The immediate effect of manipulation in chronic ankle instability syndrome in terms of objective clinical findings.

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I, Catriona Lindsey-Renton, do declare that this dissertation represents my own work in both conception and execution.

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DEDICATION

I would like to dedicate this work to the memory of my grandfather,
Ian Peter Lindsey-Renton

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ABSTRACT

Damage to the proprioceptive organs, as well as lack of proprioceptive retraining, after an inversion ankle sprain, has been shown to contribute to the problem of recurring ankle joint injuries, which has the highest incidence of sports related injuries. The proprioceptive organs are important as afferent pathways in reflexes and for the adjustment of posture and muscle tone (Miller and Narson, 1995 and Jerosch and Bischof, 1996).

Manipulation is thought to cause a change in the afferent pathways of the manipulated joints and it is proposed that this change may restore normal proprioceptive input, in a previously injured joint (Wyke, 1981 and Slosberg 1988). This however is unproven as indicated in a study by Lephart and Fu, (1995), where techniques to improve proprioception remain untested and according to Brynin and Farrar (1995), screening for proprioceptive and neuromuscular co-ordination should be carried out as part of a chiropractor's physical examination and injury evaluation.

This was a qualitative pre-post clinical study. Forty (40) subjects between the ages of 25 and 45, who had been diagnosed with chronic ankle instability syndrome, were recruited. The only treatment they received was a single mortise separation adjustment and all participants received the same treatment. Clinical outcomes were measured before and after the adjustment on both ankles using a Dualer Electronic Inclinometer and algometer. Only the affected ankle received an adjustment, but both ankles were measured.

The participants were evaluated by the examiner at an initial consultation during which diagnosis of chronic ankle instability syndrome was made based on case history, physical examination and foot and ankle regional examination. Participants presented with at least four of the following (Kessler and Hertling 1983):

- Instability,
- Pain,

- Crepitus,
- Weakness,
- Stiffness,
- Edema

Participants with a history of complete soft tissue tearing injuries or ankle or foot fractures in the affected ankle, undergoing any other modes of treatment for their ankle injury or gross mechanical ankle instability were excluded from the study.

All the relevant data required to diagnose chronic ankle instability syndrome was collected at the initial and only consultation. Relevant objective data was also gathered at the initial consultation immediately prior to and immediately after the mortise adjustment of the affected ankle.

Objective data was obtained from all participants using the algometer and Dualer Electronic Inclinometer. Data were exported into SPSS version 12 (SPSS inc. Chicago, Ill) for analysis.

Repeated measures ANOVA was used to assess factors associated with the change between pre and post treatment measurements. Categorical demographic variables were put into the models as factors, and continuous measurements as covariates. The significance of the change was examined and compared between the univariate model and multivariate model to assess the affect of the demographic variables on the change. Significant interactions between demographic variables and the change indicated factors affecting the change. Pearson's correlation was used to examine the relationships between the changes in the various measurements separately for affected and unaffected ankles. All statistical analysis was completed at the 95% ($p<0.05$) level of confidence.

The results indicated that the hypothesis indicating that manipulation would have an effect on proprioception, was rejected with respect all the parameters of the affected ankle. In contrast the hypothesis indicating that manipulation would have an effect on the contralateral ankle was accepted with respect to the parameters of dorsiflexion 5°, plantaflexion 10° (when gender and sport are taken into account) and dorsiflexion 5° (when race is taken into account). Rejection of this hypothesis occurred with respect to the parameters of plantaflexion 5° and 10° and inversion 5°.

When assessing the hypothesis that manipulation would have an effect on range of motion and pain, the hypothesis was accepted with respect to the parameters of inversion range of motion of the affected ankle, plantaflexion (when the side of injury is taken into account) and pain in the affected and unaffected ankles.

In terms of the last hypothesis indicating that there would be a correlation between the changes in proprioception and changes in clinical outcomes in the ipsilateral and contralateral limbs, the hypothesis was accepted with respect to the parameters of inversion 5° in the affected ankle and plantaflexion range of motion in the affected ankle and rejected with respect to the rest of the parameters noted above.

Thus despite some improvements within certain demographic groups, there were no overall statistically significant immediate changes in proprioception in patients with chronic ankle instability syndrome.

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DEFINITION OF TERMS

Joint Position Sense

A specialized variation of the sensory modality of touch that encompasses the sensation of joint position. (Lephart and Fu, 1995)

Proprioception

The body's ability to transmit information concerning movements and position in relation to the body parts and their environment (Kessler and Hertling, 1983 and Miller and Narson. 1995)

Chronic ankle instability syndrome

History of a recent grade 1 or grade 2 sprain and any combination of the following continuing symptoms of: instability, pain, crepitus, weakness, stiffness, edema. (Kessler and Hertling, 1983)

Affected ankle

The ankle in which the chronic ankle instability syndrome occurs.

Unaffected ankle

The ankle contralateral to the affected ankle.

CHAPTER ONE

1.1 INTRODUCTION

Inversion ankle sprains occur when a person's ankle is inverted and they cannot effectively use their peroneal muscles to prevent further inversion. The inversion will continue until the calcaneous and medial malleoli meet, putting strain upon the lateral ligaments, which can cause them to tear or rupture (Shapiro et al. 1994). Damage to the proprioceptive organs, as well as lack of proprioceptive retraining, after an inversion ankle sprain, has been shown to contribute to the problem of recurring ankle joint injuries, which has the highest incidence of sports related injuries (Jerosch and Bischof, 1996). This could be as a result of the proprioceptive organs being important as afferent pathways in reflexes and thus by default for the adjustment of posture and muscle tone (Miller and Narson, 1995 and Jerosch and Bischof, 1996).

In this respect the ankle inversion sprain has been classified as having a chronic phase, which begins after the acute and subacute phases. Subacute and chronic are defined by Reid (1992), as more than 48 hours after the initial injury and more than 5 days after the initial injury, respectively. Further it has been found that those patients that do not have treatment / proprioceptive retraining after the acute phase, will be more susceptible to re-injury as a result of the proprioceptive organs not being able to function within their normal range (Hertling and Kessler, 1983) as found in the chronic ankle instability syndrome. This is supported by the fact that proprioceptive training reduces the incidence of ankle sprains in athletes with recurrent ankle sprains to the same level as subjects without any history of ankle sprains (Verhagen et al. 2000).

It is thought that manipulation causes a change in the afferent pathways of the manipulated joints and it is proposed that this change may restore normal proprioceptive input, in a previously injured joint (Wyke, 1981 and Slosberg 1988). This is supported by a study done by Konradsen et al. (1993) where the results suggested that the afferent input from intact lateral ankle ligaments is important in sensing correct placement of the foot at heel-strike. This has, however not been conclusively shown as indicated in a study by Lephart and Fu, (1995), where techniques to improve proprioception remain untested. Nevertheless Brynin and Farrar (1995), indicate that screening for proprioceptive and neuromuscular co-ordination should be carried out as part of a chiropractor's physical examination and injury evaluation.

This research aimed to test these inconsistencies by quantifying the immediate effect of an ankle adjustment in terms of proprioceptive feedback in patients with chronic ankle instability syndrome.

1.2 AIMS AND OBJECTIVES

The aims and objectives were to determine the immediate effect of manipulation in chronic ankle instability syndrome:

a. To evaluate if manipulation had an effect on proprioception in the ipsilateral limb in chronic ankle instability syndrome.

   Hypothesis
   It is hypothesized that manipulation would have an effect on proprioception.

b. To ascertain if manipulation had an effect on proprioception in the contralateral limb, when the affected ankle was manipulated.

   Hypothesis
   Manipulation would have an effect on the contralateral ankle.

c. To ascertain the effect of manipulation on clinical outcomes (range of motion, pain readings).

Hypothesis

Manipulation would have an effect on range of motion and pain readings.

d. To ascertain if any correlations exist between the changes in clinical outcomes and the proprioception in the affected and unaffected ankles.

Hypothesis

There would be a correlation between the changes in proprioception and changes in clinical outcomes in the ipsilateral and contralateral limbs.

1.2.1 Limitations of study

Proprioception can be defined as a combination of:

1. Joint position sense which is described as conscious awareness of limb position (Deshpande et al., 2003) and
2. Kinesthesia, which is described as the awareness of joint position (Lephart and Fu, 1995 and Deshpande et al., 2003)

Thus Deshpande et al. (2003) propose that there are different aspects of proprioception – viz. those related to movement and those related to position specifically, which need to be measured independently as they are not necessarily related to one another. Therefore this study only looked at joint position sense because measures of joint position sense do not correlate with measures of kinesthesia (Deshpande et al. 2003). In addition there are decreased reliability and sensitivity of movement measures as reported by the reliability and validity study completed by Deshpande et al. (2003), with respect to kinesthetic measures.

1.3 RATIONALE

a) Proprioceptive deficits after ankle injury seem to be frequently evident and may be considered as one of the reasons for resulting functional instability (Jerosch and Bischof, 1996).
b) 20-30% of acute ankle sprains result in chronic instability and 30-40% of all inversion injuries result in reinjury (Prentice, 1994; Yeung et al. 1994; Lofvenberg et al. 1996; Jerosch and Bischof, 1996). Chronic ankle instability makes the ankle more susceptible to re-injury as a result of the proprioceptive organs not being able to function within their normal range (Hertling and Kessler, 1983).
c) Some of the therapeutic effects of manipulation are due to post-manipulative changes in afferent patterns of manipulated joints and their resultant reflexogenic effects (Wyke, 1981).

CHAPTER TWO

2.1 INTRODUCTION

In this chapter follows a detailed discussion with regards to ankle structure, chronic ankle instability syndrome and proprioception.
The information will be presented as follows:

1 Incidence and prevalence of ankle sprains
2 Review of the anatomy
3 Ankle biomechanics
4 Clinical presentation
5 Proprioception
6 Conclusion

2.2 INCIDENCE AND PREVALENCE

Ankle sprain is a common condition, which is estimated to effect many people each year and as many as 1 per 10,000 persons per day (Fallat, Grimm and Saracco, 1998:280).

Literature on the epidemiology of ankle sprains explains that the incidence is approximately 16% while the prevalence ranges between 6% and 25% depending on the activity performed. Running and jumping sports constitute 20-25% of inversion ankle sprains. The literature also states that 20-30% of acute ankle sprains result in chronic instability and 30-40% of all inversion injuries result in reinjury (Prentice, 1994; Yeung et al. 1994; Lofvenberg et al. 1996; Jerosch and Bischof, 1996). A six and a half year review (Garrick and Requa, 1988) of 16,754 injuries seen in a multispecialty sports medicine clinic found that 25 per cent of the 12,681 injuries in the top 19 sports occurred at the ankle and foot.

In 1-year retrospective study by Grimm and Fallat (1999:102) on occupational medicine (injuries in the work place), of the 3851 new injuries that presented to a clinic over the period of a year, 245 (6.4%) were due to foot and ankle injuries. When analysed, the most commonly injured region was the ankle (46.9%) and of those patients, 40.8% were diagnosed with “ankle sprain”.

When a comparison is made between the various population groups studied in South Africa (Needham, 2001:78; and Pellow and Brantingham, 2001), it is evident that the incidence and prevalence of ankle sprain varies considerably but still accounts for a large number of injuries within the population groups under study.

Therefore the above-mentioned prevalence and incidence indicate that ankle sprains are a common condition in many spheres of life and that the injury to the lateral ligament complex is the most frequent injury.

2.3 ANATOMY

2.3.1 Osseous Anatomy

There are three bones that make up the ankle joint: the fibula; tibia and talus. The tibia supports the body weight and is located on the antero-medial side of the leg and runs almost parallel with the fibula. The distal end of the tibia has facets for articulation with the talus and the fibula. The inferiorly directed projection from the medial side of the inferior end is the medial malleolus and this medial malleolus has a facet on its lateral surface for articulation with the talus. The interosseous border of the tibia is sharp and is the attachment site for the interosseous membrane which unites the tibia and fibula. (Moore and Dalley, 1999)

The talus is the most proximal of the tarsal bones with its medial surface articulating with the medial malleolus and its lateral surface articulating with the lateral malleolus to form the mortise joint of the ankle.

The ankle joint is a hinge-joint. The structures entering into its formation are the lower end of the tibia and its malleolus, the malleolus of the fibula, and the transverse ligament (inferior portion of tibio-fibular syndesmosis), which together form a mortise for the reception of the upper convex surface of the talus and it's medial and lateral facets. [Gray's Anatomy, 2000]

The fibula does not transmit body weight but does provide an attachment site for muscles and gives stability to the ankle joint, by holding the talus in its socket. At its distal end, the fibula enlarges to form the lateral malleolus, which is more prominent and posterior to the medial malleolus and projects approximately 1cm more distally. The lateral malleolus articulates with the lateral surface of the talus. [Moore and Dalley, 1999]

2.3.2 Ligaments

The lateral ankle ligaments, responsible for resistance against inversion and internal rotation stress, are the anterior talofibular ligament (ATFL), the calcaneofibular ligament (CFL) and the posterior talofibular ligament (PTFL).

The medial supporting ligaments are the superficial and deep deltoid ligaments, which are responsible for resistance to eversion and external rotation stress and are less commonly injured.

The lateral ligament complex is injured in at least 95% of isolated ankle sprains (Reid, 1992). The most commonly sprained ankle ligament is the ATFL, followed by the CFL. The PTFL is rarely injured. The incidence of ligamentous injury usually matches both the mechanism of injury and relative ligamentous strength

(Anderson, 2002). The strength of the ankle ligaments from weakest to strongest is the ATFL, PTFL and CFL (Anderson, 2002).
Therefore the table below lists the lateral ligaments with respect to the most commonly injured:

Ligament	Structure	Location	Action
Anterior talofibular ligament	Flat weak band	Extends anteromedially from the lateral malleolus to the neck of the talus	Resists ankle inversion in plantar flexion. Resistance to anterior talar displacement from the mortise. Resistance to internal rotation of the talus within the mortise.
Calcaneofibular ligament	Round cord	Passes posteroinferiorly from the tip of the lateral malleolus to the lateral surface of the calcaneous	Resists ankle inversion during dorsiflexion. contributes to ankle and subtalar joint stability
Posterior talofibular ligament	Thick, strong band	Runs horizontally medially and posteriorly from malleolar fossa to the lateral tubercle of the talus.	Limits posterior talar displacement within the mortise as well as talar external rotation.

Moore and Dalley (1992) and Hockenbury (2001)

The term closed-packed position refers to a specific joint position where the articular surfaces are at their maximum point of congruency. The closed-packed position of the ankle joint is full dorsiflexion (Hertling and Kessler, 1983).
The loose-packed position of the ankle is approximately 10 - 20 degrees of plantaflexion and it's in this position that injury is most likely to occur (Hertling and Kessler, 1983).

2.3.3 Musculature

Only the muscles most strongly associated with inversion, plantaflexion and dorsiflexion are listed and they are the following:

MUSCLE	PROXIMAL ATTACHMENT	DISTAL ATTACHMENT	INNERVATION	ACTION
Fibularis (peroneus) longus	Head and superior two-thirds of lateral surface of fibula	Base of first metatarsal and medial cuneiform	Superficial fibular (peroneal) nerve (L5, S1, S2)	Eversion of foot and weakly plantaflexes ankle
Fibularis (peroneus) brevis	Inferior two-thirds of lateral surface of fibula	Dorsal surface of tuberosity on lateral side of base of fifth metatarsal	Superficial fibular (peroneal) nerve (L5, S1, S2)	Eversion of foot and weakly plantaflexes ankle
Fibularis (peroneus) tertius	Inferior third of anterior surface of fibula and interosseous membrane	Dorsum of base of fifth metatarsal	Deep fibular (peroneal) nerve (L5 and S1)	Dorsiflexes ankle
Tibialis Anterior	Lateral condyle and superior half of lateral surface of tibia and interosseous membrane	Medial and inferior surfaces of medial cuneiform and base of 1st metatarsal	Deep fibular (peroneal) nerve (L4 and L5)	Dorsiflexes ankle and inverts foot
Tibialis Posterior	Interosseous membrane, posterior surface of tibia inferior to soleal line, and posterior surface of fibula	Tuberosity of navicular, cuneiform and cuboid and bases of 2nd -4th metatarsals	Tibial nerve (L4 and L5)	Plantaflexes ankle and inverts foot

Soleus	Posterior aspect of head of fibula, superior fourth of posterior surface of fibula soleal line and medial border of tibia	Posterior surface of calcaneous via calcaneal tendon	Tibial nerve (S1 and S2)	Plantaflexes ankle and steadies leg on foot
Extensor digitorum longus	Lateral condyle of tibia and superior part of medial surface of the fibula and interosseous membrane	Middle and distal phalanges of lateral four digits	Deep fibular (peroneal) nerve (L5 and S1)	Dorsiflexes ankle and extends lateral four digits
Extensor hallicus longus	Middle part of anterior surface of fibula and interosseous membrane	Dorsal aspect of base of distal phalanx of great toe	Deep fibular (peroneal) nerve (L5 and S1)	Dorsiflexes ankle and extends great toe
Flexor digitorum longus	Medial part of posterior surface of tibia inferior to soleal line and by a broad tendon to the fibula	Bases of distal phalanges of lateral four digits	Tibial nerve (S2 and S3)	Plantaflexes ankle and flexes lateral four digits
Flexor hallicus longus	Inferior two-thirds of posterior surface of fibula and inferior part of interosseous membrane	Base of distal phalanx of great toe	Tibial nerve (S2 and S3)	Weakly plantaflexes ankle and flexes great toe

(Table abridged from Moore and Dalley, 1992)

The peroneal muscles resist inversion and can become injured in the process. The degree to which muscles provide stability is also affected by proprioception. With optimal proprioceptive function, the stabilizing muscles react more rapidly to inversion stresses. Impaired proprioception is associated with functional instability and recurrent sprains. [Hinterman, 1999]

2.3.4 Nerve Supply

The nerves of the ankle are derived from the tibial nerve and the deep fibular nerve, a division of the common fibular nerve (Moore and Dalley, 1999).
For the purpose of this study a more in depth look will be taken at the proprioceptors - the Ruffini corpuscles, the Pacinian corpuscles and the Golgi end-organs.

Peripheral proprioception involves various sensory receptors, including cutaneous touch and pressure receptors, mechanoreceptors of synovial joints, muscle spindles, and tendon Golgi organs. Muscle spindles are the more important for detecting changes in joint angulation in the mid-range of movement, whereas joint mechanoreceptors (Pacinian corpuscles and Ruffini corpuscles), which detect stretch of ligaments and deep tissues, are more important at the extremes of joint movement (Hassan et al. 2001).
Ruffini corpuscles are a special variety of nerve-ending in the subcutaneous tissue that are slowly adapting receptors that respond to skin stretch. These endings link subcutaneous tissue to skin folds overlying joints (Gilman, 2002).

Pacinian corpuscles are rapidly adapting and respond to vibration and are found in the subcutaneous tissue and occur in connection with the nerves of the joints (Gilman, 2002).

According to Gilman (2002), Golgi tendon organs consist of receptors in tendons that mediate contractile force from a group of muscle fibers. Joint capsules receive innervation principally from small afferent fibers and most of these afferents are nociceptors that respond to the extremes of joint position. Joint capsules also receive some innervation from mechanoreceptors that respond to joint angle.

2.4 MECHANISM OF INJURY

When the body is in the erect position, the foot is at right angles to the leg. The movements of the ankle joint are those of dorsiflexion and extension; dorsiflexion consists in the approximation of the dorsum of the foot to the front of the leg, while in extension the heel is drawn up and the toes pointed downward. The range of movement varies in different individuals from approximately 50° to 90°. The malleoli tightly embrace the talus in all positions of the joint, so that any slight degree of side-to-side movement which may exist is simply due to stretching of the lateral or medial ligaments. The superior articular surface of the talus is broader in front than behind. In dorsiflexion, therefore, greater space is required between the two malleoli. [Gray's Anatomy, 2000]

When the ankle is in a position of low bony stability (plantaflexion, inversion), the ligaments have a more significant role in providing joint stability and are more likely to be injured. In plantaflexion, the ATFL assumes a vertical orientation and is the first ligament to be injured with inversion stress. If the ATFL fails, the CFL can be sprained. The PTFL can be injured in conjunction with the ATFL and CFL but is rarely injured in isolation. [Moore and Dalley, 1999]

Inversion ankle sprains occur as a result of landing on a plantaflexed and inverted foot. These injuries occur while running on uneven terrain, stepping in a hole, stepping on another athlete's foot during play, or landing from a jump in an unbalanced position. During periods of ankle unloading, the ankle rests in a position of plantaflexion and inversion. If the ground or another object is met unexpectedly by the unloaded foot, lateral ligament injury may occur. [Hertling and Kessler, 1983]

2.5 CLINICAL PRESENTATION

2.5.1Ankle Sprains

The effect of an ankle sprain is dependent on the grade of sprain that occurs. Inversion ankle sprains are graded into three categories according to Reid (1992):

SEVERITY	PATHOLOGY	DISABILITY
Grade 1 – Mild	Mild stretch, no instability, single ligament involved.	No or little limp, minimal functional loss, difficulty hopping.
Grade 2 - Moderate	Large spectrum of injury, mild to moderate instability, complete tear of anterior talofibular ligament or partial tear of anterior talofibular ligament & calcaneofibular ligaments.	Limp with walk, inability to toe raise, inability to hop, unable to run.
Grade 3 - Severe	Significant instability Complete tear of anterior capsule and talofibular ligament and associated tear of anterior talofibular and calcaneofibular ligaments	Diffuse swelling both sides of Achilles tendon, Early hemorrhage May be tenderness medially and laterally Positive anterior drawer positive varus laxity

However, only the first 2 categories are pertinent to this study.

2.5.2. Chronic ankle Instability Syndrome

The effect of chronic ankle instability is an inability to walk or run on uneven surfaces, inability to play sports that require jumping or sudden changes of direction, loss of confidence and an increase risk of repeat injury (Langram, 1998 and Hockenbury and Sammarco, 2001). Kessler and Hertling (1983) and Reid (1992) explained the main causes for chronic symptoms following acute ankle sprains are directly related to ligament damage due to functional instability, loss of fibular and subtalar motion, tight sensitive scar and incomplete rehabilitation. Proprioception is one of the systems affected and proprioceptive rehabilitation in this respect is therefore included as part of a treatment and rehabilitation protocol (Lephart and Fu, 1995).

2.6 PROPRIOCEPTION

According to the literature (Kessler and Hertling, 1983 and Miller and Narson. 1995); proprioception is the body's ability to transmit information concerning movements and position in relation to the body parts and their environment. The nerve fibres responsible for proprioception are the Ruffini corpuscles, the Pacinian corpuscles and the Golgi end-organs. These proprioceptive organs are stimulated whenever there is joint movement, muscle contraction around the joint and when the intra-articular pressure changes (Sandoz, 1978). When a single injury occurs, the kinetic chain is affected and proprioception is inhibited. Tendons and ligaments are the structures primarily affected and therefore, impairment in proprioception is cumulative in several areas of the body (Sandoz, 1978; Patterson and Steinmetz 1986; Leach, 1994).

Four types of mechanoreceptors and pain receptors are described by Wyke (1981):

- Type I receptors: These are located in the articular capsule and are low threshold, slowly adapting static and dynamic mechanoreceptors. Their discharge pattern signals static joint position, intra-articular pressure changes and the direction, amplitude and velocity of joint movement.

- Type II receptors: These are located in the articular capsule and are low threshold, rapidly adapting mechanoreceptors. They are dynamic receptors which signal joint acceleration and deceleration and are entirely inactive at rest.

- Type III receptors: These are found in the joint ligaments and are high-threshold, slowly adapting mechanoreceptors. They only become active towards extreme ranges of motion, when considerable stresses are generated in the joint ligaments.

- Type IV receptors: These are the free nerve endings and plexuses which are found in the articular capsule and ligaments. They are non-adapting pain receptors with a higher threshold. They are only active when the articular tissues are subjected to marked mechanical deformation or direct irritation.

According to Sandoz (1978), the rapid acceleration and the phenomenon of cavitation that accompanies a manipulation, causes a sudden change in the intra-articular pressure which in turn is thought to produce an intense stimulation of the Type I and Type II mechanoreceptors. This should therefore have an advantageous effect on the proprioception in a chronically injured ankle.

The sudden stretching of the ligaments at the barrier of anatomical resistance produces a stimulation of the Type III receptors located in the ligaments and should therefore have an effect on end range of motion of the joint affected (Sandoz, 1978 and Wyke, 1981)

The volley of mechanoreceptor impulses tends to inhibit the input coming through the Type IV receptors which convey pain. Therefore a decrease in pain should occur (Sandoz, 1978)

In a study by Pellow and Brantingham (2001), it was concluded that patients with subacute and chronic ankle sprains who received manipulation improved more rapidly, in terms of pain and range of motion, than the patients in the placebo group.

The effect of manipulation, as proposed by Sandoz (1978) and Patterson and Steinmetz (1986) is that the presence of abnormal joint mechanics will result in abnormal firing of the Wyke receptors, resulting in abnormal neuronal pool patterns. This abnormal neurological pattern becomes deeper ingrained within the neurological system with increased time of abnormalcy. This is referred to as a "neural scar" (Patterson and Steinmetz, 1986). Lephart and Fu (1995) concur that a decrease in sensory input from joint receptors can lead to abnormal body positioning and decreased postural reflex responses leading to an increased probability of reinjury (Hertling and Kessler, 1983).

It is proposed that manipulation provokes changes in afferent input that may restore normal proprioceptive input (Slosberg, 1988). This is supported by Needham (2001), who found that manipulation of the ankle is beneficial in terms of pain, range of motion and foot functionality when treating subacute and chronic inversion ankle sprain patients. As a result of the above studies (Pellow and Brantingham, 2001 and Needham, 2001), inferences where made based on the effect on the same (ipsilateral) side as the intervention, however the effects of abnormal neurological pattern that become deeper ingrained within the neurological system with increased time of abnormalcy is a central mechanism

(Sandoz 1978 and Patterson and Steinmetz, 1986) and the effect (treatment effect) could well be bilateral. Thus with Pellow and Brantingham (2001) and Needham (2001) only looking at the improved ability ipsilaterally, at the ankle joint, in terms of pain, ROM and functional ability (as reported by the patient) there is no clinical or inferred significance in relation to proprioception that was assessed ipsilaterally or bilaterally.

Neuromuscular control and joint stabilisation is mediated mainly by the central nervous system, where sensory input, originating from the somatosensory, visual and vestibular systems, is received and processed by the brain and spinal cord. The culmination of this information results in conscious awareness of joint position and motion, unconscious joint stabilisation through protective spinal-mediated reflexes and the maintenance of posture and balance [Lephart, Pincivero and Rozzi, 1998].

Research aimed at determining the effects of articular musculoskeletal injury, on joint proprioception, neuromuscular control and balance, has focused on the ankle joint and has demonstrated alterations in proprioception subsequent to capsuloligamentous injury, partial restoration of proprioceptive acuity following ligamentous reconstruction, and has suggested beneficial proprioceptive changes resulting from comprehensive rehabilitation programmes (Lephart, Pincivero, Rozzi, 1998). Thus proprioception and accompanying neuromuscular feedback mechanisms have been found to provide an important component for the establishment and maintenance of functional joint stability (Lephart, Pincivero and Rozzi, 1998).

2.7 CONCLUSION

The literature suggests that manipulation could have an effect in chronic ankle instability syndrome but conclusive evidence is not available, it is necessary to determine and evaluate the effect of manipulation in chronic instability syndrome for purposes of treatment and rehabilitation. This research was aimed at determining the effect of manipulation in chronic ankle instability syndrome in terms of objective clinical findings.

Chapter Three

3.1 Introduction

From the literature review it can be seen that chronic ankle instability is a common condition and proprioceptive deficits after ankle injury seem to be frequently evident (Jerosch and Bischof, 1996) thus this chapter will discuss the:

- Study design
- Method
- Inclusion criteria
- Exclusion criteria
- Intervention
- Data collection
- Statistical analysis,

with respect to this study.

3.2 Study Design:

This study was a prospective, pre-post clinical trial of the immediate effect of manipulation in chronic ankle instability syndrome in terms of joint position sense, pain and range of motion.

3.3 Method:

3.3.1 Advertising

Advertisements informing the public about the study were placed in newspapers, at the Durban Institute of Technology campus and at various sporting clubs and sporting events (Addendum A). Word of mouth was also used to inform the general public. The subjects all reside in the Greater Durban Metropolitan area.

3.3.2 Sampling – method

The method was that of convenience sampling. This occurred on a 'first-come, first served' basis where, as the patient presented to the Chiropractic Day Clinic, they were treated as soon as was convenient for the patient and the researcher.

3.3.3 Sampling – allocation

All subjects accepted into the study were in one group.

3.3.4 Sampling – size

In studies by Pellow and Brantingham (2001) and Bellingham (2001) only thirty subjects were required however their suggestion was to include a larger sample size and therefore, this study included forty subjects.

3.3.5 Patient screening

The participant evaluation and selection process began with all possible subjects undergoing a cursory telephonic discussion with the examiner to exclude subjects that obviously did not fit the criteria for the study.

In this telephonic discussion the subjects were asked four cursory questions to determine if the patient would be eligible for the study. These questions were:

1) How old are you?
2) How long ago did you sprain your ankle?
3) How many times in the past two years have you sprained your ankle?
4) Have you ever seriously injured or broken a bone in the foot or ankle that has been sprained?

Participants successfully complying with this interview were evaluated at an initial consultation, at which the patient received a letter of information (Addendum B) and signed an informed consent (Addendum C) form explaining the study and allowing them to withdraw at any time from the study. At this consultation a diagnosis was made based on a case history (Addendum D), relevant physical examination (Addendum E) and foot and ankle regional examination (Addendum F) for the following inclusion and exclusion criteria:

3.4 Inclusion Criteria

1) Patients were between 25 and 45 years of age, which fell within the age group of 15 to 50 years, recommended by Pellow and Brantingham (2001). The limitation or decrease in age group in this study facilitates increased population group homogeneity, by excluding persons that are not skeletally mature and those that had early onset degeneration in the foot and ankle complex (Yochum and Rowe, 1996).
2) The diagnosis for the study was based on the history of the most recent sprain and any combination of the continuing symptoms of:

    - Instability,
    - Pain,
    - Crepitus,
    - Weakness,
    - Stiffness,
    - Edema

    If 4 out of 6 of the above symptoms were experienced, it was taken that the patient had chronic ankle instability syndrome (Kessler and Hertling, 1983 and Pellow and Brantingham, 2001)

3) Patients presenting with two or more ankle sprains (Goldie et al. 1994), which is in agreement with Reid (1996:226), who also indicated that chronic ankle sprain symptoms are suffered when the patients have had these symptoms intermittently over the last 2 years. The patients had to have had

their last ankle sprain at least five days prior to the consultation (Pellow and Brantingham, 2001) having had the acute signs and symptoms abate.

4) The patients had to have had an ankle sprain no more than two years prior to the consultation. (Goldie et al. 1994), and these ankle sprains had to conform to Reid's (1996:226) grade I and II sprains as indicated below:
   - Grade description
     - Grade 1 – Mild
       No haemorrhage, minimal swelling, point tenderness, negative anterior drawer test, no varus laxity
     - Grade 2 – Moderate
       Some haemorrhage, localized swelling, margins of Achilles tendon less defined, may be positive anterior drawer test, no varus laxity.

   Previous ankle sprains had to have resulted in: functional instability, loss of fibular and subtalar motion, tight sensitive scar and incomplete rehabilitation (Kessler and Hertling, 1983).

5) The mechanism of injury must have involved weight-bearing on an inverted foot. (Goldie et al. 1994)

3.5 Exclusion Criteria

1) Any patients who had previously sustained complete soft tissue tearing injuries or ankle or foot fractures in the affected ankle (Slatyer et al. 1997).
2) Patients who were taking any medications or undergoing any other modes of treatment for their ankle injury (Pellow and Brantingham, 2001).

3) Patients who showed signs of gross mechanical ankle instability (grade III ankle sprain) and syndesmosis injury (Pellow and Brantingham, 2001).
   - Grade description
     - Grade 3 – Severe

       Diffuse swelling both sides of Achilles tendon, early haemorrhage, may be tenderness medially and laterally, positive anterior drawer, positive varus laxity.
4) Patients who demonstrated any relative or absolute contraindications to manipulative therapy on the basis of case history, physical examination and foot and ankle examination (Bergmann, 1993; Pellow and Brantingham, 2001).
5) Patients who did not sign the informed consent form.
6) Patients who experience significant post-manipulation pain.

Those subjects that were rejected from the study i.e. those who did not meet the inclusion criteria were referred to other interns in the chiropractic day clinic for treatment of their condition.

3.6 Intervention

3.6.1 Intervention – frequency

Those accepted (40) underwent one treatment

3.6.2 Intervention – method

Those accepted were treated with a mortise separation adjustment of the affected ankle. The mortise separation adjustment is less likely to compromise the integrity of the lateral ligament complex of the already injured ankle and is indicated in the treatment of subacute inversion ankle sprains (Bergmann et al., 1993 and Pellow, 1999).

Technique according to Bergmann et al. (1993):

Patient position:	The patient is supine on the table.
Doctor position:	Stand at the foot of the bed, facing cephalad.
Segmental contact point:	Dome of the talus
Contact point:	Use either hand to apply proximal interphalangeal contact with the middle finger over the dome of the talus.
Indifferent hand:	With your other hand, use a middle-finger contact over the contact hand to reinforce it. With the thumbs of both hands, grasp the plantar surface of the foot.
Vector:	Long axis distraction
Procedure:	Maintain the ankle in dorsiflexion and eversion, and apply a long axis distraction with both hands.

3.7 Data Collection

3.7.1 Data collection – frequency

Data collection took place on the day of the treatment. As this was a pre-post study, data was collected immediately prior to the adjustment being administered and immediately after the adjustment was administered.

3.7.2 Data collection – instruments

Instruments utilized measured the components of chronic ankle instability syndrome as appropriate.
The instruments used for measurement in the study were:

a) Objective Data

1) Instability

Discrepancies / error in repositioning the ankle (subtalar joint) between the set readings (as below) and the repositioning by the patient, were completed using the Dualer Electronic Inclinometer (Addendum G). The Inclinometer was able to detect the degree of inclination from the set point (preset by the researcher). From this position the difference to the set point and the patient position was calculated and used as a means of gauging the person's ability to actively reproduce ankle joint position in each of the following positions (Gross, 1987; Burke et al., 1988; Thelen et al., 1998 and Deshpande et al, 2003):

a) 5° of plantaflexion
b) 10° of plantaflexion
c) 5° of dorsiflexion
d) 5° of inversion

Measurement procedure that was utilized:

- Inclinometer was set to a neutral position (90 degrees).
- The participant was asked to actively move their ankle through their available ROM.
- The participant was then told to position the foot so as to reach the preset positions (indicated above) here the participant was stopped.
- The participant then concentrated on this position for 5 seconds.
- The foot was then moved through its full range of motion (the use of the first 5 characters of the alphabet was utilized).

- Thereafter the patient was requested to return to the position previously held for 5 seconds.
- Data was collected when the participant indicated they had reproduced the position in terms of the degrees attained.
- Further to this, the absolute difference between the preset position and patient attained reposition was calculated in order to gauge improvement over time as suggested by Gross (1987) and Thelen et al. (1998)

Reposition was attained through active participation of the patient and without involvement of the researcher. This active – active position and reposition technique was chosen over the passive – passive, passive-active and active-passive techniques, due to the passive techniques utilizing the researcher in positioning the patient in at least one of the position(s) / reading attempt(s). The involvement of the researcher in this procedure would have resulted in additional sensory input from cutaneous receptors (touch and pressure), which could potentially have nullified or amplified the results obtained in the position or reposition readings, as the patient now had collateral sensory input aiding / inhibiting in the central nervous system integration of the peripheral information (Konradsen et al., 1993).

2) Pain

Objective: The algometer (Addendum H) was used to measure pain and any changes in pain before and after the adjustment on both the affected and unaffected ankles (Fischer, 1986).
The algometer was placed over the anterior talo-fibular ligament, just inferior to the lateral malleolus, for these measurements.

3) Range of Motion

The Dualer Electronic Inclinometer (Addendum I) was used to test the end range of motion in the patient in the affected limb.

The ranges of motion tested were:

- Dorsiflexion, as decreased dorsiflexion is a common sequela of chronic ankle sprains (Brantingham and Pellow 2001).
- Inversion, as this is the direction of injury
- Plantaflexion, as chronic ankle instability may result in joint stiffness (Kessler and Hertling, 1983).

3.8 Statistical analysis

Data were captured in MS Excel and exported to SPSS version 11.5 (SPSS Inc., Chicago, Ill, USA) for analysis.

Affected and unaffected ankle measurements were compared pre treatment using paired t-tests. This was repeated for post treatment measurements. Pre and post treatment measurements were compared using paired t-tests separately for affected and unaffected ankles.

Repeated measures ANOVA was used to assess factors associated with the change between pre and post treatment measurements. Categorical demographic variables were put into the models as factors, and continuous measurements as covariates. The significance of the change was examined and compared between the univariate model and multivariate model to assess the affect of the demographic variables on the change.

Significant interactions between demographic variables and the change indicated factors affecting the change.

Pearson's correlation was used to examine the relationships between the changes in the various measurements separately for affected and unaffected ankles.

Chapter Four

4.1 Introduction

The statistical findings and the results obtained from the data will be discussed in this chapter.

All the data was objective and was obtained from the algometer and the Dualer Electronic Inclinometer.

Pre and post-manipulation results were analysed for all participants and demographic data consisting of age, gender, race, sport and side affected were also highlighted.

4.2 Demographics:

Forty participants were recruited for the study. The consisted of 67.5% males (n=27) and 32.5% females (n=13) (See Figure 1).

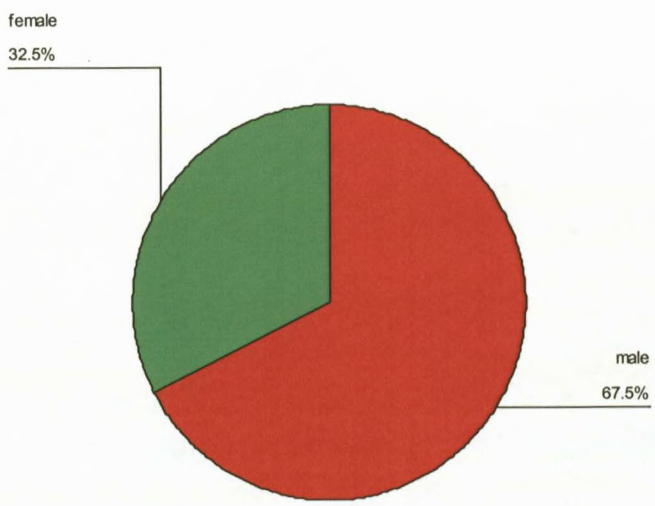

Figure 4.1: Pie chart of participants' gender (n=40)

Their mean age was 30.5 years (SD 5.3) and ranged from 25 to 43 years. The population group to which the majority (65%, n=26) belonged was Caucasian. Percentage of participants by population group is shown in Figure 2.
This is consistent with the gender distribution of 63% males and 37% females seen by Pellow and Brantingham (2001).

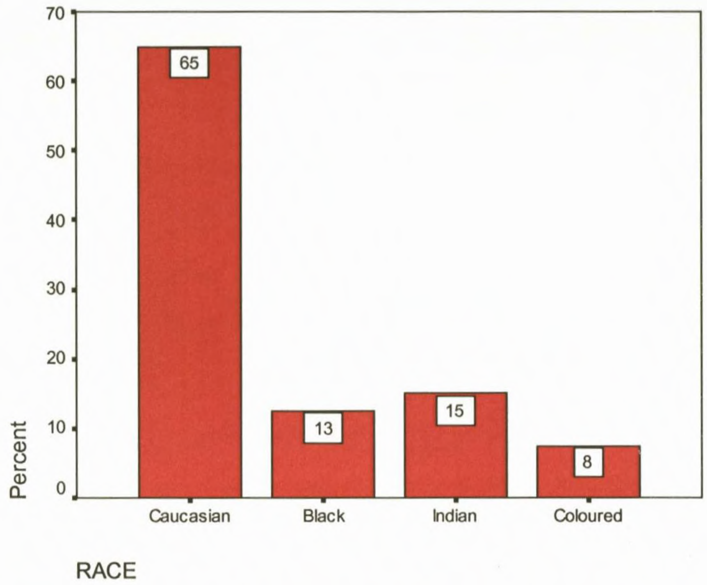

Figure 4.2: Population group of participants (n=40)

The sports played by participants are shown in Figure 3. The majority of participants played rugby (28%) or soccer (25%). 23% of the ankle injuries were non-sport related.

This is congruent with a study by Thaker et al. (1999) who states that the ankle sprain is one of the most common injuries in athletes who participate in sports which require frequent landing on one foot and who are expected to make sharp cutting maneuvers, for example soccer and rugby. Pellow and Brantingham (2001) also had the highest percentage of their patients participating in rugby.
In South Africa, the majority of rugby players are Caucasian while the majority of soccer players are black.

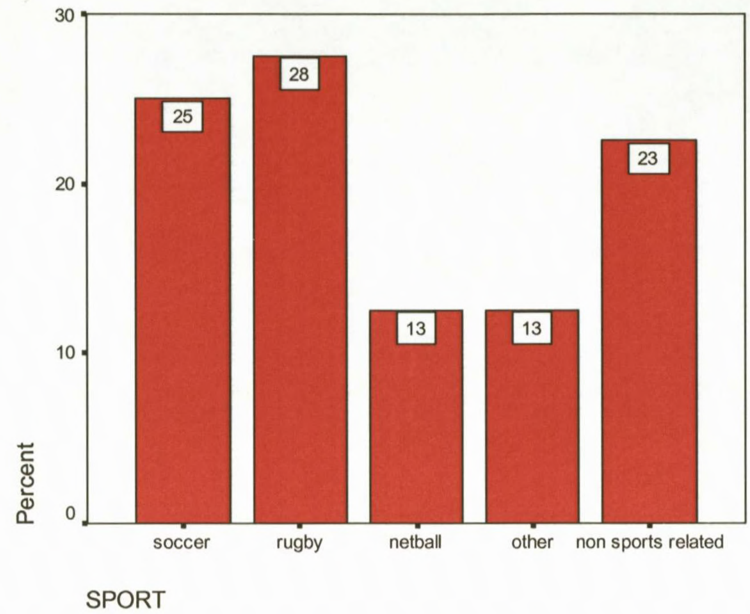

Figure 4.3: Sports played by participants (n=40)

Eighteen (45%) participants' left ankles were affected, while for 22 (55%) it was their right ankle.

No literature reviewed indicated the side of sprain most prevalent, thus no comparison is possible.

Refer to discussion on page 42.

4.3 Pre measurements

Data are presented as means and standard deviations. Paired t-test p-values are shown.

<u>Table 4.1: Means (SD) and comparison of affected and unaffected ankles pre intervention</u>

Measurement	Affected	Unaffected	p value
Algometer	7.2 (2.8)	8.2 (2.4)	0.001*
Inclinometer plantaflexion 5°	5.0 (3.4)	5.5 (2.2)	0.414
Inclinometer plantaflexion 10°	10.9 (3.9)	10.3 (3.6)	0.372
Inclinometer dorsiflexion 5°	5.5 (2.9)	5.5 (2.1)	0.864
Inclinometer inversion 5°	7.0 (6.3)	7.8 (4.0)	0.434
ROM plantaflexion	47.6 (12.0)		
ROM dorsiflexion	14.9 (5.6)		
ROM inversion	19.4 (5.5)		

* statistically significant at the 0.05 level of significance

Although in most measurements the unaffected ankle had a higher mean than the affected ankle, this was only statistically significant for algometer (p=0.001), where the unaffected mean was higher than the affected mean.

4.4 Post measurements

Table 4.2: Means (SD) and comparison of affected and unaffected ankles post intervention

Measurement	Affected	Unaffected	p value
Algometer	6.9 (2.7)	7.8 (2.2)	0.016*
Inclinometer plantaflexion 5°	5.2 (2.9)	5.1 (2.6)	0.761
Inclinometer plantaflexion 10°	10.2 (3.1)	10.1 (2.9)	0.934
Inclinometer dorsiflexion 5°	5.6 (2.1)	4.7 (1.7)	0.018*
Inclinometer inversion 5°	7.5 (4.5)	6.8 (3.5)	0.301
ROM plantaflexion	48.8 (11.9)		
ROM dorsiflexion	15.1 (6.2)		
ROM inversion	20.5 (4.2)		

* statistically significant at the 0.05 level of significance

Only algometer measurements and dorsiflexion showed a significantly different mean in the unaffected and affected ankles (p=0.016 and 0.018) post treatment. With algometer measurements the unaffected ankles showed a higher mean than the affected ankles, but with dorsiflexion it was the opposite.

The algometer procedure utilized for taking the measurements recorded above was as follows; the algometer was placed over the anterior talo-fibular ligament, just inferior to the lateral malleolus, for these measurements. This placement was roughly over the ATFL (Brantingham and Pellow, 2001), which is the ligamentous structure supporting the antero-lateral aspect of the ankle most commonly injured in ankle sprains. In congruence with the application of the algometer over soft tissue, the application over the ATFL is consistent with the recommendations of Fischer (1986).

It was expected that the algometer readings would improve post manipulation, as based on the theories of Wyke (1981), where he indicated that the stimulation of the Wyke receptors I through III should override the pain reception in Wyke receptor IV, as is congruent with the theory of Melzack and Wall (Leach, 1994).

This is however not evident when comparing the findings pre and post manipulation, as both the affected and unaffected limbs show a decrease in the kg/cm^2 indicating that the pain experienced by the patient on application of the algometer was worse and less pressure could be exerted.

Several factors could have influenced these readings, amongst which:

- Breaking of adhesions by manipulation could result in increased sensitivity of the region tested (Bergmann et al., 1993)
- The application of the algometer over an area that has a paucity of soft tissue underlying the region, thereby possibly magnifying the sensitivity of the periosteum and other pain sensitive structures, which should not be measured by the algometer (Fischer, 1986).
- The application of the algometer immediately post the intervention, which was normally within 5 minutes of the initial reading. This immediate application after the initial reading could have been influenced by
  - The patients having a learned response to understanding the process and procedure, thereby influencing the sensitivity of the measure (Mouton, 1996:141-144).
  - The increased sensitivity of the soft tissues structures such as the periosteum, which could have been irritated post the initial reading (Fischer, 1986).

In light of the above it is therefore recommended that future research investigate another tool related to pain measures that accurately measure the effects of the manipulation as opposed to measuring potentially reactive sensitivity or altered / learned patient reactivity.

4.5 Comparison of pre and post measurements

Paired t-test p values are shown in Tables 3 and 4 for affected and unaffected sides respectively.

4.5.1 Affected ankles:

Table 4.3: Comparison of pre and post treatment measurements in affected ankles

	Mean	Std. Deviation	Std. Error Mean	p-value
Pre algometer affected	7.213	2.7644	.4371	0.308
Post algometer affected	6.883	2.6719	.4225	
Pre inclinometer affected plantaflexion 5 ^{o}	4.975	3.3778	.5341	0.674
Post inclinometer affected plantaflexion 5 ^{o}	5.225	2.9307	.4634	
Pre inclinometer affected plantaflexion 10 ^{o}	10.950	3.9285	.6212	0.262
Post inclinometer affected plantaflexion 10 ^{o}	10.175	3.1041	.4908	
Pre inclinometer affected dorsiflexion 5^{o}	5.450	2.8640	.4528	0.730
Post inclinometer affected dorsiflexion 5^{o}	5.600	2.1460	.3393	
Pre inclinometer affected inversion 5^{o}	6.975	6.3427	1.0029	0.479
Post inclinometer affected inversion 5^{o}	7.475	4.4892	.7098	
Pre ROM affected plantaflexion	47.625	11.9779	1.8939	0.195
Post ROM affected plantaflexion	48.825	11.8601	1.8752	
Pre ROM affected dorsiflexion	14.900	5.5737	.8813	0.736
Post ROM affected dorsiflexion	15.125	6.2108	.9820	
Pre ROM affected inversion	19.400	5.4669	.8644	0.019*
Post ROM affected inversion	20.500	4.2184	.6670	

* statistically significant at the 0.05 level of significance

Table 3 shows that affected ankles only changed significantly with ROM inversion. There was an increase from 19.4 to 20.5 (p=0.019). The other variables showed a slight non significant increase to post treatment, except for algometer and plantaflexion 10° which showed slight decreases.

The normal ranges of motion for the ankle are as follows:

- Dorsiflexion – 20°-30° (Bergmann et al.1993) The participants in this study had a decreased dorsiflexion range of motion which is congruent with Kessler and Hertling (1983) who state that chronic ankle instability syndrome leads to a restriction in dorsiflexion.
- Plantaflexion – 30°-50° (Bergmann et al.1993) The participants in this study fell within these parameters.
- Inversion - 25°-30° (Patterson 2001) Although inversion range of motion is not agreed it seems to range between 5° and 30° (Bergmann et al, 1993 and Patterson, 2001).

Following an inversion sprain there is spasm of the peronei muscles, as a protective mechanism against further injury (Kessler and Hertling (1983). Manipulation and subsequent stimulation of the Wyke receptors could lead to a reduction in the peronei spasm and therefore a greater range of motion in inversion (Sandoz, 1978)

4.5.2 Unaffected ankles

Table 4.4: Comparison of pre and post treatment measurements in unaffected ankles

	Mean	Std. Deviation	Std. Error Mean	p-value
Pre algometer unaffected	8.220	2.3702	.3748	0.057
Post algometer unaffected	7.763	2.2101	.3494	
Pre inclinometer unaffected plantaflexion 5 °	5.450	2.2298	.3526	0.462
Post inclinometer unaffected plantaflexion 5 °	5.075	2.5559	.4041	
Pre inclinometer unaffected plantaflexion 10 °	10.275	3.5733	.5650	0.819
Post inclinometer unaffected plantaflexion 10 °	10.125	2.8929	.4574	
Pre inclinometer unaffected dorsiflexion 5°	5.525	2.1362	.3378	0.005*
Post inclinometer unaffected dorsiflexion 5°	4.700	1.7276	.2732	
Pre inclinometer unaffected inversion 5°	7.800	3.9691	.6276	0.138
Post inclinometer unaffected inversion 5°	6.775	3.5409	.5599	

* statistically significant at the 0.05 level of significance

Unaffected ankles changed significantly with regard to inclinometer dorsiflexion (p=0.005) (see Table 4). The change in algometer measurements in the unaffected ankles was borderline significant (p=0.057). Both showed significant decreases in mean values post treatment. All other variables showed non significant decreases post treatment.

The change in dorsiflexion on the unaffected side concurs with a study by Glencross and Thornton (1981) as cited in Stefanini and Marks (2003) who found that the injured patients showed better position sense on the unaffected side, which indicates that a central mechanism of neurological response seems evident (from this research and the research of Glencross and Thornton (1981) as cited in Stefanini and Marks (2003)), as the changes in the unaffected ankle could only have been due to a crossed reflex at spinal cord level as suggested by Leach (1994) and Patterson and Steinmetz (1986).

4.6 Factors affecting change between pre and post treatment measurements

In the following repeated measures ANOVA models, the effects of age, race, gender, left or right side and sport were adjusted for.

4.6.1 Affected ankles:

Algometer

Table 4.5: Repeated measures ANOVA for algometer measurements in affected ankles

	Wilk's lambda	p-value
Change between pre and post treatment	0.988	0.640
Change*age	0.981	0.555
Change*sex	0.986	0.613
Change*race	0.970	0.899
Change*sport	0.907	0.594
Change*side	0.999	0.872

Controlling for demographic variables decreased the significance of the change in algometer measurements from pre to post treatment from 0.308 to 0.640.

However, none of the demographic variables interacted significantly with the change. Thus for algometer measurements on the affected side there was no significant treatment effect, which was not influenced by any demographic variables.

Table 4.6: Repeated measures ANOVA for inclinometer plantaflexion 5 $^{\circ}$ measurements in affected ankles

	Wilk's lambda	p-value
Change between pre and post treatment	0.878	0.121
Change*age	0.897	0.157
Change*sex	0.993	0.711
Change*race	0.792	0.209
Change*sport	0.962	0.863
Change*side	0.993	0.726

In table 6 the effect of controlling for demographic variables made the change slightly more significant compared with the univariate model (p=0.674). However, the change was not quite statistically significant after controlling for confounders (p = 0.121) and neither were there any significant interaction between demographics and change in inclinometer plantaflexion 5 $^{\circ}$. Thus for plantaflexion 5 $^{\circ}$ measurements on the affected side there was no significant treatment effect, which was not significantly influenced by any demographic variables.
Therefore any changes can be deemed to be related to the intervention and not to any extraneous variables.

Table 4.7: Repeated measures ANOVA for inclinometer plantaflexion 10 ° measurements in affected ankles

	Wilk's lambda	p-value
Change between pre and post treatment	0.940	0.284
Change*age	0.922	0.220
Change*sex	1.000	0.958
Change*race	0.802	0.232
Change*sport	0.977	0.930
Change*side	0.978	0.525

There was not much difference in the significance of the change between pre and post treatment after controlling for demographics ($p = 0.262$ to $p = 0.284$). Thus demographics did not influence the plantaflexion 10 ° change.
Therefore any changes can be deemed to be related to the intervention and not to any extraneous variables.

Table 4.8: Repeated measures ANOVA for inclinometer dorsiflexion 5° measurements in affected ankles

	Wilk's lambda	p-value
Change between pre and post treatment	0.986	0.606
Change*age	0.987	0.623
Change*sex	1.000	0.988
Change*race	0.925	0.677
Change*sport	0.792	0.209
Change*side	0.870	0.109

The univariate model for the change between pre and post treatment for dorsiflexion gave a p value of 0.730. This changed to 0.606 after controlling for demographics. Thus there was no significant change in dorsiflexion in the affected side which was not influenced by demographics.
Therefore any changes can be deemed to be related to the intervention and not to any extraneous variables.

Table 4.9: Repeated measures ANOVA for inclinometer inversion 5° measurements in affected ankles

	Wilk's lambda	p-value
Change between pre and post treatment	0.900	0.163
Change*age	0.907	0.179
Change*sex	1.000	0.967
Change*race	0.733	0.109
Change*sport	0.872	0.445
Change*side	0.968	0.435

After controlling for demographics there was still a non significant change between pre and post treatment inversion measurements (p =0.479 to 0.163). This means that the change was confounded by demographics to a small degree, but there still was not a significant treatment effect on inversion on affected ankles.

Therefore any changes can be deemed to be related to the intervention and not to any extraneous variables.

Table 4.10: Repeated measures ANOVA for ROM plantaflexion measurements in affected ankles

	Wilk's lambda	p-value
Change between pre and post treatment	1.000	1.000
Change*age	0.999	0.918
Change*sex	1.000	0.977
Change*race	0.842	0.340
Change*sport	0.922	0.666
Change*side	0.789	0.036*

* statistically significant at the 0.05 level of significance

Univariate analysis produced a p value of 0.195 for the change between pre and post treatment for ROM plantaflexion. After controlling for demographics this changed to 1.000, indicating no change between pre and post measurements. However, there was a significant interaction between change and the affected side. The profile plot (Figure 4.4) showed that those whose left ankle was affected showed an increase in ROM plantaflexion over the time periods, while the opposite was true of those whose right ankle was affected. Thus side of affected ankle influenced the change in ROM plantaflexion measurements significantly.

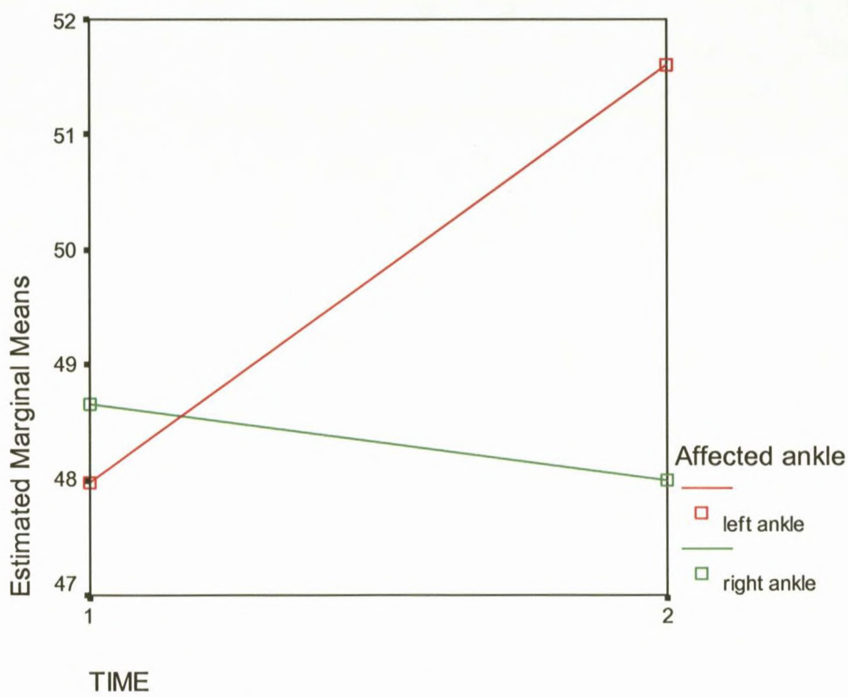

Figure 4.4: Profile plot of mean ROM plantaflexion measurements over time by affected side

The left ankle conforms to the Wyke norms as there was an improvement on this side (Sandoz, 1978). The right does not conform to these norms and this could be related to the following, however these suggestions are not based on the literature and therefore require further studies in order to confirm or refute their contribution:

- The degree of injury to the ankle
- Whether or not it was the dominant ankle that was injured
- The number of injuries the affected ankle had sustained

Table 4.11: Repeated measures ANOVA for ROM dorsiflexion measurements in affected ankles

	Wilk's lambda	p-value
Change between pre and post treatment	0.980	0.540
Change*age	0.976	0.506
Change*sex	0.975	0.494
Change*race	0.953	0.816
Change*sport	0.950	0.799
Change*side	0.992	0.699

Controlling for demographics failed to produce a significant treatment effect (p =0.540). However, the p value changed slightly from 0.736 in univariate analysis. Thus change in ROM dorsiflexion in the affected ankle was not significantly influenced by the treatment, or demographics.

Therefore any changes can be deemed to be related to the intervention and not to any extraneous variables.

Table 4.12: Repeated measures ANOVA for ROM inversion measurements in affected ankles

	Wilk's lambda	p-value
Change between pre and post treatment	0.819	0.054
Change*age	0.852	0.085
Change*sex	0.959	0.381
Change*race	0.715	0.088
Change*sport	0.933	0.715
Change*side	0.998	0.863

Controlling for demographics increased the p value from 0.019 in univariate analysis to 0.054. Thus demographics were responsible for some of the significance in the change in ROM inversion in affected ankles, but there was still a borderline significant change independent of demographics. There were no significant interactions between change and demographics.

Therefore any changes can be deemed to be related to the intervention and not to any extraneous variables.

4.6.2 Unaffected side

Table 4.13: Repeated measures ANOVA for algometer measurements in unaffected ankles

	Wilk's lambda	p-value
Change between pre and post treatment	0.816	0.052
Change*age	0.846	0.078
Change*sex	1.000	0.941
Change*race	0.908	0.598
Change*sport	0.879	0.547
Change*side	0.990	0.660

In unaffected ankles there was a slight change in p value from univariate analysis ($p=0.057$) to after controlling for demographics ($p = 0.052$). Thus demographics did not affect the change in algometer measurements between pre and post treatment in unaffected ankles. There was a borderline significant change in algometer readings after treatment.

Therefore any changes can be deemed to be related to the intervention and not to any extraneous variables.

Table 4.14: Repeated measures ANOVA for inclinometer plantaflexion 5° measurements in unaffected ankles

	Wilk's lambda	p-value
Change between pre and post treatment	0.969	0.448
Change*age	0.962	0.400
Change*sex	0.908	0.181
Change*race	0.901	0.566
Change*sport	0.796	0.216
Change*side	0.998	0.856

There was a very slight change in p value from 0.462 in univariate analysis to 0.448 in multivariate analysis after controlling for demographics. Thus demographics did not influence the change in inclinometer plantaflexion 5° in unaffected ankles.

Therefore any changes can be deemed to be related to the intervention and not to any extraneous variables.

Table 4.15: Repeated measures ANOVA for inclinometer plantaflexion 10° measurements in unaffected ankles

	Wilk's lambda	p-value
Change between pre and post treatment	0.978	0.523
Change*age	0.983	0.571
Change*sex	0.805	0.045*
Change*race	0.874	0.452
Change*sport	0.667	0.049*
Change*side	0.953	0.343

* statistically significant at the 0.05 level of significance

After controlling for demographics, the rate of change after treatment was dependant on sex (p = 0.045). The profile plot in Figure 5 shows that females decreased while males increased between pre and post treatment. Sport also significantly influenced the change after treatment (p = 0.049), shown in Figure 6. Those who had been injured by other sports and netball showed an increase post treatment, but those who had been injured by rugby showed a decrease after treatment. Thus the change overall was influenced significantly by gender and sport.

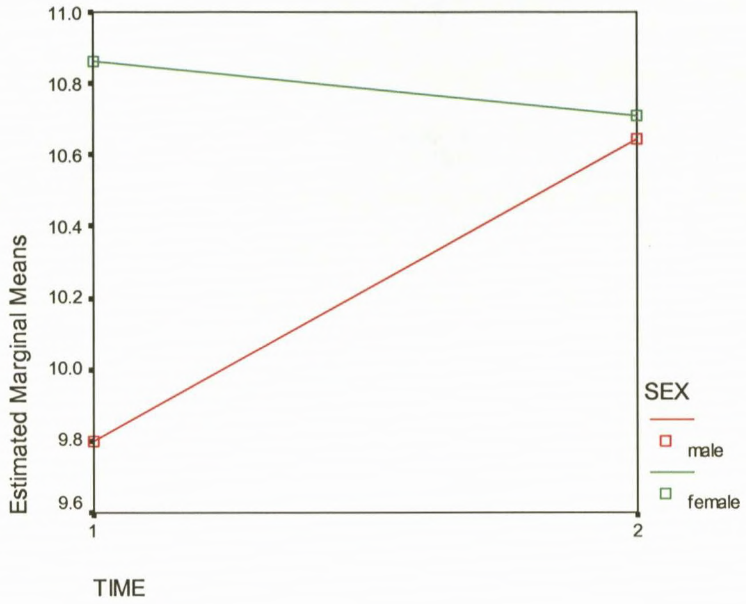

Figure 4.5: Profile plot of mean inclinometer plantaflexion 10° in unaffected ankles over time by gender

This does not concur with a study by Perle (2002) who found that gender did not play any significant role in changes to the ankle after manipulation. The changes seen in this study could be due to the relatively smaller sample size of the females compared to the males, allowing for an outlier amongst the females to change the average significantly.

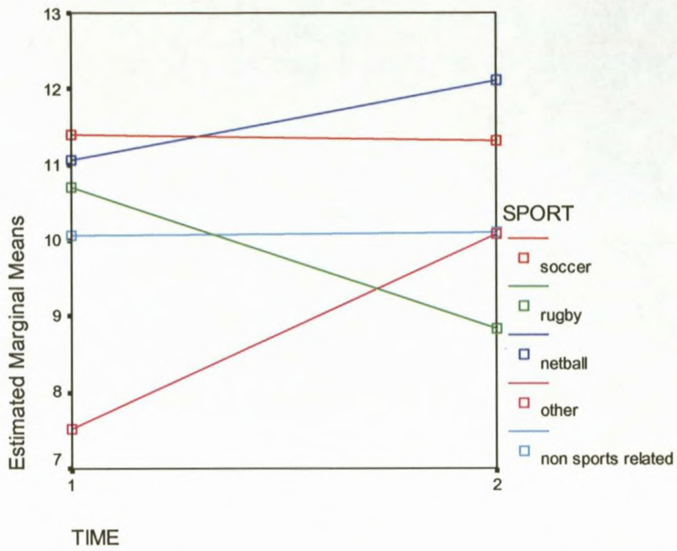

Figure 4.6: Profile plot of mean inclinometer plantaflexion 10° in unaffected ankles over time by sport

The non-sports related injuries stayed the same, showing no improvement or worsening of proprioception at 10° plantaflexion. Those patients who participate in sports other than rugby, soccer and netball had a substantial improvement from 7.5° to 10°. The netball participants got worse but the number of netball participants was a small enough sample size that one outlier could have had an effect on the average score. The rugby players got worse as the trend in these participants was that they had more recent injuries making the degree of healing and restoration of normal different to the other groups. Marginal improvement was seen in the soccer players but all these participants had repetitive injuries and were still playing soccer on a weekly basis, despite their injuries.

This is congruent with the argument presented with regard to the affected left / right theory, where the degree of the injury and the number of injuries to a specific side may influence the improvement / regression in the ankle treated. This assertion however requires further investigation.

Table 4.16: Repeated measures ANOVA for inclinometer dorsiflexion 5° measurements in unaffected ankles

	Wilk's lambda	p-value
Change between pre and post treatment	1.000	0.951
Change*age	1.000	0.999
Change*sex	1.000	0.958
Change*race	0.633	0.031*
Change*sport	0.925	0.679
Change*side	0.824	0.058

* statistically significant at the 0.05 level of significance

Race affected the change in inclinometer dorsiflexion in unaffected ankles (p = 0.031). The profile plot in figure 7 shows that Black and Caucasian participants experienced a decrease post treatment, while Coloured participants experienced an increase.

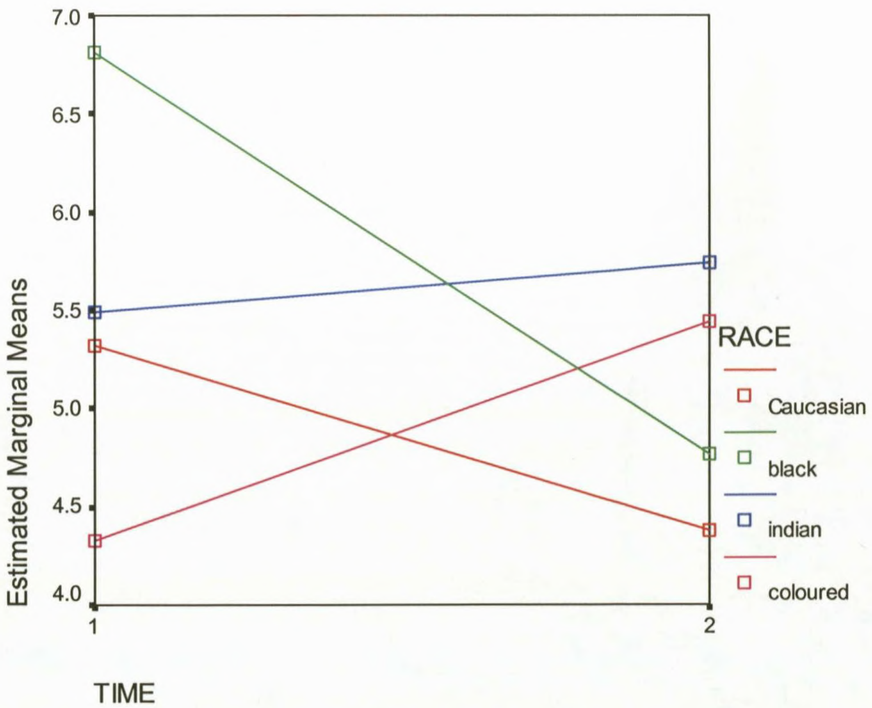

Figure 4.7: Profile plot of mean inclinometer dorsiflexion 5° in unaffected ankles over time by race

- The relative difference remained the same for the black and coloured participants.
- The Caucasian participants had an improvement of 0.1
- Indian participants got marginally worse.

The reasons for these results could be due to the following:

- Having only 3 coloured participants argues in their favour, especially if all responded favourably.
- The Caucasian participants were the largest race group, at 65%, and they therefore represent the average of the masses of this study and is a more reflective and accurate recording. This does not represent the masses of the general population which is predominantly black.
- The Indian and black participants were of a small enough sample size that any outliers could have had an effect on the specific outcome (Mouton, 1996; 132-141).

Table 4.17: Repeated measures ANOVA for inclinometer inversion 5° measurements in unaffected ankles

	Wilk's lambda	p-value
Change between pre and post treatment	0.991	0.687
Change*age	0.985	0.603
Change*sex	1.000	0.989
Change*race	0.963	0.867
Change*sport	0.946	0.779
Change*side	0.987	0.621

After controlling for demographics, the p value for the change post treatment went from 0.138 to 0.687. None of the demographic variables interacted with the change. Thus there was still no significant change post treatment in unaffected ankles for inclinometer inversion, and this was not influenced by demographics.

Therefore any changes can be deemed to be related to the intervention and not to any extraneous variables.

4.7 Correlations between variables

4.7.1 Affected side:

Table 19 shows the correlation matrix for measurements done on affected ankles. Algometer changes did not correlate with changes in any other measurement. Changes in inclinometer plantaflexion 5^{o} was significantly positively correlated with plantaflexion 10^{o} (r=0.589, p <0.001). Change in inclinometer inversion was significantly positively correlated with change in ROM plantaflexion, although the correlation was weak (r=0.375, p =0.017).

4.7.2 Unaffected side

In Table 20, the correlations between changes in unaffected ankles is shown. Changes in inclinometer plantaflexion 5^{o} was significantly positively correlated with plantaflexion 10^{o} (r=0.596, p <0.001). Changes in dorsiflexion were also positively but weakly correlated with changes in 5o and 10o plantaflexion (r=0.339, p = 0.032 and 0.317, p =0.046).

Table 4.18: Pearson's correlation between changes from pre to post treatment in measurements in affected ankles

		change in algometer affected	change in plantaflexion 5° affected	change in plantaflexion 10° affected	change in dorsiflexion 5° affected	change in inversion5° affected	change in ROM plantaflexion	change in ROM dorsiflexion	change in ROM inversion
change in algometer affected	Pearson Correlation	1	.176	.199	.095	.092	.093	-.234	-.065
	Sig. (2-tailed)	.	.278	.219	.559	.572	.567	.146	.691
change in plantaflexion 5° affected	Pearson Correlation	.176	1	.589(**)	-.135	-.168	.091	.114	.000
	Sig. (2-tailed)	.278	.	.000	.407	.300	.577	.482	1.000
change in plantaflexion 10° affected	Pearson Correlation	.199	.589(**)	1	-.053	.174	-.060	.201	.036
	Sig. (2-tailed)	.219	.000	.	.745	.282	.714	.213	.826
change in dorsiflexion 5° affected	Pearson Correlation	.095	-.135	-.053	1	.253	.195	-.148	.177
	Sig. (2-tailed)	.559	.407	.745	.	.116	.227	.361	.275
change in inversion 5° affected	Pearson Correlation	.092	-.168	.174	.253	1	.375(*)	-.190	-.239
	Sig. (2-tailed)	.572	.300	.282	.116	.	.017	.240	.137
change in ROM plantaflexion	Pearson Correlation	.093	.091	-.060	.195	.375(*)	1	-.269	.129
	Sig. (2-tailed)	.567	.577	.714	.227	.017	.	.093	.427
change in ROM dorsiflexion	Pearson Correlation	-.234	.114	.201	-.148	-.190	-.269	1	-.120
	Sig. (2-tailed)	.146	.482	.213	.361	.240	.093	.	.459
change in ROM inversion	Pearson Correlation	-.065	.000	.036	.177	-.239	.129	-.120	1
	Sig. (2-tailed)	.691	1.000	.826	.275	.137	.427	.459	.

** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).

A change in plantaflexion of 5° correlates with a change in plantaflexion of 10° as the movement is in the same direction (Bergmann, 1993).

Plantaflexion range of motion is controlled by the motion induced by the anterior and posterior tibialis as well as the peroneal muscles (Moore and Dalley, 1999). Decreased spasm in these muscles would have allowed for increased ROM in this movement (plantaflexion). In addition the normalization of the neurological pathways by stimulation of the Wyke receptors (affecting the gate control theory) and allowing for normalization of Korr's "set gain" (Leach, 1994), could also allow for an improvement in the joint position sense within the movement of the talocrural joint, which is also principally controlled by the peroneal muscles (Moore and Dalley, 1999)

Table 4.19: Pearson's correlation between changes from pre to post treatment in measurements in unaffected ankles

		change in algometer unaffected	change in plantaflexion 5° unaffected	change in plantaflexion 10° unaffected	change in dorsiflexion 5° unaffected	change in inversion 5° unaffected
change in algometer unaffected	Pearson Correlation	1	.248	.010	-.125	-.151
	Sig. (2-tailed)	.	.123	.952	.443	.353
change in plantaflexion 5° unaffected	Pearson Correlation	.248	1	.596(**)	.339(*)	-.021
	Sig. (2-tailed)	.123	.	.000	.032	.896
change in plantaflexion 10° unaffected	Pearson Correlation	.010	.596(**)	1	.317(*)	-.169
	Sig. (2-tailed)	.952	.000	.	.046	.297
change in dorsiflexion 5° unaffected	Pearson Correlation	-.125	.339(*)	.317(*)	1	-.013
	Sig. (2-tailed)	.443	.032	.046	.	.937
change in inversion 5° unaffected	Pearson Correlation	-.151	-.021	-.169	-.013	1
	Sig. (2-tailed)	.353	.896	.297	.937	.

** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).

A change in plantaflexion of 5° correlates with a change in plantaflexion of 10° as the movement is in the same direction (Bergmann et al., 1993). A change in plantaflexion of 5° and 10° could correlate with a change in dorsiflexion of 5° as the overall movement in the sagittal plane will have changed (Bergmann et al., 1993).

4.8 Summary and recommendations:

There was a trend towards increases in inclinometer and ROM measurements post treatment, and a decrease in algometer measurements in affected ankles. In unaffected ankles there was a trend towards a decrease post treatment in all measured outcomes.

Demographic factors did not have a large influence on the treatment effect, except for ROM plantaflexion, where treatment effect depended on the side of the affected ankle. In unaffected ankles, 10° plantaflexion was affected by sex and sport, while 5° dorsiflexion was affected by race.

The study was underpowered to detect small differences between pre and post treatment, and thus many differences were not statistically significant. A larger study would be recommended to give more definite conclusions. This study does however, uncover trends which are useful in determining treatment effect.

Another possible limitation was the lack of a control group. This study does not distinguish between the natural history effect and the effect of the intervention. Any changes between pre and post treatment are assumed to be due to the intervention. Inclusion of a control or placebo group would strengthen the study by measuring the change due specifically to the intervention.

Hypothesis

1) It is hypothesized that manipulation would have an effect on proprioception.

Rejected with respect to all the parameters of the affected ankle.

2) Manipulation would have an effect on the contralateral ankle

Accepted with respect to the parameters of:

- Dorsiflexion 5°
- Plantaflexion 10° when gender and sport are taken into account.
- Dorsiflexion 5° when race is taken into account.

Rejected with respect to the parameters of:

- Plantaflexion 5° and 10°
- Inversion 5°.

3) Manipulation would have an effect on range of motion and pain.

Accepted with respect to the parameters of:

- Inversion range of motion of the affected ankle
- Plantaflexion when the side of injury is taken into account
- Pain in the affected and unaffected ankles.

4) There would be a correlation between the changes in proprioception and changes in clinical outcomes in the ipsilateral and contralateral limbs.

Accepted with respect to the parameters of:

- Inversion 5° in the affected ankle and plantaflexion range of motion in the affected ankle
- Rejected with respect to the rest of the parameters noted above.

CHAPTER FIVE

5.1 INTRODUCTION

This chapter will discuss the outcomes of this research and make recommendations with regards to further research on chronic ankle instability syndrome.

5.2 CONCLUSIONS

Despite the literature suggesting that manipulation should have an immediate effect on proprioception in chronic ankle instability syndrome (Wyke, 1981 and Kessler and Hertling, 1983), the results of this study did not support this.

ALGOMETER READINGS

The algometer readings in both the affected and unaffected ankles showed no improvement which is not consistent with the literature by Wyke (1981) and thus warrants further investigation.

INCLINOMETER (PROPRIOCEPTION) READINGS

Although there was a slight improvement within certain areas of proprioception in the unaffected ankle, the affected ankle showed no improvement in proprioception which is what is expected according to Sandoz (1978) and thus congruent with the current literature.

RANGE OF MOTION READINGS

There was an increase in certain ranges of motion immediately post-manipulation but there was no evidence to suggest that manipulation in chronic ankle instability syndrome causes an immediate overall improvement in range of motion of the ankle. This supports the findings of Pellow and Brantingham (2001) where range of motion improvement in chronic ankle sprains seems only to have changed over a more protracted period of time (1 month).

5.3 RECOMMENDATIONS

OBJECTIVE MEASUREMENTS

Two areas of potential error in using the algometer and the Dualer Electronic Inclinometer are examiner error and instrument error. The algometer used had a metal tip instead of a rubber tip, which may have had an effect on the readings. Therefore it is recommended the readings be taken as an average of several readings and with more suitable instruments.

PATIENT HISTORY AND DEMOGRAPHICS

Not all participants' histories were similar in terms grade and chronicity of chronic ankle instability syndrome. Therefore suggestion to stratify the patients in terms grade, chronicity or other pertinent variables or to ensure that the selection criteria are stricter for inclusion of the research participants.

SAMPLE SIZE AND PATIENT ALLOCATION

A larger sample size should be selected to improve the validity of the study. There should be equal number of females and males within the sample group and all participants should have injured the same ankle to the same degree for a more accurate outcome.

STATISTICAL LIMITATIONS

The sample size was too small to accommodate a more powerful parametric statistical analysis. Furthermore the small sample size allowed for an outlier to change the average significantly.

Due to the chronicity of the condition of chronic ankle instability syndrome, it is probably unrealistic to expect significant immediate improvements in proprioception, pain and range of motion. The literature supports the hypothesis that manipulation should have an effect on proprioception in chronic ankle instability syndrome and so a study determining the intermediate and long term effects of manipulation is recommended.

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ADDENDUM A

Are you between the ages of 25 and 45 and suffering from

RECURRENT ANKLE SPRAINS

Research is currently being carried out at the Durban Institute of Technology Chiropractic Day Clinic

FREE TREATMENT

Is available to those who qualify to take part in this study

For more information contact

Catriona on

204 2205 / 2512

ADDENDUM B

Date

Dear Participant

Welcome to my research project.

Title of Research: Determining the immediate efficacy of manipulation on proprioception in chronic ankle instability syndrome.

Name of Research Student
Catriona Lindsey-Renton Contact number (031) 204-2205

Name of Research Supervisor
Dr. Andrew Jones Contact number (031) 204-2244 or (031) 903-4467

Introduction and Purpose of the Study: You have been selected to take part in a study comparing proprioception before and after manipulation in ankle sprains. Forty people will be required to complete this study. All participants, including you, will all be in one group and will receive the same treatment.

Reasons why you may be withdrawn from the study: If you are taking any medication, or undergoing any other form of treatment for your ankle sprain, or taking any medication that may have an effect on the symptoms of the ankle sprain, you may be excluded from the study. Please try not to alter your normal lifestyle or daily activities in any way as this could interfere with the results of the study.

Procedure: At the first and only consultation you will be screened for suitability as a participant using a case history, physical examination and foot and ankle regional examination. Specific measurements of your foot pain, range of motion of your ankle and proprioception will be taken.

Risks and Cost of the Study: All treatments will be performed under the supervision of a qualified Chiropractor and will be free of charge. The treatment is safe and is unlikely to cause any adverse side effects, other than transient tenderness and stiffness that is common post manipulation.

Confidentiality: All patient information is confidential and the results of the study will be made available in the Durban Institute of Technology library in the form of a mini-dissertation.

You are free to withdraw at any stage. Please don't hesitate to ask questions on any aspect of this study. Your full co-operation will assist the Chiropractic profession in expanding its knowledge of this condition.

Thank you.

Yours sincerely,

....

Catriona Lindsey-Renton Dr Andrew Jones

ADDENDUM C

INFORMED CONSENT FORM

(To be completed by patient / subject)

Date :

Title of research project : **To determine the immediate effect of manipulation in chronic ankle instability syndrome**

Name of supervisor : **Dr Andrew Jones**
Tel : **(031) 2042205**

Name of research student : **Catriona Lindsey-Renton**
Tel : **(031) 2042205**

Please circle the appropriate answer YES /NO

1.	Have you read the research information sheet?	Yes	No
2.	Have you had an opportunity to ask questions regarding this study?	Yes	No
3.	Have you received satisfactory answers to your questions?	Yes	No
4.	Have you had an opportunity to discuss this study?	Yes	No
5.	Have you received enough information about this study?	Yes	No
6.	Do you understand the implications of your involvement in this study?	Yes	No
7.	Do you understand that you are free to withdraw from this study? at any time without having to give any a reason for withdrawing, and without affecting your future health care.	Yes	No
8.	Do you agree to voluntarily participate in this study	Yes	No
9.	Who have you spoken to? ______________________		

Please ensure that the researcher completes each section with you
If you have answered NO to any of the above, please obtain the necessary information before signing

Please Print in block letters:

Patient /Subject Name:______________________ Signature: ______________

Parent/ Guardian:______________________ Signature:______________

Witness Name:______________________ Signature:______________

Research Student:______________________ Signature:______________

ADDENDUM D

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:		
< Cause:		
< Duration		
< Frequency		
< Pain (Character)		
< Progression		
< Aggravating Factors		
< Relieving Factors		
< Associated S & S		
< Previous Occurrences		
< Past Treatment		
< **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

ADDENDUM E

DURBAN INSTITUTE OF TECHNOLOGY
CHIROPRACTIC DAY CLINIC
PHYSICAL EXAMINATION

Patient:____File#:__________Date:________

Clinician:________________________________Signature:________________________

Student:_________________________________Signature:________________________

1. VITALS

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

2. GENERAL EXAMINATION

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

Urinalysis:

3. CARDIOVASCULAR EXAMINATION

1) Is this patient in **Cardiac Failure** ?
2) Does this patient have signs of **Infective Endocarditis** ?
3) Does this patient have **Rheumatic Heart Disease ?**

Inspection
- Scars
- Chest deformity:
- Precordial bulge:
- Neck -JVP:

Palpation:
- Apex Beat (character + location):
- Right or left ventricular heave:
- Epigastric Pulsations:
- Palpable P2:
- Palpable A2:

Pulses: - General Impression:
- Radio-femoral delay:
- Carotid:
- Radial:
- Dorsalis pedis:
- Posterior tibial:
- Popliteal:
- Femoral:

Percussion: - borders of heart

Auscultation:- heart valves (mitral, aortic, tricuspid, pulmonary)
- Murmurs (timing,systolic/diastolic, site, radiation, grade).

4. RESPIRATORY EXAMINATION

1) Is this patient in **Respiratory Distress** ?

Inspection - Barrel chest:
- Pectus carinatum/cavinatum:
- Left precordial bulge:
- Symmetry of movement:
- Scars:

Palpation - Tracheal symmetry:
- Tracheal tug:
- Thyroid Gland:
- Symmetry of movement (ant + post)
- Tactile fremitus:

Percussion - Percussion note:
- Cardiac dullness:
- Liver dullness:

Auscultation - Normal breath sounds bilat.:
- Adventitious sounds (crackles, wheezes, crepitations)
- Pleural frictional rub:
- Vocal resonance
  - Whispering pectoriloquy:
  - Bronchophony:
  - Egophony:

5. ABDOMINAL EXAMINATION

1) Is this patient in **Liver Failure** ?

Inspection - Shape:
- Scars:
- Hernias:

Palpation - Superficial:
- Deep = Organomegally:
- Masses (intra- or extramural)
- Aorta:

Percussion - Rebound tenderness:
- Ascites:
- Masses:

Auscultation - Bowel sounds:
- Arteries (aortic, renal, iliac, femoral, hepatic)

Rectal Examination	- Perianal skin: - Sphincter tone & S4 Dermatome: - Obvious masses: - Prostate: - Appendix:

6. G.U.T EXAMINATION

External genitalia:
Hernias:
Masses:
Discharges:

7. NEUROLOGICAL EXAMINATION

Gait and Posture	- Abnormalities in gait: - Walking on heels (L4-L5): - Walking on toes (S1-S2): - Rombergs test (Pronator Drift):
Higher Mental Function	- Information and Vocabulary: - Calculating ability: - Abstract Thinking:

G.C.S.: - Eyes:
- Motor:
- Verbal:

Evidence of head trauma:

Evidence of Meningism:	- Neck mobility and Brudzinski's sign: - Kernigs sign:

Cranial Nerves:

I Any loss of smell/taste:
Nose examination:

II External examination of eye:
- Visual Acuity:
- Visual fields by confrontation:
- Pupillary light reflexes = Direct:
= Consensual:
- Fundoscopy findings:

III Ocular Muscles:
Eye opening strength:

IV Inferior and Medial movement of eye:

V
a. Sensory - Ophthalmic:
- Maxillary:
- Mandibular:

b. Motor - Masseter:
- Jaw lateral movement:

c. Reflexes - Corneal reflex
- Jaw jerk

VI Lateral movement of eyes

VII a. Motor - Raise eyebrows:
- Frown:
- Close eyes against resistance:
- Show teeth:
- Blow out cheeks:

b. Taste - Anterior two-thirds of tongue:

VIII General Hearing:
Rinnes = L: R:
Webers lateralisation:
Vestibular function - Nystagmus:
- Rombergs:
- Wallenbergs:

Otoscope examination:

IX & X Gag reflex:
Uvula deviation:
Speech quality:

XI Shoulder lift:
S.C.M. strength:

XII Inspection of tongue (deviation):

Motor System:

a. Power
- Shoulder = Abduction & Adduction:
  = Flexion & Extension:
- Elbow = Flexion & Extension:
- Wrist = Flexion & Extension:
- Forearm = Supination & Pronation:
- Fingers = Extension (Interphalangeals & M.C.P's):
- Thumb = Opposition:
- Hip = Flexion & Extension:
  = Adduction & Abduction:
- Knee = Flexion & Extension:
- Foot = Dorsiflexion & Plantar flexion:
  = Inversion & Eversion:
  = Toe (Plantarflexion & Dorsiflexion):

b. Tone
- Shoulder:
- Elbow:
- Wrist:
- Lower limb - Int. & Ext. rotation:
- Knee clonus:
- ankle clonus:

c. Reflexes
- Biceps:
- Triceps:
- Supinator:
- Knee:
- Ankle:
- Abdominal:
- Plantar:

Sensory System:

a.	Dermatomes	- Light touch: - Crude touch: - Pain: - Temperature: - Two point discrimination:
b.	Joint position sense	- Finger: - Toe:
c.	Vibration:	- Big toe: - Tibial tuberosity: - ASIS: - Interphalangeal Joint: - Sternum:

Cerebellar function:

Obvious signs of cerebellar dysfunction:
= Intention Tremor:
= Nystagmus:
= Truncal Ataxia:
Finger-nose test (Dysmetria):
Rapid alternating movements (Dysdiadochokinesia):
Heel-shin test:
Heel-toe gait:
Reflexes:
Signs of Parkinsons:

8. SPINAL EXAMINATION:(See Regional examination)

Obvious Abnormalities:
Spinous Percussion:
R.O.M:
Other:

9. BREAST EXAMINATION:

Summon female chaperon.

Inspection
- Hands rested in lap:
- Hands pressed on hips:
- Arms above head:
- Leaning forward:

Palpation
- masses:
- tenderness:
- axillary tail:
- nipple:
- regional lymph nodes:

ADDENDUM F

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

Resisted Isometric movements

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

Neurological

	Ⓡ	Ⓛ
Dermatomes		
Myotomes		
Reflexes		
Balance/proprioception		

Special tests

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

Alignment

	Ⓡ	Ⓛ
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

	Ⓡ	Ⓛ
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		

ADDENDUM G

INCLINOMETER READINGS

Patient Name:______________

Date:______________________

Affected foot:______________

DEGREE OF ROM	PRE-ADJUSTMENT	POST-ADJUSTMENT
5° Plantaflexion		
10° Plantaflexion		
5° Dorsiflexion		
5° Inversion		

Non-affected foot:___________

DEGREE OF ROM	PRE-ADJUSTMENT	POST-ADJUSTMENT
5° Plantaflexion		
10° Plantaflexion		
5° Dorsiflexion		
5° Inversion		

ADDENDUM H

ALGOMETER READINGS

Patient Name:________________ Date:____________

Patient number:________________ File Number:______

	Pre-manipulation	Post-manipulation
Affected ankle		
Unaffected ankle		

ADDENDUM I

RANGE OF MOTION (INCLINOMETER) READINGS

Patient Name:________________ Date:_____________

File number:_________________

Patient number:______________

	Pre-manipulation	Post-manipulation
Plantaflexion		
Dorsiflexion		
Inversion		