THE EFFICACY OF MANIPULATION OF THE ELBOW JOINT IN PATIENTS SUFFERING FROM LATERAL EPICONDYLITIS

by

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I, Bradley Scott Roodt, do hereby declare that this dissertation is representative of my own work.

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ABSTRACT

The purpose of this investigation was to perform a placebo controlled, randomised clinical study to determine the efficacy of manipulative therapy of the elbow, based on motion palpation findings, in the treatment of lateral epicondylitis.

Forty patients participated in the study, all of who underwent a case history, physical examination, and elbow regional examination. They were then randomly assigned to one of the two groups, so that twenty patients received manipulative therapy of the elbow, and the remainder of the patients received detuned ultrasound.

All patients received 6 treatments over a 3-week period, with subjective and objective data being collected before the first, third and sixth treatments. The short-form McGill pain questionnaire and the NRS101 questionnaire where used to monitor each patients subjective response, while algometer and dynamometer readings were taken to provide objective data. Motion palpation of the symptomatic elbow was performed on all patients before treatments 1, 3, and 6.

Examination of the statistical data reveals that there was no significant difference in improvement between the two groups, ie. manipulative therapy of the elbow was found to be no more

effective in the treatment of tennis elbow than detuned ultrasound. However due to limitations in study design, such as the small sample size and the lack of blinding, it is recommended that further investigations be conducted in order to determine the role of this treatment in the management of tennis elbow. It is also worthwhile considering that motion palpation, which is similar to a grade 3 or 4 mobilization in it's application, may have had a therapeutic effect on the placebo group. Although both groups would have been affected similarly by the motion palpation procedure, it may nonetheless have influenced the subjective and objective findings of the placebo group to the extent that it adversely affected intra-group analysis of placebo group data, and therefore, the overall result.

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DEFINITIONS

Palpation: a) The act of feeling with the hands. b) The application of variable manual pressure through the surface of the body for the purpose of determining the shape, size, consistency, position, inherent motility, and health of the tissues beneath (Bergmann et al. 1993:762).

Motion Palpation: Used to determine the joints in dysfunction and the specific direction of motion loss. The level of joint dysfunction and the direction in which the joint fails to function determine the level of the manipulation and the line of drive of a manipulative force (Haldeman 1992:305).

Restriction: Limitation of movement. Describes the direction of limited movement in subluxated and/or dysfunctional joints (Bergmann et al. 1993:762).

Manipulation: Therapeutic application of manual force. Spinal manipulative therapy broadly defined includes all procedures where the hands are used to mobilize, adjust, manipulate, apply traction, massage, stimulate, or otherwise influence the spine and paraspinal tissues with the aim of influencing the patients health (Bergmann et al. 1993:760).

Adjustment: The chiropractic adjustment is a specific form of direct articular manipulation utilizing either long or short leverage techniques with specific contacts. It is characterized by a dynamic thrust of controlled velocity, amplitude and direction (Bergmann et al. 1993:754).

CHAPTER 1

1.1. INTRODUCTION

Lateral epicondylitis is an overuse syndrome affecting 1-3% of all adults (Sharat and Maffulli 1997), and up to 50% of all tennis players (Kamien 1990; Field and Savoie 1998), with its peak incidence occurring between the ages of 30 and 55 (Jackson 1997). It is reported to be four times more common in the fourth decade of life than in any other decade (Coonrad and Hooper 1973). The syndrome is rarely seen in individuals under the age of 30 (Ernst 1992). Nearly one third of all cases will be severe enough to limit daily activity.

The term lateral epicondylitis is most frequently used to describe an overuse syndrome characterized by a macroscopic tear of the extensor carpi radialis brevis tendon (Coonrad and Hooper 1973; Wadsworth 1987) or, less frequently, of the extensor digitorum tendon with the enthesis showing altered collagen content, a reduction in cell numbers and ground substance, and increased lipid deposition. These changes are thought to predispose to injury (Ernst 1992)

It occurs as the result of repetitive overload of the wrist extensors (Field and Savoie 1998), and according to Fu and Stone (1994:540), mechanical factors play an important role in the pathogenesis of this problem. Unskilled tennis players may place the elbow under greater stress through faulty swing mechanics, with the backhand being the most common swing to initiate symptoms (Nirschl 1979). Many of these patients are middle-aged athletes who tend to lack the tissue resiliency of their younger years (Jackson 1997).

The wrist extensors may also be overloaded under other conditions such as work involving repetitive activities, especially with flexion-extension or pronation-supination movements, or when carrying heavy loads.

According to Hyde and Gengenbach (1997:282), a loss of joint play at the radiocapitellar or proximal radioulnar joint are common, and a gentle, high velocity, low-amplitude manipulation is essential in such cases, possibly requiring several applications to restore full accessory mobility.

1.2. THE STATEMENT OF THE PROBLEM

The purpose of this investigation was to perform a placebo controlled, randomised clinical study to determine the efficacy of chiropractic manipulative therapy of the elbow in the treatment of lateral epicondylitis.

1.3. OBJECTIVES OF THE STUDY

1.3.1. The first objective was to determine the efficacy of manipulative therapy of the elbow in the treatment of lateral epicondylitis, in terms of objective measures.

1.3.2. The second objective was to determine the efficacy of manipulative therapy of the elbow in the treatment of lateral epicondylitis, in terms of subjective measures.

1.4. HYPOTHESES

1.4.1 Hypothesis One

It was hypothesised that manipulative therapy of the elbow would be effective in decreasing pain and disability in patients with lateral epicondylitis.

1.4.2 Hypothesis Two

It was hypothesised that manipulative therapy of the elbow would be more effective than placebo ultrasound in the management of patients with lateral epicondylitis.

1.5. BENEFITS OF THE STUDY

According to Ernst (1992), the ideal remedy for tennis elbow has not yet been found. He suggests that the initial treatment should be conservative with physical methods being tried first as they rarely harm and often help.

Tennis elbow can produce a long-lasting, severe medical condition with possible economic implications such as sick-leave, workers

compensation claims, transfer to lower paying jobs, and possible early retirement (Viola 1998).

Even though there is a growing interest within the chiropractic profession with regards to the diagnosis and manipulation of extravertebral joint dysfunction, no placebo-controlled study has yet been conducted with regards to the manipulative treatment of lateral epicondylitis. Shaik (2000) expressed the opinion that it would be of interest to ascertain the effectiveness of chiropractic manipulation based on motion palpation findings of the elbow versus placebo in the treatment of lateral epicondylitis. The results of this study will hopefully contribute to determining the role of chiropractic manipulative therapy in the successful management of lateral epicondylitis.

CHAPTER 2

2.1. INTRODUCTION

This chapter will concern itself with the relevant literature pertaining to lateral epicondylitis, as well as highlighting problems in its management.

According to Wadsworth (1987), tennis elbow is one of the commonest lesions of the arm and although it is sometimes used as a blanket term for a variety of pathological conditions affecting the lateral compartment of the elbow, most authors believe that degenerative changes in the enthesis of the extensor carpi radialis brevis muscle are a key factor (Nirschl and Pettrone 1979, Ernst 1992).

2.2. INCIDENCE

Lateral epicondylitis affects approximately 1-3% of the general population (Verhaar 1996, Bourne 1997), with a considerably greater incidence in manual workers. The syndrome is rarely seen in people under the age of 30, with a peak incidence in the fourth decade of life. No reliable data documenting the incidence of this condition in South Africa has been found, however Ernst (1992)

reported that the condition is more common in white people, and Wadsworth (1987) stated that black people are rarely affected. It is therefore likely that the incidence of lateral epicondylitis may be lower in South Africa than in Europe or North America because of South Africa's large black population.

2.3. AETIOLOGY AND PATHOLOGY

Kivi (1982) stated that the main cause (61.4%) of tennis elbow was over-exertion of the finger and wrist extensors resulting in pain over the lateral epicondyle. He added that although isometric exertion of the forearm has not drawn much attention as an aetiological factor, it is a considerable risk in manual workers. Sudden repetitive movement at work and trauma were said to be less significant as causative factors.

According to Coonrad and Hooper (1973), the syndrome is initiated by micro/macroscopic tears at the origins of the extensor muscle groups where degenerative changes have occurred in the tendon fibres. Stress or trauma then tears the weakened fibres. Of 39 surgically treated patients, 28 demonstrated tears of the extensor or flexor tendon cuff- 22 were superficial and 6 were deep (with an intact superficial portion). In 11 patients an actual tear was not noted, but in 9 of these, scar tissue replacement of the tendon could be demonstrated. In 2 cases, no definite lesion other than the

presence of minute calcareous deposits was observed. Microscopic studies of the torn margins of tendon that were seen in the 28 patients showed round cell infiltration, scattered foci of fine calcification, and scar tissue with marginal areas of cystic degeneration. In some cases fibrinoid degeneration was evident. In the 9 patients who displayed no macroscopic evidence of a tear, the abnormal appearing tissue in the aponeurosis adjacent to the epicondyle contained scar tissue similar to that seen in those patients with gross tears. Macroscopic and microscopic foci of calcification were observed at the epicondylar origin in the 2 patients who showed no gross evidence of an aponeurotic tear.

Granulation tissue, which contains plentiful nerve endings (Kamien 1990), may be largely responsible for the pain experienced in lateral epicondylitis according to Viola (1998).

2.4. CLINICAL PRESENTATION AND DIAGNOSIS

Tennis elbow is characterized by lateral epicondylar pain and tenderness with disability (Sharat and Maffulli 1997). The pain may be sudden or gradual in onset, and there is often a history of repetitive movement. The discomfort is frequently aggravated by gripping and may radiate to the forearm. Range of motion is usually normal although there may be a slight loss of terminal extension in acute-on-chronic cases. Aching and morning stiffness, are also

frequently reported by patients (Field and Savoie 1998). Tennis players usually experience maximum pain when playing backhand strokes. General activities that cause pain, include shaking hands, turning door handles, lifting teapots, and shaving with an electric razor (Kamien 1990). Rest generally improves symptoms temporarily.

Pain can be reproduced over the lateral epicondyle using the following provocative manoeuvres:

1) Resisted wrist extension- the wrist is extended against resistance with the forearm pronated and extended, and the fingers gently clenched (Wadsworth 1987).

2) Forced elbow extension- the forearm is held fully pronated and the wrist flexed while the elbow is passively extended (Wadsworth 1987).

3) Resisted third finger extension- the elbow is extended, the forearm pronated, and the fingers extended, while the middle finger is actively extended against resistance (Wadsworth 1987).

4) Palpation of the lateral epicondyle, which reveals palpatory tenderness (Sharat and Maffulli 1997).

2.5. DIFFERENTIAL DIAGNOSIS

Other conditions that may be the source of lateral elbow pain include radial tunnel syndrome, osteochondritis dissecans, radiocapitellar arthritis, cervical nerve root entrapment, lateral ligamentous strain, supinator myofascial trigger points and posterolateral plicas.

Radial tunnel syndrome pain differs from that of tennis elbow with the area of maximal tenderness usually being more distal, in the proximal forearm at the leading edge of the supinator muscle. The pain is often more vague, diffuse and aching in nature. Lateral epicondylitis and radial tunnel syndrome can, however, occasionally occur together (Field and Savoie 1998).

Osteochondritis dissecans generally occurs in younger patients presenting with diffuse elbow pain of insidious onset, and a decreased range of motion (loss of full extension). Patients sometimes complain of intermittent locking of the elbow, and there may be crepitation with a resisted range of motion (Field and Savoie 1998).

Arthritis of the radiocapitellar joint can be differentiated from tennis elbow by application of an axial load combined with gentle passive supination and pronation. This test compresses the radio-capitellar

joint and may cause pain if there is articular degeneration, but does not usually exacerbate lateral epicondylitis if the wrist is maintained in a neutral position (Field and Savoie 1998).

Posterolateral plicas produce pain along the posterolateral elbow, and there may be associated popping or catching. The lesion is easily palpated in the posterolateral gutter (Field and Savoie 1998).

Cervical nerve root entrapment. In addition to elbow pain, there may also be neck pain with restricted range of motion. Lateral flexion towards the affected side may reproduce the elbow pain. Palpation over C4, C5 and C6 may reproduce the pain and/or be particularly tender (Thomson et al. 1991:62).

Lateral ligamentous strain can be confirmed by performing a ligamentous instability test with the elbow extended and the radioulnar joint supinated (Thomson et al. 1991:62).

Myofascial trigger points of the supinator muscle: A combination of epicondylar pain and pain at the base of the thumb, on percussion of the lateral epicondyle, strongly suggests an active supinator trigger point. Thumb motion is usually not restricted and is often painless. (Travell and Simons 1983 1:514).

2.6. TREATMENT

Many treatments (including rest, ultrasound, laser, steroid injection, cross friction, manipulation, bracing and surgery) have been suggested in the treatment of tennis elbow, indicating that the ideal remedy has not yet been found (Ernst 1992). Viola (1998) added that although the conservative treatment of this condition has been investigated in a number of clinical studies, there is no unanimous agreement as to the most effective therapy. However, most agree that a conservative approach should be employed at first, reserving the more radical interventions for the small percentage of resistant cases.

Viola (1998) emphasises the importance of substantiating an effective, non-invasive, conservative therapy for this condition.

2.6.1. Rest and Activity Modification

Reduced elbow activity is frequently advised (Ernst 1992), and may result in the resolution of symptoms in some patients (Wadsworth 1987). Elimination of painful activities is considered important, and complete rest is obtained through the use of a moulded cast or splint with the wrist held in supination and extension, and the elbow in a position of flexion (Sharat and Maffulli 1997). Jackson (1997) suggests that the management of tennis elbow begin with rest and avoidance of any activities that lead to pain.

2.6.2. Ultrasound

Lundeberg, Abrahamsson, et al. (1988) conducted a randomised control study comparing continuous ultrasound, placebo ultrasound and rest in epicondylalgia. Of 99 patients, 33 were randomly allocated to receive continuous ultrasound, 33 to placebo ultrasound, and the remaining 33 to rest. Clinical assessment at each visit included a pain score using a visual analogue scale, an evaluation of resisted wrist dorsiflexion, and a grip strength test with the elbow extended. The results showed no difference in recovery in patients receiving continuous or placebo ultrasound treatment. When comparing continuous ultrasound with rest there was a statistically significant reduction in pain in patients receiving the ultrasound treatment.

A randomised, blinded clinical trial conducted by Binder et al. (1985) demonstrated that pulsed ultrasound enhanced recovery in 63% of cases. 29% of the patients in the placebo group recovered without any other treatment which, the authors felt, might reflect the benefits of careful supervision, increased rest, and natural remission but may also have resulted from the massage effect of the transducer head over the affected area during mock treatment. The authors did however note that by serial assessment of clinical variables, they were able to confirm that the rate of recovery was significantly better in treated patients than in the placebo group, and later review

suggested a lower incidence of recurrence in the patients who responded to ultrasound.

Haker and Lundeberg (1991) investigated the effects of pulsed ultrasound compared to placebo in the treatment of lateral epicondylitis. Each session was for 10-minute, 2-3 times per week, with each patient receiving a total of 10 treatments in all. Follow-ups were done at 3 and 12 months. They found no significant statistical difference in the subjective or objective outcomes between the groups after the treatments or at the follow-ups.

2.6.3. Laser

A randomised, blinded study to investigate the effects of placebo versus laser on tennis elbow was conducted by Lundeberg, Haker, et al. (1987). The results showed that laser was not significantly better than placebo in the treatment of the condition.

Krasheninnikoff et al. (1994) concurred that no difference existed between laser and placebo, in the management of lateral epicondylitis.

Low power laser was found to have an effect over placebo in a clinical trial conducted by Vasseljen et al. (1992), however the authors concluded that the modality is of limited value as a sole

treatment, and added that further studies were necessary to evaluate the reliability of their findings.

2.6.4. Corticosteroid Injection

Price et al. (1991) compared local injections of 2ml lignocaine with either 10mg triamcinolone or 25mg hydrocortisone made up to 2ml with 1% lignocaine. Within the first 8 weeks, the response to the steroid preparations was significantly better than for lignocaine but at 24 weeks, the degrees of improvement were similar for all three groups with many patients still complaining of pain. Relapse was common, with post-injection worsening of the pain, which was sometimes severe and persistent and occurred in approximately half of all steroid treated patients. Skin atrophy was reported in all groups but was more frequent amongst those given triamcinolone.

In a clinical series of patients who had already failed to respond to oral drug treatment, rest and physiotherapy, thus acting as their own controls, Bourne (1997) found corticosteroid injection to be an effective means of treating epicondylitis. Of the 27 patients in the series, 63% of patients recorded an excellent result with pain relief for at least 6 months, 26% had pain relief that required re-injection during the first 6 months, and 11% reported no benefit from the injections.

According to Hertling and Kessler (1996:221), corticosteroid injection often provides dramatic symptomatic relief, but has no permanent beneficial effect on the pathological process involved.

The major benefit of corticosteroid injections is the anti-inflammatory action, so it's use should be confined to those situations where active inflammation is present (Fu and Stone 1994:541).

2.6.5 Surgery

Approximately 10% of tennis elbow cases will not respond to conservative therapy (Wadsworth 1987). Ernst (1992) suggests that a course of steroid injections be tried, and surgery only considered if the steroid injections fail to provide pain relief.

Several surgical techniques have been described for tennis elbow. According to Viola (1998), some of the most common surgical techniques are:

1) Excision of part of the extensor origin together with excision of the orbicular ligament.
2) Denervation.
3) Distal tendon lengthening of the affected muscle.
4) Total release of the extensor musculature from the lateral epicondyle.

Nirschl (1988) suggests that surgery be individualized to the circumstance. The basic concept is to identify pathological changes, resect abnormal tissue, and repair adjacent healthy tissue.

Kamien (1990) emphasizes the fact that tennis elbow is nearly always a self-limiting condition, and suggests a very conservative attitude towards surgical intervention. Surgery is only considered if there has been 12 months of failed conservative therapy with a level of residual pain which interferes with daily living, or in the well balanced patient who is anxious to get back to work or tennis and who, after 6 months of pain, is pessimistic about the outcome of further conservative management.

Operative treatment may present with a difficult problem for further management, particularly when lateral surgical release has been unsuccessful (Wadsworth 1987).

2.6.6 Cross Friction Massage

Deep friction massage has been advocated as a treatment for tennis elbow, and is intended to restore mobility of the involved structure by promoting the orientation of immature collagen along the lines of stress, and by stimulating tissue maturation (Hertling and Kessler 1996:220). The possible therapeutic effects of this

modality in the treatment of tennis elbow, awaits elucidation (Viola 1998).

Shaik (2000) conducted a prospective, controlled study in order to determine the relative effectiveness of cross friction with Mill's manipulation compared to cross friction alone in the treatment of lateral epicondylitis. Statistical analysis revealed that there was no significant difference in improvement between the two groups in terms of subjective or objective data between treatments 1,3,6 or at the one-month follow-up.

2.6.7 Percutaneous Cervical Rhizotomy

Percutaneous cervical rhizotomy involves making a thermic lesion in the sensory ganglion of a cervical segmental nerve, under roentgenological control. In a study conducted by Sanders (1996), rhizotomy C6 was carried out 27 times and rhizotomy C5, 26 times. Twelve patients returned within 2 years for a second treatment. All were followed up for at least 2 years after the last intervention. Results were excellent in 42% (pain free with normal elbow function and strength), moderate in 31% (mitigation of pain by more than 50% and limited elbow function), and poor in 27% (no benefit). The author concluded that percutaneous cervical rhizotomy should be considered first before resorting to surgical procedures.

2.6.8 Acupuncture

Brattberg (1983) found acupuncture to be an effective treatment protocol in the management of tennis elbow, in a control study. 34 patients underwent acupuncture, 31 of which had been afflicted for over 6 months. 24 patients had previously received one or more steroid injections. The control group comprised 26 patients who were treated solely with steroid injections, 11 of whom had been afflicted for over 6 months. 21 of the 34 patients treated with acupuncture reported that they were completely free of pain, while only 8 of the 26 patients who received steroid injections showed a corresponding improvement.

2.6.9 Bracing

The effect of standard and aircast tennis elbow bands on integrated electromyography (IEMG) of the forearm extensor musculature proximal to the brace, was investigated by Mackler and Epler (1989). Ten healthy human subjects, aged 20-43, were tested. The standard band did not produce a statistically significant reduction in IEMG of the extensor carpi radialis brevis or extensor digitorum communis, however the Aircast did cause a significant reduction in IEMG of these muscles. The results of this study should be interpreted with caution, due to the small sample size and because

the testing was performed on patients with no evidence of upper extremity pathology.

2.6.10 Manipulation

Mill's technique is the most popular manipulative procedure employed in the management of tennis elbow, and was used successfully by Wadsworth (1987) over a twenty-year period, in 100 cases resistant to conservative treatment with only 6 patients requiring more than one manipulation. This treatment, however, as performed by Wadsworth, requires that the patient be fully relaxed and under general anaesthesia. The patient is placed supine on the operating table and a mixture of 0.5 ml methylprednisolone and 0.5 ml 2% Xylocaine is injected into the proximal tendon of the extensor carpi radialis brevis at the lateral epicondyle. The hand is grasped and the arm stabilized above the elbow, with the forearm fully pronated and the wrist palmar flexed. The elbow is then forcefully extended from the fully flexed position. Typically there is an audible snap as full elbow extension is gained, with the sound being attributed either to completion of a partial tear of the extensor tendon, or to breakdown of adhesions that have formed at the common extensor origin (Wadsworth 1987).

Maitland (1991:189), however, believes that the beneficial effects of Mill's manipulation occur due to manipulation of the joint and not

because it has stretched the tenomuscular junction. He adds that careful examination of the patient with tennis elbow will reveal a joint component to the symptoms in addition to the tenomuscular component. Initially joint signs alone should be treated until a clear picture of the pattern of progress can be predicted. On many occasions, the tenomuscular component recovers spontaneously when joint movement recovers. According to Maitland, all chronic tennis elbow cases will have a joint component.

A randomised, double blind, placebo controlled study was conducted by Vincenzino et al. (1996) to investigate the initial effects of cervical spine manipulative therapy on the pain and dysfunction of lateral epicondylalgia. The treatment condition produced significant objective and subjective improvement relative to placebo and control group conditions. This substantiates clinical observations that manipulative therapy is capable of producing improvements in pain and function immediately following application. The mechanisms by which it achieves this are yet to be elucidated, however the authors hypothesised that manipulative therapy applied to the cervical spine produces a non-noxious sensory input, which might be sufficient to activate descending pain inhibitory systems.

A loss of joint play at the radiocapitellar or proximal radioulnar joint is common in tennis elbow. However, other areas of joint play

restriction may be noted in any direction in the elbow. Gentle, high-velocity, low-amplitude manipulative therapy is essential in such cases and may require several applications to restore full mobility (Hyde and Gengenbach 1997:282).

2.6.11 Summary

There is insufficient scientific evidence in the current literature to favour any particular treatment protocol (Sharat and Maffulli 1997). Labelle et al. (1992) reviewed 185 articles pertaining to the treatment of lateral epicondylitis, between 1966 and 1990. Only 18 of these were randomised, controlled studies, all of which where then graded for scientific validity. The mean score of the 18 articles was only 33%, with a minimum of 70% being required for a valid clinical trial. A definite placebo effect was shown in 6 of the studies, which was equivalent to that of the treatment in 3 of them. The authors concluded that there could be a significant improvement with any treatment, due to placebo or to the natural history of lateral epicondylitis, and that this emphasizes the need to evaluate all types of therapy with properly controlled, randomised trials, using blinding where possible.

CHAPTER 3

3.1. OBJECTIVE

This study was a randomised, placebo controlled clinical trial, which investigated the efficacy of chiropractic manipulation in the treatment of lateral epicondylitis in terms of subjective and objective findings.

3.2 RESEARCH METHODOLOGY

3.2.1. Subjects

The proposed sample size was sixty (thirty patients per group), however, due to a poor patient response and the unrealistic time frame anticipated for completion of the study, this was later reduced to forty. The patient profile was as follows: age ten to seventy, of any sex, race or occupation from the province of Kwazulu Natal. The sample group was obtained by advertising on local radio stations, and in local newspapers. In addition, flyers were posted at local tennis clubs, sports clubs, health shops and libraries. Some patients were made aware of the study through word of mouth. Individuals who responded to the advertisements, or who presented

to the Chiropractic Day Clinic with lateral epicondylitis, were examined and a diagnosis of tennis elbow made if any of the following provocative tests were positive, in conjunction with an associated palpatory tenderness over the lateral epicondyle:

- Resisted wrist extension- the wrist is extended against resistance with the forearm pronated and extended, and the fingers gently clenched (Wadsworth 1987).
- Forced elbow extension- the forearm is held fully pronated and the wrist flexed while the elbow is passively extended (Wadsworth 1987).
- Resisted third finger extension- the elbow is extended, the forearm pronated, and the fingers extended, while the middle finger is actively extended against resistance (Wadsworth 1987).

Although the duration of symptoms was documented, no distinction was made between acute, subacute or chronic presentation in terms of patient inclusion. Pregnant patients who did not meet with any of the exclusion criteria were included into the study.

The exclusion criteria were as follows:

- Fractures of any bone of the involved extremity
- Tumours, either benign or malignant, primary or secondary, of any structures of the involved extremity.
- Musculoskeletal or connective tissue disorders.
- Osteogenesis imperfecta.

- Severe ligamentous sprain (grade III) of the involved elbow region.
- Severe hypermobility of the involved elbow.

All patients underwent a detailed case history (Appendix A), a physical examination (Appendix B), and an elbow regional examination (Appendix C) at the initial consultation, with patients being accepted into the study upon confirmed diagnosis of lateral epicondylitis. Patients were then informed that they would receive 6 treatments over a 3 week period during which they were not to receive any other treatment for the condition. All patients signed an informed consent form (Appendix D) before treatment commenced.

3.2.2. Subject Allocation

Subjects were randomly allocated to one of two groups. Forty pieces of paper, twenty marked "A" and twenty marked "B", were placed in a box and patients were then asked to pick one piece of paper. Patients were grouped according to the piece of paper selected, with those in Group "A" receiving manipulative therapy of the elbow, and those in Group "B" receiving ultrasound at 0,0w/cm^2.

3.2.3. Study Design

All patients were required to complete the NRS101 questionnaire (Appendix E) and the McGill short-form pain questionnaire (Appendix F) before the first, third and sixth treatments.
The NRS101 was used to quantify the patient's subjective pain intensity. Patients were instructed to rate their pain at its worst and at its least, on a scale of zero to one hundred, with zero indicating "no pain at all', and one hundred indicating "pain as bad as it could be". These two values were then added and divided by two to give an average pain score. In a study comparing six pain intensity measures, Jensen et al. (1986) found the NRS101 to be the most practical index for rating worst, least and average pain intensities.

According to Melzack (1987), the short-form McGill pain questionnaire "provides valuable information on the sensory, affective and evaluative dimensions of pain experience and is capable of discriminating among different pain problems." The questionnaire consists of fifteen descriptors, which are each rated on a scale from zero to three, giving a raw score out of forty-five.

The dynamometer was found to be a reliable method of testing the maximal muscle strength of upper extremity muscle groups by Agre et al. (1987). A portable JAMAR dynamometer was used to measure grip strength in two different positions, with the elbow in

90° flexion and with the elbow in full extension. DeSmet and Fabry (1997) measured grip force in 55 patients with chronic tennis elbow. Their results showed that grip force was significantly less at the pathological side compared to the control side ($p<0.001$), and that the relative difference between grip force in elbow flexion and extension was highly significant at the pathological side compared with the normal side ($p<0.0001$), with the pathological side showing a marked grip strength reduction with the elbow held in extension.

The lateral aspect of the elbow was carefully palpated in each patient in order to identify the area of most tenderness. An algometer was then used to quantify the tenderness over this point at treatments 1, 3, and 6 using the pressure threshold measurement which, is the minimum pressure required to induce pain or discomfort (Fischer 1987). Nussbaum and Downes (1998) found that measurement of pressure pain threshold obtained with a non-electronic algometer was reliable from trial to trial, within the same day, and from day to day over 3 consecutive days. In addition, measurements by one examiner were found to be more reliable then measurements between examiners.

Motion palpation of the symptomatic elbow was carried out on all patients before treatment's 1, 3 and 6, as referenced by Bergmann et al. (1993:594-600), in order to determine the location and direction of restriction. Subjects in group A had the procedure

explained to them after which the elbow was adjusted using the appropriate technique/s as referenced by Bergmann et al. (1993:600-608). Subjects in group B had the procedure explained to them after which ultrasound was administered at 0.0w/cm^2 for 5 minutes with the patient seated or semi-recumbent.

3.3. THE DATA

3.3.1. Primary Data

A thorough case history was taken which was followed by physical and elbow examination in order to ensure a correct diagnosis of tennis elbow. This process also aided in the identification of patients who met with the exclusion criteria.

Motion palpation of the involved elbow was performed in order to identify any motion restrictions and only patients with at least one restriction, as determined by motion palpation, were admitted into the study. This provided they were not excluded based on exclusion criteria.

3.3.2. Secondary Data

Secondary data was obtained from journal articles, books and any related literature to obtain information on the aetiology, pathology, diagnosis, and treatment of tennis elbow as well as the motion palpation, manipulation and contraindications to manipulation of the elbow joint.

3.3.3. Location of Data

Data was collected at the Technikon Natal Chiropractic Day Clinic, at visits 1, 3 and 6. Data collected was recorded onto appendices A, B, C, E, F and G.

3.4 STATISTICAL ANALYSIS

3.4.1. Treatment of Data

All subjective and objective results were entered into a spreadsheet, and then analysed using the SPSS (Statistical Package for Social Sciences). Non-parametric tests were used to analyse the categorical variable (McGill), while parametric tests were used to analyse continuous variables (Algometer, NRS101, Grip Strength).

3.4.1.1. Comparison between 2 unpaired samples with respect to the categorical variable.

The Mann-Whitney unpaired U test was used to compare groups 1 and 2 with respect to the McGill short form pain questionnaire. The null hypothesis states that there is no significant difference between groups 1 and 2 at the $\alpha = 0.05$ level of significance. The alternate hypothesis states that there is a significant difference.

3.4.1.2. Comparison between 2 unpaired samples with respect to the continuous variables.

The two-sample unpaired t-test was used to compare groups 1 and 2 with respect to the continuous variable in charge (NRS, algometer, grip strength at 90° flexion, and grip strength in extension). The null hypothesis states that there is no significant difference between Group1 and Group 2 at the $\alpha = 0.05$ level of significance. The alternate hypothesis states that there is a significant difference at the same level.

Decision rule: The null hypothesis is rejected at the α level of significance if $p<\alpha$ where p is the observed significance level or p-value. Otherwise the null hypothesis is accepted at the same level.

3.4.1.3. Comparison between 2 related samples within group 1 with respect to the categorical variable.

Wilcoxon's signed rank test was used to compare results from related samples within Group1 with respect to the categorical variable. The null hypothesis (H_o) states that there is no significant improvement between the 2 related samples being compared. The alternate hypothesis (H_a) states that there is a significant improvement.

3.4.1.4. Comparison between 2 related samples within group 1 with respect to the continuous variables.

The two-sample paired t-test test was used to compare results from related samples within Group1 with respect to continuous variables. In each test, the null hypothesis (H_o) states that there is no significant improvement between the 2 related samples being compared. The alternate hypothesis (H_a) states that there is a significant improvement.

Decision rule: The null hypothesis is rejected at the α level of significance if $p<\alpha$ where p is the observed significance level or p-value. Otherwise the null hypothesis is accepted at the same level.

3.4.1.5. Comparison between 2 related samples within group 2 with respect to the categorical variable.

Wilcoxon's signed rank test was used to compare results from related samples within Group 2 with respect to the categorical variable. The null hypothesis (H_o) states that there is no significant improvement between the 2 related samples being compared. The alternate hypothesis (H_a) states that there is a significant improvement.

3.4.1.6. Comparison between 2 related samples within group 2 with respect to the continuous variables.

The two-sample paired t-test test was used to compare results from related samples within Group 2 with respect to the continuous variables. In each test, the null hypothesis (H_o) states that there is no significant improvement between the 2 related samples being compared. The alternate hypothesis (H_a) states that there is a significant improvement.

Decision rule: The null hypothesis is rejected at the α level of significance if $p<\alpha$ where p is the observed significance level or p-value. Otherwise the null hypothesis is accepted at the same level.

3.4.1.7. Means and variances for continuous variables.

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

3.4.1.8. Comparison using bar charts.

Visual summaries of analytical findings are given, by use of bar charts, to compare groups 1 and 2 with respect to the continuous variables. Mean readings were used to construct bar charts.

3.4.1.9. Power analysis for continuous variables.

The power of each two-sample unpaired t-test used in this study was computed using the following UCLA web site: http://www.stat.ucla.edu/calculators/powercalc/normal. Each test was two sided and the variable involved, continuous.

CHAPTER 4

4.1. INTRODUCTION

This chapter concerns itself with the results obtained after statistical analysis of the data from the measurement criteria as discussed in chapter 3. The data is presented in table form with comments and interpretations in order to accept or reject the null hypothesis.

4.2. HYPOTHESES

The null hypothesis (H_o) states that there is no significant difference between Group1 and Group 2 at the $\alpha = 0.05$ level of significance. The alternate hypothesis (H_a) states that there is a significant difference at the same level.

4.3. ANALYSED DATA

Data was analysed at $\alpha = 0.05$ specified level of significance.

Decision rule:

H_o is rejected at the α level of significance if $p<\alpha$ where p is the observed level of significance or the p-value. Otherwise H_o is accepted at the same level.

For 2-tailed tests, H_o is rejected if $p < \alpha/2$. Therefore, the null hypothesis would be rejected if $p<0.025$, otherwise H_o is accepted. All test were 2-tailed.

4.4 DEMOGRAPHIC DATA

Table 1: Age, Gender and Racial Distribution:

	Group 1	Group 2	Overall
Age:			
Minimum	26	19	19
Maximum	66	66	66
Average	*47 yrs*	*46 yrs*	*47yrs*
Gender:			
Male	10	12	22
Female	10	8	18
Racial:			
Black	0	0	0
White	12	16	28
Indian	6	4	10
Coloured	2	0	2
Other	0	0	0

Table 2: Occupation

Occupation	Number of patients
Academic Registrar	1
Accounts Executive	1
Administrator	2
Broker	1
Chef	1
Computer Networking	1
Defence Instructor	1
Director	1
Engineer	1
Furrier	1
Hairdresser	2
Housewife	6
Interior Decorator	1
Lecturer	1
Manager	5
Property Developer	1
Retired	5
Store Owner	1
Student	4
Tailor	1
Unemployed	2

Table 3: Aggravating Activity.

Aggravating Activity	Number of patients
Ball Throwing	1
Blow-drying (hair)	2
Dishwashing	1
Fishing (Line Casting)	1
Gardening	1
Golf	2
Lifting	9
Push-ups	1
Racquet Sports	8
Snow skiing	1
Swimming	1
Typing	1
Unknown	11

Table 4: Duration of symptoms

Duration of Symptoms	Percentage of Patients
Less than1 month	17.5%
1 – 6 months	47.5%
6 - 12 months	12.5%
More than 12 months	22.5%

Table 5: Motion Palpation Findings

Motion Palpation	**Percentage of total observed restrictions**
Long axis distraction	1.30
P-A extension	27.59
Medial to lateral	13.79
Lateral to medial	18.97
Anterior to posterior (radioulnar)	18.10
Posterior to anterior (radioulnar)	4.74
Posterior to anterior in pronation	15.51

4.5. COMPARISON BETWEEN TWO UNPAIRED SAMPLES

Table 6: Results of the Mann-Whitney Test comparing group's 1 and 2, with respect to the McGill pain questionnaire.

Mc Gill	Group	Mean	p-value
1	1	5.400	0.047
	2	8.850	
3	1	3.950	0.332
	2	5.400	
6	1	2.550	0.363
	2	3.850	

The results indicate that at the α=0.05 level of significance, no significant difference was observed between Groups 1 and Group 2, at treatments 1, 3 or 6. The null hypothesis is therefore accepted. However, at the 10% level of significance, McGill 1 shows a significant difference.

Table 7: Results of the two sample unpaired t-test comparing group 1 and group 2, with respect to Algometer values.

Algometer	Group	Mean	Std. Deviation	Std. Error Mean	p-value
1	1	3.210	0.986	0.220	0.356
	2	2.915	1.012	0.226	
3	1	3.405	0.923	0.206	0.327
	2	3.120	0.892	0.200	
6	1	3.815	1.025	0.229	0.594
	2	3.595	1.516	0.339	

The results indicate that at the α=0.05 level of significance, no significant difference in improvement was observed between the two groups, at treatments 1, 3 or 6. The null hypothesis is therefore accepted.

Table 8: Results of the two sample unpaired t-test comparing group 1 and group 2, with respect to NRS101 values.

NRS 101	Group	Mean	Std. Deviation	Std. Error Mean	p-value
1	1	49.125	21.140	4.727	0.821
	2	50.250	17.621	3.940	
3	1	36.075	19.657	4.396	0.478
	2	31.900	17.101	3.824	
6	1	24.075	20.329	4.546	0.271
	2	17.975	13.525	3.024	

The results indicate that at the α=0.05 level of significance, no significant difference was observed between Groups 1 and Group 2, at treatments 1, 3 or 6. The null hypothesis is therefore accepted.

Table 9: Results of the two sample unpaired t-test comparing group 1 and group 2, with respect to grip strength values (elbow at 90° flexion).

Grip Strength	Group	Mean	Std. Deviation	Std. Error Mean	p-value
1	1	33.700	10.776	2.410	0.191
	2	29.050	11.311	2.529	
3	1	34.950	12.155	2.718	0.276
	2	30.750	11.894	2.660	
6	1	38.050	13.379	2.992	0.264
	2	33.300	13.115	2.933	

The results indicate that at the $\alpha=0.05$ level of significance, no significant difference in improvement was observed between Group's 1 and 2, at treatments 1, 3 or 6. The null hypothesis is therefore accepted.

Table 10: Results of the two sample unpaired t-test comparing group 1 and group 2, with respect to grip strength values (elbow in extension).

Grip Strength	Group	Mean	Std. Deviation	Std. Error Mean	p-value
1	1	32.700	13.127	2.935	0.396
	2	29.150	13.015	2.910	
3	1	33.650	14.031	3.137	0.501
	2	30.600	14.384	3.216	
6	1	36.800	16.558	3.703	0.291
	2	31.650	13.697	3.063	

The results indicate that at the α=0.05 level of significance, no statistically significant difference in improvement was noted between Group's 1 and 2 at treatments 1, 3 or 6. The null hypothesis is therefore accepted.

4.6. COMPARISON BETWEEN TWO RELATED SAMPLES WITHIN GROUP ONE

Table 11: Results of Wilcoxon's signed rank test for McGill readings- Group1.

	McGill	Mean		p-value
Group 1	Treatment interval 1-3	5.400	3.950	0.132
	Treatment interval 3-6	3.950	2.550	0.002
	Treatment interval 1-6	5.400	2.550	0.001

The results indicate that at the α=0.05 level of significance, there was no significant difference between consultations 1 and 3, however, a significant change was observed between visits 3 and 6, which contributed to the significant overall improvement.

Table 12: Results of the two-sample paired t-test for algometer readings– Group 1.

	Algometer	Mean		p-value
Group 1	Treatment interval 1-3	3.210	3.405	0.267
	Treatment interval 3-6	3.405	3.815	0.014
	Treatment interval 1-6	3.210	3.815	0.008

The results indicate that at the $\alpha=0.05$ level of significance, there was no significant improvement between consultations 1 and 3, however, a significant improvement was observed between visits 3 and 6, and overall. See figure 1.

Table 13: Results of the two-sample paired t-test for grip strength readings (elbow at 90° flexion)– Group 1.

	Grip Strength (90°)	Mean		p-value
Group 1	Treatment interval 1-3	33.700	34.950	0.281
	Treatment interval 3-6	34.950	38.050	0.028
	Treatment interval 1-6	33.700	38.050	0.036

The results indicate that at the $\alpha=0.05$ level of significance, there was no significant difference between treatments 1 and 3, 3 and 6, or 1 and 6. At the $\alpha=0.10$ level of significance, however, a significant difference was observed between treatments 3 and 6 and overall. See figure 2.

Table 14: Results of the two-sample paired t-test for grip strength readings (elbow in extension)– Group 1.

	Grip Strength (ext.)	Mean		p-value
Group 1	Treatment interval 1-3	32.700	33.650	0.339
	Treatment interval 3-6	33.650	36.800	0.037
	Treatment interval 1-6	32.700	36.800	0.045

The results indicate that at the α=0.05 level of significance, there was no significant change between treatments 1 and 3, 3 and 6, or overall. At the α=0.10 level of significance, a significant difference was observed between treatments 3 and 6, and also overall. See figure 3.

Table 15: Results of the two-sample paired t-test for NRS101 readings– Group 1.

	NRS 101	Mean		p-value
Group 1	Treatment interval 1-3	49.125	36.075	0.007
	Treatment interval 3-6	36.075	24.075	0.001
	Treatment interval 1-6	49.125	24.075	0.000

The results indicate that at the α=0.05 level of significance, there was a significant difference between consultations 1 and 3, 3 and 6, and overall. See figure 4.

4.7. COMPARISON BETWEEN TWO RELATED SAMPLES WITHIN GROUP TWO

Table 16: Results of Wilcoxon's signed rank test for McGill readings– Group2.

	Mc Gill	Mean		p-value
Group 2	Treatment interval 1-3	8.850	5.400	0.007
	Treatment interval 3-6	5.400	3.850	0.005
	Treatment interval 1-6	8.850	3.850	0.000

The results indicate that at the α=0.05 level of significance, there was a significant improvement between consultations 1 and 3, 3 and 6, and hence overall.

Table 17: Results of the two-sample paired t-test for algometer readings– Group 2.

	Algometer	Mean		p-value
Group 2	Treatment interval 1-3	2.915	3.120	0.107
	Treatment interval 3-6	3.120	3.595	0.038
	Treatment interval 1-6	2.915	3.595	0.018

The results indicate that at the α=0.05 level of significance, there was no significant difference between consultations 1 and 3 or 3 and 6, however a significant change was observed overall. See figure 1.

Table 18: Results of the two-sample paired t-test for grip strength readings (elbow at 90° flexion)– Group 2.

	Grip Strength (90°)	Mean		p-value
Group 2	Treatment interval 1-3	29.050	30.750	0.084
	Treatment interval 3-6	30.750	33.300	0.056
	Treatment interval 1-6	29.050	33.300	0.003

The results indicate that at the α=0.05 level of significance, there was no significant change between treatments 1 and 3, or between treatments 3 and 6, however, a significant difference was observed overall. See figure 2.

Table 19: Results of the two-sample paired t-test for grip strength readings (elbow in extension)– Group 2.

	Grip Strength (ext.)	Mean		p-value
Group 2	Treatment interval 1-3	29.150	30.600	0.186
	Treatment interval 3-6	30.600	31.650	0.196
	Treatment interval 1-6	29.150	31.650	0.038

The results indicate that at the α=0.05 level of significance, there was no significant difference between treatments 1 and 3, 3 and 6, or 1 and 6. However, at the α=0.10 level of significance, a significant change was observed overall. See figure 3.

Table 20: Results of the two-sample paired t-test for NRS101 readings– Group 2.

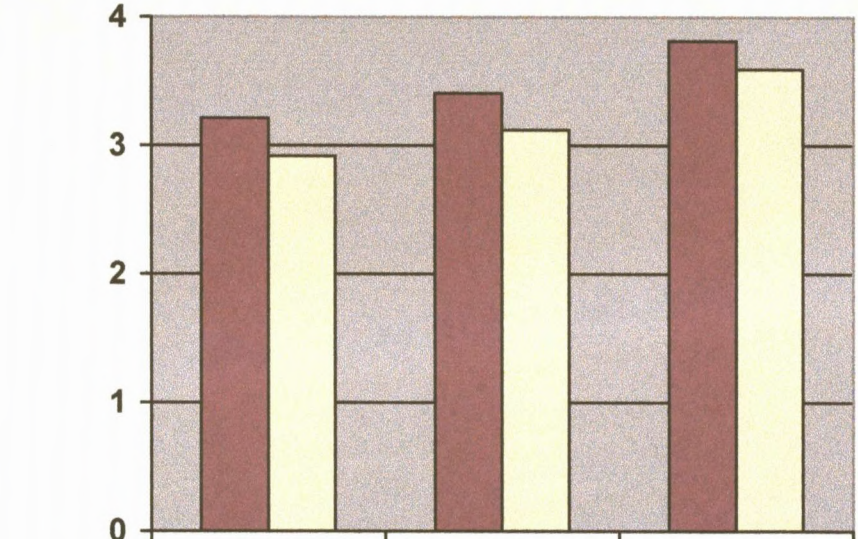
	NRS 101	Mean		p-value
Group 2	Treatment interval 1-3	50.525	31.900	0.000
	Treatment interval 3-6	31.900	17.975	0.002
	Treatment interval 1-6	50.525	17.975	0.000

The results indicate that at the $\alpha=0.05$ level of significance, there was a significant difference between consultations 1 and 3, 3 and 6, and hence, overall. See figure 4.

4.8. COMPARISON USING BAR CHARTS

Figure 1. Algometer

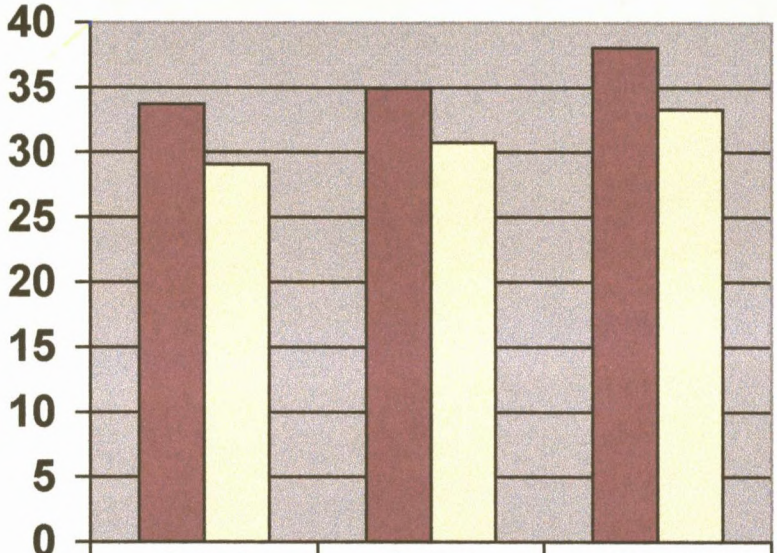
This figure indicates the changes in the mean algometer values over the evaluation period. Readings were taken at the first (Alg 1), third (Alg 3) and sixth (Alg 6) consultation.



	Alg 1	Alg 3	Alg 6
Group 1	3.21	3.405	3.815
Group 2	2.915	3.12	3.595

Figure 2. Grip Strength 90° Flexion

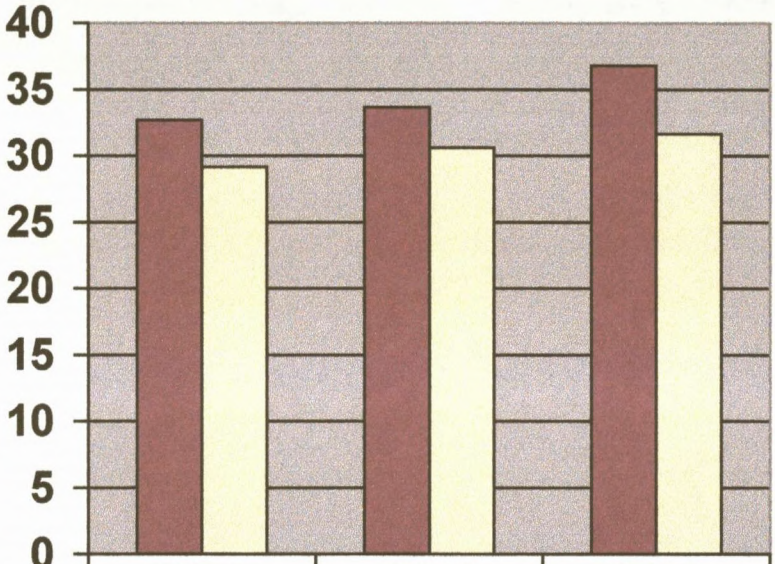
This figure demonstrates the changes in the mean grip strength values measured with the elbow in 90° of flexion. Readings were taken at the first, third and sixth consultation.



	Grip 1	Grip 3	Grip 6
Group 1	33.7	34.95	38.05
Group 2	29.05	30.75	33.3

Figure 3. Grip Strength in Extension

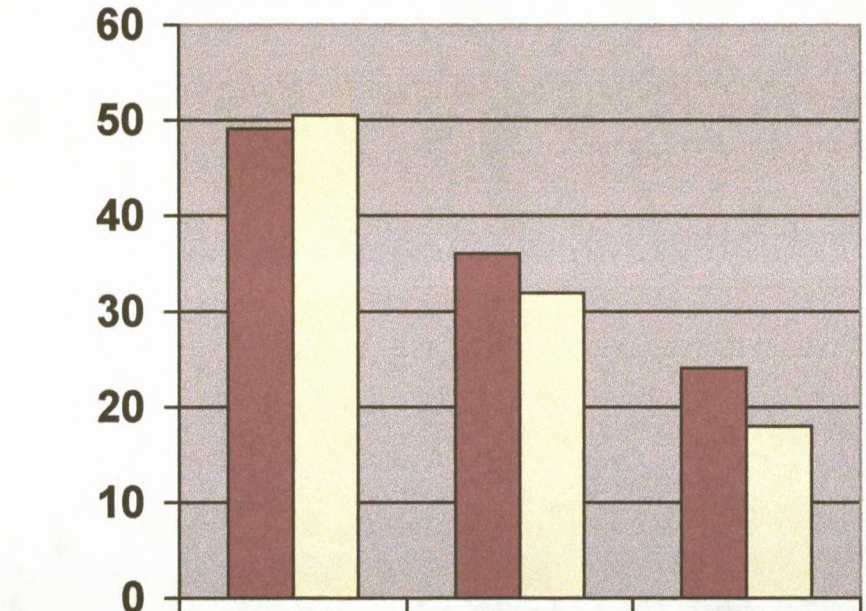
This figure demonstrates the changes in the mean grip strength, measured with the elbow in extension. Readings were taken at the first, third and sixth consultation.



	Grip 1	Grip 3	Grip 6
Group 1	32.7	33.65	36.8
Group 2	29.15	30.6	31.65

Figure 4. NRS 101

This figure demonstrates the changes in the mean NRS 101 values, over the evaluation period. Questionnaires were completed at the first, third and sixth consultation.



	NRS1	NRS3	NRS6
Group 1	49.125	36.075	24.075
Group 2	50.525	31.9	17.975

4.9. POWER ANALYSIS FOR CONTINUOUS VARIABLES

The power value assesses the sensitivity of the statistical tests by assessing the probability of a particular test detecting a difference between the groups and is dependant on sample size, accuracy of measurements involved in the study, and the specified level of significance of the study. The probability of making a type II error is β, therefore the power of a statistical test is $(1- \beta)$. The smaller the power, the greater the likelihood of incorrectly accepting the null hypothesis.

Table 21: Power Analysis

	Algometer	Grip 90°	Grip ext.	NRS 101
Treatment 1	0.144	0.247	0.129	0.055
Treatment 3	0.098	0.183	0.098	0.104
Treatment 6	0.080	0.191	0.175	0.187

Chapter 5

This chapter will discuss the results of the objective and subjective clinical data gathered from dynamometer and algometer measurements, the Short Form McGill Pain Questionnaire and the Numerical Pain Rating Scale (NRS101).

5.1. DEMOGRAPHIC DATA

Demographic data can be found in tables 1-5. The average patient age for this study was 47 years, which is consistent with reports that tennis elbow occurs more frequently in the fourth decade than any other decade (Coonrad and Hooper 1973). Of the 40 patients who participated in the study, 22 were male and 18 were female. Examination of the racial distribution reveals that 28 patients were white, 10 indian, and 2 mixed race. No blacks participated in the study. This is in keeping with Wadsworth's (1987) observation that tennis elbow seldom affects blacks. It is, however, also possible that the publications that carried the advertising were not dispersed across an appropriate geographical spread, and thus did not reach certain sectors of the population.

Many different occupations were represented in this study, however few patients attributed their pain to work related activities unless their job involved heavy lifting or gripping, as in the case of the

engineer and the storeowner. The only other occupation that appeared to uniquely predispose individuals toward tennis elbow was hairdressing, with both of the participating hairdressers reporting symptomatic aggravation when "blowdrying" which involves repetitive flexion and extension of the wrist.

Table 3 shows the wide range of activities that were reported as the prime aggravating activity. Lifting activities and racquet sports, which included tennis, squash and badminton, appeared to aggravate the injury more so than other activities.

Of the patients that participated in this study, 82,5% had experienced their symptoms for a period of longer than one month, with nearly 50% of patients having had the problem betweenone and six months. The most commonly observed restriction, detected through motion palpation, was restricted posterior to anterior glide of the humeroulnar joint in extension (27,59%), followed by lateral to medial glide of the humeroulnar and humeroradial joints (18.97%), anterior to posterior glide of the radioulnar joint in flexion (18,10%), posterior to anterior glide of the radioulnar joint in pronation (15,51%), medial to lateral glide of the humeroradial and humeroulnar joints (13,79%), posterior to anterior glide of the radioulnar joint (4,74%), and finally long axis distraction of the humeroulnar joint (1,30%).

5.2. THE FIRST OBJECTIVE

The first objective was to determine the efficacy of manipulative therapy of the elbow in the treatment of lateral epicondylitis, in terms of objective measures. Objective data was collected through algometer readings, and dynamometer (grip strength) readings with the elbow at 90° flexion and in extension.

5.2.1. Intragroup Analysis

Intragroup analysis examines the improvement experienced by each group from the first to the final treatments, and provides information on the therapeutic effect of manipulation over placebo, in the treatment of lateral epicondylitis.

Statistical data can be found in tables 12, 13, 14, 16, 17 and 18. The results from analysis of algometer readings indicates that neither group demonstrated a significant improvement between consultations 1 and 3, however, there was a significant improvement in group 1 between treatments 3 and 6 which in turn contributed to the overall improvement. No significant improvement was observed in group 2 between visits 3 and 6, however it too showed a significant overall improvement.

Results from analysis of grip strength results, with the elbow at 90° of flexion, indicate that at the specified level of significance, neither group 1 nor group 2 demonstrated any significant improvement between treatments 1 and 3 or 3 and 6, however group 2 did demonstrate a significant overall improvement whilst group 1 did not.

The results from analysis of grip strength results, with the elbow in extension, indicate that neither group showed any significant improvement between treatments 1and 3, 3 and 6, or overall.

5.2.2. Intergroup Analysis

Evaluation of the first treatment measurements shows any variance in findings between the 2 groups in terms of their original presentation. Comparison of the two groups at treatment six provides information on whether or not manipulation had an effect over placebo.

Statistical data can be found in tables 7, 9 and 10. The 2 sample paired t-test was used to compare group's 1 and 2 with respect to the objective measures. The results indicate that at the $\alpha=0.05$ level of significance, no significant difference was observed between Groups 1 and Group 2 at treatments 1, 3 or 6. This was true for all of the objective measures. The null hypothesis was therefore

accepted, indicating that adjustment of the elbow was no more effective than placebo in terms of these objective measures.

5.3. THE SECOND OBJECTIVE

The second objective was to determine the efficacy of manipulative therapy of the elbow in the treatment of lateral epicondylitis, in terms of subjective measures. Subjective data was collected through use of the Short form McGill Pain Questionnaire and the NRS101 questionnaire.

5.3.1. Intragroup Analysis

The relevant statistical data for the McGill Pain Questionnaire can be found in tables 11 and 16.The results indicate that at the $\alpha=0.05$ level of significance, there was no significant improvement between consultations 1 and 3 in group 1. A significant improvement was observed in group 2 between visits 1 and 3, and both groups went on to demonstrate a significant improvement between visits 3 and 6, which in turn contributed to the overall improvement seen in both groups.

The statistical data for the NRS101 pain questionnaire can be found in tables 15 and 20. The results indicate that at the 95% level of significance, both groups showed a significant difference in

improvement between consultations 1 and 3, 3 and 6, and hence, overall.

5.3.2. Intergroup Analysis

The statistical data can be found in tables 6 and 8. The Mann-Whitney unpaired U-test was used to compare groups 1 and 2 with regard to the categorical variable (McGill), whilst the unpaired t-test was used to compare the 2 groups with regard to the continuous variable (NRS101). The results indicate that at the $\alpha=0.05$ level of significance, no significant difference was observed between Groups 1 and Group 2 at treatments 1, 3 or 6. This was true for each of the subjective measures. The null hypothesis was therefore accepted, indicating that adjustment of the elbow was no more effective than placebo in terms of these subjective measures.

5.4. POWER VALUES

Power analysis was performed for all continuous variables. The low power of the study may have been due to the small sample size according to Cloete (personal communication 2000).

Chapter 6

6.1. CONCLUSION

The purpose of this investigation was to perform a placebo controlled, randomised clinical study to determine the efficacy of chiropractic manipulative therapy of the elbow in the treatment of lateral epicondylitis.

Forty patients were accepted into the study, all of who underwent a case history, physical examination, and elbow regional examination. They were then randomly allocated to one of the two groups, so that twenty patients received manipulative therapy of the elbow, and the other twenty patients received detuned ultrasound.

All patients received 6 treatments over a 3-week period, with subjective and objective data being collected before the first, third and sixth treatments.

Examination of the statistical data reveals that there was no significant difference in improvement between the two groups, ie. manipulative therapy of the elbow was found to be no more effective in the treatment of tennis elbow than detuned ultrasound.

Certain points, however, need to be considered when analysing the results of this experiment:

- The small sample size, and consequent low power of the study may have caused incorrect conclusions to be drawn.
- Motion palpation, which is in effect a grade 3 or 4 mobilization, may have had a therapeutic effect on the placebo group. Although both groups would have been affected similarly by the motion palpation procedure, it may nonetheless have affected the subjective and objective findings of the placebo group, adversely affecting intra-group analysis of placebo group data, and therefore, the overall result.
- Ultrasound, although detuned, may have been of some therapeutic benefit. In an investigation into the effects of ultrasound on soft tissue lesions, Binder et al. (1985) found that several of the patients in the placebo group improved, and suggested that one explanation for this, was because of the massaging effect of the transducer head over the affected area during treatment.
- Several patients found that grip strength testing caused an aggravation in symptoms.

Whilst the results reflect that manipulative therapy of the elbow may be of limited value as a sole treatment in the management of tennis elbow, it would be of interest to investigate the benefit of

manipulative therapy when used in conjunction with other treatment modalities, or when followed by a comprehensive rehabilitation program. No other motion palpation based, manipulative studies of the elbow were found. Mill's manipulation has been more extensively researched with favourable results being reported by Wadsworth (1987) and Shaik (2000), however it remains unclear as to whether the therapeutic effect of this intervention occurs at the soft tissue or at the articular level.

6.2. RECOMMENDATIONS

Below is a list of recommendations for any further investigation into this topic.

- An increased sample size to reduce the likelihood of making statistical errors, and falsely accepting the null hypothesis. Cloete (personal communication 2000) suggests that the power of the study be decided on beforehand, and that this be used to determine the appropriate sample size.
- Introduction of a second examiner, for collection and collation of data, who should be blinded as to which treatment the patient is receiving. This would serve to decrease observer bias.
- Use of alternative objective measurements as several patients reported a symptomatic aggravation following grip

strength testing, with increased pain and discomfort over the lateral epicondyle and proximal extensor musculature.

- Follow-up examination at prescribed intervals to determine the long-term effects of manipulative therapy in the treatment of tennis elbow.
- Investigation into the combined effect of manipulative therapy, used in conjunction with other therapeutic modalities.

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APPENDIX A

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

APPENDIX B.

TECHNIKON NATAL

TECHNIKON NATAL CHIROPRACTIC DAY CLINIC

PHYSICAL EXAMINATION

Patient:_____File#: _____Date:_____
Clinician:_____Signature:_____
Intern:_____Signature:_____

1. VITALS

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

2. GENERAL EXAMINATION

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

Urinalysis:

3. CARDIOVASCULAR EXAMINATION

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

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

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

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

Percussion: - borders of heart

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

4. RESPIRATORY EXAMINATION

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

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

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

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

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

5. ABDOMINAL EXAMINATION

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

Inspection
- Shape:
- Scars:
- Hernias:

Palpation
- Superficial:
- Deep = Organomegally:

- Masses (intra- or extramural)
- Aorta:

Percussion - Rebound tenderness:
- Ascites:
- Masses:

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

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

6. G.U.T EXAMINATION

External genitalia:
Hernias:
Masses:
Discharges:

7. NEUROLOGICAL EXAMINATION

Gait and Posture
- Abnormalities in gait:
- Walking on heels (L4-L5):
- Walking on toes (S1-S2):
- Rombergs test (Pronator Drift):

Higher Mental Function
- Information and Vocabulary:
- Calculating ability:
- Abstract Thinking:

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

Evidence of head trauma:

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

Cranial Nerves:

I Any loss of smell/taste:
Nose examination:

II External examination of eye:
- Visual Acuity:
- Visual fields by confrontation:

- Pupillary light reflexes = Direct:
  = Consensual:
- Fundoscopy findings:

III Ocular Muscles:
Eye opening strength:

IV Inferior and Medial movement of eye:

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

b. Motor - Masseter:
- Jaw lateral movement:

c. Reflexes - Corneal reflex
- Jaw jerk

VI Lateral movement of eyes

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

b. Taste - Anterior two-thirds of tongue:

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

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

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

XII Inspection of tongue (deviation):

Motor System:

a. Power
- Shoulder = Abduction & Adduction:
  = Flexion & Extension:
- Elbow = Flexion & Extension:
- Wrist = Flexion & Extension:

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

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

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

Sensory System:

a. Dermatomes
- Light touch:
- Crude touch:
- Pain:
- Temperature:
- Two point discrimination:

b. Joint position sense
- Finger:
- Toe:

c. Vibration:
- Big toe:
- Tibial tuberosity:
- ASIS:
- Interphalangeal Joint:
- Sternum:

Cerebellar function:

Obvious signs of cerebellar dysfunction:
= Intention Tremor:
= Nystagmus:
= Truncal Ataxia:

Finger-nose test (Dysmetria):
Rapid alternating movements (Dysdiadochokinesia):
Heel-shin test:
Heel-toe gait:
Reflexes:
Signs of Parkinsons:

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

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

9. **BREAST EXAMINATION:**

Summon female chaperon.

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

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

APPENDIX C

ELBOW REGIONAL EXAMINATION

Patient: _____ File No.: _____ Date: _____
Intern / Resident: _____ Signature: _____
Clinician: _____ Signature: _____

OBSERVATION:

- Posture and willingness to move _____
- Carrying angle (anatomical position) _____
- Colour and texture of skin _____
- Bony and soft tissue contours _____
- Swelling _____
- Position of function (triangle sign) _____

PALPATION:

Anterior :

- Cubital fossa _____
- Bicep tendon _____
- Brachial artery _____
- Coronoid process _____
- Radial head _____
- Bicep and Brachialis _____

Medial:

- Medial epicondyle _____
- Medial collateral ligament _____
- Ulnar nerve _____

Lateral:

- Lateral epicondyle _____
- Supracondylar ridge (ECRL) _____
- Lateral collateral ligament _____
- Radial head and annular ligament _____

Posterior:

- Olecranon process _____

ACTIVE MOVEMENTS:

- Flexion (140 – 150°) _____
- Extension (0-10°) _____
- Supination (90°) _____
- Pronation (80-90°) _____

PASSIVE MOVEMENTS:

- Flexion (tissue approximation) _____
- Extension (bone to bone) _____
- Supination (tissue stretch) _____
- Pronation (tissue stretch) _____

RESISTED ISOMETRIC MOVEMENTS: (elbow at 90° flexion and supinated)

- Flexion _____
- Extension _____
- Supination _____
- Pronation _____
- Elbow flexion _____
- Elbow extension _____

JOINT PLAY MOVEMENTS:

- Upward glide of radial head on ulna _____
- Downward glide of radial head on ulna _____
- Rotation of radial head _____
- Medial to lateral side tilt _____
- Lateral to medial side tilt _____
- Distraction of olecranon process on the humerus (90° flexion) _____

SPECIAL TESTS:

- Ligamentous Instability Test:
  - valgus / adduction stress (MCL) _____
  - varus / abduction stress (LCL) _____
- Lateral epicondylitis:
  - Cozen's Test _____
  - Mill's Test _____
  - Lateral epicondyle test (extensor digitorum) _____
- Medial epicondyle test _____
- Tinel's Sign (ulnar nerve) _____
- Wartenberg's Sign (ulnar neuritis) _____
- Elbow flexion test (ulnar nerve - cubital tunnel syndrome) _____
- Pronator teres syndrome test (median nerve) _____
- Pinch Grip test (ant. interosseous branch of median nerve) _____

NEUROLOGICAL:

- Reflexes
  - Biceps (C5/6) R _____ L _____
  - Brachioradialis (C5/6) R _____ L _____
  - Triceps (C7/8) R _____ L _____
- Dermatomes C4 _____ C5 _____ C6 _____ C7 _____ C8 _____
  T1_____ T2 _____
- Cutaneous distribution
  - median nerve _____
  - ulnar nerve _____
  - radial nerve _____

RADIOLOGICAL EXAMINATION:

_____

_____

_____

DIAGNOSIS:

_____

_____

_____

MANAGEMENT PLAN:

_____

_____

_____

APPENDIX D

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. Who have you spoken to? _____		
7. Do you understand the implications of your involvement in this study?	Yes	No
8. Do you understand that you are free to withdraw from this study?	Yes	No
a) at any time		
b) without having to give any a reason for withdrawing, and		
c) without affecting your future health care.		
9. Do you agree to voluntarily participate in this study	Yes	No

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:_____

Witness Name:_____ Signature:_____

Research Student Name:_____ Signature:_____

APPENDIX E

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.

_____

APPENDIX F

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				

APPENDIX G:

Patient name: _____ File No.: _____
Group: _____

Consultation 1:

Grip strength- 90° flexion	
Grip strength- extension	
Algometer	

Motion palpation:

Long axis dist. (HU)		A-P (RU)	
Med-Lat (HU, HR)		P-A (RU)	
Lat-Med (HU, HR)		P-A pronation (Radial)	
P-A in ext. (HU)			

Consultation 3:

Grip strength- 90° flexion	
Grip strength- extension	
Algometer	

Motion palpation:

Long axis dist. (HU)		A-P (RU)	
Med-Lat (HU, HR)		P-A (RU)	
Lat-Med (HU, HR)		P-A pronation (Radial)	
P-A in ext. (HU)			

Consultation 6:

Grip strength- 90° flexion	
Grip strength- extension	
Algometer	

Motion palpation:

Long axis dist. (HU)		A-P (RU)	
Med-Lat (HU, HR)		P-A (RU)	
Lat-Med (HU, HR)		P-A pronation (Radial)	
P-A in ext. (HU)			