

THE EFFICACY OF ADJUSTING FOOT AND ANKLE FIXATIONS IN THE
TREATMENT OF SUB-ACUTE AND CHRONIC ACHILLES TENDONITIS

BY

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A thesis presented to the faculty of health in partial compliance with the requirements for the
Masters Degree in Chiropractic.

I, Jason Gaymans do declare that this dissertation is a representation of my own work.

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ABSTRACT

Objectives

The purpose of this study was to investigate the efficacy of adjusting foot and ankle fixations compared to placebo in the treatment of sub-acute and chronic Achilles tendonitis. It is hypothesised that by adjusting those fixations in terms of the above would result in more of a significant improvement than placebo.

Summary of the background data

A search of the literature failed to reveal any studies on this topic.

Study design

A single blind, comparative, controlled study.

Methods

Forty subjects with sub-acute or chronic Achilles tendonitis were randomly divided into two different groups (Group 1 = 21 patients, Group 2 = 19). The ages ranged from 15 to 60 years. The first group received adjustments to any fixations present in the foot and ankle, whilst the second group received placebo (detuned ultrasound) only. Both groups received six interventions over a maximum period of four weeks.

Subjective measurements were the McGill Short Form Pain Questionnaire and the Numerical Pain Rating Scale-101, and the objective measurements included algometer

readings to assess pain threshold and goniometer readings to measure ankle dorsiflexion range of motion. All assessments were taken at the 1st, 2nd, 3rd, and final interventions.

Results

Significant improvements were detected *between* Group 1 and Group 2 in terms of percentage pain intensity between the 1st and 3rd and 1st and final visit.

Significant improvements were detected between Group 1 and Group 2 in terms of pain threshold between the 1st and 2nd, 1st and 3rd and 1st and final visit.

Significant improvements were detected between Group 1 and Group 2 in terms of pain experienced (quality and intensity), between the 1st and 3rd, and 1st and final visit.

Significant improvements were detected between Group 1 and Group 2 in terms of ankle dorsiflexion range of motion between the 1st and 3rd, 1st and final visit.

Statistical analysis *within* Group 1 showed significant improvements in pain experienced (quality and intensity) between the 1st and 2nd, 1st and 3rd, and 1st and final visits.

Significant improvements were noted in ankle dorsiflexion range of motion between the 1st and 2nd, 1st and 3rd, and 1st and final visits. Significant differences were observed in percentage pain intensity between the 1st and 2nd, 1st and 3rd, and 1st and final visits.

Significant increases in pain threshold were noted between the 1st and 2nd, 1st and 3rd, and 1st and final visits.

Statistical analysis within Group 2 showed no significant improvements in pain experienced (quality) between the 1st and final visits.

Significant improvements were noted in ankle dorsiflexion range of motion, percentage pain intensity and pain threshold was noted between the 1st and final visits only.

Conclusions:

Statistically highly significant differences were found in terms of all outcomes ($p = < 0.001$), some as early as after only one treatment. In the light of this, chiropractic adjustments should be included in any management program of sub-acute and chronic Achilles tendonitis.

TABLE OF CONTENTS

Acknowledgments	1
Abstract	2
Table of contents	5
List of tables	12
List of graphs	14
List of abbreviations	14
Definition of terms	15

Chapter One

Introduction

1.1 Background to the problem.....	18
1.2 Objectives of the study.....	20
1.3 Hypothesis	20

Chapter Two

Review of the Related Literature

2.1 Introduction	22
2.2 Historical perspective.....	22
2.3 Epidemiology	23

2.4	Anatomy of the Achilles tendon	23
2.4.1	Anatomy	23
2.4.2	Blood supply.....	26
2.5	Normal structure of a tendon	27
2.6	Myotendinous junction	27
2.7	Biochemical composition.....	28
2.8	Tendon biomechanics	28
2.9	Anatomy of the ankle joint	30
2.9.1	Blood supply.....	30
2.9.2	Nerve supply.....	30
2.10	Anatomy of the subtalar joint	31
2.11	Plantar aponeurosis	31
2.12	Biomechanics	32
2.12.1	Ankle joint.....	32
2.12.2	Subtalar joint	33
2.13	General foot biomechanics	33
2.14	Biomechanical factors relating to the development of the Achilles tendonitis	35
2.14.1	Prolonged pronation	35
2.14.2	Tendon mechanics.....	36
2.14.3	Poor flexibility.....	38
2.14.4	Faulty footwear	38
2.15	Aetiology of Achilles tendonitis	39
2.15.1	Intrinsic factors	40

2.15.1.1	Poor flexibility.....	40
2.15.1.2	Sudden loading and excessive force.....	40
2.15.1.3	Forces through the tendon	40
2.15.1.4	Overuse injury	41
2.15.1.5	Effect of disuse and exercise	41
2.15.1.6	Tendon shear forces.....	42
2.15.1.7	Excessive pronation.....	42
2.15.1.8	Forefoot and rearfoot varus	42
2.15.1.9	Muscle weakness	42
2.15.1.10	Other muscular skeletal factors	43
2.15.1.11	Systemic factors.....	43
2.15.1.12	Corticosteroids.....	44
2.15.1.13	Rheumatic conditions	45
2.15.2	Extrinsic factors.....	45
2.15.2.1	Training errors	45
2.15.2.2	Age	46
2.15.2.3	Gender	47
2.15.2.4	Body weight and height.....	47
2.16	Differentiation between Achilles tendonitis and Achilles tendinosis	47
2.17	Prognosis for patients with Achilles tendonitis	49
2.18	Treatment of Achilles tendonitis.....	49
2.19	Specific treatment stage	51
2.19.1	Acute stage	51

2.19.2	Subacute stage.....	52
2.19.3	Chronic phase.....	53
2.20	Surgical intervention for patients with achilles tendonitis.....	57
2.21	Placebo response.....	57
2.22	Conclusion	59

Chapter Three

Material and Methods

3.1	Introduction	60
3.2	Subjects	60
3.3	Inclusion and exclusion criteria of patient.....	61
3.3.1	Inclusion criteria.....	61
3.3.2	Exclusion criteria	62
3.4	Sample group	62
3.5	Interventions	63
3.6	The data	63
3.6.1	Primary data	63
3.6.2	Secondary data	64
3.7	Measurements	64
3.7.1	Method of measurements.....	64
3.7.1.1	Subjective measurements	65
3.7.1.1.1	Numerical Pain Rating Scale-101	65
3.7.1.1.2	Short Form McGill Pain Questionnaire.....	65

3.7.1.2	Objective measurements.....	65
3.7.1.2.1	Algometer.....	65
3.7.1.2.2	Goniometer.....	66
3.8	Specific treatment of each objective.....	66
3.8.1	First objective.....	66
3.8.2	Second objective.....	66
3.9	How the data was secured.....	67
3.10	Statistical analysis.....	68
3.10.1	Treatment of the data.....	68
3.10.2	Methods of data analysis.....	68
3.10.3	Hypothesis testing and decision rule.....	68
3.10.3.1	Procedure One: Comparison between Group 1 and Group 2 (continuous variables).....	69
3.10.3.2	Procedure Two: Comparison between Group 1 and Group 2 (discrete variables).....	70
3.10.3.3	Procedure Three: Comparison between related samples within Group 1 (discrete variables).....	70
3.10.3.4	Procedure Four: Comparison between related samples within Group 1 (continuous variables).....	71
3.10.3.5	Procedure Five: Comparison between related samples Group 2.....	71
3.10.3.5	Procedure Six: Comparison using bar charts.....	71

Chapter Four

Results of the study

4.1	Introduction	72
4.2	Abbreviations	72
4.3	Demographic data	73
4.4	Clinical data	75
	4.4.1 Parametric testing.....	75
	4.4.2 Non-parametric testing.....	79
4.5	Motion palpation findings.....	88

Chapter Five

Discussion of results

5.1	Introduction	93
5.2	Inter-group comparison.....	94
	5.2.1 Subjective data	94
	5.2.1.1 McGill Short Form Pain Questionnaire	94
	5.2.1.2 Numerical Pain Rating Scale-101	94
	5.2.2 Objective data.....	95
	5.2.2.1 Goniometer readings	95
	5.2.2.2 Algometer reading	95

5.3	Intra-group treatment comparison.....	96
5.3.1	Subjective data	96
5.3.1.1.	McGill Short Form Pain Questionnaire.....	96
5.3.1.2.	Numerical Pain Rating Scale 101	96
5.3.2	Objective data	97
5.3.2.1	Goniometer readings	97
5.3.2.2	Algometer reading	97
5.4	Other studies	93
5.5	Limitations of the study	98
5.4.1	Subjective measures.....	98
5.4.2	Objective measures	98
5.4.3	Demographics	99

Chapter Six

Recommendations and conclusions

6.1	Recommendations.....	101
6.2	Conclusions	102

References	103
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Appendices	111
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List of tables

2.1	Tendon healing and suggested therapy	50
2.2	Five step eccentric program	55
4.0	Demographic data	
4.1	Age distribution	73
4.2	Gender distribution	73
4.3	Race distribution	73
4.4	Occupation	74
4.5	Chronicity of the tendonitis	74
4.6	Parametric testing	
4.6.1	A comparison of Group 1 and Group 2 using the unpaired t-test for continuous data at visit one.....	75
4.6.2	A comparison of Group 1 and Group 2 using the unpaired t-test for continuous data at visit two.....	76
4.6.3	A comparison of Group 1 and Group 2 using the unpaired t-test for continuous data at visit three.....	77
4.6.4	A comparison Group 1 and Group 2 using the unpaired t-test for continuous data at last visit	78

4.7	Non parametric testing	
4.7.1	Comparison of Group 1 and Group 2 using the Mann-Whitney U- test to analyse discrete data to asses inter group changes between the 1 st and 2 nd , 1 st and 3 rd and 1 st and 6 th visit	79
4.7.2	Comparison of results within Group 1 using the paired t-test to analyse continuous data and changes between the 1 st and 2 nd , 1 st and 3 rd and 1 st and 6 th visit	80
4.7.3	Comparison of results within Group 1 using the Wilcoxon Signed Ranks test to analyse discrete data collected between the 1 st and 2 nd visit	81
4.7.4	Comparison of results within Group 1 using the Wilcoxon Signed Ranks test to analyse discrete data collected between the 1 st and 3 rd visit	82
4.7.5	Comparison of results within Group 1 using the Wilcoxon Signed Ranks test to analyse discrete data collected between the 1 st and final visit	83
4.7.6	Comparison of results within Group 2 using the paired t-test to analyse the continuous data collected between the 1 st and 2 nd , 1 st and 3 rd and 1 st and final visit.....	84
4.8.1	Comparison of results within Group 2 using the Wilcoxon Signed Ranks test to analyse discrete data collected between the 1 st and 2 nd visit	85
4.8.2	Comparison of results within Group 2 using the Wilcoxon Signed Ranks test to analyse discrete data collected between the 1 st and 3 rd visit	86
4.8.3	Comparison of results within Group 2 using the Wilcoxon Signed Ranks test to analyse discrete data collected between the 1 st and final visit	87

List of Graphs

1. Graphical representation of the mean values obtained from the
McGill Short-form Pain Questionnaire.89
2. Graphical representation of the mean values obtained from the
Algometer readings.....90
3. Graphical representation of the mean values obtained from the Numerical
Pain Rating Scale - 101.....91
4. Graphical representation of the mean values obtained from the Goniometer
readings measuring ankle dorsiflexion range of motion.....92

List of abbreviations

Group 1:	Adjustment group
Group 2:	Placebo group
McGill:	McGill Short Form Pain Questionnaire
NRS-101:	Numerical Pain Rating Scale-101
GON:	Ankle dorsiflexion range of motion in degrees
ALG:	Algometer readings in Kg per squared centimeter
SD:	Standard deviation
Group 1:	Experimental group
Group 2:	Control group
Bold numbers:	Statistically significant findings

DEFINITION OF TERMS

ADHESION

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

ADJUSTMENT

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

BIOMECHANICS

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

CONTRA-INDICATION

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

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.)

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.)

GONIOMETER

Instrument for measuring angles. (Gatterman 1990: 408.)

JOINT DYSFUNCTION

Joint mechanics showing areas of disturbed function. (Gatterman 1990: 409.)

JOINT PLAY

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

MANUAL THERAPY

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

MOBILISATION

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

SUBJECTIVE CLINICAL FINDINGS

For the purposes of this study this refers to the data obtained from the patients through the use of the McGill Short-form Pain Questionnaire and the Numerical Pain Rating Scale-101. (Gatteman 1990: 411.)

OBJECTIVE CLINICAL FINDINGS

For the purposes of this study this refers to the data obtained from the goniometer readings in terms of ankle dorsiflexion range of motion and algometer readings as a measure of pain threshold. (Gatteman 1990: 411.)

ACUTE

The first five days after injury is considered the acute phase for the tendon. (Chazan 1998a)

SUBACUTE

The time between the 5 days and 20 days after injury. (Chazan 1998 a)

CHRONIC

More than twenty days after injury. (Chazan 1998 a)

CHAPTER ONE

INTRODUCTION

1.1 BACKGROUND TO THE PROBLEM

“Any person who runs or participates in a sport that involves running, risks incurring Achilles tendonitis. With the recent fitness explosion, more people than ever before have been exposed to this risk. In fact Achilles tendonitis has become one of the most common athletic injuries.” (Curwin & Stanish 1984 : 26). It is also reported to be the most common injury in sport (Delee and Drez 1994 2: 473). Tendonitis of the Achilles is the most commonly reported form of tendonitis (Nicholas & Hershman 1995 1: 64), and accounts for between 10 and 15% of all running injuries (Soma and Mandelbaum 1994). “Millions of people in the USA run to improve and maintain there fitness and 60% of the adult population of the USA is engaged in some type of exercise” (Carter and Carter 1997).

The Achilles tendon has extreme functional importance as it endures the highest tensile forces in the body. According to Soma & Mandelbaum (1994) the Achilles tendon is the strongest and largest tendon in the body and has to endure tensile forces of up to eight times body weight during running.

In an extensive review of the literature, Kvist (1994) found that surgery was required for about 25% of athletes with Achilles tendon overuse injuries, and the frequency increased with age and duration of symptoms, that is the more chronic the condition became. Of this percentage, 20% required a second operation, because of incomplete healing with

immense annual costs. "Surgery is important for those cases where Achilles tendon complaints may occur as a result of irreversible lesions that not only interfere with sports activities, but also may cause pain during daily activities, and even at rest" (Nelen, Martens and Burssens 1989). Chazan (1998 b) showed that approximately 15% of Achilles tendon ruptures are associated with antecedent symptoms of a tendonitis. Thus the importance of finding conservative, more cost-effective forms of treatment for Achilles tendonitis. Furthermore, after a thorough literature review, no studies testing the efficacy of conservative treatment of Achilles tendonitis were found.

The Achilles tendon has no synovial sheath but instead has a paratendon. It is this paratendon that becomes inflamed as a result of injury and therefore the condition is sometimes called Achilles paratendonitis (Smart, Taunton and Clement 1980). The most common site of tendonitis occurs 2-6 cm above the insertion of the tendon and occurs as a result of the tendon twisting on itself (Nelen, Martens and Burssens 1989).

No studies to date have been done to investigate the effectiveness of adjusting foot and ankle fixations in the treatment of sub-acute and chronic Achilles tendonitis. According to Bergmann (1993: 51-52), manual therapy is an effective form of treatment for a wide variety of conditions, but is most commonly associated with disorders that have their beginnings in pathomechanical or pathophysiological alterations of the locomotor system especially of its synovial joints. Peterson (1993: 139) also suggests that early intervention for soft tissue injury by means of manual therapy will promote better healing, decrease pain and inflammation, prevent further injury and promote flexibility. Thus there is a need for research of this nature.

1.2 OBJECTIVES OF THE STUDY

The purpose of this placebo-controlled study was to determine the efficacy of adjusting foot and ankle fixations in the treatment of sub-acute and chronic Achilles tendonitis in terms of subjective and objective clinical findings.

The first objective was to determine the efficacy of adjusting foot and ankle fixations, in comparison to detuned ultrasound, in terms of subjective clinical findings, whilst the second objective was to determine the efficacy of adjusting foot and ankle fixations, in comparison to detuned ultrasound, in terms of objective clinical findings in the treatment of sub-acute and chronic Achilles tendonitis. This was done in terms of the patients' subjective and objective clinical findings in order to determine which of the interventions was more efficacious. The subjective findings were analysed using the McGill Short Form Pain Questionnaire, and the Numerical Pain Rating Scale 101. Objective measurements used in this study were an extremity motion goniometer, and an algometer.

1.3 THE HYPOTHESES:

HYPOTHESIS ONE

Adjusting the fixations of the foot and ankle would be effective in improving the pain in those patients suffering with Achilles tendonitis.

HYPOTHESIS TWO

Adjusting the fixations of the foot and ankle would be effective in improving ankle dorsiflexion range of motion, indicating improvement within the Achilles tendon.

HYPOTHESIS THREE

It was hypothesized that adjusting the fixations of the foot and ankle would be effective in improving the pain in those patients suffering with Achilles tendonitis, in terms of subjective and objective clinical findings.

HYPOTHESIS FOUR

It was hypothesized that adjusting the fixations of the foot and ankle would be more effective than placebo, in the management of sub-acute and chronic Achilles tendonitis.

CHAPTER TWO

REVIEW OF THE RELATED LITERATURE

2.1 INTRODUCTION

The primary function of the Achilles tendon is to transmit forces from the triceps surae to the calcaneus (DeMaio, Paine & Drez 1995). Owing to its structure and functional demands, the Achilles tendon is extremely susceptible to acute and chronic injury. Chronic repetitive loads that exceed the tendons intrinsic repair capabilities may cause tendonitis. (Soma and Mandelbaum 1994.)

Achilles tendonitis is one of the most common injuries in sport, typically affecting the mature male athlete that engages in a high degree of running and jumping activities. (Soma and Mandelbaum 1994.) Any person who runs or participates in a sport that involves running risks incurring Achilles tendonitis (DeMaio, Paine and Drez 1995). Tendon problems are most common in the lower limb, especially in those engaged in sports or related physical activities. These injuries have been linked to eccentric muscle contractions where greater stresses are placed on tendons. (Smart, Taunton and Clement 1980)

2.2 HISTORICAL PERSPECTIVE

The tendon is named after Achilles, the Greek warrior whose mother Thetis, had made him invulnerable by dipping the baby Achilles into the river Styx. She held him by the heels as he was dipped into the rivers waters, rendering that region vulnerable. Achilles

was later fatally wounded in the Trojan war by an arrow striking his unprotected heel. (DeMaio, Paine & Drez 1995.)

2.3 EPIDEMIOLOGY: INCIDENCE AND PREVALENCE

Achilles tendon overuse injuries are particularly common in runners, and the number of runners has rapidly increased in the 1970s and 1980s (Kvist 1991). Tendonitis of the Achilles is the most commonly reported form of tendonitis (Nicholas & Hershman, 1995 1: 64), and accounts for between 10 and 15% of all running injuries (Soma and Mandelbaum 1994). Achilles tendonitis is frequently found in runners, ballet dancers and basketball players, and those involved in racket and jumping sports. Clement Taunton and Smart (1984) followed 650 runners (60% males) for two years during which time 109 (6,9%) developed Achilles tendonitis, 78% of whom were males.

2.4 THE ACHILLES TENDON

2.4.1 ANATOMY

With reference to the anatomy and biomechanics of the foot and ankle, the researcher has chosen to review only the sections relevant to this study in an attempt to bring across what is relevant in a clear and concise manner.

The Achilles tendon is covered by a thin sheath, the epitendon. Another fine sheath the peritendon, composed of fatty areolar tissue which fills the interstices of the fascial compartment in which the tendon is situated, overlies the epitendon. A potential space therefore exists between the two layers. The blood vessels run in a longitudinal septum from the deep tissues near the attachment of the peritendon to join the deep aspect of the

Achilles tendon. It is similar to a mesentery and is called a mesotendon. It is in this sheath that inflammation occurs frequently. Therefore this condition is sometimes referred to as Achilles paratendonitis. (Reid 1992: 201)

The Achilles tendon is the largest tendon of the body, it receives fibres from the soleus and the gastrocnemius muscles (DeMaio, Paine & Drez 1995). The soleus originates from the posterior superior fibula and tibia and functions as a plantarflexor. The gastrocnemius originates in two heads, from the distal medial and lateral posterior femoral condyles, thus crossing the knee, talocrural, and subtalar joints. The gastrocnemius acts as a knee flexor and a plantarflexor. The soleus and the gastrocnemius together make up the triceps surae. Crossing only the ankle and subtalar joints the soleus is more effective as a plantarflexor when the knee is flexed, whereas the gastrocnemius is most effective when the knee is extended. (DeMaio, Paine & Drez 1995). Thus the Achilles tendon crosses both the ankle and subtalar joints, it is therefore hypothesised that correcting reduced motion in these joints with a chiropractic adjustment will facilitate healing of the inflamed tendon.

“The Achilles tendon is broad and flat near its proximal insertion to the gastrocnemius and becomes more narrow and round distally. On the anterior surface the gastrocnemius receives muscle fibres from the soleus that continue almost to the gastrocnemius' distal end. The gastrocnemius portion of the tendon ranges from 11-26 cm long, with its most rounded portion approximately 4 cm above the calcaneus. The soleus tendon length can vary from 3-11 cm. The distal portion of the tendon expands from approximately 4 cm

distally and attaches to the mid posterior calcaneus via a stiff fibrocartilagenous expansion." (Reynolds and Worrell 1991.)

A distal muscles' tendon is larger and better developed than a proximal muscles' tendon, and the Achilles tendon becomes more round as it descends and expands slightly as it inserts into the posterior calcaneus (DeMaio, Paine & Drez 1995). As the tendon descends, it may spiral up to 90 degrees laterally, so that the medial aspect becomes the posterior aspect at the distal end. The rotation is variable and depends on the amount of fusion between the gastrocnemius and soleus. The more proximal the fusion, the less the degree of rotation. (Kvist 1994.) The significance of the rotation is that a region of concentrated stress may be produced where the two tendons meet. This is most prominent at 2.0-5.0 cm proximal to the insertion and corresponds to the region of the tendon with the poorest vascular supply. (Kvist 1994.)

Two bursa are associated with the insertion of the Achilles tendon into the calcaneus: the subcutaneous bursa lies between the skin and the tendon, and the retrocalcaneal bursa lies deep between the tendon and the calcaneus (DeMaio, Paine & Drez 1995). These bursae could be a source of pain alone, and could be confused with an Achilles insertional tendonitis or could occur in combination with it.

The plantaris tendon runs between the gastrocnemius and soleus muscles but has its own insertion separate from the Achilles tendon just medial to it, and in some cases it inserts into the plantar fascia (Moore 1992: 401.) The plantaris muscle and the triceps surae make up the superficial compartment of the posterior calf and are innervated by the tibial nerve (S1 and S2). (Moore 1992: 401.) Occasionally the plantaris tendon is lost in the

internal annular ligament or in the fascia of the leg. The plantaris is the rudiment of a large muscle which exists in some of the lower mammals, inserting to the plantar fascia. The vestigial in man, the plantaris is absent in about 6-8% of all people. (Smart, Taunton and Clement 1980.) Snow *et al.* (1995) report that there is some continuity between fibres of the Achilles tendon and the plantar fascia. There is a thick layer in neonates and as one approaches and continues through adulthood these fibres diminish in number.

The researcher chose to adjust all foot and ankle fixations, as it was hypothesised that adjusting the joints between the origin and insertion of the plantar fascia might have an effect on loosening the fascia and this would in turn have an effect on the Achilles tendon and plantaris muscle and tendon. Thus adjusting all foot and ankle fixations was chosen as opposed to only adjusting the mortice and sub-talar joints as recommended by Clement, Taunton and Smart (1984). Pellow (1999) also showed an increase in the ankle dorsiflexion range of motion following mortice separation adjustments alone, and this was seen to be an indication of healing (improved dorsiflexion) in patients suffering from Achilles tendonitis. (Leach, James and Wasilewski 1981)

2.4.2 BLOOD SUPPLY

The tendon's blood supply originates from three major regions. The musculotendinous junction; along the length of the tendon; and the tendon-bone junction. The majority of the blood supply comes to the tendon through the paratendon (Kvist 1994). Small branches from the posterior tibial and peroneal arteries run transversely through the paratendon. These then branch repeatedly, becoming longitudinally and transversely

oriented along the fascicles, to form a uniform mesh-like system along the length of the tendon. (Smart, Taunton and Clement 1980.)

Several authors speculate that the reduced vascularity occurring 2-6 cm above the tendon insertion may be an important etiological factor in the development of Achilles tendonitis. (Clement, Taunton and Smart 1984, and Curwin and Stanish 1984)

2.5 NORMAL STRUCTURE OF A TENDON

Typical tendon cells are fibroblasts lying in rows between bundles of collagen fibres that are wavy when the tendon is unstretched. They have numerous cell processes that are responsible for laying down oriented collagen and which communicate with those of other cells via gap junctions. These gap junctions probably allow the cells to detect, interpret and respond to different loads. (Benjamin and Ralphs 1996).

Collagen fibrils are grouped into fibres, fibres into bundles, and bundles into fascicles. Collections of fascicles wrapped in epitendon form the whole tendon. The fiber bundles are separated from each other by an endotendon which allows them to slide relative to one another and contributes to tendon flexibility. (Benjamin and Ralphs 1996.)

2.6 MYOTENDINOUS JUNCTION

The myotendinous junction allows force to be transferred from a muscle to a tendon, and is an important site of muscle growth. It is where muscle strains and delayed onset muscle soreness commonly occur (Noonan and Garrett 1992). "Strains are typical of eccentric contractions, where muscles lengthen while producing a force greater than that

of a concentric contraction. Muscles crossing two joints are at particular risk and it is probably significant that their tightness limits joint movement and that they commonly act eccentrically in athletic activities" (Noonan and Garrett 1992).

It is the opinion of the researcher that the limited joint movement, as a result of the tight muscles, further aggravates the problem and that restoring this motion might initiate healing. The myotendinous junction corresponds to the area where patients with Achilles tendonitis frequently complain of having pain (Chazan 1998 b).

2.7 BIOCHEMICAL COMPOSITION

Collagen accounts for 70-80% of tendon dry weight. Water and proteoglycan help tendon fibres to glide over each other, and boundary lubrication at the tendon surface may be promoted by lipid in the epitendon. (Benjamin and Ralphs 1996.)

2.8 TENDON BIOMECHANICS

The stress experienced by a tendon depends upon the contraction of the muscle and the relative size of the tendon. The greater the cross-section of the muscle, the greater the force it generates, putting more stress on the tendon. The larger the cross-section of the tendon the larger the load it can bear. The tensile strength of a healthy tendon is far greater than that of its muscle, and thus muscle ruptures occur far more frequently than those of tendons. (Benjamin and Ralphs 1996.)

The typical stress-strain curve for a tendon has an initial toe region where the tendon deforms readily, a linear region where irreversible elongation results in mild, moderate or

severe tears, and a failure point where the tendon is completely ruptured. (Oakes 1994 in Benjamin and Ralphs 1996.) Initially, slippage occurs within the fibrils, then between fibrils and then finally tearing of the fibrils or even the fibres. Injuries occur not only when the tendons are loaded, but also when they are rapidly unloaded. This occurs in athletes with both the application and release of sudden forces leading to the development of Achilles tendonitis seen in athletes. (Benjamin and Ralphs 1996.)

Tendons are visco-elastic and can withstand larger forces when these are applied rapidly. Their recovery time is also time-dependant, when a tendon is stretched at a constant rate as compared to being stretched rapidly and allowed to return to its original length, the stress-strain curves differ. Less force is borne at the same length in the relaxing tendon, thus tendons, too, exhibit the phenomenon of hysteresis. (Benjamin and Ralphs 1996.)

Exercise strengthens ligaments and tendons and immobilization weakens them. Thus cast recovery is not a recommended form of treatment for tendon and ligament injuries. It is also important to know that a tendon is transiently weaker as it adapts to exercise. It is therefore advised to start training gently at first and progress to maximum. (Benjamin and Ralphs 1996.)

According to Amiel et al. (1995 : 217), controlled passive movements of the joint that the tendon crosses over promotes healing in the tendon. However, the optimal magnitude and the direction of motion for healing purposes is unknown. It is hypothesised that perhaps the direction of motion and the specific joints to adjust will become more clear at the end of this research.

2.9 ANATOMY OF THE ANKLE JOINT

The ankle joint, also known as the mortise or talocrural joint, is a uni-axial hinge type of synovial joint, formed by the articulation of the inferior ends of the tibia and fibula and the superior part of the talus. The inferior ends of the tibia and fibula unite forming a mortise, articulating with the trochlea of the talus (Moore 1992: 490). Movement in the ankle joint occurs primarily in the sagittal plane, that is plantarflexion and dorsiflexion. In this research an increased dorsiflexion range of motion was used as an indicator of improvement in the patients' condition. Since the tendon is most elongated in dorsiflexion, if there was any inflammation in the tendon, this movement would cause pain and limited elongation capacity. According to Leach, James and Wasilewski (1981), a loss of passive dorsiflexion in patients with Achilles tendonitis was a common finding.

2.9.1 BLOOD SUPPLY

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

2.9.2 NERVE SUPPLY

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

2.10 THE SUBTALAR JOINT

The subtalar joint is a synovial joint, formed by the articulation of the talus with the calcaneus (Moore 1992: 490). The articular capsule attaches near the margins of the articular facets, whilst the fibrous capsule is thin and weak and doesn't allow communication between it and the other tarsal joints, but is well supported by the medial, lateral and posterior talocalcaneal ligaments, and the cervical ligament (Moore 1992: 490-491).

The sub-talar joint consists of two facets on the plantar surface of the talus and their calcaneal articulations. The larger concave posterior facet is the true subtalar joint.

The subtalar joint is the major and most important joint of the foot. It consists of two components, the talocalcaneal (subtalar joint) and the talonavicular. Basically these joints are all hinge joints that rotate on specific axes, and motion occurs perpendicular to these axes. (Jahss 1991 2: 1333.) Motion in the subtalar joint occurs primarily in the coronal plane, that is inversion and eversion. This movement when excessive is thought to contribute to the development of Achilles tendonitis. (Clement, Taunton and Smart 1980)

2.11 PLANTAR APONEUROSIS

"The plantar aponeurosis is an extremely strong fibrous structure longitudinally oriented on the plantar aspect of the foot. An indistinct division into medial, central, and the lateral portions is commonly made. The larger central portion arises as a thick band on the calcaneal tuberosity that broadens and thins distally before dividing into five processes-one for each toe." (Jahss 1991 1: 17.) As mentioned earlier, the plantar aponeurosis is significant to this study in that there is some continuity between it and the Achilles

tendon, and that it crosses all the joints of the foot. Hypothetically, a restriction of movement in any foot joint/s will restrict overall joint motion, which might affect the elasticity in the plantar aponeurosis and increase the strain on it. This is hypothesised to increase the tension in the Achilles tendon in those patients where the plantar fascia is continuous with the Achilles tendon as mentioned by Snow *et al.* (1995). So in trying to find alternative and more effective forms of treatment for this condition, it is postulated that one must also evaluate the motion of all the joints of the foot.

2.12 BIOMECHANICS

2.12.1 THE ANKLE JOINT

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

According to Magee (1992: 471), for minimal normal locomotion to occur the ankle should be able to actively dorsiflex ten degrees and plantarflex between twenty and twenty five degrees. The ankle should be able to dorsiflex passively a minimum of 20 degrees.

2. 12. 2 THE SUBTALAR JOINT

The subtalar complex consists of the talocalcaneal and transverse tarsal joints. These joints, singly or in combination, have axes that permit hinged motion. (Jahss 1991: 1335.) Motion in the subtalar joint has an intimate relationship with the motion that occurs in the ankle joint. "The axis of motion in the subtalar joint passes from the dorsal medial aspect of the navicular and exits on the lateral plantar aspect of the calcaneus. Generally the axes are fairly parallel to each other in the horizontal plane allowing both inversion and eversion at the subtalar joint." (Mann 1991 1: 386.)

A functional link between the leg and foot is provided by the talus and its articulation with the calcaneus. Movement in this joint occurs primarily through the saggital plane. Full contraction of the gastrocnemius and soleus muscles causes adduction and supination of the foot, because of the slightly medial of centre insertion of the Achilles tendon onto the calcaneus. (Carter and Carter 1997.) Because these plantar flexors control the ankle indirectly through the sub-talar joint, the anatomical and functional integrity of this joint is important.

2. 13 GENERAL FOOT BIOMECHANICS

According to Smart, Taunton and Clement (1980), "the subtalar (talocalcaneal) and midtarsal (talonavicular and calcaneocuboid) joints are the two major joints in the foot. Together with the ankle (talocrural) joints, these joints permit proper foot function by allowing two complex motions, pronation and supination, to occur. Motion in the foot can be described with respect to the body's three principal planes: frontal, saggital and transverse. Motion in the frontal plane is eversion and inversion; motion in the saggital

plane is dorsiflexion and plantar flexion; motion in the transverse plane is adduction and abduction." All these movements are essential movements enabling normal locomotion and with the hypothesis that an alteration or reduction of motion in these planes lead to uneven forces placed onto the tendon predisposing one to develop Achilles tendonitis, one should evaluate motion in these two joints specifically.

During normal gait movement occurs in the subtalar and mid-tarsal joints in each of the three body planes simultaneously. Supination is a collection of inversion, plantarflexion and adduction of the foot occurring together, while pronation is the collection of eversion, abduction and dorsiflexion occurring together (Smart, Taunton and Clement 1980). When the foot is referred to as being pronated or supinated, the reference is predominantly with respect to the ankle and subtalar joints. During pronation, the mid-tarsal joint becomes unlocked relieving the tension in the plantar fascia. This enables the foot to adapt to the terrain and allows the supporting structures to absorb impact forces over a greater time period, reducing their effective magnitude. Once the most distal metatarsal heads make contact with the weight bearing surface, pronation is complete. Supination begins as the total body centre of gravity passes over the foot in mid-stance, the mid-tarsal joint becomes locked in supination, this increases the tension in the plantar fascia, and transforms the foot into a rigid lever for toe off. The subtalar neutral position is the "structural relationship of the lower leg, heel and foot when the sub-talar joint is centered. Ideally in the neutral position the vertical axis of the heel is parallel to the longitudinal axis of the distal one third of the tibia, and the transverse plane of the forefoot at the metatarsal heads is perpendicular to the vertical axis of the heel." (Smart, Taunton and Clement 1980).

2. 14 BIOMECHANICAL FACTORS RELATED TO THE DEVELOPMENT OF ACHILLES TENDONITIS

2. 14. 1 PROLONGED PRONATION

At heel strike, the foot is slightly supinated and making contact with the lateral side of the heel, due to the natural swing of the leg toward the line of progression. Upon contact the foot goes through a rapid phase of eversion, abduction and dorsiflexion, or, pronation.

(Smart, Taunton and Clement 1980.)

As the foot moves from heel strike to foot flat, a certain amount of pronation is necessary to allow the foot to adapt to the surface contour. However, during excessive pronation, the Achilles tendon is at risk of injury. "Factors that may cause excessive pronation are forefoot and rearfoot varus, forefoot valgus, and a plantarflexed fifth ray. Also, internal torsional deformities of the hip, femur, or tibia, leg length inequalities, and muscular shortness of the iliopsoas, hamstrings, or gastrocnemius / soleus complex preventing full dorsiflexion of the ankle", all require abnormal excessive subtalar joint pronation.

(Reynolds and Worrell 1991.) Thus these need to be considered a possible aetiologies of Achilles tendonitis, and are there are areas for further investigation.

Clement, Taunton and Smart (1984) and Smart, Taunton and Clement (1980) have reported through observations of slow motion cinematography that prolonged pronation causes obligatory internal tibial rotation, which tends to draw the Achilles tendon medially. This produces a whipping or bowstring effect in the Achilles tendon, pulling the tendon laterally. This whipping effect may contribute to micro tears in the tendon, especially in the medial aspect, and initiate an inflammatory response. It is hypothesised

that fixations in the foot and ankle that may have been restricted for months and have been contributing to various degrees of pronation or supination, may have been the cause of the Achilles tendonitis. It is the opinion of this researcher that those fixations that have been adjusted over a course of 6 treatments, will reduce the excessive strain on the tendon and this will improve the tendonitis.

2. 14. 2 TENDON MECHANICS

Longer tendons are more suited for absorbing large forces placed on them, especially during athletic activity. Tendons are stronger than muscles per unit area, however, the Achilles tendon, being derived from two muscles and have interdigitating fibres twisting as they descend, leads to areas of high stress concentration. Also, the tendon absorbs forces in two planes: the sagittal plane (dorsiflexion and plantarflexion) and the frontal plane (inversion and eversion). These combined stresses create unequal tensile forces on different parts of the tendon, and it is further hypothesised by the researcher that these unequal forces may in turn be responsible to some degree for the formation of joint restrictions in the foot. Conversely, fixations within the foot and ankle may change the biomechanical stresses to which the tendon had previously become accustomed, and so, perhaps, contribute to the development of Achilles tendinitis. "Immediately after foot strike, when the foot rolls into pronation and the knee begins to flex, both knee flexion and pronation of the foot impart obligatory internal rotation forces to the tibia. As the foot moves from mid-stance to push-off, the tibia is externally rotated by the knee extension and foot supination. Ideally, this should occur simultaneously." (Reynolds and Worrell 1991). However, with a hyper-pronated foot, when the knee begins to extend, the forces of the external tibial rotation at the knee and internal tibial rotation at the ankle occur

simultaneously affecting the Achilles tendon negatively (Reynolds and Worrell 1991.) And so it is hypothesised that in those cases where foot and ankle fixations may be maintaining a hyperpronated foot, if the foot joints were adjusted, this may reduce the amount of pronation and would be beneficial in the healing of the tendon. The researcher was, however, unable to observe any foot postures associated with any particular foot and anklejoint dysfunction's. Clement, Taunton and Smart (1984) further speculate that the resultant torsional force on the Achilles tendon may cause an ischemic "wringing out" at or near the avascular zone, predisposing the Achilles tendon to degenerative changes.

Forces that tend to place the highest stress on the Achilles tendon occur during eccentric contraction of the gastroc-soleus muscle unit. The reason for this is that eccentric contraction places higher stresses on the tendon rather than the muscle (Curwin 1996). Examples include "pushing off the weight bearing foot while simultaneously extending the knee, as in uphill running; sudden unexpected ankle dorsiflexion, such as when stepping up a step and slipping off with the heel dropping; and rapid involuntary dorsiflexion of a plantarflexed foot." (Reynolds and Worrell 1991.) It is possible that fixations in the ankle could aggravate such a situation allowing the eccentric contraction to damage the Achilles tendon further. As an example, Pellow (1999) showed that following a mortice separation adjustment, the ankle dorsiflexion range of motion increased. Thus the reverse could be possible where a fixation or fixations prevent adequate dorsiflexion of the ankle. When running uphill more stress is placed on the tendon and this aggravates or perpetuates the situation.

2. 14. 3 POOR FLEXIBILITY

Poor flexibility within the gastrocnemius and soleus unit, estimated by the range of ankle plantar and dorsiflexion motion, was found to be a common aetiological factor for the development of Achilles tendonitis, as poor flexibility of these muscles increases the strain on the Achilles tendon. Values such as less than 12 degrees dorsiflexion and 25 degrees of plantarflexion are considered inadequate. (Clement, Taunton and Smart 1984.) Perhaps this poor flexibility is due, at least in part, to joint fixations and not entirely to the muscles, and perhaps if these joints were adjusted the flexibility would improve, and if so, a common aetiological factor would have been removed.

The relationship of tendon length to injury can be described in terms of the muscle tendon units resting length. When the resting length is increased, decreased strain (deformation) takes place during a particular range of movement. A shortened Achilles tendon is placed under greater strain than a longer Achilles tendon. Also, lack of adequate dorsiflexion could cause unwanted compensation in the form of excessive pronation, further aggravating the problem. (Reynolds and Worrell 1991.)

2. 14. 4 FAULTY FOOTWEAR

Smart, Taunton and Clement (1980), and Clement, Taunton and Smart (1984) agree that faulty foot wear can be a major contributing factor in the development of Achilles tendonitis. Rearfoot control is essential if the footwear is to help reduce the development of Achilles tendonitis. The shoes should have firm, close fitting heel counters of proper depth (they must be distal to the medial and lateral malleoli and not in contact with

them), and wide heel bases providing the necessary rear foot stability. There should also be adequate heel wedging of 12-15 mm vertical height.

According to Reynolds and Worrell (1991), the sole of the shoe must be flexible enough to allow extension of the metatarsophalangeal joints during running. If the toes cannot bend, the lever arm from the ankle to the forefoot is lengthened, thus increasing the strain on the Achilles tendon.

2.15 AETIOLOGY OF ACHILLES TENDONITIS

Many factors have been proposed in the development of Achilles tendon injuries.

Kvist (1994) reports that in recreational athletes Achilles tendonitis is usually associated with acute tendon overload, whereas in competitive athletes it is usually associated with repetitive microtrauma over time (months to years). In a study done by Clement, Taunton and Smart (1984), the three most prevalent aetiological factors were overtraining (82 cases), functional overpronation (61 cases), and gastrocnemius-soleus insufficiency (41 cases).

Repetitive trauma can be caused by intrinsic and extrinsic factors and their interplay (DeMaio, Paine and Drez 1995). Intrinsic factors result from changes or inadequacies within the tendon itself, while extrinsic factors are those from outside the tendon (Chazan 1998 a).

2.15.1 INTRINSIC FACTORS

2.15.1.1 Poor flexibility

The gastrocnemius-soleus muscle group performs eccentrically in the mid-stance while running, this controls the anterior movement of the tibia as it rotates over the talus. With reduced flexibility in gastrocnemius and soleus, especially while running uphill, the eccentric muscle contraction places increased strain on the Achilles resulting in the accumulation of microtrauma within the tendon. (Kvist 1994.)

2.15.1.2 Sudden loading /Excessive force

According to Chazan (1998 a), the sudden application of force, especially when involving eccentric muscle contractions, may lead to tendon or muscle injury. This results in a larger than usual force being applied rapidly to a tendon causing more fibril disruption than a gradual force at the same level of loading. The distribution of stress within the tendon is generally symmetrical across the tendon cross-sectional area. However, muscles are comprised of fast and slow twitch fibres. The slow twitch muscle fibres are used for slow movements with low force levels, as well as the maintenance of posture, and are loaded throughout the day. On the other hand, rapid loading causes firing of the fast twitch muscle fibres that are seldom used at slower and lower force levels.

Chazan (1998 a) feels that some tendon fascicles are weaker as a result of little loading throughout the day, and that they become susceptible to injury from sudden demands for rapid force production.

2.15.1.3 Forces through the tendon

Whilst running, an ordinary push-off produces an estimated 2000 N of force through the tendon. An estimated maximum of 4030 N have been measured in the Achilles tendon in

a person who suddenly changed direction whilst running, and ruptured his Achilles tendon. Activities such as running and jumping can increase the forces to 5000 N, suggesting that the tendon is often maximally loaded during vigorous athletic activity, thus lending itself to being injured. (Chazan 1998 a.) Although only estimates, they shed light on the possible aetiology of Achilles injury.

2.15.1.4 The overuse injury

This occurs in a normal tendon that is exposed to large loads. Chazan (1998 a) feels that chronic overloading in a tendon may lead to partial rupture of some of the fibrils within the tendon. This is a repetitive micro-strain injury, where the loads are within the physiological range, and are repeated frequently enough without adequate recovery and then the tendon fatigues. This occurs gradually and is generally related to high training levels.

2.15.1.5 Effects of disuse and exercise

Under decreased load all musculoskeletal tissues atrophy, collagen and cross link concentrations decrease and the tissues become weaker, increasing the susceptibility to injury. (Chazan 1998 a.)

The incidence of tendon injuries increases after a sudden increase in the amount of training, or if training is resumed at a too high a level after a period of rest. Tendons, like all musculoskeletal tissues, hypertrophy under increased load, increasing the tensile strength of the tendon and thus reducing further risk to injury. (Chazan 1998 a.)

2.15.1.6 Tendon shear forces

Tendon shear occurs as a result of the tendons of the soleus and the gastrocnemius not running parallel to each other, instead twisting from proximal to distal as they insert into the calcaneus. The shear motion from this arrangement can set up the tendon for an injury or rupture. (DeMaio, Paine & Drez 1995.)

2.15.1.7 Excessive pronation

Increased pronation (early or late in the gait), causes increased internal tibial rotation, drawing the Achilles tendon medially. This causes a wringing out effect of the hypovascular area in the Achilles tendon. (Clement, Taunton and Smart 1984).

Kvist (1994) believes that this increases the stress on the medial side of the tendon, and predispose the patient to developing Achilles tendonitis.

2.15.1.8 Forefoot or rear foot varus

The varus foot is believed to be of aetiological importance since varus increases stress on the tendon in the mid-stance phase due to a whipping action on the tendon (Reynolds and Worrell 1991)

2.15.1.9 Muscle weakness

Weak gastrocnemius-soleus muscles result in increased strain on the Achilles tendon when contracting concentrically during push-off to propel the foot. Weakness of these muscles can increase strain in the Achilles tendon resulting in microtears and inflammation. Running uphill places higher demands on an already dorsiflexed foot (Chazan 1998 a).

2.15.1.10 Other musculo skeletal factors

According to De Maio, Paine and Drez (1995) clinical associations between patients with Achilles tendonitis and having other conditions, have been made, especially in those with cavus feet, pes planovalgus, obesity and motion restrictions in the talocrural and subtalar joints. In the cavus foot a longer lever arm is created for the tendon to work through, also poor shock absorbtion and poor adaptation to uneven terrain is noted on heel strike (Chazan 1998 a). The cavus foot is related to Achilles tendon overuse injuries especially if there is a postero-superior bone spur of the calcaneus. The increased prominence of the superior tuberosity is believed to cause insertional complaints. The cavus foot tends to place more stress on the lateral side of the tendo-Achilles as a result of poor shock absorbtion (Reynolds and Worrell 1991). Furthermore tibia vara, functional talipes equinus, and tight hamstrings or calf muscles may be associated with Achilles tendonitis. (Kvist 1991.)

2.15.1.11 Systemic factors

Certain systemic diseases have been implicated in the development of Achilles tendonitis, as they result in weakness within the tendon rendering it vulnerable to injury. According to Chazan (1998 a) these include:

- Diabetes mellitus
- Systemic lupus erythematosus
- Psoriatic arthritis
- Reiter's disease

Diseases causing defects in collagen metabolism include :

- Ehler-Danlos syndrome

- Osteogenesis imperfecta
- Marfan's syndrome

These all contribute to the development of Achilles tendonitis as a result of the defects in collagen metabolism that these conditions present with.

In diabetic patients, increased cross linkages are seen, which results in stiffer tissues that require more force to stretch (Chazan 1998 a).

2.15.1.12 Corticosteroids

Corticosteroid injections are sometimes used to treat Achilles paratendonitis and tendinosis (Chazan 1998 b). The aim of using corticosteroids, according to Da Cruz *et al.* (1988), is to decrease inflammation and pain and to inhibit the formation of adhesions and scar tissue. If used excessively, the corticosteroids destroy connective tissue and may lead to a rupture. Severe adverse effects of corticosteroid injections are rare if no more than two or three injections are given in the same area and the interval between injections is at least 10-14 days, although this is a gray area. Glucocorticoids are the principal anti-inflammatory steroids. They achieve their effect by reducing capillary permeability, presumably by inhibiting the formation of kinins and the release of histamine from mast cells. Glucocorticoids prevent the chemotactic migration of leukocytes in the exudate by inhibiting the formation of leukocytosis-promoting factor at the inflammatory site. Tissue repair is dependant upon the in-growth of fibrous connective tissue and blood vessels into the damaged region, stimulated by the inflammatory process. Fibroblasts, the foundation for connective tissue, lay down collagen fibres. The adverse effects of the glucocorticoids occur as a result of the inhibition of fibroblastic proliferation, this reduces their ability to produce mature

collagen, the formation of fibrin from fibrinogen, the aggregation of platelets, and capillary proliferation into the damaged tissue. Inhibiting these vital functions results in the healing process being delayed (Clement, Taunton and Smart 1980).

2.15.1.13 Rheumatic conditions

The following conditions have all been implicated in the development of Achilles tendonitis. (DeMaio, Paine and Drez 1995):

- Hyperuricemia and gout
- Pseudogout
- Sever's disease
- Ankylosing spondylitis

2. 15. 2 EXTRINSIC FACTORS

2.15.2.1 Training errors

Clement, Taunton and Smart (1984), feel that there is a link between increasing one's training mileage and the onset of injury, and according to Reid (1992 : 176), less experienced runners are more likely to develop Achilles tendon injuries than experienced runners.

Other training errors according to Chazan (1998 a), include:

- Running on uneven surfaces
- Using poor or worn-out shoes
- Uneven increments in training program
- Sudden change in training program
- Sudden change in training surface

- Training on surfaces that are too hard, soft or slippery
- Inadequate general training (warm up and strengthening of muscles)
- Training in cold weather
- Shoe problems:
 - Ill-fitting shoes, with direct pressure to the posterior ankle
 - Training with shoes lacking a heel counter to stabilize the rear foot
 - Shoes with insufficient heel height
 - The sole of a shoe's cushion that does not impact sufficiently, or twists too easily.
 - Shoes with worn-out soles
- Direct blow to the tendon has been implicated with tendon damage or rupture (De Maio, Paine and Drez (1995).
- Tendonitis may be secondary to: prolonged ambulation, extreme muscular effort, or fatigued muscles. Fatigued muscles are associated with decreasing ability to absorb shock and dynamic stability for joints. (Kvist 1994.)

Out of 109 patients with Achilles tendonitis, Clement, Taunton and Smart (1984) found 75% of cases were due to training errors, 56% were due to moderate to severe hind-foot alignment problems, 39% were due to poor gastrocnemius- soleus flexibility and 10% were due to improper shoes.

2.15.2.2 Age

The occurrence of Achilles tendon injuries increases with age in athletes, Kvist (1991) found that Achilles tendon overuse injuries are more common in the elderly than in the young. With increasing age there is a reduced blood supply to tendons, decreased muscle

and joint flexibility, and decreased muscle strength and neuromuscular co-ordination, thus indicating that the aging tendon is more vulnerable to injury at any given level of physical load.

2.15.2.3 Gender

Kvist (1991), found that 76% of all athletes injured were males, which compares with 60% found by Clement, Taunton and Smart (1981).

2.15.2.4 Body weight and height

A large body weight and size may predispose an athlete to injury of the Achilles. Kvist (1991) found in a survey of 1000 runners that the heavier runners sustained injuries more frequently than the lighter weight athletes.

Essential to the diagnosis and treatment of these cases is the correct determination of the intrinsic and extrinsic factors that predispose the patient to developing Achilles tendonitis.

2.16 DIFFERENTIATING BETWEEN ACHILLES TENDONITIS AND TENDINOSIS

As outlined by Mann and Chou (1998).

Definition:

Tendonitis refers to inflammation of the tendon sheath, whereas tendinosis refers to an intra-substance process commonly associated with degeneration and microtearing within the tendon.

Clinical Features:*Tendonitis*

Pain and swelling during normal daily activity or even at times of rest.

Tendinosis

May also cause pain, swelling, redness and increased heat. The swelling may be more localized and within the tendon. Some patients may be asymptomatic.

Physical findings:*Tendonitis*

Inflammation of the peritendon produces tenderness, swelling, increased warmth, and crepitation, no palpable nodules are experienced during ankle movement.

Tendinosis

Tendon increases in thickness by 2-5 cm, and crepitus is unlikely.

Tenderness during squeezing or deep palpation, and nodules, if present, move with the tendon on dorsiflexion and plantarflexion.

If chronic, there may be no increased warmth, and the patient may have trouble standing on tip-toe secondary to degenerative change.

Distinguishing test:

To help distinguish tendinosis from tendonitis, ask the patient to stand individually and raise himself on tip-toe several times. Most patients with tendinosis cannot perform a toe raise because of weakness, while those with tendonitis usually can. (Mann and Chou 1998.)

2.17 PROGNOSIS FOR PATIENTS WITH ACHILLES TENDONITIS

Achilles tendon injuries in the athletic population usually resolve in 12 weeks with treatment. For those patients seeking treatment after many months of symptoms, recovery can sometimes take as long as two years (Curwin 1996: 44). Failure of the treatment program in the athletic population, according to Curwin (1996: 44), may be due to the following:

1. Incorrect diagnosis-The patient may be suffering with spinal, systemic or other musculoskeletal problems.
2. Unrecognised extrinsic factors.
3. Non-compliance - either doing too much or too little.
4. Incorrect treatment progression – progressed too fast for level of healing, or did not progress enough to make adaptive tissue changes.

2.18 TREATMENT OF ACHILLES TENDONITIS

“The components of management of Achilles tendon injury include: avoiding re-injury of the tendon in the early stages of healing while tensile strength is low; minimising the adverse local effects of acute injury; promoting an uncomplicated healing process while simultaneously preventing the detrimental effects of disuse and restoring function” (Chazan 1988 b).

Table 2.1

TENDON HEALING AND SUGGESTED THERAPIES (Curwin 1996: 43)

STAGE OF HEALING			
	Inflammatory	Fibroblastic	Remodeling
Days	0-6	5-21	20 days and onward progressive stress on tissue
Suggested therapy	Rest, ice, anti-inflammatory modalities, decrease tension	Gradual introduction of stress. Modalities to increase collagen synthesis	
Physio- logical Rationals	Prevent prolonged inflammation. Prevent disruption of new blood vessels and collagen fibrils. Promote ground substance synthesis.	Increase collagen Increase collagen cross linkage Increase fibril size and alignment	Increase cross-linking (tendons and ligaments) Decrease cross-linking (joint capsule) Increase fibril size
Main goals	Avoid new tissue disruption	Prevent excessive muscle and joint atrophy	Optimize tissue healing

2. 19 **SPECIFIC TREATMENT** [adapted from Chazan (1998 b)]

2. 19. 1 **ACUTE STAGE** (Early Fibroblastic / Proliferative Stage of healing.)

PROTECTION: The Achilles tendon can be protected by the use of heel lifts which take pressure off the tendon, as well as taping the foot in slight plantar flexion relaxing the tendon.

REST: The extent of which depends upon the severity of the injury, and can range from walking with crutches for a few days if acute to the modification of activity.

The patient must then still perform non-weight bearing exercises in the form of swimming to avoid the effects of disuse.

ICE: Ice helps decrease pain and the inflammatory response to injury in the body.

ULTRASOUND: This must be pulsed ultrasound to avoid thermal effects in acute injuries.

Ultrasound has also been shown to be good for increasing collagen synthesis, speeding wound healing, and increasing tensile strength in healing tendons. The use of phonophoresis is also recommended (Soma and Mandelbaum 1994).

NON-STERIODAL ANTI-INFLAMMATORY DRUGS: Unlike corticosteroids the NSAIDS do not inhibit fibroblast or macrophage activity, rather they work by affecting the release or synthesis of prostaglandin.

EARLY EXERCISE: Done within the patients' pain tolerance, and progressing from non-weight bearing to full weight bearing as tolerated. According to Chazan (1998 b), the benefits of exercise include improved circulation, prevention of disuse atrophy, maintaining range of motion, and stimulate fibroblast activity. Active dorsiflexion, adding resistance as tolerated, and gentle calf stretches, can be beneficial.

PATIENT EDUCATION: In terms of managing the condition, and minimising the risk factors for further injury. This is important in all phases of healing and is probably most important for the prevention of re-injury.

2. 19. 2 SUBACUTE STAGE (Fibroblastic/ proliferative stage of healing)

ICE: Can still be used to decrease the inflammation of micro-tears and therefore pain.

ULTRASOUND: Still applied in the pulsed mode.

MOBILISATION: The talocrural and subtalar joints can be mobilised early without injury to the tendon.

SOFT TISSUE MOBILISATION: Soft tissue mobilisation applied to peri-achilles structures and to the tendon and paratendon itself will reduce the stiffening effect of the fibrin deposition that occurs in this phase.

MUSCLE STRETCHING: The calf muscles must be stretched with the subtalar joint in its neutral position, this can be done by stretching with an orthotic on or by placing a small arch support under the foot during the stretch.

MUSCLE STRENGTHENING: Concentrating on improving strength, power and endurance.

There are some basic exercise principles that should be followed:

1. Specificity of training: training the tendon-muscle unit specifically, for example the use of a step allows training of the gastroc-soleus and loads the Achilles tendon concentrically and eccentrically. This training must be specific to the affected muscle tendon unit, and the type of exercise that the tendon undergoes, that is it must be strengthened in the direction that it was injured in to make that point stronger again.

2. **Maximal loading:** Done to induce adaptive changes in the tissues, within pain tolerance levels. Curwin (1996: 44) has determined that the patient should experience inflammation and pain after 20-30 repetitions, and if there is no pain after the completion of 30 reps then the load/stimulus was inadequate.
3. **Progression of loading:** As the tendon adapts the load must be increased, either by increasing the speed, or magnitude of resistance be it isometric, concentric or eccentric. This again is determined by the change in the patients' symptoms.

PROPRIOCEPTION EXERCISES: This is important through all phases of healing. An example of which is the asking a patient to gradually progress through a spectrum of balancing exercises, to stand on one foot with the eyes closed, bend the opposite hip and knee flexed to 90 degrees, and with the eyes closed.

PROTECTION: A heel lift is still useful in this phase to protect the tendon as the patient increases their activity levels. The height of which can be reduced as the patient's symptoms improve, and the patient slowly returns to full weight-bearing function. In some difficult, long-standing and difficult cases an Air-Cast is used.

2. 19. 3 **CHRONIC STAGE (Remodelling/ Maturation stage of healing)**

In this stage the collagen is maturing and progressive stress is needed to help align the scar. Aggressive training, resisted exercise, and stretching should not begin until pain and swelling have disappeared.

ICE AND ULTRASOUND: Useful, although evidence suggests that ultrasound is less effective in this phase of healing than in the others.

MOBILISATION: Applied to the talocrural and subtalar joints including posterior to anterior and anterior to posterior and medial to lateral glides.

TRANSVERSE FRICTION MASSAGE: Beginning with soft tissue mobilisation and then progressing to transverse friction massage which is hypothesised to decrease adhesions.

MUSCLE STRETCHING: These stretches must be increased in time and effort within patient pain tolerance.

MUSCLE STRENGTHENING: Concentrating on improving strength, power and endurance.

There are some basic exercise principles that should be followed:

a) Specificity of training: Apply higher magnitudes of force with the speed of eccentric loading increased.

b) Maximal loading: Increase the repetitions.

c) Progression of loading: Increase the load, creating further stimulus for adaptation.

PROPRIOCEPTION EXERCISES: Are important through all phases of healing.

PROTECTION: A heel lift is still useful, the height of which can be reduced as the patient's symptoms improve, and the patient slowly returns to full weight-bearing function. In long-standing and difficult cases an Air-Cast is used.

FUNCTION: As a slow return to full weight-bearing function begins, the patient continues to modify the program, slowly progressing in terms of speed, duration and frequency provided that there is no pain and inflammation present.

Maintaining cardiovascular fitness is vital throughout the program and can be done in a pool or on a bike until the patient is able to walk or run again.

RETURN TO FULL ACTIVITY: According to Chazan (1998 b) the resumption to full activity is one of the most difficult challenges to the rehabilitation process as there are no strict guidelines in the literature. Although Curwin (1996: 47) suggests resumption of 25% of the pre-injury level on alternate days to allow the evaluation of the tendons response to activity. If there are no problems then progressions can be made in 10% increments until full training is resumed.

Running backwards may also be beneficial, as it requires less ankle plantarflexion range of motion and less peak plantarflexion torque.

Curwin developed an exercise program based on these principles in the treatment of chronic tendonitis.

Table 2.2

FIVE-STEP ECCENTRIC PROGRAM

(Curwin 1996)

1. **Warm Up:**

Generalised exercise such as cycling or light jogging for twenty minutes, done daily to increase the body temperature and circulation. This exercise is not intended to load the tendon and should not be uncomfortable.

2. **Flexibility:**

The athlete performs at least two 30 second static stretches per day of the affected muscle tendon unit involved and its antagonist. If hypo-mobility is felt to be a major factor in causing the athletes symptoms, more stretching should be done.

3. Specific Exercise:

Three sets are performed at the start with a brief rest and sometimes stretching between each set. The athletes should feel a reproduction of the symptoms after 20 repetitions. If the pain is felt more readily, the speed of movement is reduced or the load (not both) is increased. If this is the first exercise session and the initial level of loading is being determined, the intensity of exercise may be increased and the repetitions repeated until the appropriate level of intensity is reached.

An example:

- a) Begin with double heel raises on a flat surface (both feet), go up on two and down on one, 8-10 reps, for three sets. Add three to five reps daily, working up to thirty reps in each set.
- b) Then do 40 doubles (both feet), up on two , down on one, with ten singles on the affected side up and down (one foot only).
- c) Every third day, three to ten doubles are taken away and three to ten singles are added.
- d) Once fifty singles are reached add a 2-5 cm wedge under the forefoot to increase the range of motion.
- e) Start at half the amount of reps and progress to the previous amount of reps over a 10 to 14 day period.
- f) If the red flags appear, which include pain and /or stiffness, a rest day is taken and the next workout is reduced by 25% efficiency.

4. Repeat flexibility exercises.

5. Apply ice:

10-15 minutes to the affected area, which reduces the inflammatory response caused by microscopic damage to the tendon that might occur during exercise.

2. 20 SURGICAL INTERVENTION FOR ACHILLES TENDONITIS

Packer, McLatchie and Bowden (1997) showed that the most common reasons for considering surgery were a failure of the conservative treatment and a desire of the patient to return to sporting activity. The features that most commonly act as indications for surgery are: duration of symptoms, (> 1 year) bilateral symptoms and evidence of tendon nodularity or thickening. In an extensive review of the literature, Kvist (1994) found that surgery is required for about 25% of athletes with Achilles tendon overuse injuries, and the frequency increases with age and duration of symptoms, that is the more chronic the condition becomes. Of this percentage, 20% will require a second operation, because of incomplete healing. Chazan (1998 b) showed that approximately 15% of Achilles tendon ruptures are associated with antecedent symptoms of a tendonitis. In light of the above the importance of finding conservative, more cost-effective forms of treatment for the tendonitis becomes clear.

2. 21 THE PLACEBO RESPONSE

The placebo response is best defined by Basmajian (1993: 2) as "a response in a conscious patient to the treatment of a symptom or sign, where the administrator of the treatment has no scientific basis in demonstrated fact that the treatment has a specific

effect on the target sign, symptom, disease, or condition." From this "the definition of a placebo can be derived as the substance or procedure received by the patient for the purpose of treatment which will bring about a placebo response, whether it is planned as deliberate deception, suggestion, or in good faith without scientific proof of efficacy in advance." (Basmajian 1993: 2) According to Basmajian (1993: 3) the manual therapy setting and a highly confident therapist handling the equipment will have a powerful influence on the patient, and that if the therapist is knowledgeable about the specific intervention used and most importantly comes into close contact with the patient, almost any type of intervention will have a thirty to fifty percent success rate.

Astrom and Westlin (1992) tested the efficacy of piroxicam in a double-blinded trial in 70 non-rheumatic adults with painful Achilles tendinopathy. No differences were seen between the groups at any time during the study. The overall success rate within the experimental group was slightly better than 50% which corresponds to the placebo response seen in other studies. It is possible however that a portion of the success was due to the natural history of this condition, and that it was improving anyway. Lowdon, Bader and Mowat (1984) in a double blinded trial showed that in a study comparing ultra-sound with exercises and the use of the viscoelastic heel pad was no more beneficial than doing exercises and ultra-sound alone. They concluded that the claimed value of viscoelastic heel pads widely used by athletes with Achilles tendonitis could not be substantiated.

2.22 CONCLUSION

There is a paucity in the literature in terms of the chiropractic treatment of Achilles tendonitis. It is recommended by Clement, Taunton, Smart (1984) that the mortise and sub-talar joints be assessed for motion and end-feel, and the restoration of motion is hypothesised by the authors to be beneficial. However, there are no studies to date on the effect of adjusting these joints in testing the efficacy of this theory.

CHAPTER THREE

MATERIALS AND METHODS

3.1 INTRODUCTION

In this chapter a detailed description of the design of the study, the methods employed in data collection, as well as the statistical methods used for the analysis and interpretation of the data, will be discussed.

This study was designed as a prospective, single-blinded, comparative, placebo-controlled study, with patients being randomly assigned to either group. This study included 40 patients that were accepted into the study based on a set of inclusion criteria. An inter-group analysis was performed to determine whether or not adjusting foot and ankle joint fixations was a superior treatment to placebo in the management of subacute and chronic Achilles tendonitis. An intra-group analysis was also done to assess whether there were any differences within each group.

3.2 THE SUBJECTS

The study was limited to patients presenting to the Technikon Natal with subacute and chronic Achilles tendonitis. These patients were obtained by means of advertisements placed in local newspapers, notice boards placed around the Technikon campus, and at various sporting facilities. Patients were screened for admissibility into the trial according to their case history (Appendix A), physical examination (Appendix B), and foot and ankle regional examination (Appendix C).

Patients in both groups were assessed for fixations of all the joints of the foot and ankle, using motion palpation techniques outlined by Brantingham (1999).

3.3 INCLUSION AND EXCLUSION CRITERIA OF PATIENTS

3.3.1 THE INCLUSION CRITERIA

A diagnosis of Achilles tendonitis was made if the first two of the following criteria and at least two of the other criteria were present (Chazan 1998 b):

1. A history of pain and pain at the time of presentation that localised to the inferior aspect of the posterior calf, Achilles tendon and heel.
2. Tenderness to palpation along the tendon from its insertion into the calcaneus and the 5-6 centimetres proximal thereto.
3. Generalised swelling in the lower calf and Achilles tendon.
4. Increased warmth over the tendon.
5. Reduced passive or active dorsiflexion with pain.
6. Stiffness within the lower calf and Achilles tendon
7. Crepitus along the tendon.

In addition to this

- 1) Patients had to be between the ages of 15 and 60 years.
- 2) Only those patients diagnosed by the researcher to have subacute or chronic Achilles tendonitis were considered for this study.
- 3) All patients included in the study were required to sign an informed consent form
(Appendix F)

3.3.2 THE EXCLUSION CRITERIA

1. If the patient required X rays for suspected pathologies. These would include advanced degenerative disease, septic arthritis, fractures, neuropathy, and metastatic diseases which would contra-indicate adjusting (Brantingham 1998).
2. Patients on anti-coagulant therapy, and those with bleeding disorders. (Kirkaldy-Willis and Burton, 1992: 291).
3. Their Achilles tendonitis was associated with disorders such as tumors, cholesterol deposits and seronegative arthropathies such as ankylosing spondylitis (McLaughlan and Tytherleigh-Strong, 1996).
4. They were on any form of medication for the tendonitis.
5. They re-injured their Achilles tendon during the course of the trial.
6. They were receiving any other treatment for their Achilles tendonitis.
7. They embarked upon any stretching of the Achilles.
8. The patient presented with a positive Thompson's test.
The patient had instability in the foot and ankle joints.

3.4 THE SAMPLE GROUP

Initially the study required 60 patients, however, after six months fifty-one subjects were entered into the study, with only forty patients completing the course of treatment (22% non-compliance) the researcher was granted a patient reduction to forty subjects for the study. Participants were randomly allocated to two groups by drawing a number one or two out of a hat. Patients drawing a one were assigned to treatment Group 1, and patients

drawing a two number were assigned to Group 2. Patients in Group 1 received manipulation, while patients in Group two received de-tuned ultrasound. The patients were not informed as to which group they were assigned in terms of placebo.

3.5 INTERVENTIONS

Patients in both groups were informed of all the procedures involved in the study, and that they had a 50% chance of receiving a sham treatment (Appendix E).

Patients in Group 1 received manipulations to all fixations found in the foot and ankle as outlined by Bergmann *et al.* (1993: 704-720). Patients in Group 2 received a course of detuned ultrasound. Patients in both groups received 6 treatments within a one-month period, with visits evenly spaced apart.

3.6 THE DATA

The data used in this study was of two kinds: primary and secondary.

3.6.1 THE PRIMARY DATA

The primary data includes the following:

- Case history (Appendix A)
- Physical examination (Appendix B)
- Foot and ankle regional examination (Appendix C)
- Patients' ankle dorsiflexion range of motion (Appendix I) was assessed using a J Tech Autogon 11 goniometer. Diamond *et al.* (1989) reported very high intra-examiner reliability ranging between 0,74 and 0,99 and high interexaminer reliability ranging between 0,58 to 0,89 for measuring maximum ankle dorsiflexion. According

to Leach, James and Waselewski (1981) a common finding in patients with Achilles tendonitis is a loss of passive ankle dorsiflexion, thus it is hypothesised that an increase in dorsiflexion range of motion will suggest improvement in the condition.

- The patients' pain perception was assessed by the use of the Short-Form McGill Pain Questionnaire (Appendix G) and the Numerical Pain Rating Scale-101 (Appendix H).
- An algometer reading (Appendix I), for pressure pain threshold, was taken over the point of most pain. This device was re-calibrated 6 months before it was used in this study.
- Motion palpation findings (Appendix K)

The researcher had prior training and experience in using the goniometer and algometer, which was gained in the Certification in Chiropractic Foot Care course conducted in 1999.

3.6.2 SECONDARY DATA

Current literature was obtained from journals, textbooks, internet, CD Mantis and Medline, which contained information pertaining to sub-acute and chronic Achilles tendonitis.

3.7 MEASUREMENTS

3.7.1 METHOD OF MEASUREMENT

The subjective and objective measurements were taken at the first, second, third, and sixth visits. These measurements allowed for the assessment of any change of the condition, especially early on, as any initial improvements would be considered clinically important.

3.7.1.1 SUBJECTIVE MEASUREMENTS

3.7.1.1.1 The numerical pain rating scale

The numerical pain rating scale (Appendix H) was used to assess the perceived level of pain intensity (quantitative) of the patients (Jenson, Karoly and Braver 1986).

3.7.1.1.2 The short form McGill pain questionnaire

The short form McGill pain questionnaire (Appendix G) was used to acquire data as to the sensory, and affective pain (qualitative). It allows for rapid acquisition of data, and is simple in nature to apply. (Melzack 1987.)

3.7.1.2 OBJECTIVE MEASUREMENTS

Objective assessments of the changes in the patients' condition during the treatment were performed using an algometer and an extremity goniometer. These were used to obtain objective data with regards to the patients' level of pain and range of motion respectively.

3.7.1.2.1 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 Achilles. The dial on the algometer was initially set to zero, and the one-centimeter rubber disc was applied to the marked spot. The pressure at which the pain or discomfort was first felt when the algometer was applied to the specific site was recorded (Appendix I). The researcher stopped applying pressure as soon as the patient first indicated they were experiencing pain. The pressure readings were taken at the 1st, 2nd, 3rd, and 6th visit for both groups.

3.7.1.2.2 The Extremity Goniometer

Range of motion measurements are often used to record patient progress in clinical practice and research (Wilson et al. 1998). The goniometer is used to assess for dysfunction and to evaluate the efficacy of the treatment. The goniometer is often used to measure the range of motion at the ankle joint in dorsiflexion. (Youdas et al. 1993.)

Dorsiflexion was measured using the technique tested and described by Jonson and Gross (1997).

3.8 THE SPECIFIC TREATMENT OF EACH OBJECTIVE

3.8.1 THE FIRST OBJECTIVE

The first objective was to determine the efficacy of adjusting foot and ankle fixations in comparison to detuned ultrasound, in terms of subjective clinical findings in the treatment of sub-acute and chronic Achilles tendonitis.

3.8.2 THE SECOND OBJECTIVE

The second objective was to determine the efficacy of adjusting foot and ankle fixations, in comparison to detuned ultrasound, in terms of objective clinical findings in the treatment of sub-acute and chronic Achilles tendonitis.

3.9 HOW THE DATA WAS SECURED

Data was collected from the patients that were treated at the Technikon Natal Chiropractic Day clinic. This data was recorded in each patient's file at the aforementioned times of data collection.

Questionnaires completed by the patients were completed under the researcher's supervision to ensure that they were completed correctly. Figures obtained from the questionnaires were converted into percentages or ratios. The data gathered from the two groups were recorded separately.

The continuous data was treated as follows:

- The amount of dorsiflexion at the ankle, recorded in degrees, was recorded separately for both groups.
- The algometer readings in kg/cm^2 , were recorded separately for the two groups.
- The scores of the Numerical pain rating scale – 101 were represented as a percentage.
- The data was statistically analysed using a 95% level of confidence

The categorical data was treated as follows:

- The fixations found were recorded separately for the two groups.
- The McGill Short Form Pain Questionnaire was represented as a whole number, not as a ratio.
- The data was statistically analysed using a 95% level of confidence

3.10 STATISTICAL ANALYSIS

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

3.10.1 TREATMENT OF THE DATA

1. The scores from measuring the ankle dorsiflexion range of motion were represented as degrees.
2. The scores from measuring the Achilles tendon tenderness were measured in kilograms per square centimeter.
3. Statistical analyses were performed once all the data was collected.

3.10.2 METHODS OF DATA ANALYSIS

Since the sample sizes were small (21 in the treatment group and 19 in the placebo group), parametric and non-parametric tests were used in the analysis of the data. These tests included the Mann-Whitney U-test and the Wilcoxon Signed Rank test (non-parametric). The unpaired t-test was used to compare the means of the continuous data, that is the NRS and the algometer readings (parametric).

3.10.3 HYPOTHESIS TESTING AND THE DECISION RULE

a) FOR THE MANN-WHITNEY U-TEST AND THE UNPAIRED T-TEST:

The Null hypothesis (H_0) states that there will be no difference between the two groups whilst the Alternative hypothesis (H_1) states that there will be a difference between the two groups.

For a two tailed test:

Ho: There is no difference between the two groups.

H1: There is a difference between the two groups.

$\alpha = 0.05$ = Level of significance.

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

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

b) FOR THE PAIRED-T TEST AND THE WILCOXON SIGNED RANKS TEST:

The Null hypothesis (Ho) states that there will be no improvement between consultations whilst the Alternative hypothesis (H1) states that there will be an improvement between consultations.

For a one tailed test:

Ho: There is no improvement between the consultations.

H1: There is an improvement between the consultations.

$\alpha = 0.05$ = Level of significance.

Reject Ho if $P \leq \alpha = 0.5$

Accept Ho if $P > \alpha = 0.5$

P: was the observed level of significance.

3.10.3.1 Procedure one: Comparison between Groups 1 and 2 (continuous variables)

The unpaired t-test was used for continuous variables testing between Group 1 and Group 2. Unpaired t-tests were used at the $\alpha = 0.05$ level of significance, to compare the two groups at treatment one, two, three, and six.

The purpose of conducting unpaired t-tests was to determine whether or not there were any significant differences between the two treatment groups with respect to the NRS-101 and the algometer readings.

3.10.3.2 Procedure two: Comparison between Groups 1 and 2

The Mann-Whitney U-test was used to compare the two groups. The groups were treated as being independent of one another. Mann-Whitney U-Tests were used at the $\alpha = 0.05$ level of significance, to compare the two groups at treatment one, two, three, and six. The purpose of conducting Mann-Whitney U-tests was to determine whether or not there were any differences between the two treatment groups with respect to the McGill and goniometer readings.

3.10.3.3 Procedure three: Comparison between related samples within Group 1

Wilcoxon Signed Rank Tests were used at a 95 % level of confidence (5% level of Significance). These tests were used to determine whether or not there were any statistically significant improvements within Group 1, between the 1st and 2nd treatment, between the 1st and 3rd treatment, and between the 1st and 6th treatment with respect to the McGill and Goniometer readings.

For a one tailed test:

Reject H_0 if $P \leq \alpha = 0.5$

Accept H_0 if $P > \alpha = 0.5$

P: was the observed level of significance

**3.10.3.4 Procedure four: Comparison between related samples within
Group 1**

Paired t-tests were used at a 95 % level of confidence. ($\alpha = 0.05$)

These tests were used to determine whether or not there were any changes within group one, between the 1st and 2nd treatment, between the 1st and 3rd treatment, and between the 1st and 6th treatment, with respect to the NRS-101 and the Algometer readings.

**3.10.3.5 Procedure Five: Comparison between related samples within
Group 2**

Procedures 3 and 4 were repeated for continuous and discrete variable within Group 2 with the same decision rules.

3.10.3.6 Procedure six: Comparison using bar charts

Bar charts were constructed to present major findings of the study as a visual summary of results obtained from the data. Bar charts were constructed using the computer software package named Excel 97

CHAPTER FOUR

THE RESULTS

4.1 INTRODUCTION

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

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

4.2 ABBREVIATIONS

Group 1: Adjustment Group

Group 2: Placebo Group

McGill: McGill Short Form Pain Questionnaire

NRS-101: Numerical Pain Rating Scale -101

GON: Ankle dorsiflexion range of motion

ALG: Algometer readings in kg per squared centimeter

SD: Standard deviation

4.3 DEMOGRAPHIC DATA

Age distribution.

Table 4.1

Age	Group 1 (n =)	Group 2 (n =)	Total %
15-24	2	3	12
25-34	4	6	25
35-44	3	4	18
45-54	12	4	40
55-65	0	2	5

Gender distribution.

Table 4.2

Gender	Group 1 (n =)	Group 2 (n =)	Total %
Male	14	12	63
Female	8	7	37

Race distribution

Table 4.3

Race	Group 1 (n = 21)	Group 2 (n = 19)	Total %
White	16	10	65
Indian	3	8	27,5
Coloured	1	2	7,5
Black	0	0	0

Reasons for research subjects not completing treatment period.

Lack of transport	3
Moved to another city	2
Got better before the end of treatment	1
No time to continue treatment	4
Had another form of treatment and was excluded	1
Total	11
Percentage Non-complying	22%

Occupations

Table 4. 4

Occupation	Group 1	Group 2
Professional persons	3	6
Sales	7	4
Managerial	3	2
Administration	2	4
Self-employed	7	4
Unemployed	5	5
Bank broker	1	3

Chronicity of the tendonitis

Table 4. 5

Chronicity	Group 1	Group 2	Total %
Subacute	1	0	2.5
Chronic	20	19	97.5

4.4 CLINICAL DATA

4.4.1 PARAMETRIC TESTING

A comparison of Group 1 and Group 2 using the unpaired t-test to analyse the continuous data at Visit 1.

Table 4.6.1

TREATMENT 1							
	Group 1				Group 2		
	mean	SD	variance	P-value	mean	SD	variance
NRS	44.857	17.778	3.8796	0.646	47.395	16.814	3.857
ALG	3.686	1.547	.33875	0.226	3.1053	1.4203	.3258

The null hypothesis is thus accepted ($P \geq 0.025$) for the Numerical Pain Rating Scale-101 and the algometer readings, which indicate that at the $\alpha=0.05$ level of significance there was no significant difference between Groups 1 and 2 at treatment one.

A comparison of Group 1 and Group 2 using the unpaired t-test to analyse the continuous data collected from visit two.

Table 4.6.2

TREATMENT 2							
	Group 1				Group 2		
	mean	SD	Variance	P-value	mean	SD	variance
NRS-101	39.1667	18.7865	4.0996	0.187	46.7632	16.7716	3.8477
ALG	4.0952	1.3441	.2933	0.004	2.8684	1.1809	.2709

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

The null hypothesis is rejected ($p \leq 0.025$) for the algometer readings which indicates that at the $\alpha=0.05$ level of significance there was a significant difference between Groups 1 and 2 at the second visit.

A comparison of Group 1 and Group 2 using the unpaired t-test to analyse the continuous data at visit three.

Table 4.6.3

TREATMENT 3							
	Group 1				Group 2		
	mean	SD	Variance	P-value	mean	SD	variance
NRS-101	31.7857	20.9807	4.5784	0.022	46.8421	18.5750	4.2614
ALG	4.2904	1.2280	.2680	0.001	2.8158	1.2602	.2891

The null hypothesis is rejected ($p \leq 0.025$) for the Numerical pain Rating scale-101 which indicates that at the $\alpha=0.05$ level of significance there was a significant difference between Groups 1 and 2 at the third visit.

The null hypothesis is rejected ($p \leq 0.025$) for the algometer readings which indicates that at the $\alpha=0.05$ level of significance there was a significant difference between Groups 1 and 2 at the third visit.

A comparison of Group 1 and Group 2 using the unpaired t-test to analyse the continuous data at the last visit.

Table 4.6.4

TREATMENT 6							
	Group 1				Group 2		
	mean	SD	Variance	P-value	mean	SD	variance
NRS-101	19.0000	17.3746	3.7914	0.000	45.0000	18.1812	4.1711
ALG	4.8571	1.4627	.3192	0.000	2.7211	1.2757	.2927

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

The null hypothesis is rejected ($p \leq 0.025$) for the Algometer readings which indicates that at the $\alpha=0.05$ level of significance there was a significant difference between Groups 1 and 2 at the final visit.

4.4.2 NON-PARAMETRIC TESTS

A comparison of Group 1 and Group 2 using the Mann-Whitney U-test to analyse the discrete data to assess inter group changes between consultations.

Table 4.7.1

Results: p-values

McGill 1: 0.694

McGill 2: 0.045

McGill 3: **0.012**

McGill 6: **0.000**

The null hypothesis is accepted ($p \geq 0.025$) for the McGill at the first and second visit, which indicates that at the $\alpha=0.05$ level of significance there was no significant difference between Groups 1 and 2.

The null hypothesis is rejected ($p \leq 0.025$) for the McGill, at the 3rd and 6th visit which indicates that at the $\alpha=0.05$ level of significance there was a significant difference between Groups 1 and 2.

p-values

Goniometer 1: 0.858

Goniometer 2: 0.119

Goniometer 3: **0.002**

Goniometer 6: **0.000**

The null hypothesis is accepted ($p \geq 0.025$) for the goniometer readings at the 1st and 2nd visits, which indicates that at the $\alpha=0.05$ level of significance there was no significant difference between Groups 1 and 2.

The null hypothesis is rejected ($p \leq 0.025$) for the goniometer readings at the 3rd and 6th visit, which indicates that at the $\alpha=0.05$ level of significance there was a significant difference between Groups 1 and 2.

A comparison of results within Group 1 using the paired t-test to analyse the continuous data and changes between consultations.

Table 4.7.2

	<u>p-values</u>
NRS1-NRS2:	0.001
NRS1-NRS3:	0.000
NRS1-NRS6:	0.000
ALG1-ALG2:	0.004
ALG1-ALG3:	0.002
ALG1-ALG6:	0.000

The null hypothesis is rejected ($p \leq 0.050$) for the NRS-101 readings between the 1st and 2nd, 1st and 3rd, 1st and 6th visit which indicates that at the $\alpha = 0.05$ level of significance there was a significant improvement between consultations.

The null hypothesis is rejected ($p \leq 0.050$) for the algometer readings between the 1st and 2nd, 1st and 3rd, 1st and 6th visit which indicates that at the $\alpha = 0.05$ level of significance there was a significant improvement between consultations.

A comparison of the results within Group 1 using the Wilcoxon Signed Rank Test to analyse the discrete data collected between the 1st and 2nd visit.

Table 4.7.3

GROUP 1							
	TREATMENT 1				TREATMENT 2		
	mean	SD	median	P-value	Mean	SD	median
McGill	13.95	9.95	12.00	0.001	8.71	7.81	8.00
Goniometer	24.33	6.51	25.00	0.000	27.38	6.23	26.00

The null hypothesis is rejected ($p \leq 0.05$) for the both the McGill Short Form Pain Questionnaire and the Goniometer readings, which indicates that at the $\alpha=0.05$ level of significance there was a significant improvement between visits one and two within Group 1.

A comparison of the results within Group 1 using the Wilcoxon Signed Rank Test to analyse the discrete data collected between the 1st and 3rd visits.

Table 4.7.4

GROUP 1							
	TREATMENT 1				TREATMENT 3		
	mean	SD	median	P-value	mean	SD	median
McGill	13.95	9.95	12.00	0.000	6.81	6.42	5.00
Goniometer	24.33	6.51	25.00	0.000	31.14	5.35	30.00

The null hypothesis is rejected ($p \leq 0.05$) for the both the McGill Short Form Pain Questionnaire and the Goniometer readings, which indicates that at the $\alpha=0.05$ level of significance there was a significant improvement between visits one and three within Group 1.

A comparison of the results within Group 1 using the Wilcoxon Signed Rank Test to analyse the discrete data collected between the 1st and final visit.

Table 4.7.5

GROUP 1							
	TREATMENT 1				TREATMENT 6		
	mean	SD	median	P-value	mean	SD	median
McGill	13.95	9.95	12.00	0.000	3.71	5.87	2.00
Goniometer	24.33	6.51	25.00	0.000	33.43	5.76	32.00

The null hypothesis is rejected ($p \leq 0.05$) for the both the McGill Short Form Pain Questionnaire and the Goniometer readings, which indicates that at the $\alpha=0.05$ level of significance there was a significant improvement between the first and final visit within Group 1.

A comparison of the results within Group 2 using the paired t-test to analyse the continuous data collected between the 1st and 2nd, 1st and 3rd and 1st and final visit.

Table 4.7.6

	<u>p-values</u>
Pair 1: NRS1-NRS2:	0.278
Pair 2: NRS1-NRS3:	0.674
Pair 3: NRS1-NRS6:	0.028
Pair4:ALG1-ALG2:	0.075
Pair5:ALG1-ALG3:	0.109
Pair6:ALG1-ALG6:	0.043

The null hypothesis is accepted ($p > 0.050$) for the NRS-101 readings between the 1st and 2nd, 1st and 3rd visit, which indicates that at the $\alpha=0.05$ level of significance there was no improvement between consultations.

The null hypothesis is rejected ($p \leq 0.050$) for the NRS-101 readings between the 1st and final visit, which indicates that at the $\alpha=0.05$ level of significance there is a significant improvement between consultations.

The null hypothesis is accepted ($p > 0.050$) for the algometer readings between the 1st and 2nd, 1st and 3rd visit, which indicates that at the $\alpha=0.05$ level of significance there was no improvement between consultations.

The null hypothesis is rejected ($p \leq 0.050$) for the algometer readings between the 1st and final visit, which indicates that at the $\alpha=0.05$ level of significance there is a significant improvement between consultations.

A comparison of the results within Group 2 using the Wilcoxon Signed Rank Test to analyse the discrete data collected between the 1st and 2nd visit.

Table 4.8.1

GROUP 2							
	TREATMENT 1				TREATMENT 2		
	mean	SD	median	P-value	mean	SD	median
McGill	13.05	7.31	13.00	0.360	13.58	56.28	13.00
Goniometer	25.89	6.18	25.00	0.391	25.63	6.02	23.00

The null hypothesis is accepted ($p > 0.050$) for the both the McGill Short Form Pain Questionnaire and the Goniometer readings, which indicates that at the $\alpha=0.05$ level of significance there was no improvements between visits one and two within group two.

A comparison of the results within Group 2 using the Wilcoxon Signed Rank Test to analyse the discrete data collected between the 1st and 3rd visit.

Table 4.8.2

GROUP 2							
	TREATMENT 1				TREATMENT 3		
	mean	SD	median	P-value	mean	SD	median
McGill	13.05	7.31	13.00	0.475	13.63	8.67	13.00
Goniometer	25.89	6.18	25.00	0.058	24.58	6.74	22.00

The null hypothesis is accepted ($p > 0.050$) for the both the McGill Short Form Pain Questionnaire and the Goniometer readings, which indicates that at the $\alpha=0.05$ level of significance there was no improvements between visits one and three within Group 2.

A comparison of the results within Group 2 using the Wilcoxon Signed Rank Test to analyse the discrete data collected between the 1st and final visit.

Table 4.8.3

GROUP 2							
	TREATMENT 1				TREATMENT 6		
	mean	SD	median	P-value	mean	SD	median
McGill	13.05	7.31	13.00	0.959	12.95	8.16	13.00
Goniometer	25.89	6.18	25.00	0.042	24.05	6.78	23.00

The null hypothesis is accepted ($p > 0.050$) for the McGill Short Form Pain

Questionnaire, which indicates that at the $\alpha=0.05$ level of significance there was no improvement between visits one and six within Group 2.

The null hypothesis is rejected ($p < 0.05$) for the Goniometer readings, which indicates that at the $\alpha=0.05$ level of significance there was an improvement between visits one and six within

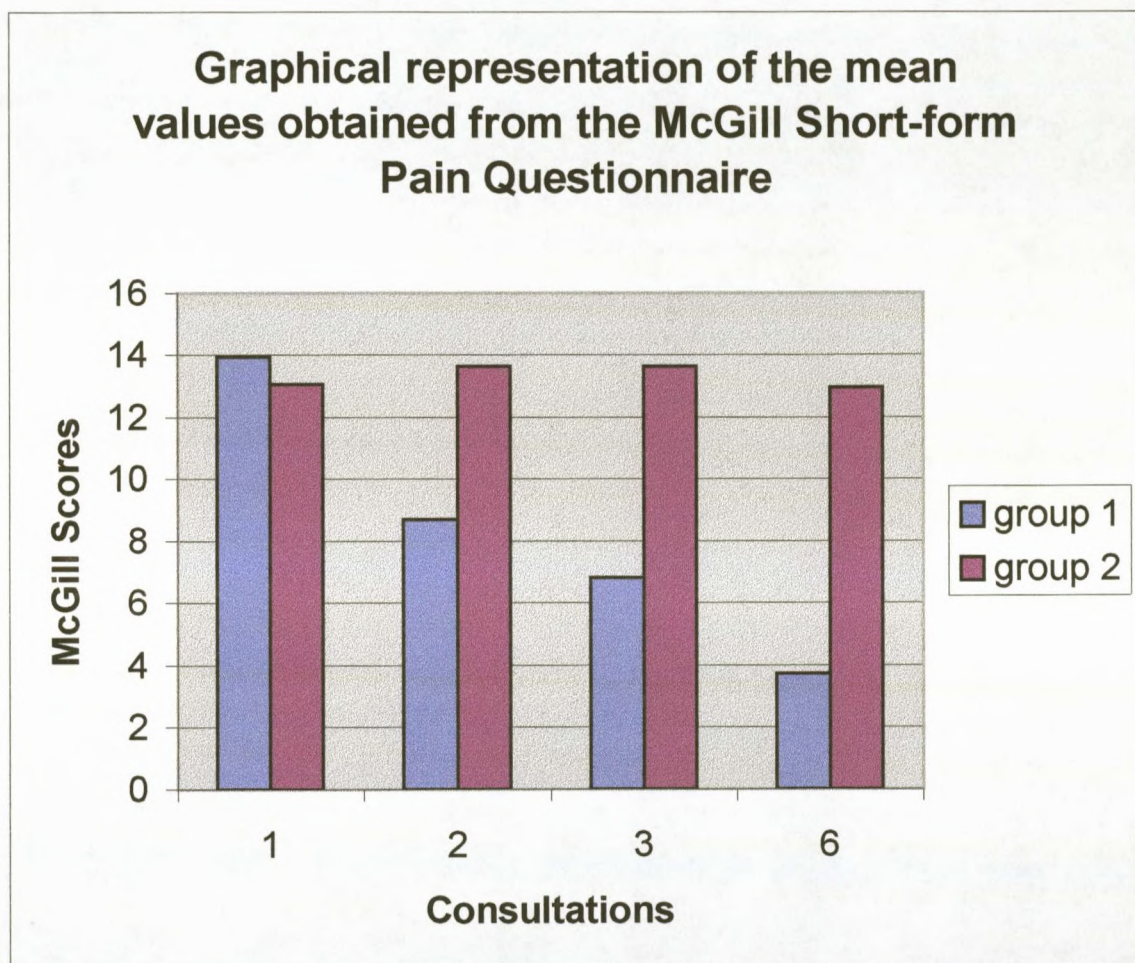
Group 2.

4.5 MOTION PALPATION FINDINGS

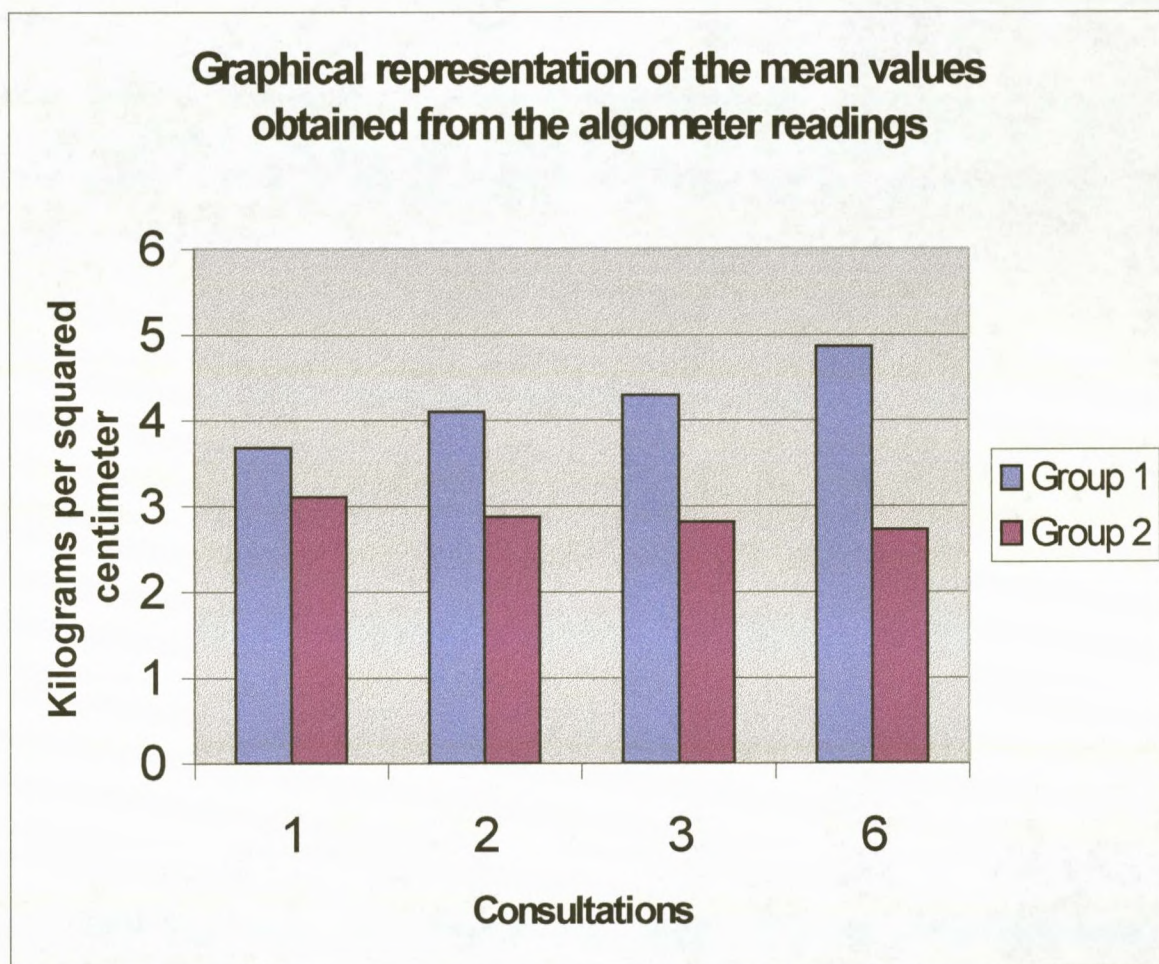
~~Restrictions found in order of prevalence~~

Mortice joint: Long axis distraction joint play	34 (38.0%)
Subtalar joint: Long axis distraction joint play.....	19 (21.6%)
Subtalar joint: Valgus or eversion end feel.....	17 (19.3%)
Mortice joint: Plantar flexion end feel.....	9 (10.2%)
First metatarsal (first ray): Plantar flexion with eversion end feel	7 (7.9%)
Mid tarsal joint: Lateral P-A shear joint play	6 (6.8%)
Mid tarsal joint: Medial P-A shear joint play	5 (5.7%)
Mortice joint: Dorsiflexion end feel	3 (3.4%)
Subtalar joint: Varus or inversion end feel	3 (3.4%)
First metatarsal (first ray): Dorsiflexion with inversion end feel	3 (3.4%)
Mid tarsal joint: Medial A-P shear joint play	2 (2.2%)
Hiss test: clockwise circumduction	2 (2.2%)
Metatarsophalangeal and Interphalangeal Joints: P-A joint play	1 (1.1%)
Intermetatarsal glide: Between the 2 nd and 3 rd metatarsal heads	1 (1.1%)
Small Tarsals: Dorsal to plantar joint play	1 (1.1%)
Mortice joint: Posterior to anterior joint play	1 (1.1%)

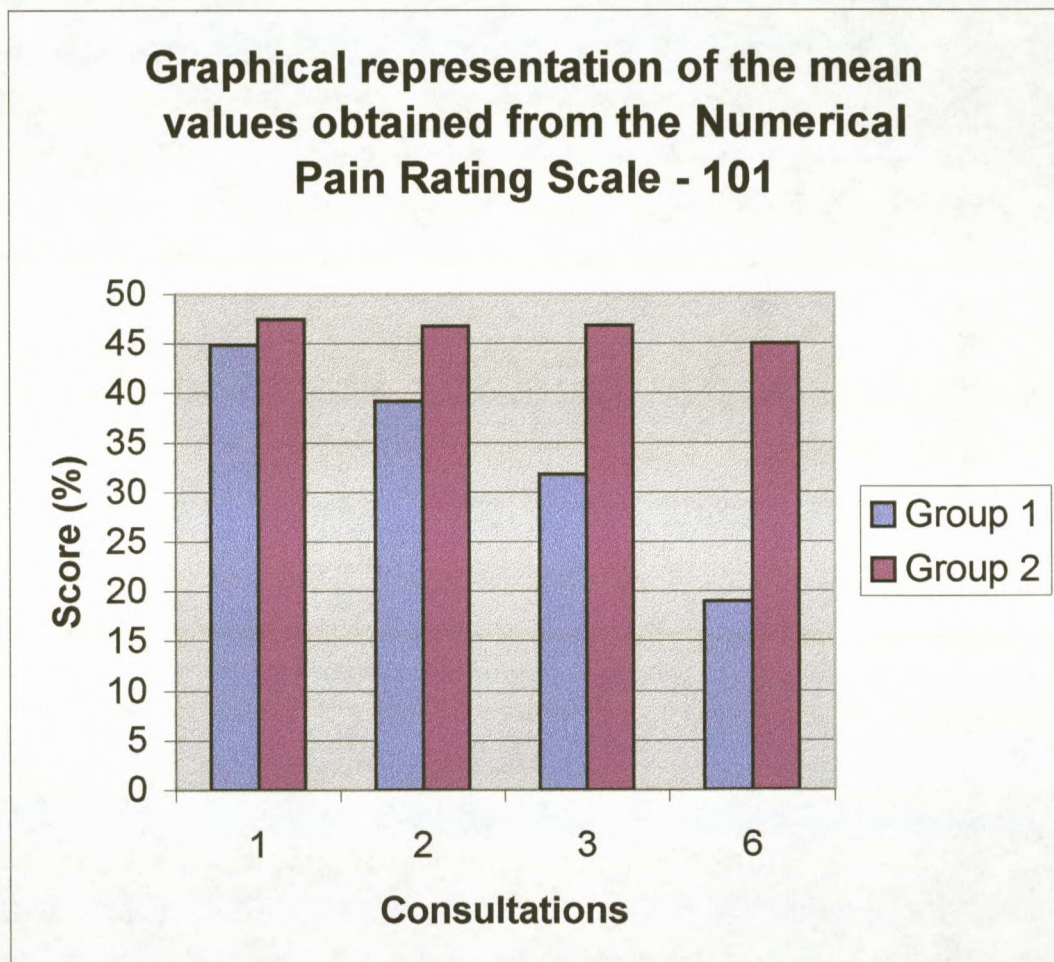
GRAPH 1



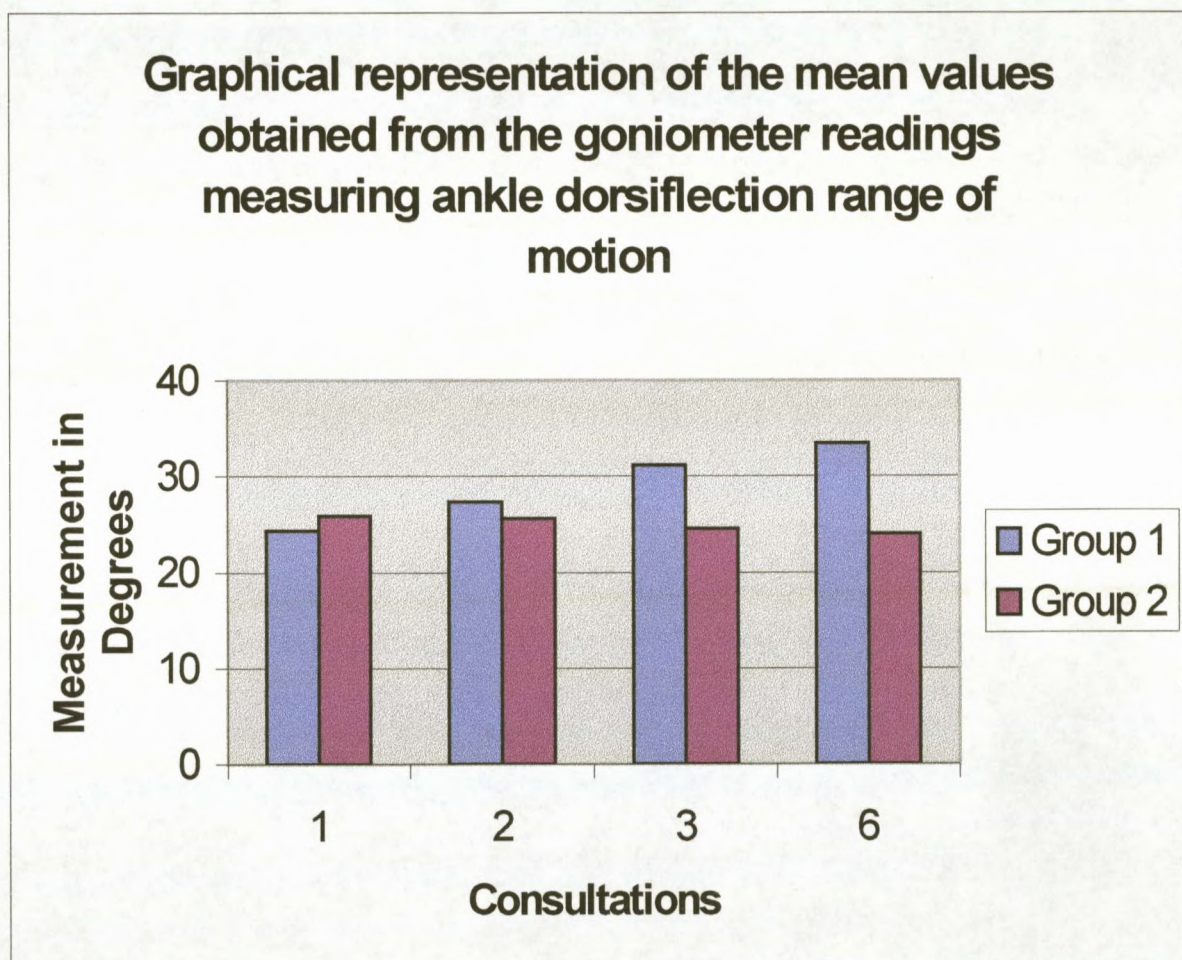
GRAPH 2



GRAPH 3



GRAPH 4



CHAPTER FIVE

DISCUSSION OF RESULTS

5.1 INTRODUCTION

The results obtained from the Numerical Pain Rating Scale-101, the McGill Short Form Pain Questionnaire, the goniometer readings and the algometer readings will be discussed in this chapter.

Evaluation of the inter-group data obtained at the 1st treatment shows the base line results before the course of treatment. Evaluation of the results from the 3rd and final visits show the relatively longer term effects of the two protocols.

The analysis of the subjective and objective intra-groups results between the 1st and final treatments represent the efficacy of the treatment regimes within each treatment group.

The inter-group evaluation of the final treatment measurements indicate which treatment is more effective.

The results are discussed below in two separate sections:

1. The inter-group comparison
2. The intra-group comparison

Each section is composed of statistical evaluations of both the subjective and objective data. The appropriateness of this format lends to ease of use with which these results can be critically assessed.

5.2 INTER-GROUP COMPARISONS

5.2.1 THE SUBJECTIVE DATA

The subjective data is comprised of the results from the Numerical Pain Rating Scale-101 and the McGill Short Form Pain Questionnaire. On statistical analysis, no significant differences could be found between the two groups at the 1st treatment. This suggests that the symptoms, in terms of pain intensity and quality, were initially similar between the two groups.

5.2.1.1 McGill Short Form Pain Questionnaire (Table 4.7.1)

There were no differences between the two groups at the 2nd visit, however, a significant difference in the results between both groups was detected for the McGill Short Form Pain Questionnaire at the 3rd and final visits. This suggests that adjusting foot and ankle fixations was superior to placebo in reducing the patients' quality of pain as early as after only two treatments. The results from the placebo group indicate that there were no significant improvements between the first and final visit with respect to the quality and intensity of pain.

5.2.1.2 Numerical Pain Rating Scale-101 (Table 4.6.1)

The statistical analysis of the Numerical Pain Rating Scale-101 showed that there were no differences between the two groups at the 2nd visit, however, there were significant differences between the groups at the third and final (6th) visit. This suggests that adjusting foot and ankle fixations was more efficacious than placebo in reducing the patients perception of his / her percentage pain level of intensity.

The results from the placebo group indicate that there were no significant improvements between the first and fourth visit, however, there was a difference between the first and final visit with respect to the quality and intensity of pain

5.2.2 THE OBJECTIVE DATA

The objective data is comprised of the results from the goniometer and algometer readings. Statistical analysis did not indicate any significant differences between the two groups at the 1st treatment. This suggests that the objective findings were initially similar in nature.

5.2.2.1 Goniometer readings (Table 4.7.2)

Statistical analysis of the goniometer readings indicate no difference at the 1st and 2nd visits, however, a significant difference between the groups at the 3rd and final visits existed. The results from the placebo group indicate that there were no significant improvements between the first and third visits, however, there was a difference between the first and final visits with respect to the ankle dorsiflexion range of motion. This suggests that adjusting foot and ankle fixations was more efficacious than placebo in improving the patients dorsiflexion range of motion at the ankle joint.

5.2.2.2 Algometer Readings (Table 4.6.1 - 4.6.4)

Statistical analysis of the algometer readings did not reveal any significant differences between the two groups at the first treatment, however a significant difference existed at the 2nd, 3rd, and final consultations. The results from the placebo group indicate that there were no significant improvements between the first and third visits however there was a difference between the first and final visits with respect to patients pain threshold level.

This suggests that adjusting foot and ankle fixations was more efficacious than placebo in improving the patients' pain threshold level.

5.3 INTRA-GROUP TREATMENT COMPARISONS

5.3.1 SUBJECTIVE DATA

5.3.1.1 McGill Short Form Pain Questionnaire (Table 4.7.4 – 4.7.6)

Statistical analysis within Group 1 showed that there were significant differences between the 1st and 3rd and 1st and final treatments. This suggests that adjusting foot and ankle fixations is an effective treatment in reducing the quality and intensity of the pain experienced by the patient. No significant difference was found between the 1st and final treatments within Group 2, thus placebo therapy was not effective in reducing the quality and intensity of the pain. These findings conclude that adjusting foot and ankle fixations to reduce of quality and intensity of the pain is superior to placebo.

5.3.1.2 Numerical Pain Rating Scale-101 (Table 4.7.3)

Statistical analysis within Group 1 revealed that there was a significant difference between the 1st and 2nd, 1st and 3rd, and 1st and final treatments. This suggests that adjusting foot and ankle fixations is an effective treatment in reducing the percentage of pain intensity.

A significant difference was found between the 1st and final visit within Group 2 (Table 4.8.1). This suggests that the placebo is also effective in reducing the percentage of pain intensity. A natural history of this disorder will account for some improvement within both groups. These findings conclude that adjusting foot and ankle fixations to reduce the percentage of pain intensity is superior to placebo.

5.3.2 OBJECTIVE DATA

5.3.2.1 Goniometer Readings (Tables 4.7.4 – 4.7.6)

Statistical analysis within Group 1 revealed that there was a significant difference between the 1st and 2nd, 1st and 3rd, and 1st and final treatments. This suggests that adjusting foot and ankle fixations is an effective treatment in improving the dorsiflexion range of motion at the ankle.

A significant difference was found between the 1st and final visit within Group 2 (Tables 4.8.2 – 4.8.4) This suggests that the placebo was also effective in improving the dorsiflexion range of motion at the ankle.

5.3.2.2 Algometer Readings (Table 4. 7. 4)

Statistical analysis within Group 1 revealed that there were significant improvements between the 1st and 2nd, 1st and 3rd, and 1st and final treatments. This suggests that adjusting foot and ankle fixations is an effective treatment in improving pain threshold along the Achilles tendon.

A significant difference was found between the 1st and final visit within Group 2 (Table 4.8.1). This suggests that the placebo was also effective in improving the pain threshold along the Achilles tendon.

The findings of this research were congruent with the recommendations made by Clement, Taunton and Smart (1984), where it was recommended that one should focus on restoring motion in the sub-talar and mortice joints in the treatment of Achilles tendonitis.

From the list of all the restrictions found in the subjects of the study (pg 87), it can be seen that by far most of the restrictions were found in the subtalar and mortice joints.

The results indicate that there was a clear difference between the Groups 1 and 2, this in agreement with the hypothesis of Clement, Taunton and Smart (1984).

5.4 OTHER STUDIES

There are currently only two randomised controlled trials investigating the treatment of Achilles tendonitis; Astron and Westlin (1992) and Bader and Mowat (1984). This suggests that there is scope for further research into the treatment of this condition and that this study is another step forward in determining more effective forms of treatment for Achilles tendonitis.

5.5 LIMITATIONS OF THIS STUDY

5.5.1 SUBJECTIVE MEASUREMENTS

As a result of the questionnaires being filled in under the supervision of the researcher (i.e the lack of blinding) in order to oversee that they were filled in correctly, there was always the possibility that the patient may try to please the researcher by recording lower scores indicating an improvement that was not actually there. However, this procedure was not isolated to one group and therefore did not prejudice one group more than the other.

5.5.2 OBJECTIVE MEASUREMENTS

Two areas of potential error in using the universal goniometer are examiner error and instrument error. Sporting, occupational and recreational activities at times lead to Achilles tendon stiffness and pain, which altered the expected results when the measurements were done.

It is also important to note that all the motion palpation, adjustments and measurements were done by a sixth year Chiropractic student and not by an experienced doctor of Chiropractic.

5.5.3 DEMOGRAPHICS

The majority of the patients in this study were males (63%) and were between 45 and 55 years old (40%). This is consistent with other studies, thus identifying a target population for those most at risk of developing Achilles tendonitis. It is also evident from the data that only one black African person took part in this study. He dropped out of the study due to transport problems, so this study was not a true representation of the population in this province or country. A possible reason for this is that black people in South Africa have had little exposure to Chiropractors, and as yet, it is not their custom to visit a Chiropractor for musculo-skeletal pain. Furthermore, it is also possible that the social structure within the area the advertisements were placed, would impact more on the white and English speaking population than the black and Zulu speaking population.

According to Curwin (1996: 45), the natural history for this condition is usually 12 weeks with treatment, although if a patient seeks treatment for a continuing chronic condition after many months of symptoms, recovery can sometimes take as long as two years. The patients that took part in this study were treated within a 4 week period and the majority of them improved significantly, thus the likelihood that the patients would have improved as much regardless of the treatment given is small.

It is also important to note that the patients' stage of healing is a significant determinant of how long it will take for full recovery. The duration of time following injury does not always indicate the stage of healing. In an acute injury with the time of injury known, it is much easier to ascertain the stage of healing, but in a chronic injury it is likely that the patient is constantly re-injuring his tendon, making it more difficult to place the patient into one of the stages of healing.

The ratio between sub-acute and chronic was uneven as there was only one patient in the trial that was in the subacute stage. This possibly occurred because the tendonitis wasn't severe enough to warrant treatment initially, and the patients might have thought that the condition may improve by itself. Taking this into account, the title of the study should perhaps have read: The Efficacy of Adjusting Foot and Ankle Fixations and the Treatment of Chronic Achilles Tendonitis.

CHAPTER SIX

RECOMMENDATIONS AND CONCLUSIONS

6.1 RECOMMENDATIONS

The patients that took part in this research were seen over a four-week period. It is recommended that this time should have been reduced to 2 weeks as this allows a more accurate assessment of improvement, and reduces the potential amount of variables as a lot could happen in four weeks to re-aggravate the Achilles tendon. Ironically if the 2 week option had been chosen, many patients would have had to be excluded as the study was interrupted by public holidays and other such disruptions that affected the regularity of the treatment intervals.

In research of this nature involving assessment of the extensibility of the Achilles tendon, patient compliance, especially in terms of resting from sporting or other activities is questionable. Muscular and tendon stiffness as a result of activity would most certainly compromise the readings. In further research of this nature some form of live-in environment should be created so as to eliminate this effect, by preventing activities which could further strain the Achilles tendon, although the financial burden of this scale of research would for most researchers be impossible.

In future studies it is recommended that researchers incrementally add other modalities to assess their relative efficaciousness as well as assessing the effectiveness between them and adjusting the joints of the foot and ankle.

Stratified randomisation procedures should be used taking age, gender, race, and occupation into account. This would allow a more homogenous sample and produce

more valid conclusions. Furthermore, patients should be stratified based on the severity of the injury (Grade I and Grade II), and whether or not they participate in sports, as this may lead to uneven distributions between the treatment groups occurring by chance.

It is further recommended that blinding in the form of an objective observer taking the readings rather than the researcher should be incorporated as this will improve the validity of the study.

6.2 CONCLUSIONS

This is the first time that a study of this nature has been done in testing the efficacy of adjusting the joints of the foot and ankle in the treatment of subacute and chronic Achilles tendonitis. This study has produced statistically highly significant results of significant clinical importance, indicating that adjusting foot and ankle fixations is an effective intervention for sub-acute and chronic Achilles tendonitis.

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TECHNIKON NATAL CHIROPRACTIC DAY CLINIC
CASE HISTORY

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

FOR CLINICIAN'S USE ONLY

Initial visit clinician: _____ Signature: _____

Case History:

Examination:

Previous:

Current:

X-Ray Studies:

Previous:

Current:

Clinical Path. lab:

Previous:

Current:

Case Status:

PTT:

Conditional:

Signed Off:

Final Sign out:

Recommendations:

Intern's Case History

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

3. Present Illness:

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

4. Other Complaints:

5. Past Medical History:

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

6. Current health status and life-style:

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

7. Immediate Family Medical History:

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

8. Psychosocial history:

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

9. Review of Systems:

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

Pulses:

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

Percussion: - borders of heart

Auscultation:

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

4. RESPIRATORY EXAMINATION

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

Inspection

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

Palpation

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

Percussion

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

Auscultation

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

5. ABDOMINAL EXAMINATION

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

Inspection

- Shape:
- Scars:
- Hernias:

Palpation

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

Percussion - Rebound tenderness:

- Ascites:
- Masses:

Auscultation - Bowel sounds:

- Arteries (aortic, renal, iliac, femoral, hepatic)

Rectal Examination

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

6. G.U.T EXAMINATION

External genitalia:

Hernias:

Masses:

Discharges:

7. NEUROLOGICAL EXAMINATION

Gait and Posture - Abnormalities in gait:

- Walking on heels (L4-L5):
- Walking on toes (S1-S2):
- Rombergs test (Pronator Drift):

Higher Mental Function - Information and Vocabulary:

- Calculating ability:
- Abstract Thinking:

G.C.S.:

- Eyes:
- Motor:
- Verbal:

Evidence of head trauma:

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

- Kernigs sign:

Cranial Nerves:

I Any loss of smell/taste:

Nose examination:

II External examination of eye: - Visual Acuity:

- Visual fields by confrontation:

- Pupillary light reflexes = Direct:

= Consensual:

- Fundoscopy findings:

- III Ocular Muscles:
Eye opening strength:
- IV Inferior and Medial movement of eye:
- V
 - a. Sensory
 - Ophthalmic:
 - Maxillary:
 - Mandibular:
 - b. Motor
 - Masseter:
 - Jaw lateral movement:
 - c. Reflexes
 - Corneal reflex
 - Jaw jerk
- VI Lateral movement of eyes
- VII
 - a. Motor
 - Raise eyebrows:
 - Frown:
 - Close eyes against resistance:
 - Show teeth:
 - Blow out cheeks:
 - b. Taste
 - Anterior two-thirds of tongue:
- VIII General Hearing:
Rinnes = L: R:
Webers lateralisation:
Vestibular function
 - Nystagmus:
 - Rombergs:
 - Wallenbergs:
 Otoscope examination:
- IX & X Gag reflex:
Uvula deviation:
Speech quality:
- XI Shoulder lift:
S.C.M. strength:
- XII Inspection of tongue (deviation):

Motor System:

- a. Power
 - Shoulder = Abduction & Adduction:
= Flexion & Extension:
 - Elbow = Flexion & Extension:
 - Wrist = Flexion & Extension:
 - Forearm = Supination & Pronation:
 - Fingers = Extension (Interphalangeals & M.C.P's):
 - Thumb = Opposition:
 - Hip = Flexion & Extension:
= Adduction & Abduction:

- Knee = Flexion & Extension:
- Foot = Dorsiflexion & Plantar flexion:
- = Inversion & Eversion:
- = Toe (Plantarflexion & Dorsiflexion):

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

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

Sensory System:

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

Cerebellar function:

Obvious signs of cerebellar dysfunction:

- = Intention Tremor:
- = Nystagmus:
- = Truncal Ataxia:

Finger-nose test (Dysmetria):

Rapid alternating movements (Dysdiadochokinesia):

Heel-shin test:

Heel-toe gait:

Reflexes:

Signs of Parkinsons:

8. **SPINAL EXAMINATION:**(See Regional examination)

Obvious Abnormalities:

Spinous Percussion:

R.O.M:

Other:

9. **BREAST EXAMINATION:**

Summon female chaperon.

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

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

APPENDIX C

Foot and ankle regional examination

Patient: _____ File no: _____ Date: _____
Intern / Resident _____ Signature: _____
Clinician: _____ Signature: _____

Observation

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

Swelling _____
Heloma dura / molle _____
Skin _____
Nails _____
Shoes _____
Contours (achilles tendon, bony prominences) _____

Active movements

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

Resisted Isometric movements:

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

Passive movement motion palpation

(Passive ROM quality, ROM overpressure, joint play)

Ankle joint: Plantarflexion _____ Dorsiflexion _____
Talocrural: Long axis distraction _____
Subtalar joint: Varus _____ Valgus _____
First ray: Dorsiflexion _____ Plantarflexion _____
Circumduction of forefoot on fixed rearfoot: _____
Midtarsal: A-P glide _____ P-A glide _____ rotation _____
Tarso metatarsal joints: A-P _____

Intermetatarsal glide: _____
Metatarsophalangeal dorsiflexion (with associated plantar flexion of each toe) _____

Interphalangeal joints: *long axis distraction* _____ *A-P glide* _____
lat and med glide _____ *rotation* _____

Neurological: Dermatomes _____
Reflexes _____

Special tests

Anterior drawer test _____
Talar tilt _____
Thompson test _____
Homan sign _____
Tinel's sign _____
Subtalar neutral position _____
Balance/proprioception _____
Test for rigid/flexible flatfoot _____
Kleiger test (med. deltoid) _____

Alignment

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

Palpation

Anteriorly

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

Posteriorly

Calcaneus _____
Achilles tendon _____
Musculotendinous junction _____

Plantarily

Plantar muscles and fascia _____
Sesamoids _____

<i>Patient Name:</i>		<i>File #:</i>	<i>Page:</i>
<i>Date:</i>	<i>Visit:</i>	<i>Intern:</i>	<i>Clinician:</i>
<i>S:</i>			<i>A:</i>
<i>O:</i>			<i>P:</i>
			<i>E:</i>
<i>Special attention to:</i>		<i>Next appointment:</i>	
<i>Date:</i>	<i>Visit:</i>	<i>Intern :</i>	<i>Clinician:</i>
<i>S:</i>			<i>A:</i>
<i>O:</i>			<i>P:</i>
			<i>E:</i>
<i>Special attention to:</i>		<i>Next appointment:</i>	
<i>Date:</i>	<i>Visit:</i>	<i>Intern: :</i>	<i>Clinician:</i>
<i>S:</i>			<i>A:</i>
<i>O:</i>			<i>P:</i>
			<i>E:</i>
<i>Special attention to:</i>		<i>Next appointment:</i>	

PATIENT INFORMATION LETTER

Dear patient

Welcome to this research study. You have been selected to participate in a clinical trial comparing two different forms of treatment for your Achilles tendonitis. One of the treatments is a placebo treatment; i.e. there will be no benefits and no side effects from the treatment.

There will be two groups containing 30 patients in each. You have a 50% chance of being in either group. You will receive a course of six treatments within a one-month period. During this study you will not be able to receive any other form of treatment for your condition, and you are asked not to engage in any new or similar activities that risk further injury.

Treatment is free of charge, and for the duration of the study will be under the supervision of a qualified Chiropractor. You are free to withdraw from the study at any time, no explanations required.

Your full co-operation in this study will assist the Chiropractic profession by providing new information on a topic that has never been studied before, thereby increasing the available knowledge and benefiting the profession as a whole.

Thank you,

Yours sincerely,

Jason Gaymans

(6th year Chiropractic resident)

INFORMED CONSENT FORM

(To be completed by patient / subject)

Date : _____

Title of research project : _____

Name of supervisor : _____

Name of research student : _____

Please circle the appropriate answer YES NO

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

If you have answered NO to any of the above, please obtain the necessary information before signing

Please Print in block letters:

Patient /Subject Name:..... Signature:.....

Parent/ Guardian:..... Signature:.....

Witness Name:..... Signature:.....

Research Student Name:..... Signature:.....

APPENDIX G

Short-form McGill Pain Questionnaire (SF-MPQ)
Ronald Melzack (1984)

Date: _____ File no.: _____ Visit no: _____

Patient name: _____

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

Numerical Rating Scale - 101 Questionnaire

Date: _____ File no: _____ Visit no: _____

Patient name: _____

Please indicate on the line below, the number between 0 and 100 that best describes the pain you experience when it is at its worst. A zero (0) would mean “no pain at all”, and one hundred (100) would mean “pain as bad as it could be”.

Please write only **one** number.

Please indicate on the line below, the number between 0 and 100 that best describes the pain you experience when it is at its least. A zero (0) would mean “no pain at all” and one hundred (100) would mean “pain as bad as it could be”.

Please write only **one** number.

PATIENT PAIN THRESHOLD (ALGOMETER) AND GONIOMETER READINGS.

PATIENT NAME:.....

FILE NUMBER:.....

GROUP:.....

DATE:.....

Visit:

	ALGOMETER READINGS (Kg/cm)	GONIOMETER READINGS (Degrees)
VISIT 1		
VISIT 2		
VISIT 3		
VISIT 6		

Accessory Joint Motions of the Foot and Ankle

Mortice joint:

- Dorsiflexion end feel
- Plantar flexion end feel
- Long axis distraction joint play
- Posterior to anterior joint play
- Anterior to posterior joint play

Subtalar joint:

- Varus or inversion end feel
- Valgus or eversion end feel
- Long axis distraction joint play
- Rotary (fig 8) calcaneal combination accessory motion

Midtarsal joint:

- Medial: A-P shear joint play
P-A shear joint play
- Lateral: A-P shear joint play
P-A shear joint play
- Adduction: Combined accessory joint motion
- Abduction: Combined accessory joint motion
- Brantingham modification of the Hiss test: clockwise circumduction
: counterclockwise circumduction

Small Tarsals:

- Dorsal to plantar joint play
- Plantar to dorsal joint play
- Varus (inversion)
- Valgus (eversion)

First Metatarsal (First ray)

- Dorsiflexion with inversion end feel
- Plantarflexion with eversion end feel

Metatarsophalangeal and Interphalangeal Joints:

- Long axis distraction joint play
- Anterior to posterior joint play
- Posterior to anterior joint play
- Rotation (medial)
- Rotation (Lateral)
- Lateral to medial glide
- Medial to lateral glide

(CCFC 1999)

Adjustments for the following reduced accessory joint motions:

Mortice joint:

- Long axis distraction
- Anterior to posterior glide
- Posterior to Anterior glide
- Lateral to medial or medial to lateral glide
- Tibiotalar distraction

Subtalar joint:

- Subtalar distraction
- **Subtalar glide**

Midtarsal joints:

- Plantar to dorsal glide- cuboid, navicular, cuneiform
- Dorsal to plantar glide-tarsal push

Tarso-metatarsal joints:

- Plantar to dorsal metatarsal
- Navicular-cuneiform-1st ray distraction

Intermetatarsal joints:

- Anterior to posterior and posterior to anterior glide

Metatarsophalangeal joints:

- Medial to lateral glide – 1st metatarsophalangeal joint

Interphalangeal joints:

- Posterior to anterior
- Anterior to posterior
- Lateral to medial
- Medial to lateral
- Axial rotation

(CCFC 1999)

MOTION PALPATION FINDINGS

Restrictions found in order of prevalence

Mortice joint: Long axis distraction joint play.....	34 (38%)
Subtalar joint: Long axis distraction joint play.....	19 (21.6%)
Subtalar joint: Valgus or eversion end feel.....	17 (19.3%)
Mortice joint: Plantar flexion end feel.....	9 (10.2%)
First metatarsal (first ray): Plantar flexion with eversion end feel.....	7 (7.9%)
Mid tarsal joint: Lateral P-A shear joint play.....	6 (6.8%)
Mid tarsal joint: Medial P-A shear joint play.....	5 (5.7%)
Mortice joint: Dorsiflexion end feel.....	3 (3.4%)
Subtalar joint: Varus or inversion end feel.....	3 (3.4%)
First metatarsal (first ray): Dorsiflexion with inversion end feel.....	3 (3.4%)
Mid tarsal joint: Medial A-P shear joint play.....	2 (2.2%)
Hiss test: clockwise circumduction.....	2 (2.2%)
Metatarsophalangeal and Interphalangeal Joints: P-A joint play.....	1 (1.1%)
Intermetatarsal glide: Between the 2 nd and 3 rd metatarsal heads.....	1 (1.1%)
Small Tarsals: Dorsal to plantar joint play.....	1 (1.1%)
Mortice joint: Posterior to anterior joint play.....	1 (1.1%)