THE RELATIVE EFFECTIVENESS AND COST EFFECTIVENESS OF PIROXICAM COMPARED TO MANIPULATION IN THE TREATMENT OF ACUTE GRADES 1 AND 2 INVERSION ANKLE SPRAINS.

by

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I, Denise Jeanette Coetzer,
do hereby declare
that this dissertation
represents my own work
in both conception and execution.

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DEDICATION

This dissertation is dedicated to my parents, Merle and Jimmy Coetzer, for their encouragement, love, and continued support.

May those that love us, love us

And those that don't love us

May God turn their hearts;

And if He doesn't turn their hearts

May he turn their ankles

So that we'll know them by their limping.

Irish Proverb

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ABSTRACT

The aim of this investigation was to compare the relative effectiveness and cost effectiveness of piroxicam and manipulation in the management of acute grades 1 and 2 inversion ankle sprains in terms of subjective and objective clinical findings.

Thirty people, all of whom were diagnosed as having an acute, grade 1 or 2 inversion ankle sprain, were required to complete the study. Participants were randomly allocated into two treatment groups of 15 patients each.

Patients in group one received chiropractic manipulations of the fixations found at the subtalar and talocrural joints. Patients in group two received 40mg of piroxicam for the first two days, and then 20 mg for the following five days administered with meals or milk.

All patients were required to be present for six sessions equally spread over a two week period, and to return one month following the injury.

All patients applied ice to the injured area three times a day for ten days after the injury. Patients were taught how to apply an elastic crepe bandage to the area, with firm pressure, which was to be used at all times for the first three days after the injury.

All subjects were assessed subjectively using the Numerical Pain Rating Scale-101, and the Short Form McGill Pain Questionnaire. The extent to which physical training and/or normal daily activities were hampered was noted. Objective measurements used in this study included the use of an extremity range of motion goniometer, an algometer, fixations found at the talocrural and subtalar joints by the researcher and clinician, and the anterior drawer test of the ankle. The mean cost of both treatment protocols was documented.

As categorical and continuous variables were used in this study, both parametric, and non-parametric tests were used in order to analyze the data obtained. Continuous variables were compared using the two-sample unpaired t-test and the two-sample paired t-test. The Mann-Whitney U-test and the Wilcoxon Signed Rank test was used in order to analyze categorical data.. Intra and intergroup comparisons were made, and the efficacy of both treatments was compared. Statistical analysis was conducted at a 95% level of confidence. Data was represented in the form of tables and barcharts.

From the results it can be seen that both groups demonstrated a significant improvement in terms of functional disability, range of motion at the ankle (dorsiflexion), and pain intensity, indicating that both treatment protocols were effective in the treatment of acute, grades 1 and 2, inversion ankle sprains. No significant difference between the two treatment groups was noted for all subjective findings. In terms of objective findings, no significant difference between the two groups was found aside from the fixations found by both the researcher and the clinician, and the mean cost of the two treatment protocols.

In terms of fixations found by the researcher, more patients were found to be fixation free in treatment group1 than in treatment group 2 at the end of the treatment period, even though both groups had similar fixations initially.

In the short term no difference in effectiveness of the two treatment regimes was noted with regards to the fixations found by the clinician. In the long term, however, a difference between the two treatment groups was evident. At the end of the treatment period, group 1 presented predominantly without fixations of the talocrural and subtalar joints, while in group 2 no patients were found to be fixation free.

The total treatment costs incurred, for groups 1 and 2, demonstrated a statistically significant difference at the end of the treatment period. This suggests that the two treatment groups were not equally cost effective in this study. Treatment protocol 1 was found to be more cost effective than treatment protocol 2.

In conclusion, statistical and clinical evidence exists to demonstrate the effectiveness of both treatment protocols in the treatment of acute, grade 1 and 2 inversion ankle sprains. There was no statistical evidence, with the exception of the fixations found by the researcher and the clinician, to support the alternate hypothesis which stated that one treatment protocol would be more effective than the other.

The mean treatment costs incurred in this study support the hypothesis that one treatment protocol would be more cost effective than the other. Chiropractic treatment, in this study, was found to be more cost effective than anti-inflammatory medication in the treatment of acute, grades 1 and 2 inversion ankle sprains.

TABLE OF CONTENTS

LIST OF APPENDICES

LIST OF TABLES

LIST OF FIGURES

DEFINITION OF TERMS

Manual Therapy: Therapeutic application of manual force. This includes massage, mobilization, manipulation, and adjustments. (Gatterman 1990: 410.)

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

Adjustment: A specific form of direct articular manipulation using, in the case of this study, short lever techniques with specific contacts, characterized by a dynamic thrust of controlled velocity, amplitude, and direction (Gatterman 1990: 405).

Fixation: The state whereby an articulation has become temporarily immobilized in a position that it may normally occupy during any phase of physiological movement (Haldeman 1992: 623).

Joint Play: Short-range movements of a joint, independent of the action of voluntary muscles, determined by springing the joint in the neutral position (Gatterman 1990: 409).

End Feel: Short-range movements of a joint, independent of the action of voluntary muscles, determined by springing the joint at the limit of its passive range of motion (Gatterman 1990: 407).

Long Axis Fixation: For the purpose of this study, a long axis fixation is a restriction of accessory motion (or joint play in this case) in long axis at the talocrural joint, or the subtalar joint.

Eversion fixation: For the purpose of this study, an eversion fixation is a restriction of accessory motion (or end feel in this case) in eversion at the subtalar joint.

CHAPTER ONE

1.1 INTRODUCTION

The ankle sprain is one of the most common musculoskeletal injuries found in sports medicine (Geppert and Buckley 1998). Ankle injuries, according to Mack (1982), account for 20 to 25% of time lost due to injury in running or jumping sports. According to Bouché et al. (1994:243), the lateral collateral ligaments of the ankle are the most frequently injured structures in the human body. Inversion sprains account for 85% of all ankle sprains (Jaivin and Ferkel 1994: 982).

Ankle sprains often force athletes into periods of partial or complete inactivity (Isakov and Mizrahi 1997). According to Kuwada (1995), many physicians are unaware of the long term effects of a poorly managed acute ankle sprain. Singer et al. (1995 1:424), suggest that all ankle sprains be carefully assessed and treated so as to limit further injury and disability.

The treatment of acute ankle sprains is quite controversial and depends on the expertise of the involved physician or therapist. A consensus as to the most effective treatment protocol has not been established. In a critical review of numerous treatment protocols currently being used in the treatment of acute soft tissue injuries of the ankle by Ogilvie-Harris and Gilbart (1995), conservative treatment was found to produce satisfactory outcomes.

In the acute phase rest, ' ice', compression, elevation, support, and controlled movements are essential for the healing process to take place. Active exercises, manual therapy, and electrical modalities may also be used to promote healing. (Thomson et al. 1991:40.) Reid (1992: 240-250), suggests gentle mobilization of the distal fibula and subtalar joint in the treatment of ankle sprains. Active mobilization and manipulative procedures restore accessory motion of the talocrural and subtalar joints in acute ankle sprains (Thomson et al. 1991:41-43).

Joint manipulation allows for greater pain-free movement, increases the flexibility of the joint and surrounding structures, and limits adhesion formation following injury (Edmond 1993:2-4). Few studies have been done on the effects of peripheral joint manipulation following injury. Nield et al. (1993), conducted a controlled study on 20 asymptomatic patients to test the effectiveness of a single manipulation of the talocrural joint on dorsiflexion of the ankle joint. No increase in dorsiflexion was noted. The authors suggested a further study to investigate the effects of manipulative therapy on symptomatic patients. The effect of repeated manipulative therapy in the management of acute grade 1 and 2 inversion ankle sprains has yet to be investigated. Furthermore, the cost-effectiveness of the aforementioned intervention has yet to be established.

Piroxicam is a drug which has anti-pyretic, anti-inflammatory, and analgesic properties (Insel 1990:688). A few studies have shown piroxicam to be effective in the treatment of acute injuries (American Medical Association 1983:126-127). An observer-blinded comparative clinical study was done on 108 patients presenting with acute ankle sprains. The efficacy of

piroxicam, diclofenac potassium, and placebo treatments were compared. There was no significant difference between the two groups taking the medication with respects to inflammation, and both groups were found to be superior to placebo.(Moran 1990.)

A randomized, placebo-controlled clinical trial of piroxicam in the treatment of acute ankle sprains was performed by Slatyer et al. (1997), in which 364 patients were treated. The patients who received treatment with piroxicam had less pain, resumed training more rapidly, were treated at a lower cost, and had increased endurance on resumption of activity than those patients in the placebo group.

The aim of this investigation was to compare the relative effectiveness and cost effectiveness of piroxicam and manipulation in the management of acute grades 1 and 2 inversion ankle sprains in terms of subjective and objective clinical findings. Thirty patients participated in this study. Subjective and objective clinical findings were analyzed in order to determine which of the treatments was the more effective one. The subjective findings were analyzed using the Numerical Pain Rating Scale-101, and the Short Form McGill Pain Questionnaire. Objective measurements used in this study included the use of an extremity range of motion goniometer, an algometer, fixations found at the talocrural and subtalar joints by the researcher and clinician, and the anterior drawer test of the ankle.

The extent to which physical training and/or normal daily activities were hampered was also noted. The mean cost of both treatment protocols was also documented

These measurements were then compared using the two-sample unpaired t-test, the two-sample paired t-test, the Mann-Whitney U-test and the Wilcoxon Signed Rank test. Intra and intergroup comparisons were made, and the efficacy of both treatments was compared.

This investigation will hopefully aid practitioners and therapists in the treatment of acute grade 1 and 2 inversion ankle sprains, and allow for more cost-effective management of the aforementioned injury.

CHAPTER TWO

2.0 REVIEW OF RELATED LITERATURE

2.1 INTRODUCTION

Ankle sprains are often under- treated by many physicians who are unaware of the many long term associated complications (Kuwada 1995). Ankle sprains present a major problem for most coaches, team physicians, athletic trainers, and other professionals involved in the care of athletes due to their frequency and resulting disability. Some feel that the ankle sprain is worse than an ankle fracture because fractures are usually aggressively treated and conservatively cared for with immobilization and activity restriction. Athletes suffering from ankle sprains are, however, often rushed back into training before the injured ankle has healed completely. This may result in a chronically inflamed and unstable ankle which would hamper the performance of the athlete.(Arnheim and Prentice 1993: 486-494.)

According to Singer et al. (1995 1: 424), ankle sprains should be assessed very carefully and aggressively treated so as to prevent further disability. Although most patients do not have fractures, the ankle sprain should not be underestimated as the patient may experience significant pain and loss of function. Incorrect rehabilitation of the acute ankle sprain may lead to future disability and increase the risk of repeat injury. (Langran 1998.)

A critical review was performed by Ogilvie-Harris and Gilbart (1995), which included prospective and retrospective comparative and non-comparative studies of the pharmacological, surgical, and physiotherapeutic treatment modalities currently being used to treat soft tissue injuries of the ankle. Of the 84 studies reviewed, 19 (22.6%) assessed pharmacological agents, 41 (48.8%) examined surgical and active mobilization, and 24 studies (28.6%) reviewed the use of physical modalities. Non-steroidal anti-inflammatory drugs offered significant symptomatic relief over placebo, although no single drug was said to be superior. Comparison of surgical repair, plastering, casting, and active mobilization, indicated that conservative treatment of these ankle injuries produced satisfactory outcomes. According to these authors cryotherapy proved beneficial to the patient, diathermy showed some benefit, while other therapies such as ultrasound and intermittent pneumatic compression offered limited symptomatic relief.

The treatment of ankle sprains is quite controversial and although numerous studies have been performed on the treatment of this traumatic musculoskeletal condition, a consensus as to the most effective treatment protocol has not been established.

2.2 ANATOMY AND BIOMECHANICS

The ankle joint is a complex joint formed by the articulations between the talus and the distal tibia, the talus and the distal fibula, and the distal tibiofibular joint. The tibio-fibulo-talar complex is a synovial hinge joint, with a joint capsule and associated peri-articular ligaments. The tibial and fibular malleoli, and the distal tibial facet all have concave surfaces which form an almost continuous concave joint surface with which to articulate with the body of the talus below. (Norkin and Levangie 1992: 381-383.) The malleoli project inferior towards the trochlea. The lateral malleolus projects further inferior than the medial malleolus, and provides the lateral ankle joint with greater bony stability. (Mack 1982.)

The body of the talus has three articular surfaces. These surfaces are the large lateral facet, the trochlear facet, and the smaller medial facet. The trochlear facet is large and has a convex surface. The ankle joint is said to be the most congruent joint in the human body. (Norkin and Levangie 1992: 381-383.) The trochlea is wider anteriorly than posteriorly, as is the tibial portion of the joint complex. On dorsiflexion the wider anterior part of the talus articulates with the narrower portion of the bony area lying between the two adjacent malleoli. This allows for a greater amount of bony stability. On plantar flexion, however, the opposite is true. The narrower portion of the talus articulates with the wider portion of the tibia, allowing for a small amount of increased movement (free play) in the joint. (Mack 1982.) The distal tibiofibular joint is comprised of a fibrous union between the convex facet of the distal fibula, and the concave facet of the distal tibia. These two bony facets do not come into contact with

each other and are separated by fibrous tissue. The ankle joint has one degree of freedom as it normally only allows the movements of dorsiflexion and plantar flexion.

The subtalar joint must, however, be included when looking at the functional unit of the ankle. (Reid 1992: 215.) The subtalar joint is formed by the articulation of the talus on the calcaneous. This joint has three articulations. The posterior talocalcaneal articulation is the largest of the three, and lies between the talus and the calcaneus. This articulation is formed by a concave facet on the body of the talus, and a convex facet on the body of the calcaneus. The anterior and middle talocalcaneal articulations are smaller than the posterior articulation, and are formed by two convex facets on the inferior portion of the talus and two concave facets on the calcaneus. The subtalar joint allows for triplanar movement which is necessary for correct functioning of the rearfoot. The subtalar joint also dampens rotational forces upon weight-bearing while keeping the foot in contact with the surface. (Norkin and Levangie 1992: 388.) Inversion and eversion movements occur at the subtalar joint. Movements of the forefoot and midtarsal joints are dictated by the movement of the subtalar joint. (Donatelli 1990:14.)

According to Krivickas and Feinberg (1996), the flexibility of a joint is determined by joint architecture and by muscle, tendon, ligament, and capsular laxity. Stability of the joint on the lateral aspect is provided mainly by the strong anterior and posterior talofibular ligaments, the calcaneofibular ligament, and the interosseous membrane. (Reid 1992: 215.) The anterior talofibular ligament is on average 20 mm long, 10 mm wide, and 2 mm thick. This ligament runs perpendicular to the long axis of the leg and prevents anterior displacement of the talus.

The calcaneofibular ligament is about 20 mm long, 5 mm wide, and 3 mm thick. It runs vertically, deep to the peroneal tendons, and protects the ankle joint complex against excessive inversion occurring at the calcaneus. The posterior talofibular ligament is the smallest of the lateral ankle ligaments and only provides minimal resistance to posterior displacement of the talus. (Rubin 1997:446.)

The anterior talofibular ligament is a thickening of the anterior joint capsule of the ankle. A rupture in this ligament may produce a tear in the joint capsule with associated haemarthrosis of the joint. The calcaneofibular ligament is extra-articular, but is closely associated with the peroneal tendon sheath. A rupture of this ligament will often result in a tear in the tendon sheath with possible damage to the peroneal tendons. (Boruta et al. 1990.)

The lateral ankle ligaments are comprised of white connective tissue bands found adjacent to the capsules of the joints. Although these ligaments are tough, inelastic, and generally unyielding, they are still pliant and flexible enough to control normal movement without preventing the movement from occurring.(Thomson et al. 1991: 38.) The lateral ligaments as a complex are inherently weaker than the broader medial ligament of the ankle (Langran 1998). The capsule of the ankle joint is thinner and weaker on the anterior and posterior aspects than the rest of the capsule. It is, therefore, important that the ligamentous structures surrounding the ankle remain intact in order for the joint to remain stable. (Norkin and Levangie 1992: 384.) Several ligaments, responsible for restricting motion of the distal tibiofibular joint, can be found surrounding the joint. (Norkin and Levangie 1992: 381-383.)

Dorsiflexion at the ankle is produced by four muscles. These muscles are the tibialis anterior, extensor digitorum longus, extensor hallucis longus, and the peroneus tertius muscles. All four of these muscles are supplied by the common peroneal nerve. Tibialis anterior receives fibres from L4 and L5 spinal nerves, while the other three muscles receive fibres from L5 and S1 spinal nerves. (Rogers 1992: 301- 303.)

Plantar flexion at the ankle joint is produced by three muscles. These muscles are the gastrocnemius, plantaris, and soleus muscles. Tibialis posterior, flexor digitorum longus, and flexor hallucis longus muscles aid in plantar flexion at the ankle joint. All six of these muscles are supplied by the tibial nerve. Tibialis posterior receives fibres from L4 and L5 spinal nerves, and the plantaris muscles receives fibres from L4, L5, and S1 spinal nerves. L5, S1, and S2 spinal nerve fibres supply the soleus, flexor digitorum longus, and flexor hallucis longus muscles. The gastrocnemius muscle receives fibres from S1 and S2 spinal nerves. (Rogers 1992: 303-304.)

Peroneus longus and peroneus brevis muscles produce eversion at the ankle. Peroneus tertius assists in this action. These muscles are supplied by the common peroneal nerve. They receive fibres from L5 and S1 spinal nerves. (Rogers 1992: 304.) The invertors of the ankle are tibialis anterior and posterior. Tibialis anterior is supplied by the common peroneal nerve, and tibialis posterior is supplied by the tibial nerve (L4 and L5 spinal nerve fibres). (Rogers 1992: 304.) The ankle joint itself is supplied by an articular branch of the tibial nerve (Williams and Warwick 1980: 1112).

The weakest aspect of the lateral ankle, in terms of stability, is the muscular arrangement. The long muscle tendons which cross over the ankle allow for maximum muscular leverage, but minimal ankle stabilization. (Arnheim and Prentice 1993:489.) According to Bassett and Speer (1993), longitudinal rupture of the peroneal tendons can occur in association with a plantar flexion-inversion ankle injury.

Arteries found around the ankle joint anastomose to form networks around and inferior to the corresponding malleoli. The medial malleolar network is formed by the anterior medial malleolar branch of the anterior tibial artery, the medial tarsal branches of the dorsalis pedis artery, the malleolar and calcaneal branches of the posterior tibial artery, and branches of the medial plantar artery. The lateral malleolar network is formed by the anterior lateral malleolar branch of the anterior tibial artery, the lateral tarsal branch of the dorsalis pedis artery, the perforating and the calcaneal branches of the peroneal artery, and branches from the lateral plantar artery. (Williams and Warwick 1980: 732.)

2.3 PREVALENCE OF ANKLE SPRAINS

Ankle sprains are sustained by most people at some stage during their lifetime (Robbins and Waked 1998). According to Mack (1982), ankle injuries constitute 20 to 25% of the total time lost due to injuries in running or jumping sports. The ankle sprain is one of the most common musculoskeletal injuries found in sportsmedicine (Geppert and Buckley 1998). At the University of Washington no fewer than one-sixth of all the time lost due to injury, during any single year over a six year period, involved ankle sprains. In 482 junior football players in the greater Seattle area, aged between eight and sixteen, 18% of the documented time-loss injuries involved the ankle. (Garrick 1977.)

In the USA alone, six million ankle x-rays are taken each year, of which less than 15% have fractures (Langran 1998). In a two-year epidemiological study of four high schools' athletes, it was found that 14% of all injuries in athletes involved the ankle. Of these ankle injuries, 85% were sprains. In a study of 317 female gymnasts 106 injuries were reported, of which 13% involved the ankle. (Garrick 1977.)

According to Robbins and Waked (1998), athletes wearing shoes have a higher frequency of ankle sprains than those who do not wear athletic footwear. Ankle injuries occur as frequently in women athletes as in male athletes (Garrick 1977).

Sports injuries in general are said to be sport specific in that certain injuries are found more often in certain sports than in others. Activities which require an athlete to run, jump, or perform cutting manoeuvers subject the foot and ankle to significant stresses. (Garrick and Requa 1988.) According to Garrick (1977), ankle sprains constituted 38% of men's and 45% of women's basketball injuries. Football had the next highest frequency with 13,2% of all injuries involving the ankle, of which 81% were sprains.

According to Bouché et al. (1994: 243), the lateral collateral ligaments of the ankle are the most frequently injured structures in the human body. Inversion sprains account for 85% of all ankle sprains (Jaivin and Ferkel 1994: 982).

A prospective study done on 639 patients with sprained ankles showed that of the 547 patients (85,6%) who did not have fractures associated with the ankle sprain, 453 patients (82,8%) had injured the anterior talofibular ligament, 366 patients (66,9%) had an injured calcaneofibular ligament, and only 187 patients (34,2%) injured the posterior talofibular ligament. The anterior talofibular, calcaneofibular, and posterior talofibular ligaments were solely injured 90 (16,5%), 4 (0,7%), and 9 (1,6%) times respectively. Injury to both the anterior talofibular ligament and the calcaneofibular ligament occurred in 187 patients (34,2%). All three of the lateral ankle ligaments were injured in 171 patients (31,3%). Soft tissue pathology comprised 85,6% of all injuries in this study, with injuries to the lateral ankle ligaments occurring in 71,7% of all the injuries evaluated. Lateral ankle ligament damage was present in 83,7% of all soft tissue injuries evaluated in this study. (Fallat et al. 1998.)

2.4 MECHANISMS AND PATHOPHYSIOLOGY

Forces that move the ankle past its physiological limits of motion will usually cause damage to the osseous and/or ligamentous components of the ankle complex (Hertling and Kessler 1990: 395). Most ankle sprains occur during weight-bearing agility moves such as running and jumping (McBryde 1996:483). Injury to soft tissue comprises damage to muscles, tendons, fascia, ligaments, and intra-articular cartilage (Thomson et al. 1991:38-39).

The most common ankle sprain occurs from an inversion stress applied when the foot is slightly plantar flexed resulting in damage to the lateral ankle ligaments. These ligaments usually tear at their proximal or distal attachments. (Cailliet 1968: 117-118.) Usually only some of the fibres are injured or torn. The severity of the injury, and stability of the joint is directly proportional to the number of fibres affected. (Thomson et al. 1991:38-39.) According to McBryde (1996:484), 85% of acute ankle sprains occur when excessive forces of inversion and plantar flexion are applied to the ankle joint complex, and only 15% following excessive dorsiflexion and eversion.

The lateral side of the ankle joint complex has more bony stability than the medial side which causes the foot to invert rather evert when excessive rotational forces are applied to the ankle joint complex. Once inversion is initiated, the ankle joint complex loses the bony stability it had in the neutral position. The medial malleolus loses its stabilizing function and acts as a fulcrum for further inversion. If the force is great, and inversion continues into the

pathological range, the lateral ankle ligaments and surrounding structures are damaged. The peroneals, and other everting muscles, usually resist these inversion forces. If the force is too great, or the muscles are not strong enough, damage occurs at the lateral aspect of the ankle.(Arnheim and Prentice 1993:494.)

As the anterior talofibular ligament is orientated most in line with the inversion forces applied to the ankle joint complex when the foot is plantar flexed, it is usually the first of the lateral ligaments to rupture. This ligament is said to be the weakest of the lateral ankle ligaments. The calcaneo-fibular ligament is more obliquely orientated to the inversion forces upon plantar flexion of the foot, and often ruptures following an anterior talofibular ligament rupture. (Bouche et al. 1994:243-244.)

Ligaments heal slowly due to their moderate vascularity, and heal by fibrous tissue formation. The fibrous union is weak, and the stabilizing function of the injured ligament is decreased. (Thomson et al. 1991:39.)

Some people are more likely to sustain inversion ankle sprains due to inherent ankle instability. This instability may be due to ligamentous laxity or foot structures, such as a high arch foot, which increases ankle instability and enhances the likelihood of spraining the ankle. These people may have unprovoked ankle sprains. (Kuwada 1995.)

2.5 DIAGNOSIS AND GRADING OF ANKLE SPRAINS

The diagnosis of an acute ankle sprain is best made as soon as possible after the injury occurs. A detailed description of the manner of injury, and exact site of pain are important indicators of the type of injury. Protective spasm and subsequent swelling and bruising often confuse the examiner upon examination of the injured foot. (Cailliet 1968:118-119.) It is necessary to determine whether a patient has concomitant injuries such as a fracture or dislocation, as mis-diagnosis of the initial injury can result in chronic disability (Garrick and Schelkun 1997).

On physical examination careful attention should be paid to the extent of injury to the lateral ankle area. Palpation of the fibula, malleoli, ligaments, and bony processes should be performed. (Bouche et al. 1994:244.) Range of motion of the ankle should be tested and should be compared to the uninjured ankle, and both the dorsal pedal pulse and the posterior tibial pulse should be measured. (Arnhein and Prentice 1993:490). Testing of individual lateral ankle ligaments is difficult as these ligaments often rupture together (Rice 1991:185-186). The anterior drawer test is used to test the anterior talofibular ligament, while the talar tilt test is used to determine whether the calcaneofibular ligament is injured. (Magee 1992: 479-482.) The anterior drawer test will be discussed in chapter three. Other foot and ankle orthopaedic tests, such as Thomson's test and Tinel's sign, may be performed to assess the patient for any other possible injuries (Magee 1992:479-482).

Swelling may be noted beneath the extensor tendons, anterior to the lateral malleolus, and may progress to either side of the Achilles tendon as it becomes more generalized. Differing degrees of bruising may also occur. (Cailliet 1968:117-119.)

Radiographs may also be performed to rule out fractures associated with the ankle sprain. The Ottowa ankle rules are used to determine the need for ankle radiographs following injury to the ankle. These rules have been shown to be 100% sensitive for fractures, and allow physicians the opportunity to reduce the number of radiographs ordered in patients with ankle injuries with negligible risk of missing fractures. According to these rules radiographs of the ankle are only necessary if there is pain in the region of the malleolus, and either bone tenderness along the posterior edge or tip of either malleolus, or inability to weight-bear (take four steps) both immediately and upon consultation with the physician. Foot radiographs are only necessary if there is midfoot pain and any one of the following:

- Inability to weight-bear (take four steps) immediately, and on consultation.
- bone tenderness at the base of the fifth metatarsal.
- bone tenderness at the navicular.

These rules should remain secondary to clinical judgement. (Steill et al. 1993.) The Ottowa rules have not been tested in patients under the age of 18 years. Patients who are intoxicated, have suffered multiple painful injuries, have suffered a head injury, have diminished sensory perception in the lower extremities, or is pregnant should not be judged using these rules. A

language barrier may also exclude the use of the Ottowa rules in patients with ankle injuries. (Stiell et al. 1995.)

In this study all patients had ankle radiographs taken so as to minimize the chance of missing a fracture, and place all of the patients involved in the study on an equal footing in terms of costs involved in their treatment.

Inversion ankle sprains have traditionally been graded into three categories. Grade one inversion ankle sprains involve only a single ligament which is usually the anterior talofibular ligament. Grade two inversion ankle sprains involve complete tearing of the anterior talofibular ligament, or partial tearing of the talofibular ligament and the calcaneofibular ligament. In a grade three inversion ankle sprain there is complete tearing of the anterior capsule and associated tearing of the anterior talofibular ligament and calcaneofibular ligament. (Reid 1992: 226.) Although this classification clearly outlines the ligaments involved in each grade of inversion ankle sprain, it is very difficult to differentiate the ligaments involved when clinically assessing the acute ankle sprain.

Jaivin and Ferkel (1994: 983), suggest the incorporation of the anterior drawer test and the lateral talar tilt test in order to assess anterior and lateral ankle stability. The extent of swelling, hemorrhage, tenderness, and ligamentous laxity, according to Reid (1992: 226), should also be taken into account when grading an acute ankle sprain.

A more practical functional grading system, which incorporates all of the aforementioned criteria, is outlined in a randomized, placebo-controlled trial done by Slatyer et al. (1997) in which 364 army recruits with acute ankle sprains were randomly divided into two treatment groups. The first group were treated with piroxicam, while the other group received placebo treatment. In the aforementioned study a grade one inversion ankle sprain produced minimal pain and swelling, the ankle joint was stable and had full range of movement, and weight-bearing heel and toe walking was pain free. Moderate pain and swelling was seen in grade two ankle sprains. In these injuries the anterior drawer test was negative or slightly positive, there was decreased range of joint movement, and difficulty in weight-bearing and ambulation. In grade three inversion ankle sprains, pain and swelling was severe, the joint was unstable and had minimal range of motion or inability to dorsiflex. Weight-bearing was impossible.

2.6 DIFFERENTIAL DIAGNOSES

The ankle sprain is generally associated with injury to the lateral ankle ligaments alone. Other structures are, however, often injured in conjunction with this injury. (Fallat et al. 1998.) An acute ankle sprain may mimic a variety of conditions. Differential diagnoses are as follows:

1. Achilles tendon rupture: Although this injury is sometimes painless, the patient may describe a "pop" sensation in the ankle area. In order to rule out this injury it is important for the examiner to palpate the Achilles tendon.(Garrick and Schelkun

1997.)

2. Peroneal tendon dislocation: The mechanism is different in this injury to the normal inversion ankle sprain in that it usually occurs during hyper-dorsiflexion. The tendon often spontaneously reduces leaving only residual swelling and tenderness along the posterior border of the fibula, proximal to the lateral ligaments of the ankle. The tendon sheath may also have swelling in and around it.(Garrick and Schelkun 1997.)

3. Peroneal tendon subluxation: This is a dorsiflexion injury often associated with a painful snapping sensation. Pain and swelling usually occur posterior to the lateral malleolus. (Bassewitz and Shapiro 1997.)

4. Syndesmosis injury: This injury usually occurs on excessive external rotation and often occurs in conjunction with an inversion ankle sprain. Patients present with symptoms of an inversion ankle sprain in addition to supra-malleolar swelling and pain on passive dorsiflexion and external rotation of the ankle. (Bassewitz and Shapiro 1997.)

5. Calcaneocuboid ligament sprain: Tenderness is felt over the calcaneocuboid area in this injury. Radiographs are necessary to diagnose this sprain as an opaqueness is often seen just lateral to the cuboid on an anterior to posterior view.(McBryde 1996:487.)

6. Sinus tarsi syndrome: This may develop after an ankle sprain and is usually painful during activity. Anterolateral ankle pain is usually felt, and there is tenderness to palpation over the sinus tarsi area. Pain may be elicited on passive inversion of the subtalar joint.(Bouche et al.1994:245.)

7. Impingement syndrome: Pain is elicited, in an anterior synovial impingement, with passive ankle dorsiflexion with the knee flexed (Bouche et al.1994:245). Anterolateral soft tissue entrapments may occur following injury causing pain. The anterior capsule of the joint may also become impinged. Patients complain of vague pain along the anterolateral aspect of the ankle. Pain usually occurs during activity, but is absent at rest. (Jaivin and Ferkel 1994:988-989.)

8. Fractures: Proximal and distal fractures are painful when the tibia and fibula are squeezed together midway between the ankle and the knee. Epiphyseal fractures produce pain over the malleoli and do not allow weight-bearing. Two types of fractures occur at the base of the 5th metatarsal. The first is an avulsion fracture of the styloid process of the 5th metatarsal. The second is a Jones fracture which is a transverse fracture distal to the proximal end of the 5th metatarsal. Radiographs are used to rule out these fractures, although repeat radiographs are often necessary. (Garrick and Schelkun 1997.) Talar dome fractures also require radiographs for diagnosis (Jaivin and Ferkel 1994:991).

9. Common peroneal, superficial peroneal or crural nerve injury: Sensory hypaesthesia or hyperaesthesia is usually present in the involved sensory distribution area (McBryde 1996:487).

In a prospective study of 639 patients, presenting with ankle sprains over a 33-month period, performed by Fallat et al. (1998), 92 patients (14,4%) had avulsion or compression fractures of the foot or ankle. The ankle joint capsule was injured in 180 cases (28,2%), the extensor digitorum brevis muscle was injured in 111 cases (17,4%), the sinus tarsi in 88 cases (13,8%), the peroneal tendons in 83 cases (13%), the Achilles tendon in 67 cases (10,5%), the calcaneo-cuboid ligament in 41 cases (6,4%), and syndesmosis injuries were found in 31 cases (4,9%). Neuritis was noted in 80 patients (12.5%). The number of patients who suffered multiple injuries were not noted.

2.7 PROPRIOCEPTION AT THE ANKLE

Proprioception is the ability to sense movement and the position of a body part in space (McBryde 1996:489). According to Jerosch and Bischof (1996), proprioception is one of the key mechanisms in the control of joint motion and stability. Intact neural input from sensory organs in the soft tissue surrounding the ankle joint is important for functional weight-bearing activities such as running, standing, walking and jumping (Isakov and Mizrahi 1997). When ligaments, muscles, and other soft tissue structures are subjected to mechanical deformation,

action potentials are generated. The action potentials are conducted to the central nervous system whereupon muscular response and position sense is influenced. This is known as proprioceptive feedback. (Mattacola and Lloyd 1997.)

Proprioceptive deficit is a term commonly used by practitioners and therapists to refer to a disturbance in the portion of the neuromuscular system governing muscular responses following joint motion (Wilkerson et al. 1997). According to Tropp et al. (1993: 277-279), reduced motor skills and co-ordination may complicate disorders of the musculoskeletal system. They also state that proprioception is the most important body sense.

Proprioceptive deficits of the ankle joint may result in a large amount of disability for an athlete. According to Jerosch and Bischof (1996), the literature regarding proprioception is controversial. They state that the majority of the available literature agree that the proprioceptive function in an injured ankle is decreased. Proprioceptive deficit following an ankle injury could account for functional instability of the ankle, allowing for recurrent ankle sprains. According to Ryan (1994), functional instability may be caused by mechanical instability of the talocrural joint, peroneal muscle weakness, and impaired proprioception. In a prospective study performed by Leanderson et al. (1996), 53 ballet dancers were studied in order to determine the influence of recurrent ankle sprains on proprioception. Proprioception was measured using postural sway. During the study six of the dancers sustained grade 2 or 3 ankle sprains. These dancers demonstrated impaired postural sway for several weeks following injury, with gradual improvement on rehabilitation.

Proprioceptive capabilities of the injured ligaments and muscles need to be improved by coordination and balancing exercises (Cailliet 1968:122). Following injury, deficiencies in balance are often tested using static tests of balance (Mattacola and Lloyd 1997). In a prospective study performed by Boyle and Negus (1998), joint position sense was assessed, using a pedal goniometer, in patients with recurrent ankle sprains. According to these authors, a measurable deficit in passive joint position sense in patients having suffered multiple sprained ankles, was noted.

In a study performed by Forkin et al. (1996), eleven gymnasts with multiple, chronic, unilateral ankle sprains were used to determine if balance deficits existed during single-legged standing. The ability to detect passive plantar flexion of the injured ankle in comparison to the uninjured side was also analyzed in these gymnasts. These patients exhibited a diminished ability to sense passive ankle motion on the injured side as opposed to the uninjured side. During single-legged standing with eyes opened, balance was perceived to be better on the uninjured side by 9 of the 11 patients (81,8%). Only two patients (18,2%) perceived balance to be better on the injured side. During single-legged standing with eyes closed, 9 of the 11 patients (81,8%) perceived balance to be better on the uninjured side, 1 patient (9,1%) perceived balance to be equal bilaterally, while the remaining patient (9,1%) perceived balance to be better on the injured side. Two independent observers judged balance to be better on the uninjured side in 7 of the 11 patients (63,6%), while the remaining 4 patients (36,4%) were judged to have better balance on the injured side ankle.

The use of the single- legged standing test (Romberg test) has been advocated for testing proprioception (Magee 1992:334). This test has the added advantage of testing the patient's proprioception in the weight-bearing position (Boyle and Negus 1998). The Romberg test will be discussed in detail in chapter three.

2.8 LIGAMENT HEALING

The animal model of ligament healing has been studied in detail and can be divided into four phases. These phases, as described by Chan and Stephen (1993:65-67), are outlined below.

1. This is the inflammatory phase. Following an acute rupture of a ligament, a blood clot fills the gap that is formed. Interstitial fluid collects at the injured site resulting in local swelling. White blood cells and fibroblasts accumulate in the area, and capillary buds proliferate in order to increase the vascularity of the area.

2. Matrix and cellular proliferation occurs during this phase. Fibroblasts produce ground matrix, and collagen fibrils are laid down. A large number of macrophages and mast cells accumulate at the injured site, and a network of capillaries is formed.

3. This phase is mainly concerned with the remodeling of tissue. Fibroblast and inflammatory cell numbers begin to decrease. Collagen density increases and the orientation of the fibres, along the length of the ligament, improves.

4. Maturation of the remodeled tissue occurs during this phase. Maturation is a slow process. The healed ligament becomes stiffer and stronger, and this is the phase where ligament contracture may occur. This process is ligament-specific and helps to restore the healed ligament to its original length

Avascular ligaments, and intra-articular ligaments are susceptible to poor healing. Physiological stress and motion are beneficial to the healing ligament and may actually accelerate ligamentous healing and remodeling. Too early movement following injury may, however, lead to prolonged recovery so caution is taken when prescribing early movement. (Chan and Stephen 1993:66-67.)

2.9 TREATMENT OF ACUTE ANKLE SPRAINS

Acute grade 1 and 2 ankle sprains are treated in a wide variety of ways depending on the attending doctor or therapist (Boruta et al. 1990). Early management of the aforementioned injury is important in relation to the long-term outcome. In the acute phase rest, ' ice', compression, elevation, support, and controlled movement are essential for the healing process to take place. Active exercises, manual therapy, and various electrical modalities may also be used to promote healing. (Thomson et al. 1991:40.)

The treatment of ankle sprains is quite controversial and although numerous studies have been done on the treatment of this traumatic musculoskeletal condition, a consensus as to the most effective treatment protocol has not been established. Numerous treatments are currently used in the management of ankle sprains. The current available treatment methods are briefly outlined below:

1. REST

Resting the injured area helps to relieve stress on the injured soft tissue and joints, and reduces the likelihood of further injury (Harris 1995:527). In the acute stage, the patient should be instructed to rest the affected area, as this reduces the blood pressure and also reduces fluid leakage from the surrounding blood vessels within the injured tissue. A thorough examination of the injured area can then be performed. (Allingham 1995:147.)

2. ICE

Ice is used to decrease blood flow to the injured area, and in doing so decrease the local swelling (Hertling and Kessler 1990:397). Ice reduces pain, swelling, and improves recovery rates if it is applied correctly within the first two days following injury (Ogilvie-Harris and Gilbart 1995). An increase in pain-free range of motion is also noted on application of ice following injury (McBryde 1996:489). According to Harris (1995:527), ice should be applied for 15-20 minutes every 2-3 hours following injury. If ice therapy is applied for more than 20 minutes, there may be a compensatory reaction to the cooling in the form of vasodilation of the blood vessels in the area. Vasodilation of the blood vessels in the injured area would allow

for more fluid to escape from the blood vessels, into the injured tissue, and increase the overall swelling in the area. Prolonged cooling may also freeze the superficial tissue causing an 'ice burn'. (Allingham 1995:148.)

3. COMPRESSION

According to Garrick and Schelkun (1997), proper use of compression materials following an acute injury is the most important measure in the initial management of the injury. External pressure applied over the injured site minimizes fluid leakage from the surrounding capillaries into the tissue space. In this way total swelling is controlled. Elastic strapping or bandaging also helps to limit movement of the injured area and control pain. (Hertling and Kessler 1990:397.) According to Allingham (1995:148), compression allows for faster re-establishment of normal circulation and lymphatic drainage in the injured area. A compression wrap should be applied for the first 24 to 36 hours, or until most of the swelling has subsided (Garrick and Schelkun 1997). Patients should be monitored, following the application of a compression bandage, to ensure that circulation is maintained distal to the bandage. Patients may also be instructed to reapply the bandage if there is any swelling distal to the bandage, coldness, cyanosis, or tingling sensations in the area. (Allingham 1995:148-149.)

4. ELEVATION

Elevation reduces fluid loss from the capillaries into the surrounding tissue space, and assists venous and lymphatic return (Hertling and Kessler 1990:397). According to Allingham (1995:149), elevation is valuable in any injury to the lower limb as it ensures that the patient remains off the injured part and allows it to rest. The recommended period of time of elevation could not be found.

5. COUNTER-IRRITANTS

Although heat is not prescribed in the treatment of acute ankle injuries, patients often use lotions or balms which "heat" the tissue and symptomatically reduce pain. According to the gate-control theory these products inhibit, via a spinal cord modulating mechanism, pain impulses from reaching the brain. reaching the brain. Endorphins may also be released upon application of these products. (Thornton 1997.)

6. ULTRASOUND

This modality is applied over the site of injury. It aids in the removal of inflammatory exudate and in doing so decreases the amount of adhesion formation in the injured tissue. Pulsed ultrasound is used in acute injuries, as constant ultrasound waves may aggravate the condition. (Thomson et al. 1991:42.) Analgesia produced by the ultrasonic waves allows for early use of the injured part. Scar tissue becomes more pliable and this allows for greater movement in the area. Although an acute inflammatory response is often increased by ultrasound, the

therapeutic benefits, according to Forster and Palastanga (1985: 174), are said to outweigh the adverse effects of ultrasound.

7. PHONOPHORESIS AND IONTOPHORESIS

Topically applied analgesics and non-steroidal anti-inflammatories are often used in conjunction with ultrasound, in the case of phonophoresis, and electrical current in the case of iontophoresis. These topically applied drugs are driven deep into the underlying tissue. There are, however, very few studies available which show that either of these treatment methods are superior to topically applied drugs for acute conditions. (Thornton 1997.)

8. SUPPORT

Bracing or splinting is often recommended to reduce pain and support the injured structures in acute injuries (Harris 1995:527). The brace or splint should allow for a certain amount of movement while still supporting the injured structures. Early movement of the injured ankle is said to allow patients to return to work sooner than those patients whose ankles were immobilized. (Eiff et al. 1994.) Ankle orthoses should, however, protect the foot against stresses in supination and excessive plantar flexion (Hintermann 1998). Inadequate protection allow for easy re-injury and could cause chronic instability. Supportive orthoses should be used until full strength is regained if the patient wishes to participate in vigorous activities.(Reid 1992:228.)

9. MANUAL THERAPY

Manual therapy is used to reverse or decrease soft tissue and mechanical dysfunction. In acute injury, manual therapy is directed at decreasing pain and inflammation, promoting healing and movement, and preventing further injury. Commonly applied therapies during the acute phase of injury include massage, passive joint mobilizations, and gentle distractive adjustments. (Petersen 1993:139-140.)

Gentle massage may be applied to reduce swelling, improve lymphatic drainage, and prevent chronic impaired function and pain in the ankle area (Thomson et al. 1991:42). Functional use of the injured part is essential for the maturation and restoration of normal ligamentous strength as stress is applied to the healing ligament with use (Hertling and Kessler 1990:398). Recovery is hastened through early mobilization (Harris 1995:526-527), and gentle manipulation (Thomson et al. 1991:40).

10. MEDICATION

Inflammation following an acute injury is associated with the synthesis and release of prostaglandins at the site of injury. Drugs, which inhibit the production or release of these chemicals, are beneficial to the patient. (Moran 1990.) According to Ogilvie-Harris and Gilbart (1995), non-steroidal anti-inflammatories significantly improved recovery time and symptomatic pain relief over placebo in the treatment of soft tissue injuries of the ankle. Topical gels provided temporary pain relief although no long-term benefits were noted. Early use of non-steroidal anti-inflammatory drugs, used continuously for at least five days, reduces

pain and improves the recovery rate of the patient. This allows for an earlier return to full function by the patient. (Langran 1998.)

It is important that alcohol not be consumed in the acute phase of injury as it may increase swelling at the joint (Rundle 1995:647).

11. OTHERS

Proprioceptive, strengthening, and range of motion exercises are often prescribed to the patient after the initial swelling, pain, and bruising have subsided. These exercises are vital in maintaining full range of motion, balance, general strength of the ankle joint complex, and preventing future injury. (Arnheim and Prentice 1993:498.)

2.10 COMPARISON OF TREATMENTS

2.10.1 MANIPULATIVE THERAPY

Adequate treatment of an acute ankle sprain is important as the normal biomechanics of the ankle joint complex needs to be restored (Hintermann 1998). Passive mobilization techniques, according to Austin et al. (1995: 181-184), are used to treat mechanical disorders. These movements include physiological, as well as accessory movements. All musculoskeletal structures are capable of producing symptoms of a mechanical nature. Manual therapy should

then be used to relieve these symptoms and restore normal mechanical functioning to the area, as mechanical injuries respond to mechanical treatment.

In a prospective study done by Linde et al. (1986), 150 patients with lateral ligament ankle sprains were treated with early motion exercises and weight bearing with excellent results. Passive mobilization may be useful immediately following an injury, although the area should be carefully assessed with regards to ligamentous integrity and possible fractures before treatment begins. (Austin et al. 1995:183.) Early mobilization aided by the use of strapping or bandages, as Ogilvie-Harris and Gilbart (1995) point out, increases the rate of recovery in ankle injuries.

Stiffness in the ankle joint due to loss of subtalar and fibula motion, according to Reid (1992: 240-250), is one of the main causes of delayed recovery from ankle sprains. He suggests gentle mobilization of the distal fibula and subtalar joint in the treatment of ankle sprains to prevent stiffness in the area following injury. Rundle (1995:645-648), also states that abnormal movement in the foot and ankle may be improved with passive mobilization of these joints. He also states that these movements reduce pain and may decrease healing time by improving joint nutrition and improving circulation in the area.

Mobilization techniques are effective, according to Maitland (1991:265), if they are applied only to the faulty joint. Most techniques applied to the hindfoot, however, cannot be isolated to the talo-crural joint complex as movement also occurs at the subtalar joint. Passive

mobilization is advocated, according to Austin et al. (1995:199), in the treatment of acute sprained ankles. Active mobilization, according to Thomson et al. (1991: 41-43), restores accessory motion of the talocrural and subtalar joints. This group states that treatment of acute ligament injuries should include manipulative procedures.

According to Austin et al. (1995:184), treatment of intra-articular or peri-articular structures often respond well in the acute phase to gentle distractive techniques, with progression to larger amplitude movements.

Joint manipulation increases extensibility of the joint, structures surrounding the joint, and peri-articular restrictions, allowing for greater pain-free movement. Immobilization or inflammation of the tissue surrounding the joint may cause the formation of restrictions and capsular adhesions. Joint manipulation promotes movement between capsular fibres and decreases the formation of capsular adhesions, increasing the amount of available movement in the joint. Continuous passive motion machines were shown, in a few studies, to decrease the formation of capsular adhesions. (Edmond 1993: 2-4.) Manipulation, which is more aggressive than passive motion, is thought to break the adhesions within the joint capsule and in the synovial folds. (Petersen 1993:144). All tissue surrounding the joint is also affected by these manipulative techniques (Edmond 1993: 2-4). Peripheral joint manipulation, in the management of specific joint disorders, has a more diverse application than spinal manipulation and has a role to play in the treatment of sports injuries. (Maitland 1991:1,12.)

Although manipulation is commonly used to treat peripheral joint disorders, there have been few studies which have evaluated this form of treatment in terms of effectiveness. A controlled study was conducted on twenty asymptomatic patients, with one ankle acting as the experimental ankle and receiving manipulative therapy to the talocrural joint, while the other ankle acted as the control. It was found that a single manipulation of the talocrural joint did not increase dorsiflexion at the ankle. No long term follow-up was undertaken in this study. Further research is suggested to investigate the effects of manipulative therapy on symptomatic patients. (Nield et al. 1993.)

No studies have been found that illustrate the effect of repeated manipulative intervention on range of movement at the ankle in symptomatic or asymptomatic patients. The effect of repeated manipulative intervention in the management of acute ankle injuries has yet to be investigated. Furthermore, the cost-effectiveness of manipulative therapy in the management of acute grade one and grade two inversion ankle sprains has yet to be established.

2.10.2 PIROXICAM

Non-steroidal anti-inflammatory drugs are the most prescribed drugs in the United States with over 100 million prescriptions per year (Tanji and Batt 1997:226). Piroxicam is an oxicam derivative that possesses anti-inflammatory, analgesic, and antipyretic properties. It is an inhibitor of prostaglandin biosynthesis, although its primary action is the inhibition of the cyclo-oxygenase pathway.(Insel 1990:668.) The drug also inhibits chemotaxis, the release of lysosomal enzymes, and platelet aggregation (American Medical Association 1983: 126-127).It is better tolerated than asprin, indomethacin, and has a long half-life allowing the administration of a single daily dose (Insel 1990: 668). Piroxicam is rapidly absorbed after oral administration with peak plasma levels occurring within 3 to five hours (Swinyard 1985: 1120).

Adverse effects in patients taking piroxicam occur in approximately 20% of all cases, causing approximately 5% of patients to stop using the drug. Gastrointestinal reactions are the most common. (Insel 1990: 668-669.) Life-threatening symptoms include a rash, intense itching, and feeling faint and/or breathless soon after a dose of the medicine. Common side effects include nausea, indigestion, and abdominal pain. Dizziness and headaches are rare side effects. Piroxicam interacts with a wide variety of drugs, increasing the risk of prolonged bleeding and/or peptic ulcers. These drugs include oral anticoagulants, asprin, and other anti-inflammatory drugs. Reduced effects of diuretics and anti-hypertensive drugs may be experienced with simultaneous administration of piroxicam. (Medical Association of South Africa 1989: 335.)

A limited number of studies have shown piroxicam to be effective in the treatment of acute musculoskeletal disorders (American Medical Association 1983: 126-127). An observer-blind comparative clinical study was done on 108 patients presenting with acute ankle sprains. The efficacy of piroxicam, diclofenac potassium, and placebo treatments were compared. 36 patients were randomly allocated to each group. Patients in the piroxicam group were prescribed one 20mg capsule per day for seven days, while those in the diclofenac potassium group received 50mg three times daily for a seven day period. Patients were assessed in terms of inflammation at the injured joint (recorded by volumetry in millimetres), tenderness at the injured site to finger pressure, pain on passive movement, severity of joint injury, the 10 cm visual analogue scale, and an overall tolerability score using a 4-point scale. At the end of the study all the patients treated with piroxicam and diclofenac potassium stated that they would be prepared to take the drugs again, while only 10 of the 36 placebo-treated patients (27,8%), expressed the same opinion. There was no significant difference between the two groups taking the medication with respects to inflammation, although both groups were found to be superior to placebo. (Moran 1990.) 35 of the 36 patients (97%) in both medication groups had good to excellent improvement with regards to swelling at the end of the treatment period, while the in placebo group only 20 of the patients (55.6%) had good to excellent improvement. The investigator's overall assessment of improvement in pain showed that all of the patients (100%) receiving medication had good to excellent results. Only 7 patients (19,4%) of the placebo group showed good results.

In a randomized, placebo-controlled clinical trial of piroxicam in the management of acute ankle sprains done by Slatyer et al. (1997), three hundred and sixty four Australian Regular Army recruits with acute ankle sprains were treated. Of the 364 patients, 184 (50,5%) were allocated to the piroxicam group, and 180 (49,5%) were allocated to the placebo group. 85% of the subjects were male. Compared to the placebo group, those patients treated with piroxicam had less pain, resumed training more rapidly, were treated at a lower cost, and had increased endurance on resumption of activity. The patients in the group that received treatment with piroxicam, used fewer acetaminophen tablets for pain relief than the placebo group. According to the authors the analgesia provided by piroxicam, in acute ankle sprains, is significant. In this study early treatment of acute ankle sprains with piroxicam was proven to be more cost-effective than placebo treatment. Greater instability at the ankle joint was, however, demonstrated in the piroxicam group on performance of the anterior drawer test. Patients in the piroxicam group also showed increased swelling and less limitation of range of motion than the placebo group. It was postulated that the analgesic effects of non-steroidal anti-inflammatories allowed for the premature return of patients to normal activity, before sufficient tissue healing had taken place. Early resumption of normal activity would, therefore, increase inflammation in the injured area, and increase instability.

2.11 SUMMARY OF THE RELATED LITERATURE

The ankle sprain is one of the most common musculo-skeletal injuries found in sports medicine (Geppert and Buckley 1998). Ankle sprains are often under- treated by many physicians who are unaware of the many long term associated complications (Kuwada 1995). In a critical review of the medication, surgical interventions, and physiotherapeutic treatment modalities currently being used to treat soft tissue injuries of the ankle, it was stated that conservative treatment of these ankle injuries produced satisfactory outcomes (Ogilvie-Harris and Gilbart 1995). The treatment of ankle sprains is quite controversial and although numerous studies have been performed on the treatment of this traumatic musculoskeletal condition, a consensus as to the most effective treatment protocol has not been established.

Although manipulation is commonly used to treat peripheral joint disorders, there have been few studies which have evaluated this form of treatment in terms of effectiveness. Nield et al. (1993), conducted a controlled study on 20 asymptomatic patients to test the effectiveness of a single manipulation of the talocrural joint on dorsiflexion of the ankle joint. No increase in dorsiflexion of the ankle was noted. The authors suggested a further study to investigate the effects of manipulative therapy on symptomatic patients. The effect of repeated manipulative therapy in the management of acute grade 1 and 2 inversion ankle sprains has yet to be investigated. Furthermore, the cost-effectiveness of the aforementioned intervention has yet to be established.

Early use of non-steroidal anti-inflammatory drugs, used continuously for at least five days, reduces pain and improves the recovery rate of the patient. This allows for an earlier return to full function by the patient. (Langran 1998.) A randomized, placebo-controlled clinical trial of piroxicam in the treatment of acute ankle sprains was done by Slatyer et al. (1997), in which 364 patients were treated. The patients who received treatment with piroxicam had less pain, resumed training more rapidly, were treated at a lower cost, and had increased endurance on resumption of activity than those patients in the placebo group.

After thorough evaluation of the available literature no studies were found to be in existence that compared manipulative therapy of the talocrural and subtalar joints in acute grade one and grade two inversion ankle sprains to the administration of piroxicam in the aforementioned injury.

The aim of this investigation was to compare the relative effectiveness and relative cost effectiveness of piroxicam and manipulation in the management of acute grades 1 and 2 inversion ankle sprains in terms of subjective and objective clinical findings. The research design was similar to that used by Slatyer et al. (1997), so an indirect comparison could be assertained against placebo treatment.

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 INTRODUCTION

A detailed description of the study design, interventions used, and the patients within the study is discussed in this chapter. Measurements obtained and the statistical procedures used in the analysis of the data are also discussed.

This study was designed as a prospective, comparative, clinical trial concerned with the treatment of acute grade 1 and 2 inversion ankle sprains. An intra-group statistical analysis was performed to assess differences within the two treatment groups (namely, the group which received chiropractic manipulation, and the group which received piroxicam). An inter-group analysis was also performed to determine which of the two treatment protocols was the more effective, and relatively cost-effective.

3.2 SUBJECTS

The study was limited to patients presenting to the Chiropractic Clinic at Technikon Natal with acute grade one or two inversion ankle sprains. These patients were obtained by means of advertisements placed in local newspapers, notice-boards around the Technikon campus, various sporting facilities, and an emergency room at a local hospital. Patients were also obtained at sporting events attended by the Technikon Natal Chiropractic Sports Association. No restrictions were placed on the patient's race, sex, income bracket, residential area, or occupation.

Patients were screened for admissibility into the clinical trial according to their case history (appendix A), physical examination (appendix B), regional examination of the ankle (appendix C), and radiographic findings.

Ankle sprains were grouped into three grades using a functional clinical grading system (Slatyer et al. 1997) (appendix L). Radiographic views taken were anterior - posterior, lateral, and medial-oblique ankle views to rule out fractures.

Patients in both groups were assessed for muscular and/or ligamentous fixations of the subtalar joint and talocrural joint by the researcher, and a blinded clinician. These assessments were done initially on the day of injury, and one month following the injury. Muscular and/or ligamentous fixations of the subtalar joint and talocrural joint were assessed for loss of normal

end feel/joint play using the motion palpation techniques outlined by Nook (1997: 235, 247-250). Loss of joint play in long axis distraction of the subtalar and talocrural joints was recorded along with loss of eversion end feel of the subtalar joint (appendix D), for analysis of order of frequency.

Patients in group one were not examined by a medical doctor as they did not receive any form of medication.. Patients in group two were examined by a medical doctor and had piroxicam prescribed to them immediately if the drug was not contra-indicated.

The two groups were compared for similarities in terms of age, gender, race, occupation, activity associated with the ankle sprain, and clinical severity.

3.3 INCLUSION AND EXCLUSION CRITERIA OF PATIENTS - as similar to the study by Slatyer et al. (1997)

1) Patients had to be between the ages of 15 and 50 years.
2) Only patients diagnosed by the researcher as having sustained an acute grade 1 or 2 inversion ankle sprain were considered for the study.
3) Any patients who had previously sustained major soft tissue injuries or ankle fractures in the affected ankle, or a history of chronic instability in the affected ankle were not considered for the study.

4) Patients with a history of adverse reactions to non-steroidal anti-inflammatory drugs, or patients with proven peptic ulcers or gastrointestinal bleeding were excluded from the study.

5) Patients taking any prescription medication, with the exception of the oral contraceptive pill, which does not interact with piroxicam, were excluded from the study due to possible drug interactions.(Slatyer et al. 1997.)

6) Patients found to have sustained a fracture to the ankle as demonstrated on ankle radiographs, were also excluded from this study.

7) Patients of both groups were not to receive any other form of treatment for their injury. Patients requiring treatment for other conditions during the course of the study were able to receive such treatment provided these additional therapeutic interventions did not include prescription medication or direct treatment of the injured foot and ankle.

8) Patients who re-injured their ankle during the course of the study were excluded from the study.

9) All patients included in the study were required to sign a consent form which allowed the researcher to include them in the study (appendix E).

3.4 THE SAMPLE GROUP

Thirty people were required to complete the study. Participants were randomly allocated into two treatment groups of 15 patients each by drawing a number between 1 and 30 out of a hat. Patients drawing even numbers were assigned to treatment group 1, and patients drawing odd numbers were assigned to treatment group 2. Patients in group 1 received manipulation, while patients in group 2 had piroxicam prescribed.

There was no patient blinding as all patients were informed of the of the two different treatment protocols in this study.

3.5 INTERVENTIONS

Patients in both groups were informed of the all procedures involved in the study (appendix F).

Patients in group one received manipulations of the fixations found at the subtalar and talocrural joints. Manipulations used at the talocrural and subtalar joints were limited to long axis distraction (Bergmann et al. 1993: 704-706), eversion of the subtaloid joint, and the gapping thrust to the subtaloid joint (Hartman 1986:193). Those patients in treatment group one received six treatments equally spread over a two week period, and returned one month

after the injury.

Patients in group two received 40mg of piroxicam for the first two days, and then 20 mg for the following five days administered with meals or milk (Slatyer et al. 1997).

All patients applied ice to the injured area three times a day for ten days after the injury. Patients were taught how to apply an elastic crepe bandage to the area, with firm pressure, which was to be used at all times for the first three days after the injury. (Slatyer et al. 1997.)

3.6 MEASUREMENTS

Patients in a study performed by Slatyer et al. (1997) were assessed for severity of the ankle sprain at the time of injury, on days 3, 7, 14, and one month following the injury. For easier correlation of data between the two groups in this study, all patients were required to be assessed at the time of injury, on six occasions equally spread over a two week period after the injury, and one month following the injury.

The subjective and objective measurements were taken at each consultation. These measurements allowed for the assessment of any improvement during the treatment period, and at the one month follow-up consultation.

3.6.1 SUBJECTIVE MEASURES

All patients were required to complete questionnaires at the initial consultation, before consultations 3 and 6, and at the one month follow-up consultation. Both treatment groups completed the Numerical Rating Scale 101 (appendix G), and the Mc Gill pain questionnaire (appendix H). Patients in both groups were asked to report on their athletic ability, in comparison to previous normal activity, at each consultation. They were required to note when physical training first became possible, and to what extent the injury hampered their training, if at all (appendix I).

3.6.1.1 THE NUMERICAL PAIN RATING SCALE (NRS 101)

The Numerical Pain Rating Scale is used to assess the perceived level of pain intensity of a patient (Jenson et al. 1986).

This questionnaire consists of a numerical scale from 0 to 100. A rating of 0 represents no pain, while a rating of 100 represents the other extreme where pain is at its worst. The intensity of the perceived level of pain is indicated by the patient, in the form of a percentage, both at its best and at its worst.

In a study by Jenson et al. (1986), 75 patients who suffered from chronic pain (more than 6

months of pain) were asked to rate their pain using 6 pain intensity measures. Of these 6 measures the NRS-101 was found to be superior in many ways. Firstly, it is easy to administer and score, and can be used both verbally or in written form. In addition, it has 101 response categories which makes it better than other pain intensity measures which have limited response options. The NRS-101, in comparison to other pain intensity measures, is not associated with incorrect responses, and the difficulty of the scale is not associated with age.

3.6.1.2 THE SHORT-FORM McGILL PAIN QUESTIONNAIRE

The short-form McGill Pain Questionnaire was used to acquire data as to the sensory, affective, and overall intensity of pain. It allows for rapid acquisition of data and is simple in nature. (Melzack 1987.)

This form consists of 15 words, with 11 being sensory and 4 affective in nature. Each pain descriptor is ranked by the patient on an intensity scale of 0 = none, 1 = mild, 2 = moderate, and 3 = severe pain.

Melzack (1987), performed two studies involving the short-form McGill Pain Questionnaire. The first study involved both the long and the short form of the McGill Pain Questionnaire. In this study post-surgical (n =40), obstetrical (n = 20), and patients complaining of musculoskeletal pain (n = 10) were first presented with the standard McGill Pain

Questionnaire, and then the short-form McGill Pain Questionnaire. These patients were asked to choose the words that best described their pain, and to rate the intensity of the pain accordingly. The patients were tested before and 30 minutes after medication or other therapy for their pain was administered.

To ensure that the results of the first test were not biased due to the order of presentation of the forms, a second test was conducted where 31 post-surgical, and 31 dental patients were randomly assigned to firstly complete the standard form and than the short form of the McGill Pain Questionnaire, or vise versa. In both of the aforementioned studies the long and short form of the McGill Pain Questionnaire correlated in terms of sensory, affective and total scores. The short-form McGill Pain Questionnaire correlates highly with the other pain rating indices of the longer form, and is sensitive to many clinical therapies.

3.6.1.3 SELF-REPORTED ATHLETIC ABILITY

In a prospective study done by Wilson et al. (1998), 13 collegiate athletes were measured at approximately 3 and 10 days following injury to the ankle (grade 1 or 2 ankle sprains were used). A visual analogue scale was used to assess the patient's athletic limitations in comparison to normal. According to the authors, self-reported athletic ability was useful as an indicator of change, whether it be improvement or regression, in acute grade 1 and 2 inversion ankle sprains.

In this study patients were required to note when physical training first became possible, and to what extent the injury hampered their training, if at all (appendix I). The limitation to training was documented in the form of a percentage.

3.6.2 OBJECTIVE MEASUREMENTS

Objective assessments of the changes in the patients condition during the treatment period and one month following injury were also performed. An algometer and extremity goniometer were used to obtain objective data with regards to the patients level of pain and range of motion at the ankle joint respectively. Romberg's test was used to assess proprioception, and the anterior drawer test was used to detect ligamentous instability of the ankle (Magee 1992: 334,480-481).

3.6.2.1 THE ALGOMETER

An Effeg. Algometer (Wagner Instruments, Greenwich, CT, 06836. U.S.A.) was used to determine the amount of tenderness present at the site of injury. Pressure readings were taken at the site of worst pain in the ankle. A permanent marker was used to mark this specific site at the lateral ankle to ensure that the same site was used for evaluation during follow-up consultations. The dial on the algometer was initially set to zero, and the 1cm rubber disc was

applied to the marked spot. The pressure at which pain or discomfort was first felt, when the algometer was applied to this specific site, was recorded (appendix J). The researcher stopped applying pressure to the area as soon as the patient indicated pain or discomfort. The pressure readings were performed at the initial consultation, before consultations 3 and 6, and at the one month follow-up consultation to both treatment groups.

3.6.2.2 THE EXTREMITY (UNIVERSAL) GONIOMETER

Range of motion measurements are often used to record patient progress in clinical practice and research (Wilson et al. 1998). Physical therapists often perform active and passive range of motion measurements at the ankle of patients presenting with ankle complaints. This is performed to assess for dysfunction and to evaluate the efficacy of the treatment. The universal goniometer is often used to measure the range of motion of the ankle joint. (Youdas et al. 1993.)

In a study performed on healthy Naval midshipmen by Jonson and Gross (1997), intra and inter-examiner reliability and mean values for nine static lower extremity skeletal measures were recorded. The measures studied included femoral torsion, ankle dorsiflexion, tibial length, leg length discrepancy , genu varus and valgus, medial talonavicular joint bulge, rearfoot angle, arch angle, and foot type classification. Intra and inter-examiner reliability for maximum dorsiflexion at the ankle joint was shown to be high and moderate respectively.

Intra and inter-examiner reliability was also shown to be high for femoral torsion, tibial length, leg length discrepancy, genu varus and valgus, medial talonavicular joint bulge, rearfoot angle, arch angle, and foot type classification.

A study performed by Wilson et al. (1998), on 13 collegiate graduates presenting with acute grade 1 or 2 ankle sprains showed sagittal plane range of motion goniometer measurements at the ankle joint were sensitive to changes occurring between 3 and 10 days following injury.

According to Pope et al. (1998), ankle dorsiflexion is a strong predictor of injury of the lower limb. They state that restricted ankle dorsiflexion increases the risk of injury to the lower limb, and particularly increases the risk of spraining the ankle.

Dorsiflexion was measured using the technique tested by Jonson and Gross (1997). The patient was asked to lie prone with the affected side knee extended. The patient was then asked to actively dorsiflex the foot at the ankle, while the researcher pushed the foot passively into dorsiflexion. One arm of the goniometer was aligned with the shaft of the 5^{th} metatarsal head (distal arm), and the other arm (proximal arm) was aligned with an imaginary line joining the head of the fibula to the lateral malleolus. The amount of dorsiflexion motion was recorded at the initial consultation, before consultations 3 and 6, and at the one month follow-up consultation (appendix J).

3.6.2.3 ROMBERG'S TEST

Romberg's test was used to assess proprioception, with a positive test being indicative of a lack of proprioception (Magee 1992: 334). The patient was asked to balance first on the unaffected side, with the opposite knee bent and resting on the unaffected knee. The patient was then asked to close their eyes while maintaining this single-legged stance. The period of time that the patient was able to bear weight on the unaffected side leg was recorded in seconds. This test was then repeated with the affected side bearing the weight. This test was performed on all patients, initially, and on days of the scheduled follow-up consultations (Slatyer et al. 1997). The results of these tests, as well as the period of time that the patient was able to bear weight on the injured and uninjured ankle recorded in seconds, was documented for further analysis (appendix K) For the purpose of this study the patient was said to have a negative Romberg test when the period of time that the patient was able to bear weight on the injured side was equal to, or greater than 80% of the uninjured side.

A relative cost-effectiveness analysis was done using the cost of the average number of treatments until the patient had a negative Romberg test as an indicator of normal functioning and resumption of training (Slatyer et al. 1997).

3.6.2.4 THE ANTERIOR DRAWER TEST

The anterior drawer test is used to detect ligamentous instability of the ankle (Magee 1992: 480-481). The researcher performed this test with the patients lying supine with their legs and feet relaxed. The posterior calcaneus was grasped with one hand and the foot was gently moved from posterior to anterior, while the distal tibia was firmly secured with the other hand. This test was performed bilaterally so as to compare the amount of laxity between the injured and uninjured side ankle joints. The test was said to be positive if significant anterior displacement of the injured foot from the distal tibia, in comparison to the uninjured side, was noted. (Harris 1995:521.) Results of the anterior drawer test were recorded (appendix K). This test was performed initially and on each day of the scheduled consultations.

3.7 THE SPECIFIC TREATMENT OF EACH SUBPROBLEM

3.7.1 THE FIRST OBJECTIVE

The first objective was to compare the relative effectiveness of piroxicam and manipulation in the management of acute grades 1 and 2 inversion ankle sprains in terms of subjective clinical findings.

3.7.2 THE SECOND OBJECTIVE

The second objective was to compare the relative effectiveness of piroxicam and manipulation in the management of acute grades 1 and 2 inversion ankle sprains in terms of objective clinical findings.

3.7.3 THE THIRD OBJECTIVE

The third objective was to integrate the results of objective one and two in order to determine which of the two treatments was more effective in terms of subjective and objective clinical findings.

3.7.4 THE FOURTH OBJECTIVE

The fourth objective was to evaluate the relative direct costs of each intervention in a comparative analysis to determine which of the two treatments was more relatively cost-effective in the management of acute grades 1 and 2 inversion ankle sprains. This included the cost of medical consultations, medication, chiropractic consultations, and elastic crepe bandages.

3.8 TREATMENT OF THE DATA

The subjective data (continuous) was treated as follows:

- Questionnaires completed by the patients were checked to ensure that they were completed correctly.
- Figures obtained from the questionnaires were converted into percentages / ratios. The data gathered from the two treatment groups were recorded separately.
- The data was statistically analyzed using a 95% level of confidence.

The objective data (continuous) was treated as follows:

- The amount of dorsiflexion at the ankle, recorded in degrees, were recorded separately for each of the two treatment groups.
- The algometer readings, in Kg/cm^2, were recorded separately for the two groups.
- The data was statistically analyzed using a 95% level of confidence.

The objective data (categorical) was treated as follows:

- The results of the anterior drawer test, indicted by a positive or a negative, were also recorded separately for each of the two treatment groups.
- Fixations found by the researcher, and the fixations found by the clinician, were recorded separately for each of the two treatment groups.
- The data was statistically analyzed using a 95% level of confidence.

The two groups were compared for similarities in terms of age, gender, race, occupation, activity associated with the ankle sprain and clinical severity.

The results of the Rombergs test, in seconds, were recorded separately for the two groups. The total costs involved in treating each patient, using the average number of treatments until the patient had a negative Romberg test as an indicator of normal functioning, was recorded for further analysis. The two-sample unpaired t-test was used to determine which of the two treatments was the more cost-effective in this study. A 95% level of confidence was utilized.

3.9 STATISTICAL PROCEDURES

As categorical and continuous variables were used in this study, both parametric, and non-parametric tests were used in order to analyze the data obtained. Fixations found by the researcher, fixations found by the clinician, and the results of the anterior drawer test were all categorical variables and thus non-parametric tests were used to analyze these variables. Continuous variables were analyzed using parametric tests. Continuous variables included algometer and goniometer readings, the results of the Numerical Rating Scale-101, the Short-Form McGill Pain Questionnaire, the athletic limitation, and the total cost involved in treating the patients.

Non-parametric tests, for categorical variables, included the Wilcoxon Signed Rank test, and the Mann-Whitney U-test. Parametric tests, for continuous variables, included the two-sample unpaired t-test, and the two-sample paired t-test.

3.9.1 PROCEDURE 1: WILCOXON SIGNED RANK TEST (CATEGORICAL)

The Wilcoxon Signed Rank test was used at a 95% level of confidence. It was used to determine whether there was any statistically significant changes within group 1, and group 2 between treatment 1 and treatment 6, between treatment 6 and the one month follow-up consultation, and finally between treatment 1 and the one month follow-up with respect to the

anterior drawer test. The Wilcoxon Signed Rank test was also used, at the aforementioned level of significance, to determine whether there was any statistically significant changes within group 1, and group 2 between treatment 1 and the one month follow-up with respect to the fixations found by the researcher, as well as the fixations found by the clinician.

HYPOTHESIS TESTING AND THE DECISION RULE

In terms of the anterior drawer test, the null hypothesis (H_0) stated that there was no significant improvement between treatment 1 and 6, between treatment 6 and the one month follow-up treatment, and finally between treatment 1 and the follow-up consultation on analysis of the objective (categorical) data. This hypothesis stated that the treatment was ineffective. The alternative hypothesis (H_1) stated that significant improvement was noted between the aforementioned treatment intervals on analysis of the objective (categorical) data. This hypothesis stated that the treatment protocol was effective.

In terms of the fixations found by the researcher and the clinician, the null hypothesis (H_0) stated that there was no significant improvement between treatment 1 and the follow-up consultation on analysis of the objective (categorical) data. This hypothesis stated that the treatment was ineffective. The alternative hypothesis (H_1) stated that significant improvement was noted between the aforementioned treatment intervals on analysis of the objective (categorical) data. This hypothesis stated that the treatment protocol was effective.

H_0 : No significant improvement noted

H_1 : Significant improvement was noted

$\propto$ = 0.05 level of confidence

For a two-tailed test:

Reject H_0 if $P \leq \propto / 2 = 0.025$

Accept H_0 if $P > \propto / 2 = 0.025$

P was the observed level of significance

3.9.2 PROCEDURE 2: MANN-WHITNEY UNPAIRED TEST (CATEGORICAL)

This test was used to compare the two groups to each other. The groups were treated as being independent of one another. The purpose of the tests was to determine whether there was significant difference between the two treatment groups with respect to the anterior drawer test, and the fixations found by the researcher, as well as the fixations found by the clinician..

The Mann-Whitney Unpaired tests were used, at a $\propto / 2 = 0.025$ level of confidence, to compare the two groups' measurements taken at treatment 1, treatment 6, and the one month follow-up treatment in the case of the anterior drawer test, and measurements taken at treatment 1 and the one month follow-up in the case of the fixations found by both the researcher and the clinician.

HYPOTHESIS TESTING AND THE DECISION RULE

The null hypothesis (H_0) stated that there was no significant difference between group1 and 2 on analysis of the objective (categorical) inter-group data. This hypothesis stated that the two treatments were equally effective. The alternative hypothesis (H_1) stated that significant difference was noted between the two groups on analysis of the objective (categorical) inter-group data. This hypothesis stated that the two treatment protocols were not equally effective.

$H_0 : \mu_1 = \mu_2$

$H_1 : \mu_1$ and μ_2 were significantly different from each other

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

For two-tailed test:

Reject H_0 if $P \leq \propto / 2 = 0.025$

Accept H_0 if $P > \propto / 2 = 0.025$

P was the observed level of significance

3.9.3 PROCEDURE 3:THE TWO-SAMPLE PAIRED T-TEST (CONTINUOUS)

For each of the continuous variables, the two-sample paired t-test was used to compare results from related samples (ie. from within group 1 and within group 2). The two-sample paired t-test was used, at a $\propto = 0.05$ level of confidence.

HYPOTHESIS TESTING AND THE DECISION RULE

The null hypothesis (H_0) stated that there was no significant improvement between treatment 1 and 6, treatment 6 and the one month follow-up, and treatment 1 and the one month follow-up on analysis of the subjective and objective (continuous) inter-group data. The alternative hypothesis (H_1) stated that significant improvement was noted between treatments 1 and 6, treatments 6 and the one month follow-up, and treatment 1 and the one month follow-up on analysis of the subjective and objective (continuous) inter-group data.

$H_0 : \mu_1 = \mu_2$

$H_1 : \mu_1$ and μ_2 were significantly different from each other

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

For two-tailed test:

Reject H_0 if $P \leq \propto / 2 = 0.025$

Accept H_0 if $P > \propto / 2 = 0.025$

P was the observed level of significance

3.9.4 PROCEDURE 4: THE TWO-SAMPLE UNPAIRED T-TEST (CONTINUOUS)

For each of the continuous variables, the two-sample unpaired t-test was used to compare results from independent samples (ie. from group 1 and group 2). The two-sample unpaired t-test was used, at a $\propto = 0.05$ level of confidence.

HYPOTHESIS TESTING AND THE DECISION RULE

The null hypothesis (H_0) stated that there was no significant difference between the two groups' measurements taken at treatment 1, treatment 6, and the one month follow-up treatment on analysis of the subjective and objective (continuous) inter-group data. The alternative hypothesis (H_1) stated that significant difference was noted between the two groups' measurements taken at treatment 1, treatment 6, and the one month follow-up on analysis of the subjective and objective (continuous) inter-group data.

$H_0 : \mu_1 = \mu_2$

$H_1 : \mu_1$ and μ_2 were significantly different from each other

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

For two-tailed test:

Reject H_0 if $P \leq \propto / 2 = 0.025$

Accept H_0 if $P > \propto / 2 = 0.025$

P was the observed level of significance

3.9.5 PROCEDURE 5: SUMMARY STATISTICS

Summary statistics included the mean, median, standard deviation and standard error. These statistics were obtained, using the two-sample paired t-test and the two-sample unpaired t-test, to support the results obtained from continuous variables only. These results were used for power analysis and the construction of barcharts.

If significant differences were calculated between the two groups, using the two aforementioned statistical tests, the mean was then used to identify the superior of the two groups. Standard deviation, which measures the spread of the data around the mean, was then used to determine the reliability of the mean. The bigger the standard deviation value was, the

wider was the spread of the values. This would indicate that the data was less reliable. The standard error was used to measure the reliability of the mean used in the statistical tests. Frequencies and percentages were computed for categorical variables only.

3.9.6 PROCEDURE 6: COMPARISON USING BARCHARTS

Visual summaries of analytical findings were demonstrated using barcharts to compare groups 1 and 2 with respect to continuous variables. Average (mean) readings were used to construct these barcharts (Fisher and Van Belle: 1993:315-319.)

3.9.7 PROCEDURE 7: POWER ANALYSIS

The power of a test is a measure of the tests sensitivity. The power of a test depends on the sample size, the accuracy of measurements involved in this study, and the level of significance of the study. The power of a statistical test is the probability of detecting a difference between the two groups. The power value should be as close to one as possible. The smaller the power of a test, the larger the likelihood of a type II error, ie. falsely accepting the null hypothesis. (Portney and Watkins 1993: 656-663.)

All statistical data was entered and analyzed using SPSS statistical computer package and the computer package user guide (SPSS Inc. 1999:356-370)

CHAPTER FOUR

4.0 THE RESULTS

4.1 INTRODUCTION

This chapter covers the data obtained in this study. The data was analyzed in order to accept or reject the null hypothesis. This study concluded with a total of 30 patients, with 15 patients in group one and 15 in group two. Two volunteers were rejected during the study due to non-compliance (lack of attendance, and re-injury). As categorical and continuous variables were used in this study, both parametric, and non-parametric tests were used in order to analyze the data obtained.

The Wilcoxon Signed Rank Test was used for intra-group comparisons of categorical variables. In each of these tests the null hypothesis stated that there was no significant difference between the two samples being compared, at the $\propto = 0.05$ level of significance. The alternative hypothesis stated that there was significant difference between the two samples being compared.(Fisher and Van Belle 1993: 315-319).

The Mann-Whitney U-test was used for inter-group comparisons of categorical variables. In each of these tests the null hypothesis stated that there was no significant difference between groups one and two with respect to the variable in charge, at the $\propto = 0.05$ level of significance.

The alternative hypothesis stated that there was a significant difference between the two groups.(Fisher and Van Belle 1993: 315-319).

The null hypothesis was rejected for both the Wilcoxon Signed Rank Test, and the Mann-Whitney U-test, at the $\propto$ level of significance if $P \leq 0.025$ where P was the observed level of significance or P-value. The null hypothesis was accepted at the same level ($P \leq 0.025$). (Fisher and Van Belle 1993: 315-319).

The two-sample paired t-test was used for intra-group comparisons of continuous variables. In each of these tests the null hypothesis stated that there was no significant difference between the two samples being compared, at the $\propto = 0.05$ level of significance. The alternative hypothesis stated that there was significant difference between the two samples being compared. (Fisher and Van Belle 1993: 315-319).

The two-sample unpaired t-test was used for inter-group comparisons of continuous variables. In each of these tests the null hypothesis stated that there was no significant difference between groups one and two with respect to the variable in charge, at the $\propto = 0.05$ level of significance. The alternative hypothesis stated that there was a significant difference between the two groups. (Fisher and Van Belle 1993: 315-319).

The null hypothesis was rejected for both the two-sample unpaired and the two-sample paired t-tests, at the $\propto$ level of significance if $P \leq 0.025$ where P was the observed level of significance or P-value. The null hypothesis was accepted at the same level ($P \leq 0.025$). (Fisher and Van Belle 1993: 315-319).

The power of a test is a measure of the tests sensitivity. The power of a test depends on the sample size, the accuracy of measurements involved in this study, and the level of significance of the study. The power of a statistical test is the probability of detecting a difference between the two groups. The power value should be as close to one as possible. The smaller the power of a test, the larger the likelihood of a type II error, ie. falsely accepting the null hypothesis. (Portney and Watkins 1993.)

The power of non-parametric tests are usually low. Results from non-parametric tests are, therefore, not necessarily reliable as decision-making tools. (Portney and Watkins 1993.)

The tables in this chapter show the median, mean, standard deviation, standard error, P-value and the results from the two-sample unpaired t-test power analysis.

Demographic data obtained in this study represents the age, gender, race, occupation, grade of ankle sprain, and activity associated with injury.

Key for abbreviations in tables

Group 1: received chiropractic adjustments of the ankle

Group 2: received piroxicam

NRS-101: Numerical Pain Rating Scale-101 Questionnaire

McGill: Short-Form McGill Pain Questionnaire

ALG: algometer reading

GON: goniometer reading (dorsiflexion of the ankle)

ATH: athletibility (limitation of training)

S.D.: standard deviation

S.E.: standard error of mean

FixDoc: fixations found by the clinician

FixSelf: fixations found by the researcher

Ant: anterior drawer test

Bolded text and numbers: significant

4.2 DEMOGRAPHIC DATA

4.2.1 Age percentages

Table 4.1: Age distribution within the sample group of 30

AGE	NUMBER OF PATIENTS	TOTAL PERCENTAGE
15 - 25	21	70%
26 - 35	4	13.3%
36 - 45	4	13.3%
46 - 55	1	3.3%

The average age for the sample was 24

4.2.2 Gender percentages

Table 4.2 Gender distribution within the sample group of 30

GENDER	NUMBER OF PATIENTS	TOTAL PERCENTAGE
MALE	19	63.3%
FEMALE	11	36.7%

4.2.3 RACE PERCENTAGES

Table 4.3 Race distribution within the sample group of 30

RACE	NUMBER OF PATIENTS	TOTAL PERCENTAGE
WHITE	21	70%
BLACK	5	16.7%
INDIAN	3	10%
COLOURED	1	3.3%

4.2.4 OCCUPATION PERCENTAGES

Table 4.4 Occupational distribution within the sample group of 30

OCCUPATION	NUMBER OF PATIENTS	TOTAL PERCENTAGE
STUDENT	18	60%
LECTURER	3	10%
SALES REPRESENTATIVE	2	6.7%
SECRETARY	1	3.3%
SCHOLAR	1	3.3%
CATERER	1	3.3%
LAND SURVEYOR	1	3.3%
DRESS DESIGNER	1	3.3%
INVESTMENT ADVISOR	1	3.3%
UNEMPLOYED	1	3.3%

4.2.5 GRADE OF SPRAIN

Table 4.5 Grade of sprain distribution within the sample group of 30

GRADE	GROUP 1	GROUP 1 %	GROUP 2	GROUP 2 %	TOTAL %
GRADE 1	11	36.7%	10	33.3%	70%
GRADE 2	4	13.3%	5	16.7	30%

4.2.6 ACTIVITY ASSOCIATED WITH ANKLE SPRAIN

Table 4.6 Activity distribution within the sample group of 30

ACTIVITY	NUMBER OF PATIENTS	TOTAL PERCENTAGE
RUGBY	6	20%
FALLING DOWN STAIRS	5	16.7%
FOOTBALL	5	16.7%
WALKING	4	13.3%
RUNNING	2	6.7%
DANCING	2	6.7%
GYMNASTICS	1	3.3%
SQUASH	1	3.3%
BASEBALL	1	3.3%
HOCKEY	1	3.3%
BASKETBALL	1	3.3%
MUGGING	1	3.3%

4.3 COMPARISON BETWEEN 2 RELATED SAMPLES WITHIN GROUP 1

4.3.1 CATEGORICAL VARIABLES

4.3.1.1 Analysis of objective data

Table 4.7 Comparison of the results of the objective data, using the Wilcoxon Signed Rank test, between treatment 1 and treatment 6 for group 1.

GROUP 1	
TREATMENT 1 VERSUS TREATMENT 6 : P-VALUE	
ANT	0.083

The null hypothesis is accepted for the anterior drawer test, as there was no significant improvement between treatments 1 and 6 at the $\propto = 0.05$ level of significance.

Table 4.8 Comparison of the results of the objective data, using the Wilcoxon Signed Rank test, between treatment 1 and the one month follow-up for group 1.

GROUP 1	
TREATMENT 1 VERSUS THE ONE MONTH FOLLOW-UP : P-VALUE	
ANT	0.083
FIXSELF	0.444
FIXDOC	0.083

The null hypothesis is accepted for the anterior drawer test, the fixations found by the researcher, and the fixations found by the clinician, as there was no significant improvement between treatment 1 and the one month follow-up at the $\propto = 0.05$ level of significance. This indicates that fixations found initially were still present at the one month follow-up.

Table 4.9 Comparison of the results of the objective data, using the Wilcoxon Signed Rank test, between treatment 6 and the one month follow-up for group 1.

GROUP 1	
TREATMENT 6 VERSUS THE ONE MONTH FOLOW-UP : P-VALUE	
ANT	1.000

The null hypothesis is accepted for the anterior drawer test, as there was no significant improvement between treatment 6 and the one month follow-up at the $\propto = 0.05$ level of significance.

4.3.2 CONTINUOUS VARIABLES

4.3.2.1 Analysis of subjective data

Table 4.10 Comparison of the results of the subjective data, using the two-sample paired t-test, between treatment 1 and treatment 6 for group 1.

GROUP 1									
	TREATMENT 1					TREATMENT 6			
	MEAN	S.E	S.D	VARIANCE	P-VALUE	MEAN	S.E	S.D	VARIANCE
NRS	39.83	5.21	20.17	406.667	**0.000**	11.23	2.83	10.94	119.781
McGILL	0.16	0.03	0.13	0.020	**0.001**	0.04	0.01	0.04	0.002
ATH	64.00	7.80	30.20	911.429	**0.000**	11.80	4.69	18.15	329.314

The null hypothesis is rejected for the NRS, the Short-Form McGill Pain Questionnaire, and the athletibility (limitation of activity), as there was a significant improvement between treatment 1 and treatment 6 at the $\propto = 0.05$ level of significance.

Table 4.11 **Comparison of the results of the subjective data, using the two-sample paired t-test, between treatment 1 and the one month follow-up for group 1.**

GROUP 1									
	TREATMENT 1					ONE MONTH F/U			
	MEAN	S.E	S.D	VARIANCE	P-VALUE	MEAN	S.E	S.D	VARIANCE
NRS	39.83	5.21	20.17	406.667	**0.000**	4.90	2.38	9.27	84.936
McGILL	0.16	0.03	0.13	0.020	**0.000**	0.02	0.007	0.03	0.0007
ATH	64.00	7.80	30.20	911.429	**0.000**	4.73	3.32	12.84	164.924

The null hypothesis is rejected for the NRS, the Short-Form McGill Pain Questionnaire, and the athletibility (limitation of activity), as there was a significant improvement between treatment 1 and the one month follow-up at the $\propto = 0.05$ level of significance.

Table 4.12 Comparison of the results of the subjective data, using the two-sample paired t-test, between treatment 6 and the one month follow-up for group 1.

GROUP 1									
	TREATMENT 6					ONE MONTH F/U			
	MEAN	S.E	S.D	VARIANCE	P-VALUE	MEAN	S.E	S.D	VARIANCE
NRS	11.23	2.83	10.94	119.781	0.074	4.90	2.38	9.27	84.936
McGILL	0.04	0.01	0.04	0.002	0.074	0.02	0.007	0.03	0.0007
ATH	11.80	4.69	18.15	329.314	0.095	4.73	3.32	12.84	164.924

The null hypothesis is accepted for the NRS, the Short-Form McGill Pain Questionnaire, and the athletibility (limitation of activity), as there was no significant improvement between treatment 1 and treatment 6 at the $\propto = 0.05$ level of significance.

4.3.2.2 Analysis of objective data

Table 4.13 Comparison of the results of the objective data, using the two-sample paired t-test, between treatment 1 and treatment 6 for group 1.

GROUP 1									
	TREATMENT 1					TREATMENT 6			
	MEAN	S.E	S.D	VARIANCE	P-VALUE	MEAN	S.E	S.D	VARIANCE
ALG	1.71	0.38	1.46	2.126	**0.001**	3.67	0.51	1.96	3.841
GON	3.53	1.88	7.28	52.981	**0.000**	13.20	0.84	3.23	10.457

The null hypothesis is rejected for both the algometer and goniometer readings, as there was a significant improvement between treatment 1 and treatment 6 at the $\propto = 0.05$ level of significance.

Table 4.14 Comparison of the results of the objective data, using the two-sample paired t-test, between treatment 1 and the one month follow-up for group 1.

GROUP 1									
	TREATMENT 1					ONE MONTH F/U			
	MEAN	S.E	S.D	VARIANCE	P-VALUE	MEAN	S.E	S.D	VARIANCE
ALG	1.71	0.38	1.46	2.126	**0.000**	4.22	0.55	2.11	4.452
GON	3.53	1.88	7.28	52.981	**0.000**	14.27	0.84	3.26	10.638

The null hypothesis is rejected for both the algometer and goniometer readings, as there was a significant improvement between treatment 1 and the one month follow-up at the $\propto = 0.05$ level of significance.

Table 4.15 Comparison of the results of the objective data, using the two-sample paired t-test, between treatment 6 and the one month follow-up for group 1.

GROUP 1									
	TREATMENT 6					ONE MONTH F/U			
	MEAN	S.E	S.D	VARIANCE	P-VALUE	MEAN	S.E	S.D	VARIANCE
ALG	3.67	0.51	1.96	3.841	0.036	4.22	0.55	2.11	4.452
GON	13.20	0.84	3.23	10.457	0.108	14.27	0.84	3.26	10.638

The null hypothesis is accepted for both the algometer and goniometer readings, as there was no significant improvement between treatment 1 and treatment 6 at the $\propto = 0.05$ level of significance.

4.4 COMPARISON BETWEEN 2 RELATED SAMPLES WITHIN GROUP 2

4.4.1 CATEGORICAL VARIABLES

4.4.1.1 Analysis of objective data

Table 4.16 Comparison of the results of the objective data, using the Wilcoxon Signed Rank test, between treatment 1 and treatment 6 for group 2.

	GROUP 2
	TREATMENT 1 VERSUS TREATMENT 6 : P-VALUE
ANT	**0.025**

The null hypothesis is rejected for the anterior drawer test, as there was a significant improvement between treatments 1 and 6 at the $\propto = 0.05$ level of significance.

Table 4.17 Comparison of the results of the objective data, using the Wilcoxon Signed Rank test, between treatment 1 and the one month follow-up for group 2.

GROUP 2	
TREATMENT 1 VERSUS THE ONE MONTH FOLLOW-UP : P-VALUE	
ANT	**0.025**
FIXSELF	0.892
FIXDOC	**0.010**

The null hypothesis is rejected for the anterior drawer test and the fixations found by the clinician, as there was a significant improvement between treatment 1 and the one month follow-up at the $\propto = 0.05$ level of significance.

The null hypothesis is accepted for the fixations found by the researcher, as there was no significant improvement between treatment 1 and the one month follow-up at the $\propto = 0.05$ level of significance. This indicates that the fixations found initially were still present at the one month follow-up.

Table 4.18 Comparison of the results of the objective data, using the Wilcoxon Signed Rank test, between treatment 6 and the one month follow-up for group 2.

GROUP 2	
TREATMENT 6 VERSUS THE ONE MONTH FOLLOW-UP : P-VALUE	
ANT	1.000

The null hypothesis is accepted for the anterior drawer test, as there was no significant improvement between treatments 1 and 6 at the $\propto = 0.05$ level of significance.

4.4.2 CONTINUOUS VARIABLES

4.4.2.1 Analysis of subjective data

Table 4.19 Comparison of the results of the subjective data, using the two-sample paired t-test, between treatment 1 and treatment 6 for group 2.

GROUP 2									
	TREATMENT 1					TREATMENT 6			
	MEAN	S.E	S.D	VARIANCE	P-VALUE	MEAN	S.E	S.D	VARIANCE
NRS	43.67	5.12	19.84	393.631	**0.000**	5.69	1.47	5.69	32.412
McGILL	0.19	0.04	0.14	0.020	**0.000**	0.05	0.01	0.05	0.003
ATH	59.00	9.86	38.18	1457.857	**0.000**	5.07	1.45	5.61	31.495

The null hypothesis is rejected for the NRS, the Short-Form McGill Pain Questionnaire, and the athletibility (limitation of activity), as there was a significant improvement between treatment 1 and treatment 6 at the $\propto = 0.05$ level of significance.

Table 4.20 Comparison of the results of the subjective data, using the two-sample paired t-test, between treatment 1 and the one month follow-up for group 2.

GROUP 2									
	TREATMENT 1					ONE MONTH F/U			
	MEAN	S.E	S.D	VARIANCE	P-VALUE	MEAN	S.E	S.D	VARIANCE
NRS	43.67	5.12	19.84	393.631	**0.000**	2.12	0.80	3.09	9.541
McGILL	0.19	0.04	0.14	0.020	**0.000**	0.03	0.008	0.03	0.001
ATH	59.00	9.86	38.18	1457.857	**0.000**	2.29	1.05	4.06	16.490

The null hypothesis is rejected for the NRS, the Short-Form McGill Pain Questionnaire, and the athletibility (limitation of activity), as there was a significant improvement between treatment1 and the one month follow-up at the $\propto = 0.05$ level of significance.

Table 4.21 **Comparison of the results of the subjective data, using the two-sample paired t-test, between treatment 6 and the one month follow-up for group 2.**

GROUP 2									
	TREATMENT 6					ONE MONTH F/U			
	MEAN	S.E	S.D	VARIANCE	P-VALUE	MEAN	S.E	S.D	VARIANCE
NRS	5.69	1.47	5.69	32.412	**0.006**	2.12	0.80	3.09	9.541
McGILL	0.05	0.01	0.05	0.003	**0.006**	0.03	0.008	0.03	0.001
ATH	5.07	1.45	5.61	31.495	**0.006**	2.29	1.05	4.06	16.490

The null hypothesis is rejected for the NRS, the Short-Form McGill Pain Questionnaire, and the athletibility (limitation of activity), as there was a significant improvement between treatment 6 and the one month follow-up at the $\propto = 0.05$ level of significance.

4.4.2.2 Analysis of objective data

Table 4.22 Comparison of the results of the objective data, using the two-sample paired t-test, between treatment 1 and treatment 6 for group 2.

GROUP 2									
	TREATMENT 1					TREATMENT 6			
	MEAN	S.E	S.D	VARIANCE	P-VALUE	MEAN	S.E	S.D	VARIANCE
ALG	0.76	0.24	0.92	0.847	**0.000**	3.22	0.34	1.32	1.754
GON	2.00	2.03	7.87	61.857	**0.001**	9.39	1.13	4.37	19.077

The null hypothesis is rejected for both the algometer and goniometer readings, as there was a significant improvement between treatment 1 and treatment 6 at the $\propto = 0.05$ level of significance.

Table 4.23 Comparison of the results of the objective data, using the two-sample paired t-test, between treatment 1 and the one month follow-up for group 2.

GROUP 2									
	TREATMENT 1					ONE MONTH F/U			
	MEAN	S.E	S.D	VARIANCE	P-VALUE	MEAN	S.E	S.D	VARIANCE
ALG	0.76	0.24	0.92	0.847	**0.000**	4.07	0.30	1.15	1.322
GON	2.00	2.03	7.87	61.857	**0.000**	11.75	0.88	3.40	11.590

The null hypothesis is rejected for both the algometer and goniometer readings, as there was a significant improvement between treatment1 and the one month follow-up at the $\propto = 0.05$ level of significance.

Table 4.24 Comparison of the results of the objective data, using the two-sample paired t-test, between treatment 6 and the one month follow-up for group 2.

GROUP 2									
	TREATMENT 6					ONE MONTH F/U			
	MEAN	S.E	S.D	VARIANCE	P-VALUE	MEAN	S.E	S.D	VARIANCE
ALG	3.22	0.34	1.32	1.754	**0.005**	4.07	0.30	1.15	1.322
GON	9.39	1.13	4.37	19.077	0.054	11.75	0.88	3.40	11.590

The null hypothesis is rejected for the algometer reading, as there was a significant improvement between treatment 6 and the one month follow-up at the $\propto = 0.05$ level of significance. The null hypothesis is accepted for the goniometer reading, as there was no significant improvement between treatment 6 and the one month follow-up at the $\propto = 0.05$ level of significance.

4.5 COMPARISON BETWEEN 2 UNRELATED SAMPLES

4.5.1 CATEGORICAL VARIABLES

4.5.1.1 Analysis of objective data

Table 4.25 Comparison of groups 1 and 2, using the Mann-Whitney U- test, to analyze results collected from the objective data at treatment 1.

TREATMENT 1	
GROUP 1 VERSUS GROUP 2 : P-VALUE	
ANT	0.417
FIXSELF	0.133
FIXDOC	0.570

The null hypothesis is accepted for the anterior drawer test, the fixations found by the researcher, and the fixations found by the clinician, as there was no significant difference between group 1 and group 2 at the $\propto = 0.05$ level of significance.

Table 4.26 Comparison of groups 1 and 2, using the Mann-Whitney U- test, to analyze results collected from the objective data at treatment 6.

TREATMENT 6	
GROUP 1 VERSUS GROUP 2 : P-VALUE	
ANT	1.000

The null hypothesis is accepted for the anterior drawer test, as there was no significant difference between group 1 and group 2 at the $\propto = 0.05$ level of significance.

Table 4.27 Comparison of groups 1 and 2, using the Mann-Whitney U- test, to analyze results collected from the objective data at the one month follow-up.

ONE MONTH F/U	
GROUP 1 VERSUS GROUP 2 : P-VALUE	
ANT	1.000
FIXSELF	0.029
FIXDOC	**0.002**

The null hypothesis is accepted for the anterior drawer test and the fixations found by the researcher, as there was no significant difference between group 1 and group 2 at the $\propto = 0.05$ level of significance. The null hypothesis is rejected for the fixations found by the clinician, as there was a significant difference between group 1 and group 2 at the $\propto = 0.05$ level of significance. At the one month follow-up, more patients in group 1 were found to be fixation free than in group 2, according to the clinician.

4.5.2 CONTINUOUS VARIABLES

4.5.2.1 Analysis of subjective data

Table 4.28 Comparison of groups 1 and 2, using the two-sample un-paired t-test to analyze results collected from the subjective data at treatment 1

TREATMENT 1									
	GROUP 1					GROUP 2			
	MEAN	S.E	S.D	VARIANCE	P-VALUE	MEAN	S.E	S.D	VARIANCE
NRS	39.83	5.21	20.17	406.667	0.604	43.67	5.12	19.84	393.631
McGILL	0.16	0.03	0.13	0.020	0.611	0.19	0.04	0.14	0.020
ATH	64.00	7.90	30.20	911.429	0.694	59.00	9.86	38.18	1457.857

POWER	
NRS	0.0773
McGILL	0.0768
ATH	0.0655

The null hypothesis is accepted for the NRS, the Short-Form McGill Pain Questionnaire, and the athletibility (limitation of activity), as there was no significant difference between group 1 and group 2 at the $\propto = 0.05$ level of significance.

Table 4.29 Comparison of groups 1 and 2, using the two-sample un-paired t-test to analyze results collected from the subjective data at treatment 6.

TREATMENT 6									
	GROUP 1					GROUP 2			
	MEAN	S.E	S.D	VARIANCE	P-VALUE	MEAN	S.E	S.D	VARIANCE
NRS	11.23	2.83	10.94	119.781	0.093	5.69	1.47	5.69	32.412
McGILL	0.04	0.01	0.04	0.002	0.386	0.05	0.01	0.05	0.003
ATH	11.80	4.69	18.15	329.314	0.181	5.07	1.45	5.61	31.495

POWER	
NRS	0.3805
McGILL	0.1157
ATH	0.2532

The null hypothesis is accepted for the NRS, the Short-Form McGill Pain Questionnaire, and the athletibility (limitation of activity), as there was no significant difference between group 1 and group 2 at the $\propto = 0.05$ level of significance.

Table 4.30 Comparison of groups 1 and 2, using the two-sample un-paired t-test to analyze results collected from the subjective data at the one month follow-up.

ONE MONTH F/U									
	GROUP 1					GROUP 2			
	MEAN	S.E	S.D	VARIANCE	P-VALUE	MEAN	S.E	S.D	VARIANCE
NRS	4.90	2.38	9.27	84.936	0.283	2.12	0.80	3.09	9.541
McGILL	0.02	0.007	0.03	0.0007	0.328	0.03	0.08	0.03	0.001
ATH	4.73	3.32	12.84	164.924	0.487	2.29	1.05	4.06	16.490

POWER	
NRS	0.1799
McGILL	0.1486
ATH	0.0999

The null hypothesis is accepted for the NRS, the Short-Form McGill Pain Questionnaire, and the athletibility (limitation of activity), as there was no significant difference between group 1 and group 2 at the $\propto = 0.05$ level of significance. The likelihood of making a type II error is high, however, as the power of these tests are low.

4.5.2.2 Analysis of objective data

Table 4.31 Comparison of groups 1 and 2, using the two-sample un-paired t-test to analyze results collected from the objective data at treatment 1

TREATMENT 1									
	GROUP 1					GROUP 2			
	MEAN	S.E	S.D	VARIANCE	P-VALUE	MEAN	S.E	S.D	VARIANCE
ALG	1.71	0.38	1.46	2.126	0.042	0.76	0.24	0.92	0.847
GON	3.53	1.88	7.28	52.981	0.584	2.00	2.03	7.87	61.857

POWER	
ALG	0.2971
GON	0.0804

The null hypothesis is accepted for both algometer and goniometer readings, as there was no significant difference between group 1 and group 2 at the $\propto = 0.05$ level of significance.

Table 4.32 Comparison of groups 1 and 2, using the two-sample un-paired t-test to analyze results collected from the objective data at treatment 6.

TREATMENT 6									
	GROUP 1					GROUP 2			
	MEAN	S.E	S.D	VARIANCE	P-VALUE	MEAN	S.E	S.D	VARIANCE
ALG	3.67	0.51	1.96	3.841	0.460	3.22	0.34	1.32	1.754
GON	13.20	0.84	3.23	10.457	**0.011**	9.39	1.13	4.37	19.077

POWER	
ALG	0.1070
GON	0.7465

The null hypothesis is accepted for the algometer reading, as there was no significant difference between group 1 and group 2 at the $\propto = 0.05$ level of significance. The null hypothesis is rejected for the goniometer reading, as there was a significant difference between group 1 and group 2 at the $\propto = 0.05$ level of significance. Group 1 showed more of an improvement than group 2, with regards to goniometer readings, at treatment 6.

Table 4.33 Comparison of groups 1 and 2, using the two-sample un-paired t-test to analyze results collected from the objective data at the one month follow-up.

ONE MONTH F/U									
	GROUP 1					GROUP 2			
	MEAN	S.E	S.D	VARIANCE	P-VALUE	MEAN	S.E	S.D	VARIANCE
ALG	4.22	0.55	2.11	4.452	0.807	4.07	0.30	1.15	1.322
GON	14.27	0.84	3.26	10.638	0.048	11.75	0.88	3.40	11.59

POWER	
ALG	0.0559
GON	0.5086

The null hypothesis is accepted for both algometer and goniometer readings, as there was no significant difference between group 1 and group 2 at the $\propto = 0.05$ level of significance.

Table 4.34 Comparison of groups 1 and 2, using the two-sample un-paired t-test to analyze results collected from the objective data at the end of the treatment period (total costs involved).

END OF TREATMENT									
	GROUP 1					GROUP 2			
	MEAN	S.E	S.D	VARIANCE	P-VALUE	MEAN	S.E	S.D	VARIANCE
COST	178.53	17.52	67.84	5602.857	**0.000**	305.72	14.69	56.90	3237.245

POWER	
COST	0.9992

The null hypothesis is rejected, as there was a significant difference between group 1 and group 2 at the $\propto = 0.05$ level of significance. The cost of treatment group1 is significantly less than the cost of treatment group 2. This finding is strongly supported by the statistical power analysis.

4.6 SUMMARY STATISTICS

4.6.1 FREQUENCIES AND PERCENTAGES FOR CATEGORICAL VARIABLES

KEY: ANT 1 = (+ve) anterior drawer

ANT 2 = (-ve) anterior drawer

FIXSELF / DOC 1 = long axis fixation

FIXSELF / DOC 2 = eversion fixation

FIXSELF / DOC 3 = long axis and eversion fixations

FIXSELF / DOC 4 = no fixations found

Table 4.35 Frequencies and percentages of groups 1 and 2, collected from the categorical data at treatment 1.

TREATMENT 1				
	GROUP 1		GROUP 2	
	FREQUENCY	%	FREQUENCY	%
ANT 1	3	20.0	5	33.3
ANT 2	12	80.0	10	66.7
FIXSELF 1	2	13.3	4	26.7
FIXSELF 2	0	0.0	2	13.3
FIXSELF 3	13	86.7	9	60.0
FIXSELF 4	0	0.0	0	0.0
FIXDOC 1	3	20.0	3	20.0
FIXDOC 2	4	26.7	2	13.3
FIXDOC 3	8	53.3	10	66.7
FIXDOC 4	0	0.0	0	0.0

Table 4.36 Frequencies and percentages of groups 1 and 2, collected from the categorical data at treatment 6.

TREATMENT 6				
	GROUP 1		GROUP 2	
	FREQUENCY	%	FREQUENCY	%
ANT 1	0	0.0	0	0.0
ANT 2	15	100.0	15	100.0

Table 4.37 Frequencies and percentages of groups 1 and 2, collected from the categorical data at the one month follow-up.

ONE MONTH F/U				
	GROUP 1		GROUP 2	
	FREQUENCY	%	FREQUENCY	%
ANT 1	0	0.0	0	0.0
ANT 2	15	100.0	15	100.0
FIXSELF 1	3	20.00	4	26.7
FIXSELF 2	2	13.3	3	20.0
FIXSELF 3	0	0.0	8	53.3
FIXSELF 4	10	66.7	0	0.0
FIXDOC 1	3	20.0	5	33.3
FIXDOC 2	0	0.0	6	40.0
FIXDOC 3	2	13.3	4	26.7
FIXDOC 4	10	66.7	0	0.0

Fig. 4.1 Comparison with respect to the NRS-101 Rating Scale for both groups.

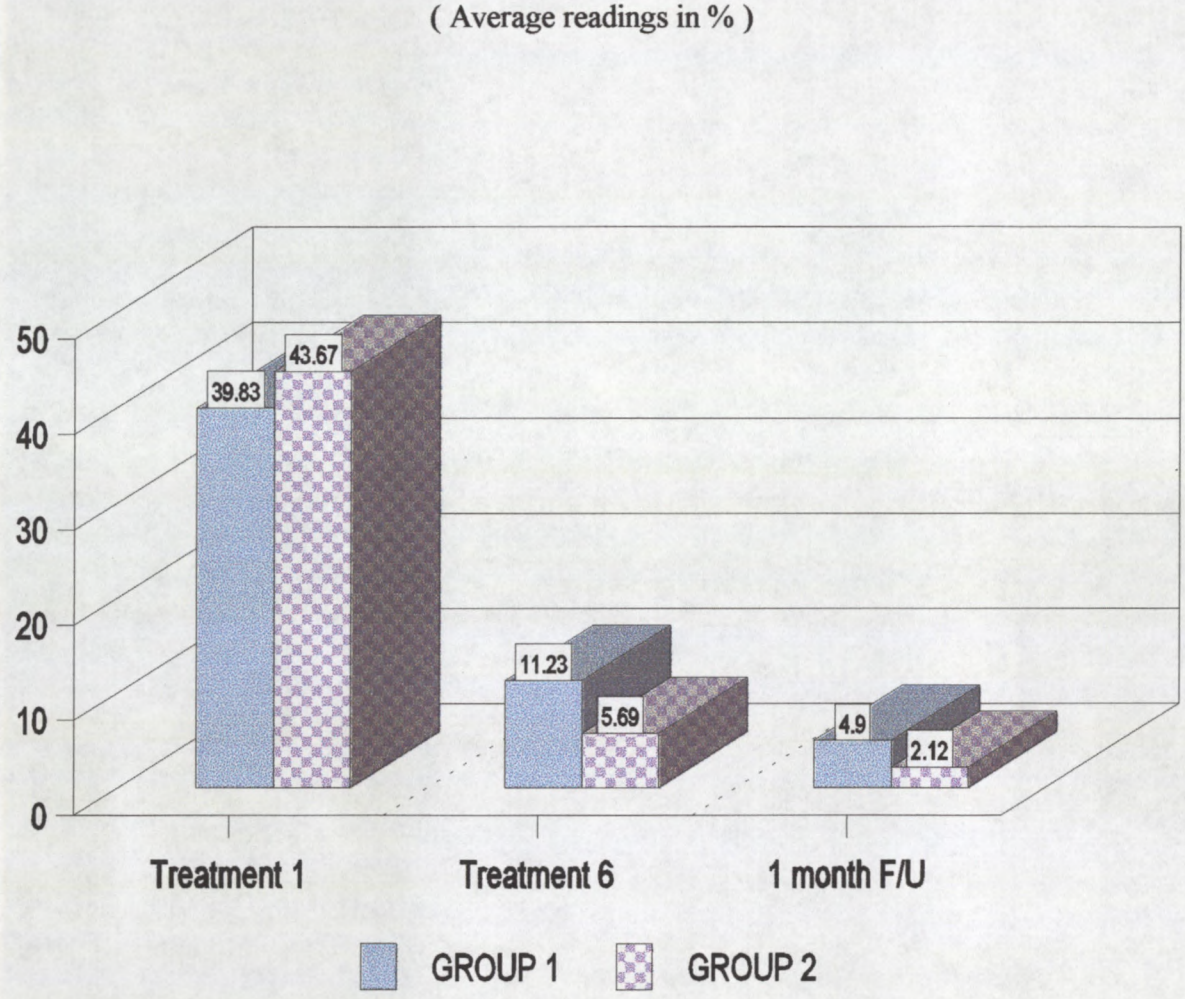


Fig. 4.2 Comparison with respect to the Short-Form McGill Pain Questionnaire for both groups.

(Average readings in a ratio between 0 and 1)

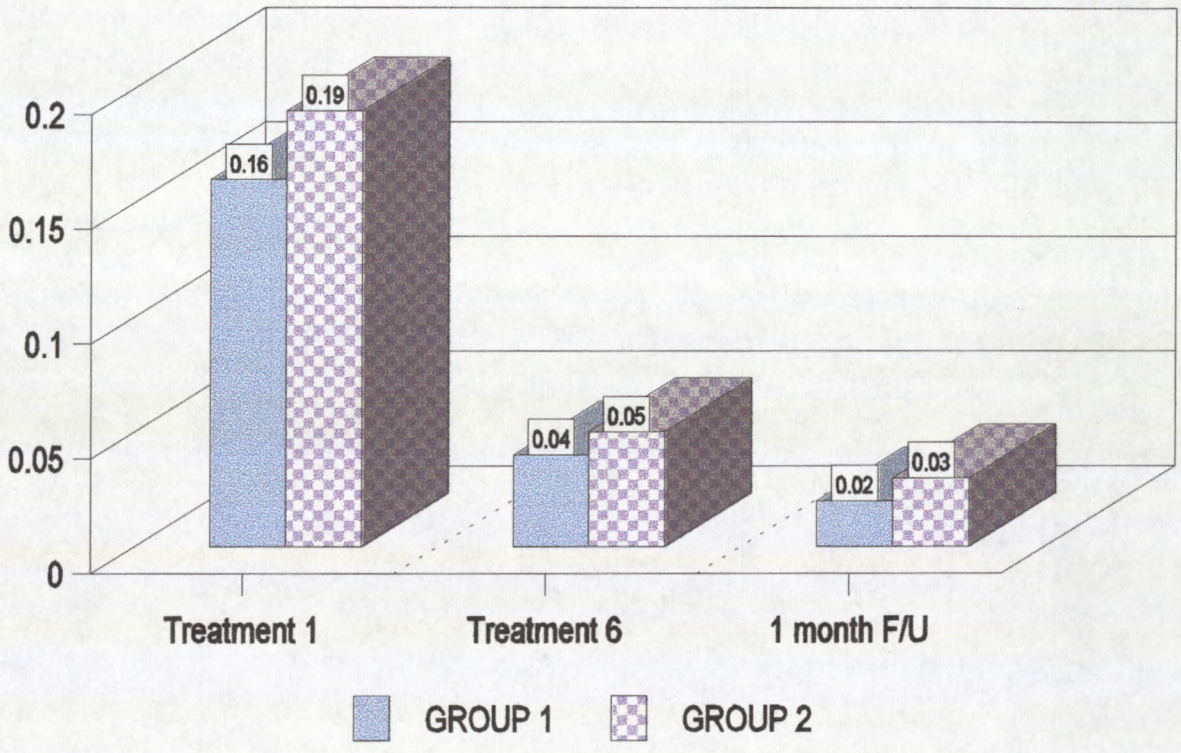


Fig. 4.3 Comparison with respect to the patients' athletibility (percentage limitation) for both groups.

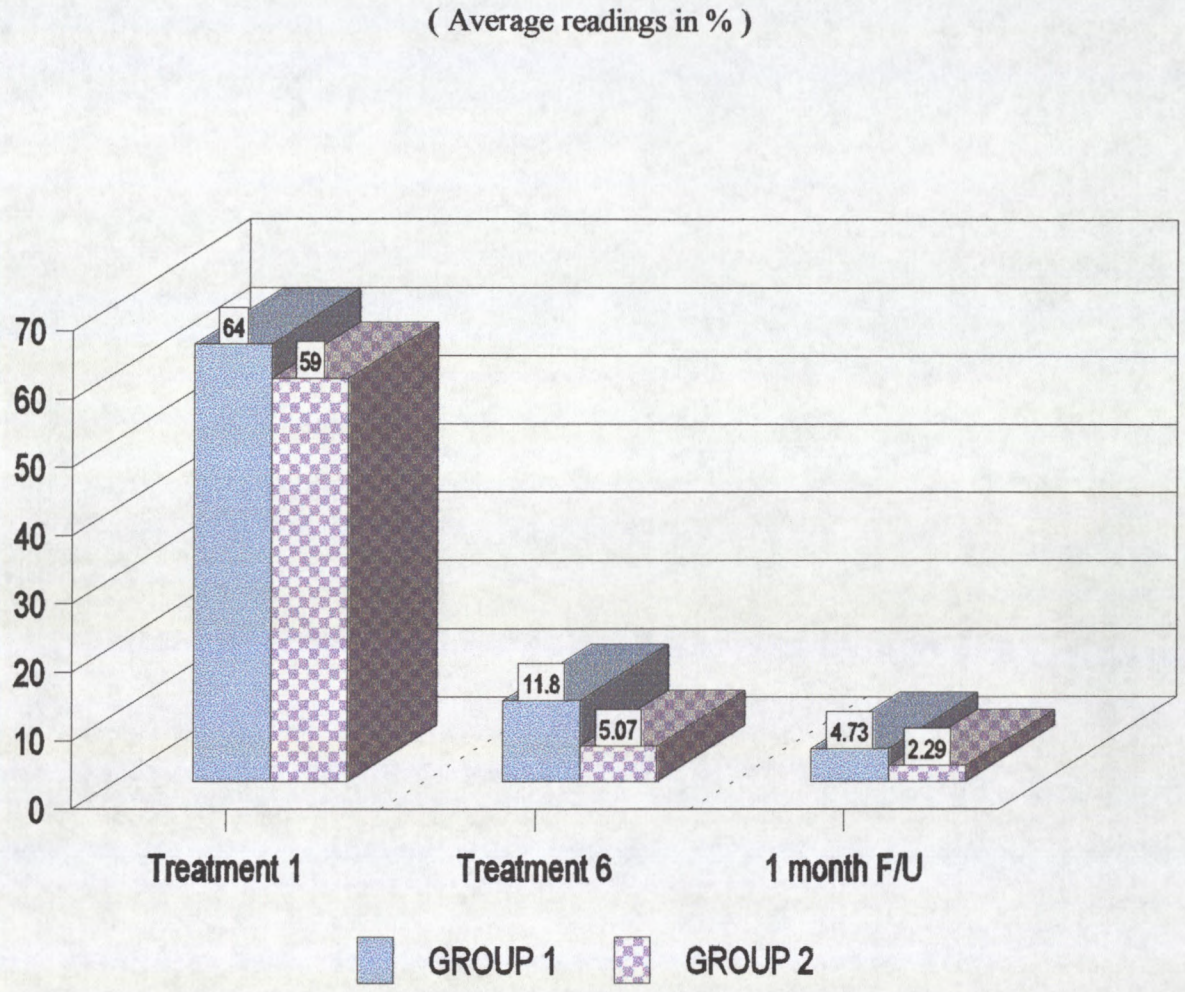


Fig. 4.4 Comparison with respect to Algometer readings for both groups.

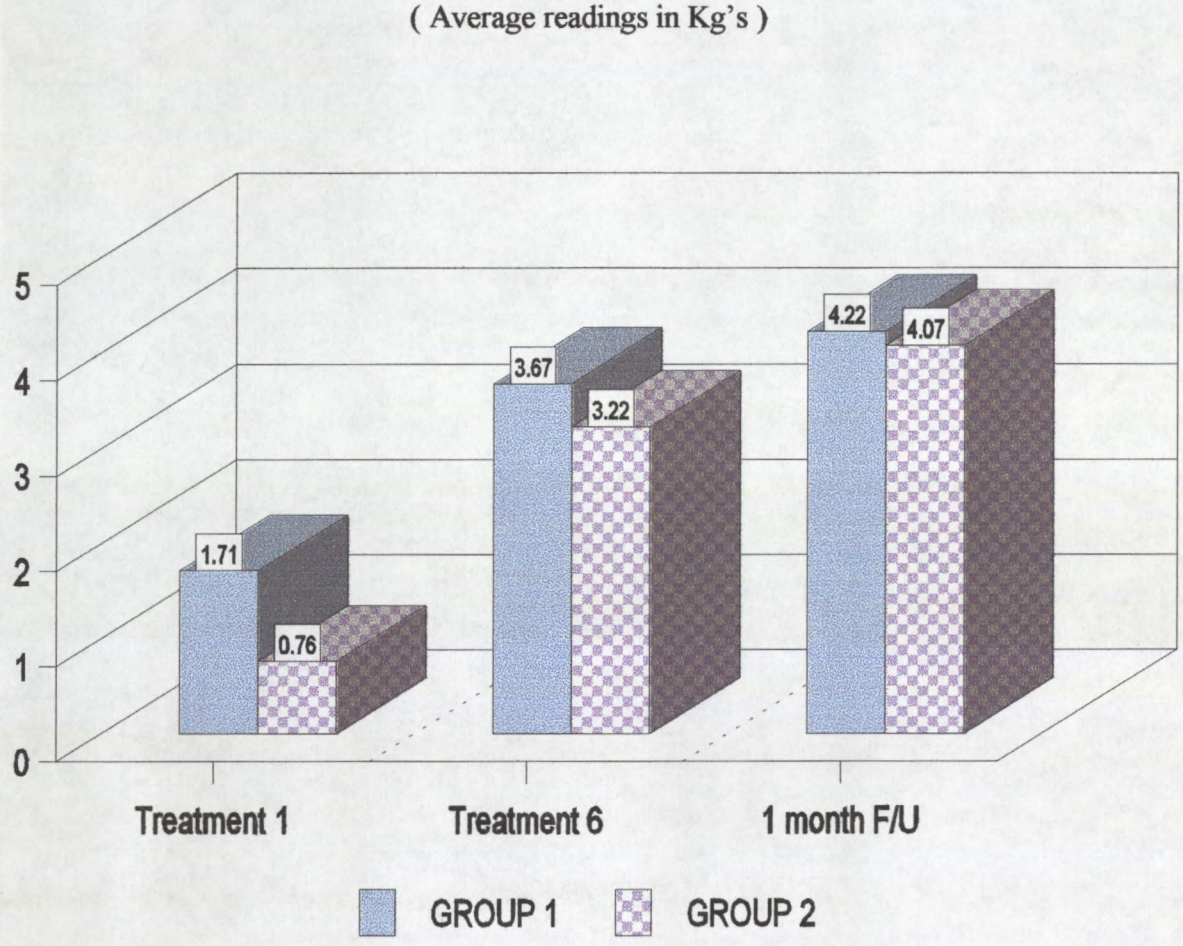


Fig. 4.5 Comparison with respect to Goniometer readings for both groups.

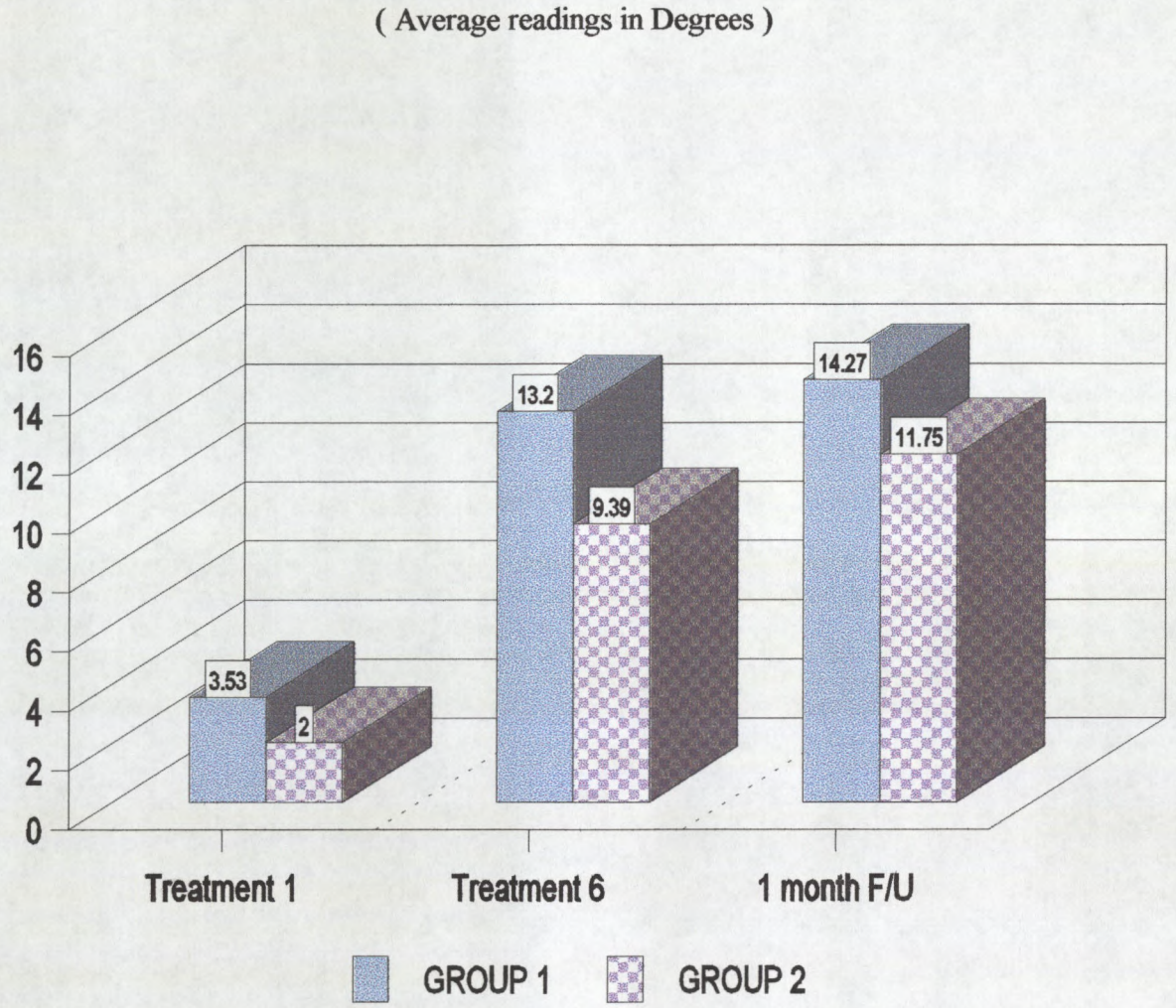
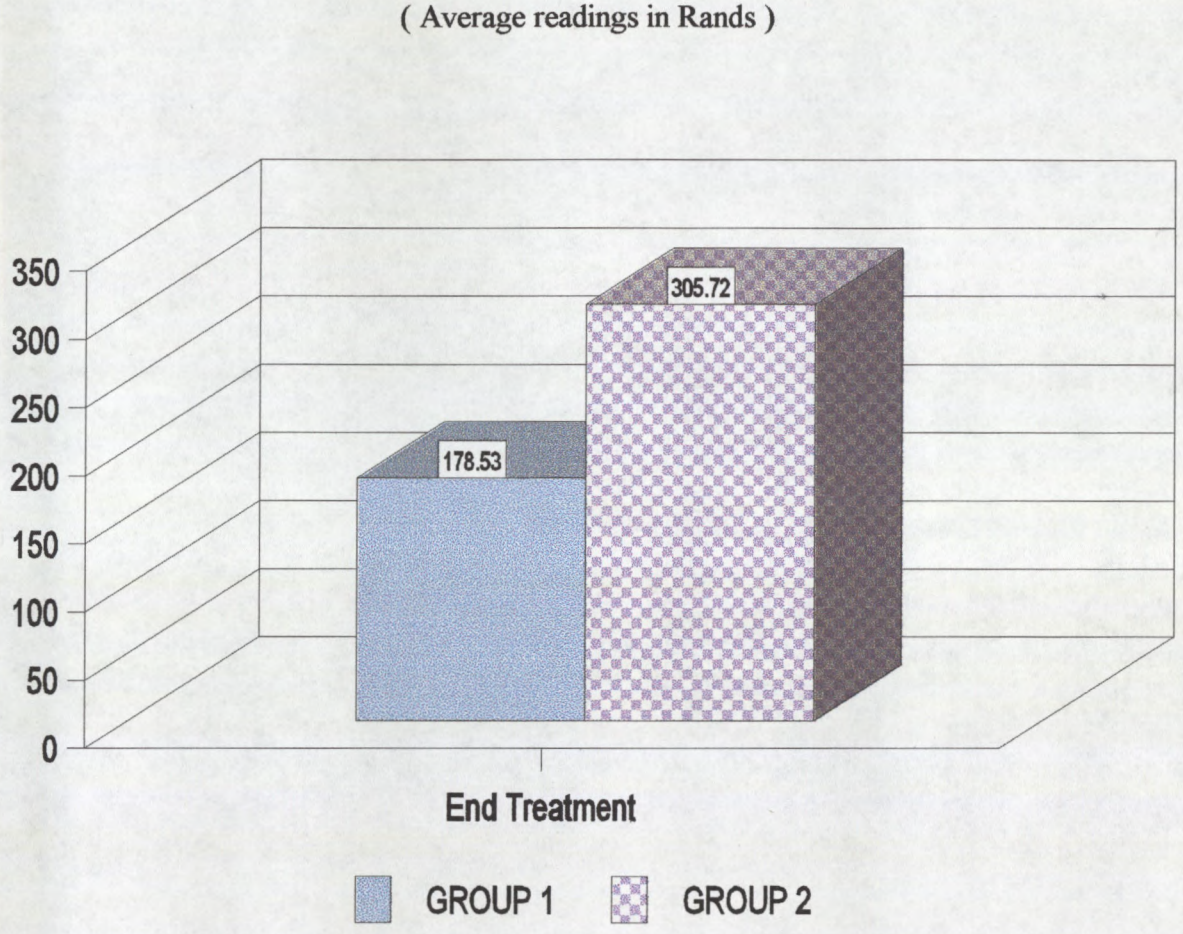


Fig. 4.6 Comparison with respect to Total Costs for both groups.



1 US $ = 6.15 Rand (30th July 1999)

Average cost of treatment for group 1 = 29.03 US $

Average cost of treatment for group 2 = 49.71 US $

CHAPTER FIVE

5.0 DISCUSSION OF RESULTS

5.1 INTRODUCTION

This chapter will discuss the results obtained from the subjective and objective data.

The analysis of the subjective and objective intra-group results of treatments 1 and 6 represent the efficacy of each treatment protocol in the short term. Evaluation of the results at the one month follow-up gives an indication as to the benefits of the two treatment protocols at the end of treatment (long term benefits).

Evaluation of the inter-group data at treatment one indicates any differences in objective and subjective findings between the two treatment groups in terms of their original presenting signs and symptoms. Inter-group comparison at treatment 6 shows which of the two treatment protocols is the more effective one. Assessment of the results obtained at the one month follow-up indicates the long term benefits of each treatment regime, as well as determining which of the two treatment protocols were the more effective one in the long term.

5.2 INTRA-GROUP COMPARISON

5.2.1 CATEGORICAL VARIABLES

5.2.1.1. Subjective Data

5.2.1.1.1 The Anterior Drawer Test (Appendix K)

Intra-group comparison of the anterior drawer test revealed no statistically significant improvement between treatments 1 and 6 (Table 4.7), treatment 6 and the one month follow-up (Table 4.9), and treatment 1 and the one month follow-up (Table 4.8) for group 1. A comparison made within group 2 of the anterior drawer test revealed no statistically significant improvement between treatment 6 and the one month follow-up (Table 4.18), however, there was a significant improvement between treatments 1 and 6 (Table 4.16), and treatment 1 and the one month follow-up (Table 4.17). This indicates that ligament healing has taken place, and stability of the ankle joint has improved.

From the above results, it would appear in terms of improvement, that treatment group 2 experienced a significant improvement in the anterior drawer test over the initial two week treatment period, however, there was no significant improvement after the initial two week period. Group 1 demonstrated no significant improvement over the entire treatment period with regards to the anterior drawer test. This may be so due to the fact that only a small

percentage of patients in both groups, but especially in group 1, presented initially with a positive anterior drawer test and, therefore, only a small percentage of patients could possibly have shown an improvement in the anterior drawer test during the treatment period.

5.2.1.1.2. Fixations Found By The Researcher (Appendix D)

Statistically, both groups 1 and 2 revealed no significant improvement between treatment 1 and the one month follow-up with regards to the fixations found by the researcher (Tables 4.8 and 4.17). According to the researcher, fixations found initially in both treatment groups were still present at the end of the treatment period.

5.2.1.1.3. Fixations Found By The Clinician (Appendix D)

Group 1 revealed no significant improvement between treatment 1 and the one month follow-up with regards to the fixations found by the clinician (Table 4.8). This indicates that, for group 1, fixations found initially were still present at the one month follow-up. Group 2, however, showed a statistically significant change in the fixations found by the researcher between treatment 1 and the one month follow-up (Table 4.17). This does not, however, necessarily indicate that group 2 had fewer fixations at the one month follow-up consultation than initially, but merely indicates that the fixations found initially were different to those found at the one month follow-up consultation.

5.2.2. CONTINUOUS VARIABLES

5.2.2.1. Subjective Data

5.2.2.1.1. The Numerical Rating Scale-101 Questionnaire (Appendix G)

Comparison between treatments 1 and 6 (Tables 4.10 and 4.19, Fig. 4.1), and treatment 1 and the one month follow-up (Tables 4.11 and 4.20, Fig. 4.1) revealed a statistically significant improvement for both treatment groups. No significant improvement between treatment 6 and the one month follow-up was noted for group 1 (Table 4.12, Fig. 4.1). Group 2, however, did show a significant improvement between treatment 6 and the one month follow-up (Table 4.21, Fig. 4.1).

From the above results it would appear, in terms of improvement, that both groups experienced a significant reduction in pain during the initial two week treatment period. Group 2, however, continued to improve after treatment 6 while group 1 did not improve further.

5.2.2.1.2. The Short-Form McGill Pain Questionnaire (Appendix G)

Comparison between treatments 1 and 6 (Tables 4.10 and 4.19, Fig. 4.2), and treatment 1 and the one month follow-up (Tables 4.11 and 4.20, Fig. 4.2) revealed a statistically significant improvement for treatment groups 1 and 2. No significant improvement between treatment 6 and the one month follow-up was noted for group 1 (Table 4.12, Fig. 4.2). Group 2, however, did show a significant improvement between treatment 6 and the one month follow-up (Table 4.21, Fig. 4.2).

From the above results it would appear that both groups experienced a significant reduction in pain during the initial two week treatment period. Group 2, however, continued to improve after the initial treatment period while group 1 did not improve further.

5.2.2.1.3. Athletibility (Percentage Limitation) (Appendix I)

In terms of the percentage limitation experienced by the patients in both treatment groups, there was a significant improvement between treatments 1 and 6 (Tables 4.10 and 4.19, Fig. 4.3), and treatment 1 and the one month follow-up (Tables 4.11 and 4.20, Fig. 4.3).No statistically significant improvement was noted, in both treatment groups, between treatment 6 and the one month follow-up (Tables 4.12 and 4.21, Fig. 4.3).

This indicates that both treatment regimes were effective in improving the patients athletic ability during the initial two week treatment period, although further improvement did not occur between treatment 6 and the one month follow-up.

5.2.2.2. Objective Data

5.2.2.2.1. Algometer Readings (Appendix J)

Statistical analysis disclosed a significant improvement in algometer readings between treatments 1 and 6 (Tables 4.13 and 4.22, Fig. 4.4), and treatment 1 and the one month follow-up (Tables 4.14 and 4.23, Fig. 4.4) for both treatment groups. No significant improvement was noted between treatment 6 and the one month follow-up for group 1 (Table 4.15, Fig. 4.4). Group 2, however, revealed a significant improvement between treatment 6 and the one month follow-up in terms of algometer readings (Table 4.24, Fig 4.4).

These results indicate that both treatment protocols were effective in improving algometer readings during the initial two week treatment period. Group 1 did not show further improvement following treatment 6, although group 2 improved following the initial two week treatment period.

5.2.2.2.2. Goniometer Readings (Appendix J)

Statistical analysis of data obtained, with regards to goniometer readings, disclosed a significant improvement between treatments 1 and 6 (Tables 4.13 and 4.22, Fig.4.5), and treatment 1 and the one month follow-up (Tables 4.14 and 4.23, Fig. 4.5) for both groups. No statistically significant improvement was noted, for groups 1 and 2, between treatment 6 and the one month follow-up (Tables 4.15 and 4.24, Fig. 4.5).

Both treatment protocols were proven to be effective in improving goniometer readings during the initial two week treatment period, but no significant improvement was noted between treatment 6 and the one month follow-up in both groups.

5.3. INTER-GROUP COMPARISON

5.3.1. CATEGORICAL VARIABLES

5.3.1.1. Objective Data

5.3.1.1.1. The Anterior Drawer Test (Appendix K)

A comparison of the data obtained, with regards to the anterior drawer test, showed no statistically significant difference between treatment 1 (Table 4.25), treatment 6 (Table 4.26), and the one month follow-up for both treatment groups. This suggests that there was no difference between the two treatment groups initially, and throughout the treatment period, with regards to the anterior drawer test.

The anterior drawer test was positive in only 20% of patients in group 1, and 33.3% of patients in group 2 at treatment 1 (Table 4.35). At treatment 6 (Table 4.36), and the one month follow-up

(Table 4.37) patients in both groups all had a negative anterior drawer test.

5.3.1.1.2. Fixations Found By The Researcher (Appendix D)

Inter-group comparison of the statistical data obtained at both the 1st treatment (Table 4.25) and the one month follow-up (Table 4.27) displayed no significant difference between the two treatment groups in terms of the fixations found by the researcher.

The lack of significant difference, in terms of fixations found by the researcher, suggests that similar fixations were found in both groups initially, and at the end of the treatment period. The two treatment regimes were, thus, equally effective in removing fixations found initially in the talocrural and subtalar joints during the treatment period. Whether these fixations returned or not, during the treatment period, was not established.

According to the researcher, at treatment 1, patients in group 1 presented predominantly with long axis and eversion fixations (loss of long axis and eversion accessory motion) together at the talocrural and subtalar joints, followed by pure long axis fixations of either the talocrural and / or subtalar joints (Table 4.35). Patients in group 2 also presented predominantly with long axis and eversion fixations, followed by pure long axis, and then pure eversion fixations (Table 4.35). At the one month follow-up, patients in group 1 presented predominantly with no fixations of the talocrural and subtalar joints, followed by fixations found in long axis, and then fixations found in eversion. No fixations were found in long axis as well as eversion (Table 4.37). Patients in group 2 presented predominantly with fixations in both long axis and eversion, followed by pure long axis, and then pure eversion. No patients were found to

be free of fixations (Table 4.37). This indicates that more patients were free of fixations by the end of the treatment period in group 1 than in group 2.

5.3.1.1.3. Fixations Found By The Clinician (Appendix D)

No statistically significant difference was noted between groups 1 and 2, with regards to the fixations found by the clinician, at treatment 1 (Table 4.25). Analysis of the data obtained at the one month follow-up showed a significant difference between treatment groups 1 and 2 (Table 4.27).

This suggests that the two treatment protocols were not equally effective in terms of fixations found by the clinician in the long term, although in the short term no difference in effectiveness was noted.

According to the clinician, at treatment 1, patients in group 1 presented predominantly with long axis and eversion fixations together, followed by pure eversion fixations of the subtalar joint, and then pure long axis fixations of the talocrural and / or subtalar joints (Table 4.35). Patients in group 2 presented initially with predominantly long axis and eversion fixations together, followed by pure long axis fixations, and then pure eversion fixations. No patients in either group were found to be free of fixations at treatment 1(Table 4.35). At the one month follow-up patients in group 1 presented predominantly without fixations in either the

talocrural or subtalar joints. Fixations in pure long axis followed, in terms of frequency, and then fixations in long axis as well as eversion (Table 4.37). Patients in group 2 presented predominantly with fixations in pure eversion, followed by pure long axis fixations, and then long axis in conjunction with eversion fixations (Table 4.37). None of the patients were fixation free at the end of the treatment period in group 2 (Table 4.37).

From the above information group 1 improved, in terms of fixations cleared, more than group 2 did, in that at the one month follow-up a high percentage of patients in group 1 (66.7%) were fixation free, while no patients (0%) were found to be free of fixations in group 2.

As different clinicians were used to assess patients at treatment 1 and at the one month follow-up, no intra-examiner reliability tests could be performed. A variety of clinicians were used in assessing patients due to the lack of availability of a single clinician. This did not allow for inter-examiner reliability tests to be performed, as motion palpation procedures may have varied amongst the clinicians.

5.3.2. CONTINUOUS VARIABLES

5.3.2.1. Subjective Data

5.3.2.1.1. Numerical Rating Scale-101 Questionnaire (Appendix G)

Statistical comparison between groups 1 and 2 at treatment 1 (Table 4.28, Fig. 4.1), treatment 6 (Table 4.29, Fig. 4.1), and the one month follow-up (Table 4.29, Fig. 4.1) bore no significant difference in the degree of pain intensity, suggesting a similarity in the nature of pain intensity initially, and throughout the treatment period, in both treatment groups. A similarity in the efficacy of the two treatment regimes in both the short and long term is also indicated.

5.3.2.1.2. The Short-Form McGill Pain Questionnaire (Appendix H)

Over the duration of the treatment period, no statistically significant difference was noted between the two treatment groups for the short-form McGill pain questionnaire (Tables 4.28, 4.29, and 4.30, Fig. 4.2). This suggests that the two treatment protocols were equally effective in both the short and long term, and that the intensity of the pain perceived by patients in both treatment groups was equal initially, and throughout the treatment period.

5.3.2.1.3. Athletibility (Percentage Limitation) (Appendix I)

A comparison of the data obtained in terms of the percentage limitation experienced by the patients at treatment 1 (Table 4.28, Fig 4.3), treatment 6 (Table 4.29, Fig. 4.3), and the one month follow-up (Table 4.30, Fig. 4.3) in both treatment groups was found to be statistically insignificant. This indicates that both groups presented initially with a similar percentage limitation, and that both treatment regimes were equally effective in the short as well as the long term in decreasing the patients percentage limitation following injury.

5.3.2.2. Objective Data

5.3.2.2.1. Algometer Readings (Appendix J)

No statistically significant difference was evident between groups 1 and 2 in terms of algometer readings obtained at treatment 1 (Table 4.31, Fig.4.4), treatment 6 (Table 4.32, Fig. 4.4), and the one month follow-up (Table 4.33, Fig. 4.4). This suggests that both treatment groups displayed similar pressure readings (algometer readings) initially, and throughout the treatment period. An equal efficacy of the two treatment regimes is also indicated, in terms of algometer readings, in both the short and long term.

5.3.2.2.2. Goniometer Readings (Appendix J)

At treatment 1 (Table 4.31, Fig. 4.5) and the one month follow-up (Table 4.33, Fig 4.5) no statistically significant difference was noted between the two treatment groups for ankle dorsiflexion (goniometer readings). This suggests that both treatment approaches were equally effective in increasing ankle dorsiflexion in the long term.

A statistically significant difference was evident between groups 1 and 2, for ankle dorsiflexion, at treatment 6 (Table 4.32, Fig 4.5). This indicates that the two treatment groups were not equally effective in increasing ankle dorsiflexion in the short term. Treatment 1 was shown to be more effective than treatment two, at the 95% level of confidence, in increasing ankle dorsiflexion in the short term.

5.3.2.2.3. Total Cost

The total treatment costs incurred, for groups 1 and 2 (Table 4.34, Fig.4.6), demonstrated a statistically significant difference at the end of the treatment period. This suggests that the two treatment groups were not equally cost effective in this study. Treatment protocol 1 was found to be more cost effective than treatment protocol 2.

5.4 DISCUSSION

The first objective stated that both piroxicam and manipulation would be effective in the management of acute grades 1 and 2 inversion ankle sprains in terms of subjective clinical findings. As demonstrated by the results of the subjective data, both treatment protocols were found to be effective.

The second objective stated that piroxicam and manipulation would be effective in the management of acute grades 1 and 2 inversion ankle sprains in terms of objective clinical findings. This was found to be true for algometer readings (Appendix J), goniometer readings (Appendix J), and athletibility of the patient (Appendix I). This hypothesis is also true for the fixations found by the clinician for group 2 (Appendix D), but is not true for the fixations found by the clinician for group 1 (Appendix D), fixations found by the researcher for both treatment groups (Appendix D), and the anterior drawer test for both treatment groups (Appendix K).

The third objective was to integrate the results of objective one and two in order to determine which of the two treatments was more effective in terms of subjective and objective clinical findings. No difference between the two treatment protocols was found for the anterior drawer test (Appendix K), the fixations found by the researcher (Appendix D), the Numerical Rating Scale-101 questionnaire (Appendix G), the Short-Form McGill Pain Questionnaire (Appendix H), the patients athletibility (Appendix I), and algometer readings (Appendix J). Significant

difference between the two treatment groups was noted for the fixations found by the clinician (Appendix D) in the long term, although no difference was noted, for the aforementioned fixations, in the short term. Significant differences between the two treatment groups was noted for goniometer readings (Appendix J) in the short term, although no difference was shown in the long term.

The fourth objective was to evaluate the relative direct costs of each intervention in a comparative analysis to determine which of the two treatments was more cost-effective in the management of acute grades 1 and 2 inversion ankle sprains. This included the cost of medical consultations, medication, chiropractic consultations, and elastic crepe bandages. In terms of the costs involved in treating each of the two treatment groups in this study, treatment protocol 1 was found to be more cost effective than treatment protocol 2.

5.5. LIMITATIONS OF THE STUDY

Inaccuracy of the subjective questionnaires, as well as lack of understanding of the questionnaires, may have biased the result. Athletibility results may have been biased as this index has not been tested using large patient numbers and subjected to further scrutiny, and due to patients trying to please the researcher with favourable results. This test may or may not be deemed a valid and reliable method of assessing the actual limitation of a patient.

Objective measurements, in the form of algometer readings, goniometer readings, motion palpation findings (fixations found by the researcher and the clinician), the anterior drawer test, and Rombergs test for proprioception may have been subject to observer error and bias. Subtle changes may not have been observed by the researcher, and as different clinicians were used throughout the study for motion palpation, this data may be subject to human error as well as lack of inter-examiner (clinician) reliability. Motion palpation was also only performed at the initial consultation and at the one month follow-up which ignored changes occuring within the treatment period.

There may be a need to attempt to standardize motion palpation techniques, as this may have varied amongst the clinicians in this study.

The sample size of this study was very small, thus increasing the possibility of accepting a false null hypothesis (Type II error).

There was also an unequal amount of grades 1 and 2 inversion ankle sprains in each of the two treatment groups which could have biased the results of the study.

Acute ankle sprains have a natural tendency to improve following injury. As no control group was included in this study for comparison with the two treatment groups, it cannot be determined if the improvement of the patients in both groups, initially, was due to the natural history of the condition, or due to the treatments administered.

5.6 COMPARISON OF THE RESULTS WITH OTHER RESEARCH

Wilson et al. (1998), assessed 13 collegiate athletes with acute ankle sprains while they were undergoing sports rehabilitation. Dorsiflexion, among other tests, was used to determine impairment, and self-perceived athletic ability (or lack thereof) as well as motor ability scores were used to indicate functional limitations. Four subjects (31%) demonstrated range of motion changes (dorsiflexion at the ankle) greater than those expected due to chance. Six subjects (46%) demonstrated changes greater than those expected due to chance in self-perceived athletibility.

The study performed by Wilson et al. (1998), cannot be directly compared with this study as subject sample sizes were different, the subjects in the study by Wilson et al. (1998) were not treated with manipulation or piroxicam, and reliable change due to chance was not calculated

in this study. The fact that the specifics of the sports rehabilitation received by the patients in the study by Wilson et al. (1998), was not clearly outlined also makes for difficult comparison to other treatment protocols. Both studies did, however, demonstrate subjective and objective improvement with regards to dorsiflexion at the ankle, and self-perceived athletibility.

In a controlled, prospective study of 20 asymptomatic subjects Nield et al. (1993), it was found that a single manipulation of the talocrural joint did not increase dorsiflexion of the ankle. Direct comparison between this study and the study by Nield et al. (1993), cannot be made as Nield et al. (1993) only used a single manipulation of the talocrural joint, and there was no long term follow-up. Nield et al. (1993), conducted their study on asymptomatic patients whereas this study was conducted on symptomatic patients over a period of one month. Numerous treatments were also performed in this study, incorporating the subtalar joint into the treatment regime along with the talocrural joint.

In a randomized, placebo-controlled clinical trial of piroxicam in the management of acute ankle sprains performed by Slatyer et al. (1997), three hundred and sixty four Australian Regular Army recruits with acute ankle sprains were treated. Compared with the placebo group, those patients treated with piroxicam had less pain, resumed training more rapidly, and were treated at a lower cost.

The cost analysis in the study by Slatyer et al. (1997), was calculated using the dollar cost per training day saved. The cost analysis in this study used the mean of the total cost incurred in treating patients in both treatment groups, therefore, comparison in terms of cost cannot be made between this study and the study by Slatyer et al. (1997).

In the study performed by Slatyer et al. (1997), patients in the piroxicam group had less limitation of range of motion (dorsiflexion of the ankle) than the placebo group. Patients in this study also improved with regards to pain, limitation of athletic ability, and dorsiflexion of the ankle, although direct correlation with the study performed by Slatyer et al. (1997) cannot be easily done as subject samples were different, and no long term follow-up was performed on the patients in the study by Slatyer et al. (1997). The number of patients presenting with a positive anterior drawer test initially, and throughout treatment, were different in the aforementioned studies making correlation of data difficult.

CHAPTER SIX

6.0. CONCLUSIONS AND RECOMMENDATIONS

6.1. CONCLUSIONS

This study was performed using 30 patients, all of whom were diagnosed with an acute, inversion, grade 1 or 2 ankle sprain after undergoing an extensive case history, physical, and orthopaedic examination. Participants were randomly allocated into two treatment groups of 15 patients each. Patients in group 1 received manipulation, while patients in group 2 had piroxicam prescribed to them. Both groups were required to be present at the Technikon Natal Chiropractic Day Clinic for six sessions over a two week period, and were required to return for a follow-up one month following injury.

From the results it can be seen that both groups demonstrated a significant improvement in terms of functional disability, range of motion at the ankle (dorsiflexion), and pain intensity, indicating that both treatment protocols were effective in the treatment of acute, grades 1 and 2, inversion ankle sprains.

With regards to the anterior drawer test, group 2 revealed a short term improvement, while group 1 did not improve over the initial two week treatment period.. This may be so due to the fact that only a small percentage of patients in both groups, but especially in group 1,

presented initially with a positive anterior drawer test and, therefore, only a small percentage of patients could possibly have shown an improvement in the anterior drawer test during the treatment period. At the end of the treatment period, all patients in both treatment groups demonstrated a negative anterior drawer test.

In terms of the Numerical Rating Scale-101 Questionnaire and the Short-form McGill Pain Questionnaire, there was no significant difference in the degree of pain intensity, suggesting a similarity in the nature of pain intensity initially, and throughout the treatment period, in both treatment groups. Both groups experienced a significant reduction in pain initially, although group 2 continued to improve after treatment 6, while treatment group 1 did not improve any further. This difference between groups 1 and 2, however, is not statistically significant and, therefore, a similarity in the efficacy of the two treatment regimes in both the short and long term is indicated.

Athletibility (percentage limitation) and goniometer readings improved, in both treatment groups, initially. No further improvement was noted after the initial two week treatment period in both treatment groups. The efficacy of the two treatment regimes can, thus, be said to be equal in terms of athletibility and goniometer readings.

With regards to algometer readings (pressure-pain readings), there was no significant difference between treatment groups 1 and 2. Both groups experienced a significant improvement in algometer readings initially, although group 2 continued to improve after

treatment 6, while treatment group 1 did not improve any further. This difference between groups 1 and 2, however, is not statistically significant and, therefore, a similarity in the efficacy of the two treatment regimes in both the short and long term is indicated with regards to algometer readings.

In terms of fixations found by the researcher, more patients were found to be fixation free in treatment group1 than in treatment group 2 at the end of the treatment period, even though both groups had similar fixations initially.

In the short term no difference in effectiveness of the two treatment regimes was noted with regards to the fixations found by the clinician. In the long term, however, a difference between the two treatment groups was evident. At the end of the treatment period, group 1 presented predominantly without fixations of the talocrural and subtalar joints, while in group 2 no patients were found to be fixation free.

The total treatment costs incurred, for groups 1 and 2, demonstrated a statistically significant difference at the end of the treatment period. This suggests that the two treatment groups were not equally cost effective in this study. Treatment protocol 1 was found to be more cost effective than treatment protocol 2.

6.2. RECOMMENDATIONS

Due to the small sample size used in this study, the results may not have a significant impact on the current knowledge with regards to the management of acute, grades 1 and 2 inversion ankle sprains. A larger sample size, therefore, should be used so as to make future studies more powerful.

In this study, only patients with acute ankle sprains were accepted. The acute ankle sprain has a natural history of improvement of between two and six weeks. As no control group was incorporated into this study, a comparison of the natural history and the two treatment protocols utilized in this study could not be made. Future studies should include a control group if acute ankle sprains are to be studied.

It may be advisable that, in the future, all measurements are taken three consecutive times, and the average (mean) reading used in order to improve the accuracy of the measurements and reduce researcher error.

In this study, fixations found by both the researcher and the clinician, were recorded initially and at the end of the treatment period. This method did not allow for the recording of re-occurring fixations during the treatment period. Subsequent studies should record the fixations found at each treatment for further analysis of the frequency of fixations found.

Numerous clinicians were asked to perform motion palpation, in order to determine whether fixations in the talocrural and subtalar joints were present or not. This may have caused a distortion of the results due to possible lack of inter-examiner standardization. In order to increase the accuracy of the data, future studies should use only one clinician to perform motion palpation of the aforementioned joints.

It is recommended that a longer follow-up period be used, so as to assess the long term benefits or lack of benefits, of the two treatment protocols. This would also assess the symptomatic progression or regression of the patients in the two treatment groups.

A more extensive controlled trial should also be done with regards to the self-perceived percentage limitation of activity so as to assess whether or not this is a true reflection of the patients actual limitation.

As most of the patients in this study were students from Technikon Natal, a true reflection of the population group may not have been used. Subsequent studies should take into account gender, age, race, occupation, and activities performed, in order to make the sample group more linear in distribution.

Further analysis of the costs involved in the management of acute ankle sprains by chiropractors, and prescribing doctors, should be performed.

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APPENDIX A

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 Lifestyle:

- Allergies
- Immunizations
- Screening Tests
- Environmental Hazards (home, school, work)
- Safety Measures (seat belts, condoms)
- Exercise and Leisure
- Sleep Patterns
- Diet
- Current Medication
- Tobacco
- Alcohol
- Social Drugs

7. Immediate Family Medical History:

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

8. Psychosocial History:

- Home Situation and Daily Life
- Important Experiences
- Religious Beliefs

9. Review of Systems:

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

APPENDIX B

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 and 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 the 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 and 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 pectoriloquay
  : Bronchophony
  : Egophony

5. ABDOMINAL EXAMINATION

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

Inspection
- Shape
- Scars
- Hernias

Palpation
- Superficial
- Deep = Organomegally

- Masses
- Aorta

Percussion - Rebound tenderness
- Ascites
- Masses

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

Rectal Examination - Peri-anal skin
- Sphincter tone and 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 the 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 the eye

V
a. Sensory
- Opthalmic
- Maxillary
- Mandibular

b. Motor
- Masseter
- Jaw lateral movement

c. Reflexes
- Corneal
- 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 2/3 of tongue

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

Otoscope examination

IX Gag reflex

X Uvula deviation
Speech quality

XI Shoulder lift
S.C.M. strength

XII Inspection of tongue (deviation)

Motor system:

a.	Power:	Shoulder	- Abduction and adduction
			- Flexion and extension
		Elbow	- Flexion and extension
		Wrist	- Flexion and extension
		Forearm	- Supination and pronation
		Fingers	- Extension (interphalangeals and M.C.P's)
		Thumb	- Opposition
		Hip	- Flexion and extension
			- Adduction and abduction
		Knee	- Flexion and extension
		Foot	- Dorsiflexion and plantar flexion
			- Inversion and eversion
			- Toe (plantar flexion and dorsiflexion)

b.	Tone:	Shoulder
		Elbow
		Wrist
		Lower limb (int and 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

Obvious abnormalities
Spinous percussion
R.O.M.
Other

9. BREAST EXAMINATION

Summon a 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 C

FOOT AND ANKLE REGIONAL

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 Plantarflexion:	40°(mtp)
	Big toe dorsiflexion(mtp) (65-70°):
	Big toe plantar flexion (mtp) (45°0:
	Toe abduction and adduction:
	5° first ray dorsiflexion:
	5° first ray plantar flexion:

Resisted Isometric Movements
Knee flexion:
Plantar flexion:
Dorsiflexion:
Supination (inversion):
Pronation (eversion):
Toe Extension (dorsiflextion):
Toe Flexion (plantar flexion):

Passive Movement Motion Palpation (Passive ROM quality, ROM overpressure, joint play)

Ankle Joint:	Plantar flexion	Dorsiflexion .....
Talocrural:	Long axis distraction	
Subtalar Joint:	Varus	Valgus .....
First Ray:	Dorsiflexion	Plantar Flexion .....

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 and midtarsal neutral):
First Ray Alignment:
Digital Deformities:
Digital Deformity Flexible:

Palpation

<u>Anteriorly:</u>
Medial Maleoli:
Med Tarsal Bones, tibial (post) artery:
Lat. Malleolus, calcaneus, sinus tarsi, and cuboid bones:
Inferior tib/fib joint, tibia, mm of leg:
Anterior tibia, neck of talus, dorsalis pedis artery:

<u>Posteriorly:</u>
Calcaneus:
Achilles Tendon:
Musculotendinous Junction:

<u>Plantarily:</u>
Plantar muscles and Fascia:
Sesamoids:

APPENDIX D

FIXATIONS FOUND

DAY1:	Subtalar joint-	Long axis distraction Eversion
	Talocrural joint-	Long axis distraction
1 MONTH F/U:	Subtalar joint-	Long axis distraction Eversion
	Talocrural joint-	Long axis distraction

ADJUSTMENTS USED: Gapping thrust
Long axis distraction
Eversion of STJ

APPENDIX E

PATIENT INFORMED CONSENT FORM

I the undersigned, ..., have been explained the nature of this research project involving the treatment of acute grades 1 and 2 inversion ankle sprains and therefore give my informed consent to be examined, treated and x-rayed at the Technikon Natal Chiropractic Day Clinic. I agree to comply with the instructions stipulated by the resident in order for the successful completion of this research project.

Signature: ..... Date: .....

APPENDIX F

Dear Participant

The aim of this study is to compare the relative effectiveness and cost-effectiveness of two treatment therapies in the management of acute grades one and two inversion ankle sprains.

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

One group will receive manipulative treatment of the ankle, as well as ice therapy and the application of a compression bandage. Stiffness in the ankle joints after injury often delays recovery. Manipulation of the ankle joints restores motion in the joints and allows for greater pain-free movement.

The second group of patients will receive a one week supply of piroxicam tablets, as well as ice therapy and the application of a compression bandage. Piroxicam is an anti-inflammatory drug which helps to control inflammation and pain. This drug may, however, produce side-effects in some patients such as gastric irritation and bleeding, as well as instability in the ankle joint.

Both groups will have x-rays taken of their injured ankles in order to rule out fractures in the area. Patients found to have sustained a fracture to the ankle as demonstrated on the ankle x-rays will be excluded from the study. Patients who have had previous serious ankle injuries, chronic instability of the injured ankle, a history of adverse reactions to anti-inflammatory drugs, peptic ulcers or gastrointestinal bleeding will be excluded from the study. Patients taking any prescription medication, with the exception of the contraceptive pill, will also be excluded from the study.

Patients will be required to return for six follow-up consultations equally spread over two weeks, and an additional follow-up one month following the injury.

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

Thank you.

Yours faithfully
Denise Coetzer
(6th year Chiropractic Resident)

APPENDIX G

NUMERICAL RATING SCALE-101 QUESTIONNAIRE

Patient name: _____ File: _____ Date: _____

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 only write 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 only write number.

_____

APPENDIX H

SHORT-FORM McGILL PAIN QUESTIONNAIRE (SF-MPQ)

Ronald Melzack

Patients Name:_____ File #: _____ Date: _____

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

APPENDIX I

LIMITATION OF TRAINING

TRAINING: (POSSIBLE / POSSIBLE BUT HAMPERED / NOT POSSIBLE)

TREATMENT 1:

TREATMENT 2:

TREATMENT 3:

TREATMENT 4:

TREATMENT 5:

TREATMENT 6:

1 MONTH F/U :

NB: IF TRAINING IS HAMPERED, TO WHAT EXTENT (PERCENTAGE)

APPENDIX J

GONIOMETER AND ALGOMETER READINGS

DORSIFLEXION : (DEGREES)

TREATMENT 1:

TREATMENT 3:

TREATMENT 6:

1 MONTH F/U :

ALGOMETER : (KILOGRAMS)

TREATMENT 1:

TREATMENT 3:

TREATMENT 6:

1 MONTH F/U :

APPENDIX K

ANTERIOR DRAWER AND ROMBERG TEST

ANTERIOR DRAWER : (+VE / -VE)

TREATMENT 1:

TREATMENT 2:

TREATMENT 3:

TREATMENT 4:

TREATMENT 5:

TREATMENT 6:

1 MONTH F/U :

RHOMBERG'S TEST (SECS)

TREATMENT 1:

TREATMENT 2:

TREATMENT 3:

TREATMENT 4:

TREATMENT 5:

TREATMENT 6:

1 MONTH F/U :

APPENDIX L

FUNCTIONAL CLINICAL GRADING SYSTEM FOR ANKLE SPRAINS

GRADE	CLINICAL FINDINGS
1	Minimal pain and swelling Stable joint Full range of joint movement Pain-free walking
2	Moderate pain and swelling Stable joint or minimal anterior drawer Decreased range of movement Difficulty in weight-bearing and ambulation
3	Severe pain and swelling Unstable joint Minimal range of motion or inability to dorsiflex Inability to bear weight