THE EFFECTIVENESS OF MANIPULATION COMBINED WITH STATIC STRETCHING OF THE GASTROCNEMIUS-SOLEUS COMPLEX COMPARED TO MANIPULATION ALONE IN THE TREAMENT OF SUBACUTE AND CHRONIC GRADES I AND II ANKLE INVERSION SPRAINS.

BY

KIM JANE NEEDHAM

A dissertation presented to the faculty of Health at Technikon Natal in partial compliance with the requirements for the Master's Degree in Technology: Chiropractic.

I, Kim Jane Needham do hereby declare that this dissertation represents my own work in both conception and execution.

Signed: ____________ Date: 25/10/01

Approved for final submission

Dr. H. White, B.Sc., B.Ed., M.Tech: Chiro., CCFC, MCASA, SCA.

Supervisor

Signed: ____________ Date: 25/10/01

DEDICATION

To my loving husband, my tower of strength and my inspiration.

ACKNOWLEDGEMENTS

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

My parents, Roy and Carol Mitchell, whose love and support financially and otherwise, enabled me to reach this goal.

Dr. H. White for all your help, guidance and encouragement when I needed it most.

All the patients who participated in this study, and who made this study possible.

Mrs Ireland, Pat and Linda whose help made this research study just that much easier.

Mr K. Thomas, Shanie and Sonia for all your help regarding statistics.

ABSTRACT

The purpose of this study was to evaluate the relative effectiveness of chiropractic manipulation alone compared to chiropractic manipulation in conjunction with gastrocnemius and soleus stretching in the treatment of subacute and chronic grade I and II ankle inversion sprains.

It was hypothesized that, in terms of subjective and objective clinical findings, the combination of chiropractic manipulation with gastrocnemius and soleus stretching would be more effective as a treatment protocol than the chiropractic manipulation alone.

This comparative, randomized, controlled clinical trial consisted of sixty patients between the ages of 15 and 50 years. Once selected, these patients were screened according to inclusion and exclusion criteria and randomly divided into two groups consisting of 30 patients in each. Group 1 received manipulation of the ankle mortise joint and Group 2 received a combination of manipulation and gastrocnemius and soleus static stretching, with a maximum of six treatments over a two week period or until the patient was symptom free. Readings were taken at the initial consultation and again at the final consultation after the final treatment.

Statistical analysis of the data was performed using the SPSS version 9.0 package and recorded in the form of graphs and tables. Both parametric and non-parametric statistical analysis was used. Inter-group analysis of data consisted of the Mann-Whitney U-Test and the Unpaired T-Test, in order to detect any differences between the two treatment groups from the initial to the final consultation. Intra-group analysis of data consisted of the Wilcoxon Signed Ranks Test and the Paired T-Test, in order to detect any improvement within each individual group from the initial to the final consultation. A 5 % level of significance was set for all tests.

Inter-group data analysis showed a statistically significant difference between treatment group 1 and treatment group 2 from the initial to the final consultation, in terms of overall ankle functioning. This difference indicated that treatment group 2 improved significantly better than treatment group 1. Other than this, no other statistically significant difference was found between treatment group 1 and treatment group 2 in terms of the rest of the subjective and the objective findings.

Intra-group data analysis showed a statistically significant improvement within both treatment group 1 and treatment group 2 from the initial to the final consultation, in terms of all subjective and objective clinical findings.

In conclusion, the group receiving manipulation and stretching (group 2) responded better in terms of overall ankle functioning as compared to the group receiving manipulation alone (group 1).

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

DEFINITIONS

CAPSULAR PATTERN:

Limit of movement in a specific pattern which is peculiar to each joint and indicates the presence of arthritis (Kesson and Atkins, 1998:461).

CLOSE-PACKED POSITION:

The position in which a joint is most stable, when the joint surfaces fit closely together and are maximally congruent (Kesson and Atkins, 1998:461).

DORSIFLEXION:

Dorsiflexion is movement toward the dorsal surface (Schafer and Faye, 1989:31).

END-FEEL:

A specific sensation imparted through the examiners hands at the extreme of passive movement (Kesson and Atkins 1998:461).

EVERSION:

Eversion of the foot means to turn the plantar surface outward in relation to the leg (Schafer and Faye, 1989:31).

INVERSION:

A type of adduction of the foot where the plantar surface is turned inward (Schafer and Faye, 1989:31).

JOINT DYSFUNCTION:

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

MANIPULATION:

A manual procedure that involves a direct thrust to move a joint past the physiologic range of motion without exceeding the anatomic limit (Gatterman, 1995:12).

MOBILISATION:

Movement applied singularly or repetitively within or at the physiologic range of joint motion, without imparting a thrust or impulse, with the goal of restoring joint mobility (Gatterman, 1995:12).

PLANTARFLEXION:

Plantarflexion is the opposite of dorsiflexion and is movement towards the plantar surface (Schafer and Faye, 1989:31).

PROPRIOCEPTION:

Sensing the motion and position of the body (Gatterman, 1990:413).

SPRAIN:

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

STRETCHING:

Separation of the origin and insertion of a muscle or attachments of fascia or ligaments by applying constant pressure at a right angle to the fiber of the muscle or fascia (Gatterman, 1990:415).

CHAPTER ONE

CHAPTER ONE

1.1 INTRODUCTION

Although ankle sprains may be thought of by some to be minor injuries, their incidence is fairly high. According to Jerosch and Bischof (1996:167), the literature indicates that the overall incidence of ankle sprains is approximately 16% and that ankle inversion sprains are one of the most common musculoskeletal injuries, particularly amongst sportspersons. Parker, et al. (1997:1), explain that although this may be less disruptive in those with a more sedentary lifestyle, in athletes or those with more demanding work, such injuries may have an important life-long effect.

When a stress is placed on a joint, the ligaments play a major role to provide mechanical restraint to abnormal movement (Lephart and Fu, 1995:96). They go further to say that injury to these tissues results in an inherent loss of mechanical stability to the joint, leading to aberrations to normal kinematics.

It has been calculated that during walking, the force across the ankle joint is about 4½ times the body weight and that this force is present at 40% of the walking cycle (Mann and Mann, 1995:387). It can therefore be determined that a great deal of force is applied to the ankle even with the routine demands of daily living and this force can occasionally be sufficient enough to result in ligamentous injury. (Harris, 1995:525).

The most common mechanism of injury, according to Parker, et al. (1997:1), is internal rotation of the plantarflexed foot. Furthermore, they explain that injury occurs first to the anterior talofibular ligament, followed by injury to the calcaneofibular ligament, and that the posterior talofibular ligament is usually uninjured unless there is frank dislocation. Mann and Mann (1995:443) expand on this by suggesting that the severity of the inversion stress and the ankle joint position will determine the degree of injury, as well as which ligaments are involved.

Reid (1992:226) classifies ankle sprains according to three grades which are described in more detail further on in chapter two (page 30) as well as in tabulated form (Appendix A).

According to Kesson and Atkins (1998:348), mismanagement of a sprained ankle can result in a chronic persistent condition and a likelihood of recurrence. This may be one of the reasons why ankle injuries result in considerable morbidity and financial cost (Olgivie-Harris and Gilbart ,1995:175).

Treatment of ankle sprains is very controversial (Glick, et al. 1976:136) and Eiff, et al. (1994:83) explain, that no accepted single method of treatment predominates with ankle sprains, despite the frequency of this injury and the potential for significant morbidity. Singer, et al. (1995:424) advise that these injuries should be carefully evaluated and treated aggressively to prevent further disability. They go on to say that lateral ligamentous injuries to the ankle are frequently under treated.

Conservative methods of treatment are predominantly used for grade 1 and 2 sprains (Parker, et al. 1997:1).

Manipulation has been used for many years in the treatment of spinal and peripheral musculoskeletal disorders (Nield, et al. 1993:163). Kesson and Atkins (1998:372,79) describe, that with a chronic lateral ligament sprain of the ankle there is adherence of ligament fibers to underlying bone, and suggest that the principle treatment at each treatment session should be manipulation so as to rupture unwanted adhesions. Furthermore they explain that permanent elongation and restoration of full painless function is achieved by the rupturing of these unwanted adhesions by means of manipulation.

According to Cahill (1973:38), heelcord tightness is a frequent condition found in the young athlete. He goes on to mention that because the ankle cannot be dorsiflexed, these athletes are subject to chronic fibular collateral ligament strains. When forced into extreme dorsiflexion against a tight heelcord, he further explains, that the subtalar joint, due to the normal buffering aspect of the medial malleolus and the extremely taut deltoid ligament, tends to supinate resulting in additional stress on the fibular collateral ligament which experiences chronic strain. He advises that this is a common condition in which the ankle sprain is usually treated rather than the heelcord tightness and further suggests that the only treatment is repeated heelcord stretching exercises.

According to McCluskey, et al. (1976:153,154) in their study on the recording of dorsiflexion in over 1000 preseason athletic physicals, early results were showing a decrease in the occurrence of severe ankle sprains due to routine heelcord stretching. Singer, et al. (1995:427) also mention heelcord stretching as part of a treatment regime for lateral ligamentous injuries of the ankle.

The results of this study may help to determine the effectiveness of combining manipulation, a recommended treatment of choice (Kesson and Atkins, 1998:372; Pellow and Brantingham, 2001:23; Lawrence, 1994:283; Bergmann, et al. 1993:707), with gastrocnemius-soleus muscle stretching, a suggested adjunct (McCluskey et al. 1976:153), for the treatment of chronic grade I and II ankle inversion sprains.

1.2 OBJECTIVES OF THE STUDY

The purpose of this randomized controlled study was to determine the effectiveness of manipulation combined with static stretching of the gastrocnemius-soleus complex, compared to manipulation alone in the treatment of subacute and chronic grade I and II ankle inversion sprains in terms of subjective and objective clinical findings.

The first objective is to determine the effectiveness of manipulation alone compared to manipulation in conjunction with static stretching of the gastrocnemius-soleus complex in terms of subjective clinical findings.

The second objective is to determine the effectiveness of manipulation alone compared to manipulation in conjunction with static stretching of the gastrocnemius-soleus complex in terms of objective clinical findings.

1.3 STATEMENT OF THE HYPOTHESIS

It is hypothesized that a combination of chiropractic manipulation and static stretching of the gastrocnemius and soleus muscles i.e. group 2, will prove to be a more effective treatment protocol in terms of subjective and objective data, as compared to chiropractic manipulation alone i.e. group 1.

CHAPTER TWO

CHAPTER TWO – LITERATURE REVIEW

2.1 INTRODUCTION

The review of the related literature will describe the anatomy and biomechanics of the ankle joint, as well as the incidence and prevalence of ankle sprains. Diagnosis and grading of ankle sprains, differential diagnosis and chronic sprains will also be discussed. Furthermore, a description of the mechanism of injury, the natural history of ankle sprains and connective tissue healing will be given. Finally, treatment in the form of manipulation, stretching and a few other conservative approaches will be discussed, along with indications and contraindications to extremity manipulation.

2.2 ANATOMY AND BIOMECHANICS OF THE ANKLE

2.2.1 Osteology

Miller (1998:69) explains that ankle joint anatomy is inherently tied to function and that failure to appreciate bony or ligamentous damage may result in joint instability.

Donatelli (1990:14) advises that the talocrural joint is a very efficient weightbearing structure. This ankle/mortise joint is located between the talus, the medial malleolus of the tibia, and the lateral malleolus of the fibula and is a uniaxial, modified hinge, synovial joint (Magee, 1997:599). He goes on to explain that while the medial malleolus extends only halfway down the talus, the lateral malleolus is longer extending almost to the level of the subtalar joint. This, according to Mack (1982:71), provides greater bony stability for the lateral side of the ankle joint.

An articular facet is present on the lateral malleolus of the fibula, which faces medially and articulates with the facet on the lateral surface of the talus (Moore, 1992:488). There is articulation between the tibia and the talus in two places (1) the roof of the mortise is formed by its inferior surface, which is wider anteriorly than posteriorly and slightly concave from anterior to posterior; and (2) the lateral surface of its medial malleolus articulates with the talus (Moore, 1992:488). He then clarifies that the talus' three articular facets articulate with the inferior surface of the tibia and malleoli. Moore (1992:488) further points out that because of its pulley-like shape, the superior articular surface of the talus is often called the trochlea and is wider anteriorly than posteriorly, convex from anterior to posterior and slightly concave from side to side. In addition, it is explained by Mack (1982:71) that the reason for the trochlea being wider anteriorly than posteriorly is that instead of being parallel to the medial wall, the lateral wall slopes outward.

Dorsiflexion is the closed-packed position of the talocrural joint, explains Donatelli (1990:10). Because of its shape, the talus becomes wedged between the malleoli in dorsiflexion, thus allowing little or no inversion or eversion at the ankle joint but when going into plantarflexion, the narrower posterior portion of the talus and the wider anterior portion of the tibia are brought into contact, and the wedge effect noted in dorsiflexion is lost, which permits a small amount of free play in the ankle (Mack, 1982:71). Static support is given to the ankle by surrounding ligament complexes and dynamic support by musculotendinous units crossing the ankle (Baker and Todd, 1995:51).

Classically, according to Norkin and Levangie (1992:385), the ankle joint is considered to move around a single axis and contributes one degree of freedom to the foot when it is free to move, or to the tibia and fibula when the foot is weightbearing. They go on further to clarify that dorsiflexion and plantarflexion predominate at the talocrural joint and that these motions do not occur purely in the saggital plane, they are a single motion, which crosses three planes. They add to this by explaining that the ankle joint axis obliquity and the shape of the talus' body, attribute to the triplanar motion. According to Moore (1992:488), plantarflexion range is greater than that of dorsiflexion, but there is considerable variation in these movements. Norris (1993:306) points out that the capsular pattern of the ankle joint, presents as a greater limitation of plantarflexion.

2.2.2 Ligaments

Ankle stability is achieved in flexion and extension, by means of its saddle shape and its three malleoli, however ligaments and the capsule provide additional stability (Sammarco, 1998:7).

The ankle capsule anteriorly, as well as posteriorly, is thin and structurally insignificant, however, medially and laterally the capsule thickens and blends with the stabilizing ankle ligaments (Baker and Todd, 1995:51). Superiorly, it is attached to the borders of the articular surfaces of the tibia and the malleoli, while inferiorly it is attached to the talus close to the superior articular surface, except anteroinferiorly, where the attachment is to the dorsum of the neck of the talus (Moore, 1992:488).

Medially, the ankle is stabilized by the strong, flat, fan-shaped deltoid ligament that has been described as having deep and superficial fibers (Reid, 1992:218). Furthermore he reports that for the most part, these fibers form a large, continuous bundle around the tip of the medial malleolus, extending to the navicular, sustentaculum tali and posterior area of the talus. Norris (1993:306) expands on this by explaining that the superficial part is split into the tibionavicular and tibiocalcaneal portions, whilst the deep portion may be divided into anterior and posterior tibiotalar bands. The strength of the deltoid ligament is necessary because of the decreased bony protection medially (Mack, 1982:74).

The lateral ligament is composed of three separate components, and is somewhat weaker than its medial counterpart (Norris, 1993:306). They go on further to describe the anterior talofibular (ATF) ligament as a flat, broad band that travels from the anterior tip of the lateral malleolus to the neck of the talus. Baker and Todd (1995:52) advise that the ATF ligament is the primary stabilizer when the foot is plantarflexed and acts as a collateral ligament. They go on to conclude that the lateral ankle ligaments are therefore the most vulnerable to injury in an inversion sprain. The posterior talofibular (PTF) ligament travels almost horizontally from the fossa on the bottom of the lateral malleolus to the posterior surface of the talus

(Norris, 1993:204). Baker and Todd (1995:52) explain that only after disruption of both the ATF ligament and calcaneofibular ligament does the PTF ligament serve as a primary stabilizer. Lying between the ATF and PTF ligaments is the calcaneofibular (CF) ligament, arising from the front of the lateral malleolus to pass down and back to attach on to the lateral surface of the calcaneum (Norris, 1993:204). The location of the CF ligament is deep to the peroneal tendon sheath at the inferior tip of the fibula (Baker and Todd, 1995:52). In addition they explain that it is lax during plantarflexion and taut during dorsiflexion as compared with the ATF ligament and that this ligament's role in providing lateral ankle stability is unclear.

The ligament that maintains the relationship of the tibia and fibula is the syndesmosis (Mack, 1982:77,78). He further points out that it consists of anterior and posterior tibiofibular ligaments and an interosseous membrane. The anterior and posterior tibiofibular ligaments blend into the interosseous membrane 2-3 cm above the ankle joint and function in holding the fibula in the groove of the tibia (Mack, 1982:78). The interosseous ligament, a continuation of the interosseous membrane of the tibia and fibula, extends between the adjacent surfaces of the bones at the syndesmosis (Hertling and Kessler, 1990:365). They go on to describe a fat pad, which separates the tibia and fibula at the syndesmosis. Orientation of the ligaments of the inferior tibiofibular articulation is to prevent widening of the mortise, as well as to prevent posterior displacement of the fibula at the syndesmosis, which tends to occur when the leg is forcibly internally rotated on the tarsus. (Hertling and Kessler, 1990:366)

2.2.3 Muscles and Tendons

Muscles and tendons, which act as secondary stabilizers, are often injured in ankle sprains (Trojian and McKeag, 1998:3). According to Mack (1982:78), important musculotendinous structures are related to the deltoid and lateral collateral ligaments of the ankle. He goes on to explain that it is important to have knowledge of these muscles so as to understand methods of ankle injury prevention, as well as for rehabilitation of athletes following an ankle injury.

The muscles of the ankle are located in the calf, and can be divided into positional groups and also according to the actions they perform (Bergmann, et al. 1993:692,695).

The posterior tibialis, flexor digitorum communis, and the flexor hallucis longus form the medial stabilizers of the ankle and originate from the posterior compartment of the leg and pass posteriorly and inferiorly to the medial malleolus (Mack, 1982:78). The posterior and middle parts of the deltoid ligament is covered by the tibialis posterior muscle, which explains why this tendon is often trapped between the talus and medial malleolus and blocks reduction of deltoid ruptures (Mack, 1982:78). These muscles along with the tibialis anterior and extensor hallucis longus muscles, produce inversion of the ankle (Magee, 1997:628).

The tibial nerve innervates the tibialis posterior muscle (L4-L5 nerve root), the flexor digitorum longus and flexor hallucis longus muscles are innervated by the tibial nerve

(S2-S3 nerve root), and the tibialis anterior and extensor hallucis longus muscles are innervated by the deep peroneal nerve (L4-L5 and L5-S1 nerve roots respectively) (Magee, 1997:628).

Mack (1982:78,79) explains that the lateral stabilizers of the ankle, which make up the lateral compartment of the leg, are the peroneal muscles. Furthermore he describes their path with the peroneus brevis and longus passing distal and inferior to the lateral malleolus. He goes on to conclude that because the peroneal tendon sheath covers the posterior and lateral portion of the CF ligament, when this ligament is ruptured the overlying innerwall of the peroneal tendon sheath is also torn because it lies adjacent to the ligament. Additionally he explains that because of the intricate relationship between these muscles and the stabilizing ligaments of the ankle, they are capable of absorbing stress and protecting these ligaments from injury. This protective role is confirmed by Konradsen, et al. (1997:54). The peroneus longus and brevis, along with the peroneus tertius and extensor digitorum longus are involved in everting the foot (Magee, 1997:628).

The peroneus longus and brevis muscles are innervated by the superficial peroneal nerve (L5, S1 and S2 nerve roots) and the peroneus tertius and extensor digitorum longus muscles are innervated by the deep peroneal nerve (L5 and S1 nerve roots) (Magee, 1997:628).

Bergmann, et al. (1993:692) point out that posteriorly, the gastrocnemius, soleus and plantaris muscles are responsible for plantarflexion of the foot and ankle. The large gastrocnemius muscle group attaches from the femoral condyles, proximal fibula, and tibia to the calcaneus (Bergmann, et al. 1993:692). Plantarflexion at the ankle joint is also aided by the flexor digitorum longus, peroneous longus, peroneous brevis, flexor hallucis longus and tibialis posterior muscles (Magee, 1997:628).

The gastrocnemius, soleus and plantaris muscles are all innervated by the tibial nerve (S1-S2 nerve root) (Magee, 1997:628).
Anteriorly, the extensor hallucis longus, extensor digitorum longus, peroneus tertius and tibialis anterior serve primarily in dorsiflexion of the foot and extension of the toes (Bergmann, et al. 1993:694).

Like all of the above muscles, the tibialis anterior is innervated by the deep peroneal nerve, but unlike them, it has a nerve root derivation from L4 and L5 (Magee, 1997:628).

2.2.4 Blood Supply

Articular arteries supplying the ankle are derived from the malleolar branches of the fibular (peroneal) and anterior and posterior tibial arteries (Moore, 1992:490). The anterior and posterior tibial arteries are divisions of the popliteal artery. (Richardson and Iglarsh, 1994:501)

2.2.5 Nerve supply

The articular nerves are derived from the tibial nerve and the deep fibular (peroneal) nerve, a division of the common fibular (peroneal) nerve (Moore, 1992:490).

2.2.6 The Subtalar Joint

According to Reid (1992:215), key motions of inversion and eversion take place at the subtalar joint and thus this joint must be included in the functional unit of the ankle. The motions of the joint are approximately 30° of inversion and approximately 10° of eversion (Mann and Mann, 1995:387), with the gastrosoleus and posterior calf muscles controlling inversion of the subtalar joint (Mann, 1998:41). Donatelli (1990:11) explains that the subtalar joint assists the ankle in the accommodation of the transverse rotations of the lower limb.

The bones making up the subtalar joint are the talus and calcaneus (Donatelli, 1990:14). It is a synovial joint and is surrounded by an articular capsule (Moore, 1992:488). Although weak, Moore (1992:488) goes on to explain, that the fibrous capsule is supported by medial, lateral and posterior talocalcaneal ligaments, as well as being supported anteriorly by the interosseous talocalcanean ligament.

Norkin and Levangie (1992:388) advise that there are three articulations which are found between the talus and calcaneus, with the posterior talocalcaneal articulation being the largest. They go on to describe the anterior and middle talocalcaneal articulations as being smaller and sharing a capsule with the talonavicular joint unlike the posterior articulation, which has its own capsule (Norkin and Levangie, 1992:388).

Norkin and Levangie (1992:389) suggest that although the subtalar joint has three articulations, the potential mobility of the joint is limited by the alternating convex-concave facets. Furthermore they describe the subtalar joint as a uniaxial joint with one degree of freedom: supination/pronation (Norkin and Levangie, 1992:389).

2.3 INCIDENCE AND PREVALENCE

Ligament sprains of the ankle are the most common musculoskeletal complaint in the emergency room, and they also make up a great deal of private office practice (Boruta, et al. 1990:107). According to Oloff (1994:243), the most common traumatic injury seen in sports medicine is the ankle injury. Garrick (1977:241) describes the thigh, knee and ankle as the three most commonly injured areas when considering interscholastic or intercollegiate sports. Furthermore he explains that the vast majority (85%) of injuries to the ankle are of a single type, sprains, and an equally high proportion of the sprains involve the same (lateral) structures. Thus he concludes, that in athletes, the most frequently injured structure in the body is the lateral ligament complex of the ankle. Riddle (1994:539) confirms this by pointing out that in most epidemiological studies it is reported that of all ankle sprains, approximately 95% are lateral while only approximately 5% occur on the medial side of the ankle.

Mack (1982:71) suggests that ankle injuries constitute up to 25% of all time-loss injuries in running and jumping sports. In a study by Garrick and Requa (1988:30), on the epidemiology of foot and ankle injuries in sport, the findings indicated that of 16,754 injuries which occurred in the 19 most frequently cited sports, the foot and ankle made up 25.2 percent of the injuries in the 19 sports and that over half (50.4%) of the injuries at the ankle were sprains. In the same study, the sport with the highest proportion of sprains was volleyball (82%), with cycling having the lowest with 20%. However, Fallat, et al. (1998:30) states that the prevailing athletics of a certain geographical region, will determine the most common athletic cause of injury in that region.

In an epidemiological survey carried out by Yeung, et al. (1994:113-115) on 380 athletes, 48.2% of the athletes reported having bilateral ankle sprains, whilst 51.8% had unilateral sprains. The results went on to show that of the athletes presenting with unilateral ankle sprains, injury solely to the dominant ankle was 2.40 times higher than solely to the non-dominant side. Only 41% of the injured ankles in this study were reported to be completely symptom free, whilst 59% of those questioned complained of one or more residual symptom(s) of pain, crepitus, instability and/or weakness in their ankles. 30.2% of the athletes in this study complained about pain around the ankle(s) and this was the major complaint of the athletes, whilst the major complaint for the athletes with multiple episodes of sprains became ankle instability or giving way. This study also showed that the number of occurrences of the ankle sprain was related to the degree to which athletic performance was affected, with the recurrence rate of ankle sprains for athletes in this study group being 73.5%. In a study by Tropp, et al. (1985:260) the results showed that 48 out of 439 players had experienced previous ankle problems with one or both ankles.

A study by Fallat, et al. (1998:282) of 639 patients over a 33 month period who had incurred a twisting injury to the ankle, found that the left ankle was affected 48.2% of the time, whilst the right ankle was affected 51.8% of the time. The sole involvement of the lateral ligaments was also recorded, with the anterior talofibular ligament (ATFL), calcaneofibular ligament (CFL) an posterior talofibular ligament being involved 16.5%, 0.7% and 1.6% of the time respectively, and with the most common pattern being the ATFL and CFL in 34.2% of the patients.

In Fallat, et al.'s (1998:281) study, the age groups involved ranged from 4 – 85 years with an average being 34 years old. In the same study, 54.8% of the patients were male, whilst 45.2% were female. According to Garrick (1977:241), the ankle has provided equal opportunities to be injured regardless of sex. He goes on to say that women basketball players have a frequency of ankle sprains equal to that of men. Furthermore he points out that of 106 injuries yielded in a recent study of 317 women gymnasts competing at high school, college and club levels, 13% involved the ankle.

Garrick and Requa (1988:29) explain that although foot and ankle injuries in sports are exceedingly common, at the same time they appear to be less exciting than injuries to other parts, like the knee and shoulder, perhaps because of fewer opportunities for dramatic surgical improvement or perhaps little sense that serious disabilities could occur as a result of injuries to these areas.

2.4 MECHANISM OF INJURY

According to Bassewitz and Shapiro (1997:1), the magnitude of the applied force (usually the body weight) and the position of the ankle at the time of the injury, determines the degree and type of damage sustained by the ankle. Mack (1982:79) points out, that inversion sprains are the most common, and it can be postulated that predisposing factors include anatomy and activity of the running foot. He expands on this further by explaining that the way that the ankle is used by the athlete predisposes to inversion injuries, with a cutting or turning maneuver often as an initiating factor in these injuries (Mack, 1982:79).

The ankle is at highest risk when it is plantarflexed, since bony and ligamentous stability when the ankle is in this position is less, and the foot has a longer lever arm (Bassewitz and Shapiro, 1997:2). They go on further to explain that the anterior talofibular ligament is most exposed during plantarflexion and therefore is the ligament most commonly injured and that the calcaneofibular ligament is injured when the ankle is sprained in dorsiflexion. Expanding on this, Mack (1982:79) explains that bony stability is greater laterally than medially, thereby predisposing to inversion rather than eversion and that once inversion has been initiated, the bony stability once enjoyed by the ankle in the neutral position, is lost. Furthermore he goes on to say that as inversion increases the stabilizing function of the medial malleolus may be lost and act as a fulcrum for further inversion. The tensile strength of the lateral ligaments may be exceeded resulting in injury, if the everting muscles (peroneals) are not strong enough (Mack, 1982:79).

Reid (1992:221) states that a pull is exerted on the ankle joint by the gastrocnemius and soleus tendons via the calcaneus and not directly through the talus. He goes on to explain that along with the other flexors, their pull during strong contraction or while on a stretch, tends to direct the heel into slight inversion, resulting in an increased tendency to land on the outside of the foot during jumping maneuvers. It is important to identify and manage this as part of a preventative or treatment program. (Reid, 1992:221).

According to Baker and Todd (1995:61) Achilles tendon tightness is a common sequel of ankle sprains and is a factor contributing to functional instability. They make further mention of the fact that this tightness can lead to limited dorsiflexion (normally 15° to 20° past neutral), as well as preventing full locking of the talar dome into the ankle mortise during walking and that with reduced mechanical stability there is a predisposition to further ankle injury. Similarly, a study done by Pope, et al. (1998:171), on army recruits, found that restricted ankle dorsiflexion range confers an increase in lower limb injury, particularly ankle sprains. Subjects abilities to perform tasks in activities of daily living and sports is disturbed by limited range of motion at the ankle joint (Kaikkonen, et al.1994:469). They further suggest that occasionally some subjects with shortened calf muscles may have movement limitation in dorsiflexion before the extreme of the articular range of motion is reached. The limitation of dorsiflexion range of motion, a reliable sign of inadequate joint motion, they go on to mention, results in poor functional performance and poor overall outcome.

2.5 CHRONIC ANKLE SPRAIN

According to Brantingham, et al., unresolved, chronic ankle pain that develops secondary to ankle inversion sprains is a condition that is commonly seen. Kesson and Atkins (1998:59) make mention of the fact that excessive movement or tension on devitalized tissues, caused by chronic trauma, can lead to unwanted scarring. This, they go on to say, is the mechanism of chronic overuse syndromes, in which tissue unity is disrupted by repetitive trauma, resulting in microtrauma and setting up of a secondary inflammatory change. According to Snook (1995:248), the basic problem when developing chronic lateral instability of the ankle is that because of its bony supports the ankle is an inherently stable joint. He goes on to explain that the foot returns to its normal position after a severe sprain and some ligament healing then takes place. He further points out that when the patient is able to walk, the ligaments are subjected to constant motion and stretching if the joint is not properly protected and they either heal elongated or are replaced with a mass of scar tissue. The ankle then becomes unstable and subject to recurrent sprains due to the loss of integrity of the ligamentous supports (Snook, 1995:248).

Chronic ankle sprains may be sports related ie. when there are constant stresses and forces around the ankle which lead to chronic bone and joint changes eg. soccer, or non-sports related eg. the patient is stepping off a curb or down a stair (Reid, 1992:222). Greenman (1996:552) further adds that recurrent ankle sprains are equally common in both the weekend warrior and the high level athlete.

Bennet (1994:384) suggests that the history will distinguish an acute injury from a chronic injury and that patients who sustain injury to the lateral ankle ligaments may experience chronic disability. According to him, this results from pain, swelling and recurrent ankle sprains. He goes on to say that the patient with chronic lateral ankle instability will complain of pain and swelling, recurrent sprains and instability during walking on uneven ground. According to Coker (1991:2433), the most common symptom of an unstable chronic lateral ankle ligament tear is giving way. In a study by Tropp, et al. (1985:261), it was determined that players who had a history of previous ankle problems suffered more ankle sprains than those with no history. A similar conclusion was drawn in a study by Lysens, et al. (1984:7,8) on the predictability of sports injuries in a group of physical education students, and it was determined that there was a high risk of injury recurrence in those students with a history of previous injury, with ankle sprains representing 44.5% of the re-injuries. In the same study when considering flexibility and ligamentous laxity, an increase in the extent of these seemed to predispose athletes to sprains.

According to Reid (1992:252), besides being a painful, inconvenient symptom, functional instability increases the possibility of degenerative changes in the ankle, particularly if associated with demonstrable mechanical instability. This view is supported by both Merrill, et al. (1995:137) and Harrington (1979:354), who suggest that degenerative arthrosis may result from severe chronic instability.

Recurrent sprains, representative of chronic ankle joint laxity, is approached and treated differently from an acute ankle sprain (Juliano and Amis, 1998:81). In addition, Greenman (1996:552) makes mention of the fact that they are difficult to treat, even though they do not present a difficult diagnostic challenge. He goes on to advise that in this population, structural diagnostic findings consistently show dysfunction at the proximal tibiofibular joint and talar dorsiflexion restriction at the talotibial articulation. Furthermore, altered subtalar gliding movement and pronation of the cuboid on the same side, is considered by him, to be common in these patients. Brantingham, et al., also make mention of the fact that some chronic ankle pain may be due to unrecognised and untreated joint dysfunction.

2.6 DIAGNOSING ANKLE SPRAINS

Juliano and Amis (1998:81) explain that patients can present as early as 1 hour or as late as several months after an ankle injury and it is therefore important to determine the stage of the injury, whether it be acute, subacute or chronic.

When taking the history of a patient with an acute inversion sprain, they usually cannot provide many details about the injury mechanism because of how quickly the injury occurs, however, they usually describe inversion of the ankle after an awkward landing on their own or on an opponent's foot (Bassewitz and Shapiro, 1997:9). The patient may also describe a "pop" or "snap", or a sensation of giving way, as well as feeling immediate pain and difficulty in bearing weight following the injury (Mack, 1982:80). According to Baker and Todd (1995:52), it is also important to ascertain in the history, whether the patient was treated before the visit eg. ice or elevation of the ankle, as well as whether this problem is recurrent or if this is the first injury to the ankle. Furthermore they advise that the exact site of pain, as well as the onset of swelling is also important for the diagnosis. They also mention that the diagnosis of the injury is best made at the site of the injury or as soon as possible so that the patient will be able to recall the exact mechanism of the injury. Protective spasm, in the early phase, may deceive the examinar upon examination of the injured ankle (Calliet 1968:119). Age, according to Reid (1992:222), is also important when considering a diagnosis, as injuries such as bony avulsions are more common in the older patient, while growth plate injuries of the tibia or epiphyseal separation of the fibula are more common in the younger, skeletally immature patient.

Physical examination of the ankle should include inspection for swelling and ecchymosis (Baker and Todd, 1995:53). According to Reid (1992:222), assessing the areas of swelling, as well as areas of maximum tenderness will help to determine which ligaments have been injured. The position of the foot should also be noted, as in the case of a sprained ankle, it is usually in a more inverted position (Arnheim and Anderson, 1991:320). Baker and Todd (1995:53) advise that palpation should include the medial and lateral malleoli. They go on to suggest that laterally, the anterior capsule, anterior talofibular ligament, calcaneofibular ligament, posterior talofibular ligament and their attachments should be examined and that even though the lateral aspect of the ankle should be focussed on with an inversion sprain, palpation should also include the medial malleolus, talus, deltoid ligaments, as well as the fifth metatarsal to rule out an eversion sprain or any fractures.

According to Arnheim and Anderson (1991:320), range of ankle motion should also be tested, with a normal range being approximately 20° of dorsiflexion and 45°-50° of plantarflexion. However, Garrick and Schelkun (1997:2) explain that a loss of range of motion is found in all ankle injuries, so range of motion assessment does not offer a large contribution to the diagnosis. Baker and Todd (1995:53) on the other hand, suggest that a marked limitation of range of motion may indicate a fracture. Neurovascular assessment should also be included in examination of an ankle injury (Bassewitz and Shapiro, 1997:9).

More information regarding the extent of the injury may be added using gentle stress maneuvers, such as the talar tilt test and the anterior drawer test (Boruta, et al. 1990:108). The anterior drawer test is a test primarily for the anterior talofibular ligament and the talar tilt test tests the calcaneofibular ligament (Magee, 1997:633). Other orthopaedic tests such as Thompsons test, Homan's sign, Squeeze test, Kleiger test and Tinels sign, can be performed to rule out any differential diagnoses (Magee, 1997:633).

Mennell (1964:2) explains that joint dysfunction can only be recognised by clinical means and is not demonstrable by routine static x-ray examination. According to Boruta, et al. (1990:108), when it comes to determining the extent of ligament damage in the injured ankle, routine radiographic examination provides few clues. However, Mack (1982:80) suggests that clinical recognition of the unstable ankle is extremely important, and goes on further to state that routine plain films of the ankle are very important when it comes to diagnosing significant injuries such as fractures.

Baker and Todd (1995:54) claim that management of sprains without roentgenograms can take place in the case of simple, uncomplicated first and second degree sprains that are well localised to the medial or lateral aspect, with no gross deformity or point tenderness over the bone, and no previous sprain. They go on to say that if there is no satisfactory improvement at two to four weeks after the injury, x-rays are indicated and they are also indicated if there is a questionable chip, avulsion or talar fracture. Brantingham (1999), mentions some indications for x-ray before applying stress tests. These include immediate, significant swelling (especially if it is on both sides of the ankle), obvious deformity, inability to bear weight and pain mainly over the bone (malleoli and fifth metatarsal base).

The Ottowa Ankle Rules (Stiell, et al. 1993:1130) provide the opportunity to use clinical judgement to screen patients with acute ankle injuries for the need for radiography. These rules have been shown by Stiell, et al. (1993:1127-1130) to be reliable and 100% sensitive for fractures, as well as having the potential to allow for a one third reduction in the ordering of radiographs for patients with ankle injuries. According to these rules, an ankle x-ray is only necessary if there is pain near the malleoli, and either inability to weight-bear immediately and at the consultation (take 4 steps), or bone tenderness at the posterior edge or tip of either malleolus. Foot radiographs are required if there is pain in the midfoot and if there is an inability to bear weight both immediately and at the consultation (take 4 steps), or bone tenderness at the navicular or the base of the fifth metatarsal (Stiell, et al. 1993:1130).

According to Stiell, et al. (1993:1131), although these rules are reliable, it is suggested that they remain secondary to clinical judgement and common sense. In addition to this they advise that there is obviously no need for these rules in the event of obvious fracture or deformity and caution should be taken in patients with multiple painful injuries, altered sensation, intoxication, paraplegia or bone disease. They also go on to mention the fact that these rules have not been tested in patients under 18 years of age. Garrick and Schelkun (1997:2) explain that the reason for this may have been out of concern for epiphyseal fractures. However, they go on to say that in their experience these types of fractures will cause the same symptoms as any other type of fractures and that in their opinion these rules can be applied to both children and adults.

2.6.1 Orthopaedic Ligamentous Tests

2.6.1.1 Anterior Drawer Test

This test is designed primarily to test the anterior talofibular ligament, which is the ligament most frequently injured, and to test for ankle instability (Reid, 1992:213). This test is performed, according to Baker and Todd (1995:62) with the patient lying on the examining table with their hip and knee on the affected side flexed to 90 degrees. The examiner the holds the patient's foot stationary on the table and grasps the distal tibia with the other hand and then tests for anteroposterior translation. They state that a positive result is indicated by an excessive translation of the tibia on the talus and indicates rupture or elongation of the anterior talofibular ligament. Bassewitz and Shapiro (1997:9) explain that because laxity varies greatly between patients, side-to-side comparison is essential. They go on to say that although a 5-10mm translational difference is probably abnormal, the quality of the endpoint is also important.

2.6.1.2 Talar Tilt Test

According to Boruta, et al. (1990:109), this test is defined as the angle produced by the tibial plafond and the dome of the talus in response to forceful inversion of the hindfoot. This test is used to determined damage to the calcaneofibular ligament. Magee (1997:635) suggests that flexing the patient's knee relaxes the gastrocnemius muscle. He goes on to mention that the examiner should first test the normal side for comparison. The test is performed by holding the foot in the anatomical position, which brings the calcaneofibular ligament perpendicular to the long axis of the talus, and the talus is then tilted from side to side into adduction and abduction (Magee, 1997:635). A positive test is determined when there is a differing in laxity compared with the normal ankle and the presence of a significant previous injury to either ankle, will determine the significance of finding a positive test (Harris, 1995:521).

2.6.1.3 Syndesmosis Tests (Bassewitz and Shapiro, 1997:10)

a) Squeeze test: This test is performed by compressing the tibia and fibula together above the level of injury. Pain referring to the anterolateral ankle in the area of the syndesmosis, indicates a positive test.

b) External rotation test: This test is performed by holding the talus in neutral flexion and applying an external rotation force to the hind foot. Again, pain in the syndesmotic area indicates a positive.

2.7 GRADING OF ANKLE SPRAINS (Reid, 1992:222)

Reid (1992:222) explains that pain is not always proportional to the injury. The three grades of ankle sprains can be classified according to ligament damage and instability (Appendix A). Grade I sprains are stable with stretching or partial tearing of only a single ligament, usually the anterior talofibular ligament. Anterior Drawer test is negative and there is no varus laxity. Grade II sprains involve complete tearing of the anterior talofibular ligament or partial tearing of the anterior talofibular ligament and the calcaneofibular ligament and there is mild to moderate instability. Anterior Drawer test may be positive and there is no varus laxity. Grade III sprains are unstable and involve complete tearing of the anterior capsule and anterior talofibular ligament and associated tearing of the calcaneofibular ligament. There is a positive Anterior Drawer test and varus laxity is present.

2.8 DIFFERENTIAL DIAGNOSIS

Reid (1992:222) advises that when assessing a patient for a sprained ankle, it is important to rule out fractures, dislocation, tendon injuries and other ligamentous disruptions. On examination, location of tenderness and swelling, obvious deformity, excessive oedema or increased pain and swelling with weightbearing should be some indication of a more complex diagnosis (Reid, 1992:223). Fallat, et al. (1998:281) goes on further to say that in addition to the ligamentous injury, there may be concomitant injuries. Although there are many differential diagnoses for an ankle sprain, Reid (1992:224) indicates that the commonest of these problems are fifth metatarsal fractures, cracks or avulsions of the fibular malleolus and osteochondral lesions of the talar dome.

2.8.1 **Fractures** (Garrick and Schelkun, 1997:2)

Squeezing the tibia and fibula together midway between the ankle and the knee will cause pain in the presence of a proximal fibular fracture and it may also cause pain with a distal fibular fracture. Epiphyseal fractures may result in tenderness over the malleoli and comfortable weight bearing may not be possible. Avulsion or flake fractures of the styloid process of the fifth metatarsal occur frequently with inversion sprains, as do Jones fractures (transverse fracture approximately one inch distal to the proximal end of the fifth metatarsal). For this reason, it is important to palpate the fifth metatarsal for tenderness. Radiographic examination will identify all of the above fractures.

2.8.2 Syndesmosis Injury

In a study by Hopkinson, et al. (1990:327), the incidence of these sprains was found to be 1% of all the ankle sprains. Trojian and McKeag (1998:8) however state that the incidence of these injuries range from 1 % to 11 % of all ankle sprains, with contact sports resulting in a higher rate of occurrence. Garrick and Schelkun (1997:3) explain that the way to distinguish a syndesmosis sprain is by the mechanism of injury, which is different to that of an inversion sprain i.e. the foot is dorsiflexed. Bassewitz and Shapiro (1997:6) claim that these types of injuries occur with external rotation injuries. Rundle (1995:643) point out, that either or both the anterior talofibular ligament and the posterior tibiofibular ligament may be injured along with the interosseous membrane in a syndesmotic sprain. The tibiofibular ligament is usually the area of maximum tenderness (Garrick and Schelkun, 1997:3) and unlike lateral sprains, these injuries have little swelling and lack recurrence (Trojian and McKeag, 1998:8). They go on to explain that typically there is delayed healing with syndesmotic sprains and that a recovery time of 55 days expected as compared to 35 days for a grade 3 lateral sprain.

2.8.3 Achilles Tendon Rupture

Rapid plantarflexion is the mechanism of injury for Achilles tendon rupture (Trojian and McKeag, 1998:8). Garrick and Schelkun (1997:3) mention that this is often a misdiagnosed injury. They go on to explain that the patients may hear a pop at the time of the injury, which is sometimes painless and that although the patients may not have tenderness in this area, it is therefore important to palpate the Achilles tendon. Thompson's test can be performed to help diagnose Achilles tendon rupture (Trojian and McKeag, 1998:6). Magee (1997:636) explains that although the patient may be able to plantarflex the foot while not weightbearing, one should not assume that the Achilles tendon is not ruptured, as the long flexor muscles are able to perform this function in the non-weightbearing stance even with a ruptured Achilles tendon.

2.8.4 Peroneal Tendon Dislocation

The mechanism of injury is usually hyperdorsiflexion (Garrick and Schelkun, 1997:3). They further suggest that because the tendon has often spontaneously reduced by the time the patient presents at the consultation, diagnosis relies upon the mechanism of injury, swelling and tenderness that extends up along the posterior border of the fibula, proximal to the ligaments, in addition there may also be swelling in and around the tendon sheath. Rundle (1995:643) explains that due to the close association of the peroneal sheath to the calcaneofibular ligament, this condition should be kept in mind when assessing a lateral ligament injury. Peroneus brevis or longus tendon subluxation or dislocation can occur with an inversion sprain but is not common (Trojian and McKeag, 1998:9).

2.8.5 Sinus Tarsi Syndrome

Injury to the sinus tarsi and its ligaments can occur following an inversion or twisting injury to the ankle (Rundle, 1995:643). There may also be a history of multiple sprains and the subject may experience pain and tenderness over the lateral aspect of the sinus tarsi, as well as a feeling of instability (Singer, et al. 1995:438). They go on to further advise that symptoms may be increased by applying an inversion force and may be relieved by local anaesthetic injection into the sinus tarsi.

2.8.6 Bifurcate Ligament Injury (Trojian and McKeag, 1998:8).

The bifurcate ligament injury is associated with 19 % of ankle inversion sprains. This ligament is taut with plantarflexion and inversion and therefore violent dorsiflexion, forceful plantarflexion or direct trauma usually result in injury to it and this mechanism may cause avulsion of the anterior process of the calcaneus. There is usually pain and swelling under the lateral malleolus and therefore bifurcate sprain or avulsion fracture is often mistaken for a lateral ankle sprain. The maximum point of tenderness is midway on a line connecting the tuberosity of the fifth metatarsal and the distal tip of the lateral malleolus.

2.8.7 Lateral Periostitis (Trojian and McKeag, 1998:9).

This injury may occur when the foot is suddenly dorsiflexed and everted, causing trauma to the talus from the distal fibula. The symptoms of this injury appear to be similar to that of a lateral sprain but without the anterior talofibular ligament tenderness. Pain is elicited when palpating over the lateral talus with the foot in a plantarflexed and inverted position.

2.8.8 Os Trigonum Injury (Trojian and McKeag, 1998:9)

This injury results in pain in the lateral posterior triangle. There is no pain when attempting resisted eversion, however symptoms are produced by forceful plantarflexion.

2.8.8 Impingement Syndrome

This syndrome results from recurrent trauma to the joint capsule, synovial membrane and articular cartilage (Snook, 1995:249). Bassewitz and Shapiro (1997:3) explain that after a sprain, fibrous tissue can form in the anterolateral or anteromedial ankle. The resulting pain may be related to mild, undetected injury to the anterior tibiofibular ligaments, with sydesmotic fibers falling into the lateral aspect of the tibiotalar joint. Dorsiflexion motion can increase this pain due to pinching of abnormal soft tissue and/or bone spurs in the anterior tibiotalar joint (Bassewitz and Shapiro, 1997:3). Although it can present with the same clinical picture as recurrent ligament sprains, the anterior drawer sign is negative (Snook, 1995:249).

2.9 CONNECTIVE TISSUE HEALING

According to Reid (1992:74,75), there are three phases of connective tissue healing:

Phase I: Reaction Phase: (Reid, 1992:74)

The initial inflammatory response to trauma occurs in this phase. Included in this response is vasodilation, exudation of fluids, haemorrhage, edema, pain, phagocytosis of debris, an immune response, and the initiation of cell division and other elements required for healing. This response is manifested as swelling, pain, and loss of function.

Phase II: Regeneration Phase: (Reid, 1992:74,75)

The main activities occurring in this phase include elimination of debris, revascularization and fibroblastic proliferation. Phagocytosis eliminates debris so as to protect the devitalized tissue from infection. Capillary buds form as an indirect stimulation from oxygen deprivation in damaged tissues and fibroblasts are attracted to the area and produce collagen.

Phase III: Remodelling Phase: (Reid, 1992:75)

This phase usually lasts about six months and is characterised by contraction of the scar tissue and subsequently by maturation of collagen.

According to Chan and Hsu (1993:67), the healed ligament never attains its original strength mechanically (50%-70% at most) and the deformation is greater even within physiological loading. They go on to suggest that physiological stress and motion is one of the factors conducive to ideal ligamental healing and that it appears to be beneficial and may accelerate the processes of ligamental healing and remodelling. However, they advise that further haemorrhage and oedema may occur if movement is commenced too early after the injury and this leads to prolongation of recovery.

2.10 NATURAL HISTORY OF ANKLE SPRAINS

According to Reid (1992:239), a Grade I ankle sprain should have a recovery period of 8 days (range 2-10). He goes on to say that the recovery period for a Grade II sprain is 20 days (range 10-30) and a Grade III ankle sprain's recovery period is 40 days (range 30-90). Kesson and Atkins (1998:369,370) suggest similar periods of recovery with early mobilization i.e. 8-10 days for a grade I sprain and 15-21 days for a grade II sprain.

2.11 TREATMENT PROTOCOLS

The treatment protocol for managing ankle inversion sprains is controversial (Glick, et al. 1976:136), even more so the treatment of chronic ankle inversion sprains. Treatment recommendations range from almost neglect to early surgical repair (Colter, 1984:113) and most of the recommended management programmes are not as a result of controlled clinical trials.

Rundle (1995:643) explains that a patient may experience ongoing problems with pain and re-injury, if full range of movement is not regained after an ankle injury. She goes on to say that a full return of dorsiflexion range of the ankle is required to permit running and other sporting manoeuvres without subjecting adjacent structures to undue stress. Vegso (1995:246) mentions that in his experience a decrease in dorsiflexion is the most common reason for chronic pain and reinjury following an ankle sprain. In a study by Lysens, et al. (1984:7) on the predictability of sports injuries, 16% of 499 injuries occurred within one month after return to sports practice and were attributed to inadequate rehabilitation. It is concluded by them that the high incidence of re-injuries in this study were due to inadequate rehabilitation, underestimation of the primary injury's severity and /or premature return to sports activity. It has been suggested by Fallat, et al. (1998:281) that ankle sprains should be treated as a syndrome, including the treatment of all surrounding anatomical structures injured in the incident. According to Baker and Todd (1995:67) function is effectively restored with non-operative treatment in approximately half of the patients with chronic functional instability. Thomson, et al. (1991:41) suggest the use of treatments such as transverse friction, passive stretching, ultrasound and active exercises to regain flexibility in chronic injuries.

2.11.1 Stretching

Flexibility is defined as the ability of the muscles to elongate as a joint or body segment moves through a range of motion (ROM) whilst, ROM refers to the movement of a specific joint (Vegso, 1995:476,477). He further states that for normal activities of daily living and athletic performance, full ROM and flexibility are essential and consequently, loss of flexibility and ROM in the lower extremities can have a significant effect on normal gait and running patterns, followed by a decrease in performance and conditioning. Early research in the area of flexibility, according to him, indicated that stretching exercises done on a regular basis may help improve the tensile strength and elasticity of ligaments and fascia. He goes on to explain that after injury, stretching can have significant effect on the healing of connective tissue as connective tissue responds to stress by organizing itself along the axis of that stress and that as new collagen is formed and placed under stress, it organizes itself in the direction of tension, thereby creating stronger and more elastic tissue and reducing the chance of re-injury. O'Sullivan (1975:109) agrees with the need for muscle flexibility, stating that it is the key to stopping injuries.

Overactivity or increased tension in local musculature is a typical response to pain or dysfunction (Liebenson, 1989:446). Consequently, according to Wajswelner and Webb (1995:207), biomechanical efficiency can be reduced by an alteration in an athlete's style, due to tight muscles and adaptive changes in connective tissues and this can predispose the athlete to injury. Baker and Todd (1995:61) explain that Achilles tendon tightness is a common sequel of ankle sprains and is a contributing factor in functional instability.

Juehring and Weinert (2000:200) suggest that sustained muscle stretching should be used for chronically shortened muscles to return it to its original length, because sustained stretching not only has an effect on contractile tissue, but also causes plastic deformation of non-contractile tissues. Passive stretching is one of the techniques used most often in the treatment of injuries to athletes (Wasjelwener and Webb, 1995:207). Vegso (1995:477) confirms this statement by pointing out that static stretching is the most popular and safest method of stretching. Christensen (1991:48) also agrees by mentioning that slow or static stretching of muscles is now preferred to repeated rapid joint movements as it avoids reflex activity of the stretched muscles.

Heelcord stretching is suggested as an important part of both rehabilitation and prevention of ankle sprains by Coker (1991:2418). This view is supported by Baker and Todd (1995:67) who claim that Achilles tendon stretching should by one of the components initiated in a rehabilitation program. McCluskey, et al. (1976:153), as mentioned previously, also agrees by stating that heelcord or gastroc/soleus muscle stretching is a important adjunct in ankle injury prevention. He goes on further to mention others who have had success in reducing the number of ankle sprains incurred by putting their athletes on to a heelcord stretching routine.

Types of stretching include static stretching, which according to Vegso (1995:477) is the safest and most popular method of stretching. He goes on to explain that the techniques used in performing this type of stretching involve the movement of a joint or muscle to the extreme of comfortable motion and then holding the position for a given period. Another form of stretching is ballistic stretching which, as Vegso (1995:477) points out, is not often used for therapeutic purposes because of the potential risk of overstretching. He further describes this type of stretch as one which utilizes repetitive contractions of an agonist muscle or muscles to produce a quick, active stretch of the antagonistic muscle(s). Proprioceptive Neuromuscular Facilitation (PNF), is another type of stretching which involves several techniques, all of which involve alternating a muscle contraction with relaxation in order to produce an increase in motion (Vegso 1995:477).

2.11.2 Manipulation/Mobilisation

Mennell (1964:1) explains that the normal functioning of much of the rest of the musculoskeletal system can be affected by the loss of function in one joint. He goes on to suggest that perhaps the commonest cause of residual symptoms following severe bone and joint injury, is joint dysfunction, and it is the most common cause of residual symptoms following any inflammatory condition of a joint. He further mentions that it may or may not be associated with the presence of intra-articular adhesions.

Greenman (1996:434) states that one of the more common dysfunctions in the lower extremity, is talar dysfunction at the tibiofibular mortise. Restriction of the talus from either above or below results in significant ankle motion restriction and that restricted dorsiflexion is the most common dysfunction at this joint (Greenman, 1996:434).

According to Greenman (1996:45), the goal of manipulation is to achieve maximal, painless movement of the musculoskeletal system in postural balance by the use of the hands in a patient management process using instructions and manoeuvres.

Kesson and Atkins (1998:79) suggest that manipulation may be required to rupture unwanted scar tissue in chronic lesions. Unwanted adhesions that have developed between the ligament and the underlying bone, lead to disruption in the normal functional movement of the joint, resulting in a non-capsular pattern of pain and limitation on examination (Kesson and Atkins, 1998:79) and they further indicate peripheral manipulation to be applied to a chronic ligamentous sprain of the lateral collateral ligament at the ankle. Likewise, Edmond (1993:2) goes on to say that restrictions in the joint capsule, usually as a result of immobilization or inflammation of the articular and surrounding structures, are often accompanied by limited joint range of motion. It is further suggested by him that manipulation of the joint is thought to promote movement between capsular fibers. Similarly, Rundle (1995:643) points out that dorsiflexion is commonly restricted in ankle injuries, and that mobilization of the ankle complex will help in pain reduction and in regaining range of motion at the talocrural and subtalar joints.

According to Maitland (1991:10), mobilization and manipulation show their best effects when directed at mechanical type problems and mobilization techniques are most effective when localized to the movement of the faulty joint. Authors such as Lawrence (1994:283), suggest that manipulation of the ankle be included in general therapy considerations for ankle sprains and Bergmann, et al. (1993:707), claim that ankle joint adjusting may be effective in treating palpable pain over the lateral collateral ligaments, pain anterior to the lateral malleolus and for inversion ankle sprains.

In Pellow and Brantingham's (2001:17) study on subacute and chronic inversion sprains, it is suggested that ankle adjusting is superior to placebo treatment, with patients showing reduced pain and improved ankle range of motion and ankle function.

In another study done by Coetzer, et al (2001:1) on the comparison of piroxicam and chiropractic manipulation in the treatment of acute grade I and II inversion ankle sprains, the results showed a significant improvement in both groups in terms of functional disability, range of ankle dorsiflexion motion and pain intensity.

A randomized, controlled, clinical trial by Green, et al. (2001:991), showed that the addition of talocrural mobilization to the RICE protocol in the management of ankle inversion injuries resulted in the achievement of pain free dorsiflexion in a fewer number of treatments.

2.11.3 Strengthening Exercises

Glick, et al. (1976:140) states that that to prevent injury, strong peroneal muscles are required in order to support the ankle mortise. Boruta, et al. (1990:112) explains that inversion stresses are resisted by the lateral ligaments and the lateral compartment muscles. they go on further to mention that with severe sprains, the peroneal complex is often stretched and torn and will atrophy after injury. They suggest that to decrease weakness, physical therapy should be directed towards inversion-eversion strengthening. Ryan (1994:43) further expands on this by proposing that this evertor muscle weakness is one of the factors to cause functional instability.

Reid (1992:252) suggests that peroneal muscle strengthening is the mainstay of therapy with functional instability. This is supported by Baker and Todd (1995:67), who suggest the inclusion of peroneal tendon strengthening as part of a conservative management program for patients with chronic ankle instability.

Coker (1991:2418) suggests that toe raises appear to be very beneficial. According to him, probably owing to the need to maintain balance, electromyograms show these to be more effective in utilizing the peroneals and posterior tibials. He also recommends stretching against surgical tubing, which is both simple and effective. Theraband exercises are also recommended by Garrick and Schelkun (1997:5). Mack (1982:84) however suggests starting with isometric exercises and progressing later to dynamic progressive resistive exercises. Hamilton (1982:99) points out that he has not had to perform a lateral ligament construction in a professional dancer since instituting peroneal rehabilitation in plantarflexion.

2.11.4 Proprioception Exercises

Tropp, et al. (1985:261) claim that one of the functional factors leading to functional instability and a predisposition to recurrent sprains, is impaired postural control. Jerosch and Bischof (1996:169,170) confirm this statement by stating that one of the reasons for functional instability of the ankle, is proprioceptive deficit after an ankle sprain. They go on to say that proprioception is one of the most important factors for controlling joint stability and motion.

Thomson, et al. (1991:41) claims that proprioception can be re-educated by the use of proprioceptive neuromuscular facilitation, weight-bearing activities, co-ordination exercises and balance (wobble) boards for lower limb injuries. Lephart and Fu (1995:100) mention that, proprioceptive training techniques are the most widely used, following acute and chronic ankle sprain injuries, as compared to other injuries.

Authors such as Thomson, et al. (1991:44) suggest the use of balance board practice in the recovery of both acute and chronic ankle sprains. In a study by Wester, et al. (1996:334,335), wobble board training was effective in preventing functional instability of the ankle in patients with primary ankle sprains, as well as reducing the number of recurrent distortions. Hoffman and Payne (1995:145) agree with the use of the ankle training disk, saying that it has been shown to decrease functional instabilities of the ankle and decreases the incidence of re-injury.

2.11.5 Strapping/Bracing

According to Reid (1992:232), much controversy exists regarding the value of supportive strapping techniques in sports. This statement is supported by McCluskey, et al. (1976:151) who claim that strapping of the ankle to reduce ankle problems is very controversial.

Glick, et al. (1976:140) suggests that the advantages of taping are probably due to the stimulating effect on the peroneus brevis muscles or to a dynamic action.

Author such as Garrick and Schelkun (1997:6), suggest the use of ankle wrapping or bracing for the first few months after an injury to avoid recurrent injuries. Coker (1991:2419) supports the idea of prophylactic taping for sports injuries and Thomson, et al. (1991:44) suggest that support is necessary to control swelling and to reduce causing further trauma to the injury if the patient decides to walk/run some distance.

Although some might say that loosening of the tape is a disadvantage, Reid (1992:232) claims this to be an advantage as it still supports at the limit of range, however also allowing a satisfactory range of movement. Although Reid (1992:237) recommends taping, he also states that it can become expensive, which is also supported by Baker and Todd (1995:67). Reid (1992:237) further suggests the use of a brace, which unlike taping (Baker and Todd 1995:67), can be applied without needing any skill once the correct size has been chosen.

2.11.6 Transverse Friction

Kesson and Atkins (1998:67,68) explain that transverse friction massage is a specific type of connective tissue massage and is applied precisely to the soft tissue structure of tendons, muscles and ligaments for a specific purpose. They go on to suggest that it can be applied prior to or in conjunction with mobilization techniques.

Furthermore they point out that grading of the depth of transverse friction massage takes place according to whether it is an acute or chronic lesion. Deep transverse friction massage produces therapeutic movement and softens and mobilizes adhesions in the chronic inflammatory phase and in addition other aims of transverse friction massage are (Kesson and Atkins, 1998,67,68):

- To produce therapeutic movement
- To produce a traumatic hyperaemia in chronic lesions
- To induce pain relief
- To improve function

Thomson, et al. (1991:43) claims that transverse frictions are necessary to restore the pliability to the anterior and middle bands of the ligament for chronic sprains.

2.11.7 Ultrasound

Prentice (1994:255) claims that in sports medicine, ultrasound is one of the most widely used modalities. Reid (1992:41) explains that the main therapeutic goals of ultrasound in sports therapy include to reduce inflammation, accelerate hematoma absorption, reduce pain and spasm, promote healing, increase extensibility of scar and perform phonophoresis. He further suggests the use of ultrasound as one of the modes of treatment for chronic soft tissue swelling (Reid, 1992:232).

Thomson et al. (1991:41,44) indicate that ultrasound can be used in chronic injuries to regain ligament flexibility. He goes on to explain that it should be applied with the ligament on a stretch and that it will help in mobilizing adhesions or to reduce any chronic swelling. He suggests 0.8 W/cm² at 3MHz continuous for 5 minutes and increasing it to 1W/cm² if a greater effect is required. Coker (1991:2418) on the other hand says that the indiscriminate use of ultrasound should be deplored, however he suggests its use in conditions such as tenosynovitis with a usual treatment being under water at 1-1.5W/cm² for 5 minutes.

Bogduk and Mercer (1995:174) explain that ultrasound does not abolish pain, however it can be used as an analgesic, by increasing the threshold of pain perception. Prentice (1994:274) mentions that although ultrasound does not appear to have any anti-inflammatory effects, it is thought to accelerate the inflammatory phase of healing (refer to 2.8 above).

2.11.8 Laser

According to Saliba and Foreman (1994:222), low-power lasers are effective in reducing pain and aiding wound healing. According to them, it has been observed by some authors that there are faster healing rates and less pain when sprains are treated with the laser therapy. They suggest the use of the infra-red laser for some soft tissue injuries, as the depth of penetration is about 5cm.

However, in a randomized, double blinded, controlled, clinical trial done by de Bie, et al. (1998:1415), it was concluded that neither the high- or low-dose laser therapy was effective in treating lateral ankle sprains.

2.12 INDICATIONS AND CONTRA-INDICATIONS TO EXTREMITY MANIPULATION

2.12.1 **Indications** (Edmond 1993:2-6)

Edmond (1993:2-6) suggests that manipulation can be used to increase joint extensibility, correct positional faults, for nutrition and in pain control or muscle relaxation.

2.12.1.1 Increase joint extensibility:

Joint manipulation maintains the extensibility of a joint and other periarticular structures or increases the extensibility in the presence of periarticular restrictions, thereby promoting optimal, pain-free movement.

2.12.1.2 Correcting positional faults:

Pain can be caused by abnormal stress placed on periarticular structures by even a minimal amount of displacement. Pain can be reduced by normalizing the static positioning of one joint surface in relation to the other. This can be done by manipulation of one of the joint surfaces in the direction consistent with realigning it into proper position.

2.12.1.3. Nutrition:

Restricted joints result in an insufficient range of motion to produce movement of synovial fluid within the synovial cavity, thereby resulting in inadequate nutrition of the joint. Fluid movement within the synovium is thought to be produced by the use of manipulation.

2.12.1.4. Pain control/ muscle relaxation:

Stimulation of joint receptors by manipulation can reduce pain in a joint and periarticular structures. The resultant decrease in pain perception is due to blockage of pain impulses through the gate control mechanism and reflexive muscle relaxation. Temporary pain relief can also be due to a reduction of compressive forces on the joint, which is achieve when using techniques to distract two joint surfaces. Pain reduction may have a secondary effect on muscle relaxation. Periarticular muscle relaxation is also achieved by joint receptor stimulation through joint manipulation.

2.12.2 **Contra-indications**

Wells, et al. (1988:208) explain that all forceful manipulative procedures are contraindicated with the presence of disease processes and injuries affecting bone and joint structures, as well as other soft tissues, and weaken them thus making them vulnerable to stress. They go on to say that the use of certain drugs eg. steroids and anticoagulants, precludes any vigorous passive treatment.

Although there do not appear to be specific contraindications to peripheral manipulation, the following can be adapted from contraindications to spinal manipulation. Edmond (1993:8) indicates that joint manipulation should not be performed in the presence of:

- Any undiagnosed lesions
- Joint ankylosis
- Joint hypermobility

Other contraindications as added by Greenman (1996:52) include:

- Primary joint disease (eg. rheumatoid arthritis, infectious arthritis)
- Metabolic bone disease (eg. osteoporosis)
- Primary/ metastatic malignant bone disease
- Genetic disorders (eg. Downs syndrome)

2.13 CONCLUSION

In summary, it is agreed that ankle sprains, especially inversion sprains, are one of the most common types of musculoskeletal injuries (Jerosch and Bischoff, 1996:167; Boruta, et al. 1990:107 and Oloff, 1994:243).

Although no single treatment protocol for ankle sprains predominates (Eiff, et al. 1994:83), some agree that lateral ligament injuries are frequently under treated

(Singer, et al. 1995:424) and patients may receive incorrect or possibly unnecessary treatment for this condition. As Colter (1984:113) explains that treatment can range anywhere from neglect to early surgical repair, which may be unnecessary as Baker and Todd (1995:67) further go on to point out that in about half of patients with chronic functional instability, function is effectively restored with non-operative treatment.

Manipulation appears to be one of the conservative treatments of choice for many authors (Kesson and Atkins, 1998:372; Pellow and Brantingham, 2001:23; Lawrence, 1994:283; Bergmann, et al. 1993:707). As pain and limitation of movement can be the result of an ankle sprain due to the formation of unwanted adhesions (Kesson and Atkins 1998:79), manipulation can be used to achieve maximal, painless movement (Greenman, 1996:45) perhaps by rupturing these adhesions (Kesson and Atkins, 1998:79).

Another suggested and often forgotten adjunct in the treatment of ankle sprains is heelcord or gastrocnemius-soleus muscle stretching (McCluskey, et al. 1976:153). Stretching can have a significant effect on the healing of connective tissue (Vegso, 1995:477) and as Achilles tendon tightness is a common sequel of ankle sprains (Baker and Todd, 1995:67) stretching of this tendon along with the gastrocnemius-soleus muscle may be useful in the rehabilitation process.

With such varied views on how to treat ankle sprains, this study will attempt to determine a conservative treatment approach for this condition by combining manipulation with static stretching of the gastrocnemius and soleus muscles, so as to find an effective protocol for the management of subacute and chronic grade I and II ankle inversion sprains.

CHAPTER THREE

CHAPTER THREE – MATERIALS AND METHODS

3.1 INTRODUCTION AND STUDY DESIGN

This chapter will include a detailed description of the design, subjects involved and interventions used in this study. Measurements and statistical analysis are also discussed.

This study was designed as a prospective, comparative, randomized clinical trial and compared two groups of patients both suffering from subacute or chronic, grades I or II, ankle inversion sprains, with both groups receiving manipulation and one group receiving an additional set of stretches. Data collected from the two groups was statistically analysed to determine which treatment protocol was more effective between the two groups, as well as to identify differences within a specific group.

3.2 PATIENT SELECTION

Only patients presenting to the Technikon Natal Chiropractic Day Clinic with subacute or chronic grades I or II ankle inversion sprains were considered for the study. Advertisements about the research were placed in local newspapers, as well as on notice boards around the Technikon campus, Natal University campus, sports clubs, pharmacies and also by word of mouth. Sixty patients were selected by consecutive sampling. To determine whether the patient could participate in the study, a brief history of the injured ankle, as well as a brief ankle examination was performed. Once it was established whether the patient was able to partake in the study, a more thorough history and examination was conducted.

3.3 INCLUSION AND EXCLUSION CRITERIA

Inclusion 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 and give their informed consent. Minors had to receive permission from their parents/guardians.
3. Diagnosis was made according to the criteria set out by Reid (1992:226). The number of sprains incurred by each subject was recorded. For the purposes of this study subacute will be defined as more than 48 hours after the initial injury and chronic as more than 5 days after the initial injury Reid (1992:239).

Exclusion criteria:

1. Patients taking any medication, or undergoing any other form of treatment for their ankle injury, or using any other medication that may have an effect on the inflammatory processes in the ankle. However, if the patient was taking any form of analgesic medication when they entered into the study, the amount taken was recorded at the initial and final consultations.
2. Patients demonstrating any contraindications (outlined in chapter 2) to manipulative therapy.
3. Re-injuries during the study.

4. Any patients who required x-rays to confirm a suspected pathology in the ankle joint.

3.4 PATIENT EXAMINATION

Once the patient was accepted into the study, a case history (Appendix D), including whether the patient had experienced any previous sprains to that specific ankle, as well as whether they were taking any medication (Appendix K) or were receiving any other form of treatment for their ankle injury at that time or any time previously, a physical examination (Appendix E) and foot/ankle regional examination (Appendix F) was conducted to confirm the diagnosis. The Ottowa Rules (Stiell, et al. 1993:1130) were applied to the patient's ankle in order to determine whether or not a fracture might be present, in which case the patient would need x-rays and would have to be excluded from the study. Once the examination was completed, a diagnosis was confirmed by both the researcher and the clinician present. If accepted into the study, the patient was fully informed of the treatment (Appendix B) that they would receive and were given a chance to ask any questions. Informed consent (Appendix C) was then given by the patient before the researcher could commence with the treatment.

3.5 PATIENT SAMPLING

All patients in this study were informed of the treatment that they would be receiving as well as of the treatment that the other group would receive i.e. no patient blinding took place. Patients were allocated to a treatment group by choosing a small folded piece of paper, with either the letter "M" or "S" on it, from an envelope. As sixty patients were required for this study, thirty of the folded pieces of paper had the letter "M" on it and indicated allocation to the manipulation only group, while the other thirty pieces of folded paper with the letter "S" on it indicated allocation to the stretching group. The manipulation only group was labelled as group 1, while the group receiving a combination of stretching and manipulation was labelled as group 2.

3.6 TREATMENT

Patients in both groups were required to receive up to a maximum of six treatments over a two week period or until they were symptom free. Once examined and diagnosed with a subacute or chronic grade I or II ankle inversion sprain, patients received treatment in the form of manipulation with or without stretching.

3.6.1 **Manipulation** (Kirk, et al. 1991:155)

Both groups received manipulation of their ankles in the form of a mortise separation, as described by Kirk, et al. (1991:155). They suggest that this manipulation is indicated to mobilize the tibiotalar joint as well as being useful for subacute inversion sprains of the ankle.

The manipulation is performed with the patient lying in the supine position. With the doctor kneeling at the foot of the table, he/she grasps the medial or lateral border of the foot with either hand so that the thumb is positioned on the sole of the foot and the fingers on the dorsum. The other hand then grasps the opposite border of the foot in the same manner. The ankle is then dorsiflexed, the entire leg is internally rotated and the foot is everted before thrusting straight towards the doctor, with a line of drive parallel to the floor. The added eversion is to ensure the protection of the lateral ligaments of the ankle.

3.6.2 Static Stretching

Group 2 received static stretching of the gastrocnemius-soleus muscles in addition to manipulation. The stretching was performed as follows:

Gastrocnemius stretch: (Travell and Simons, 1983:415; White, 2000)
The patient lies in the supine position with their legs straight. The affected leg is lifted off the bed by the researcher to a position in which the patient feels a comfortable stretch in the gastrocnemius muscle. A firm pressure is then applied to the ball of the foot to take up slack while dorsiflexing the ankle. The researchers other hand is placed on the patient's knee to keep it locked in an extended position.

Soleus stretch: (Travell and Simons, 1983:449)
The patient lies in the prone position with the unaffected leg straight on the examining table and the affected leg flexed at the knee. The researcher applies a firm pressure to the ball of the affected foot, dorsiflexing the foot at the ankle. The patient should feel a comfortable stretch in the soleus muscle.

Two sets of both the gastrocnemius and soleus stretch were performed, with each stretch being held for a period of 20 seconds (Pope, et al. 1998:167). According to Arnheim and Prentice (1993:44), although the recommended optimum time for holding a stretch position varies, they suggest that a 20 second hold appears to be sufficient.

3.7 MEASUREMENTS

Subjective and objective measurements were taken at the initial consultation and again at the final consultation after the final treatment, so as to determine any change in the patient's condition from the initial consultation to the end of the treatment period at the final consultation.

3.7.1 Subjective Measurements

Patients provided subjective information by completing the Numerical Pain Rating Scale-101 (NRS-101) (Appendix H) and the short-form McGill Pain Questionnaire (Appendix G), at the initial consultation before the first treatment and again at the final consultation, after the last treatment. Subjective and functional information was provided by the functional evaluation scale (Appendix I), which was also completed at the initial consultation and after the last treatment at the final consultation.

3.7.1.1 Numerical Pain Rating Scale -101 (NRS-101):

According to Jensen, et al. (1986:117-125), subjective pain intensity measurement is important to clinicians and researchers. They go on to explain that the NRS-101 is used to determine the patients perceived level of pain intensity. In their study, 75 patients with chronic pain were asked to rate 4 kinds of pain using 6 different scales. The utility and validity of these scales were judged according to five different categories. The results to this study indicated that the NRS-101 had certain advantages over the other scales used. These advantages included being easy to administer and score and it can be administered in either the written or verbal form, it has 101 response categories, it does not seem to be associated with incorrect responding more than any other scale, and difficulty with it does not appear to be associated with age.

In a study by Bolton and Wilkinson (1998:5), in comparing three pain intensity measures on 79 patients, it was concluded that although the visual analogue scale (VAS) and the NRS, were equally sensitive in terms of their ability to detect change, the NRS seemed to be the superior option when considering the ease of use and scoring.

The NRS-101 questionnaire was completed at the initial consultation and after the final treatment. This questionnaire evaluates the patients subjective perception of pain by scoring a number between 0 and 100, where 0 indicates no pain at all, and

100 indicates pain as bad as it could be. On each questionnaire, the patient has to evaluate their pain both when it is at its worst as well as when it is at its least. An average of the two scores indicates the patients pain level in the form of a percentage.

3.7.1.2 The short form McGill Pain Questionnaire (SF-MPQ)

The SF-MPQ was completed at the initial consultation and again after the final treatment.

Melzack (1987:191) explains that the data obtained provides information on the sensory, affective and overall pain intensity and has been shown to be sufficiently sensitive in demonstrating differences due to treatment at statistical levels.

The main component of the SF-MPQ consists of 15 descriptors (11 sensory; 4 affective), which are rated on an intensity scale as 0 = none, 1 = mild, 2 = moderate, 3 = severe (Melzack, 1987:191).

Melzack (1987:197) concludes that the SF-MPQ is a useful instrument and is sensitive to traditional clinical therapies. He goes on to suggest that it should be useful in researching requiring slightly more information than that provided by the Visual Analogue Scale. He also mentions that it is fairly quick to administer and that the wording is simple and easy to understand by the patients.

3.7.1.3 Scoring Scale for subjective and functional follow-up evaluation

This scoring scale produced by Kaikkonen, et al. (1994:468,469), is used to evaluate ankle injuries. In their study, an evaluation was performed of 11 different functional ankle tests, questionnaire answers, and results of clinical ankle examinations. The final scoring scale that was developed by them consists of a subjective assessment of symptoms and function of the injured ankle, 4 functional tests and a clinical evaluation of joint laxity and range of motion in dorsiflexion. They concluded that each selected test showed excellent reproducibility, and also significantly differentiated healthy controls and patients with excellent overall healing from those with poor or fair recovery. It is furthermore recommended by them that the scale be used for studies evaluating functional recovery after ankle injury.

This scale was completed at the initial consultation and again after the final treatment.

3.7.2 Objective Measurements

3.7.2.1 The Algometer

The algometer used in this research study was a force dial manufactured by Wagner Instruments: P.O. Box 1217, Greenwich, CT 06836, USA.

The algometer is used to determine pressure threshold (i.e. minimum pressure inducing pain) (Fischer, 1986:836). The use of the algometer in this study was to record the patient's response to the ankle treatment and to make any record of their improvement from the beginning to the end of the treatment period.

The algometer was placed at a 90° angle verticle to the skin, over the most tender area of the anterior talofibular ligament and pressure was then exerted as indicated by Fischer (1986:837), at an even rate. The patient was told to indicate verbally when discomfort was felt. At this point, the reading was taken and recorded in kilograms per square centimetre, with a higher reading indicating less tenderness. The algometer reading was taken at the first consultation, before the first treatment, and again at the final consultation, after the last treatment (Appendix J).

3.7.2.2 The Goniometer

The goniometer used in this study was manufactured by Baseline®, Fabrication Enterprise, Inc., Irvington, New York, USA and was used to measure ankle dorsiflexion range.

In a study done by Rothstein, et al. (1983:1613), the goniometer (regardless of the type) was found to have a high degree of intratester reliability for both elbow and knee measurements. It is a primary tool of measurement both for initial assessment and for charting patient progress (Rothstein, et al. 1983:1611).

Goniometer readings were taken according the procedure described by Jonson and Gross (1997:255), with the patient lying prone with the knee extended. The patient was then instructed to actively dorsiflex the foot, while the examiner passively moved the foot into dorsiflexion at the same time. The goniometer was placed with one of its arms aligned with the fifth metatarsal shaft and the other arm with the fibula head.

The goniometer readings were taken at the first consultation, before the initial treatment and again at the final consultation, after the final treatment (Appendix J).

3.8 SOLVING THE SUB-PROBLEMS AND HYPOTHESES

The purpose of this study was to determine the effectiveness of manipulating the mortise joint, as compared to a combination of manipulation and gastrocnemius/soleus stretching, in terms of subjective and objective clinical findings in the treatment of subacute and chronic grade I and II ankle inversion sprains. As previously mentioned, it was hypothesised that both stretching and manipulation would prove to be a more effective treatment protocol, in terms of subjective and objective findings, than the manipulation alone.

3.8.1 The First Subproblem

The first subproblem was to compare the relative effectiveness of manipulation and manipulation combined with stretching in the treatment of subacute and chronic grade I and II ankle inversion sprains in terms of subjective clinical findings.

3.8.2 The Second Subproblem

The second subproblem was to compare the relative effectiveness of manipulation and manipulation combined with stretching in the treatment of subacute and chronic grade I and II ankle inversion sprains in terms of objective clinical findings.

3.9 STATISTICAL ANALYSIS

3.9.1 Treatment of the data

3.9.1.1 Subjective Data:

The subjective data was treated as follows:

- The questionnaires were screened to ensure that they were completed correctly by the patient.
- Data collected from the questionnaires were converted into percentages. This information was recorded separately for the two groups.
- The scores obtained by the subjective and functional evaluation of the ankle injury were represented by a score out of 100.
- Statistical analysis of data was performed using a 5 % level of significance.

3.9.1.2 Objective Data:

The objective data was treated as follows:

- The scores obtained to measure ankle dorsiflexion were recorded separately for each group.
- Algometer readings were recorded separately for each group.
- Statistical analysis of data was performed using a 5 % level of significance.

3.9.2 Statistical Analysis of the data

To determine the manner in which the data should be statistically analysed, the Technikon Natal statistician was consulted. The sample size of the research group was 60 (30 per group) and both parametric and non-parametric testing was used in statistical analysis of the data using the SPSS version 9.0 package.
Statistical analysis was conducted at a 5 % level of significance.

3.9.2.1 <u>Non-parametric Testing</u>

Categorical variables were analysed using non-parametric testing, regardless of the sample size.
The categorical variables include the results from:

1. McGill Pain Questionnaire
2. Functional Evaluation Scale

A) MANN-WHITNEY U-TEST

The Mann-Whitney U-Test is used to determine inter-group comparison between groups 1 and group 2, in terms of subjective data using the results from the McGill

Pain Questionnaire and the Functional Evaluation Scale. The purpose of this was to analyse whether there was a significant difference between the two groups at the initial and final consultations.

Ho: There is no difference between the two groups.

Ha: There is a difference between the two groups.

Decision rule:

If $p < \alpha$, reject Ho.

If $p \geq \alpha$, accept Ho.

Where p is the reported p-value.

B) WILCOXON SIGNED RANKS TEST

The Wilcoxon Signed Ranks Test is used to determine intra-group comparison within group 1 and group 2, in terms of subjective data using the results of the McGill Pain Questionnaire and the Functional Evaluation Scale. The purpose of this was to analyse whether there was a significant improvement within each group between the initial and final consultations.

Ho: There is no improvement between the consultations.

Ha: There is an improvement between the consultations.

Decision rule:

If $p < \alpha$ reject Ho.

If $p \geq \alpha$, accept Ho.

(i) $p = \frac{\text{reported p-value}}{2}$ — If Ha is of form > and z is positive; If Ha is of form < and z is negative

(ii) $p = 1 - \frac{\text{(reported p-value)}}{2}$ — If Ha is of form > and z is negative; If Ha is of form < and z is positive

(The reported p-value is the SPSS print out value of p).

3.9.2.2 Parametric Testing

Continuous variables were analysed using parametric testing method.

Continuous variables include results from the:

1. Algometer

2. Goniometer

3. Numerical Pain Rating Scale 101

A) TWO SAMPLE UNPAIRED T-TEST

The two sample unpaired t-test, is used to determine inter-group comparison, in terms of subjective and objective data using the results of the continuous variables. The purpose of this was to analyse whether there was a significant difference between the two groups at the initial and final consultations.

Ho: There is no difference between the two groups.

Ha: There is a difference between the two groups.

Decision Rule:

If $p < \alpha$, reject Ho.

If $p \geq \alpha$, accept Ho.

Where p is the reported p-value.

B) TWO SAMPLE PAIRED T-TEST

The two sample paired t-test is used to determine intra-group comparison, in of subjective and objective data, using the results from the continuous variables. The purpose of this was to analyse whether there was a significant improvement within group 1 and group 2 between the initial and final consultations.

Ho: There is no improvement between the consultations.

Ha: There is an improvement between the consultations.

Decision rule:

If $p < \alpha$, reject Ho.

If $p \geq \alpha$, accept Ho.

(i) $p = \frac{\text{reported p-value}}{2}$

If Ha is of form > and z is positive

If Ha is of form < and z is negative

(ii) $p = 1 - \frac{\text{(reported p-value)}}{2}$

If Ha is of form > and z is negative

If Ha is of form < and z is positive

(The reported p-value is the SPSS print out value of p).

CHAPTER

FOUR

CHAPTER FOUR – THE RESULTS

4.1 INTRODUCTION

This chapter includes the demographic data obtained from all subjects who took part in this study, as well as the statistically analysed results obtained from the objective and subjective data collected from the subjects over the treatment period.

Subjective data was obtained from the short-form McGill Pain Questionnaire, the Funcional Evaluation Scale and the Numerical Pain Rating Scale 101. Objective data was obtained from the algometer and goniometer readings.

A total of 60 patients participated in this study ie. 30 in group 1 and 30 in group 2. Both parametric and non-parametric tests were used to analyse data in this study, in order to accept or reject the null hypothesis. The results from the inter- and intra-group analysis were represented in tables.

4.1.1 Non-parametric tests

Non-parametric tests were conducted due to the use of the short-form McGill Pain Questionnaire and the Functional Evaluation Scale. The Mann-Whitney U-Test and Wilcoxon Signed Ranks Test were therefore used.

For inter-group comparison, the Mann-Whitney U Test was used. The null hypothesis stated that there was no difference between the two samples being compared at the $\alpha = 0.05$ level of significance. The alternative hypothesis stated that there was a difference between the two samples being compared (Fischer and Van Belle, 1993:315-319).

Intra-group comparison was carried out by using the Wilcoxon Signed Ranks Test. The null hypothesis stated that there was no improvement between the two samples being compared at the $\alpha = 0.05$ level of significance. The alternative hypothesis stated that there was an improvement between the two samples being compared (Fischer and Van Belle, 1993:315-319).

4.1.2 Parametric Tests

Parametric tests were used due to the sample size being 60. The paired and unpaired t-tests are used when the sample size is greater than or equal to 30.

For inter-group comparison, the two-sample unpaired t-test was used to determine whether there was any difference between the two groups at the initial and final consultations.

In this test the null hypothesis stated that there was no difference between the two samples being compared at the $\alpha = 0.05$ level of significance. The alternative hypothesis stated that there was a difference between the two samples being compared (Fischer and Van Belle, 1993:315-319).

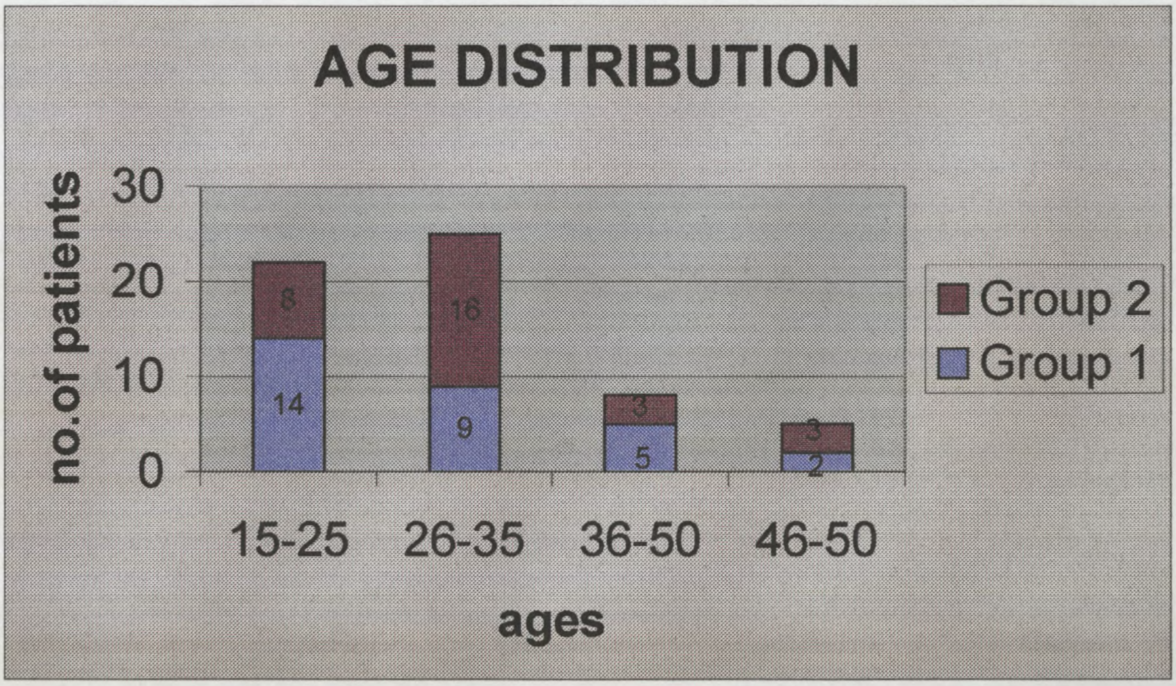
For intra-group comparison, the two-sample paired t-test was used to determine whether or not there was any improvement between the initial and final consultations.

In this test the null hypothesis stated that there was no improvement between the two samples being compared at the $\alpha = 0.05$ level of significance. The alternative hypothesis stated that there was an improvement between the two samples being compared (Fischer and Van Belle, 1993:315-319).

4.2 DEMOGRAPHIC DATA

4.2.1 AGE DISTRIBUTION

Figure 4.1



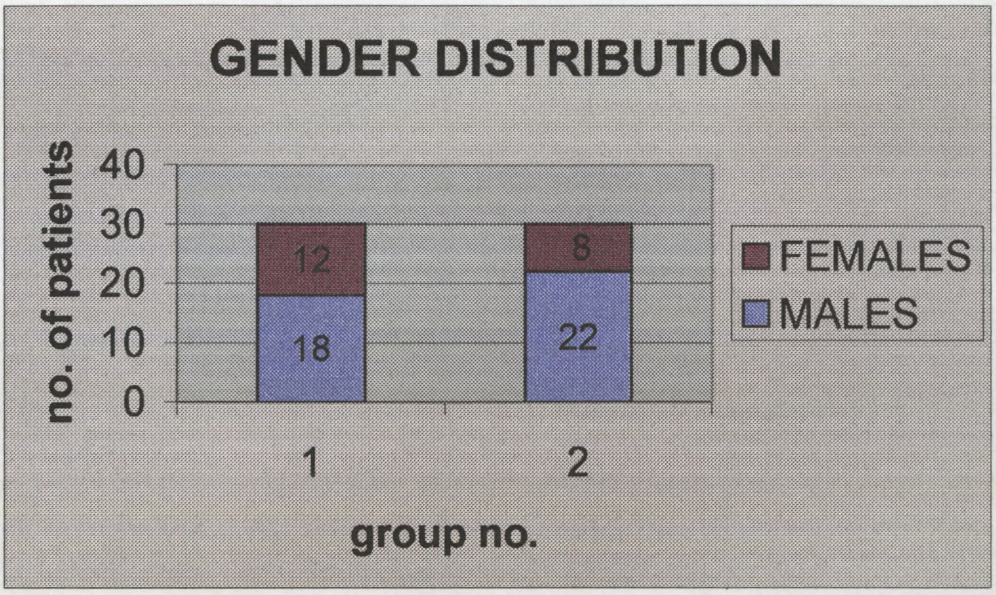
The mean age for group 1 was 28.9.

The mean age for group 2 was 30.36

The mean age for both group 1 and group 2 was 29.63.

4.2.2 GENDER DISTRIBUTION

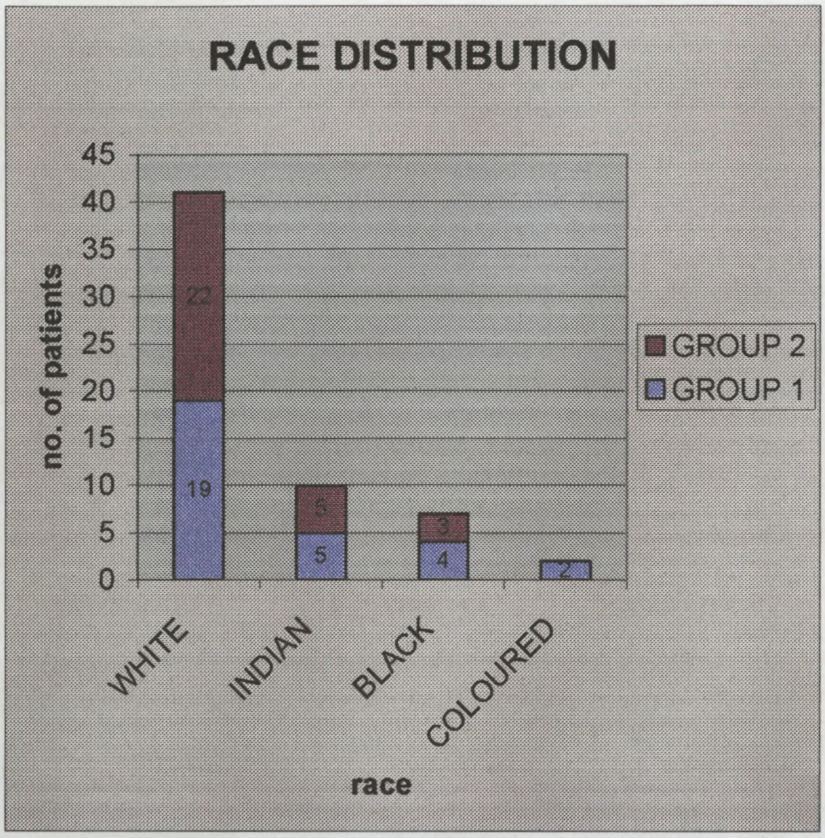
Figure 4.2



The total number of males participating in this study was 40 (67%) and the total number of females was 20 (33%). Thus, the total number of males was exactly double that to the number of females.

4.2.3 RACE DISTRIBUTION

Figure 4.3



The total number of Whites amounted to 41 (68%).

The total number of Indians amounted to 10 (17%).

The total number of Blacks amounted to 7 (12%).

The total number of Coloureds amounted to 2 (3%).

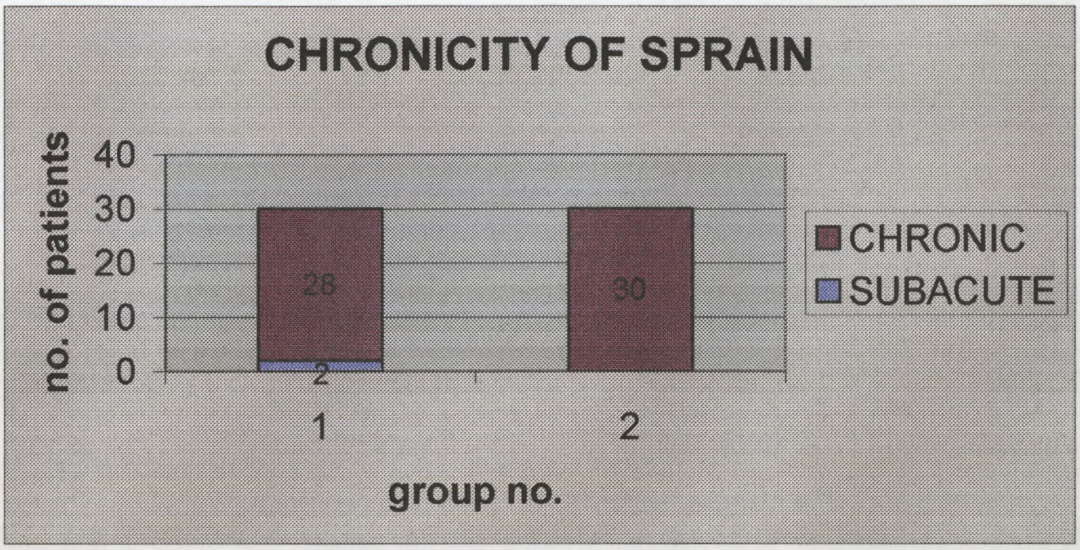
4.2.4 ACTIVITY LEADING TO INJURY

Table 4.1

ACTIVITY	*GROUP 1*	*GROUP 2*	*TOTAL*
Running	3	7	10
Soccer	5	4	9
Squash	3	4	7
Walking	3	3	6
Rugby	2	3	5
Fell down stairs	3	2	5
Basketball	1	1	2
Netball	1	0	1
Tennis	0	1	1
Wrestling	1	0	1
Hockey	1	0	1
Skateboarding	1	0	1
Other	6	5	11
TOTAL	30	30	60

4.2.5 CHRONICITY OF SPRAIN

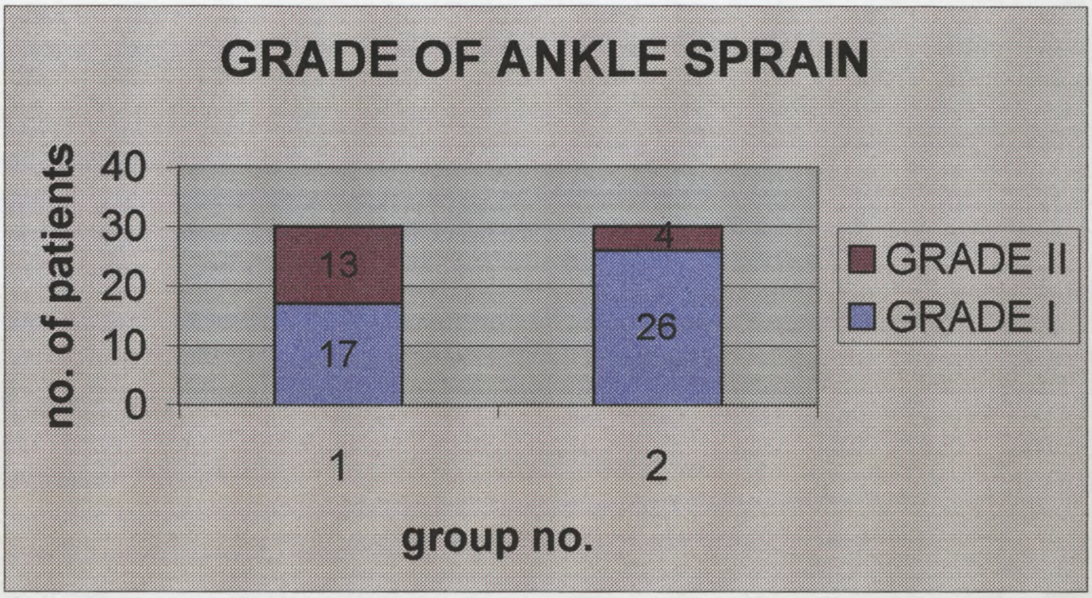
Figure 4.4



Subacute sprains only totaled 2 (3%) of the sprains encountered in this study, while chronic ankle sprains accounted for the rest i.e. 58 (97%).

4.2.6 GRADE OF ANKLE SPRAIN

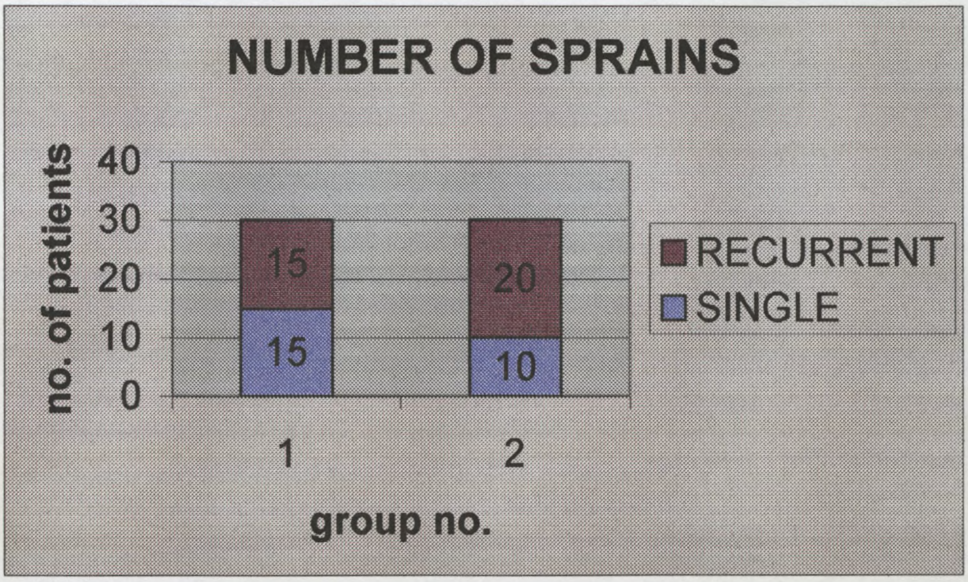
Figure 4.5



Of all the ankle sprains encountered in this study, 43 (72%) were grade I sprains, while only 17 (28%) were grade II sprains.

4.2.7 NUMBER OF SPRAINS INCURRED

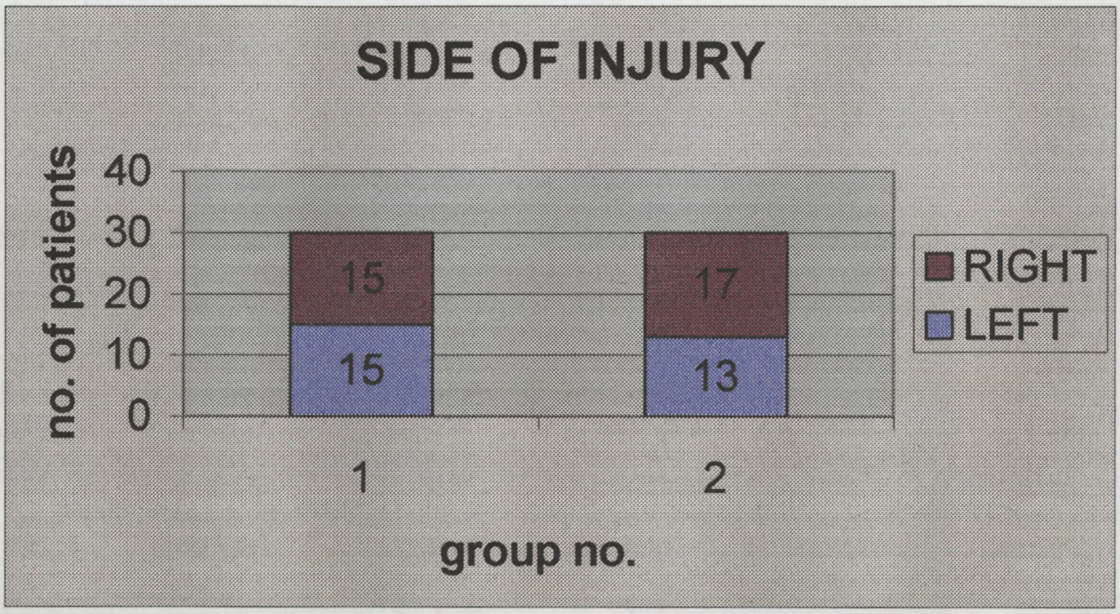
Figure 4.6



The number of patients with single sprains amounted to 25 (42%), while the rest of the patients suffered from recurrent ankle sprains i.e. 35 (58%).

4.2.8 SIDE OF INJURY

Figure 4.7



The left ankle was affected 47% (totaling 28) of the time and the right ankle was affected 53% (totaling 32) of the time.

4.3 NON-PARAMETRIC INTER-GROUP COMPARISON

Analysis of the subjective data with regards to the short-form McGill Pain Questionnaire (SF-MPQ) and the Functional Evaluation Scale (FES).

Table 4.2

Mann-Whitney U-Tests comparing group 1 and group 2, assessing subacute/chronic ankle sprains with regards to the *subjective* data from the first and final consultations.

	FIRST CONSULTATION (p-value)	FINAL CONSULTATION (p-value)
SF-MPQ	0.830	0.748
FES	0.004 (*0.002)	0.016 (*0.008)

*p-value = $\frac{\text{reported p-value}}{2}$

The null hypothesis is accepted according to the defined decision rule for the SHORT-FORM MCGILL PAIN QUESTIONNAIRE, indicating no difference between group 1 and group 2 between the first and final consultations for the SF-MPQ results. The null hypothesis is rejected according to the defined decision rule for the FUNCTIONAL EVALUATION SCALE, indicating a difference between group 1 and group 2 between the first and final consultations for the FES results. Upon examination of the Z-value, this negative figure indicates that the score for group 1 is less than the score for group 2. This clearly shows that group 2 did better than group 1.

4.4 PARAMETRIC INTER-GROUP COMPARISON

Analysis of the subjective data with regards to the NUMERICAL PAIN RATING SCALE-101 (NRS-101).

Table 4.3

Unpaired t-tests comparing group 1 and group 2, assessing subacute/chronic ankle sprains with regards to the *subjective* data at the first and final consultations.

	FIRST CONSULTATION (p-value)	FINAL CONSULTATION (p-value)
Numerical Pain Rating Scale-101	0.198	0.126

The null hypothesis is accepted according to the defined decision rule, indicating no difference between group 1 and group 2 for the NRS-101 results, between the initial and final consultation.

Analysis of the objective data with regards to the ALGOMETER AND GONIOMETER READINGS.

Table 4.4

Unpaired t-tests comparing group 1 and group 2 assessing subacute/chronic ankle sprains with regards to *objective* data from the initial and final consultations.

	FIRST CONSULTATION (p-value)	**FINAL CONSULTATION** (p-value)
ALGOMETER	0.699	0.734
GONIOMETER	1.000	0.815

The null hypothesis is accepted according to the defined decision rule for both the ALGOMETER and GONIOMETER READINGS indicating no difference between group 1 and group 2 in terms of objective results, between the initial and final consultation.

4.5 NON-PARAMETRIC INTRA-GROUP COMPARISON

Analysis of subjective data with regards to the short-form McGill Pain Questionnaire (SF-MPQ) and the Functional Evaluation Scale (FES).

Table 4.5

Wilcoxon-signed Ranks Test comparing the initial and final consultations, assessing subacute/chronic ankle sprains with regards the *subjective* data within group 1.

	GROUP 1 (p-value)
SF-MPQ	0.000
FES	0.000

The null hypothesis is rejected according to the defined decision rule for the SHORT-FORM MCGILL PAIN QUESTIONNAIRE and the FUNCTIONAL EVALUATION SCALE, indicating an improvement between the initial and final consultations, for the subjective data, within group 1.

Table 4.6

Wilcoxon-signed Ranks Test comparing the initial and final consultations, assessing subacute/chronic ankle sprains with regards the *subjective* data within group 2.

	GROUP 2 (p-value)
SF-MPQ	0.000
FES	0.000

The null hypothesis is rejected according to the defined decision rule for the SHORT-FORM MCGILL PAIN QUESTIONNAIRE and the FUNCTIONAL EVALUATION SCALE, indicating an improvement between the initial and final consultations, for the subjective data, within group 2.

4.6 PARAMETRIC INTRA-GROUP COMPARISON

Analysis of the subjective data with regards to the NUMERICAL PAIN RATING SCALE-101.

Table 4.7

Paired t-tests comparing the initial and final consultations assessing subacute/chronic ankle sprains with regards to the *subjective* data within group 1.

	GROUP 1 (p-value)
Numerical Pain Rating Scale-101	0.000

The null hypothesis is rejected according to the defined decision rule, indicating an improvement within group 1 between the initial and final consultation for the NRS-101 results.

Table 4.8

Paired t-tests comparing the initial and final consultations assessing subacute/chronic ankle sprains with regards to the *subjective* data within group 2.

	GROUP 2 (p-value)
Numerical Pain Rating Scale-101	0.000

The null hypothesis is rejected according to the defined decision rule, indicating an improvement within group 2 between the initial and final consultation, for the NRS-101 results.

Analysis of the objective data with regards to the ALGOMETER and GONIOMETER READINGS.

Table 4.9

Paired t-tests comparing the initial and final consultations assessing subacute/chronic ankle sprains with regards to *objective* data within group 1.

	GROUP 1 (p-value)
ALGOMETER	0.000
GONIOMETER	0.000

The null hypothesis is rejected according to the defined decision rule for both the ALGOMETER and GONIOMETER READINGS indicating an improvement within group 1 between the initial and final consultation, for the objective results.

Table 4.10

<u>Paired t-tests comparing the initial and final consultations assessing subacute/chronic ankle sprains with regards to *objective* data within group 2.</u>

	GROUP 2 (p-value)
ALGOMETER	0.000
GONIOMETER	0.000

The null hypothesis is rejected according to the defined decision rule for both the ALGOMETER and GONIOMETER READINGS indicating an improvement within group 2 between the initial and final consultation, for the objective results.

CHAPTER

FIVE

CHAPTER FIVE – DISCUSSION

5.1 INTRODUCTION

This chapter deals with the discussion of the results obtained from the subjective and objective data. Readings were taken at the initial consultation, before the first treatment and again at the final consultation, after the final treatment. Subjective data was obtained using the Numerical Pain Rating Scale-101 and the short-form McGill Pain Questionnaire. Objective data was obtained using an algometer and a goniometer. The Functional Evaluation Scale provided both subjective and objective data on ankle functioning.

Both parametric and non-parametric statistics were used when analyzing data. Non-parametric statistics made use of the Mann-Whitney U and the Wilcoxon Signed Ranks tests when analyzing the data. The Mann-Whitney U test was used for inter-group analysis of subjective data, namely the short-form McGill Pain Questionnaire and the Functional Evaluation Scale. The Wilcoxon Signed Ranks test was also used when analyzing subjective data, namely the short-form McGill Pain Questionnaire and the Functional Evaluation Scale, however this test was used for intra-group analysis of data.

Parametric statistics made use of the Paired and Unpaired T-tests when analyzing the data. The Unpaired T-test was used for inter-group analysis of both subjective data, namely the Numerical Pain Rating Scale-101 (NRS-101), and objective data, namely the algometer and goniometer readings. The Paired T-tests also analysed subjective (NRS-101) and objective (algometer and goniometer) data, however these tests were concerned with intra-group analysis.

Statistical analysis of the data was performed by comparing the initial and the final consultation, in order to determine the effectiveness of each of the treatments for subacute and chronic grade I and II ankle inversion sprains.

5.2 INTER-GROUP ANALYSIS OF DATA

5.2.1 Objective Measures

5.2.1.1 Algometer

The statistically analyzed data obtained from the algometer representing inter-group comparison, is found in table 4.6. These results did not indicate a statistically significant difference when comparing group 1 and group 2 between the initial and final consultations, suggesting that both forms of treatment were equally effective for the subacute and chronic grade I and II ankle inversion sprains.

5.2.1.2 Goniometer

The statistically analyzed data obtained from the goniometer representing inter-group comparison, is found in table 4.6. These results did not indicate a statistically significant difference when comparing group 1 and group 2 between the initial and final consultations, suggesting that both forms of treatment were equally effective for subacute and chronic grade I and II ankle inversion sprains.

5.2.1.3 <u>Summary</u>

In conclusion, it can be seen that in terms of the objective data, neither one of the two groups benefited more than the other in terms of their respective treatments between the initial and final consultations.

It was hypothesized that there would be a statistically significant difference in terms of objective findings between the two groups, thus demonstrating that one of the treatment protocols was more effective than the other. The null hypothesis however was accepted, thereby indicating no difference between the two groups in terms of the objective data at a 5 % level of significance.

5.2.2 Subjective Measures

5.2.2.1 <u>The short form McGill Pain Questionnaire (SF-MPQ)</u>

The statistically analyzed data obtained from the SF-MPQ representing inter-group comparison, is found in table 4.2. These results did not indicate a statistically significant difference when comparing group 1 and group 2 between the initial and final consultations, suggesting that both forms of treatment were equally effective for subacute and chronic grade I and II ankle inversion sprains.

5.2.2.2 Functional Evaluation Scale

The statistically analyzed data obtained from the Functional Evaluation Scale representing inter-group comparison, is found in table 4.2. These results did indicate a statistically significant difference when comparing group 1 and group 2 between the initial and final consultations, suggesting that one form of treatment was more effective than the other for subacute and chronic grade I and II ankle inversion sprains. As previously explained, the data revealed that group 2 performed better than group 1.

5.2.2.3 Numerical Pain Rating Scale-101 (NRS-101)

The statistically analyzed data obtained from the NRS-101 representing inter-group comparison, is found in table 4.5. These results did not indicate a statistically significant difference when comparing group 1 and group 2 between the initial and final consultations, suggesting that both forms of treatment were equally effective for subacute and chronic grade I and II ankle inversion sprains.

5.2.2.3 Summary

In conclusion, analysis of the subjective data indicates that when considering the SF-MPQ and the NRS-101, neither one of the two groups benefited more than the other in terms of their respective treatments between the initial and final consultations. However, in terms of the Functional Evaluation Scale there is an indication that the group receiving a combination of manipulation and stretching benefited more than the group receiving manipulation alone, between the initial and final consultations.

It was hypothesized that there would be a statistically significant difference in terms of subjective findings between the two groups, thus demonstrating that one of the treatment protocols was more effective than the other. The null hypothesis however was accepted for the SF-MPQ and NRS-101, thereby indicating no difference between the two groups in terms of this data. However, the null hypothesis was rejected for the Functional Evaluation Scale, thereby indicating a difference between the two groups in terms of this data at a 5 % level of significance.

5.3 INTRA-GROUP ANALYSIS OF DATA

5.3.1 Objective Measures

5.3.1.1 Algometer

The statistically analyzed data obtained from the algometer representing intra-group comparison, is found in tables 4.9 and 4.10. These results indicated a statistically significant improvement within group 1 and also within group 2 between the initial and final consultations. This suggests that each form of treatment was effective in treating subacute and chronic grade I and II ankle inversion sprains, as patients within each group showed significant improvement at the final consultation as compared to the initial consultation.

5.3.1.2 Goniometer

The statistically analyzed data obtained from the goniometer representing intra-group comparison, is found in tables 4.9 and 4.10. These results indicated a statistically significant improvement within group 1 and also within group 2 between the initial and final consultations. This suggests that each form of treatment was effective in treating subacute and chronic grade I and II ankle inversion sprains, as patients within each group showed significant improvement at the final consultation as compared to the initial consultation.

5.3.1.3 Summary

In conclusion, it can be seen that in terms of the objective data, both group 1 and group 2 benefited from their respective treatments between the initial and final consultations.

It was hypothesized that there would be a statistically significant improvement between the treatments in terms of objective findings in each of the two groups. The null hypothesis is rejected, thereby indicating a statistically significant improvement within each group at a 5 % level of significance.

5.3.2 Subjective Measures

5.3.2.1 The short form McGill Pain Questionnaire (SF-MPQ)

The statistically analyzed data obtained from the SF-MPQ representing intra-group comparison, is found in tables 4.3 and 4.4. These results indicated a statistically significant improvement within group 1 and also within group 2 between the initial and final consultations. This suggests that each form of treatment was effective in treating subacute and chronic grade I and II ankle inversion sprains, as patients within each group showed significant improvement at the final consultation as compared to the initial consultation.

5.3.2.2 Functional Evaluation Scale

The statistically analyzed data obtained from the Functional Evaluation Scale representing intra-group comparison, is found in tables 4.3 and 4.4. These results indicated a statistically significant improvement within group 1 and also within group 2 between the initial and final consultations. This suggests that each form of treatment was effective in treating subacute and chronic grade I and II ankle inversion sprains, as patients within each group showed significant improvement at the final consultation as compared to the initial consultation.

5.3.2.3 Numerical Pain Rating Scale-101 (NRS 101)

The statistically analyzed data obtained from the NRS-101representing intra-group comparison, is found in tables 4.7 and 4.8. These results indicated a statistically significant improvement within group 1 and also within group 2 between the initial and final consultations. This suggests that each form of treatment was effective in treating subacute and chronic grade I and II ankle inversion sprains, as patients within each group showed significant improvement at the final consultation as compared to the initial consultation.

5.3.2.4 Summary

In conclusion, there is indication in terms of the subjective data, that both group 1 and group 2 benefited from their respective treatments from the initial to the final consultations.

It was hypothesized that there would be a statistically significant improvement between the treatments in terms of subjective findings in each of the two groups. The null hypothesis is rejected, thereby indicating a statistically significant improvement within each group at a 5 % level of significance.

5.4 DISCUSSION OF DEMOGRAPHIC DATA

Figure 4.1 depicting the age distribution of the patients participating in this study, shows that the largest overall number of patients fall into the 26-35 year age group, with the 46-50 year old age group containing the least number of patients. Group 1 appeared to have a larger number of patients in the 15-25 year age group than group 2, whilst group 2 had double the number of patients in the 26-35 year age group than group 1 did. The average age for the individual groups was fairly close with group 1 being 28.9 and group 2 being 30.36. The average age for both groups was 29.63, which is slightly younger than the average age of 34, which was calculated in Fallat, et al.'s (1998:281) study of 639 patients who had had a twisting injury to their ankles.

Gender distribution (Figure 4.2), showed double the number of males compared to females, thereby indicating a predominance of subacute or chronic grade I and II ankle inversion sprains for males in this study. This is in opposition to Garrick (1977:241) who implies that the ankle has provided equal opportunities to be injured regardless of sex.

From the demographic data it can therefore be concluded that the majority of the patients participating in this study were white males between the ages of 26-35 years.

Chronic ankle sprains were the predominant type of injury in this study, with grade I sprains occurring more frequently than grade II, and with multiple/recurrent sprains being more common than sprains occurring for the first time. This correlates with the fact that a history of previous ankle problems seems to result in more ankle sprains than those without a history (Tropp, et al. 1985:261 and Lysens, et al. 1984:7,8).

The result in this study of the most common side to be injured, i.e. the left ankle being affected 47% of the time as compared to the right ankle which was affected 53% of the time, is in close keeping with the results of Fallat et al.'s (1998:282) study, in which their results found the left ankle to be affected 48.2% of the time and the right ankle to be affected 51.8% of the time.

5.5 STUDY LIMITATIONS

5.5.1 Limitations of the subjective data

One of the limitations of this study was the lack of stratification. Garrick (1977:241) implies that there appears to be no preference for males when it comes to spraining the ankle, however, there were double the amount of males compared to females that participated in this study. This lack of stratification can also be seen when looking at the racial distribution, with the white population dominating the racial distribution in this study.

Another limitation is the possibility that patients may not have fully understood the questionnaires even though every attempt was made by the researcher to explain any difficulties that the patient may have had. In addition to this, patients may have provided results that would please the examiner. Both of these factors would result in the data being affected either positively or negatively.

Patient compliance with respect to not partaking in any other form of treatment, is reliant upon the integrity of the patient.

5.5.2 Limitations of the objective data

Although placement and measurement of the algometer and goniometer was attempted with as much accuracy as possible by the researcher, slight inaccuracies may have resulted due to human error.

5.6 COMPARISON WITH OTHER STUDIES

A direct comparison to other studies could not be made as no other study could be found comparing manipulation and stretching for the treatment of subacute and chronic grade I and II ankle inversion sprains.

Pellow (1999) conducted a trial comparing manipulation of the mortise joint to placebo for the treatment of subacute and chronic grade I and II ankle inversion sprains. In both his study and the present study, the age groups i.e. 15-50 years were the same, as was the use of the same subjective and objective measurements i.e. algometer, goniometer, short-form McGill Pain Questionnaire, Numerical Pain Rating Scale and Functional Evaluation Scale. However his study consisted of 30 patients as compared to the 60 patients of the present study. In addition, Pellow's (1999) study was conducted over a 4 week period with a maximum of 8 treatments as well as a one month follow up consultation, unlike the present study which was conducted over a 2 week period with a maximum of 6 treatments and no follow up consultation.

Similarities in the results of both studies were found in terms of the intra-group analysis of the data, with both studies showing an improvement in objective results in terms of improvement in dorsiflexion range and an increase in the patients pain threshold. Subjective results also showed improvement in both studies in terms of overall ankle functioning as well as a decrease in the patient's pain quality and intensity.

CHAPTER

SIX

CHAPTER SIX – RECOMMENDATIONS AND CONCLUSIONS

6.1 RECOMMENDATIONS

It is recommended that in future studies stratification should be undertaken so as to provide homogeneity between the two groups in terms of age, gender, race, occupation, chronicity, severity of pain, etc.

Researcher bias may have resulted due to the lack of blinding in this study. A single-blinded study may reduce the risk of such bias and increase the studies validity. This can be done by getting someone else to assess and record objective measurements as well as to aid in the completion of subjective questionnaires.

Exact intervals between consultations should be stipulated i.e. although the treatment period was 2 weeks each individual patients consultations varied in terms of intervals between visits. This is in keeping with the study done by Coetzer (2001:1), in which the manipulation group received six sessions of treatment spread equally over a two week period. In another study by Pellow (2001:17), the treatment period was longer with patients receiving a maximum of eight treatments spread over a period of 4 weeks. Both of the fore mentioned studies included a one month follow-up consultation.

A follow-up consultation of one month or more is required to accurately assess the effectiveness of the treatment provided. It was noted that at least six of the patients that took part in this study were encountered after a short period of time of completing the study, and who claimed to be feeling much improved compared to at their final consultation.

More frequent stretching may have had a more positive effect on the outcome of this study. Self-stretching by patients at home may have aided in further improving results in terms of subjective and objective data. Compliance of these stretches however would need to be controlled so as to ensure the accuracy of the results.

Objective and subjective data should be recorded at one or more other consultations throughout the treatment period, rather than at just the initial and final consultations, so as to provide a more accurate assessment on the development of the patients condition throughout the study.

6.2 CONCLUSIONS

The purpose of this study was to compare the effectiveness of manipulation with and without the addition of static stretching of the gastrocnemius and soleus muscles in the treatment of subacute and chronic grade I and II ankle inversions sprains.

The results of this study indicated an improvement within each individual group between the initial and final consultations. In terms of the subjective data, it was determined that statistically significant improvement was evident with regards to patient's pain intensity, the quality of their pain, as well as in the overall functioning of the patient's ankle. Objective data indicated a statistically significant improvement in terms of patient's pain threshold and in the range of ankle dorsiflexion. Excepting for a difference between the two groups in terms of ankle functioning, neither of the two groups otherwise showed any statistically significant benefit over the other in terms of the treatment received.

In conclusion, the results of this study demonstrate that chiropractic manipulation of the ankle mortise joint combined with static stretching of the gastrocnemius and soleus muscles is more effective for improving overall ankle functioning in the treatment of subacute and chronic grade I and II ankle inversion sprains than chiropractic manipulation of the ankle mortise joint alone.

REFERENCES

Arnheim, D.D. and Anderson, M.K.1991. *Essentials of Athletic Training*. 2 edition. St. Louis: Mosby Year Book.

Arnheim, D.D. and Prentice, W.E. 1993. *Principles of Athletic Training.* 8th edition. St. Louis: Mosby-Year Book, Inc.

Baker, C.L. and Todd, J.L. 1995. Intervening in acute ankle sprain and chronic instability. *The Journal of Musculoskeletal Medicine*, July: 51-68.

Bassewitz, H.L. and Shapiro, M.S. 1997. Persistent Pain After Ankle Sprain: Targeting the Causes. *The Physician and Sportsmedicine* [online], **25**(12). Available from: http://www.physsportsmed.com/issues/1997/12dec/shapiro [Accessed 1July 2001]

Bennet, W.F. 1994. Lateral Ankle Sprains: Part I: Anatomy, Biomechanics, Diagnosis and Natural History. *Orthopaedic Review*, **23**(5): 381-387.

Bergmann,T.F., Peterson, D.H. and Lawrence , D.J. 1993. *Chiropractic Technique.* New York: Churchill Livingstone.

Bogduk, N. and Mercer, S. 1995. Selection and application of treatment. *In:* Refshauge, K. and Gass, E. (eds.) *Musculoskeletal Physiotherapy: Clinical Science and Practice.* Oxford: Butterworth-Heinemann. pp. 169-181.

Bolton, J.E. and Wilkinson, R.C. 1998. Responsiveness of Pain Scales: A Comparison of Three Pain Intensity Measures in Chiropractic Patients. *Journal of Manipulative and Physiological Therapeutics*, **21**(1): 1-7.

Boruta P.M., Bishop, J.O., Braly, W.G. and Tullos H.S. 1990. Acute Ligament Injuries: A Literature Review. *Foot and Ankle*, **11**(2): 107-113.

Brantingham, J. 1999. *Clinical Biomechanics* [unpublished handout]. Technikon Natal.

Brantingham, J., Snyder, R., Wong, J., Brantingham, C. and Haggart, B. Chronic Ankle Pain (Unresolved Ankle Sprain) [online]. Available from: http://www.chiroweb.com/archives/11/02/16.html [Accessed 11 July 2001].

Cahill, B.R. 1973. Chronic orthopedic problems in the young athlete. *The Journal of Sports Medicine*, March/April: 36-39.

Calliet, R. 1968. *Foot and Ankle Pain.* 3rd edition. Philadelphia: FA Davis.

Chan, K.M. and Hsu, S.Y.C. 1993. Cartilage and Ligament Injuries. *In*: Renström, P.A.F.H. *Sports Injuries-Basic principles of prevention and care.* Oxford: Blackwell Scientific Publications. pp. 65-67.

Christensen, K.D. 1991. *Chiropractic Rehabilitation.* Washington: Publication Division C.R.A.

Coetzer, D.J., Brantingham, J. and Nook, B. 2001. The Relative Effectiveness of Piroxicam Compared to Manipulation in the Treatment of Acute Grades 1 and 2 Inversion Ankle Sprains. *Journal of the Neuromusculoskeletal System,* **9**(1): 1-12.

Coker, T.P. 1991. Sports Injuries to the Foot and Ankle. *In:* Jahss, M.H. *Disorders of the Foot and Ankle: Medical and Surgical Management.* 2nd edition. Philadelphia: W.B. Saunders Company. pp. 2415-2445.

Colter, J.M. 1984. Lateral Ligamentous Injuries of the Ankle. *In*: Hamilton, W.C. (ed.) *Traumatic Disorders of the Ankle.* New York: Springer Verlag. pp. 113-120.

de Bie, R.A., de Vet, H.C.W., Lenssen, T.F., van den Wildenberg, F.A.J.M., Kootstra, G. and Knipschild, P.G. 1998. Low-Level Laser Therapy in Ankle Sprains: A Randomized Clinical Trial. *Archives of Physical Medicine and Rehabilitation,* **79**(11): 1415-1420.

Donatelli, R.1990. *The Biomechanics of the Foot and Ankle.* Philadelphia: F.A. Davis Company.

Edmond, S.L. 1993. *Manipulation and Mobilization-Extremity and Spinal Techniques.* St. Louis: Mosby-Year Book, Inc.

Eiff, M.P., Smith, A.T. and Smith, G.E. 1994. Early Mobilization Versus Immobilization in the Treatment of Lateral Ankle Sprains. *The American Journal of Sports Medicine,* **22**(1): 83-88.

Fallat, L., Grimm, D.J. and Saracco, J.A. 1998. Sprained Ankle Syndrome: Prevalence and Analysis of 639 Acute Injuries. *The Journal of Foot and Ankle Surgery*, **37**(4): 280-285.

Fischer, A.A. 1986. Pressure Threshold Meter: Its Use for Quantification of Tender Spots. *Archives of Physical and Medical Rehabilitation*, **67**:36-38.

Fischer, L.D. and van Belle, G. 1993. *Biostatistics: A Methodology For The Health Sciences.* New York: John Wiley and Sons, Inc.

Garrick J.G. 1977. The frequency of injury, mechanism of injury and epidemiology of ankle sprains. *The American Journal of Sports Medicine*, **5**(6): 241-242.

Garrick, J.G. and Requa, R.K. 1988. The Epidemiology of Foot and Ankle Injuries in Sports. *Clinics in Sports Medicine*, **7**(1): 29-36.

Garrick, J.G.and Schelkun, P.H. 1997. Managing Ankle Sprains: Keys to Preserving Motion and Strength. *The Physician and Sports Medicine* [online], **25**(3). Available from: http://www.physsportsmed.com/issues/1997/03mar/garrick [Accessed 1 July 2001]

Gatterman, M.I. 1990. *Chiropractic Management of Spine Related Disorders.* Baltimore: Williams and Wilkins.

Gatterman, M.I. 1995. *Foundations of Chiropractic Subluxation*. St. Louis: Mosby-Year Book, Inc.

Glick, J.M.,Gordon, R.B. and Nishimoto, D. 1976. The prevention and treatment of ankle injuries. *The American Journal of Sports Medicine,* **4**(4): 136-141.

Green, T., Refshauge, K., Crosbie, J. and Adams, R. 2001. A Randomised Controlled Trial of Passive Accessory Joint Mobilisation on Acute Ankle Inversion Sprains. *Physical Therapy,* **81**(4): 984-994.

Greenman, P.E. 1996. *Principles of Manual Medicine*. 2nd edition. Baltimore: Williams and Wilkins.

Hamilton, W.G. 1982. Sprained Ankles in Ballet Dancers. *Foot and Ankle,* **3**(2): 99-102.

Harrington, K.D. 1979. Degenerative Arthritis of the Ankle Secondary to Long-Standing Lateral Ligament Instability. *The Journal of Bone and Joint Surgery,* **61-A**(3): 354-361.

Harris, C.R. 1995. Ankle Injuries. *In*: Ruiz, E. and Cicero, J.J. *Emergency Management of Skeletal Injuries*. St. Louis: Mosby Year Book, Inc. pp. 517-540.

Hertling, D. and Kessler, R.M. 1990. *Management of common Musculoskeletal disorders-Physical Therapy Principles and Methods.* 2nd edition. Philadelphia: J.B. Lippincott.

Hoffmann, M. and Payne, V.G. 1995. The Effects of Proprioceptive Ankle Disk Training on Healthy Subjects. *Journal of Orthopedic and Sports Physical Therapy*, **21**(2): 140-143.

Hopkinson, W.J., St. Pierre, P., Ryan, J.B. and Wheeler, J.H. 1990. Syndesmosis Sprains of the Ankle. *Foot and Ankle*, **10**(6): 325-330.

Jensen, M.P., Karoly, P. and Braver, S. 1986. The Measurement of Clinical Pain Intensity: A Comparison of Six Methods. *Pain*, **27**: 117-126.

Jerosch, J. and Bischof, M. 1996. Proprioceptive capabilities of the ankle in stable and unstable joints. *Sports Exercise and Injury*, **2**: 167-171.

Jonson, S.R. and Gross, M.T. 1997. Intraexaminer Reliability, Interexaminer Reliability, and Mean Values for Nine Lower Extremity Skeletal Measures in Healthy Naval Midshipmen. *Journal of Orthopedic and Sports Physical Therapy*, **25**(4): 253-263.

Juerhing, D. and Weinert, D. 2000. Physical Rehabilitation. *In:* Gardner, S and Mosby, J.S. *Chiropractic Secrets*. Philadelphia: Hanley and Belfus Inc. pp. 195-203.

Juliano, P.J. and Amis, J.A. 1998. Soft Tissue Injuries about the Ankle. *In*: Sammarco, G.J. and Cooper, P.S. (eds.) *Foot and Ankle Manual*. USA: Williams and Wilkins. pp. 79-91.

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

Kesson, M. and Atkins, E. 1998. *Orthopaedic Medicine – A Practical Approach*. Oxford: Butterworth-Heinemann.

Kirk, C.K., Lawrence, D.J. and Valvo, N.L. (eds.) 1991. *States Manual of Spinal, Pelvic and Extravertebral Technic.* 2nd edition. Illinois: National College of Chiropractic.

Konradsen, L., Voigt, M. and Højsgaard, C. 1997. Ankle Inversion Injuries: The Role of the Dynamic Defence Mechanism. *The American Journal of Sports Medicine*, **25**(1): 54-58.

Lawrence, D.J. (ed.) 1994. *Year Book of Chiropractic 1995.* St Louis: Mosby-Year Book Inc.

Lephart, S.M. and Fu, F.H. 1995. The role of proprioception in the treatment of sports injuries. *Sports Exercise and Injury*, **1**: 96-102.

Liebenson, C. 1989. Active Muscular Relaxation Techniques. Part I. Basic Principles and Methods. *Journal of Manipulative and Physiological Therapeutics*, **12**(6): 446-454

Lysens, R., Steverlynck, A., van den Auweele, Y. Lefevre, J., Renson, L., Claessens, A. and Ostyn, M. 1984. The Predictability of Sports Injuries. *Sports Medicine*, **1**: 6-10.

Mack, R.P. 1982. Ankle Injuries in Athletics. *Clinics in Sports Medicine*, **1**(1): 71-84.

Magee, D.J. 1997. *Orthopedic Physical Assessment.* 3^{rd} edition. Philadelphia: WB Saunders Company.

Maitland, G.D. 1991. *Peripheral Manipulation.* 3^{rd} edition. Oxford: Butterworth-Heinemann.

Mann, R.A. 1998. Biomechanics of the Foot and Ankle. *In:* Sammarco, G.J. and Cooper, P.S. *Foot and Ankle Manual.* 2^{nd} edition. USA: Williams and Wilkins. pp. 33-43.

Mann, R.A. and Mann, J.A. 1995. Foot and Ankle. *In:* Skinner, H.B. (ed.) *Current Orthopaedic Diagnosis and Treatment in Orthopedics.* USA: Appleton and Lange. pp. 385-452.

McCluskey, G.M., Blackburn, T.A. and Lewis, T. 1976. Prevention of ankle sprains. *The American Journal of Sports Medicine*, **4**(4): 151-157.

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

Mennell, J.M. 1964. *Diagnosis and Treatment using Manipulative Techniques.* Boston: Little, Brown and Company.

Merrill, K.D., Ketsche, R.P. and Friedman, R.J. 1995. Sports Medicine. *In*: Skinner, H.B. (ed.) *Current Orthopaedic Diagnosis and Treatment in Orthopedics.* USA: Appleton and Lange. pp. 116-164.

Miller, S.D. 1998. Ankle Fractures and Dislocations. *In*: Sammarco, G.J. and Cooper, P.S. *Foot and Ankle Manual.* USA: Williams and Wilkins. pp. 69-77.

Moore, K.L. 1992. *Clinically Oriented Anatomy.* 3rd edition. Baltimore: Williams and Wilkins.

Nield, S., Davis, K., Latimer, J., Maher, C. and Adams, R. 1993. The Effect of Manipulation on Range of Movement at the Ankle Joint. *Scandinavian Journal of Rehabilitation Medicine*, **25**: 161-166.

Norkin, C.C. and Levangie, P.K. 1992. *Joint Structure and Function – A comprehensive analysis.* 2nd edition. Philadelphia: F.A. Davis Company.

Norris, C.M. 1993. *Sports Injuries: Diagnosis and Management for Physiotherapists.* Oxford: Butterworth-Heinemann.

Ogilvie-Harris, D.J. and Gilbart, M. 1995. Treatment Modalities for Soft Tissue Injuries of the Ankle: A Critical Review. *Clinical Journal of Sports Medicine*, **5**(3): 175-186.

Oloff, L.M. 1994. *Musculoskeletal Disorders of the Lower Extremities.* Philadelphia: WB Saunders Company.

O'Sullivan, M.P. 1975. Indians Stretch for Strength. *The Physician and Sportsmedicine,* **7**: 109-110.

Parker, P., Armour, K., Craig, M., de Bie, R., Guly, H., Hill, P., Quinn, K., Ross, J. and Rowe, B. 1997. The treatment of acute and chronic injury to the lateral complex of the ankle. *The Cochrane Library*, **3**: 1-6.

Pellow, J.E. and Brantingham, J.W. 2001. The Efficacy of Adjusting the Ankle in the Treatment of Subacute and Chronic Grade I and II Ankle Inversion Sprains. *Journal of Manipulative and Physiological Therapeutics,* **24**(1): 17-24.

Pope, R., Herbert, R. and Kirwan, J. 1998. Effects of ankle dorsiflexion range and pre-exercise calf muscle stretching on injury risk in Army recruits. *Australian Physiotherapy*, **44**(3): 165-171.

Prentice, W.E. 1994. Therapeutic Ultrasound. *In:* Prentice, W.E. *Therapeutic Modalities in Sports Medicine.* 3rd edition. St. Louis: Mosby-Year Book, Inc. pp. 255-288.

Reid, D.C. 1992. *Sports Injury Assessment and Rehabilitation*. New York: Churchill Livingstone Inc.

Richardson, J.K. and Iglarsh, Z.A. 1994. *Clinical Orthopaedic Physical Therapy*. . Philadelphia: WB Saunders Company.

Riddle, D.L. 1994. Foot and Ankle. *In*: Richardson, J.K. and Iglarsh, Z.A. *Clinical Orthopaedic Physical Therapy*. Philadelphia: WB Saunders Company. pp. 483-562.

Rothstein, J.M., Miller, P.J. and Roettger, R.F. 1983. Goniometric Reliability in a Clinical Setting. *Physical Therapy*, **63**(10): 1611-1615.

Rundle, E. 1995. The foot and ankle. *In*: Zuluaga, M., Briggs, C., Carlisle, J., McDonald, V., McMeeken, J., Nickson, W., Oddy, P. and Wilson, D. (eds.) *Sports Physiotherapy: Applied Science and Practice*. Melbourne: Churchill Livingstone. pp. 643-686.

Ryan, L. 1994. Mechanical stability, muscle strength and proprioception in the functionally unstable ankle. *Australian Physiotherapy*, **40**(1): 41-47.

Saliba, E. and Foreman, S. 1994. Low-Power Lasers. *In*: Prentice, W.E. *Therapeutic Modalities in Sports Medicine*. 3rd edition. St. Louis: Mosby-Year Book, Inc. pp. 215-238.

Sammarco, G.J. 1998. Anatomy of the Foot and Ankle. *In*: Sammarco, G.J. and Cooper, P.S. (eds.) *Foot and Ankle Manual*. 2nd edition. USA: Williams and Wilkins. pp. 1-32.

Schafer, R.C. and Faye, L.J. 1989. *Motion Palpation and Chiropractic Technic: Principle of Dynamic Chiropractic*. California: The Motion Palpation Institute.

Singer, K.M. Jones, D.C. and Taillon, M.R. 1995. Ligament Injuries of the Ankle and Foot. *In*: Nicholas, J.A. and Hershman, E.B. *The Lower Extremity and Spine in Sports Medicine*. 2nd ed. St. Louis: Mosby-Year Book, Inc. pp. 423-439.

Snook, G.A. 1995. Lateral Ankle Reconstruction for Chronic Instability. *In:* Torg, J.S. and Shephard, R.J. *Current Therapy in Sports Medicine*. 3rd edition. St.Louis: Mosby -Year Book, Inc. pp. 248-251.

Stiell, I.G., Greenberg, G.H., McKnight, 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*, **269**(9): 1127-1132.

Thomson, A., Skinner, A., Piercy, J. 1991. *Tidy's Physiotherapy.* 12th edition. Oxford: Butterworth-Heinneman.

Travell, J.G. and Simons, D.G. 1983. *Myofascial Pain and Dysfunction: The Trigger Point Manual. The Lower Extremities.* Vol 2. Baltimore: Williams and Wilkins.

Trojian, T.H. and McKeag, D.B. 1998. Ankle Sprains: Expedient Assessment and Management. *The Physician and Sportsmedicine* [online], **26**(10). Available from: http://www.physsportsmed.com/issues/1998/10Oct/mckeag.htm [Accessed 1 July 2001]

Tropp, H., Askling, C. and Gillquist, J. 1985. Prevention of ankle sprains. *The American Journal of Sports Medicine*, **13**(4): 259-262.

Vegso, J.J. 1995. Principles of Stretching. *In:* Torg, J.S. and Shephard, R.J. *Current Therapy in Sports Medicine*. 3rd edition. St.Louis: Mosby -Year Book, Inc. pp. 476-478.

Wajswelner, H. and Webb, G. 1995. Therapeutic exercise. *In*: Zuluaga, M., Briggs, C., Carlisle, J., McDonald, V., McMeeken, J., Nickson, W., Oddy, P. and Wilson, D. (eds.) *Sports Physiotherapy: Applied Science and Practice.* Melbourne: Churchill Livingstone. pp. 207-221.

Wells, P.E., Frampton, V. and Bowsher, D. (eds.) 1988. *Pain – Management and Control in Physiotherapy.* Oxford: Butterworth-Heinemann Ltd.

Wester, J.U., Jespersen, S.M., Nielsen, K.D. and Neumann, L. 1996. Wobble Board Training After Partial Sprains of the Lateral Ligaments of the Ankle: A Prospective Randomized Study. *Journal of Orthopedic and Sports Physical Therapy*, **23**(5): 332-336.

White, H. 2000. Personal communication to K. Needham, 3 March 2000.

Yeung, M.S., Chan, K, So, C.H. and Yuan, W.Y. 1994. An epidemiological survey on ankle sprain. *British Journal of Sports Medicine*, **28**(2): 112-116.

CLASSIFICATION OF ANKLE SPRAINS

Severity	Pathology	Signs and Symptoms	Disability
Grade I (mild) stable	Mild stretch No instability Single ligament involved Usually anterior talofibular ligament	No hemorrhage Minimal swelling Point tenderness No anterior drawer No varus laxity	No or little limp Minimal functional loss Difficulty hopping Recovery (range 2-10 days)
Grade II (moderate) stable	Large spectrum of injury Mild to moderate instability Complete tearing of anterior talofibular ligament or Partial tearing of anterior talofibular plus calcaneoufibular ligaments.	Some hemorrhage Localized swelling Margins of Achilles tendon less defined May be anterior drawer No varus laxity	Limp with walking Inability to toe raise Inability to hop Unable to run Recovery 20 days (range 10-30)
Grade III (severe) two-ligament, unstable	Significant instability Completer tear of anterior capsule and talofibular ligament and associated tear of anterior talofibular and calcaneofibular ligaments	Diffuse swelling both sides of Achilles tendon, early hemorrhage May be tenderness medially and laterally Positive anterior drawer Positive varus laxity	Unable to bear weight fully Significant pain inhibition Initially almost complete loss of range of motion Recovery 40 days (range 30-90)

Taken from Reid (1992:226).

Patient information sheet

Dear Participant

The aim of this study is to evaluate the relative effectiveness of chiropractic manipulation combined with stretching compared to manipulation alone for subacute and chronic grades one and two inversion ankle sprains.

Sixty people will be required to complete this study. The participants will be randomly divided into two groups of 30 patients each. Patients in both groups will receive treatment.

One group will receive manipulation and stretching, whilst the other group will receive only manipulation. There is a 50 % chance of you being in either group.

If you are taking any medication, or undergoing any other form of treatment for your ankle injury, or taking any medication that may have an effect on the inflammatory processes in the ankle, you may be excluded from the study.

You will need to return for a maximum of six consultations spread over two weeks.

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

Thank you.

Yours faithfully
Kim Needham
(Chiropractic Intern)

APPENDIX C

INFORMED CONSENT FORM

Date: ______________

To be completed in duplicate by patient.

TITLE OF RESEARCH
The effectiveness of manipulation with and without static stretching of the gastrocnemius and soleus muscles in the treatment of subacute and chronic grade I and II ankle inversion sprains.

NAME OF RESEARCH STUDENT
Kim Needham

NAME OF SUPERVISOR
Dr. H. White

PLEASE CIRCLE THE APPROPRIATE ANSWER

1. Have you read the research information sheet? Yes/No
2. Have you had the opportunity to ask questions? Yes/No
3. Have you received satisfactory answers to your questions? Yes/No
4. Have you had an opportunity to discuss this study? Yes/No
5. Have you received enough information about this study? Yes/No
6. Who have you spoken to?..
7. Do you understand the implications of your involvement in this study? Yes/No
8. Do you understand that you are free to withdraw from this study? 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

Please do not sign unless all your questions have been adequately answered by the researcher.

Fill in below in block letters

PATIENT/SUBJECT Name ________________________ Signature__________

PARENT/GUARDIAN Name ________________________ Signature __________

WITNESS Name ________________________ Signature __________

RESEARCH STUDENT Name ________________________ Signature __________

APPENDIX D

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

TECHNIKON NATAL

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:

APPENDIX F

TECHNIKON NATAL

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

weight bearing:	*Non weight bearing:*
Plantar flexion__________	50°______________________
Dorsiflexion__________	20°______________________
Supination__________	
Pronation__________	
Toe dorsiflexion__________	40°(mtp)____________________
Toe plantar flexion__________	40° (mtp)____________________
	Big toe dorsiflexion (mtp) (65-70°)________
	Big toe plantar flexion (mtp) 45°________
	Toe abduction + adduction________
	5° first ray dorsiflexion________
	5° first ray plantar flexion________

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 maleoli____________________
Med tarsal bones, tibial (post) artery____________________
Lat.malleolous, calcaneus, sinus tarsi, and cuboid bones____________________
Inferior tib/fib joint, tibia, mm of leg____________________
Anterior tibia, neck of talus, dorsalis pedis artery____________________

Posteriorly
Calcaneus____________________
Achilles tendon____________________
Musculotendinous junction____________________

Plantarily
Plantar muscles and fascia____________________
Sesamoids____________________

Short-form McGill Pain Questionnaire (SF-MPQ)

Ronald Melzack (1984)

Date:______________ File no.:________________ Visit no:____

Patient name:____

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

Numerical Rating Scale - 101 Questionnaire

Date:____________ **File no:**____________ **Visit no:**__________

Patient name:____________________________________

Please indicate on the line below, the number between 0 and 100 that best describes the pain you experience **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.

____

Please indicate on the line below, the number between 0 and 100 that best describes the pain you experience **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.

____

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	
	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	VII	Single limb stance with injured leg ✸	
II	Can you walk normally?			Longer than 55 seconds	10
	Yes	15		50-55 seconds	5
	No	0		Less than 55 seconds	0
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♣			Severe instability (>10mm)	0
	Less than 18 seconds	10	IX	Dorsiflexion range of motion of injured leg	
	18 to 20 seconds	5		≥ 10°	10
	Longer than 20 seconds	0		5°-9°	5
V	Rising on heel with injured leg			<5°	0
	More than 40 times	10			
	30-39 times	5			
	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, et al. (1994:465).

ALGOMETER READINGS

File No.:__________ Group:_____________

VISIT NO.	DATE	READING
VISIT 1		
FINAL VISIT		

GONIOMETER READINGS

VISIT NO.	DATE	READING
VISIT 1		
FINAL VISIT		

APPENDIX K

Patient name:_______________________

Date:_____________________________

	VISIT 1	FINAL VISIT
MEDICATION		
AMOUNT TAKEN		
FREQUENCY TAKEN		