

The efficacy of adjusting the ankle in  
the treatment of subacute and chronic  
grade I and II ankle inversion sprains

BY

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*Dissertation submitted to the Faculty of Health in partial compliance with the  
requirements for the Master's Degree in Technology: Chiropractic, at  
Technikon Natal.*

*I, Justin Edward Pellow, do hereby 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 God, my parents Allan and Paddy Pellow, and Karen Hutchings.

## ACKNOWLEDGEMENTS

I would like to thank the following people for their assistance in the completion of this dissertation:

Dr James Brantingham, my supervisor, for his guidance, encouragement, and enthusiasm in getting this project off the ground.

Dr Z. Worku, the resident statistician.

Dr A.G. Till, and the Chiropractic Department at Technikon Natal

The staff at the Chiropractic Day Clinic

To my colleague Denise Coetzer for your assistance and help in recruiting patients and in sharing knowledge with me.

Finally to all those patients who participated in this study, who through their contribution have made this study possible.

## **ABSTRACT**

### **Objectives**

To investigate the efficacy of adjusting the ankle in the treatment of subacute and chronic grade I and II ankle inversion sprains. The researcher hypothesised that adjusting a symptomatic ankle, in terms of the above, would result in a more significant improvement than that of a placebo treatment.

### **Summary of the Background Data**

There have been no substantiated studies performed up to this date to investigate the efficacy of adjusting the ankle in a symptomatic population.

### **Study Design**

A single-blind, comparative, controlled pilot study.

### **Methods**

Thirty subjects selected from the general population, diagnosed as having subacute or chronic grade I or II ankle inversion sprains, were randomly divided into two different treatment groups. Each group consisted of fifteen

patients between the ages of 15 and 50 years. The first group received the mortise separation adjustment, whilst the second group received placebo treatment (detuned ultrasound) only.

Both groups received a maximum of eight treatments over a maximum period of four weeks. A month follow-up consultation was then scheduled subsequent to the final treatment so as to assess the relative long-term benefits of the two treatments.

Subjective measurements included the completion of the McGill Short-form Pain Questionnaire and the Numerical Pain Rating Scale 101 by the patient. These two questionnaires were completed by the patient, under the supervision of the researcher, before the first treatment, at the final treatment, and at the one-month follow-up visit.

Objective measurements included algometer readings to assess pain threshold and goniometer readings to measure ankle dorsiflexion range of motion. These readings were taken before the first treatment, at the final treatment, and at the one-month follow-up visit.

A subjective/objective functional evaluation of ankle injury was also included to evaluate the outcome of the treatment. This scale was completed before the initial consultation, at the final treatment, and at the one-month follow-up visit.

The data collected by the researcher was statistically analysed using a 95% confidence level. Due to the possible effects of a small sample size, the non-parametric Mann-Whitney Unpaired Test and the Wilcoxon's Signed Rank Test were used for comparing inter-group and intra-group data respectively. This was conducted at  $\alpha = 0.05$  level of significance. Further assessment of the data was conducted using power analysis. This data as well as the descriptive statistics are presented in tables and bar charts.

## **Results**

This study suggests that adjusting the ankle is more efficacious than placebo in short-term and possibly long-term management of subacute and chronic grade I and II ankle inversion sprains.

Significant differences were detected between the adjustment group and the placebo group in terms of pain experienced (quality and intensity) at the final treatment and at the one-month follow-up. A significant difference was found between the two groups in ankle dorsiflexion range of motion at the one-month follow-up. Significant differences were detected between the adjustment group and the placebo group in terms of overall ankle functioning at the final treatment and at the one-month follow-up.

A power analysis of the data revealed statistical differences between the adjustment group and the placebo group in terms of pain (quality and intensity), ankle dorsiflexion range of motion, and ankle function. These differences were evident at the final treatment in terms of pain perception and overall ankle function. These differences were also evident at the one-month follow-up in terms of pain perception, ankle dorsiflexion range of motion, and ankle function. This leads to the conclusion that adjusting the ankle appears to be superior to placebo in terms of subjective, objective and functional terms when comparing the two groups to each other.

Statistical analysis, within the adjustment group, showed significant changes in terms of pain experienced (quality and intensity) between treatment one and the final treatment, between treatment one and the one-month follow-up, and between the final treatment and the one-month follow-up. Significant differences were observed in percentage pain intensity between treatment one and the final treatment and between treatment one and the one-month follow-up. Significant differences were observed in ankle dorsiflexion range of motion between treatment one and the final treatment and between treatment one and the one-month follow-up. Significant increases in pain threshold were observed between treatment one and the final treatment, between treatment one and the one-month follow-up, and between the final treatment and the one-month follow-up. Significant improvements in overall ankle function were observed between treatment one and the final treatment, between

treatment one and the one-month follow-up, and between the final treatment and the one-month follow-up.

In the placebo group, a significant improvement in pain experienced (quality and intensity) was detected between the final treatment and the one-month follow-up. Significant differences were observed in percentage pain intensity between treatment one and the final treatment, and between treatment one and the one-month follow-up. Significant increases in pain threshold were observed between treatment one and the final treatment, and between treatment one and the one-month follow-up. Significant improvements in overall ankle function were observed between treatment one and the final treatment, and between treatment one and the one-month follow-up.

Power analysis revealed statistically significant improvements within the adjustment group in terms of pain (quality and intensity), the goniometer readings and the overall ankle function after the treatment period.

Significant changes between treatment one and the one-month follow-up were found in percentage pain intensity experienced, pain quality and intensity experienced, dorsiflexion range of motion, pain threshold, and ankle function.

## **Conclusions**

This pilot study suggests that adjusting the ankle is superior to placebo treatment. Due to the small sample size, the findings of this trial study should not be considered conclusive, but rather as a base from which to plan future studies.

The significant findings of this study can however be thought of as encouraging in the field of chiropractic research, especially in the relatively unexplored field of the management of extra-vertebral conditions and the role that chiropractic can play in the management of such conditions.

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## LIST OF ABBREVIATIONS

Group 1: Adjustment Group.

Group 2: Placebo Group.

McGill: McGill Short-form Pain Questionnaire.

NRS-101: Numerical Pain Rating Scale.

GON: Ankle Dorsiflexion Range of Motion in Degrees.

ALG: Algometer Readings in Kg per squared centimetre.

FE: Functional Evaluation Scores.

SD: Standard Deviation.

P-Value: The observed level of significance for a two-tailed test –

Reject  $H_0$  if  $p \leq \alpha/2 = 0.025$

Accept  $H_0$  if  $p > \alpha/2 = 0.025$

**Bold numbers:** Significant findings.

## **DEFINITION OF TERMS**

### **ADHESION**

Fibrous band or structure by which parts adhere abnormally (Gatterman 1990: 405).

### **ADJUSTMENT**

The chiropractic adjustment is a specific form of articular manipulation using either long- or short-leverage techniques with specific contacts. It is characterised by a dynamic thrust of controlled velocity, amplitude, and direction. (Peterson 1993:124.)

### **BIOMECHANICS**

Application of mechanical laws to living structures. The study and knowledge of biological function from an application of mechanical principles. (Gatterman 1990: 406.)

### **CONTRAINDICATION**

Any condition, especially any condition of disease, that renders one particular line of treatment improper or undesirable (Gatterman 1990: 407).

## **COUPLING**

Phenomenon of consistent association of one motion (translation or rotation) about an axis with another motion (translation or rotation) about a second axis. One motion cannot be produced without the other.

(Gatterman 1990: 407.)

## **GONIOMETER**

Instrument for measuring angles (Gatterman 1990: 408).

## **JOINT DYSFUNCTION**

Joint mechanics showing area disturbances of function (Gatterman 1990: 409).

## **MANIPULATION**

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

## **MANIPULATIVE THERAPY**

Includes all procedures where either the hands or machinery are used to rearrange, mobilize, adjust, manipulate, apply traction, massage, stimulate or otherwise influence the body with the aim of altering the patient's condition. (Bryner 1987: 25).

## **MANUAL THERAPY**

Therapeutic application of manual force. Spinal manual therapy broadly defined includes all procedures in which the hands are used to mobilise, adjust, manipulate, apply traction, massage, stimulate, or otherwise influence the spine and paraspinal tissues with the aim of influencing the patient's health. (Gatterman 1990: 410.)

## **MOBILISATION**

Process of making a fixed part movable. A form of manual therapy applied within the physiological passive range of joint motion, characterised by nonthrust techniques in passive joint play. (Gatterman 1990: 411.)

## **OBJECTIVE CLINICAL FINDINGS**

For the purpose of this study this refers to the data obtained from goniometer readings in terms of ankle dorsiflexion range of motion and algometer readings as a measure of pain threshold.

### **SPRAIN**

Joint injury in which some of the fibres of a supporting ligament are ruptured, but the continuity of the ligament remains intact (Gatterman 1990: 415).

## **SUBJECTIVE CLINICAL FINDINGS**

For the purpose of this study this refers to the data obtained from the patients through the use of the McGill Short-form Pain Questionnaire and the Numerical Pain Rating Scale 101.

## **CHAPTER ONE - INTRODUCTION**

### **1.1 BACKGROUND TO THE PROBLEM**

Ankle sprains are one of the most prevalent acute injuries treated in emergency departments and physician's offices Eiff et al. (1994). Ankle injuries comprise up to ten percent of sports related injuries. The ankle sprain is probably the single most common injury in sport. (Garrick and Requa 1988.) Eighty-five percent of ankle injuries are ankle sprains (Garrick 1977). It would appear that new epidemiological studies should be performed to update these findings. At least ninety-five percent of isolated ankle sprains will involve the lateral ligaments (Reid 1992: 217). According to Mack (1982), ankle injuries account for twenty to twenty-five percent of time lost due to injury in running and jumping sports.

### **1.2 STATEMENT OF THE PROBLEM**

The purpose of this randomised placebo controlled study was to determine the efficacy of adjusting the ankle in the treatment of subacute and chronic grade I and II ankle inversion sprains in terms of objective and subjective clinical findings.

This was done in terms of the patients' subjective and objective clinical findings in order to determine which of the treatments was more

efficacious. The subjective findings were analysed using the McGill Short-form Pain Questionnaire, and the Numerical Pain Rating Scale 101. Objective measurements used in this study included the use of an extremity range of motion goniometer and an algometer. A functional evaluation to assess post-injury function of the ankle was also used in this study.

These measurements were then compared using the Mann-Whitney Unpaired Test (Mann-Whitney U-test) and the Wilcoxon Signed Rank Test. Intra- and inter-group comparisons were made, and the efficacy of both interventions was compared.

### **1.3 NEED FOR A SOLUTION TO THE PROBLEM**

In a randomised controlled clinical trial, by Nield *et al.* (1993), involving a single talocrural manipulation of high velocity and low amplitude in a group of twenty asymptomatic subjects, it was found that there was no statistically significant change in ankle dorsiflexion range in both the experimental and control groups. However, Nield *et al.* (1993) suggested that a similar trial should be performed in a symptomatic population as symptomatic patients have often reported a "feeling" of reduced stiffness and subjective improvement in functional abilities, such as walking up stairs, following manipulation of the ankle joint.

Most of the continuing symptoms following a sprained ankle such as pain, a feeling of instability, crepitus, weakness, and stiffness are believed to be directly related to untreated ligament damage. Incomplete or absent rehabilitation may be a cause of these continuing symptoms. The main causes of these symptoms are functional instability, joint stiffness due to loss of joint motion, scar tissue, and incomplete rehabilitation. (Reid 1992: 250.)

Peterson (1993: 144) suggests that adjustive therapy is a procedure that may induce quick distraction and break the intra-articular adhesions. Peterson (1993: 139) also suggests that early intervention for soft tissue injury by means of manual therapy will promote better healing, decrease pain and inflammation, prevent further injury and promote flexibility.

#### **1.4 BENEFITS**

According to Peterson and Bergmann (1993: 51-52), it has been proposed that manual therapy is an effective treatment for a wide variety of conditions, but is most commonly associated with disorders that have their beginnings in pathomechanical or pathophysiological alterations of the locomotor system and its synovial joints.

Peterson (1993: 126) believes that the elements that set the chiropractic profession apart from other professions are:

- (i) the emphasis it places on the evaluation and treatment of disorders of the neuromusculoskeletal system,
- (ii) the significance it places on the relationship between structure and function of the neuromusculoskeletal system and overall health, and
- (iii) the characteristic rationale and skills it employs in the application of adjustive techniques.

## CHAPTER TWO - LITERATURE REVIEW

### 2.1 INTRODUCTION

According to Garrick and Schelkun (1997), most ankle injuries that involve the lateral ligaments of the ankle, can be managed favourably in the primary care setting. Garrick and Schelkun (1997) also maintain that early intervention by use of conservative treatment, such as compression, mobilisation, exercise, and contrast baths are important to prevent chronic symptomatology. Uncomplicated (grade I) inversion ankle sprains often resolve with little or no intervention (Baker and Todd. 1995). Fallat *et al.* (1998) state that ankle sprains should be treated as a syndrome involving all the surrounding articular, soft tissue, and osseous structures. Many patients will however remain chronically symptomatic in terms of, or a combination of, pain, swelling, crepitus, decreased range of motion or functional instability. It can therefore be suggested that without an early accurate diagnosis and relatively early intervention of the injury, complications such as chronic functional instability, synovitis, tendinitis, weakness and stiffness of the involved joint may arise. (Baker and Todd. 1995.) Bouche *et al.* (1994: 245) have also suggested that inadequate early treatment may result in joint dysfunction.

According to Baker and Todd (1995), acute ankle injuries are often overlooked when roentgenograms fail to reveal a fracture. It has been

suggested that an ankle sprain is worse than a fracture since fractures are often aggressively treated and conservatively cared for with immobilisation and activity restriction. Athletes who have sustained ankle sprains are, however, often rushed back into training before appropriate healing has occurred. This may result in complications such as a chronically inflamed and unstable ankle, which would impede the performance of the athlete. (Arnheim and Prentice 1993: 486-494.)

Coker (1991 3: 2433) believes that most (approximately ninety percent) acute complete ankle ligament tears can be managed conservatively by a primary care practitioner. McBryde (1995: 483) states that the other ten percent (the more severe sprains) should be recognised through a detailed history and thorough examination of the injury so that early and more aggressive therapy can be initiated.

Bassewitz and Shapiro (1997) suggest that other causes of persistent ankle pain may be a result of inadequate rehabilitation, post traumatic impingement syndrome, occult osteochondral injury, peroneal tendon damage, syndesmosis injury, or chronic instability.

According to Peterson (1993: 139), manual therapy, such as the chiropractic adjustment, is directed towards reversing or reducing the soft tissue pathology and mechanical dysfunction of the musculoskeletal system. This dysfunction could be attributed to a number of factors such

as: trauma, repetitive motion injuries, postural decompensation, developmental anomaly, immobilisation, reflex changes, psychological factors, and/or aging and degenerative disease (Peterson 1993: 139).

In a critical review compiled by Ogilvie-Harris and Gilbert (1995) prospective and retrospective comparative and non-comparative studies of the pharmacological, surgical, and physiotherapeutic treatment modalities currently being used to treat soft tissue injuries of the ankle were assessed. Ogilvie-Harris and Gilbert (1995) found that of the eighty-four studies reviewed, nineteen (22.6%) assessed pharmacological agents, forty-one (48.8%) examined surgical and active mobilisation, and twenty-four studies (28.6%) reviewed the use of physical modalities. Ogilvie-Harris and Gilbert (1995) concluded that early mobilisation (by ambulation, stretching and exercise) in conjunction with strapping provided the best results by speeding up recovery rates. Cryotherapy and the use of non-steroidal anti-inflammatory drugs allowed early recovery but had little effect on the final outcome. Diapulse diathermy improved recovery time and symptom relief. Surgery showed no significant improvement in outcome.

The treatment of ankle sprains is quite controversial and although numerous studies have been done on the treatment of this traumatic musculoskeletal condition in the acute stages there is a lack of similar research for chronic ankle sprains. It would also appear that a consensus

as to the most effective treatment protocol has not been established, especially for those patients who have resulting residual chronic symptoms weeks to months after their ankle injury.

## **2.2 ANATOMY AND BIOMECHANICS OF THE ANKLE**

### **2.2.1. Anatomy**

#### **2.2.1.1. The Ankle Joint**

The ankle joint, also known as the mortise or talocrural joint, is described as a hinge type of synovial joint. It is formed by the articulation of the inferior ends of the tibia and fibula and the superior part of the talus. The inferior ends of the tibia and fibula unite to form a 'mortise' which articulates with the trochlea of the talus. The articular capsule of the ankle joint is a fibrous capsule, which is thin both anteriorly and posteriorly. The articular capsule is thickened medially and laterally by strong collateral ligaments. The collateral ligaments consist of the medial or deltoid ligament and the three lateral ligaments, namely the anterior talofibular ligament, posterior talofibular ligament, and the calcaneofibular ligament. The anterior talofibular ligament, which is not considered to be strong, is described as a flat band and extends anteromedially from the lateral malleolus to the neck of the talus. The posterior talofibular ligament, which is thick and relatively strong, runs

posteriorly and horizontally medially from the malleolar fossa to the lateral tubercle of the posterior process of the talus. The calcaneofibular ligament, which is described as a round cord, passes from the inferior tip of the lateral malleolus to the lateral surface of the calcaneus. The medial or deltoid ligament complex, which consists of two deep and three superficial ligaments, is a strong ligament complex that runs inferiorly from the inferior tip of the medial malleolus and joins the talus, navicular, and calcaneus forming a broad base. (Moore 1992: 487-489.)

The ligaments of the distal tibiofibular syndesmosis are located between the triangular surface of the fibula and fibula groove of the tibia. The four ligaments that reinforce this syndesmosis are the anterior tibiofibular ligament, the posterior tibiofibular ligament, the inferior transverse ligament, and the interosseous ligament. The interosseous membrane, which contributes to the stability of the fibula, extends along almost the entire length of the interosseous space. (Pankovich 1991 3: 2363-2365.)

Anatomically the talus is wider anteriorly than it is posteriorly due to the fact that the lateral wall slants outward as opposed to being parallel to the medial wall. The tibial articular surface is also wider anteriorly than it is posteriorly. During foot dorsiflexion, the broader anterior portion of the talus contacts the narrower position between the malleoli and as a result becomes more tightly gripped. During ankle plantarflexion, the narrower posterior portion of the talus is brought into contact with the broader

anterior portion of the tibia. This allows for a small amount of free play in the mortise. This bony seat creates a certain amount of anterior stability within the ankle joint. When the tibia is driven forward on the plantarflexed talus, the narrower part of the tibia impinges on the broader anterior portion of the talus, this prevents forward dislocation of the tibia on the talus. (Mack 1982.)

The superior talar surface, also known as the trochlea, resembles a pulley and articulates with the tibial plafond. The medial and lateral surfaces articulate with the articular surfaces of the medial and lateral malleoli. The medial articular surface, a pear-shaped facet, has a similar configuration to that of the anterior colliculus of the medial malleolus and has a much wider surface anteriorly for articulation with the anterior colliculus. This reflects the profound extent of articular contact between the talus and the medial malleolus. The deep deltoid ligament inserts just below the articular surface of the posterior colliculus. The lateral articular surface, which is much larger than the medial, is concave from anterior to posterior and from superior to inferior in order to approximate with the convex articular surface of the lateral malleolus. Posterior to and below the articular surface is the posterior surface of the talus, which is divided by the groove for the tendon of the flexor hallucis longus muscle into a larger lateral and a medial tubercle. The posterior talofibular ligament is attached to the lateral tubercle. (Pankovich 1991 3: 2361.)

#### **2.2.1.2. The Subtalar Joint**

The subtalar joint is a synovial joint, which is formed by the articulation of the talus with the calcaneus (Moore 1992: 490). The subtalar joint is comprised of two facets on the plantar surface of the talus and their corresponding calcaneal articulations. The larger concave posterior facet is the true subtalar joint. The articular capsule surrounding the subtalar joint is thin and does not communicate with other tarsal joints. (Jaffe et al. 1991 1:16.) The articular capsule although thin, attaches close to the margins of the articular facets and is well supported by the surrounding ligaments (Moore 1992: 490-491). The stability of the subtalar joint is maintained by four sturdy ligaments: the medial, lateral, interosseous talocalcaneal and cervical ligament. The cervical ligament, which restricts excessive inversion by tightening, covers the lateral entrance to the sinus tarsi. The interosseous calcaneal ligament also crosses the sinus tarsi and tightens to prevent excess subtalar eversion. (Jaffe et al. 1991 1:16.)

#### **2.2.1.3. The Distal Tibiofibular Joint**

The distal tibia resembles a fork, which moulds around and fits the articular surface of the talus. The distal tibia consists of three processes: an anterior process, a posterior process and a medial malleolus. The fibular groove is found on the lateral side of the distal tibia. (Pankovich 1991 3: 2361.)

The medial malleolus is the medial process of the tibia. It is triangular in shape and articulates with the medial surface of the talus. The medial malleolus has a wide base proximally which consists of an anterior and a posterior colliculus that are separated by the intercollicular groove. The articular surface of the medial malleolus is continuous with the articular surface of the tibial plafond. (Pankovich 1991 3: 2361-2362.)

The anterior colliculus is the slender, narrow anterior part of the medial malleolus and protrudes below the level of the plafond and forms the main part of the articular surface of the medial malleolus. In this position the anterior colliculus thus serves as a buttress for the talus. The convex extra-articular medial surface of the anterior colliculus serves as an attachment for the superficial deltoid ligaments. (Pankovich 1991 3: 2362.)

The posterior colliculus is the posterior and broader part of the medial malleolus and contains the narrower posterior part of the medial malleolus providing attachment for the deep deltoid ligament. The sulcus for the tendons of the tibialis posterior and flexor digitorum muscles is found on the posterior surface of the medial malleolus. (Pankovich 1991 3: 2362.)

The intercollicular groove is a broad groove found between the colliculi of the medial malleolus and provides attachment for the deltoid ligament of the ankle (Pankovich 1991 3: 2362).

The anterior process of the tibia provides attachment for the anterior joint capsule and anterior tibiofibular ligament (Pankovich 1991 3: 2362).

The posterior process of the tibia provides attachment for both the posterior joint capsule and the posterior tibiofibular ligament (Pankovich 1991 3: 2362).

The fibular groove is formed by the anterior and posterior tibial tubercles. At the distal end, a narrow articular ring is in contact with the articular surface of the plafond. This groove forms the seat for the fibula and forms the medial wall of the tibiofibular syndesmosis. (Pankovich 1991 3: 2363.)

The distal fibula forms the lateral malleolus and has a broad and convex articular surface. The anterior and posterior fibular tubercles are located just below the level of the tibial plafond. The triangular area of the lateral malleolus which lies just above the articular surface, forms the lateral wall of the tibiofibular syndesmosis. (Pankovich 1991 3: 2363.)

#### **2.2.1.4. Blood Supply to the Ankle**

The articular branches originating from the malleolar branches of the peroneal and anterior and posterior tibial arteries supply the ankle (Moore 1992: 490).

#### **2.2.1.5. Nerve Supply to the Ankle**

The articular nerves supplying the ankle are derived from the tibial nerve and the deep peroneal nerve which is a division of the common peroneal nerve (Moore 1992: 490).

#### **2.2.1.6. Muscles Related to the Ankle Joint**

Ankle plantarflexion is produced primarily by three muscles. These muscles include the gastrocnemius, plantaris, and soleus muscles. The tibialis posterior, flexor digitorum longus, peroneus longus, peroneus brevis, and flexor hallucis longus muscles also aid in plantar flexion at the ankle joint. All of these muscles are innervated by the tibial nerve except for the peroneus longus and brevis muscles which are innervated by the superficial peroneal nerve (L5, S1, and S2 spinal nerves). The tibialis posterior receives fibres from L4 and L5 spinal nerves and the plantaris muscle is innervated by L4, L5, and S1 spinal nerves. L5, S1, and S2 spinal nerve fibres supply the soleus, flexor digitorum longus, and flexor

hallucis longus muscles. The gastrocnemius muscle is innervated by S1 and S2 spinal nerves. (Magee 1992: 475.)

Ankle dorsiflexion is produced by four muscles. These muscles are the tibialis anterior, extensor digitorum longus, extensor hallucis longus, and the peroneus tertius muscles. All four of these muscles are innervated by the deep peroneal nerve. L4 and L5 spinal nerves innervate the tibialis anterior, while the other three muscles are innervated by the L5 and S1 spinal nerves. (Magee 1992: 475.)

Inversion of the ankle is produced by five muscles. These muscles are the tibialis posterior, flexor digitorum longus, flexor hallucis longus, tibialis anterior, and extensor hallucis longus muscles. The tibialis posterior muscle is innervated by the tibial nerve (L4-L5 spinal nerves), the flexor digitorum longus and flexor hallucis longus muscles are innervated by the tibial nerve (S2-S3 spinal nerves), and the tibialis anterior and extensor hallucis longus muscles are innervated by the deep peroneal nerve (L4, L5, and S1 spinal nerves). (Magee 1992: 475.)

Eversion of the ankle joint is produced by four muscles. These muscles are the peroneus longus, peroneus brevis, peroneus tertius muscles and the extensor digitorum longus muscle. The peroneus longus and brevis muscles are innervated by the superficial peroneal nerve (L5, S1, and S2 spinal nerves) and the peroneus tertius and extensor digitorum longus

muscles are innervated by the deep peroneal nerve (L5 and S1 spinal nerves). (Magee 1992: 475.)

Reid (1992: 220) states that the anterior talofibular ligament is the key ligamentous structure involved in the stability of the ankle joint and that the peroneus longus and brevis muscles are the major dynamic stabilisers of the ankle joint.

## **2.2.2 Biomechanics**

### **2.2.2.1 The Ankle**

The movements in the ankle are considered to be essentially uniaxial, primarily involving dorsiflexion and plantarflexion. The ankle joint, when plantarflexed, does however allow some rotation, abduction and adduction. (Moore 1992: 488.) The axis of motion of the ankle joint passes through an imaginary line joining the inferior tips of both the lateral malleolus and the medial malleolus. Since the lateral malleolus is lower in relation to the medial malleolus a mildly triplaner axis exists at the joint and thus is able to allow for some rotation, abduction and adduction. (Mann 1991 1: 386.)

Motion in the subtalar joint has an intimate relationship with the motion that occurs in the ankle joint. The axis of motion in the subtalar joint

passes from the dorsal medial aspect of the navicular and exits on the lateral plantar aspect of the calcaneus. This allows both inversion and eversion movement to occur in the subtalar joint. (Mann 1991 1: 386.)

Although plantarflexion and dorsiflexion are the primary movements in the ankle joint, the joint must also accommodate sideward tilting motion in addition to longitudinal rotations of the leg to the tarsus, especially the talus. This is also known as talocrural coupling, or the proximal coupling between the foot and leg. The contact conditions of the ankle joint surfaces allow only transmission of small forces and motions through bone contact only (except at full ankle dorsiflexion). The supporting ligaments of the ankle therefore play an important role in this respect. Longitudinal rotations of the leg, alone or combined with sideward swaying motions, are converted by the tarsal mechanism into inversion and eversion mechanisms of the foot. This tarsal mechanism counteracts any external or internal rotating moments exerted by the leg on the foot. The anterior talofibular elements are crucial structures during this transmission of rotation forces of the leg through the ankle joint. (Huson 1991 1: 416.)

According to Magee (1992: 471), for minimal normal locomotion to occur the ankle should be able to actively dorsiflex ten degrees and plantarflex between twenty and twenty-five degrees.

According to Brantingham (1999) normal active dorsiflexion at the ankle joint should be between twenty and twenty-five degrees.

Baker and Todd (1995) mention that a common sequela of ankle sprains is the loss of ankle dorsiflexion and as a result of this the talar dome cannot lock fully into the ankle mortise and this leads to a loss of bony stability during locomotion.

In a prospective, randomised, controlled clinical trial by Pope *et al.* (1998), an investigation was conducted into the effects of ankle dorsiflexion range and pre-exercise calf muscle stretching on relative risk of selected lower limb injuries in army recruits. Pope *et al.* (1998) concluded that restricted ankle dorsiflexion range confers an increased risk of lower limb injuries, especially ankle sprains.

#### **2.2.2.2 The Subtalar Joint**

The axis of motion in the subtalar joint passes from the medial dorsal axis of the navicular to the lateral plantar aspect of the calcaneus. The principle motion in the subtalar joint consists of eversion and inversion of the calcaneus. (Mann 1991 1: 386.)

The compensatory movement that occurs in the ankle and subtalar joint is compared to that of a universal joint due to the fact that the degree of

inclination of the subtalar joint axis and that of the ankle joint axis are intimately related. Failure of this compensatory mechanism can lead to increased stress in the adjacent joints. Increased external rotation of the ankle joint (toe-out) results in an increase in the range of subtalar joint motion whilst the range of ankle joint motion is decreased. This is due to the fact that the subtalar joint is more perpendicular to the plane of progression, whilst the ankle is less perpendicular to the plane of progression. Conversely little or no external rotation of the ankle joint (toe-in) results in a decrease in the range of motion of the subtalar joint and an increase in the range of ankle joint motion. This occurs because the subtalar joint is less perpendicular to the plane of progression and the ankle joint is more perpendicular to the plane of progression. This is why the individual who has a stiff ankle joint walks with the foot in external rotation, so that the subtalar joint can carry the majority of the rotation. (Mann 1991 1: 386-388.)

### **2.3 INCIDENCE AND PREVALENCE**

Eighty-five percent of ankle injuries are ankle sprains (Garrick 1977). The ankle sprain is probably the single most common injury in sport and comprises up to ten percent of sports related injuries (Garrick and Requa 1988). At least ninety-five percent of isolated ankle sprains will involve the lateral ligaments (Reid 1992: 217). It would appear that new epidemiological studies should be performed to update these findings.

According to McBryde (1995: 482) approximately thirty percent of grade I and grade II ankle sprains never receive professional care. McBryde (1995: 482) also states that the majority of these acute ankle sprains not seen by a clinician are recurrent ankle sprains and occur mostly in persons between the ages of ten and thirty-five.

In a 1988 survey by the CSAO (Construction Safety Association of Ontario), it was found that, in industry, the ankle joint was the most common site of trauma involving the lower leg. Of these ankle injuries, soft tissue injury of the lateral ligaments of the ankle was the most commonly diagnosed pathology. (Hall 1991 3: 2467-2468.)

According to Reid (1992: 215), ankle injuries make up as much as twelve percent of the load in emergency rooms and about fourteen percent of all sports related problems, with an injury rate of six per one hundred participants over a single season.

## **2.4 THE MECHANICAL HYPOTHESIS**

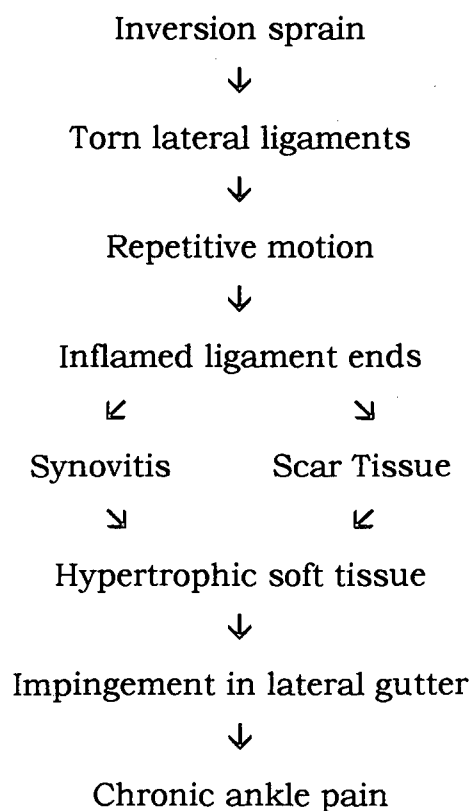
### **2.4.1 Historical Background**

According to Keating et al. (1992), manipulative foot and ankle care dates as far back as the time of Hippocrates. Keating et al. (1992) maintain that manipulative foot and ankle care was used by bone-setters of the 17<sup>th</sup>

century, and that it is also mentioned in early chiropractic and osteopathic literature. Keating et al. (1992) state that renewed interest in manipulative care of the extremities, including the foot, has become more apparent in recent times.

#### **2.4.2 Causes of Joint Aberrant Motion and Pain**

Jaivin and Ferkel (1994: 989) have proposed a possible sequence in the progression of chronic lateral ankle pain, which is described in the following flow chart:



Arthroscopy, which is often useful in the diagnosis and the management of chronic ankle sprain pain, may reveal synovitis and fibrosis of the lateral gutter combined with chondromalacia of the talus and fibula. Arthroscopy sometimes reveals the formation of a thick band (adhesion) along the lateral talomalleolar joint, which may contain torn ligament and capsule fibres as well as synovial tissue debris. (Jaivin and Ferkel 1994: 989.)

#### **2.4.3 Clinical Features of Joint Dysfunction**

The diagnosis of joint dysfunction is primarily based on the presenting symptoms and physical findings. These clinical features include:

- Local pain: commonly changes with activity.
- Local tissue hypersensitivity.
- Altered alignment.
- Decreased, increased, or aberrant joint movement.
- Altered joint play.
- Altered end-feel resistance.
- Local palpatory muscle rigidity.

(Peterson 1993: 131.)

#### 2.4.4 Theorised Effect of Adjusting a Joint

In a randomised controlled clinical trial by Nield et al. (1993), involving a single talocrural manipulation of high velocity and low amplitude in a group of twenty asymptomatic subjects, it was found that there was no statistically significant change in ankle dorsiflexion range in both the experimental and control groups. Nield et al. (1993) did however, suggest that a similar trial should be performed in a symptomatic population as symptomatic patients have often reported a “feeling” of reduced stiffness and subjective improvement in functional abilities, such as walking up stairs, following manipulation of the ankle joint. It should be noted that the study did not investigate the effect of joint manipulation over a series of treatments conducted over a specified period of time.

According to Peterson (1993: 123) joint manipulative procedures are described as physical manoeuvres designed to induce joint motion through either thrust techniques or non-thrust techniques (mobilisation). Peterson (1993: 123) also believes that these procedures are intended to treat disorders of the musculoskeletal system by improving joint alignment, range of motion, and quality of movement. In addition to this Peterson (1993: 125) states that the common application of manual joint manipulative procedures are used in the treatment of suspected joint hypomobility. When treating joint hypomobility the adjustive thrust or

mobilisation is typically delivered in the direction of established joint restriction, thus to induce joint movement Peterson (1993: 125).

According to Peterson (1993: 130), conditions causing altered structure and/or altered function in the somatic structures of the body are most often the disorders associated with the application of manual and adjustive therapy (Peterson 1993: 130).

Peterson (1993: 140-142) has proposed that as a result of significant joint injury, subsequent fibrosis, scar and adhesion formation of the intra-capsular and extra-capsular soft tissues may occur. This may result in joint degeneration, hypomobility, loss of normal joint function, and chronic pain.

#### **2.4.4.1 Cavitation and the Effect of the High Velocity, Low Amplitude Thrust.**

Peterson (1993: 144) suggests that adjustive therapy is a procedure that may induce quick distraction and break intra-articular adhesions.

Edmond (1993: 4) maintains that manipulative techniques that are administered with greater speed are more effective at breaking adhesions.

Edmond (1993: 2) suggests that joint manipulation promotes optimal, pain-free movement by preserving joint and surrounding soft tissue

flexibility or by increasing extensibility of the joint in the presence of periarticular and joint capsule restrictions.

Peterson (1993: 139) suggests that early intervention for soft tissue injury by means of manual therapy will promote better healing, decrease pain and inflammation, prevent further injury and promote flexibility.

Bergmann (1993: 707-708) indicates that adjusting the ankle joint may be effective for the treatment of palpable pain over the lateral collateral ligaments, pain over the anterior region of the lateral malleolus and for inversion ankle sprain.

Peterson (1993: 140) speculates that the physical mechanism by which adjustments have a mechanical effect on joint pain and immobility is by inducing rapid separation of joint surfaces. This separation typically occurs at the end range of passive joint motion when a quick thrust overcomes the remaining joint fluid tension. The quick separation is believed to produce a cavity within the joint, the initiation of joint cavitation, and an associated "cracking" sound. (Peterson 1993: 140.)

#### **2.4.4.2 Adjusting the Joint in the Presence of Supporting Ligamentous Instability**

Peterson (1993: 150) believes that manipulative therapy may play a role in the management of conditions where clinical joint instability is present

and not merely in mechanical disorders with associated joint hypomobility.

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. This chiropractic technique involves setting the ankle up in dorsiflexion and eversion before the thrust is applied. (Kirk et al. 1991: 155.)

The chiropractic profession emphasises specific short-lever procedures, speculating that these would be more precise in correcting local joint dysfunction without inducing stress or possible injury to adjacent joints. This may play a significant role in circumstances with adjacent joint instability. (Peterson 1993: 127.)

#### **2.4.4.3 Joint Anatomy and Arthrokinematics**

Peterson (1993: 129) states that for chiropractic care to be successful, it is crucial that the practitioner should understand the pathomechanics and pathophysiology of the condition being treated.

When performing adjustive techniques to spinal or extremity joints it is very important that the clinician is aware of the joint structure, articular surface orientations, and the arthrokinematics of the joint to which the

adjustment is being applied. When joint dysfunction is identified, the clinician should induce joint separation without producing joint compression, injury, or distraction at undesired segmental levels.

Adjustive techniques are usually directed at generating joint distraction either along the joint plane or perpendicular to the joint plane.

Adjustments cannot be efficiently accomplished without an understanding of joint configuration or movement. (Peterson 1993: 157.)

#### **2.4.4.4 Conclusion**

Adjustment techniques that are properly applied are usually painless.

Minor discomfort may however be experienced by the patient, who has experienced chronic dysfunction with a certain degree of periarticular soft tissue contracture. (Peterson 1993: 126.)

## **2.5 MECHANISMS OF INJURY**

In a prospective standardised evaluation of 547 ankle sprains by Fallat et al. (1998), 390 (71.3%) were diagnosed as being grade I sprains and 52 (9.5%) were diagnosed as grade II sprains.

According to McBryde (1995: 484), up to eighty-five percent of acute ankle sprains result from extreme plantarflexion and inversion with some

internal rotation whilst the remaining fifteen percent are as a result of excessive dorsiflexion combined with eversion.

Reid (1992: 221) lists the following as contributing factors of ankle sprains:

- Previous ankle injury.
- Low profile boots.
- Narrow, long, cleats.
- Generalised ligamentous laxity.
- Varus heel.
- Weak peronei muscles.
- Tight achilles tendon.
- Tarsal coalition.

Hamilton (1982) includes fatigue as a cause of ankle sprains, especially if a dancer or athlete is attempting new manoeuvres and techniques.

## **2.6 PATHOMECHANICS OF ANKLE SPRAINS**

When the foot is at zero degrees of dorsiflexion the anterior talofibular ligament is loose and the calcaneofibular ligament is tight. During plantarflexion the anterior talofibular ligament tightens and the orientation of its fibres become parallel with the axis of the leg. Since most lateral ankle injuries occur with the foot in a plantarflexed and inverted

position the anterior talofibular ligament is usually the first ligament injured. (Singer et al. 1995 1: 423.) The significance of this is that this ligament blends imperceptibly with the anterior joint capsule (Jaivin and Ferkel 1994: 982). A rupture in this ligament may produce a tear in the joint capsule with associated haemarthrosis of the joint (Boruta et al. 1990).

According to Baker and Todd (1995), isolated tears of the calcaneofibular ligament are rare, but may occur when the ankle is fully dorsiflexed and forcefully inverted. The posterior talofibular ligament is rarely injured, but when it is, it is usually as a result of a strong rotational component as the talus is drawn through the mortise. The posterior talofibular ligament is not thought to play a significant role in providing lateral stability to the ankle. (Singer et al. 1995 1: 424.)

## **2.7 PROPRIOCEPTION**

In a study by Takebayashi et al. (1997), the lateral ligament mechanosensitive afferent units in cats were studied with reference to the causes of lateral instability in the lateral ligaments of the ankle. The conclusions drawn from the study by Takebayashi et al. (1997) indicated that there are both proprioceptors and nociceptors in the lateral ligament of the cat ankle, and confirmed that afferent fibres from the lateral ligament may contribute to the stability of the joint by regulation of

position and movement. Although one cannot extrapolate from animal studies these results suggest that comparable studies on human subjects may yield similar results.

In a controlled clinical trial by Jerosch and Bischof (1996), it was concluded that a proprioceptive deficit after inversion ankle injuries is frequently evident and may be considered as one of the reasons for the resulting functional instability associated with inversion ankle injuries. This study may offer some support for the loss of proprioception associated with inversion ankle sprains.

A prospective, randomised controlled study was conducted by Boyle and Negus (1998), which investigated joint position sense in the recurrently sprained ankle. Boyle and Negus (1998), found that significant differences were recorded in patients with recurrently sprained ankles, as compared to controls, with respect to demonstrating greater errors in passive ankle joint position sense.

### **2.7.1 Chronic Ankle Instability**

Giving way is the most common symptom of an unstable chronic lateral ankle ligament tear. This type of instability is characterised by either a relatively frequent (every 2-3 months) severe sprain, or minor episodes caused by minimal mis-steps occurring daily or more often. Examination

and radiographs are merely confirmatory. Anterior drawer and talar tilt tests can be felt on examination. Anterior drawer of four millimetres or more, or, talar tilt of five degrees greater than the opposite side is considered to be significant. Occasionally, on careful palpation, with the ankle inverted, the lateral portion of the talar dome slides forward as a result of anterior-lateral rotatory instability. Stress X-rays may prove to be negative. If combined with patient complaints of giving way, this finding is believed by some to be sufficient to call for surgical intervention. (Coker 1991 3: 2433.)

In a prospective controlled study by Birmingham et al. (1997) involving patients with a history of recurrent inversion ankle sprains, the results suggested that functional instability could exist in the absence of mechanical lateral instability.

## **2.8 NATURAL HISTORY OF ANKLE SPRAINS**

According to Reid (1992: 226) grade I ankle sprains usually recover over a period of eight days (range two to ten days) and grade II ankle sprains usually recover over a period of twenty days (range ten to thirty days).

## **2.9 LIGAMENT HEALING**

The healing process in ligaments is customarily divided into three phases: the substrate phase, the proliferative phase, and the remodelling phase.

These phases, as discussed by Stanish et al. (1995 :364), occur as follows:

### **Phase I**

The substrate phase occurs within the first four days following trauma. This phase involves a vascular response, haemostasis, and a cellular response. The cells which aggregate at the wound site include polymorphonuclear leukocytes, lymphocytes, macrophages, mast cells, and fibroblasts. Neovascularisation occurs at the periphery of the wound site toward the end of this phase.

### **Phase II**

The proliferative phase begins approximately four days after the initial trauma and continues for two to three weeks. It is during this phase that fibroblastic proliferation is the predominant cellular activity at the wound site. The cellular proliferation results in the formation of collagen which aids in the rapid gain of wound strength.

### Phase III

The remodelling phase continues for an indistinct period of time. Fibroblasts and collagen formation peaks early in this phase and then begins a gradual decline. Collagen scar tissue undergoes remodelling as the fibres become oriented parallel to the direction of tension on the newly formed scar. Wound strength continues to increase and collagen turnover and maturation begins to take place as the type III collagen (healing collagen) is transformed into type I collagen of normal tissue. The continuation of this phase is thought to be essentially as a result of mechanical forces stimulating the wound. It is universally accepted that phase III is of an indefinite period and that the repaired tissue never regains its original architecture or strength.

Stanish et al. (1995: 368-369) summarise the ligament healing process as follows:

- Ligament healing follows the three fundamental phases of soft tissue healing. The strength of the wound is determined proportionately to the amount of collagen laid at the wound site. Progressive stress loading is an important stimulus of healing.
- Long-term studies have shown that both surgical and non-surgical ligament repair show an equal success rate.

- Early mobilisation is considered to be a critical step in accomplishing optimum results as long as it does not interfere with the early phases of healing. Studies have shown that remobilisation shows maximum benefits between six and twelve months post-injury.
- In experimental animal models, the regained maximum mechanical strength, does not exceed more than seventy percent of normal ligament strength at a forty-eight week follow-up.
- Human ligament healing follows a similar pattern of healing to experimental animal models except at a slower rate.

## **2.10 DIAGNOSIS AND GRADING OF ANKLE SPRAINS**

When examining the patient careful attention should be paid to the extent of the injury to the lateral ankle area. Palpation of the fibula, malleoli, ligaments, and bony processes should be performed. (Bouche *et al.* 1994:244.) Range of motion of the ankle should be tested and should be compared to the uninjured ankle. Both the dorsal pedal pulse and the posterior tibial pulse should be assessed. (Arnhein and Prentice 1993:490.) Testing of individual lateral ankle ligaments includes the anterior drawer test, which is used to test the anterior talofibular ligament, and the talar tilt test, which is used to determine whether the calcaneofibular ligament is injured (Magee 1992: 479-482). Other foot and ankle orthopaedic tests, such as Tinel's sign and Thomson's test, should be performed to assess the patient for any other possible injuries (Magee

1992:479-482). If swelling is found beneath the extensor tendons, anterior to the lateral malleolus, and on either side of the achilles tendon, it should be noted. Differing degrees of bruising may also occur. (Cailliet 1968:117-119.) X-rays should also be performed to rule out any suspected fractures associated with the ankle sprain.

#### **2.10.1 Orthopaedic Tests for Ankle Stability:**

In order to detect gross mechanical instability of the ankle the following tests are routinely performed:

##### **2.10.1.1 Anterior Drawer Test of the Ankle**

This test is performed with the patient lying supine. The patient's knee on the involved side is at ninety degrees to decrease tension on the achilles tendon and the foot is relaxed resting on the examination table and plantarflexed at approximately twenty degrees. In the plantarflexed position, the anterior talofibular ligament lies perpendicular to the long axis of the tibia. The examiner stabilises the foot and talus and attempts to push the distal tibia and fibula posteriorly on the talus. Stress on the anterior talofibular ligament can be augmented by also inverting the foot. Excessive posterior movement of the tibia and fibula indicates a positive test. (Magee 1992: 480-481.)

### **2.10.1.2 Talar Tilt Test**

The talar tilt test is used to detect tears in the calcaneofibular ligament. The patient is instructed to lie supine or side lying with the involved side up. The patient's knee is flexed to ninety degrees so as to relax the gastrocnemius muscle. The examiner positions the involved foot in the anatomic position and stresses the talus by tilting it side to side into adduction (varus) and abduction (valgus). The adduction or varus part of the test stresses the calcaneofibular ligament. The asymptomatic side is tested first for comparison. Pain and/or increased laxity are indicative of a positive test. (Magee 1992: 481.)

### **2.10.1.3 Tests for Syndesmosis Sprains**

The squeeze test is executed by the examiner by compressing the fibula to the tibia above the midpoint of the calf. A positive test is indicated by pain which occurs distally over the area of the interosseous ligament or its supporting structures. (Hopkinson et al. 1990.)

The external rotation test is performed by applying a passive external rotation stress to the involved foot and ankle with the knee held at 90 degrees and the ankle in a neutral position. This test is positive if it produces pain over the area of the syndesmotic ligaments. (Alonso et al. 1998.)

#### **2.10.1.4 Thompson Test for Achilles Tendon Rupture**

The patient is positioned prone with his/her feet hanging over the edge of the examination table. Whilst the patient is relaxed the examiner squeezes the patient's calf muscles. A positive test is indicated by the absence of plantarflexion of the foot and ankle when the muscle is squeezed. This indicates a complete rupture of the achilles tendon. (Magee 1992: 482.)

#### **2.10.2 Grading of Ankle Sprains**

Grade I ankle sprains are characterised by a mild stretch of the anterior talofibular ligament without any instability. The signs and symptoms of grade I ankle sprains include no evidence of haemorrhage, minimal swelling, point tenderness, no varus laxity and a negative anterior drawer sign. Grade II ankle sprains are characterised by a large spectrum of injury. Grade II ankle sprains display mild to moderate instability and may involve either a complete tear of the anterior talofibular ligament or a partial tear of both the anterior talofibular and the calcaneofibular ligaments. The signs and symptoms of grade II ankle sprains include some haemorrhage, localised swelling, decreased definition of the achilles tendon margin, a possible positive anterior drawer sign, and no varus laxity. (Reid 1992: 226.)

## 2.11 CLINICAL CONSIDERATIONS

In a prospective study conducted by Fallat *et al.* (1998), lasting thirty-three months, six-hundred and thirty-nine ankle sprain patients were evaluated. Fallat *et al.* (1998), found that of the 639 patients, 92 (14%) had an associated avulsion or compression fracture of the foot or ankle. In 547 of the remaining patients the following prevalence of anatomical structures in ankle sprains without osseous injury were as follows (Fallat *et al.* 1998):

Structure	Number and Percent of Patients
Anterior talofibular ligament	453 (82.8%)
Calcaneofibular ligament	366 (66.9%)
Posterior talofibular ligament	187 (34.2%)
Deltoid ligament	180 (32.9%)
Ankle joint capsule	173 (31.6%)
Extensor digitorum brevis	111 (20.3%)
Sinus tarsi	88 (20.3%)
Peroneal muscles and tendons	83 (15.2%)
Achilles tendon	67 (12.2%)
Calcaneocuboid ligament	41 (7.5%)
Syndesmosis	31 (5.7%)

Adapted from Fallat *et al.* (1998)

Fallat et al. (1998) concluded that the term ankle sprain should be more aptly named the “ankle sprain syndrome” on account of the many structures (soft tissue and osseous) which may be involved in ankle sprains.

## **2.12 DIFFERENTIAL DIAGNOSES**

Fallat et al. (1998) consider ankle sprains to be a syndrome and therefore they suggest that there are many factors which can contribute to chronic ankle pain. These factors are discussed in more detail under this section.

Bassewitz and Shapiro (1997) suggest that other causes of persistent ankle pain may be as a result of inadequate rehabilitation, post traumatic impingement syndrome, occult osteochondral injury, peroneal tendon damage, syndesmosis, or chronic instability.

### **2.12.1 Eversion/Deltoid Ligament Sprains**

According to Singer et al. (1995 1: 424), deltoid ligament injuries, which result from severe eversion sprains, are uncommon in athletes. Fallat et al. (1998), reported that of 547 evaluated ankle sprains, 19 (3.5%) of the patients sustained eversion ankle sprains. The most common and probable mechanism of injury is when the weight-bearing foot is planted and slightly pronated with a lateral to medial force acting on the fixed foot.

Since a large amount of force is usually required to disrupt the deltoid ligament, such a force may also disrupt the tibiofibular ligaments and the interosseous membrane resulting in distal tibiofibular diastasis. Deltoid ligament injuries may also be accompanied by either a proximal or distal fibula fracture. (Singer et al. 1995 1: 424.)

### **2.12.2 Synovitis**

Synovitis presents most commonly with pain at either the anterolateral and anteromedial tibiotalar joint line or both. The alternating motion of the tibia and talar neck during extreme motion of the ankle joint may contribute to chronic irritation. Pain at the joint line usually increases over a period of weeks or months. This is diagnosed by palpating between the medial malleolus and the anterior tibial tendon or between the lateral malleolus and the extensor digitorum longus tendons. Ankle effusion, visible or palpable, is usually not present in synovitis. Anterolateral pain may be confused with anterior tibiofibular ligament sprains because anterior tibiofibular ligament sprains cause lateral ankle tenderness. By injecting 3 ml of 1% lidocaine into the ankle joint the pain of synovitis should disappear, but pain from a chronic ligament sprain will remain. This usually differentiates these two conditions. (Sammarco 1991 3:2501.)

### **2.12.3 Synovial Impingement**

Synovial impingement occurs in approximately one percent of ankle sprain patients. As a result of anterior joint capsule swelling and irritation, a "little tongue" of synovium is impinged during foot dorsiflexion, which causes pain. (Garrick and Schelkun 1997.) Garrick and Schelkun (1997) assert that the pain of synovial impingement can be reproduced by palpating the anterior ankle region whilst dorsiflexing the foot.

### **2.12.4 Bony Impingement Syndromes**

According to Sammarco (1991 3: 2501), impingement of the os trigonum, an accessory bone at the posterior tip of the talus, occurs in less than eight percent of the population, and is therefore not uncommon.

The posterior border of the tibia presses backward against the posterior talar tuberosity (os trigonum) forcing it against the calcaneus, which can become painful, and may develop into a degenerative arthritis from the repeated trauma. If the osteophyte formation continues and the activity of the patient remains unchanged, the resulting irritation causes pain at the posterior ankle joint. On palpation, tenderness is noted posterolaterally and deep to the peroneal tendons at the joint line. The symptoms may also be confused with peroneal tendinitis at the lateral malleolus, and synovitis of the ankle. The diagnosis may be confirmed with a lateral X-ray of the

ankle, which may reveal the presence of an os trigonum with or without osteophyte formation. (Sammarco 1991 3:2501-2502.)

Sammarco (1991 3:2501) states that the anterior tibial joint line and the talar neck osteophyte formation, which may be seen on X-rays during the 3<sup>rd</sup> and 4<sup>th</sup> decades of life, may restrict ankle dorsiflexion range of motion.

#### **2.12.5 Ankle Fractures and Dislocations often Associated with Ankle Sprains**

In the study performed by Fallat et al. (1998), which is mentioned earlier, of the 639 patients presenting with ankle sprains, 96 (15%) of the patients had incurred fractures of the foot and ankle. The most common type of fracture found in the study by Fallat et al. (1998) was that of the fifth metatarsal base, which amounted to 24 (3.8%) of all cases in the study.

Injuries to the ankle may be complex since the ankle joint is composed of three bones and two joints. There are primarily three major types of bony trauma: the ankle fracture, the pilon fracture, and the talar body fracture. Ankle fractures essentially involve the medial, lateral, or posterior malleoli (also known as Volkmann's triangle). Occasionally, a higher fibular fracture, in association with a deltoid medial malleolus fracture, is still considered to be an ankle fracture. These fractures are however, usually

as a result of severe trauma and high-energy forces and are rarely a result of ankle sprains. (Schon and Ouzounian 1991 2: 1424.)

#### **2.12.5.1 Avulsion of the Tip of the Fibula**

A tear to the anterior talofibular ligament can result in avulsion of a bone fragment from the anterolateral aspect of the fibula. Larger fragments (4-6 mm) can be avulsed from the inferior tip of the lateral malleolus where the calcaneofibular ligament attaches. (McBryde 1995: 485.)

#### **2.12.5.2 Osteochondral Fractures of the Talar Dome**

Garrick and Schelkun (1997) agree that cartilage and subchondral bone of the talar dome may result from ankle sprain and that these fractures do not always appear initially on radiographs. Garrick and Schelkun (1997) also state that these patients often report episodes of brief, spontaneous, stabbing-type pain whilst performing rehabilitation tasks, and that these type of fractures are best detected on radio isotope bone scan or MRI.

It is a current belief that osteochondral fractures, talar dome fractures, transchondral fractures, and osteochondritis dissecans are the same lesions. Even though a specific history of trauma cannot always be found, the cause is probably related to a single traumatic event or multiple repetitive microtraumatic events. The role of ischaemic necrosis,

congenital factors, and aberrant vascular patterns still remains controversial. These lesions are also thought to be caused by inversion mechanisms. When chronic, the condition may manifest as arthritic-type symptoms, or of recurrent ankle instability. A displaced fragment results in the formation of a loose body causing more mechanical symptoms. Lateral fractures tend to be smaller, with less subchondral bone involvement, while medial fractures tend to be larger involving more subchondral bone. (Schon and Ouzounian 1991 2: 1432.)

According to Reid (1992: 256), the major symptoms of osteochondral lesions include: deep aching or pain, which is increased by activity, ankle swelling, occasional crepitus, clicking, true locking, or a catching sensation. Clinically, the signs include synovial thickening, effusion, infrequent joint line tenderness and reduced range of motion of the joint (Reid 1992: 256). Reid (1992: 256) also states that in most cases the condition is augmented by activity and there is often a past history of ankle inversion sprain or fracture.

#### **2.12.5.3 Fractures of the Talus**

Pankovich (1991 3: 2361), maintains that it should be recognised that articular fractures of the talus are common in ankle injuries.

Talar neck fractures are second most common to avulsion fractures of the neck of the talus. Severe trauma is usually necessary to produce such an

injury to the talus. These fractures usually occur as the result of dorsiflexion of the foot in which the anterior margin of the tibia acts as a wedge on the neck of the talus. Protracted dorsiflexion can cause subtalar dislocation or even cause posterior extrusion of the talus resulting in a rupture of the talocalcaneal and posterior talofibular ligaments. (King and Powell 1991 3: 2294.)

#### **2.12.5.4 Fractures of the Lateral Process of the Talus and Small Tarsal Bones**

Milgram (1991 3: 2852) notes that it is important to be aware that the subtalar joint is susceptible to sprains and may also sustain ligamentous injury and avulsion fractures of the margins of the articular surfaces, which may then result in the production of lateral pedicled osteochondral bodies.

Inversion ankle injuries may result in fissure fractures of the adjacent bones of the foot. These include anterior beak fractures of the calcaneus involving the subtalar joint and the margins of the calcaneocuboid joint, with infraction of the cuboid or avulsion of the margin of the navicular in the region of the tibialis anterior tendon attachment. Traumatic recurrent subluxations of the tarsometatarsal joints have resulted from forced inversion and may not be easy to recognise on X-rays. (Milgram 1991 3: 2852.)

Lateral talar chondromalacia according to Reid (1992: 259), is a syndrome associated with a single or repeated inversion ankle injury, and which often presents as pain over the anteroinferior aspect of the fibula, anterolateral talus, and the joint line.

#### **2.12.5.5 Fractures at the Base of the Fifth Metatarsal**

There are two common types of fractures that occur at the base of the fifth metatarsal. The first is an avulsion fracture of the styloid process of the fifth metatarsal. The second is a Jones fracture, which is a transverse fracture distal to the proximal end of the fifth metatarsal. X-rays are used to rule out these fractures, although repeat X-rays are often necessary. (Garrick and Schelkun 1997.)

Inversion injury of the ankle may result in the peroneus brevis muscle being avulsed at the epiphysis at the base of the fifth metatarsal or by an avulsion fracture in this region if the epiphysis has fused. The peroneus longus tendon may be damaged and calcify near its sesamoid bone opposite to the cuboid. As a result of this, the peroneus longus tendon may rupture, it may progress and result in a stenosing tenosynovitis, it may create a crepitating tenosynovitis behind the malleolus, or the tendon may sublunate from its confining groove. (Milgram 1991 3: 2852-2853.)

## **2.12.6 Distal Tibiofibular Disorders**

### **2.12.6.1 Occult Tibiofibular Diastasis and Syndesmosis Sprains**

Garrick and Schelkun (1997) observe that the diagnosis of a syndesmosis sprain is primarily made from the mechanism of injury, which differs from the mechanism of inversion injury, in which the ankle is usually dorsiflexed and the area of maximal tenderness is usually higher at the tibiofibular ligament.

Jaivin and Ferkel (1994: 985) estimate that syndesmotic sprains occur in as many as ten percent of all ankle injuries and are frequently observed in collision sports such as soccer, football, and ice hockey.

In a retrospective study conducted at the United States Military Academy, the clinical records and radiographs of one-thousand-three hundred and forty-four ankle sprain patients diagnosed over a forty-one month period were reviewed. From this study it was concluded that sprains with prolonged recovery could be attributed to involvement of the tibiofibular syndesmosis. The review also showed that:

1. Tibiofibular syndesmosis sprain is an injury of clinical significance, which results in prolonged post-injury pain during weight-bearing activities in comparison to other types of ankle sprains.

2. Interosseous calcification could be found (on X-ray) along the tibiofibular syndesmosis several weeks following the injury.
3. The injury does not appear to predispose the patient to recurrent ankle injury.
4. The squeeze test (compression of the fibula to the tibia at midcalf) may be useful in making the diagnosis of tibiofibular syndesmosis sprain at the time of injury.

(Hopkinson et al. 1990.)

Alonso et al. (1998) concluded in an interrater reliability study, involving four different types of orthopaedic tests for ankle syndesmosis injury and assessment of the patient's ability to return to function as a result of such an injury, that the external rotation test showed the best interrater reliability. Alonso et al. (1998) also concluded that the squeeze test showed moderate reliability. The squeeze test and external rotation test are discussed under diagnosis of ankle sprains. (2.10.1.3)

#### **2.12.6.2 Tibiofibular Synostosis**

As a result of interosseous membrane injury, a secondary tibiofibular synostosis may occur. Clinically this condition presents with restricted fibular motion, chronic pain and swelling following activity, limited ankle dorsiflexion, and X-ray findings show a bony mass between the distal tibia and fibula. (Reid 1992: 254-255.)

### **2.12.7 Tarsal Coalition**

Tarsal coalition, also known as peroneal spastic flatfoot, often presents as an incidental finding following foot and ankle trauma. When symptomatic it pathognomically presents with painful limitation of inversion in conjunction with point tenderness deep in the sinus tarsi (just anterior to the lateral malleolus). (Ehrlich and Elmer 1991 1: 925.)

### **2.12.8 Achilles Tendinitis**

Achilles tendinitis usually presents with pain over the posterior heel, calcaneus, and sometimes up the achilles tendon into the calf. Achilles tendinitis may be associated with a posterior calcaneal hyperostosis (Haglund's deformity) and infratendinous or supratendinous bursitis. (Brantingham et al. 1994.)

Fallat et al. (1998), reported that out of 547 patients presenting with ankle sprains, 67 (12.2%) patients were also diagnosed with achilles tendinitis. Fallat et al. (1998) state that this is significant because achilles tendinitis had not yet been documented to be associated with ankle sprains in terms of incidence.

### **2.12.9 Peroneal Tendon Pathology**

According to Jahss (1991 2: 1509), ruptures of the peroneal tendon are rare and most are usually partial ruptures, occur in younger age groups (mean: 33 years), and most frequently involve the peroneus brevis tendon. Jahss (1991 2: 1509) also states that peroneal tendon ruptures are associated with inversion ankle instability and may be a cause of unexplained lateral ankle pain.

#### **2.12.9.1 Subluxing Peroneal Tendon**

A subluxed peroneal tendon is usually a result of an ankle sprain and is less often a result of anatomical variations of its bony groove, or surrounding collagen supportive connective tissue (Reid 1992: 253).

The usual cause and presentation of peroneal tendon injury is considered to be acute, and the initial diagnosis is often missed. Sudden forced supination is a common cause of peroneal tendon injury. On first appearance, a subluxing peroneal tendon may be misdiagnosed as a sprained ankle and neglected. (Schon and Ouzounian 1991 2: 1442.)

### **2.12.9.2 Peroneal Tendinitis**

According to Reid (1992: 210), tendinitis of both the peroneus longus and brevis tendons may occur after repeated inversion ankle sprains resulting in chronic painful tendinitis.

Fallat et al. (1998) report, in the previously mentioned study, that out of the 547 patients diagnosed with ankle sprains, 83 (15.2%) of the patients had symptoms of peroneal tendinitis. This is significant because incidence of peroneal involvement with ankle sprains had never been documented before (Fallat et al. 1998).

### **2.12.9.3 Stenosing Peroneal Tenosynovitis**

A rare cause of functional lateral ankle instability is stenosing peroneal tenosynovitis where the main symptom is lateral ankle pain, which is aggravated by exercise and relieved by rest. Other clinical features of this condition include peroneal sheath tenderness, which is made worse with passive and active ankle motion, occasional crepitus, which can be detected by the examiner, chronic diffuse complaints about the lateral malleolar area and sometimes there is an associated functional instability. Inversion ankle injuries, ankle fractures, and overuse syndromes are associated with stenosing peroneal tenosynovitis. Peroneal tenography may be useful in confirming the diagnosis. (Reid 1992: 254.)

### **2.12.10 Extensor Digitorum Brevis Strain**

According to Fallat et al. (1998), extensor digitorum brevis strain, which was formerly unreported with ankle sprains, showed an incidence of 111 out of 547 patients (20.3%) presenting with ankle sprains.

### **2.12.11 Cuboid Syndrome**

Cuboid syndrome is an uncommon syndrome. It can occur following an inversion ankle sprain, sudden forced dorsiflexion, or as a result of over-training on uneven terrain. The main symptom is pain, which is found along the course of the peroneus longus tendon. The pain is usually aggravated by walking. Palpatory tenderness can be elicited over the peroneal groove on the plantar surface of the calcaneus. This condition may be associated with peroneal tendinitis. (Reid 1992: 174-175.)

### **2.12.12 Nerve Injuries Associated with Ankle Sprains**

According to Fallat et al. (1998), neuritis resulting from ankle sprains is often under reported. In the study by Fallat et al. (1998) an incidence of 12.5% of patients sustaining ankle sprains with some form of neuritis was found. Fallat et al. (1998) also reported that in most cases the symptoms resolved within a week of injury but occasionally the symptoms continued

for several months and in some cases the neuritis was the last constituent of the ankle sprain to abate.

Superficial peroneal nerve entrapment occurs where the nerve or its branches pass through the lateral peroneal fascial compartment. This syndrome might develop as a result of ankle sprains or secondary to external compression from poor fitting footgear. A chronic lateral compartment syndrome, which is sometimes seen in athletes, may also induce superficial peroneal nerve symptoms such as pain and dysesthesias or hyposthesias over the dorsum of the foot or lateral toes. (Schon and Ouzounian 1991 2: 1453.)

The peroneal nerve moves five to eight millimetres during full inversion and when inversion is forced the nerve is tractioned and compressed between the adjacent bone and the peroneus longus muscle. This effect is enhanced with additional plantarflexion of the foot. Seventeen percent of grade II ankle sprains may have associated peroneal nerve injury. The nerve damage, which may be as a direct result from mild traction or haematoma formation, may prolong rehabilitation, contribute to functional instability and may cause peroneal muscle weakness. (Reid 1992: 253.)

Fibular tunnel syndrome, which is usually as a result of a direct blow to the lateral side of the ankle, is a peroneal entrapment neuropathy which

may cause late onset muscle paralysis, but this paralysis is usually preceded by intense neuritic pain (Reid 1992: 253).

Tarsal tunnel syndrome is caused by compression of the posterior tibial nerve or its branches (the medial plantar nerve, the lateral plantar nerve, and the calcaneal branches) within a portion of the fibro-osseous tunnel posterior or distal to the medial malleolus. Initially patients may complain of diffuse and poorly localised pain. In the later stages of the syndrome, the presenting symptoms are dysesthesias and/or hyposthesias along the course of the posterior tibial nerve or one of its branches. The associated pain is infrequently referred up the leg. The pain is characteristically experienced during daytime activities such as walking. A clinical diagnosis is made when palpatory pressure over the area of the nerve entrapment reproduces the patient's pain and a positive Tinel's sign can be elicited. The diagnosis can be confirmed by use of electrodiagnostic testing. Dermatomal tests may reveal decreased sensation over the area of nerve distribution but it is usually intact. Weakness of the plantar muscles is rare. (Schon and Ouzounian 1991 2: 1452-1453.)

### **2.12.13 Sinus Tarsi Syndrome**

Sinus tarsi syndrome is a rare syndrome that usually occurs as a result of the talocalcaneal ligament being sprained after an inversion foot injury. The syndrome is sometimes found in patients with a history of multiple

ankle sprains. Clinical features often include pain and tenderness over the lateral aspect of the sinus tarsi, a feeling of giving way and increased symptoms with inversion forces to the foot. The symptoms are temporarily relieved by a local anesthetic injection into the sinus tarsi. (Singer *et al.* 1995 1: 4437-438.)

### **2.13 COMPLICATIONS**

Traditional conservative therapy for soft tissue trauma to the ankle often consists primarily of passive pain-relieving modalities or external support to reduce oedema. Often muscle reconditioning and the re-establishment of proprioception are abandoned. Thus, over time, an isolated ligament injury may progress into generalised joint stiffness and weakness of the adjacent muscles. (Hall 1991 3: 2467.)

In an epidemiological survey on ankle sprains in athletes by Yeung *et al.* (1994), it was found that as many as seventy-three percent of all the athletes in the survey had suffered recurrent ankle sprains. Fifty-nine percent of these athletes had significant residual symptoms such as pain, a feeling of instability, crepitus, weakness, and stiffness. The study also showed that pain around the ankle was the main complaint. (Yeung *et al.* 1994.)

Most of the continuing symptoms following a sprained ankle such as pain, a feeling of instability, crepitus, weakness, and stiffness are believed to be directly related to untreated ligament damage. Incomplete or absent rehabilitation may be a cause of these continuing symptoms. The main causes of these symptoms are functional instability, joint stiffness due to loss of joint motion, scar tissue, and incomplete rehabilitation. (Reid 1992: 250.)

According to Garrick and Schelkun (1997), chronic ankle problems are generally due to inadequate rehabilitation which results in weakness, chronic swelling, loss of full range of motion, and clinical and functional instability which can lead to recurrent ankle sprains.

Uncomplicated (grade I) inversion ankle sprains often resolve with little or no intervention. Many patients will, however, remain chronically symptomatic in terms of, or a combination of, pain, swelling, crepitus, decreased range of motion or functional instability. It can therefore be suggested that without an early accurate diagnosis and relatively early intervention of the injury, complications such as chronic functional instability, synovitis, tendinitis, weakness and stiffness of the involved joint may arise. (Baker and Todd. 1995.) It has also been suggested that inadequate early treatment may result in joint dysfunction (Bouche et al. 1994: 245).

Peterson (1993: 140-142) has proposed that as a result of significant joint injury, subsequent fibrosis, scar and adhesion formation of the intra-capsular and extra-capsular soft tissues may occur. This may result in joint degeneration, hypomobility, loss of normal joint function, and chronic pain (Peterson 1993: 140-142).

#### **2.14 THE PLACEBO RESPONSE**

The placebo response is defined by Basmajian (1993:2) as “a response in a conscious patient to the treatment of a symptom or sign (or possibly a disease and/or condition) where the administrator of the treatment has no scientific basis in demonstrated fact that the treatment has a specific effect on the target, sign, symptom, disease or condition.” From this, Basmajian (1993:2) also states, “the definition of a placebo can be derived as the substance or procedure received by the patient for the purpose of treatment which will bring about a placebo response, whether it is planned as deliberate deception, suggestion, or in good faith without scientific proof of efficacy in advance.” Basmajian (1993:3) also maintains that there is no doubt that a manual therapy setting, the equipment, and a highly competent therapist handling the equipment will have a powerful influence on the patient. Basmajian (1993:3) also states that if the therapist is knowledgeable about the specific intervention he or she is using and shows confidence and most importantly comes into close

contact with the patient, almost any type of intervention will have a thirty to fifty percent success rate.

In a randomised clinical trial by Koes et al. (1992), which compared the effectiveness of manual therapy, physiotherapy, and treatment by a general practitioner for nonspecific back and neck complaints, it was found that there was no difference between physiotherapy and manual therapy and that physiotherapy and manual therapy were better than continued treatment by the general practitioner in terms of severity of symptoms. Koes et al. (1992) also found that patients responded remarkably well to placebo treatment (10 minutes of detuned short-wave diathermy and ten minutes of detuned ultrasound) and also concluded that a substantial part of manual therapy and physical therapy appeared to be due to nonspecific (placebo) effects. Manual therapy consisted of mobilisation and manipulative techniques and physiotherapy consisted of massage, exercise, electrotherapy and heat therapy (Koes et al. 1992).

In a double-blind randomised clinical trial investigating the efficacy of low-level laser therapy in acute lateral ankle sprains, de Bie et al. (1998) concluded that both high-dose and low-dose laser therapy was not an effective treatment of lateral ankle sprains. de Bie et al. (1998) compared low-dose and high-dose laser therapy to placebo laser therapy and found that placebo was superior to both of the treatment groups.

## **2.15 INDICATIONS AND CONTRAINDICATIONS**

### **2.15.1 Indications for Thrust Manipulation**

Hertling and Kessler (1996: 122) suggest the following indications for thrust manipulation in the extremity joints:

- Replacement of a joint subluxation.
- Replacement of a joint dislocation.
- Reduction of internal joint derangement (e.g., torn knee meniscus or loose body blocking joint movement).
- Stretching or breaking down of periarticular adhesions and to increase joint mobility.

### **2.15.2 Contraindications to Adjusting Joints**

Since no specific study or literature could be found on contraindications to adjustive therapy of the extremities, one could assume that the same contraindications to specific joint mobilisation could apply to specific adjustive therapy of a joint.

### **2.15.2.1 Absolute Contraindications**

Hertling and Kessler (1996: 120) list the following absolute contraindications to specific joint mobilisation:

- Any undiagnosed lesion.
- Joint ankylosis.
- The close-packed position. Close-packed positions produce too much compression force on the articular surfaces.
- Malignancy.
- Active inflammatory and infective arthritis.

### **2.15.2.2 Relative Contraindications**

Hertling and Kessler (1996: 120-121) list the following relative contraindications to specific joint mobilisation:

- Joint effusion from trauma or disease.
- Arthrosis (e.g., degenerative joint disease) if acute, or if in the presence of a bony block.
- Rheumatoid arthritis.
- Metabolic bone disease, such as osteoporosis, Paget's disease, and tuberculosis.
- Internal derangement.

- General debilitation (e.g., influenza, chronic disease).
- Hypermobility. Patients with hypermobility may benefit from gentle joint-play techniques if kept within the limits of motion. Patients with potential necrosis of the ligaments or capsule should not be mobilised.
- Joints that have yet to ossify. The epithelium is very sensitive in babies owing to the rich blood supply. In children under 18 to 24 months of age, it is advised to work with mobility via muscle elongation and movement.
- Total joint replacements. The mechanism of the replacement is self-limiting, and therefore mobilisations may be inappropriate.

Brantingham (1998) lists some contraindications to adjusting the ankle joint, such as advanced degenerative joint disease, acute fractures, neuropathy, metastatic disease, and septic arthritis.

## **2.16 TREATMENT PROTOCOLS FOR ANKLE SPRAINS**

According to Mack (1982), the main goal when treating ankle sprains is to achieve static and dynamic stability, gain normal ankle range of motion, and to achieve optimal strength of peroneal muscles, dorsiflexors, plantarflexors and inverters of the ankle.

### **2.16.1 Gait Training**

If the patient is unable to perform activities with a normal gait, then the patient should begin walking until able to do so without limping. The patient should then be encouraged to begin jogging, gradually increasing jogging speed and stride until he/she can run. The patient is advised to run straight without sudden stops or starts until he/she has reached his/her maximal controlled speed. (Coker 1991 3: 2418.)

Thomson et al. (1991: 44), believe that incorrect toeing off is a common fault and the patient should be re-educated to plantarflex and push off with the big toe during forward propulsion in normal gait.

### **2.16.2 Proprioceptive Exercises**

In a prospective randomised study by Wester et al. (1996) it was concluded that patients with functional ankle instability, as a result of ankle sprains, showed significant improvement as compared to controls, when they received rehabilitation with wobble boards.

### **2.16.3 Strengthening Exercises**

Isometric strengthening exercises such as plantarflexion, dorsiflexion, eversion and inversion of the foot against the floor can be performed. Toe-

raises are also considered to be beneficial in developing or restoring strength to the peroneal and posterior tibial muscles. (Coker 1991 3: 2418.)

#### **2.16.4 Stretching Exercises**

Stretching provides both rehabilitative and preventative measures to the injured patient. Heelcord stretching is a common stretch used in ankle sprain rehabilitation. (Coker 1991 3: 2418.)

In a prospective randomised controlled clinical trial, Pope et al. (1998) investigated the effects of ankle dorsiflexion range and pre-exercise calf muscle stretching on relative risk of selected lower limb injuries in army recruits. Pope et al. (1998) concluded that restricted ankle dorsiflexion range confers an increased risk of lower limb injuries, especially ankle sprains.

#### **2.16.5 Ankle Bracing and Taping**

According to Jaivin and Ferkel (1994: 987), ankle taping is commonly used for both the treatment and prevention of ankle injuries.

According to Hertling and Kessler (1996: 423), taping is useful in providing support to the injured ankle as well as providing proprioceptive

feedback to enhance protective reflexes (peroneal muscle contraction) during weight bearing activities that may overstress the ankle ligaments.

Nook (1997) states that adhesive tape is used in all levels of athletic competition and is utilised in the treatment of a wide variety of conditions such as sprains, strains, fractures, dislocations, bursitis, and tendinitis.

The primary functions of taping include:

- Minimise and reduce swelling.
- Relieve pain.
- Protect and support damaged tissue.
- Enhance awareness of the injured area.
- Limit movement.
- Prevent further injury.
- Provide compression.

(Nook 1997.)

The role of adhesive taping forms a large part of the rehabilitative process.

It allows the patient to resume activities that will enable the patient to regain strength, function, and flexibility. (Nook 1997.)

### 2.16.6 Drug Therapy

Chronic pain after an ankle sprain may be as a result of a low-grade inflammatory reaction to the surrounding soft tissue structures of the ankle joint. This inflammatory process may be as a result of abnormal joint mechanics leading to increased mechanical and thermal stimulation of these tissues. (Kessler and Hertling 1996: 42.)

A double-blind, placebo-controlled comparative study involving 60 patients with acute ankle sprains (less than 48 hours post-injury) was performed by Moran (1991). Moran (1991) found that the efficacy and tolerability of a 150 mg/day diclofenac potassium given for 7 days was superior to that of 1.2 g/day ibuprofen which was, in turn, superior to placebo. Moran (1991) concluded that diclofenac potassium is thus effective in the treatment of acute ankle sprains.

Ogilvie-Harris and Gilbert (1995), maintain that non-steroidal anti-inflammatories significantly improve recovery time and symptomatic pain relief, as opposed to placebo, in the treatment of soft tissue injuries of the ankle.

According to Maddalo and Waller (1995 1: 511), non-steroidal anti-inflammatory medication may be helpful by reducing the inflammatory process associated with joint and ligamentous injury.

### **2.16.7 Whirlpool Therapy**

During the recovery phase the use of a whirlpool is often added to the treatment of ankle sprains. This is usually performed four times a day for a period of twenty minutes at each session and may also include contrast baths with alternating hot and cold water. The temperature of these baths is in the range of 106 degrees Fahrenheit and 50 degrees Fahrenheit. The patient starts in the hotter bath for four minutes and then spends two minutes in the cooler bath. This is repeated four times. (Coker 1991 3: 2418.)

### **2.16.8 Ultrasound**

The proper use of ultrasound can speed up recovery in certain conditions such as tenosynovitis. The usual treatment is for five minutes at 1-1,5 W/sq cm. (Coker 1991 3: 2418.)

Reid (1992:41-42) hypothesises that the ultimate therapeutical outcomes of ultrasound therapy are to reduce inflammation, accelerate haematoma absorption, reduce pain and spasm, increase extensibility of scar, and to perform phonophoresis (the movement of a whole molecule, rather than a charged particle through the skin with use of ultrasound radiation pressure).

In a randomised controlled clinical trial by Moodley (1998) involving thirty patients with mechanical neck pain, it was found that ultrasound was effective in treating mechanical neck pain as compared to adjustments in terms of pain relief. It was also concluded that adjustments were more effective in restoring mobility and decreasing pain than ultrasound therapy at a  $p < 0.05$  level of significance (Moodley 1998).

Reid (1992: 239) suggests the use of ultrasound therapy in the management of ankle sprains in the subacute phase (two to five days following the injury).

#### **2.16.9 Friction Massage**

Friction massage is a frequently used manual therapy technique, which is indicated in the treatment of chronic conditions of soft tissues – usually tendons, ligaments or muscles. The purpose of friction massage is to restore or maintain the mobility of the soft tissue structure with respect to adjacent tissues and improve the extensibility of the tissue under normal loading conditions. (Kessler and Hertling 1996: 137.)

Minor anterior talofibular and calcaneofibular ligament sprains are amongst the common injuries treated by means of friction massage once the acute signs and symptoms have resolved (Kessler and Hertling 1996: 137).

### **2.16.10 Laser Treatment**

In a double-blind randomised clinical trial investigating the efficacy of low-level laser therapy in acute lateral ankle sprains, de Bie et al. (1998) concluded that both high-dose and low-dose laser therapy were not an effective treatment of lateral ankle sprains.

### **2.16.11 Mobilisation**

Eiff et al. (1994), conducted a prospective trial to determine whether mobilisation (weight-bearing and a rehabilitation programme two days post-injury) or immobilisation (cast immobilisation for ten days post-injury followed by a weight-bearing and a rehabilitation programme) for first-time mild to moderate ankle sprains would be the more effective treatment. Eiff et al. (1994) found that patients in the early mobilisation group had less pain at three weeks and they also concluded from the study that both immobilisation and mobilisation prevented late residual symptoms (after a one-year follow-up). The early mobilisation patients were, however, more likely to return back to full functioning work sooner (Eiff et al. 1994).

### 2.16.12 Surgery

Kaikkonen et al. (1997) retrospectively evaluated the long-term functional outcome in 100 patients after primary repair of the lateral ligaments of their ankles over a six to eight year period. The results demonstrated that the overall long-term outcome after surgery was acceptable in most of the patients, and approximately twenty-five percent of the patient reported unsatisfactory results (Kaikkonen et al. 1997).

Singer et al. (1995 1: 435) maintain that surgical reconstruction of the lateral ligament has a high and predictable success rate and is usually indicated when all conservative methods of rehabilitation have failed and the patient remains symptomatic with regard to functional instability and pain.

According to Kaikkonen et al. (1997), the characteristics of successful recovery after surgery include restoration of balance, normal ankle dorsiflexion, good muscle strength and endurance, functional stability and coordination. Kaikkonen et al. (1997) also mention that the clinical findings of impaired healing are characterised by joint instability, restricted range of joint motion, swelling and surrounding muscle atrophy.

Coker (1991 3: 2433) believes that most acute complete ankle ligament tears should be treated conservatively. Coker (1991 3: 2433) also feels that

those patients that do poorly clinically and participate in sports participation can be treated by late direct repair of the anterior talofibular and calcaneofibular ligaments, or by substitution for those ligaments with dacron grafts. Coker (1991 3: 2433) believes that surgical reconstruction requires no larger an incision, no more of a surgical procedure, and no longer a rehabilitation process, than if the repair had been performed acutely. If complete acute ankle injuries do well with conservative therapy, one is able to avoid the possibility of post surgical complications of infection and dysesthesia. (Coker 1991 3: 2433).

According to Jaivin and Ferkel (1994: 989), arthroscopy is useful in the diagnosis and treatment of chronic sprain pain and usually involves the debridement of inflamed synovium, loose bodies, adhesions and any osteophytes from the anterolateral gutter. Indications for ankle arthroscopy include unexplained ankle pain, instability, stiffness, haemarthrosis, locking and popping. Indications for therapeutic arthroscopy include articular injury, soft tissue injury, bony impingement, arthrofibrosis, fracture, synovitis, loose bodies, osteophytes, osteochondral defects and arthrodesis. (Jaivin and Ferkel 1994: 981.)

## 2.17 CONCLUSION

This literature review serves to highlight the apparent common occurrence of ankle sprains, the role that conservative treatment fulfills in the management of ankle sprains and the lack of supporting literature with respect to chiropractic treatment of ankle sprains.

Ankle sprains can be managed favourably in a primary care setting (Garrick and Schelkun 1997). Coker (1991 3: 2433) believes that most ankle ligament tears should be treated conservatively. Chronic residual problems may arise as a result of inadequate rehabilitation and joint dysfunction (Bouche et al. 1994: 245).

Adjustments are relatively safe and carry little side effects. Adjustments may influence the healing process in a positive manner.

There are no controlled clinical trials in the treatment of ankle sprains in terms of manipulation or adjusting even though it is a common musculoskeletal disorder. There is little documented information on the management of chronic ankle sprains except for surgery and proprioceptive rehabilitation and these treatments are more specifically aimed at patients presenting with functional and/or mechanical instability.

## **CHAPTER THREE - MATERIALS AND METHODS**

### **3.1 INTRODUCTION**

A detailed description of the study design, interventions used, and the patients selected to participate in the study are discussed in this chapter. The measurements obtained and the statistical procedures used in the analysis of the data are also discussed.

### **3.2 THE STUDY DESIGN**

This pilot study was designed as a prospective, single- blinded, comparative, randomly allocated, controlled clinical trial concerned with the efficacy of adjusting the ankle in the treatment of subacute and chronic grade I and II ankle inversion sprains. An inter-group analysis was performed to determine whether ankle adjusting was a superior treatment to placebo. An intra-group statistical analysis was also done to assess differences within each treatment group.

### **3.3 MEASUREMENTS AND OBSERVATIONS**

#### **3.3.1 Objective Measurements**

All objective measurements were measured and recorded by the researcher (Appendix A). The objective measurements included the evaluation of localised lateral ankle tenderness and ankle dorsiflexion range of motion.

In a study done by Jonson and Gross (1997), it was concluded that the use of measuring ankle dorsiflexion showed high intra-examiner reliability. This was achieved by placing the subject in a prone position with the knee extended. The subject was then instructed to actively dorsiflex the foot whilst the examiner moved the foot passively into dorsiflexion. One arm of the goniometer was aligned with the fifth metatarsal and the other arm aligned with the head of the fibula. (Jonson and Gross 1997.) Ankle dorsiflexion was measured using this method as it is practical, reliable and inexpensive. Zero degrees was taken as that point where the foot was perpendicular to the leg i.e. that point where the ankle was between plantarflexion and dorsiflexion. Ankle dorsiflexion was measured before the first treatment, after the final treatment, and at the one-month follow up consultation. The goniometer used in this study was manufactured by Baseline®, Fabrication Enterprise, Inc., Irvington, New York, U.S.A.

The use of an algometer served as a means of measuring pain threshold over the lateral ligament complex. The use of algometry has been found to be useful in clinical trials as an objective measure in measuring the effects of spinal manipulation on the overlying soft tissue structures in terms of changes in pain thresholds (Vernon *et al.* 1990). The use of the algometer may be clinically useful in the evaluation of soft tissue pathology and the treatment thereof. When comparing contralateral tissues, a difference of more than two kilograms per squared centimetre is considered abnormal. An increased threshold of at least four kilograms per squared centimetre is considered to be a successful treatment. (Fischer 1986.) The most tender point along the anterior talofibular ligament was identified by means of palpation and then marked by a pen. The tip of the algometer was then placed perpendicular to the marked area. The patient was instructed to verbalise when the sensation changed from pressure to pain. The algometer readings were recorded before the first treatment, then at the last treatment, and at the one-month follow-up consultation to evaluate the relative long-term effect of the treatment. The algometer used in this study was a force dial manufactured by Wagner Instruments: P.O. Box 1217, Greenwich, CT 06836, U.S.A.

### **3.3.2 Subjective Measurements**

Subjective findings regarding pain relief were indicated by the patient under the supervision of the researcher. These findings were measured by

use of the McGill Short-form Pain Questionnaire (Melzack 1987) and the Numerical Pain Rating Scale 101 (NRS-101) (Jenson et al. 1986).

(Appendix B and C)

The McGill Short-form Pain Questionnaire was completed on the initial visit, the final treatment visit, and at the one-month follow-up visit. The main component of the McGill Short-form Pain Questionnaire consists of fifteen descriptors which are rated on an intensity scale as 0 = none, 1 = mild, 2 = moderate or 3 = severe. The McGill Short-form Pain Questionnaire has been shown to be sufficiently sensitive to demonstrate differences due to treatment at statistical levels. The questionnaire is designed to assess the quality and intensity of pain and has become one of the most widely used tests for measurement of pain. The McGill Short-form questionnaire was developed to be used where detailed information regarding pain is required quickly, as well as to reduce patient fatigue. (Melzack 1987.) Each description marked by the patient was ranked on an intensity scale. The total score was reflected as a ratio. The maximum possible score was one.

The NRS-101 is also considered to be statistically sensitive and practical to use in clinical trials. It was found that the NRS-101 was simple and practical to administer and score, it could be administered either verbally or in written form, and the scores seemed not to be affected by age.

(Jenson et al. 1986.) The NRS-101 was completed at the initial

consultation, the final treatment and at the one-month follow-up consultation in order to evaluate the relative long-term effect of the treatment. This subjective evaluation was written down by the patient as a number between 0 and 100, where 0 = no pain at all and 100 = as bad as the pain could possibly be. This subjective evaluation is done twice: once to indicate when the pain is at its least and again to indicate when the pain is at its worst. The average of the two values indicates the average pain experienced by the patient and is reflected as a percentage value. (Jenson et al. 1986.) This percentage was used for statistical analysis.

### **3.3.3 Functional Evaluation Scoring Scale for Ankle Injuries**

Kaikkonen et al. (1994) developed a scoring scale that demonstrated excellent reproducibility and could significantly differentiate between healthy controls and symptomatic patients in terms of subjective, objective and functional evaluation of ankle injuries. This scale was completed at the initial consultation, after the final treatment, and at the one-month follow-up consultation (Appendix D).

## **3.4 LOCATION OF THE DATA**

The data in this study consisted of primary and secondary data.

### **3.4.1 The Primary Data**

The primary data were obtained from the algometer readings, the goniometer readings, from the two questionnaires, and the functional evaluation scores. The data were collected before the first treatment, at the final treatment, and at the one-month follow-up consultation.

The objective means of measurement for the study were:

- Pain threshold measured with an algometer.
- Ankle dorsiflexion range of motion measured with a universal goniometer.

The subjective means of measurement for the study were:

- The patient's perception of their pain intensity level (Numerical Pain Rating Scale-101).
- The patient's perception of intensity and quality of their pain, a sensory dimension of their pain (McGill Short-form Pain Questionnaire).

A functional evaluation score, which included both subjective and objective findings, was also included for data collection.

### **3.4.2 The Secondary Data**

The secondary data consisted of the reviewed literature. Information that was considered to be relevant to this particular study was gathered from relevant journal articles, books, and the Internet (Medline).

## **3.5 STUDY DESIGN AND PROTOCOL**

### **3.5.1 Objectives of the Study**

There were three objectives in this study.

The first objective was to determine the efficacy of adjusting the ankle, in comparison to detuned ultrasound, in terms of subjective clinical findings in the treatment of subacute and chronic grade I and II ankle inversion sprains.

The second objective was to determine the efficacy of adjusting the ankle, in comparison to detuned ultrasound, in terms of objective clinical findings in the treatment of subacute and chronic grade I and II ankle inversion sprains.

The third objective was to integrate the above two objectives in order to evaluate the efficacy of adjusting the ankle, in comparison to detuned

ultrasound, in the treatment of subacute and chronic grade I and II ankle inversion sprains.

### **3.5.2. Subjects**

#### **3.5.2.1 Patient Selection**

Patients were selected by consecutive sampling. Advertisements were used to recruit potential patients. These advertisements were distributed by the researcher and posted on notice boards around the Technikon Natal Campus as well as at local sports clubs. The researcher visited local sports clubs and attended local sports tournaments in order to recruit potential patients. Adverts about the research project were also placed in local newspapers, and efforts were made to notify people of the research by word of mouth.

Any patient presenting him-/herself at the Chiropractic Day Clinic complaining of a history of ankle sprains and resulting residual ankle symptoms was considered as a potential candidate for the study. The researcher performed a brief clinical examination, including details of the patient's 'ankle' history, in order to screen the patient so as to determine whether or not the patient was a suitable candidate for the study. A more detailed foot examination and medical history was conducted at a later stage and is discussed under the section entitled: patient examination.

Thirty subjects were needed to complete the proposed trial. In order to accommodate the possibility of non-compliant subjects and/or subject attrition, thirty-six subjects were initially included in the study.

Five of the thirty-six patients were non-compliant to the terms of the study in that they failed to arrive for scheduled appointments. The data obtained from these patients were therefore dismissed from the study. One of the thirty-six patients re-injured his ankle and was excluded from the study.

### **3.5.3 Inclusion and Exclusion Criteria**

- 1) This study was limited to patients who were between the ages of 15 and 50.
- 2) All patients were required to read the patient information sheet (Appendix E) and give their informed consent before any treatment could be administered (Appendix F). Patients who were minors had to receive permission from their parents/guardians in order to participate in this study.
- 3) A patient was to be excluded from the study if he or she reinjured him-/herself during the study.

- 4) There were no delimitations with respect to race or gender, or with respect to other co-existing conditions. In addition no restrictions were placed on the patient's occupation, income bracket, or area of residence.
- 5) This study was limited to patients diagnosed with subacute and chronic grade I and grade II inversion ankle sprains. This diagnosis was made, as mentioned in Chapter Two, according to the criteria set out to determine ankle inversion sprain severity by Reid (1992: 226). The diagnosis of the severity of the ankle sprain was based on the history of the most recent sprain.
- 6) Patients were excluded from this study if they were taking any medication or receiving any mode of treatment for their ankle injury. Patients were instructed not to initiate any other forms of treatment while taking part in this study. For the purposes of this study subacute was defined as more than 48 hours after the initial injury and chronic as more than 5 days after the initial injury (Reid 1992: 239).
- 7) Patients showing signs of gross mechanical ankle instability (grade III ankle sprain) and syndesmosis injury were excluded from this study.

- 8) Patients that demonstrated any contraindications to adjustive therapy, as mentioned under the section entitled patient examination and in Chapter Two, were excluded from the study.
- 9) Radiographs, if deemed necessary, were used to exclude patients with complicating pathology or contraindications to ankle adjustments.

#### **3.5.4 Patient Examination**

The diagnosis was determined from the history (Appendix G) and the foot regional examination (Appendix H). Special note was made if patients had suffered from recurrent ankle sprains and also the types of treatment, if any, that had been received. Once the patients had been assigned to their groups, each patient underwent an initial consultation consisting of a case history, a physical (Appendix I) and a foot regional examination. After a thorough clinical examination had been conducted it was determined, by both the researcher and the clinician on duty, whether or not the patient would be sent for X-rays of the ankle joint. X-rays were to be used in order to confirm any suspected pathology, which may have been a contraindication to adjusting, such as advanced degenerative joint disease, fractures, neuropathy, metastatic disease, and septic arthritis (Brantingham 1998). X-rays would however not be used in the case of pregnant patients. If any suspected pathology could not be confirmed from the clinical examination then the patient was excluded from this study. It

should be noted however that no pregnant patients volunteered for the study.

According to Garrick and Schelkun (1997) X-rays are usually not necessary if the patient does not exhibit tenderness over the posterior distal portion of either the medial or lateral malleolus, and if the patient is able to bear weight immediately following the injury. These prerequisites were initially based on the decision rules for the use of radiography in acute ankle injuries developed by Stiell et al. (1993). (Appendix J)

On the basis of the above rules, none of the patients were sent for X-rays. Three of the patients presented to the Chiropractic Day Clinic with their foot and ankle X-rays, which showed no fractures or other underlying pathology at the time of their respective injuries.

Eligible patients were given a detailed description of the intended treatment procedure and were informed about the chance of receiving a placebo treatment as well as their right to withdraw from the trial at any time (Appendix E). After receiving this information in writing, the patients gave their informed consent to participate in the study.

### **3.5.5 Random Allocation**

The patients were allocated to their respective groups by the examiner choosing one of thirty pieces of paper drawn from an envelope. Fifteen pieces of paper were marked "1" which represented the adjustment or experimental group and the other fifteen pieces of paper were marked "2" which represented the placebo or control group.

### **3.5.6 Interventions**

The patients were treated by the researcher according to their randomly selected intervention group. The patients received treatment until symptom free or up to a maximum of eight treatments over a maximum period of four weeks. A follow-up consultation for reassessment took place one month after the last treatment.

#### **3.5.6.1 Experimental group: Mortise separation adjustment**

The experimental group received the mortise separation adjustment as outlined by Kirk et al. (1991: 155). This adjustment was chosen, as it is less likely to compromise the integrity of the lateral ligament complex of the already injured ankle, and because it is indicated in the treatment of subacute inversion ankle sprains. The reasoning behind this choice is that

the ankle is set up in dorsiflexion and eversion before the thrust is applied. (Kirk et al. 1991: 155.)

The mortise separation is performed with the patient lying supine. The doctor kneels at the foot of the table and grasps either the lateral or medial border of the patient's foot with his/her thumb on the sole of the foot, and his/her fingers on the dorsum of the foot. The doctor's other hand grasps the opposite border of the foot and holds the foot in a similar manner as the other hand. The doctor then dorsiflexes the ankle, internally rotates the patient's entire leg, everts the foot, and finally thrusts away from the patient, with the line of drive parallel to the floor. (Kirk et al. 1991: 155.)

The adjustive contacts are often placed close to the joint being treated, and the thrust is delivered in the limits of anatomic joint integrity. Adjustments are usually associated with an audible articular crack, but the presence or absence of joint cracking should not be the test for determining whether or not an adjustment has been successful. (Peterson 1993: 126-127.)

#### **3.5.6.2 Control group: Placebo**

The control group was given a course of treatments with a detuned ultrasound machine for a period of five minutes per treatment session.

This method of intervention was used so as to eliminate any possible direct mechanical changes to the ankle being treated.

### **3.5.7 Solving the Sub-problems and Hypotheses**

#### **3.5.7.1 Statement of the Problem**

The purpose of this study was to determine the efficacy of adjusting the ankle, in comparison to detuned ultrasound, in terms of subjective and objective clinical findings in the treatment of subacute and chronic grade I and II ankle inversion sprains.

The first sub-problem of this study was to determine the efficacy of adjusting the ankle, in comparison to detuned ultrasound, in terms of subjective clinical findings in the treatment of subacute and chronic grade I and II ankle inversion sprains.

The second sub-problem of this study was to determine the efficacy of adjusting the ankle, in comparison to detuned ultrasound, in terms of objective clinical findings in the treatment of subacute and chronic grade I and II ankle inversion sprains.

The third sub-problem of this study was to integrate the above two sub-problems in order to evaluate the efficacy of adjusting the ankle, in

comparison to detuned ultrasound, in the treatment of subacute and chronic grade I and II ankle inversion sprains.

### **3.5.7.2 The Hypotheses**

#### **The First Hypothesis**

It was hypothesised that adjusting the ankle would be efficacious in the treatment of subacute and chronic grade I and II ankle inversion sprains, in terms of subjective clinical findings.

#### **The Second Hypothesis**

It was hypothesised that adjusting the ankle would be efficacious in the treatment of subacute and chronic grade I and II ankle inversion sprains, in terms of objective clinical findings.

#### **The Third Hypothesis**

It was hypothesised that when integrating the results from the first two hypotheses there would be a statistically significant difference in the subjective and objective clinical findings. This would suggest that adjusting the ankle is efficacious in the treatment of subacute and chronic grade I and II ankle inversion sprains.

### **3.6 STATISTICAL ANALYSIS**

The statistical package SPSS was used for data entry and analysis, supplied by SPSS Incorporated – 1999, Chicago, USA.

#### **3.6.1 Treatment of the Data**

1. The scores from the NRS-101 were represented as a percentage.
2. The McGill Short-form Pain Questionnaire was represented as a ratio.
3. The scores from measuring ankle dorsiflexion range of motion were represented as degrees.
4. The scores from measuring lateral ankle point tenderness with the algometer were measured in kilograms per squared centimetre.
5. The scores obtained by the objective and subjective functional evaluations of the ankle injuries were represented by a score out of 100.
6. Statistical analyses were performed once all the data were collected.

### **3.6.2 Methods of Data Analysis**

The sample size of this group was small (15 per group), non-parametric tests were therefore used in the analysis of the data. These tests included the Mann-Whitney U-test and the Wilcoxon's Signed Rank Test. Power analysis was also utilised to detect the possibility of committing Type II errors (accepting a false null hypothesis) when analysis was performed on the data (Portney and Watkins 1993: 351-352).

#### **3.6.2.1 Procedure One: Comparison between Groups 1 and 2**

The Mann-Whitney U-test was used to compare the two groups to each other. The groups were treated as being independent of one another. Fifteen Mann-Whitney Unpaired Two-tailed Tests were used, at the  $\alpha/2 = 0.025$  level of significance, to compare the two groups at treatment 1, the final treatment, and the one-month follow-up consultation. The purpose of conducting fifteen Mann-Whitney U-tests was to determine whether or not there were any significant differences between the two treatment groups with respect to the McGill Short-form Pain Questionnaire, the Numerical Pain Rating Scale, the goniometer and algometer readings, and the Functional Evaluation scores.

## Hypothesis Testing and the Decision Rule

The null hypothesis ( $H_0$ ) stated that there would not be a significant difference between group 1 and 2 on analysis of the subjective, objective and functional evaluation inter-group data. This hypothesis therefore stated that the two treatments are equally effective.

The alternative hypothesis ( $H_1$ ) stated that a significant difference would be noted between the two groups on analysis of the subjective, objective and functional evaluation inter-group data. This hypothesis therefore stated that the two treatment protocols are not equally effective.

$$H_0 : \mu_1 = \mu_2$$

$H_1 : \mu_1$  and  $\mu_2$  are significantly different from each other

$\alpha = 0.05 =$  the level of significance.

For a two-tailed test:

Reject  $H_0$  if  $p \leq \alpha/2 = 0.025$

Accept  $H_0$  if  $p > \alpha/2 = 0.025$

P was the observed level of significance

### **3.6.2.2 Procedure Two: Comparison between related samples within Group 1**

Fifteen Wilcoxon Signed Rank Tests were used at a 95% level of confidence. These tests were used to determine whether or not there were any statistically significant changes within group 1, between the first treatment and the final treatment, between the first treatment and the one-month follow-up consultation, and between the final treatment and the one-month follow-up with respect to the McGill Short-form Pain Questionnaire, Numerical Pain Rating Scale, the goniometer and algometer readings, and the Functional Evaluation scores.

#### **Hypothesis Testing and the Decision Rule**

The null hypothesis ( $H_0$ ) stated that there would not be a significant improvement between treatment 1 and the final treatment, between treatment 1 and the one-month follow-up, and between the final treatment and the one-month follow-up, on analysis of the subjective, objective and functional evaluation data. This hypothesis therefore stated that the treatment is ineffective.

The alternative hypothesis ( $H_1$ ) stated that significant differences would be noted between the aforementioned treatment intervals on analysis of the subjective and objective data. This hypothesis therefore stated that the treatment protocol would be effective.

$H_0$  : No significant difference was noted

$H_1$  : Significant difference was noted

$\alpha = 0.05$  level of significance

For a two-tailed test:

Reject  $H_0$  if  $p \leq \alpha/2 = 0.025$

Accept  $H_0$  if  $p > \alpha/2 = 0.025$

P was the observed level of significance

### **3.6.2.3 Procedure 3: Comparison between related samples within group 2**

Procedure 2 is repeated within group 2 with the same decision rule.

### **3.6.2.4 Procedure Four: Averages and variances for continuous variables**

Summary statistics included the mean, standard deviation and variance.

These statistics were obtained to support the results obtained from the Mann-Whitney U-test, and the Wilcoxon Signed Rank Test.

The standard deviation is defined by Rosnow and Rosenthal (1996: 415) as "An index of the variability of a set of data around the mean value in a distribution". Rosnow and Rosenthal (1996: 224) state that the standard

deviation is the most widely used and reported of all measures of spread around the mean.

Averages and variances were only computed for continuous variables, and were used for power analysis and the construction of bar charts.

#### **3.6.2.5 Procedure Five: Comparison using Bar Charts**

Bar charts were constructed to present major findings of the study as a visual summary of results obtained from the Mann-Whitney and Wilcoxon's Signed Ranked Tests. Bar charts were constructed using the computer software package named Excel 97.

#### **3.6.2.6 Procedure Six: Power analysis for continuous variables**

Power analysis results of each test are given below the relevant tables.

These results were used in the discussion to determine the power of each test and to detect the chance of a Type II error occurring (accepting a false null hypothesis). It should be noted that the closer the power value is to 1, the smaller the chance of committing a Type II error. (Portney and Watkins 1993: 351-352.) This was performed on the UCLA web site:

[www.stat.ucla.edu/calculators/powercalc/normal](http://www.stat.ucla.edu/calculators/powercalc/normal).

## CHAPTER FOUR - THE RESULTS

### 4.1 INTRODUCTION

This chapter contains the results obtained from the statistical analysis collected from the following:

- McGill Short-form Pain Questionnaire
- Numerical Pain Rating Scale 101
- Goniometer readings
- Algometer readings
- Functional evaluation scores

The tables in this chapter display the mean, standard deviation, variance and P-values as well as the results of the power analyses.

Tables displaying demographic data are also included in this chapter.

Bar charts are also included which serve as a graphical representation of the mean values between the two groups.

#### 4.1.1 Abbreviations:

Group 1: Adjustment Group.

Group 2: Placebo Group.

McGill: McGill Short-form Pain Questionnaire.

NRS-101: Numerical Pain Rating Scale.

GON: Ankle Dorsiflexion Range of Motion in Degrees.

ALG: Algometer Readings in Kg per squared centimetre.

FE: Functional Evaluation Scores.

SD: Standard Deviation.

P-Value: The observed level of significance for a two-tailed test –

Reject  $H_0$  if  $p \leq \alpha/2 = 0.025$

Accept  $H_0$  if  $p > \alpha/2 = 0.025$

**Bold numbers:** Significant findings.

## 4.2 DEMOGRAPHIC DATA

**Table 4.1**

**The age distribution within the sample of 30.**

<b>Age</b>	<b>Group 1</b>	<b>Group 2</b>	<b>Total %</b>
15-24	10	8	60
25-34	5	4	30
35-44	0	2	7
45-50	0	1	3

**Table 4.2**

**The gender distribution within the sample of 30.**

<b>Gender</b>	<b>Group 1</b>	<b>Group 2</b>	<b>Total %</b>
Male	6	13	63
Female	9	2	37

**Table 4.3**

**The race distribution within the sample of 30.**

<b>Race</b>	<b>Group 1</b>	<b>Group 2</b>	<b>Total %</b>
Caucasian	14	12	86.7
Asian	0	2	6.7
Black	1	1	6.7

**Table 4.4**

**Occupations within the sample of 30.**

<b>Occupation</b>	<b>Group 1</b>	<b>Group 2</b>
Student	8	11
Lecturer	1	0
Accountant	1	0
Gym Instructor	1	0
Tour Guide	0	1
Sales Consultant	1	0
Director	1	0
Office Clerk	1	0
Technician	0	1
Jeweller	0	1
Caterer	0	1
Consultant	1	0

**Table 4.5**

**Activity leading to injury in the sample of 30.**

<b>Activity</b>	<b>Group 1</b>	<b>Group 2</b>
Tennis	1	1
Running	0	2
Basketball	0	2
Work Related	2	1
Jet-skiing	0	1
Squash	0	1
Water-skiing	0	1
Rugby	3	3
Skate-boarding	1	1
Volleyball	0	1
Horse riding	1	1
Aerobics	1	0
Karate	2	0
Softball	1	0
Soccer	1	0
Other	2	1

**Table 4.6**

**Grade of ankle sprain encountered in the sample of 30.**

<b>Grade</b>	<b>Group 1</b>	<b>Group 2</b>	<b>Total %</b>
Grade I	6	6	40
Grade II	9	9	60

**Table 4.7**

**Chronicity of sprain encountered within the sample of 30.**

	<b>Group 1</b>	<b>Group 2</b>	<b>Total %</b>
<b>Subacute</b>	1	0	3
<b>Chronic</b>	14	15	97

**Table 4.8**

**Single versus multiple ankle sprains encountered in the sample of 30.**

	<b>Group 1</b>	<b>Group 2</b>	<b>Total %</b>
<b>Single</b>	5	4	30
<b>Recurrent</b>	10	11	70

Table 4.9

Foot alignment encountered within the sample of 30.

Alignment	Group 1	Group 2	Total %
Hyper-pronation	4	7	36.7
Hyper-supination	4	1	16.7
Normal	7	7	46.7

**Table 4.10**

**Modes of treatment encountered within the sample of 30 prior to entering the research project.**

<b>Treatment</b>	<b>Group 1</b>	<b>Group 2</b>
None	1	1
Cryotherapy	7	7
Compression	3	9
Taping	7	3
Bracing	2	3
NSAIDS-Topical	4	9
NSAIDS-Oral	6	8
Arnica-Topical	1	2
Manual Therapy	7	3
Rest	1	2
Ultrasound	1	1
Interferential Current	1	0
Transverse Friction	2	0
Immobilisation	1	1
Crutches	1	2
Ankle Exercises	0	1

**Table 4.11**

**Average number of treatments for each group in the sample of 30.**

	<b>Group 1</b>	<b>Group 2</b>
<b>Average Number of Treatments</b>	<b>6.13</b>	<b>7.8</b>

### 4.3 THE ANALYSED DATA

#### 4.3.1 The Inter-group Analysis using Mann-Whitney U-tests

**Table 4.12**

A comparison of Groups 1 and 2 using the Mann-Whitney U-test to analyse the results collected from the subjective data at treatment 1.

TREATMENT 1							
	Group 1				Group 2		
	MEAN	SD	Varian ce	P- VALUE	MEAN	SD	Varian ce
McGill	.196	.1040	.01083	.418	.2433	.1392	.01937
NRS- 101	28.733 3	16.554 2	273.71 0	.723	30.733 3	12.790 7	163.60 2

POWER	
McGill	0.1725
NRS - 101	0.0634

The null hypothesis is accepted ( $p > 0.025$ ) for the McGill Short-form Pain Questionnaire and the Numerical Pain Rating Scale 101, which indicates that at the  $\alpha = 0.05$  level of significance there was no significant difference between groups 1 and 2 at treatment 1.

**Table 4.13**

**A comparison of Groups 1 and 2 using the Mann-Whitney U-test to analyse the results collected from the subjective data at the final treatment.**

<b>FINAL TREATMENT</b>							
	<b>Group 1</b>				<b>Group 2</b>		
	<b>MEAN</b>	<b>SD</b>	<b>Varian ce</b>	<b>P- VALUE</b>	<b>MEAN</b>	<b>SD</b>	<b>Varian ce</b>
McGill	.05667	.09817	.00963 8	<b>.005</b>	.713	.1627	.02646
NRS- 101	13.833 3	15.864 0	251.66 7	.133	21.266 7	19.303 8	372.63 8

<b>POWER</b>	
McGill	1.000
NRS - 101	0.1906

The null hypothesis is rejected ( $p \leq 0.025$ ) for the McGill Short-form Pain Questionnaire which indicates that at the  $\alpha = 0.05$  level of significance there was a significant difference between groups 1 and 2 at the final

treatment. It was noted that the power for the McGill Short-form Pain Questionnaire was 1. This is significant as it shows that the likelihood of committing a Type II error was very small (accepting a false null hypothesis).

The null hypothesis is accepted ( $p > 0.025$ ) for the Numerical Pain Rating Scale 101. This indicates that at the  $\alpha = 0.05$  level of significance there was no significant difference between groups 1 and 2 at the final treatment.

**Table 4.14**

**A comparison of Groups 1 and 2 using the Mann-Whitney U-test to analyse the results collected from the subjective data at the one-month follow-up.**

<b>ONE-MONTH</b>							
	<b>Group 1</b>				<b>Group 2</b>		
	<b>MEAN</b>	<b>SD</b>	<b>Varian ce</b>	<b>P- VALUE</b>	<b>MEAN</b>	<b>SD</b>	<b>Varian ce</b>
McGill	.02867	.05097	.00259 8	<b>.004</b>	.116	.1223	.01497
NRS- 101	8.3333	12.805 8	163.98 8	.0400	16.866 7	15.626 7	244.19 5

<b>POWER</b>	
McGill	0.7263
NRS - 101	0.3419

The null hypothesis is rejected ( $p \leq 0.025$ ) for the McGill Short-form Pain Questionnaire. This indicates that at the  $\alpha = 0.05$  level of significance

there was a significant difference between groups 1 and 2 at the one-month follow-up.

The null hypothesis is accepted ( $p > 0.025$ ) for the Numerical Pain Rating Scale 101, which indicates that at the  $\alpha = 0.05$  level of significance there was no significant difference between groups 1 and 2 at the one-month follow-up.

Table 4.15

A comparison of Groups 1 and 2 using the Mann-Whitney U-test to analyse the results collected from the objective data at treatment 1.

TREATMENT 1							
	Group 1				Group 2		
	MEAN	SD	Varian ce	P- VALUE	MEAN	SD	Varian ce
GON	5.0667	4.8619	23.638	0.603	6.6333	5.2863	27.945
ALG	2.4333	.8432	0.711	0.114	2.9267	.8498	0.722

POWER	
GON	0.1230
ALG	0.3255

The null hypothesis is accepted ( $p > 0.025$ ) for both the goniometer and algometer readings, as there was no significant difference at the  $\alpha = 0.05$  level of significance between both groups at treatment 1.

**Table 4.16**

A comparison of Groups 1 and 2 using the Mann-Whitney U-test to analyse the results collected from the objective data at the final treatment.

FINAL TREATMENT							
	Group 1				Group 2		
	MEAN	SD	Varian ce	P- VALUE	MEAN	SD	Varian ce
GON	12.533 3	5.8048	33.695	0.050	8.2667	4.9203	24.210
ALG	3.4533	1.1300	1.277	0.350	3.8333	0.9574	0.917

POWER	
GON	0.5488
ALG	0.1523

The null hypothesis is accepted ( $p > 0.025$ ) for both the goniometer and algometer readings as there was no significant difference at the final treatment between both groups at the  $\alpha = 0.05$  level of significance.

Table 4.17

A comparison of Groups 1 and 2 using the Mann-Whitney U-test to analyse the results collected from the objective data at the one-month follow-up.

ONE-MONTH							
	Group 1				Group 2		
	MEAN	SD	Varian ce	P- VALUE	MEAN	SD	Varian ce
GON	13.2	3.3848	11.457	0.001	8.0	3.9279	15.429
ALG	4.1800	1.4093	1.986	0.395	3.86	1.1482	1.318

POWER	
GON	0.9612
ALG	.0964

The null hypothesis is rejected ( $p \leq 0.025$ ) for the goniometer readings, at the  $\alpha = 0.05$  level of significance, as there was a significant difference between groups 1 and 2 at the one-month follow-up. It was noted that the

power for the goniometer readings was very close to 1, thus decreasing the likelihood of committing a Type II error (accepting a false null hypothesis).

The null hypothesis is accepted ( $p > 0.025$ ) for the algometer readings, as there was no significant difference at the one-month follow-up between both groups at the  $\alpha = 0.05$  level of significance.

**Table 4.18**

**A comparison of Groups 1 and 2 using the Mann-Whitney U-test to analyse the results collected from the functional evaluation data at treatment 1.**

<b>TREATMENT 1</b>							
	<b>Group 1</b>				<b>Group 2</b>		
	<b>MEAN</b>	<b>SD</b>	<b>Varian ce</b>	<b>P- VALUE</b>	<b>MEAN</b>	<b>SD</b>	<b>Varian ce</b>
<b>FE</b>	65.666 7	22.509 3	506.66 7	0.851	63.333 3	24.904 6	620.23 8

<b>POWER</b>	
<b>FE</b>	0.0570

The null hypothesis is accepted ( $p > 0.025$ ) for the functional evaluation scores, as there was no significant difference at treatment 1 between both groups at the  $\alpha = 0.05$  level of significance.

**Table 4.19**

**A comparison of Groups 1 and 2 using the Mann-Whitney U-test to analyse the results collected from the functional evaluation data at the final treatment.**

<b>FINAL TREATMENT</b>							
	<b>Group 1</b>				<b>Group 2</b>		
	<b>MEAN</b>	<b>SD</b>	<b>Varian ce</b>	<b>P- VALUE</b>	<b>MEAN</b>	<b>SD</b>	<b>Varian ce</b>
<b>FE</b>	92.666 7	4.9522	24.524	<b>.001</b>	79.000 6	16.604 6	275.71 4

<b>POWER</b>	
<b>FE</b>	<b>0.8387</b>

The null hypothesis is rejected ( $p \leq 0.025$ ) for the functional evaluation scores, at the  $\alpha = 0.05$  level of significance, as there was a significant difference at the final treatment between groups 1 and 2. It was noted that the power for the functional evaluation scores was high, thus decreasing

the likelihood of committing a Type II error (accepting a false null hypothesis).

**Table 4.20**

**A comparison of Groups 1 and 2 using the Mann-Whitney U-test to analyse the results collected from the functional evaluation data at the one-month follow-up.**

<b>ONE-MONTH</b>							
	<b>Group 1</b>				<b>Group 2</b>		
	<b>MEAN</b>	<b>SD</b>	<b>Varian ce</b>	<b>P- VALUE</b>	<b>MEAN</b>	<b>SD</b>	<b>Varian ce</b>
<b>FE</b>	96.666 7	3.6187	13.095	<b>0.000</b>	82.333 3	12.516 7	156.66 7

<b>POWER</b>	
<b>FE</b>	0.9824

The null hypothesis is rejected ( $p \leq 0.025$ ) for the functional evaluation scores, at the  $\alpha = 0.05$  level of significance, as there was a significant difference at the one-month follow-up between groups 1 and 2. It was noted that the power for the functional evaluation scores was very high, thus decreasing the likelihood of committing a Type II error (accepting a false null hypothesis).

### 4.3.2 The Intra-group Analysis using Wilcoxon's Signed Rank Tests

Table 4.21

A comparison of results within Group 1 using the Wilcoxon's Signed Rank Test to analyse the subjective data collected between treatment 1 and the final treatment.

GROUP 1							
	TREATMENT 1				FINAL TREATMENT		
	MEAN	SD	Varian ce	P- VALUE	MEAN	SD	Varian ce
McGill	.1960	.1040	.01083	.001	.05667	.09817	.00963 8
NRS- 101	28.733 3	16.544 2	273.71 0	.001	13.833 3	12.805 8	251.66 7

POWER	
McGill	.9560
NRS - 101	.6792

The null hypothesis is rejected ( $p \leq 0.025$ ) for both the McGill Short-form Pain Questionnaire and the Numerical Pain Rating Scale 101 which indicates that at the  $\alpha = 0.05$  level of significance there was a significant difference between treatment 1 and the final treatment within group 1. It was noted that the power for the McGill Short-form Pain Questionnaire was close to 1. This indicates that the likelihood of committing a Type II error was small (accepting a false null hypothesis).

**Table 4.22**

**A comparison of results within Group 1 using the Wilcoxon's Signed Rank Test to analyse the subjective data collected between treatment 1 and the one-month follow-up.**

<b>GROUP 1</b>							
	<b>TREATMENT 1</b>				<b>ONE-MONTH</b>		
	MEAN	SD	Varian ce	<b>P- VALUE</b>	MEAN	SD	Varian ce
McGill	.1960	.1040	.01083	<b>.001</b>	.02867	.05097	.00259 8
NRS- 101	28.733 3	16.544 2	273.71 0	<b>.002</b>	8.3333	12.805 8	163.98 8

<b>POWER</b>	
McGill	.9995
NRS - 101	.9526

The null hypothesis is rejected ( $p \leq 0.025$ ) for both the McGill Short-form Pain Questionnaire and the Numerical Pain Rating Scale 101, which indicates that at the  $\alpha = 0.05$  level of significance there was a significant

difference, within group 1, between treatment 1 and the one-month follow-up. It was noted that the power for both subjective questionnaires was close to 1. This indicates that the likelihood of committing a Type II error was small (accepting a false null hypothesis).

**Table 4.23**

**A comparison of results within Group 1 using the Wilcoxon's Signed Rank Test to analyse the subjective data collected between the final treatment and the one-month follow-up.**

GROUP 1							
	FINAL TREATMENT				ONE-MONTH		
	MEAN	SD	Varian ce	P- VALUE	MEAN	SD	Varian ce
McGill	.05667	.09817	.00963 8	.017	.02867	.05097	.00259 8
NRS- 101	13.833 3	15.864	251.66 7	.113	8.3333	12.805 8	163.98 8

POWER	
McGill	.1453
NRS - 101	.1643

The null hypothesis is rejected ( $p \leq 0.025$ ) for the McGill Short-form Pain Questionnaire, which indicates that at the  $\alpha = 0.05$  level of significance there was a significant difference between the final treatment and the one-month follow-up within group 1.

The null hypothesis is accepted ( $p > 0.025$ ) for the Numerical Pain Rating Scale 101, which indicates that at the  $\alpha = 0.05$  level of significance there was no significant difference between the final treatment and the one-month follow-up within group 1.

**Table 4.24**

**A comparison of results within Group 1 using the Wilcoxon's Signed Rank Test to analyse the objective data collected between treatment 1 and the final treatment.**

GROUP 1							
	TREATMENT 1				FINAL TREATMENT		
	MEAN	SD	Varian ce	P- VALUE	MEAN	SD	Varian ce
GON	5.0667	4.8619	23.638	<b>.002</b>	12.533 3	5.8048	33.695
ALG	2.4333	.8432	.711	<b>.013</b>	3.4533	1.13	1.277

POWER	
GON	.9565
ALG	.7715

The null hypothesis is rejected ( $p \leq 0.025$ ) for both the goniometer and algometer readings at the  $\alpha = 0.05$  level of significance, which indicates that there was a significant difference between treatment 1 and the final treatment within group 1. It was noted that the power for the goniometer

readings was high, thus decreasing the likelihood of committing a Type II error (accepting a false null hypothesis).

**Table 4.25**

**A comparison of results within Group 1 using the Wilcoxon's Signed Rank Test to analyse the objective data collected between treatment 1 and the one-month follow-up.**

<b>GROUP 1</b>							
	<b>TREATMENT 1</b>				<b>ONE-MONTH</b>		
	<b>MEAN</b>	<b>SD</b>	<b>Varian ce</b>	<b>P- VALUE</b>	<b>MEAN</b>	<b>SD</b>	<b>Varian ce</b>
<b>GON</b>	5.0667	4.8619	23.638	<b>.001</b>	13.2	3.3848	11.457
<b>ALG</b>	2.4333	.8432	.711	<b>.002</b>	4.18	1.4093	1.986

<b>POWER</b>	
<b>GON</b>	.9986
<b>ALG</b>	.9768

The null hypothesis is rejected ( $p \leq 0.025$ ) for both the goniometer and algometer readings as there was a significant difference between treatment 1 and the one-month follow-up at the  $\alpha = 0.05$  level of significance within group 1. It was noted that the power for the goniometer and algometer

readings was very high, thus decreasing the likelihood of committing a Type II error (accepting a false null hypothesis).

**Table 4.26**

**A comparison of results within Group 1 using the Wilcoxon's Signed Rank Test to analyse the objective data collected between the final treatment and the one-month follow-up.**

GROUP 1							
	FINAL TREATMENT				ONE-MONTH		
	MEAN	SD	Varian ce	P- VALUE	MEAN	SD	Varian ce
GON	12.533 3	5.8048	33.695	.505	13.2	3.3848	11.457
ALG	3.4533	1.13	1.277	<b>.009</b>	4.18	1.4093	1.986

POWER	
GON	.00644
ALG	.3133

The null hypothesis is accepted ( $p > 0.025$ ) for the goniometer readings, as there was no significant difference between the final treatment and the one-month follow-up, within group 1, at the  $\alpha = 0.05$  level of significance.

The null hypothesis is rejected ( $p \leq 0.025$ ) for the algometer readings as there was a significant difference between treatment 1 and the one-month follow-up at the  $\alpha = 0.05$  level of significance within group 1.

**Table 4.27**

**A comparison of results within Group 1 using the Wilcoxon's Signed Rank Test to analyse the functional evaluation data collected between treatment 1 and the one-month follow-up.**

<b>GROUP 1</b>							
	<b>TREATMENT 1</b>				<b>FINAL TREATMENT</b>		
	<b>MEAN</b>	<b>SD</b>	<b>Varian ce</b>	<b>P- VALUE</b>	<b>MEAN</b>	<b>SD</b>	<b>Varian ce</b>
<b>FE</b>	65.666 7	22.509 3	506.66 7	<b>.001</b>	92.666 7	4.9522	24.524

<b>POWER</b>	
<b>FE</b>	<b>.9905</b>

The null hypothesis is rejected ( $p \leq 0.025$ ) for the functional evaluation scores as there was a significant difference between treatment 1 and the one-month follow-up, within group 1, at the  $\alpha = 0.05$  level of significance. It was noted that the power for the functional evaluation scores was very

high, thus decreasing the likelihood of committing a Type II error (accepting a false null hypothesis).

**Table 4.28**

**A comparison of results within Group 1 using the Wilcoxon's Signed Rank Test to analyse the functional evaluation data collected between treatment 1 and the one-month follow-up.**

<b>GROUP 1</b>							
	<b>TREATMENT 1</b>				<b>ONE-MONTH</b>		
	<b>MEAN</b>	<b>SD</b>	<b>Varian ce</b>	<b>P- VALUE</b>	<b>MEAN</b>	<b>SD</b>	<b>Varian ce</b>
<b>FE</b>	65.666 7	22.509 3	506.66 7	<b>.001</b>	96.666 7	3.6187	13.095

<b>POWER</b>	
<b>FE</b>	<b>.9984</b>

The null hypothesis is rejected ( $p \leq 0.025$ ) for the functional evaluation scores as there was a significant difference between treatment 1 and the one-month follow-up, within group 1, at the  $\alpha = 0.05$  level of significance. It was noted that the power for the functional evaluation scores was very

high, thus decreasing the likelihood of committing a Type II error (accepting a false null hypothesis).

**Table 4.29**

**A comparison of results within Group 1 using the Wilcoxon's Signed Rank Test to analyse the functional evaluation data collected between the final treatment and the one-month follow-up.**

GROUP 1							
	FINAL TREATMENT				ONE-MONTH		
	MEAN	SD	Varian ce	P- VALUE	MEAN	SD	Varian ce
FE	92.666 7	4.9522	24.524	.010	96.666 7	3.6187	13.095

POWER	
FE	.6810

The null hypothesis is rejected ( $p \leq 0.025$ ) for the functional evaluation scores as there was a significant difference between the final treatment and the one-month follow-up, within group 1, at the  $\alpha = 0.05$  level of significance.

**Table 4.30**

**A comparison of results within Group 2 using the Wilcoxon's Signed Rank Test to analyse the subjective data collected between treatment 1 and the final treatment.**

GROUP 2							
	TREATMENT 1				FINAL TREATMENT		
	MEAN	SD	Varian ce	P- VALUE	MEAN	SD	Varian ce
McGill	.2433	.1392	.01937	.038	.1713	.1627	.02646
NRS- 101	30.733 3	12.790 7	163.60 2	.007	21.266 7	19.303 8	372.63 8

POWER	
McGill	.2357
NRS - 101	.3234

The null hypothesis is accepted ( $p > 0.025$ ) for the McGill Short-form Pain Questionnaire, which indicates that at the  $\alpha = 0.05$  level of significance there was no significant difference between treatment 1 and the final treatment within group 2.

The null hypothesis is rejected ( $p \leq 0.025$ ) for the Numerical Pain Rating Scale 101 which indicates that at the  $\alpha = 0.05$  level of significance there was a significant difference between groups 1 and 2 at the final treatment.

**Table 4.31**

**A comparison of results within Group 2 using the Wilcoxon's Signed Rank Test to analyse the subjective data collected between treatment 1 and the one-month follow-up.**

<b>GROUP 2</b>							
	<b>TREATMENT 1</b>				<b>ONE-MONTH</b>		
	<b>MEAN</b>	<b>SD</b>	<b>Varian ce</b>	<b>P- VALUE</b>	<b>MEAN</b>	<b>SD</b>	<b>Varian ce</b>
McGill	.2433	.3192	.01937	<b>.013</b>	.1160	.1223	.01497
NRS- 101	30.733 3	12.790 7	163.60 2	<b>.020</b>	16.866 7	15.626 7	244.19 5

<b>POWER</b>	
McGill	.7342
NRS - 101	.7269

The null hypothesis is rejected ( $p \leq 0.025$ ) for both the McGill Short-form Pain Questionnaire and the Numerical Pain Rating Scale 101, which indicates that at the  $\alpha = 0.05$  level of significance there was a significant

difference between treatment 1 and the one-month follow-up within group

2.

**Table 4.32**

**A comparison of results within Group 2 using the Wilcoxon's Signed Rank Test to analyse the subjective data collected between the final treatment and the one-month follow-up.**

<b>GROUP 2</b>							
	<b>FINAL TREATMENT</b>				<b>ONE-MONTH</b>		
	<b>MEAN</b>	<b>SD</b>	<b>Varian ce</b>	<b>P- VALUE</b>	<b>MEAN</b>	<b>SD</b>	<b>Varian ce</b>
McGill	.1713	.1627	.02646	.133	.1160	.1223	.01497
NRS- 101	21.266 7	19.303 8	372.63 8	.262	16.866 7	15.626 7	244.19 5

<b>POWER</b>	
McGill	.1730
NRS - 101	.0974

The null hypothesis is accepted ( $p > 0.025$ ) for both the McGill Short-form Pain Questionnaire and the Numerical Pain Rating Scale 101, which indicates that at the  $\alpha = 0.05$  level of significance there was no significant

difference between the final treatment and the one-month follow-up within group 2.

**Table 4.33**

**A comparison of results within Group 2 using the Wilcoxon's Signed Rank Test to analyse the objective data collected between treatment 1 and the final treatment.**

<b>GROUP 2</b>							
	<b>TREATMENT 1</b>				<b>FINAL TREATMENT</b>		
	<b>MEAN</b>	<b>SD</b>	<b>Varian ce</b>	<b>P- VALUE</b>	<b>MEAN</b>	<b>SD</b>	<b>Varian ce</b>
<b>GON</b>	6.6333	5.2863	27.945	.199	8.2667	4.9203	24.210
<b>ALG</b>	2.9267	.8498	.722	<b>.017</b>	3.8333	.9574	.917

<b>POWER</b>	
<b>GON</b>	.1287
<b>ALG</b>	.7490

The null hypothesis is rejected ( $p \leq 0.025$ ) for the algometer readings as there was a significant difference between treatment 1 and the final treatment, within group 2, at the  $\alpha = 0.05$  level of significance.

The null hypothesis is accepted ( $p > 0.025$ ) for the goniometer readings, as there was no significant difference between treatment 1 and the final treatment, within group 2, at the  $\alpha = 0.05$  level of significance.

**Table 4.34**

**A comparison of results within Group 2 using the Wilcoxon's Signed Rank Test to analyse the objective data collected between treatment 1 and the one-month follow-up.**

GROUP 2							
	TREATMENT 1				ONE-MONTH		
	MEAN	SD	Varian ce	P- VALUE	MEAN	SD	Varian ce
GON	6.6333	5.2863	27.945	.181	8.000	3.9279	15.429
ALG	2.9267	.8498	.722	<b>.020</b>	3.8600	1.1482	1.318

POWER	
GON	.1157
ALG	.6833

The null hypothesis is rejected ( $p \leq 0.025$ ) for the algometer readings as there was a significant difference between treatment 1 and the one-month follow-up, within group 2, at the  $\alpha = 0.05$  level of significance.

The null hypothesis is accepted ( $p > 0.025$ ) for the goniometer readings as there was no significant difference between treatment 1 and the final treatment, within group 2, at the  $\alpha = 0.05$  level of significance.

**Table 4.35**

**A comparison of results within Group 2 using the Wilcoxon's Signed Rank Test to analyse the objective data collected between the final treatment and the one-month follow-up.**

<b>GROUP 2</b>							
	<b>FINAL TREATMENT</b>				<b>ONE-MONTH</b>		
	<b>MEAN</b>	<b>SD</b>	<b>Varian ce</b>	<b>P- VALUE</b>	<b>MEAN</b>	<b>SD</b>	<b>Varian ce</b>
<b>GON</b>	8.2667	4.9203	24.210	.806	8.000	3.9279	15.429
<b>ALG</b>	3.8333	.9574	.917	.909	3.8600	1.1482	1.318

<b>POWER</b>	
<b>GON</b>	.0526
<b>ALG</b>	.0505

The null hypothesis is accepted ( $p > 0.025$ ) for both the goniometer and the algometer readings, as there was no significant difference between the final treatment and the one-month follow-up, within group 2, at the  $\alpha = 0.05$  level of significance

**Table 4.36**

**A comparison of results within Group 2 using the Wilcoxon's Signed Rank Test to analyse the functional evaluation data collected between treatment 1 and the final treatment.**

<b>GROUP 2</b>							
	<b>TREATMENT 1</b>				<b>FINAL TREATMENT</b>		
	<b>MEAN</b>	<b>SD</b>	<b>Varian ce</b>	<b>P- VALUE</b>	<b>MEAN</b>	<b>SD</b>	<b>Varian ce</b>
<b>FE</b>	63.333 3	24.904 6	620.23 8	<b>.004</b>	79.000	16.604 6	275.71 4

<b>POWER</b>	
<b>FE</b>	<b>.4916</b>

The null hypothesis is rejected ( $p \leq 0.025$ ) for the functional evaluation scores as there was a significant difference between treatment 1 and the final treatment, within group 2, at the  $\alpha = 0.05$  level of significance.

**Table 4.37**

**A comparison of results within Group 2 using the Wilcoxon's Signed Rank Test to analyse the functional evaluation data collected between treatment 1 and the one-month follow-up.**

GROUP 2							
	TREATMENT 1				ONE-MONTH		
	MEAN	SD	Varian ce	P- VALUE	MEAN	SD	Varian ce
FE	63.333 3	24.904 6	620.23 8	<b>.005</b>	82.333 3	12.516 7	156.66 7

POWER	
FE	.7206

The null hypothesis is rejected ( $p \leq 0.025$ ) for the functional evaluation scores as there was a significant difference between treatment 1 and the one-month follow-up, within group 2, at the  $\alpha = 0.05$  level of significance.

**Table 4.38**

**A comparison of results within Group 2 using the Wilcoxon's Signed Rank Test to analyse the functional evaluation data collected between the final treatment and the one-month follow-up.**

<b>GROUP 2</b>							
	<b>FINAL TREATMENT</b>				<b>ONE-MONTH</b>		
	<b>MEAN</b>	<b>SD</b>	<b>Varian ce</b>	<b>P- VALUE</b>	<b>MEAN</b>	<b>SD</b>	<b>Varian ce</b>
<b>FE</b>	<b>79.000</b>	<b>16.604 6</b>	<b>275.71 4</b>	<b>.364</b>	<b>82.333 3</b>	<b>12.516 7</b>	<b>156.66 7</b>

<b>POWER</b>	
<b>FE</b>	<b>.0885</b>

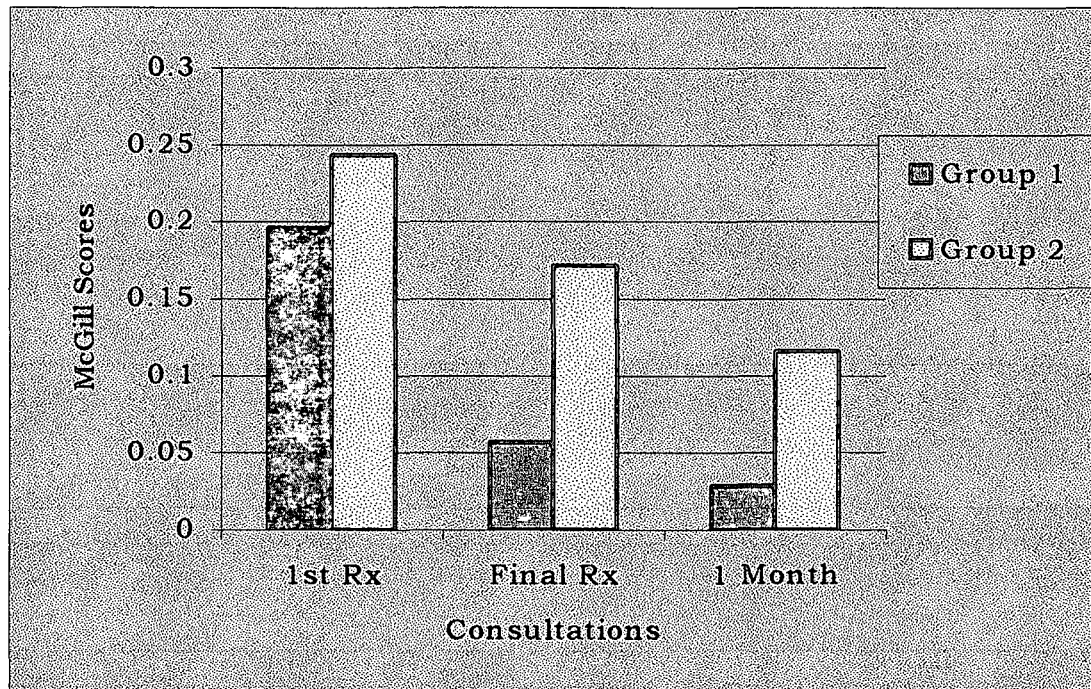
The null hypothesis is accepted ( $p > 0.025$ ) for the functional evaluation scores as there was no significant difference between the final treatment and the one-month follow-up, within group 2, at the  $\alpha = 0.05$  level of significance.

#### 4.4 BAR CHARTS

Figures 4.1-4.5 are visual representations of the mean value changes found between the first, final, and one-month follow-up consultations of group 1 and group 2. These values were taken from the summary statistics. These bar charts serve to highlight trends within the two groups.

Figure 4.1

Graphical representation of the mean values obtained from the McGill Short-form Pain Questionnaire.



**Figure 4.2**

**Graphical representation of the mean values obtained from the Numerical Pain Rating Scale 101.**

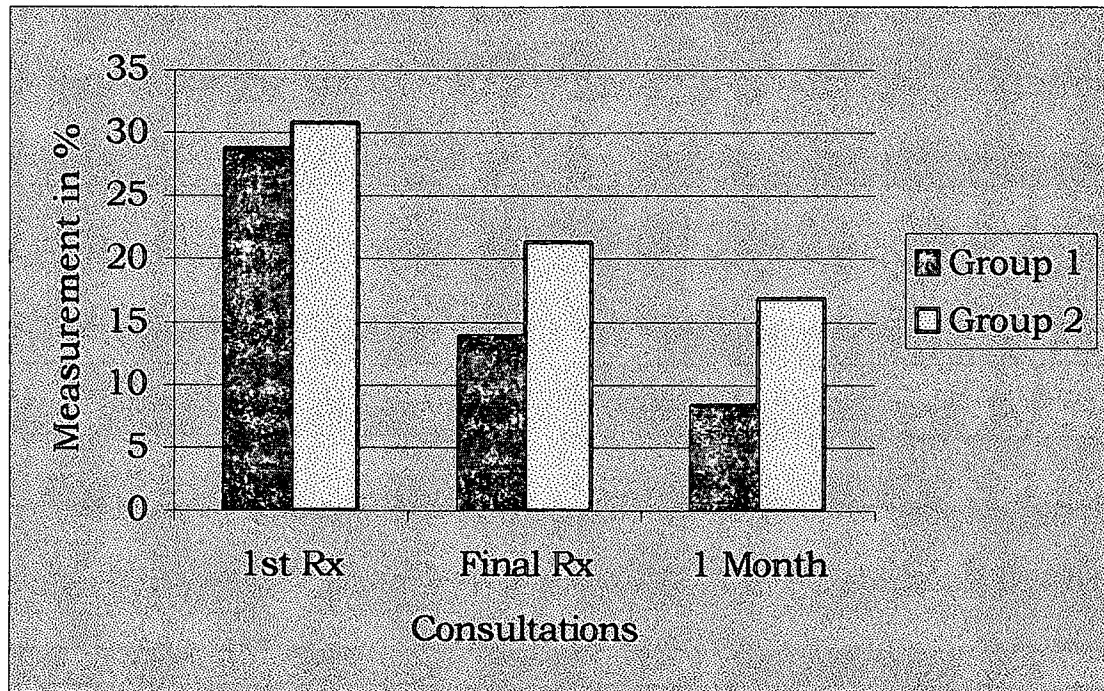


Figure 4.3

Graphical representation of the mean values obtained from the goniometer readings measuring ankle dorsiflexion range of motion.

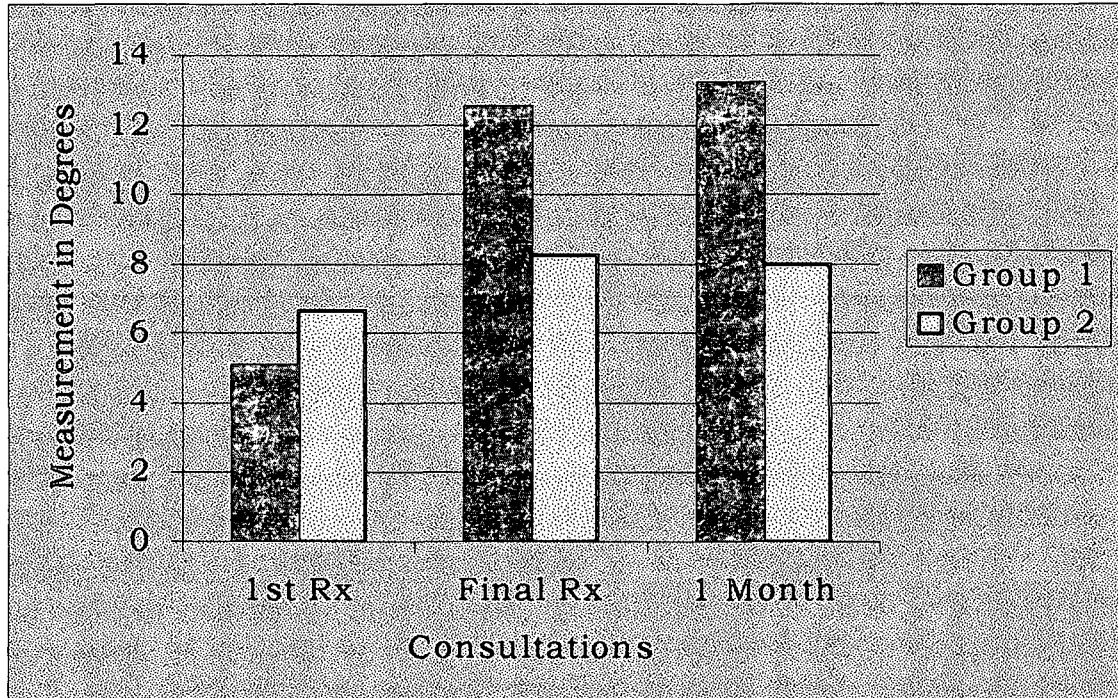


Figure 4.4

Graphical representation of the mean values obtained from the algometer readings.

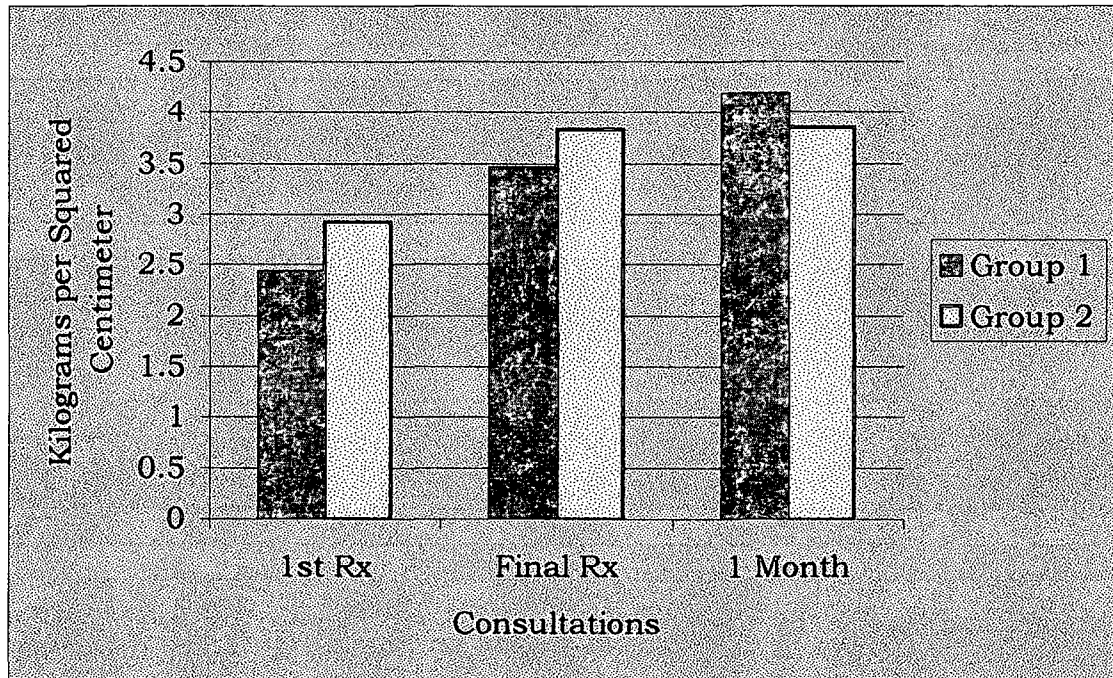
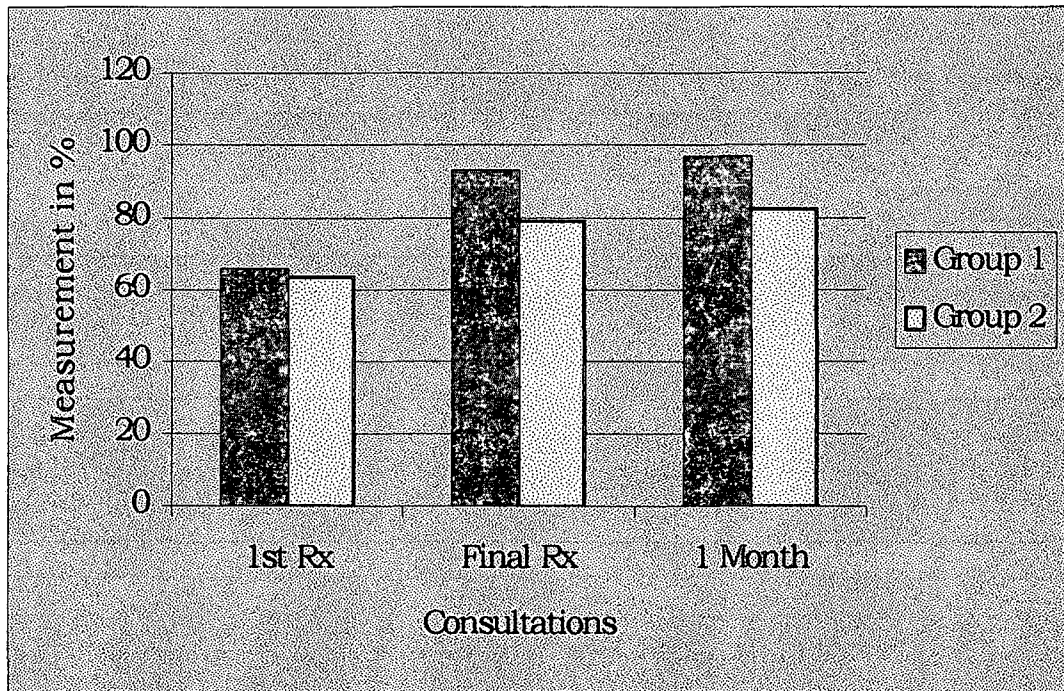


Figure 4.5

Graphical representation of the mean values obtained from the functional evaluation scores.



## **CHAPTER FIVE - DISCUSSION OF RESULTS**

### **5.1 INTRODUCTION**

This chapter will discuss the results obtained from the subjective, objective and functional evaluation data as presented in Chapter Four.

The evaluation of the inter-group data obtained from the assessment from measurements of the first treatment, gives an indication of any fundamental differences in the subjective and objective findings, between the two groups, in terms of their original signs and symptoms. The inter-group comparison at the final treatment indicates which treatment protocol is more efficacious. The assessment of the results at the one-month follow-up consultation indicates any differences in the relative long-term treatment benefits between the two groups.

The analysis of the subjective and objective intra-group results between treatments one and the final treatment represent the efficacy of the treatment regimes within each treatment group.

## **5.2 INTER-GROUP COMPARISONS**

### **5.2.1 The Subjective Data**

The subjective data is comprised of the results from the McGill Short-form Pain Questionnaire and the Numerical Pain Rating Scale 101.

This statistical data can be found in tables 4.12, 4.13 and 4.14.

On statistical analysis, no significant difference could be found between the two groups at the first treatment. This suggests that the symptoms, in terms of pain intensity and quality, were initially similar between the two groups.

#### **5.2.1.1 McGill Short-form Pain Questionnaire**

A significant difference in the results, between both groups, was detected for the McGill Short-form Pain Questionnaire at the final treatment and the one-month follow-up. This suggests that adjusting the ankle was superior to placebo in reducing the patient's quality and intensity of pain after the treatment period. This improvement continued during the month that followed the final treatment, so that by the one-month follow-up, there were even more noticeable improvements.

The mean values for both groups tend to indicate a similar trend with respect to their different treatments (Fig 4.1).

That is: both groups indicated a reduction in the quality and intensity of pain. It should be noted however, that the 'downward' trend arising from group 1 is much more distinct than that arising from group 2.

#### **5.2.1.2 Numerical Pain Rating Scale 101**

Statistical analysis of the Numerical Pain Rating Scale 101 revealed no significant difference between the two groups at any period of time throughout the study. This suggests that both treatment approaches were similarly efficacious in reducing the patient's perception of his/her level of percentage pain intensity.

The bar chart indicates that the mean values for both groups tend to indicate a similar trend with respect to their different treatments (Figure 4.2). It should be noted however, that the 'downward' trend arising from group 1 is much more distinct than that arising from group 2.

#### **5.2.2 The Objective Data**

The objective data is comprised of the results from the goniometer and algometer readings.

This statistical data can be found in tables 4.15, 4.16 and 4.17.

Statistical analysis did not indicate any significant difference between the two groups at the first treatment. This suggests that the objective findings were initially similar in nature.

#### **5.2.2.1 Goniometer readings**

Statistical analysis of the goniometer readings did not reveal a significant difference between both groups at the first and final treatment. A significant difference was however detected for the goniometer readings at the one-month follow-up. This suggests that adjusting the ankle was superior to the placebo treatment in increasing dorsiflexion range of motion of the ankle joint.

Figure 4.3 clearly indicates the documented increase in dorsiflexion range of motion of the ankle joint in group 1.

#### **5.2.2.2 Algometer Readings**

Statistical analysis of the algometer readings did not reveal a significant difference between the two groups at any period of time throughout the study. This suggests that both treatment approaches were similarly efficacious in reducing the patient's pain threshold level.

The mean values for both groups tend to indicate a similar trend with respect to their different treatments. This is illustrated in Figure 4.4.

### **5.2.3 Functional Evaluation Data**

The statistical data can be found in tables 4.18, 4.19 and 4.20.

Statistical analysis of the functional evaluation scores did not reveal a significant difference between the two groups at the first treatment. This suggests that both groups were initially fairly similar in terms of ankle dysfunction.

A significant difference was detected for the functional evaluation scores at both the final treatment and the one-month follow-up. This suggests that adjusting the ankle was superior to the placebo treatment in improving the patient's overall ankle functioning, in terms of subjective and objective findings, after the treatment period. This improvement continued during the month that followed the final treatment, so that by the one-month follow-up, there were even more noticeable improvements.

The mean values for both groups tend to indicate a similar trend with respect to their different treatments (Fig 4.5). It should be noted however, that the trend arising from group 1 is much more distinct than that arising from group 2.

## **5.3 INTRA-GROUP TREATMENT COMPARISONS**

### **5.3.1 Subjective Data**

The statistical data can be found in tables 4.21, 4.22, 4.23, 4.30, 4.31 and 4.32.

#### **5.3.1.1 McGill Short-form Pain Questionnaire**

Statistical analysis within the adjustment group showed that there were significant differences between treatment one and the final treatment, between treatment one and the one-month follow-up, and between the final treatment and the one-month follow-up. This suggests that adjusting the ankle is an effective treatment in the reduction of quality and intensity of the pain experienced by the patient. A significant difference was found between treatment one and the one-month follow-up in the placebo group. Placebo therapy did therefore, significantly reduce the quality and intensity of the pain experienced by the patient.

#### **5.3.1.2 Numerical Pain Rating Scale 101**

Statistical analysis revealed that both the adjustment and placebo groups showed significant improvements between treatment one and the final treatment, and between treatment one and the one-month follow-up. This

indicates that the treatments in both groups were efficacious in reducing the percentage of pain intensity.

### **5.3.2 Objective Data**

The statistical data can be found in tables 4.24, 4.25, 4.26, 4.33, 4.34, and 4.35

#### **5.3.2.1 Goniometer Readings**

There were no statistically significant changes in ankle dorsiflexion range of motion within the placebo group. The analysis showed significant differences within the adjustment group for goniometer readings between treatment one and the final treatment, and between treatment one and the one-month follow-up. There was however no significant difference between the final treatment and the one-month follow-up in the adjustment group. These findings indicate that adjusting the ankle to increase dorsiflexion range of motion was superior to placebo and that the gained range of motion was maintained, as observed at the one-month follow-up.

#### **5.3.2.2 Algometer Readings:**

Statistical analysis within the placebo group showed significant changes between treatment one and the final treatment, and between treatment

one and the one-month follow-up. This indicates that placebo was beneficial in increasing pain threshold from treatment one to the final treatment and from treatment one to the one-month follow-up. There were however no significant changes between the final treatment and the one-month follow-up.

Statistical analysis within the adjustment group showed significant changes between treatment one and the final treatment, between treatment one and the one-month follow-up, and between the final treatment and the one-month follow-up. This indicates that pain threshold was significantly increased during the treatment period and continued to improve over the one-month follow-up period.

### **5.3.3 The Functional Evaluation Data**

The statistical data can be found in tables 4.27, 4.28, 4.29, 4.36, 4.37, and 4.38.

Statistical analysis within the placebo group showed significant changes between treatment one and the final treatment, and between treatment one and the one-month follow-up. This indicates that placebo was beneficial in improving overall ankle functioning (in terms of subjective and objective findings) over the treatment period and between treatment

one and the one-month follow-up period but did not change significantly between the final treatment and the one-month follow-up.

Analysis within the adjustment group showed significant changes between treatment one and the final treatment, between treatment one and the one-month follow-up, and between the final treatment and the one-month follow-up. This indicates that overall ankle functioning (in terms of subjective and objective findings) was significantly improved during the treatment period and continued to improve over the period between the final treatment and the one-month follow-up.

#### **5.4 POWER ANALYSIS**

The purpose of a power analysis is to determine the probability of a Type II error occurring (i.e. falsely accepting a null hypothesis). The probability of making a Type II error is denoted by beta ( $\beta$ ). The closer the value of  $1-\beta$  is to 1, the better the power of the test. A power of 0.80 represents a reasonably high protection against committing a Type II error. When small sample sizes are used in clinical research, it may result in the power analysis being substantially low and hence findings may appear greater as a result. (Portney and Watkins 1993: 351-352.)

#### **5.4.1 Inter-group Power Analyses**

Inter-group power analyses of subjective readings were relatively poor between both groups, except for the McGill Short-form Pain Questionnaire at the final treatment where the power value was equal to 1 (Table 4.13).

The objective readings comparing both groups also displayed poor power for all goniometer and algometer readings, except for goniometer readings at the one-month follow-up (Table 4.17).

The functional evaluation scores showed strong power analysis values at both the final treatment and the one-month follow-up (Tables 4.19 and 4.20).

Although a small sample size was used, significant differences were statistically detected in subjective, objective and functional evaluation findings and were confirmed using power analysis.

#### **5.4.2 Intra-group Power Analyses**

The power analysis of group 1 was relatively strong for subjective, objective, and functional evaluation data.

The power was significant for the McGill Short-form Pain Questionnaire between treatment 1 and the final treatment (Table 4.21), and for both the McGill Short-form Pain Questionnaire and the Numerical Pain Rating Scale 101 between treatment 1 and the one-month follow-up (Table 4.22).

The power analysis for the objective findings in group 1 were also significant for goniometer readings between treatment 1 and the final treatment (Table 4.24), and for both goniometer and algometer readings between treatment 1 and the one-month follow-up (Table 4.25).

The functional evaluation scores showed significant power analysis readings, within group 1, between treatment 1 and the final treatment (Table 4.27), and between treatment 1 and the one-month follow-up.

The power analyses were poor for all subjective, objective and functional evaluation readings for group 2.

## **5.5 LIMITATIONS OF THIS STUDY**

### **5.5.1 Subjective Measurements**

Owing to the fact that this study included subjective measurements (i.e. the McGill Short-form Questionnaire and the Numerical Pain Rating Scale 101), there is always the potential for patient bias whereby he/she

attempts to please the examiner by recording lower scores to indicate an improvement that is not actually there.

### **5.5.2 Objective Measurements**

Two areas of potential error in using the universal goniometer are: examiner error and instrument error.

### **5.5.3 Statistical Limitations**

The sample is too small to do a more powerful parametric statistical analysis. Furthermore, due to the small sample size, there is predilection for a Type II error occurring (Freiman et al. 1992: 358).

### **5.5.4 Patient History and Demographics**

The patient histories, between both groups, were similar in terms of grade, chronicity, and the single or recurrent nature of the ankle sprains incurred by the sample patients (Tables 4.6, 4.7, and 4.8).

The majority of the patients in the study were under the age of 24, male, and caucasian (Tables 4.1, 4.2, and 4.3). The gender distribution was not similar between the two groups, as group 1 had more females than males and group 2 had more males than females (Table 4.2).

The researcher randomly allocated the patients into either treatment group in order to safeguard against selection bias. It is advised that future studies of this nature should use ideally matched pairs, where the subjects are matched based on similar age, sex, race, and history (Fitz-Gibbon and Morris 1987: 109). Owing to this study's clinical setting and time restraints, it was extremely fortunate to have essentially achieved this by chance.

Looking at the demographic data in Table 4.2 it can be seen that the make up of the two groups was not similar with respect to gender. It may be possible that the heterogeneity of the two groups could have affected the outcome.

## **CHAPTER SIX - CONCLUSIONS AND RECOMMENDATIONS**

### **6.1 RECOMMENDATIONS**

The author of this dissertation recommends that the same investigation be repeated with the following improvements:

#### **6.1.1 Time**

This study was interrupted by public holidays and other such disruptions that affected the regularity of the treatment intervals. Although the patients were seen over the set period of four weeks, the researcher feels that a more exact treatment schedule might eliminate irregular intervals as an uncontrolled variable.

#### **6.1.2 Patient Activity**

In an ideal setting the participating patients would be prevented from performing activities that led to the sprain and or activities that may have contributed to interfering with the results by putting the patient at further risk for aggravating the symptoms and thereby affecting the final outcome.

### **6.1.3 Financial Freedom**

If the researcher was in a position to enjoy financial freedom, then a larger sample size could be seen and allowances could be made for the use of more sensitive testing equipment.

### **6.1.4 Sample size and randomisation**

A larger sample size should be selected using parametric statistical analysis to improve the validity of the research. Parametric statistical analysis should be used with a chance of a Type II error limited to a set level.

Stratified randomisation procedures should be used, taking into account age, gender, race, location, and occupation. These factors could aid in making the sample more linear in distribution and thus produce more valid trial conclusions. Patients should be stratified based on the severity of injury (Grade I or Grade II), the frequency of sprain (recurrent or single sprains) and participation or non-participation in sports activities, to prevent unequal distributions between treatment groups occurring by chance for these prognostic factors.

### **6.1.5 Homogeneity**

Overall homogeneity was good in the study except for gender distribution.

It is recommended that future studies involve only one grade of sprain with a more specific period of chronicity and also if the sprain was of a single incidence or if it is a chronically recurring sprain.

### **6.1.6 Blinding**

Researcher bias could have been controlled for if an independent blind observer had selected the subjects, recorded all the measurements and aided the subjects in the procedure of completing the questionnaires (Bronfort 1992: 418).

### **6.1.7 Follow-up period**

An adequate follow-up period of six months or longer is recommended.

This gives a clearer indication of the long-term benefits associated with the treatment.

Eiff *et al.* (1994) suggest that follow-up periods of less than one year make detection of late outcomes of functional instability and recurrent sprains more difficult.

## 6.2 CONCLUSIONS

This controlled clinical trial was comprised of a sample of thirty patients. All patients had to be diagnosed with a subacute or chronic grade I or II inversion ankle sprain, according to specific criteria. These patients were randomly allocated into two groups of fifteen each. Group 1 received the mortise separation adjustment and group 2 received detuned ultrasound over the lateral ligaments of the ankle. Both groups received a maximum of eight treatments over a maximum period of four weeks, which was followed by a one-month follow-up evaluation.

Significant differences were detected ~~between~~ the adjustment group and the placebo group in terms of pain experienced (quality and intensity) at the final treatment and at the one-month follow-up. A significant difference was found between the two groups in ankle dorsiflexion range of motion at the one-month follow-up. Significant differences were detected between the adjustment group and the placebo group in terms of overall ankle functioning at the final treatment and at the one-month follow-up.

A power analysis of the data revealed statistical differences ~~between~~ the adjustment group and the placebo group in terms of pain (quality and intensity), ankle dorsiflexion range of motion, and ankle function. These differences were evident at the final treatment in terms of pain perception and overall ankle function. These differences were also evident at the one-

month follow-up in terms of pain perception, ankle dorsiflexion range of motion, and ankle function. This leads to the conclusion that adjusting the ankle was superior to placebo in terms of subjective, objective and functional terms when comparing the two groups to each other.

Statistical analysis ~~within~~ group 1 showed significant improvements in terms of pain experienced (quality and intensity) between treatment one and the final treatment, between treatment one and the one-month follow-up, and between the final treatment and the one-month follow-up.

Significant differences were observed in percentage pain intensity between treatment one and the final treatment and between treatment one and the one-month follow-up. Significant differences were observed in ankle dorsiflexion range of motion between treatment one and the final treatment and between treatment one and the one-month follow-up.

Significant increases in pain threshold were measured between treatment one and the final treatment, between treatment one and the one-month follow-up, and between the final treatment and the one-month follow-up.

Significant improvements in overall ankle function were observed between treatment one and the final treatment, between treatment one and the one-month follow-up, and between the final treatment and the one-month follow-up.

Statistical analysis ~~within~~ group 2, showed significant improvements in terms of pain experienced (quality and intensity) between the final

treatment and the one-month follow-up. Significant differences were observed in percentage pain intensity between treatment one and the final treatment, and between treatment one and the one-month follow-up. Significant increases in pain threshold were measured between treatment one and the final treatment, and between treatment one and the one-month follow-up. Significant improvements in overall ankle function were observed between treatment one and the final treatment, and between treatment one and the one-month follow-up.

Power analysis revealed statistically significant improvements ~~within~~ the adjustment group in terms of pain (quality and intensity), the goniometer readings and the overall ankle function after the treatment period.

Significant changes between treatment one and the one-month follow-up were found in percentage pain intensity experienced and pain quality and intensity experienced, dorsiflexion range of motion and pain threshold, and ankle function.

The placebo group did not however show statistically significant changes (after power analysis) ~~within~~ the group in terms of subjective, objective and functional findings.

**This study thus appears to indicate that the mortise separation adjustment is superior to placebo (detuned ultrasound). It may also be effective in short-term treatment and possibly long-term management of ankle sprains.**

There appear to be few studies or suggested treatment protocols for chronic inversion ankle sprains except for functional exercises and surgical intervention. In the author's opinion, subacute and chronic grade I and II inversion ankle sprains can be improved within six to eight manipulative treatments, and this could possibly be reduced and enhanced with the application of other conservative treatment modalities.

From the above it is noted that there appears to be strong evidence to conclude that adjusting the ankle may be an effective intervention for the treatment of subacute and chronic grade I and II ankle inversion sprains.

In view of the prevalence of ankle sprains and the many complications that can arise from inadequately managed ankle sprains, the ability to decrease pain, increase mobility, and improve overall ankle function, over short-term and long-term periods can have major implications when managing ankle sprains.

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**Algometer Readings**

File No.: \_\_\_\_\_ Group: \_\_\_\_\_

Visit No.	Date	Reading
Treatment 1		
Final Treatment		
One month		

**Goniometer Readings**

Initial visit Date:	Final Visit Date:	One-month Date:

APPENDIX B

1 of 1

McGill Short-form Pain Questionnaire

Ronald Melzack

Patient Name: \_\_\_\_\_

Date: \_\_\_\_\_

	<u>NONE</u>	<u>MILD</u>	<u>MODERATE</u>	<u>SEVERE</u>
THROBBING	0) _____	1) _____	2) _____	3) _____
SHOOTING	0) _____	1) _____	2) _____	3) _____
STABBING	0) _____	1) _____	2) _____	3) _____
SHARP	0) _____	1) _____	2) _____	3) _____
CRAMPING	0) _____	1) _____	2) _____	3) _____
GNAWING	0) _____	1) _____	2) _____	3) _____
HOT-BURNING	0) _____	1) _____	2) _____	3) _____
ACHING	0) _____	1) _____	2) _____	3) _____
HEAVY	0) _____	1) _____	2) _____	3) _____
TENDER	0) _____	1) _____	2) _____	3) _____
SPLITTING	0) _____	1) _____	2) _____	3) _____
TIRING-EXHAUSTING	0) _____	1) _____	2) _____	3) _____
SICKENING	0) _____	1) _____	2) _____	3) _____
FEARFUL	0) _____	1) _____	2) _____	3) _____
PUNISHING-CRUEL	0) _____	1) _____	2) _____	3) _____

Adapted from:

Melzack, R. 1987. The Short-form McGill Pain Questionnaire. Pain. 30: 191-197.

**NUMERICAL PAIN RATING SCALE 101**

Patient name: \_\_\_\_\_

File number: \_\_\_\_\_ Date: \_\_\_\_\_

Group: \_\_\_\_\_

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

Please write only one number.

0 \_\_\_\_\_ 100

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

Please write only one number.

0 \_\_\_\_\_ 100

Adapted from:

Jenson, M.P., Karoly, P. and Bravor, S. 1986. The Measurement of Clinical Pain Intensity: a Comparison of Six Methods. Pain. 27: 117-126.

APPENDIX D

1 of 4

**Scoring Scale for Subjective and Objective Functional Follow-up Evaluation After Ankle Injury.**

I	Subjective Assessment of the injured ankle †		VI	Rising on toes with injured leg	10
	No symptoms of any kind	15		More than 40 times	5
	Mild symptoms	10		30-39 times	0
	Moderate symptoms	5		Fewer than 30 times	
II	Can you walk normally?		VII	Single limb stance with injured leg *	
	Yes	15		Longer than 55 seconds	10
No	0	50-55 seconds		5	
III	Can you run normally?		VIII	Less than 55 seconds	0
	Yes	10		Laxity of the ankle joint (ADS)	
No	0	Stable (<5mm)		10	
IV	Climbing down stairs *		Moderate stability (6-10mm)	5	
	Less than 18 seconds	10	Severe instability (>10mm)	0	
	18 to 20 seconds	5			
V	Longer than 20 seconds	0	IX	Dorsiflexion range of motion of injured leg	
	Rising on heel with injured leg			≥ 10°	10
	More than 40 times	10		5°-9°	5
	30-39 times	5	<5°	0	
	Fewer than 30 times	0			

Total: Excellent, 85-100; good, 70-80; fair, 55-65; poor, <50.

† Pain, swelling, tenderness, or giving away during activity (mild, only if one of these symptoms are present; moderate, 2-3 of these symptoms are present; severe, 4 or more of these symptoms are present).

\* Two levels of a staircase with 44 steps.

\* Square beam (10cm x 10cm x 30cm).

ADS = Anterior drawer sign.

Adapted from:

Kaikkonen, A., Kannus, P. and Jarvinen, M. 1994. A Performance Test Protocol and Scoring Scale for the Evaluation of Ankle Injuries. American Journal of Sports Medicine. 22(4): 462-469.

File No.: \_\_\_\_\_ Group: \_\_\_\_\_

## Consultation 1

Date: \_\_\_\_\_

I	Subjective Assessment of the injured ankle		VI	Rising on toes with injured leg	
	No symptoms of any kind	15		More than 40 times	10
	Mild symptoms	10		30-39 times	5
	Moderate symptoms	5		Fewer than 30 times	0
II	Severe Symptoms	0	VII	Single limb stance with injured leg	10
	Can you walk normally?			Longer than 55 seconds	5
Yes	15	50-55 seconds		0	
III	No	0	Less than 55 seconds		
	Can you run normally?		VIII	Laxity of the ankle joint (ADS)	10
Yes	10	Stable (<5mm)		5	
No	0	Moderate stability (6-10mm)		0	
IV	Climbing down stairs		Severe instability (>10mm)		
	Less than 18 seconds	10	IX	Dorsiflexion range of motion of injured leg	
	18 to 20 seconds	5		$\geq 10^\circ$	10
Longer than 20 seconds	0	$5^\circ-9^\circ$		5	
V	Rising on heel with injured leg		$<5^\circ$	0	
	More than 40 times	10			
	30-39 times	5			
	Fewer than 30 times	0			

## Consultation 2

Date:

I	Subjective Assessment of the injured ankle		VI	Rising on toes with injured leg	
	No symptoms of any kind	15		More than 40 times	10
	Mild symptoms	10		30-39 times	5
	Moderate symptoms	5		Fewer than 30 times	0
II	Can you walk normally?		VII	Single limb stance with injured leg	
	Yes	15		Longer than 55 seconds	10
No	0	50-55 seconds		5	
III	Can you run normally?		VIII	Less than 55 seconds	0
	Yes	10		Laxity of the ankle joint (ADS)	
No	0	Stable (<5mm)		10	
IV	Climbing down stairs		Moderate stability (6-10mm)	5	
	Less than 18 seconds	10	Severe instability (>10mm)	0	
	18 to 20 seconds	5			
V	Rising on heel with injured leg		IX	Dorsiflexion range of motion of injured leg	
	More than 40 times	10		$\geq 10^\circ$	10
	30-39 times	5		$5^\circ-9^\circ$	5
	Fewer than 30 times	0		$< 5^\circ$	0

**Consultation 3**

Date: \_\_\_\_\_

I	Subjective Assessment of the injured ankle		VI	Rising on toes with injured leg	
	No symptoms of any kind	15		More than 40 times	10
	Mild symptoms	10		30-39 times	5
	Moderate symptoms	5		Fewer than 30 times	0
	Severe Symptoms	0			
II	Can you walk normally?		VII	Single limb stance with injured leg	
	Yes	15		Longer than 55 seconds	10
	No	0		50-55 seconds	5
III	Can you run normally?		VIII	Laxity of the ankle joint (ADS)	
	Yes	10		Stable (<5mm)	10
	No	0		Moderate stability (6-10mm)	5
IV	Climbing down stairs		IX	Severe instability (>10mm)	0
	Less than 18 seconds	10		Dorsiflexion range of motion of injured leg	
	18 to 20 seconds	5		≥10°	10
V	Longer than 20 seconds	0	5°-9°	5	
	Rising on heel with injured leg		<5°	0	
	More than 40 times	10			
	30-39 times	5			
	Fewer than 30 times	0			

**Scores**

Consultation 1 \_\_\_\_\_

Consultation 2 \_\_\_\_\_

Consultation 3 \_\_\_\_\_

**Patient information sheet**

Dear Participant

The aim of this study is to evaluate the relative efficacy of chiropractic management of subacute and chronic, grades one and two inversion ankle sprains.

Thirty people will be required to complete this study. The participants will be randomly divided into two groups of 15 patients each. Patients in both groups will receive treatment.

One group will receive the actual treatment whilst the other group will receive no treatment. There is a 50% chance that of being in either group.

If necessary, participants will have x-rays taken of their injured ankles in order to rule out fractures and other possible contraindications to the treatment. Patients taking any medication, or undergoing any form of treatment, for their ankle injury, will be excluded from the study.

Patients will be to return for a maximum of eight follow-up consultations spread equally over four weeks, and an additional one-month follow-up visit following the final treatment.

All treatments will be performed under the supervision of a qualified chiropractor and will be free of charge.

Thank you.

Yours faithfully  
Justin Pellow  
(Chiropractic Resident)

APPENDIX F

1 of 1

Informed consent form

Date: \_\_\_\_\_

TITLE OF RESEARCH PROJECT

\_\_\_\_\_  
\_\_\_\_\_

NAME OF SUPERVISOR

\_\_\_\_\_

NAME OF RESEARCH STUDENT

\_\_\_\_\_

PLEASE CIRCLE THE APPROPRIATE ANSWER

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

Fill in below in block letters

PATIENT/SUBJECT Name \_\_\_\_\_ Signature \_\_\_\_\_

PARENT/GUARDIAN Name \_\_\_\_\_ Signature \_\_\_\_\_

WITNESS Name \_\_\_\_\_ Signature \_\_\_\_\_

RESEARCH STUDENT Name \_\_\_\_\_ Signature \_\_\_\_\_

APPENDIX G

1 of 4

TECHNIKON NATAL CHIROPRACTIC DAY CLINIC  
CASE HISTORY

Patient: \_\_\_\_\_ Date: \_\_\_\_\_  
file #: \_\_\_\_\_ X-Ray#: \_\_\_\_\_  
Age: \_\_\_\_\_ Sex: \_\_\_\_\_ Occupation: \_\_\_\_\_  
Intern: \_\_\_\_\_ Signature: \_\_\_\_\_

**FOR CLINICIAN'S USE ONLY**

Initial visit clinician: \_\_\_\_\_ Signature: \_\_\_\_\_

**Case History:**

**Examination:**

Previous:

Current:

**X-Ray Studies:**

Previous:

Current:

**Clinical Path. lab:**

Previous:

Current:

**Case Status:**

PTT:

Conditional:

Signed Off:

Final Sign out:

Recommendations:

Intern's Case History

1. Source of History:
2. Chief Complaint: (patient's own words)

3. Present Illness:

- ▶ Location
- ▶ Onset
- ▶ Duration
- ▶ Frequency
- ▶ Pain (Character)
- ▶ Progression
- ▶ Aggravating Factors
- ▶ Relieving Factors
- ▶ Associated S & S
- ▶ Previous Occurrences
- ▶ Past Treatment and Outcome

4. Other Complaints:

5. Past Medical History:

- ▶ General Health Status
- ▶ Childhood Illnesses
- ▶ Adult Illnesses
- ▶ Psychiatric Illnesses
- ▶ Accidents/Injuries
- ▶ Surgery
- ▶ Hospitalizations

6. Current health status and life-style:

- ▶ Allergies
- ▶ Immunizations
- ▶ Screening Tests
- ▶ Environmental Hazards (Home, School, Work)
- ▶ Safety Measures (seat belts, condoms)
- ▶ Exercise and Leisure
- ▶ Sleep Patterns
- ▶ Diet
- ▶ Current Medication
- ▶ Tobacco
- ▶ Alcohol
- ▶ Social Drugs

7. Immediate Family Medical History:

- ▶ Age
- ▶ Health
- ▶ Cause of Death
- ▶ DM
- ▶ Heart Disease
- ▶ TB
- ▶ Stroke
- ▶ Kidney Disease
- ▶ CA
- ▶ Arthritis
- ▶ Anaemia
- ▶ Headaches
- ▶ Thyroid Disease
- ▶ Epilepsy
- ▶ Mental Illness
- ▶ Alcoholism
- ▶ Drug Addiction
- ▶ Other

8. Psychosocial history:

- ▶ Home Situation and daily life
- ▶ Important experiences
- ▶ Religious Beliefs

9. Review of Systems:

- ▶ General
- ▶ Skin
- ▶ Head
- ▶ Eyes
- ▶ Ears
- ▶ Nose/Sinuses
- ▶ Mouth/Throat
- ▶ Neck
- ▶ Breasts
- ▶ Respiratory
- ▶ Cardiac
- ▶ Gastro-intestinal
- ▶ Urinary
- ▶ Genital
- ▶ Vascular
- ▶ Musculoskeletal
- ▶ Neurologic
- ▶ Haematologic
- ▶ Endocrine
- ▶ Psychiatric

## Foot and ankle regional examination

Patient: \_\_\_\_\_ File no: \_\_\_\_\_ Date: \_\_\_\_\_  
Intern: \_\_\_\_\_ signature: \_\_\_\_\_  
Clinician: \_\_\_\_\_ signature: \_\_\_\_\_

### Observation

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

Swelling \_\_\_\_\_  
Heloma dura \_\_\_\_\_  
Skin \_\_\_\_\_  
Nails \_\_\_\_\_  
Shoes \_\_\_\_\_

### Active movements

<i>weight bearing:</i>	<i>Non weight bearing:</i>
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 _____

### Resisted Isometric movements:

Knee flexion \_\_\_\_\_  
Plantar flexion \_\_\_\_\_  
Dorsiflexion \_\_\_\_\_  
Supination (inversion) \_\_\_\_\_  
Pronation (eversion) \_\_\_\_\_  
Toe extension (dorsiflexion) \_\_\_\_\_  
Toe flexion (plantar flexion) \_\_\_\_\_

### Passive movement motion palpation

(Passive ROM quality, ROM overpressure, joint play)

Ankle joint: *Plantarflexion* \_\_\_\_\_ *Dorsiflexion* \_\_\_\_\_  
Talocrural: *Long axis distraction* \_\_\_\_\_  
Subtalar joint: *Varus* \_\_\_\_\_ *Valgus* \_\_\_\_\_  
First ray: *Dorsiflexion* \_\_\_\_\_ *Plantarflexion* \_\_\_\_\_

Circumduction of forefoot on fixed rearfoot: \_\_\_\_\_  
Midtarsal: A-P glide \_\_\_\_\_ P-A glide \_\_\_\_\_ rotation \_\_\_\_\_  
Tarso metatarsal joints: A-P \_\_\_\_\_  
Intermetatarsal glide: \_\_\_\_\_  
Metatarsophalangeal dorsiflexion (with associated plantar flexion of each toe) \_\_\_\_\_  
Interphalangeal joints: long axis distraction \_\_\_\_\_ A-P glide \_\_\_\_\_  
lat and med glide \_\_\_\_\_ rotation \_\_\_\_\_

**Special tests**

Anterior drawer test \_\_\_\_\_  
Talar tilt \_\_\_\_\_  
Thompson test \_\_\_\_\_  
Homan sign \_\_\_\_\_  
Tinel's sign \_\_\_\_\_  
Subtalar neutral position \_\_\_\_\_  
Balance/proprioception \_\_\_\_\_  
Test for rigid/flexible flatfoot \_\_\_\_\_

**Alignment**

Heel to ground \_\_\_\_\_  
Feiss line \_\_\_\_\_  
Tibial torsion \_\_\_\_\_  
Heel to leg (subtalar neutral) \_\_\_\_\_  
Forefoot to heel (subtalar & Midtarsal neutral) \_\_\_\_\_  
First ray alignment \_\_\_\_\_  
Digital deformities \_\_\_\_\_  
Digital deformity flexible \_\_\_\_\_

**Palpation**

*Anteriorly*

Medial malleoli \_\_\_\_\_  
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 \_\_\_\_\_

TECHNIKON NATAL CHIROPRACTIC DAY CLINIC

**PHYSICAL EXAMINATION**

Patient: \_\_\_\_\_ File#: \_\_\_\_\_ Date: \_\_\_\_\_  
 Clinician: \_\_\_\_\_ Signature: \_\_\_\_\_  
 Intern: \_\_\_\_\_ Signature: \_\_\_\_\_

**1. VITALS**

Pulse rate:  
 Respiratory rate:  
 Blood pressure:        R                                L  
 Temperature:  
 Height:  
 Weight:

**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:

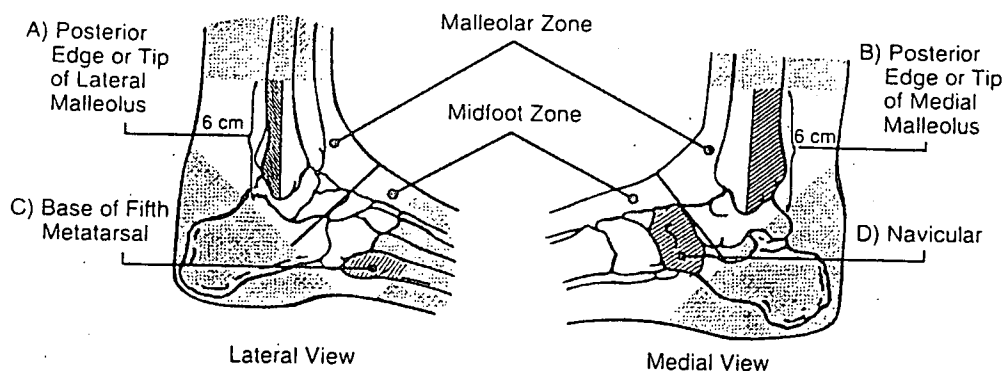
9. **BREAST EXAMINATION:**

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:

## DECISION RULES FOR THE USE OF ANKLE RADIOGRAPHY



An ankle radiographic series is only required if there is any pain in malleolar zone and any of these findings:

1. bone tenderness at A  
or
2. bone tenderness at B  
or
3. inability to bear weight both immediately and in emergency department

A foot radiographic series is only required if there is any pain in midfoot zone and any of these findings:

1. bone tenderness at C  
or
2. bone tenderness at D  
or
3. inability to bear weight both immediately and in emergency department

Adapted from:

Stiell, I.G., Greenberg, G.H., McKnight, R.D., Nair, R.C., McDowell, I. Reardon, M., Stewart, J.P. and Maloney, J. 1993. Decision Rules for the Use of Radiography in Acute Ankle Injuries. Journal of the American Medical Association, 271(11): 827-832.