could have higher inter-examiner reliability than spinal, is that the examiner has the other extremity to compare their findings.

5.2.1.2. Inter examiner reliability to determine the presence of instability (tables 4, 6, 8) in terms of Kappa statistical analysis:

The inter-examiner reliability ranged from –0.154 to 0.459 between the three examiner combinations and the average Kappa value was 0.419 indicating moderate (Landis and Koch, 1977) agreement between the examiners. There has been a lack of inter-examiner-reliability studies performed to investigate whether motion palpation is a reliable assessment tool to detect instability. But, despite the lack of inter-examiner reliability studies, the literature states that mechanical instability (an increased accessory movement at the joint) is a cause of CAIS and that mechanical instability is associated with hypermobility (Denegar and Miller, 2002). Also, studies performed by Bernier, Perrin and Rijke (1997) and Hertel *et al*. (1999) found that there was ligament laxity and instability of the mortise and subtalar joints. Therefore, a moderate agreement between examiners to detect instability is a positive finding as it shows that motion palpation is capable of detecting mechanical instability of the hindfoot and midfoot in patients with CAIS.

5.2.2 Objective 2: To determine the inter-examiner reliability of motion palpation of the foot and ankle joints in asymptomatic feet.

5.2.2.1 Inter examiner reliability to determine the presence of restrictions (tables 8,10,12) in asymptomatic feet in terms of Kappa statistical analysis:

In the asymptomatic group, the Kappa values ranged from –0.250 to 0.318 indicating poor to fair inter-examiner reliability. The mean Kappa value for detecting restrictions in asymptomatic foot and ankle joints was –0.248 indicating poor inter-examiner reliability. This is not in keeping with Brantingham *et al*., (2003) study that assessed the inter-examiner reliability of the circumduction test to detect general joint mobility in asymptomatic and symptomatic feet. They found that examiners had excellent agreement when assessing the circumduction test in asymptomatic feet (Brantingham *et al.*, 2003). One possible reason why the Kappa values were low compared to Brantingham *et al.,* (2003) could be because the examiners were required to palpate each individual joint as opposed to the general mobility of the foot. The percentage agreement was high between examiners indicating that although the examiners had low agreement between them with regards to the restrictions present they did agree when no restriction was present.

5.2.2.2 Inter examiner reliability to determine the presence of instability (tables 9, 11, 13) in asymptomatic feet in terms of Kappa statistical analysis:

Kappa values ranged from –0.081 to a perfect score of one, resulting in the average Kappa score being 0,478. This indicated that there was moderate inter-examiner reliability (Landis and Koch, 1977). Only one movement was reported to have instability in all three-examiner combinations namely; medial to lateral subtalar joint instability.

5.2.3 Objective 3: To determine if motion palpation is reliable irrespective of pathology.

The mean Kappa values for the symptomatic and asymptomatic groups were calculated by adding the mean Kappa value for the inter examiner reliability of motion palpation to detect restrictions and instability and divided by two to find the mean Kappa value for the symptomatic group as a whole and the asymptomatic group as a whole. It was found that the mean Kappa value for the symptomatic group was 0.343 and asymptomatic group was 0.115, showing that the symptomatic group had higher inter-examiner reliability. This was contrary to Brantingham *et al*., (2003) study where the inter examiner agreement to assess for decreased mobility, using the circumduction test, was higher in the asymptomatic feet with a Kappa value of 0.85. However, this was similar to finding of Lakhani *et al*. (2009) who found that the motion palpation findings were statistically significantly higher in the symptomatic group. From a clinical point this is a positive finding as this indicates that the examiners have more inter-examiner reliability when assessing the symptomatic foot, which in practice is the foot being assessed.

The comparison of inter-examiner reliability between symptomatic and asymptomatic feet for detecting instability was better than the inter examiner reliability when detecting restrictions. As no previous inter-examiner reliability studies have investigated the inter-examiner reliability of motion palpation to detect instability, no comparisons can be drawn.

Overall percentage agreement was high in both the symptomatic and asymptomatic groups when detecting joint dysfunction, although percentage agreement includes agreement between examiners when listing that no joint dysfunction was present.

5.2.4 To determine the presence or absence of joint dysfunction in both groups and then compare findings between groups.

5.2.4.1 Symptomatic:

The examiners had the highest inter-examiner agreement when detecting restrictions in the talocrural joint in a medial to lateral direction and posterior to anterior movement of the cuboid.

Previous research on chronic ankle instability syndrome showed that the following joints were found to be hypomobile in patients with CAIS:

- Subtalar, (Meadows, 2002)

- Talocrural joint, (Denegar, Hertel and Fonseca, 2002; Green *et al*., 2001; Dananberg, Shearstone and Guillano, 2000 and Crosbie, Green and Refshauge, 1999),
- Distal tibiofibular joint, (Kavanagh, 1999; O'Brien and Vicenzino, 1998), or
- Proximal tibiofibular joint (Meadows, 2002; Dananberg, Shearstone and Guillano, 2000).

Motion palpation findings in this dissertation were in keeping with recent literature on hypomobilty of the talocrural joint. Even though the Kappa values only showed fair agreement. The presence of specific joint dysfunctions in the midfoot with CAI has not yet been investigated.

More movements were reported to have instability in the symptomatic group (tables 4, 6, 8) than the asymptomatic group. Instability was found in the following movements:

- Anterior to posterior and posterior to anterior glide of the distal tibiofibular joint,
- Long axis distraction and medial to lateral movements of the talocrural joint and
- Medial to lateral movement of the subtalar joint.

The above results were similar to Hertel, Denegar, Monroe and Stokes, (1999) who found that 75% of subjects with a history of ankle sprains showed to have laxity of the talocrural joint on stress fluoroscopy, and two thirds of those who had talocrural laxity also showed to have subtalar joint laxity.

5.2.4.2 Asymptomatic:

The examiners had the highest inter-examiner reliability when detecting restrictions in the subtalar joint in a medial to lateral position as well as a posterior to anterior direction, and the cuboid in an anterior to posterior direction. The presence of the above restrictions in the asymptomatic foot could suggest that secondary restrictions occur as a result of compensating for the symptomatic foot. However, one cannot categorically state this until further research is performed on an asymptomatic population group.

Only one movement was reported to have instability in all three-examiner combinations namely medial to lateral subtalar joint instability.

5.2.4.3 Conclusion:

The asymptomatic group showed to have more restrictions reported by the examiners, however, their inter-examiner reliability was poor. No other difference reached statistical significance between symptomatic and asymptomatic feet. It was found that instability in long axis distraction (p=0.001), anterior to posterior glide of the tibiotalar joint (p=0.003), posterior to anterior glide of the subtalar joint (p<0.001), and lateral to medial tilt of the subtalar joint (p=0.006) was significantly more common in symptomatic feet. This supports previous research that suggests the presence of joint dysfunction prior to manipulation in patients with chronic ankle instability syndrome (Pellow and Brantingham, 2001).

5.2.5 To determine the percentage of agreement between all 3 examiners in symptomatic feet

The percentage agreement between the three examiners was high, however it includes agreement that there was no restriction or instability present. This is a positive finding for the use of motion palpation because the examiners showed a high (above 80%) percentage of agreement. It was noted that the joints that had the highest percentage agreement were those joints that the examiners did not find to be restricted or unstable in any of the patients. It is therefore assumed that no joint dysfunction was present.

CHAPTER 6

6.1 CONCLUSION

The objectives that were outlined in Chapter 1 will be revisited in this chapter now that the results of the study have been recorded and discussed.

The purpose of this study was to determine the inter-examiner reliability of motion palpation to detect joint dysfunction in asymptomatic feet and in feet with chronic ankle instability syndrome (CAIS).

Objective 1: To determine the inter-examiner reliability of motion palpation of the hindfoot and midfoot joints in patients with chronic ankle instability syndrome.

It was found that the inter examiner reliability of motion palpation for detecting restrictions in feet with chronic ankle instability syndrome showed to have fair Kappa agreement, whereas to detect instability they had moderate Kappa agreement.

Objective 2: To determine the inter-examiner reliability of motion palpation of the hindfoot and midfoot joints in asymptomatic feet.

Inter-examiner reliability in the asymptomatic feet showed to have poor Kappa agreement in detecting restrictions and moderate Kappa agreement in detecting instability.

Objective 3: To determine if motion palpation is reliable irrespective of pathology.

Inter-examiner reliability was higher in the symptomatic group and the examiners had more agreement when detecting instability then restrictions.

Objective 4: To determine the presence or absence of restrictions and instability in both groups and then compare findings between groups.

Instability in long axis distraction ($p=0.001$), anterior to posterior glide of the tibiotalar joint ($p=0.003$), posterior to anterior glide of the subtalar joint ($p<0.001$), and lateral to medial tilt of the subtalar joint ($p=0.006$) were more common in the symptomatic group. A statistical comparison showed that asymptomatic feet showed to have more agreement that restrictions were present. However, no other difference reached statistical significance between symptomatic and asymptomatic feet. The examiners had high specificity when detecting which foot was the symptomatic foot.

Motion palpation of the midfoot and hindfoot joints showed to have higher inter-examiner reliability when detecting instability and when assessing the symptomatic foot. Although motion palpation was not reliable enough to detect joint dysfunction in all the joints in the hindfoot and midfoot, the examiners were able to detect which foot was symptomatic. Also the examiners had a high percentage agreement with respect to when no joint dysfunction was present. The latter has not been investigated or included in previous motion palpation studies and is of importance as it showed that although the examiners did not always agree on the direction of the joint dysfunction. They did still have a high percentage agreement between them.

To conclude it is important to note that even though motion palpation may not be a specific assessment tool it can still be used as a sensitive tool that can be used with a variety of assessment tools to make clinical decisions with respect to instability in CAI.

6.2 RECOMMENDATIONS

- This study consisted of 85% males and 15% females, the examiners found that the females were easier to palpate, future motion palpation studies should ensure equal distribution of males and females in the sample group.

- When using Kappa one must ensure that the outcomes are not too similar (as discussed in the methodology) as this results in too many zero Kappa values and therefore, less statistics for comparison.

- The comparison of inter examiner reliability between symptomatic and asymptomatic feet in detecting instability was better than the inter examiner reliability when detecting restrictions. In the literature found for the purpose of this study, no previous inter-examiner reliability studies have investigated the inter-examiner reliability of motion palpation to detect instability. The above findings suggest that future inter-examiner reliability studies should investigate joint dysfunction that encompasses both restrictions and instability individually.

- It has been shown in many studies that dorsiflexion is a movement that is limited in CAIS, (Wolfe *et al*., 2001; Liu, Siegler and Techner, 2001 and Garrick and Webb, 1990) this movement was not investigated in this study as it does not form part of the motion palpatory procedures discussed in Schafer and Faye (1989) and Bergmann, Peterson and Lawrence, (1993). Future studies should include dorsiflexion range of motion when investigating patients with CAI.

- Future studies should investigate the inter-examiner reliability of motion palpation in other extremity joints. A comparison between previous spinal motion palpation inter-examiner reliability studies and extremity joint motion palpation studies could then be performed to assess whether the results differ.

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APPENDIX A

Letter of Information and Consent

Title of the Research Study:
The inter-examiner reliability of motion palpation to detect restrictions in hindfoot and midfoot joints.

Principle Investigator/s:
Lisa Williams,
Contact number: 0723351312

Co-Investigator/s:
Dr. H. Kretzmann, M Dip Chiropractic.
Contact number: (031) 2055520

Brief Introduction and Purpose of the Study:
You have been selected to take part in a study investigating the reliability of motion palpation as an assessment tool in detecting restrictions in the hindfoot and midfoot joints.

20 People will be required to complete this study.

Outline of the Procedures:
At the first consultation you will read this information sheet and ask any questions about the research. If you agree to take part in this research, you will sign this form. The researcher will take a case history and do a physical examination as well as an exam of both your feet and ankles. Three examiners will then enter the room, one at a time, and motion palpate your feet, recording any restrictions they find. You are encouraged not to communicate with these examiners. Once these examiners have assessed your feet the research component is complete and you may receive one free treatment if you so wish. All procedures will be performed under the supervision of a qualified chiropractor.

Risks or Discomforts to the Subject:
The examination procedure is unlikely to be painful or cause any side effects.

Benefits:
Your full co-operation will assist the Chiropractic profession in expanding its knowledge on the reliability of motion palpation as an assessment tool. Results will be made available in the form of a dissertation at the Durban University of Technology library. You will have the option to have a free treatment for chronic ankle instability syndrome.

Subjects may withdraw from the study:
You are free to leave the study at any time.

Remuneration:
You will not be offered any form of remuneration for taking part in the study

Costs of the Study:
There will be no costs involved for the subjects. The treatments are free.

Confidentiality:
All your medical records will be kept confidential and will be stored in the Chiropractic Day Clinic for 5 years, after which it will be shredded. Your name will not appear on any of the data sheets or the thesis.

Research-related Injury:
The risk of injury is minimal, however, if you do sustain any injuries or have any side effects to the treatment, free treatment will be offered to you at the chiropractic day clinic if the side effect falls into the scope of chiropractic.

Persons to Contact in the Event of Any Problems or Queries:
Please don't hesitate to ask questions on any aspect of this study. Should you have any complaints or queries, please do not hesitate to contact my research supervisor at the above details or the Faculty of Health officer for Faculty of Health Sciences at (031) 373 2701.

Statement of Agreement to Participate in the Research Study:
(I,……………………………………………subject's full name, ID number…………………………………………….., have read this document in its entirety and understand its contents. Where I have had any questions or queries, these have been explained to me by ……………………………………………….to my satisfaction. Furthermore, I fully understand that I may withdraw from this study at any stage without any adverse consequences and my future health care will not be compromised. I, therefore, voluntarily agree to participate in this study.

Subject's name (print) ……………………………
Subject's signature: ………………………….. Date: ……………..
Researcher's name (print): ……………………...
Researcher's signature: ………………………..Date: ....
Witness name (print): ....
Witness signature: ……….............................Date: ………………
Supervisor's name (print): ...…………………….
Supervisor's signature: ………………………Date: ……………….

APPENDIX B

Are you between the ages of 18-50?

Do you suffer with recurrent ankle sprains?

Research is currently being conducted at the Chiropractic Day Clinic Durban University of Technology where you can receive a free assessment of your ankle should you qualify for this study.

For further information please contact Lisa on (031) 373 2205

APPENDIX C:

Method of Motion Palpation

Distal Tibiofibular joint

Anterior-posterior (A-P) glide / Posterior-anterior (P-A) glide:

Patient is in lateral recumbent position, the ankle being tested is the upper one. The examiner stands perpendicular to the ankle, A-P glide is tested by grabbing the patients heel with the caudal hand and the distal part of the patients leg with the cephalid hand. Placing both the thumbs against the anterior surface of of the lateral malleolus and push foreward to test A-P glide. To test P-A glide place the finger tips against the posterior aspect of the lateral malleolus and pull foreward (Schafer,RC. and Faye, LJ. 1990).

The Ankle Mortise

Long-axis extension:

Patient lies in lateral recumbent position with their hip and knee flexed at 90' angle. The examiner sits with their back against the patients thigh, gripping the patients heel and talus by placing web contacts over the talar dome and superior aspect of the calcaneus (Bergmann. TF. *et al.*, 1993. pp 702) The patients foot is pushed away with both hands so as to distract the mortise joint (Schafer,RC. and Faye, LJ. 1990).

Anterior-posterior glide / Posterior-anterior glide:

Patient is supine, hip and knee flexed and the foot at right angle to the patients leg (Schafer,RC. and Faye, LJ. 1990). Standing at the side of the bed the examiner places their cephalad hand over anterior aspect of the distal tibia and their caudal hand over the anterior aspect of the dome of the talus. Each hand has a web contact with their respective structures and must grasp the structures to preserve the joint in its neutral position. With equal pressure apply an anterior to posterior and posterior to anterior force with the hands working in opposite directions (Bergmann. TF. *et al.,* 1993. pp 702).

Medial to lateral and lateral to medial glide:

Patient is supine and examiner is at the foot of the table. The examiner places their fingers over the dome of the talus and their thumbs grasp the plantar surface of the foot. Move the talus in a medial to lateral and lateral to medial direction (Bergmann. TF. *et al*., 1993. pp 702).

Subtalar

Talar rock

The patient is supine. The examiner supports the plantar surface of the foot with one hand while the other hand is used to push the tibia downward to produce full plantarflexion. Pushing further to increase plantarflexion produces Talar rock (Schafer,RC. and Faye, LJ. 1990).

Long-axis extension

Contact over the subtalar joint and carry out the same procedure as long-axis extension of the mortise joint (Schafer,RC. and Faye, LJ. 1990).

Medial and lateral side tilt

Patient is supine while the examiner cups the heel in his/her hands, inversion and eversion forces are applied (Schafer,RC. and Faye, LJ. 1990).

Talo-calcaneal glide

Examiner stands perpendicular to the ipsilateral limb, he/she uses their cephalad facing hand to stabilize the distal aspect of the patients leg. The examiners caudad hand cups the patients heel and pulls upwards to test P-A glide of the calcaneus and reverse to test A-P glide (Schafer,RC. and Faye, LJ. 1990).

Tarsals

Cuboid, navicular and cuneiforms

Examiner grasps the specific tarsal bone and stabilizes the proximal tarsal while applying anterior to posterior and posterior to anterior glide (Schafer,RC. and Faye, LJ. 1990).

Tarsometatarsals

A-P / P-A Tarsometatarsal Glide

The patient is supine. The examiner is perpendicular to the foot being tested. The examiners caudad hand is placed over the top of the patients forefoot and caudal hand over the tarsals, allowing the curve of the foot to fit within the webs of both hands. The caudal hand stabilizes the bases of the patients metatarsals and the cephalid hand pushes downward and then upward to create an A-P and P-A motion (Schafer,RC. and Faye, LJ. 1990).

APPENDIX D:

Motion Palpation Results

Patient code: ____________________

Foot assessed: Left ☐

Right ☐

	Restriction	Instability
Distal tibiofibular joint		
Anterior to posterior glide	☐	☐
Posterior to anterior glide	☐	☐
Tibiotalar joint		
Long axis distraction	☐	☐
Anterior to posterior glide	☐	☐
Posterior to anterior glide	☐	☐
Medial to lateral tilt (inversion)	☐	☐
Lateral to medial tilt (eversion)	☐	☐
Subtalar joint		
Anterior to posterior glide	☐	☐
Posterior to anterior glide	☐	☐
Medial to lateral tilt (inversion)	☐	☐
Lateral to medial tilt (eversion)	☐	☐
Tarsals		
Cuboid		
Anterior to posterior glide	☐	☐
Posterior to anterior glide	☐	☐
Navicular		
Anterior to posterior glide	☐	☐
Posterior to anterior glide	☐	☐
Cuneiforms		
Anterior to posterior glide	☐	☐
Posterior to anterior glide	☐	☐
Tarsometatarsal joint		
Anterior to posterior glide	☐	☐
Posterior to anterior glide	☐	☐

Which foot, on the patient, do you think was the symptomatic?

Left ☐

Right ☐

APPENDIX E:

DURBAN INSTITUTE OF TECHNOLOGY
CHIROPRACTIC DAY CLINIC
CASE HISTORY

Patient: ______________________ Date: __________

File # : __________ Age: __________

Sex : __________ **Occupation:** ______________________

Intern : ______________________ Signature ______________________

FOR CLINICIANS USE ONLY:
Initial visit
Clinician: Signature :

Case History:

Examination:
Previous: Current:

X-Ray Studies:
Previous: Current:

Clinical Path. lab:
Previous: Current:

CASE STATUS:

PTT:	Signature:	Date:

CONDITIONAL: Reason for Conditional:

Signature: Date:

Conditions met in Visit No:	Signed into PTT:	Date:
Case Summary signed off:		Date:

Intern's Case History:

1. Source of History:

2. Chief Complaint : (patient's own words):

3. Present Illness:

	Complaint 1	**Complaint 2**
< Location		
< Onset : Initial:		
Recent:		
1. Cause:		
< Duration		
< Frequency		
< Pain (Character)		
< Progression		
< Aggravating Factors		
< Relieving Factors		
< Associated S & S		
< Previous Occurrences		
< Past Treatment		
(a) **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 incl. xrays

< Environmental Hazards (Home, School, Work)

< Exercise and Leisure

< Sleep Patterns

< Diet

< Current Medication
Analgesics/week:

< 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 F

Durban University of Technology

PHYSICAL EXAMINATION: SENIOR

Patient Name : ____________________ **File no :** ________ **Date :** ________

Student : **Signature :**

VITALS:

Pulse rate:			Respiratory rate:	
Blood pressure:	R	L	Medication if hypertensive:	
Temperature:			Height:	
Weight:	Any recent change? Y / N		If Yes: How much gain/loss	Over what period

GENERAL EXAMINATION:

General Impression		
Skin		
Jaundice		
Pallor		
Clubbing		
Cyanosis (Central/Peripheral)		
Oedema		
Lymph nodes	Head and neck	
	Axillary	
	Epitrochlear	
	Inguinal	
Pulses		
Urinalysis		

SYSTEM SPECIFIC EXAMINATION:

CARDIOVASCULAR EXAMINATION

RESPIRATORY EXAMINATION

ABDOMINAL EXAMINATION

NEUROLOGICAL EXAMINATION

COMMENTS

Clinician: **Signature :**

APPENDIX G:

DURBAN INSTITUTE *of* TECHNOLOGY

Foot and ankle regional examination

Patient:______________________________File no:___________Date:_____

Intern / Resident ____________________Signature:__________________________

Clinician:_________________________Signature:__________________________

Observation

Gait analysis (antalgic limp,toe off, arch, foot alignment, tibial alignment).

____

____

Swelling____

Heloma dura / molle____

Skin____

Nails____

Shoes____

Contours (achilles tendon, bony prominences)__________________________

Active movements

Weight bearing:	Ⓡ	Ⓛ	***Non weight bearing:***	Ⓡ	Ⓛ
Plantar flexion			50°		
Dorsiflexion			20°		
Supination					
Pronation					
Toe dorsiflexion			40°(mtp)		
Toe plantar flexion			40° (mtp)		
			Big toe dorsiflexion (mtp) (65-70°)		
			Big toe plantar flexion (mtp) 45°		
			Toe abduction + adduction		
			5° first ray dorsiflexion		
			5° first ray plantar flexion		

Passive movement motion palpation (Passive ROM quality, ROM overpressure, joint play)

	Ⓡ	Ⓛ		Ⓡ	Ⓛ
Ankle joint: *Plantarflexion*			Subtalar joint: *Varus*		
Dorsiflexion			*Valgus*		
Talocrural: *Long axis distraction*			Midtarsal:*A-P glide*		
First ray: *Dorsiflexion*			*P-A glide*		
Plantarflexion			*rotation*		
Circumduction of forefoot on fixed rearfoot			Intermetatarsal glide		
			Tarso metatarsal joints: *A-P*		
Interphalangeal joints: *L / A dist*			Metatarsophalangeal		

A-P glide			dorsiflexion (with associated plantar flexion of each toe		
lat and med glide					
rotation					

Resisted Isometric movements

	R	L		R	L
Knee flexion			Pronation (eversion)		
Plantar flexion			Toe extension (dorsiflexion)		
Dorsiflexion			Toe flexion (plantar flexion)		
Supination (inversion)					

Neurological

	R	L
Dermatomes		
Myotomes		
Reflexes		
Balance/proprioception		

Special tests

	R	L
Anterior drawer test		
Talar tilt		
Thompson test		
Homan sign		
Tinel's sign		
Test for rigid/flexible flatfoot		
Kleiger test (med. deltoid)		

Alignment

	R	L
Heel to ground		
Feiss line		
Tibial torsion		
Heel to leg (subtalar neutral)		
Subtalar neutral position:		
Forefoot to heel (subtalar & Midtarsal neutral)		
First ray alignment		
Digital deformities		
Digital deformity flexible		

Palpation

Anteriorly

	R	L
Medial maleoli		
Med tarsal bones, tibial (post) artery		
Lat.malleolous, calcaneus, sinus tarsi, and cuboid bones		
Inferior tib/fib joint, tibia, mm of leg		
Anterior tibia, neck of talus, dorsalis pedis artery		

Posteriorly

Calcaneus, Achilles tendon, Musculotendinous junction		

Plantarily

Plantar muscles and fascia		
Sesamoids		

21/10/2002

APPENDIX H:

DURBAN INSTITUTE OF TECHNOLOGY

Patient Name: ***File #:*** ***Page:***

Date: ***Visit:*** ***Intern:***
Attending Clinician: ***Signature:***

S: ***Numerical Pain Rating Scale (Patient)*** ***Intern Rating***
Least 0 1 2 3 4 5 6 7 8 9 10 Worst

A:

0:

P:

E:

Special attention to: ***Next appointment:***

Date: ***Visit:*** ***Intern:***
Attending Clinician: ***Signature:***

S: ***Numerical Pain Rating Scale (Patient)*** ***Intern Rating***
Least 0 1 2 3 4 5 6 7 8 9 10 Worst

A:

O:

P:

E:

Special attention to: ***Next appointment:***

Date: ***Visit:*** ***Intern:***
Attending Clinician: ***Signature***

S: ***Numerical Pain Rating Scale (Patient)*** ***Intern Rating***
Least 0 1 2 3 4 5 6 7 8 9 10 Worst

A:

O:

P:

E:

Special attention to: ***Next appointment:***

Patient Name: ***File #:*** ***Page:***

Date: ***Visit:*** ***Intern:***
Attending Clinician: ***Signature:***

S: ***Numerical Pain Rating Scale (Patient)*** ***Intern Rating*** ***A:***
Least 0 1 2 3 4 5 6 7 8 9 10 Worst

0: ***P:***

E:

Special attention to: ***Next appointment:***

Date: ***Visit:*** ***Intern:***
Attending Clinician: ***Signature:***

S: ***Numerical Pain Rating Scale (Patient)*** ***Intern Rating*** ***A:***
Least 0 1 2 3 4 5 6 7 8 9 10 Worst

O: ***P:***

E:

Special attention to: ***Next appointment:***

Date: ***Visit:*** ***Intern:***
Attending Clinician: ***Signature***

S: ***Numerical Pain Rating Scale (Patient)*** ***Intern Rating*** ***A:***
Least 0 1 2 3 4 5 6 7 8 9 10 Worst

O: ***P:***

E:

Special attention to: ***Next appointment:***