The Effectiveness of Transcutaneous Electrical Nerve Stimulation (TENS) Versus Interferential Current (IFC) in the Treatment of Pain Following a Distal Radius Fracture

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A thesis submitted to the College of Health Sciences in part fulfilment of the requirements of the Degree of Masters in Hand Rehabilitation.

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KwaZulu-Natal

2015

ABSTRACT

Purpose : The radius bone in the forearm of the human body, is an integral component of the wrist joint. Optimal wrist joint function plays an important role in maintaining dexterity of the upper limb. The inability to use the upper limb due to injury or pathology, impacts on activities of daily living, like personal care, occupational needs, and social activities. Following the fracture of the distal radius, a period of immobilisation is required for the injured structures to heal. Physiotherapy after the period of immobilisation is aimed at improving mobility, strength and flexibility of the affected joint. At this stage, patient's main complaints are pain and stiffness which is impeding on functional use of the affected limb. Analgesia is usually prescribed to the patient for pain management, however in the South African public sector, drug shortages is a problem. Therefore there is a need to investigate a rehabilitation intervention that may reduce pain and hasten functional recovery after a distal radius fracture (DRF). Transcutaneous Electrical Nerve Stimulation (TENS) and Interferential Current (IFC) are two electrotherapy modalities, commonly used in the management of pain. Their effectiveness in reducing pain following a distal radius fracture has not been established. Therefore this study was designed to determine the effectiveness of TENS and IFC in reducing pain experienced following a distal radius fracture.

Methods: The design of the study was a pre-test, post-test between subject study. Fifty four patients were randomly assigned to a TENS and exercise or IFC and exercise group. Both groups engaged in a 2-3 week programme, which comprised of six sessions of intervention. Pain was recorded with the Verbal Numerical Rating Scale (VNRS). Range of movement was measured with a goniometer and muscle strength with a modified sphygmomanometer. Functional ability was assessed with activities from the Patient Rated Wrist Evaluation (PRWE).

Results : Statistical analysis was done with IBM SPSS (Version 21.0, IBM Corp., Armonk, NY). There was no significant differences between groups at the baseline with post 2-3 weeks showing compliance with TENS and exercises of 37% (n=20), IFC and exercises 37% (n=20). There were significant improvements ($p < 0,05$) in pain, range of movement, grip strength, and functional ability with both interventions. IFC was found to be significantly more effective in increasing wrist flexion and extension range of movements.

Conclusion : Tens and IFC are effective in reducing pain following a distal radius fracture. There was no significant difference between the two modalities in reducing pain. Other variables of range of movement, muscle strength and functional ability also improved.

Keywords : distal radius fractures, physiotherapy, physical therapy, rehabilitation, pain evaluation, transcutaneous electrical nerve stimulation, interferential current, hand assessment.

Author's Declaration

I, Ms Seleena Thaver declare that 'The Effectiveness of Transcutaneous Electrical Nerve Stimulation (TENS) versus Interferential Current (IFC) in the Treatment of Pain Following a Distal Radius Fracture,' is my own work and that all sources that were used or quoted have been indicated by means of complete references. This study has not been submitted in any form to another university or institution.

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Ms S. Thaver Date

DEDICATION

This work is dedicated to my little boy, Ahrian Moodley, the most perfect gift from God.

ACKNOWLEDGEMENTS

- A big thank you to God, for giving me the strength and knowledge to complete this thesis, and for all the opportunities you have blessed me with in this life.
- My sincere gratitude to my supervisor, Dr S.S. Maharaj for your advice, guidance and patience.
- My thanks to all the staff at Addington and King Edward hospital for your support and tolerance.
- Thank you to Pam Rangiah and Shoba Naidoo for all your assistance during this study.
- My heartfelt and sincere thanks to all my friends and family who have supported me in one way or another through this process.

And lastly, to my husband, Dinashen Moodley, thank you for your un-relenting love and support.

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LIST OF ABBREVIATIONS

DRF's	Distal Radius Fractures
DRF	Distal Radius Fracture
CRPS	Complex Regional Pain Syndrome
ADL'S	Activities of Daily Living
ADL	Activity of Daily Living
ROM	Range of Movement
TENS	Transcutaneous Electrical Nerve Stimulation
OA	Osteoarthritis
IFC	Interferential Current
PRWE	Patient Rated Wrist Evaluation
POP	Plaster of Paris
VNRS	Verbal Numeric Rating Scale
VAS	Visual Analogue Scale
MS	Modified Sphygmomanometer
CLBP	Chronic Lower Back Pain
NSAIDs	Non-Steroidal Anti-Inflammatory Drugs

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CHAPTER 1. INTRODUCTION

The Effectiveness of Transcutaneous Electrical Nerve Stimulation (TENS) Versus Interferential Current (IFC) in the Treatment of Pain Following a Distal Radius Fracture

1.1 Introduction

A fracture of the distal radius is usually caused by a twisting force on the lower arm or wrist or when the arm is used to prevent the body from a fall. To facilitate healing of the fractured radius, the forearm is immobilised with a rigid cast made of Plaster of Paris (POP) for a period of four to six weeks or as the healing of the fracture progresses. A period of immobilisation is also necessary to prevent any deformity of the fractured bone, that may occur during healing. After the period of immobilisation of the fracture of the radius, the patient requires rehabilitation to restore movement and function to the affected forearm. During the early phase of rehabilitation many patients experience pain and discomfort which directly impacts the restoration of movement and function at the affected forearm, resulting in an inability to return to normal activities of daily living (ADL'S). Electrotherapy modalities are widely used by physiotherapists to manage pain during rehabilitation. Two such modalities are Transcutaneous Electrical Nerve Stimulation (TENS) and Interferential Current (IFC). A body of literature exists on the clinical uses of TENS and IFC in the management of pain, however a gap exists on the effectiveness of these two modalities in the management of pain following a distal radius fracture and the consequent effect on restoration of movement and function at the affected forearm (Barbosa et al, 2009; Linton et al, 2010; Schade, 2006).

1.2 Background and Purpose

The radius is one of the two bones that form the framework of the forearm of the upper limb. The radius articulates proximally with the humerus and directly with the carpal bones or wrist, distally. Fractures of the distal radius thus have an impact on the optimal function of the wrist joint. Efficient hand and wrist function, in particular, play an integral role in enabling the dexterity of the upper limb. Loss of function of the upper limb impacts on activities of daily living (ADL'S), such as personal care, occupational needs, and social activities (Barbosa et al, 2009; Kakarala et al, 2015).

Distal radius fractures (DRF's) are a common consequence of a fall on an outstretched hand or high energy trauma that occurs in a motor vehicle accident, and this results in a break of the bone. Fractures of the upper limb affect all ages, with young adults sustaining fractures usually after high energy trauma, while in older adults, fractures usually occur from a fall due to osteoporotic changes. Thus, DRF's are expected to increase around 10% every five years to 2036 because of an ageing population (Bruder et al, 2011). Treatment for a fractured distal radius usually involves re-alignment of the bone by manipulation under anaesthetic, followed by immobilisation in a Plaster of Paris (POP) cast for six weeks. In more severe cases surgery is indicated where plates, pins, screws or wires are inserted to secure the fracture and facilitate healing of the bone. In order for the fracture to heal, a period of immobilisation is required, followed by a period of regaining mobility and strength at the affected joint. Some of the complications that can arise from a DRF are joint stiffness, loss of strength, reflex sympathetic dystrophy, possible median nerve injury and deformity of the wrist. After the period of immobilisation, physiotherapy treatment is aimed at improving mobility, strength and flexibility of the affected joint, and focuses on restoring function of the affected upper limb with regards to ADL's (Barbosa et al, 2009; Linton et al, 2010).

Although there are many successful treatment regimes, pain and poor recovery after a DRF is common. Only 30% - 75% of patients recover optimal function and improved pain one year following the fracture. After a fracture, the process of recovery has been linked to persistent pain problems and psychological factors, including anxiety which has been directly linked to pain perception. This pain experienced may result in fear of movement, which leads to avoidance of movement of the affected limb. This could hamper restoration of optimal functioning, which could in turn lead to more pain, disability and loss of function (Bruder et al, 2011; Cherubino et al, 2010; Linton et al, 2010).

Vranceanu et al (2011) defined pain as "A subjective perception that results from the modulation of the sensory input filtered through a person's genetic make-up, prior learning and current physiological status, appraisals, expectations, mood and socio-cultural factors." Illness, pain and disability are not separate entities as an individual's response to the nociception of pain will determine their level of function and disability. In the presence of pain an individual may avoid activities that they believe will

exacerbate their pain or worsen their injury. As such, pain often prevents an individual from meaningful engagement in their normal daily activities (Koestler et al, 2010; Vranceanu et al, 2011).

The researcher has based this study on observations in a public sector hospital in South Africa, where she assisted many patients who had a DRF. A period of immobilisation is required for fracture healing (usually 4-6 weeks), after which patients are referred to the physiotherapy outpatient department. The main complaint noted by these patients is pain and stiffness that resulted in a loss of functional use of the affected limb. This can lead to a loss of ability to work, loss of independence and possible lasting disability. While analgesia are routinely prescribed to manage their pain, there are sometimes shortages of medication and patients do not receive their medication (Goudge et al, 2009). In addition patients have to wait for long periods of time in pharmacy queues in public hospitals which many find inconvenient as it impacts on their other activities of daily living. Considering the immobilisation period and time taken for rehabilitation, the patient may be required to take analgesics 2-3 months or longer. If analgesia is not used safely, it can lead to serious side effects and possible fatal consequences. Long term use of analgesics, or exceeding the recommended daily dosages, can increase the risk of liver damage (Barbosa et al, 2009; Johnson et al, 2003; Jorge et al, 2006; Nellans et al, 2012).

The longer it takes a patient to regain functional use of their affected limb the greater the implications for loss of income. The rationale for this study was therefore to find an effective treatment regime that will hasten recovery following a DRF, which requires managing their pain effectively. In keeping with evidence based practice models, two modalities often used by physiotherapists to treat pain were investigated in this study, namely : Transcutaneous Electrical Nerve Stimulation (TENS) and Interferential Therapy (IFC). TENS and IFC are electrotherapy modalities that are non-invasive and have been widely used by physiotherapists to decrease pain, reduce swelling, to assist in the healing of wounds and fractures, and to restore the function associated with muscle weakness following a DRF (Barbosa et al, 2009; Jorge et al, 2006; Johnson et al, 2003).

It has been suggested that TENS activates the pain modulation system of the body, thereby increasing the release of endogenous opioids in the central nervous system(CNS), resulting in inhibiting the transmission of noxious stimuli from the periphery to the CNS.

TENS also increases cutaneous blood flow, significantly reduces the pain in post-surgical patients and assists in the relief of chronic pain. TENS not only reduced pain, but improved other outcome variables, such as return to work, social activities and a need for other supplementary therapy (DeSantana et al, 2008; Johnson et al, 2003; Peacock, 2013; Rakel et al, 2015; Sluka et al, 2003; Vladimir et al, 2010; White et al, 2001).

IFC is an electric current that is amplitude modulated to reduce the discomfort of stimulating deeper tissues, such as muscle fibres, allegedly promoting healing and improving muscle blood flow. It has also been suggested that IFC stimulates the pain modulation system in a similar manner as TENS. Although IFC is widely used in rehabilitation, two publications found that IFC had no additional analgesic effect in managing shoulder and low back pain compared with conservative management (Almeida et al, 2003; Johnson et al, 2003; Rakel et al, 2015; van der Heijden et al, 1999; White et al, 2001).

The use of electrotherapy began decades ago however there has been renewed interest in its use due to increased knowledge and a better understanding of the physiology of pain transmission and perception. In addition researchers are also making an effort to find alternatives to drug therapy traditionally used to treat pain (White et al, 2001).

There are currently many physiotherapy interventions that effectively treat patients following immobilisation after a DRF. Active interventions include exercise and advice for the patient in their rehabilitation. Passive interventions, such as joint mobilisations, passive movements, thermal modalities, soft tissue mobilisation, resting and dynamic splinting and cryotherapy are also administered by the physiotherapist. Using clinical reasoning, the physiotherapist usually designs a treatment regime for the individual patient depending on their ADL'S and usually includes more than one intervention, on the patient problems. It is also based on the knowledge of resources available and the physiotherapists' own professional knowledge and expertise, which is evidence based practice (Bruder et al, 2011; Bruder et al, 2013).

The purpose of this research was therefore to determine the benefits of using TENS and IFC to decrease patients' pain following a DRF, the intention being to facilitate movement, improve their ADL'S and return to normal functioning of the limb.

1.3 Aim of the Study

The aim of the study is to determine the efficacy of TENS and IFC, to reduce pain following a Distal Radius Fracture

The objectives of the study were :

1. To determine whether there was a decrease in the level of pain following the use of TENS or IFC.
2. To measure the range of movement (ROM) at the affected wrist following the use of TENS or IFC.
3. To measure muscle grip strength of the affected hand following the use of TENS or IFC.
4. To determine whether there was an improvement in functional ability of the affected hand/upper limb following the use of TENS or IFC.

1.4 Chapter outlines

This document is presented in the following chapters :

Chapter 2. Literature review: This chapter reviews the relevant literature on the wrist joint, distal radius fractures, the pathophysiology of pain, hand injury and pain, the effects of immobilisation on the affected hand, assessing the hand and the use of TENS and IFC for other painful conditions.

Chapter 3. Methodology: This chapter outlines the methods used to conduct the study and consists of the study: design, setting and population, sample, inclusion and exclusion criteria, data collection tools and process, data analysis, data management, reliability and validity, ethical considerations and confidentiality

Chapter 4. Results: The study findings are presented with respect to the participants demographic details and the four study objectives.

Chapter 5. Discussion: The study findings are discussed with respect to the four study objectives the results presented elsewhere.

Chapter 6. Conclusion : significance of the study, study limitations and recommendations.

Chapter 2. LITERATURE REVIEW

2.1 Introduction

The aim of this study was to determine the effectiveness of two electrotherapy modalities in reducing pain following a distal radius fracture (DRF). After a DRF, a period of immobilisation is required for the fracture to heal. Due to the lack of movement, patients usually experience pain and swelling once the immobilisation period is complete. This hampers rehabilitation, which is important to ensure joint mobilisation, strength, flexibility, and function of the affected hand.

This chapter will review the literature on the wrist joint, distal radius fractures, the pathophysiology of pain, hand injury and pain, the effects of immobilisation on the affected hand, assessing the hand and the use of TENS and IFC for other painful conditions.

2.2 The Wrist Joint

The radius bone has a large distal end that articulates with the bones of the carpus to form the wrist joint. When a DRF occurs, the wrist joint and carpus are immobilised in a cast of Plaster of Paris (POP) to ensure healing of the DRF. The wrist joint is surrounded by a capsule and ligaments which strengthen the joint. The volar carpal ligament extends from the radius to the ulna bones' and over the flexor tendons which enter the wrist. The transverse carpal ligament passes over the carpus and forms a 'tunnel' for muscle tendons, vessels and nerves to pass through from the distal forearm into the hand. The dorsal carpal ligament is situated on the posterior of the wrist joint and extends across the ulna, radius and carpal bones. Between the dorsal carpal ligament there are six compartments for muscle tendons to pass through into the hand (Gray, 1918; Solomon et al, 2001)).

2.3 Types of Distal Radius Fractures

Distal radius fractures are classified according to the site of the fracture at the wrist and the structures involved. The different types are; a Colles Fracture, Smith's Fracture, Radial Styloid Fracture, Barton's Fracture.

2.3.1 Colles Fracture

A Colles Fracture is a transverse fracture of the radius that occurs just above the wrist, with the dorsal displacement of the distal fragment and is usually caused by a fall on an outstretched hand. It has a high incidence in older people and is commonly related to the onset of postmenopausal osteoporosis. If the fracture is undisplaced it is managed conservatively with a Plaster of Paris (POP) cast for four to six weeks while if displaced it is reduced under anaesthesia after which a POP cast is applied and usually removed after six weeks when the fracture is united (Solomon et al, 2001).

2.3.2 Smith's Fracture

A Smith's fracture is generally due to fall on the back of the hand and is sometimes referred to as 'reverse Colles' as the site and pattern of the fracture is similar, except that distal fragment is displaced anteriorly. Managing the fracture is reduction by traction and extension of the wrist, and by immobilisation in a POP cast for six weeks (Solomon et al, 2001).

2.3.3 Radial Styloid Fracture where the fracture enters the wrist joint

The Radial Styloid fracture extends laterally from the articular surface of the radius and often results in more than just the radial styloid being displaced. This fracture can sometimes be far more serious where a trans-scaphoid perilunate fracture, dislocation occurs. The cause of the fracture is forced radial deviation of the wrist, which may occur after a fall or sometimes when a starting handle 'kicks back,' with this fracture sometimes being referred to as a 'chauffeur's fracture.' If the fracture is displaced, it is reduced and a POP cast is applied with the wrist held in ulna deviation (Solomon et al, 2001).

2.3.4 Barton's Fracture - fracture-subluxation of the wrist

A Barton's fracture is usually a volar fracture with volar subluxation of the carpus, with the fracture line runnning obliquely over the volar lip of the radius and into the wrist joint. The distal fragment displaces anteriorly, taking with it the carpus. Management includes reduction of the fracture, with internal fixation usually being recommended as the fracture easily redisplaces (Solomon et al, 2001).

2.4 Pain following a Distal Radius Fracture

Pain is a consequence of a hand injury and can complicate the recovery process, thereby negatively affecting short- and long-term functional recovery. Pain following a DRF is a public health problem and its prevalence leads to considerable costs in terms of health care utilisation as well as loss of productivity and disability making it imperative that clinicians address pain management following a hand injury (Koestler et al, 2010; Portenoy et al, 2013)

The International Association for the Study of Pain (www.iasp-pain.org) defines pain as

> "an unpleasant sensory or emotional experience associated with actual or potential tissue damage, or described in terms of such damage. Pain is always subjective and is related to previous experiences of injury in early life. Pain is a sensation in a part of the body that is unpleasant and therefore also an emotional experience."

This section reviews the classification of pain, the pathophysiology of pain, hand injury and pain.

2.4.1 Classification of Pain :

Pain is classified as either nociceptive (somatic or visceral) or non-nociceptive (neuropathic or sympathetic). Nociceptors are pain receptors that are found in the periosteum of the bone, muscles, ligaments and tendons. When the bone fractures, the ligaments and tendons surrounding the bone may also be damaged. A fracture in the bone may heal but damaged tendons and ligaments do not always heal completely and pain still persists at the affected site due to nociception from the periosteum of the bone, ligaments and tendons (Markham et al, 2014; Portenoy et al, 2013).

2.4.2 The Pathophysiology of Pain

When an injury occurs to a bone, ligament or muscle, the nociceptors are stimulated these being the A-delta and the C-fibres. These fibres enter the spinal cord and synapse in the dorsal horn from where the fibres continue to the thalamus and the cerebral cortex. Once the ‘signal of pain’ reaches the cerebral cortex, it is altered by an individual’s feelings, thoughts and beliefs. After this ‘interpretation’ of the pain, the brain sends signals down the spinal cord to increase or reduce the pain at the periphery. When tissue is injured,

inflammation occurs at the site of injury and substances such as substance P and neurokinin are released which sensitise the nociceptors and further increase the speed of the message of pain up the spinal cord to the brain (Markham et al, 2014; Portenoy et al, 2013).

2.4.3 Hand Injury and Pain

Pain is a fundamental consequence of a hand injury, and it can complicate the recovery process and negatively impact on functional outcomes. The Gate Control Theory of Pain was introduced by Melzack and Wall, and integrates pain perception and psychosocial factors. Gate control refers to the modification of the pain signal that is transmitted to the brain from the periphery as well as the efferent neural impulses that descend from the brain to the periphery in response to the pain signal. Simply put, when an individual experiences anxiety or stress the "gate is opened" and it amplifies the pain signal as it ascends the spinal cord. The descending message from the brain will thus result in an increase in the pain intensity. Stress thus intensifies the pain, and the pain itself becomes a stressor to the patient which continually threatens homeostasis. Pain is thus interpreted differently by individuals depending on their previous experiences of pain, sensory modalities, memory and genetics (Koestler, 2010).

Gatchel developed a model of pain with three phases: acute, sub-acute and chronic. He stated that "the acute phase is associated with the patients' natural emotional reaction to their perception of pain and may include anxiety and fear." Unrelieved pain has been identified as one of the emotional stressors following a hand injury. The sub acute phase is when pain persists for two to four months post injury at which stage many people experience increased distress, depression, anger and somatisation. These experiences are further confounded by the persons' current environmental and socioeconomic conditions with the stress experienced in coping with pain exacerbating the conditions. Gatchel defined the third stage in the pain model as occurring when the person "progresses toward chronic pain disability." In this stage, the person may be affected by financial problems and distress in the family. The injury may become increasingly problematic, affecting activity levels and social interaction, at which point the person begins to view pain as disabling, with the sense that they have little control over the pain and its effect on their life. Gatchels model of pain highlights the importance of appropriate assessment and treatment within the stages, because the longer the pain persists, "the more influential

psychosocial variables become in affecting the patients pain experience and response to treatment" (Koestler, 2010).

2.5 Complex Regional Pain Syndrome

Complex Regional Pain Syndrome (CRPS) is a common complication following a wrist fracture the rate being greater than 30% following a DRF. CRPS syndrome has an acute phase, where the affected body part is swollen, sensitive and the temperature is increased. In the chronic phase, these features resolve, but the pain and disability remain. A widely recognised predisposing factor for CRPS is immobilisation of a limb following trauma (Moseley et al, 2014; Pepper et al, 2013).

Pepper et al (2013), measured pain one day after cast removal (after a period of immobilisation) and one month later. The average value of pain intensity was 3.9 one week after cast removal and 3.0 one month later at which time, 42% of the participants reported moderate to severe pain in the affected limb. Moseley et al (2014) sought to quantify the incidence of CRPS four months following a wrist fracture. Baseline values for pain were collected within one week after sustaining a fracture at the wrist and again four months later. A summary of their findings was that no patient with a baseline pain score of 3 or less presented with CRPS. The 113 patients baseline scores for pain was 5 or higher, 46% of whom presented with CRPS. The study concluded that patients at a higher risk of developing CRPS need to be identified so that interventions can be implemented to prevent it. Patients with a baseline pain score of >/=5 need to be red flagged and their pain managed from early on.

2.6 Immobilisation following a Distal Radius Fracture (DRF)

After a DRF a period of immobilisation of 4-6 weeks is required to rest and protect the injured structures which go through three phases of healing : acute/inflammatory phase, fibroblastic and the remodeling phases. The acute phase of healing lasts 4-5 days following the injury during which time there is pain and swelling at the affected area. The fibroblastic stage occurs from 4-5 days to 4 weeks following the fracture during which time collagen is formed and deposited at the site of injury for scar formation. The joint remains immobilised during this stage, which results in the collagen fibres being shortened and disorganised causing tightening and shortening of the joint capsule, volar

plate and collateral ligaments. During the remodeling phase, the collagen fibres re-organise according to tensile loads placed on the joint. If the joint is still immobilised at this stage, the new collagen fibres will be shortened, thereby limiting full range of movement at the affected joint (Glasglow et al, 2010).

During immobilisation, muscle atrophy occurs which decreases muscle strength and endurance at the immobilised joint. Immobilised muscle loses about 3% of its original strength, per day, of immobility and remains in a shortened or fixed position, becoming contracted which also leads to contractures of the joint capsule and decreases the range of movement at the joint. Once the immobilisation period is complete, gentle movement of the affected joint can commence. However the presence of pain and oedema will prevent the joint from being moved through full normal range of movement, and the patient will be reluctant to move the joint due to pain (Glasglow et al, 2010; Stewart, 1989).

2.7 Assessment of Hand Function Following an Injury

This section will review the assessment of hand including; pain, activity of daily living, range of movement and muscle strength.

2.7.1 Measuring of Pain

One of the methods for measuring of pain is the Verbal Numerical Rating Scale (VNRS). In a recent study by Ismail et al (2015), an assessment of pain using the VNRS and the visual analogue scale (VAS) was compared. In a three month study, 133 patients were recruited all of whom reported acute pain to the paramedics attending them. The results indicated a strong correlation amongst these patient pain ratings reported with the VNRS and the VAS thus both methods used to assess pain where equally efficient.

2.7.2 Assessment of Activity of Daily Living

The Patient-Rated Wrist Evaluation (PRWE) is a standardized outcome tool to measure wrist function at the affected limb and was designed by conducting surveys with active members of the International Wrist Investigators. The information obtained from the clinicians was used to develop a new instrument that was designed to measure the status of the affected wrist using a simple, brief and easy scoring system. The tool also

measures pain and disability of daily living separately and uses a numeric scale for scoring. (MacDermid et al, 2007).

2.7.3 Measurement of Wrist Joint Range of Movement

Joint Range of Movement (ROM) is generally clinically measured using a standard plastic held goniometer although other instruments can be used, such as radiographs, photographs, the electrogoniometer, flexometer, or plumb line which may give objective, valid and reliable measures of ROM but is not always practical in the clinical environment. While consistency of measurement has not been absolutely established for the goniometer, it is more reliable than eye estimation. Reliability varies depending on the joint and movement been assessed with intratester reliability preferable to avoid differences that could be due to a change in the person doing the tests, therefore the same therapist should conduct all measurements on a specific respondent (Armstrong et al, 1998; Clarkson, 2000).

2.7.4 Measuring Muscle Strength

Hand grip strength is an important component of handling and movement of the hand. The literature shows many different ways to measure muscle strength with manual testing commonly used as it is easily applied and no equipment is necessary. However, this method is not accurate and sensitive, with the modified sphygmomanometer (MS) being low cost instrument that can be used to measure grip strength, and has been shown to offer quantitative and objective measurements. In a study by Lucareli et al (2010), handgrip strength measurements were compared using the MS and hand dynamometer in 40 healthy participants with no significant difference in values being noted.

2.8 Transcutaneous Electrical Nerve Stimulation

Transcutaneous Electrical Nerve Stimulation (TENS) is a commonly used type of electrotherapy to treat many conditions, such as myofascial and arthritic, lower back pain, neurogenic, sympathetic mediated, visceral, bladder incontinence and postsurgical pain. The analgesic effect of TENS has been explained with reference to the Melzack and Wall gate – control theory. When the gate is open, the C-fibres and A-delta fibres are stimulated at the periphery, and transmit nociceptive information via the spinal cord to the brain where it is interpreted as pain. When the TENS is applied to the painful area,

the electrical stimulation activates the A-beta fibres without concurrently stimulating the C-fibres and A-delta fibres. This results in inhibiting nociceptive transmission along the C-fibres and A-delta fibres, thus closing the gate and preventing further pain transmission from travelling up the spinal cord to the brain. Another postulate on the analgesic effect produced by TENS has been linked to the activation of receptors in the spinal cord that leads to a release of serotonin, opioids and muscarinic receptors (DeSantana et al, 2008; Johnson et al, 2003; Peacock, 2013; Rakel et al, 2015; Sluka et al, 2003; Vladimir et al, 2010; White et al, 2001; Wright et al, 2001).

2.8.1 Systematic Reviews on TENS

White et al (2001) examined the current literature in support of the use of electrotherapy for pain management. In this review, seventeen studies found no evidence of pain reduction with the use of TENS compared to placebo treatments. However, more recent randomised controlled trials found TENS to be beneficial in pain reduction after knee arthroscopy, hemorrhoidectomy, thoracotomy and hysterectomy surgical procedures. TENS was also beneficial in treating chronic pain and improved other outcome variables such as return to ADL'S. The conflicting reports regarding the efficacy of TENS has been related to differences in its application, i.e. different stimulation sites and varying intensities, frequencies, duration of treatment and patients psychological profile.

Sluka et al (2003) also undertook a review of the use of TENS and its efficacy in reducing pain, and found that it provides a useful adjunct treatment for pain control. In some conditions, the patient's pain level affects their ability to perform aspects of the rehabilitation programme such as exercises. If pain is controlled with the addition of TENS into the rehabilitation programme, patients were better able to adhere to an active exercise programme which improved the function with regards to ADL's and return to work. TENS was found to increase joint function in the presence of arthritis. In patients with chronic lower back pain, the use of TENS improved physical and mental components associated with this condition. After a thoracotomy procedure, TENS reduced the time patients spent in the recovery room and improved pulmonary function. In seven randomised control trials, which used TENS to treat osteoarthirits, it was more effective in pain relief in comparison to the placebo treatment.

Another review, by DeSantana et al (2008) regarding the use of TENS for pain management focused on studies published from 2005 to 2008 and found that in studies involving animals with knee joint inflammation, TENS was effective in reducing hyperalgesia associated with the condition. The application of TENS away from the site of injury, e.g. to the unaffected limb, reduced hyperalgesia of the affected inflamed limb. While different TENS units have varying characteristic, their various waveforms produced, have no effect on the analgesia it produces, but can be used to improve the patients comfort. If TENS is applied every day, by day 10 of treatment, it will become ineffective due to analgesic tolerance. TENS used in experimental pain models produced maximal hypoalgesia with high stimulus intensity and an alternating high/low frequency.

The limitations of these studies were that they are unable to replicate the physiological and psychological processes present in clinical pain. High frequency TENS had the most effect on pain reduction in a 6 week period of treatment. However, low frequency TENS produced positive long term results and improved functional measures over 32 weeks. It can be utilised as a fast acting pain treatment and proved beneficial in reducing autonomic responses to acute pain. Fading of the TENS stimulation intensity occurs during the treatment session, but this does not impede its hypoalgesic effect. This study revealed that further investigation is needed to establish a minimal effective dose to the treatment time parameter for TENS. Five randomised controlled studies found incisional pain intensity was reduced for 24 hours postoperatively as well as when the patient coughed. DeSantana et al (2008) concluded that the effectiveness of TENS on individual pain conditions is still controversial, probably due to poor study designs and sample size. Continued research of TENS mechanisms on adequately characterised patient populations is essential.

2.8.2 TENS in the treatment of knee Osteoarthritis following an arthroplasty

The knee joint is formed by the femur and tibia bones, between which is a layer of cartilage that cushions and protects the bones during movement. Surrounding the joint, is the capsule, tendons and ligaments with knee osteoarthritis (OA) occurring when the cartilage in the knee joint wears away, resulting in the femur and tibia rubbing directly on each other. Total knee arthroplasty is a surgical procedure performed at the knee joint, whereby a prosthetic is inserted at the joint to alleviate friction between the two bones, improving function and decreasing pain at this joint. After knee arthroplasty,

rehabilitation is painful as severe pain is experience with movements which has been associated with poor recovery of function. Painful structures in the knee joint following surgery are similar to those found at the wrist joint following a DRF, such as ligaments, tendons and bone, as well as inflammation and swelling. Although patients are managed with analgesics post operatively, this is not effective in controlling pain experienced with movement. Rakel et al (2015) undertook a study with patients who underwent knee arthroplasty, in which TENS was found to be beneficial following surgery. Pain during active movements of the knee joint, and pain during the postoperative period was significantly reduced compared to the use of analgesic medication alone. Another important finding was that those patients who scored high on pain catastrophizing and anxiety at baseline did not have significantly reduced pain with movement. Pain was assessed again at six weeks after surgery and the use of TENS, with no significant decrease in pain being noted, which was attributed to the patients developing tolerance to the TENS stimulation.

2.8.3 TENS in the treatment of Lower Back Pain

Anatomically, the lower back consists of the spinal vertebrae, ligaments, tendons and muscles. In the presence of chronic lower back pain (CLBP), the nociceptors in these structures are stimulated and noxious stimuli are transmitted to the brain. Following a DRF, these similar structures at the wrist joint transmit noxious stimuli. Poitras et al (2008) reviewed six randomised control studies that investigated the use of TENS for CLBP and found that it decreased pain intensity significantly immediately after application and one week later. However at 3-6 months follow up there was no statistically significant reduction in pain. TENS also improved the physical and social function, but with no statistical significance when compared to control groups. The conclusions of this review implied that TENS was useful as an adjunct tool in a rehabilitation programme for immediate and short-term pain relief.

2.8.4 TENS use in treating Neck Pain

Anatomically, the neck region consists of the spinal vertebrae, ligaments, tendons and muscles. In the presence of neck pain, the nociceptors in these structures are stimulated and noxious stimuli is transmitted to the brain, as is the case following a DRF at the wrist. Neck pain is a common cause of musculoskeletal pain and results in loss of time at work and productivity, as well as significant medical costs. Several non-invasive

modalities to treat neck pain have been investigated in the literature, however, the results were inconclusive. Escortell-Mayor et al (2011) undertook a randomised controlled trial to investigate the effectiveness of manual therapy and TENS to reduce neck pain. Patients were randomised into two groups: manual therapy and an exercise programme, TENS and an exercise programme, and their pain was measured using the visual analogue scale. Other variables were investigated in the following questionnaires; Neck Disability Index (NDI), Physical (PSC-12) and Mental(MCS-12) Component Summary. The patients received 10 sessions with a duration of 30 minutes on alternate days of either TENS or Manual Therapy. The study found that there were no differences between the two groups with regards to reduction in pain and disability, or to an improvement in the quality of life.

2.9. Interferential Current

Interferential Current (IFC) is electric current that is amplitude modulated to stimulate deeper tissues, such as muscle. It can be used to manage many clinical conditions such as acute and chronic pain, oedema, muscle re-education, stress incontinence and spasticity, and to promote healing of injured tissue. In comparison with other electrotherapy modalities, IFC delivers currents that overcome skin impedance, thereby reaching deep tissues. IFC produces a comfortable current for patients 1 and 250Hz, which previous studies have reported induces analgesia in humans. It has been postulated that IFC directly stimulates muscle fibres, allegedly promoting healing and improving blood flow to the muscles, and has been associated with an increase in opioid release. Other studies have postulated that the mechanism of action of IFC is similar to TENS with reference to the Melzack and Wall gate – control theory where nociceptive transmission along the C-fibres is inhibited (Almeida et al, 2003; Johnson et al, 2003; Rakel et al, 2015; White et al, 2001; Wright et al, 2001).

2.9.1 Interferential Current to reduce induced pain

Experimental pain studies are useful because their results can be used as guidelines for consequent clinical trials. Different experimental pain models exist like, such as mechanical, cold, electrical and ischemic pain. McManus et al (2006) investigated the use of IFC to reduce pain in cold and mechanical induced pain, the variables measured being :

- cold pain threshold defined as ‘time to first sensation of pain.’

- intensity of pain measured with the VAS.
- Mechanical pain threshold defined as tolerance to pressure and related unpleasantness using the VAS.

IFC was found to decrease pain significantly in both cold and mechanically induced pain, and was efficient in producing analgesic effects in both pain models. These findings suggest that IFC maybe be equally effective in treating a wide range of painful conditions found in clinical settings, such as DRF's.

Jorge et al (2006) investigated the use of IFC to treat inflammatory pain on 69 rats. Inflammatory pain is a result of the release of inflammatory mediators that continuously stimulate the nociceptors. To prevent the release of inflammatory mediators at the site of injury, nonsteroidal anti-inflammatory drugs (NSAIDs) are used, however, many patients are intolerant to the prolonged use of NSAIDs so the use of electrotherapy has gained popularity.

In the Jorge et al (2006) study, the rats were divided into two groups, first being injected with formalin to evoke a nociceptive response, and the second injected with carrageenan to induce inflammation and oedema. IFC was applied to the paws of both groups, and observations of the rats behaviour was documented and used for data analysis. The results of both investigations concluded that the IFC reduced inflammatory pain but had no effect on the oedema.

During the immobilisation period following a DRF, muscles and tendons around the wrist becomes shortened and stiff, resulting in pain being reproduced with movement following the removal of the cast. Fuentes et al (2010) investigated the effect of IFC and placebo IFC in reducing muscle pain that was experimentally produced. Pain was reproduced in forty healthy participants, using pressure algometry, this method being believed to induce pain in deeper tissues such as muscle with IFC being found to be effective in reducing muscle pain sensitivity.

2.9.2 IFC for Treating Shoulder Disorders

When patients experience a shoulder disorder, pain is elicited and can be aggravated by

movements. These symptoms are similar to those found at the wrist joint following a DRF, and can limit active ROM at the shoulder and negatively impact on ADL's. Van der Heijden et al (1999) investigated the use of IFC and ultrasound to manage pain elicited from a shoulder disorder using a sample comprised of 180 patients across 17 physiotherapy practices. Patients were randomised to receive a number of treatments: IFC and ultrasound, IFC plus dummy Ultrasound, dummy IFC plus Ultrasound, dummy IFC and dummy Ultrasound. Each Group also received exercises with the results indicating that neither IFC nor Ultrasound were effective adjuvants to exercise therapy. However, there was no statistically significant difference between the groups with regards to outcomes measures.

2.9.3 IFC use in treating Fibromyalgia and Lower Back Pain

Musculoskeletal pain is an important component of symptoms experienced after a DRF. Fibromylagia is defined as chronic musculoskeletal pain. Almeida et al (2003) investigated the use of IFC combined with ultrasound to treat of fibromyalgia using two randomised groups with one receiving the two modalities while the other received sham electrotherapy. The group that received electrotherapy had better improvements in pain and sleep patterns, which the authors suggested was directly linked to a decrease in pain before going to sleep. Improved sleep patterns at night could also lead to less pain in the morning.

Anatomically the lower back consists of the spine bone joints, ligaments, tendons and muscles similar to the wrist joint. Hurley et al (2000) investigated the use of IFC in the management of acute low back pain with 60 participants who were randomly assigned to receive IFC and exercises, and exercises only. IFC and exercises were found to be significantly more beneficial than exercises alone in reducing pain.

2.10 The Role of Transcutaneous Electrical Nerve Stimulation and Interferential Current in Managing Pain

There has been renewed interest in electrotherapy due to a new and better understanding of pain perception and transmission, as well as to continued research being done to find alternatives to traditional analgesics such as opioids and nonopioids. TENS provides a transfer of electrical energy from an external unit via pads placed on the skin that

transmits stimulation to the peripheral nervous system. ICF is an electric current that is also applied to the skin via pads by using different stimulation frequencies that stimulate deeper tissues with less discomfort on the skin surface than occurs with TENS (Dewan et al, 2011; White et al, 2001).

2.10.1 TENS and IFC in the treatment of Adhesive Capsulitis.

Dewan et al (2011) investigated the effect of TENS and IFC in managing adhesive capsulitis at the shoulder, which results in a decrease of (ROM), as well as pain and muscle weakness similar to symptoms experienced following a DRF. With a sample size of 50, 25 patients were allocated to the TENS group and 25 to the IFC group with each group receiving 10 sessions of their allocated modality over 4 weeks. A goniometer was used to measure ROM at the shoulder joint and the Constant Murley Assessment Score(CMA) was used to measure shoulder function while the visual analogue scale (VAS) was used to rate pain. The pre treatment VAS scores for the TENS group was 7.70 while the post treatment scores were reduced to 5.10. The pre treatment VAS scores for the IFC group was 7.50 and post treatment scores were reduced to 2.15, these scores being statistically significant. The IFC group showed a greater reduction in pain compared to the TENS group, which was statistically significant. The ROM measurements for shoulder flexion, abduction and external rotation significantly improved in both groups, however, the IFC participants showed a greater improvement in shoulder ROM compared to the TENS group, which was statistically significant. Both groups also showed a statistically significant improvement in the CMA scores, with participants showing better overall function post treatment interventions. The conclusion of this study was that IFC is more applicable in the therapeutic management of adhesive capsulitis.

2.10.2 TENS and IFC in the treatment of induced pain

Shanahan et al (2006) investigated the efficacy of TENS and IFC in reducing pain in a cold pain model. Twenty participants were recruited for the study and received both IFC and TENS at different sessions. A sham group was not allocated as the aim of the study was to compare the effectiveness of TENS and IFC. Overall, the findings were that both TENS and IFC similarly altered pain intensity rating and unpleasantness. However, TENS was significantly more effective than IFC in “increasing the experimental cold pain threshold.” In the clinical setting, the IFC was used more frequently than TENS in

pain management. This is possibly due to IFC being more comfortable and being perceived to be more effective than TENS. This study suggested that TENS should be the modality of choice when patient comfort and tolerance is not a major issue. Also noted was that pain was experimentally produced in this study while in the clinical setting, a patient's pain will also be impacted by psychological factors.

Cheing et al (2003) undertook a study to determine the analgesic effects of TENS and IFC in experimentally induced heat pain using 48 healthy participants who were randomly allocated to three groups: TENS, IFC and a control group. Experimentally induced heat pain is similar to acute pain, as it is a well defined, localised, sharp sensation. Experimental pain can be standardised in healthy subjects, therefore responses across the groups can be attributed to the intervention used and not to individual variations. This study found that both TENS and IFC elevated the heat pain threshold significantly compared to the control group. However, the heat pain threshold was slower to drop in the IFC group after the treatment intervention had ended. In other words, the anti-nociceptive effects of the IFC stimulation lasted 30 minutes after the treatment had ended compared to the TENS. Although the results of this study supported of the analgesic effect of TENS and IFC, the authors did conclude that further studies are needed to investigate these two electrotherapy modalities in the presence of clinical pain.

Johnson et al (2003) investigated the use of TENS and IFC to reduce ischemic pain using 30 participants who had no pathology. Ischemic pain was induced in the participants arm using a tourniquet to inhibit the blood flow with the arm being exercised during this procedure, which resulted in a deep ache in the arm similar to pain experienced in the presence of pathology such as a DRF. Participants were randomly allocated to three groups, receiving either TENS, IFC or sham therapy and pain was recorded using the visual analogue scale (VAS) and the McGill pain Questionnaire. The study found that while the analgesic effects produced by TENS and the IFC were similar, the ICF produced increased analgesic effects when compared to the sham therapy, which was more statistically significant compared to the TENS versus sham therapy.

2.10.3 TENS and IFC in treating Knee Osteoarthritis

Painful structures found in the knee joint following surgery are similar to those found at the wrist joint following a DRF, such as ligaments, tendons and bone. Evidence in the

literature supports the use of exercise to relieve pain and improve functional status at joints in the presence of pathology (Bruder et al, 2011). Adedoyin et al (2005) combined TENS and IFC with exercise in the treatment of knee osteoarthritis, with participants being randomly assigned to three groups: TENS and exercises, IFC and exercises, and exercises only. The study found that pain levels and function improved in all three groups, with the clinical outcomes across all three groups not being significantly different to each other.

Zeng et al (2015) undertook a systemic review to investigate the efficacy of different electrotherapy modalities to reduce pain in patients with knee osteoarthritis (OA). Knee OA is a degenerative disease that causes great pain, which leads to a decline in quality of life. Six electrotherapy modalities were investigated in this review, with IFC being found to be the only significant effective treatment in decreasing pain intensity

2.11 Physiotherapy Management of Distal Radius Fractures (DRF's)

A common consequence after a fracture and a period of immobilisation, is loss of ROM due to changes in the periarticular connective tissue. Current interventions to improve ROM that have positive support in the available literature are splinting and casting, exercises, in clinic interventions, and home exercise programmes (Michlovitz et al, 2004).

Bruder et al (2011) investigated frequently used interventions by physiotherapists following a DRF in a systemic review. Exercise and advice was the most frequently used physiotherapy intervention following a DRF while the second commonest intervention used was teaching patients a home exercise programme. Less frequently used were supervised exercises to increase ROM and flexibility, passive mobilisation of the affected joint, massage and functional exercises to assist the patient to return to ADL's. The study also found that exercise combined with advice reduced pain and improved upper limb function following a DRF. Three studies investigated supervised physiotherapy exercise and a home programme versus a home programme only. There were no statistically significant differences between the two groups with regards to impairment and activity

following a DRF. Another two trials found improved wrist range of movement when using a supervised exercise and a home exercise programme (Bruder et al, 2011).

Bruder et al (2013) found that physiotherapist spent the most time teaching home exercise programmes and providing advice to patients following a DRF. This self management approach benefits the patient by increasing knowledge, symptom management and self efficacy following a DRF. During the rehabilitation phase, promoting positive health behaviors helps to increase patient adherence to exercise programmes, as movement is a key principle of fracture management and exercise is an intervention in keeping with this principle. Passive joint mobilisation is also a commonly used intervention following a DRF with immediate benefits having been noted in joint ROM after passive joint mobilisation.

2.12. Summary

From the literature reviewed it can be deduced that there is a definite need for further investigation into rehabilitation interventions following a DRF. TENS and IFC have been proven to reduce pain in other conditions, but its effectiveness on reducing pain in DRF needs to be established.

Chapter 3. Methodology

3.1 Introduction

This chapter will consist of a description of the methodology, which includes the study design, setting, sample, and inclusion and exclusion criteria. This will be followed by an explanation of the data collection utilised in this study, as well as the statistical analysis and ethical aspects that were addressed. These will be discussed with respect to the study Objectives, as indicated in Table 3.1.

Objectives		Method
1	To determine whether there was a decrease in the level of pain following the use of TENS or IFC.	The verbal numerical rating scale (VNRS) was used to determine the patients pain
2	To measure the range of movement (ROM) at the affected wrist following the use of TENS or IFC.	The plastic hand held goniometer was used to measure ROM.
3	To measure muscle grip strength of the affected hand following the use of TENS or IFC.	A modified aneroid sphygmomanometer was used to measure grip strength.
4	To determine whether there was an improvement in functional ability of the affected hand/upper limb following the use of TENS or IFC.	Functional activities were assessed using the PRWE.

3.2 Study Design

This randomised pre-test, post-test longitudinal study entailed comparing the results of the participants who were randomly allocated to the TENS and IFC groups. Both groups participated in the same tests, which provided quantitative data that was analysed and compared for significance.

3.3 Study Setting and Population

The study was conducted at the Physiotherapy Departments two public sector hospitals in Durban, KZN, these being Addington and King Edward VIII. The study was conducted

from January 2011 to January 2012, following approval from the Humanities and Social Sciences Research Ethics Committee (HSS/1438/2010 M), the Health, Research and Knowledge Department of the Department of KwaZulu-Natal Health, and from Hospital and Physiotherapy managers at both hospitals. Patients were recruited who were referred to the Physiotherapy Outpatient Department following a distal radius fracture (DRF) and removal of their POP cast. These hospitals are referral facilities for primary health care (PHC) clinics on the outskirts of Durban that service largely lower income communities who cannot afford private health care.

Many of these patients who belong to the lower income communities require optimal functioning at both their upper limbs to complete their activities of daily living, which is apart from their occupational needs. Some patients do not have running water in their homes and usually need to collect water from a collection point near their homes. They have to walk a distance with collected water in buckets/containers. These patients also do not have support, by way of domestic workers or care givers to provide them with assistance in completing their activities of daily living, such as washing of their clothes, cooking or cleaning their homes. With regards to their occupational needs, many of these patients, from lower income communities are labourers. They need to have optimal use of both their upper limbs to complete the requirements of their occupation. Also noted, were these labourers or manual workers do not have the benefit of paid sick leave or incapacity leave. Simplified, if they do not work, they do not get paid or may lose their employment for being absent from work for a long period of time. Some of the patients in this population are bread winners in their families. A loss of income impacts on their ability to provide the basic needs of their families like food and shelter.

3.4 Study Sample, inclusion and exclusion criteria

The study participants were those individuals who had experienced an injury to their forearm, attended a local PHC clinic, and been referred to the hospitals for further diagnosis and treatment. Once the POP has been removed, they are referred to the respective Physiotherapy clinics which are open during the week, at which patients have weekly booked appointments with registered physiotherapists. Due to the lack of movement at the wrist while in the POP many structures become tight and weak. As such, they require several appointments with specific manual techniques and equipment

that has been designed to improve muscle strength and mobility of the wrist. Due to a number of factors, including transport costs of getting to the clinics, some patients do not complete their physiotherapy treatment.

All patients are referred to the relevant physiotherapy departments, with a referral letter from the Orthopaedic doctor clearly denoting the patient's diagnosis and management. All patients whose diagnosis was a DRF were given an appointment with the researcher at a stipulated date. The researcher compiled a page with numbers written down sequentially from number 1 to number 100 at each sample site. At the first appointment with said patient, his/her name was added onto the list, alongside a corresponding number. This was done in a numerical sequence starting from number one. All patients attached to an odd numbers were allocated to the TENS and exercise group (Group A). All patients attached to an even number were allocated to the IFC and exercise group (Group B).

The following inclusion criteria applied :

- 18-60 years and both genders
- had a traumatic fracture that were non surgically managed with a POP cast.

The following exclusion criteria applied :

- Under the age of 18
- previous fractures if the same limb
- pre-existing joint conditions, e.g. Arthritis, Diabetes, surgical management post fracture (internal or external fixation).

3.5 Data Collection Tools and Process

Once consent was obtained from the patient, a self – administered questionnaire was utilised to record the participant's biographical details and medical history. If patients were not fluent with the English language, a physiotherapist who was Zulu speaking assisted with the questionnaire. All patients were subject to sensation testing, to ensure that the patient could differentiate between different touch sensations (sharp versus

blunt). Pre-intervention (baseline) recordings were done for all variables. The data collection tools are described with respect to the four objectives, each procedure being conducted on the two groups of study participants for comparative purposes. This data was collected following a brief questionnaire to obtain biographical details.

a) Biographical Data

The data collected from the self-administered questionnaire consisted of age, gender, education level, hand dominance and the period of immobilisation after the fracture. This data was collected to be able to compare these variables between the groups.

b) Measurement of Pain (Objective 1)

The verbal numerical rating scale (VNRS) was used to document the patient's pain, before and after treatment at every session during their treatment. The scale is numbered from 0 to 10. Patients are verbally requested to rate their pain out of 10, where 0/10 means no pain and 10/10 is the worst pain experienced.

c) Range of Movement (Objective 2)

Joint Range of Movement (ROM) was measured at pre-intervention, during intervention (third session) and post-intervention (sixth session) using a plastic hand held goniometer. The starting position of patients was with the shoulder in neutral, elbow flexed at 90^0 with the wrist in mid prone, fingers relaxed. Wrist flexion and extension was measured first. The radial styloid was palpated and marked with a felt pen. The goniometer axis was placed on the mark, with the stationary arm on the lateral border of the radius and the movable arm parallel to the index finger. The physiotherapist then stabilised the forearm and stationery arm simultaneously and three readings for flexion and then extension were recorded. Radial and ulna deviation was measured with the forearm pronated and the palmar surface resting lightly on table, wrist neutral and fingers relaxed. A mark with a felt pen was made midway between the radial and ulna styloids, distal to the wrist joint. The goniometer axis was placed at this point, with the stationery arm along the midline of the forearm, and the movable arm parallel to the longitudinal axis of the shaft of the third metacarpal. The forearm was stabilised and three readings taken for both deviations. The starting position for measurement of supination and pronation modified. The treatment table was

adjusted so that the palm lies flat on the table with the phalanges extending beyond the edge of the table. The patient stabilised the humerus against the side of the body with the unaffected hand. A mark was made with the felt pen on the tip of the third digit for placement of the goniometer axis. The stationary arm was perpendicular to the floor and the movable arm was parallel to the tips of the four extended fingers. The forearm was actively pronated and supinated and readings taken. The average of the three readings were used for all movements.

d) Muscle Strength (Objective 3)

Muscle Strength was measured with a modified aneroid sphygmomanometer which consists of an inflatable cuff attached to a guage to measure the pressure exerted by the squeeze. The cuff was folded into three, and measured 11cm by 14cm. It was placed into a plastic bag and inflated to 100mmhg. The height of the cuff after inflation was 6cm. Patients were requested to "squeeze the cuff as much as you can." The reading was recorded from the gauge.

e) Functional Ability (Objective 4)

The Patient Rated Wrist Evaluation (PRWE) was used to assess the patients functional activity according to their difficulty in completing these tasks. This was assessed at the pre-intervention session as well as post intervention (after the sixth session)

f) TENS and IFC

The TENS and IFC was administered via the same unit, made by the Chattanooga Group (Intelect Advanced, Model - 2762CC, Serial Number – 4300). Patients in Group A received TENS therapy and exercises and patients in Group B received IFC therapy and exercises.

The distal forearm area was cleaned, and two flexible rubber electrodes encased in damp sponge covers were placed on the volar and dorsal surfaces of the distal forearm 1cm above the distal crease line of the wrist and secured with Velcro strapping. The patients were informed about how the machine works and that they would feel a tingling sensation at the electrode sites.

Conventional TENS was used with the stimulation frequency set at 100Hz, current at 20mA and pulse duration at 50ms. The intensity was set at the point where the patient was comfortable with the "tingling sensation." The patient was told to inform the therapist "when the tingly sensation diminished." The intensity was then increased once again to a comfortable level. The TENS was applied for 30 minutes. Thereafter the electrodes were removed and the taught exercises to perform daily. Exercise number 1.1 to 1.5 was demonstrated to patients and then revised. The exercise session consisted of a set of 10 repetitions per exercise and 3 sets were done in keeping with the patients comfort. The patient was given an exercise booklet to continue exercises from the session as a home programme. Patients progressed to exercises number 2 and 3, in following visits, as stipulated in the exercise booklet (Appendix 6).

Patients in group B received IFC. The fixed carrier frequency was 4000Hz and the adjustable frequency was set at 4100Hz. Patients were told that they will feel a "tingling sensation" from the electrodes. The intensity was set at the point where the patient was comfortable with the "tingling sensation." The patient was told to inform the therapist "when the tingly sensation diminished." The intensity was then increased once again to a comfortable level. The IFC was applied for 30 minutes to all patients. Once the session was complete the patient was taught exercises in the same manner as Group A and given the exercise booklet. After the treatment session, pain values were recorded.

The intervention period lasted two-three weeks with a total of 6 sessions for each patient within each group. Once patients had agreed to participate, all procedures were conducted in the physiotherapy department within the relevant hospitals. All patients with distal radius fractures who were referred to physiotherapy were given an appointment by the physiotherapy secretary at respective sites. Patients signed written informed consent to participate in the study with anonymity maintained by storing their coded data in a locked cupboard. Patients were notified of procedures and were allowed to withdraw voluntarily at any point from the study.

3.6 Data Analysis

The biographical data was summarised to enable a comparison of variables between the two groups to establish if the results would be comparable. The quantitative data from the physiotherapy test were analysed by objectives, all of which were analysed using IBM SPSS (Version 21.0, IBM Corp., Armonk, NY). Inferential techniques included the use of correlations and chi square test values, and normality was assessed using the Kolmogorov-Smirnov Z Test. Between-group differences and baseline-to-post intervention changes were assessed with the use of the Mann-Whitney Test, ANOVA and Wilcoxon W tests, with the results being presented in the form of graphs and tables.
Statistical tests were two-tailed with a $p < 0.05$ indicating statistical difference.

3.7 Data Management

All questionnaires were stored in a locked cupboard, with accessibility only available to the researcher.

3.8 Reliability and Validity

The PRWE is a validated and reliable tool to assess pain and function (MacDermid et al., 1998; MacDermid et al., 2007). The pre- test and post-test readings for pain, range of movement and muscle strength was done by the same physiotherapist at the two sites to ensure consistency. The researcher was the only physiotherapist to apply the intervention modalities and teach the exercises to all patients in the study.

3.9 Ethical Considerations and Confidentiality

Each patient was given the contact number for both the researcher and the supervisor should they have any queries before and after treatment as part of this study. The patients were reminded throughout the study that they had the right to withdraw from the study any time. Questionnaires were coded as such names were revealed.

CHAPTER 4 : RESULTS

4.1 Introduction

This chapter presents the results and findings of this study. The data collected from the responses was analysed using IBM SPSS (Version 21.0, IBM Corp., Armonk, NY version 21.0). The results are presented as descriptive statistics in the form of tables and bar graphs. Inferential techniques include the use of correlations and chi square test values. Statistical tests were two-tailed with a $p < 0.05$ indicating statistical difference.

4.2 Patient Characteristics

Seventy two patients were referred for physiotherapy with a distal radius fracture, after the immobilisation period and the POP cast removed. Six patients refused to sign consent. Fifty four patients met the inclusion and exclusion criteria. Fourteen patients were lost to follow up. A total of 40 patients (mean age range 40.93, SD - 11,35), with 15 (37.5%) males and 25 (62.5%) females completed the study. The mean age of patients in the TENS group was 40.25 (SD – 11.95) and in the IFC group 41.60 (SD – 10.98). There was no significant relationship between the groups for age and gender ($p > 0,05$).

Table 4.1 : **Education levels of participants.**

LEVEL OF EDUCATION	**GROUP**	
	TENS Group N (%)	**IFC Group N (%)**
No formal Education (Did not attend a school)	NONE	1 (5%)
Finished Primary School	12 (60%)	9 (45%)
Finished High School	5 (25%)	8 (40%)
Tertiary Education	3 (15%)	2 (10%)

There was a 15% difference in education level, in patients who completed primary school, and for those who have finished high school. The remaining categories had at most a 5% difference. There was no significant difference (in frequencies) between the groups for each education level ($p = 0.598$).

Table 4.2 : Hand Dominance

	GROUP	
	TENS Group N (%)	**IFC Group N (%)**
Left Hand	0	2 (10%)
Right Hand	20(100%)	18 (90%)

Patients in both groups were predominantly right handed. All but 10% in the Interferential group were right handed. There was no significant difference between the groups for this variable (p = 0.487).

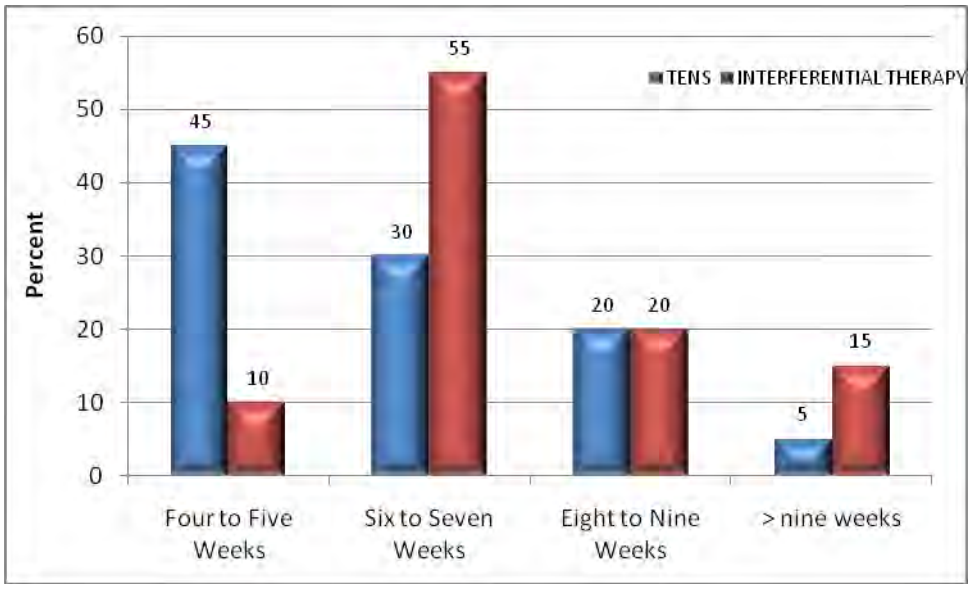

Figure 4.1 : Period of Immobilisation on Entry to the Study

Muscle function decreases proportionally to the length of time of immobilisation. The longer a patient is immobilised, there are greater changes in the "motor unit recruitment patterns" (Kitahara et al, 2003). Although patients across both groups entered the study at different time periods, there was no significant difference between the groups for this variable (p = 0.071).

4.3 OBJECTIVE 1 : To determine whether there was a decrease in the level of pain following the use of TENS or IFC

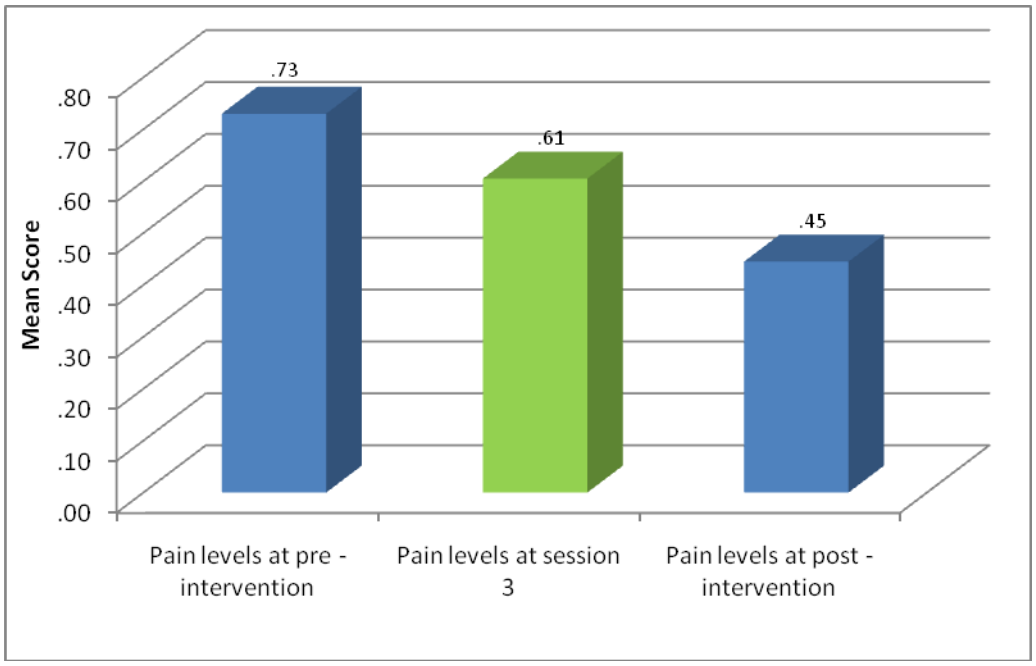

Figure 4.2 : Pain levels for the TENS group

The results indicate a decrease in the mean pain score values, with the decrease being almost linear in nature. From pre-intervention to post intervention there was a statistically significant difference with p-values < 0,05.

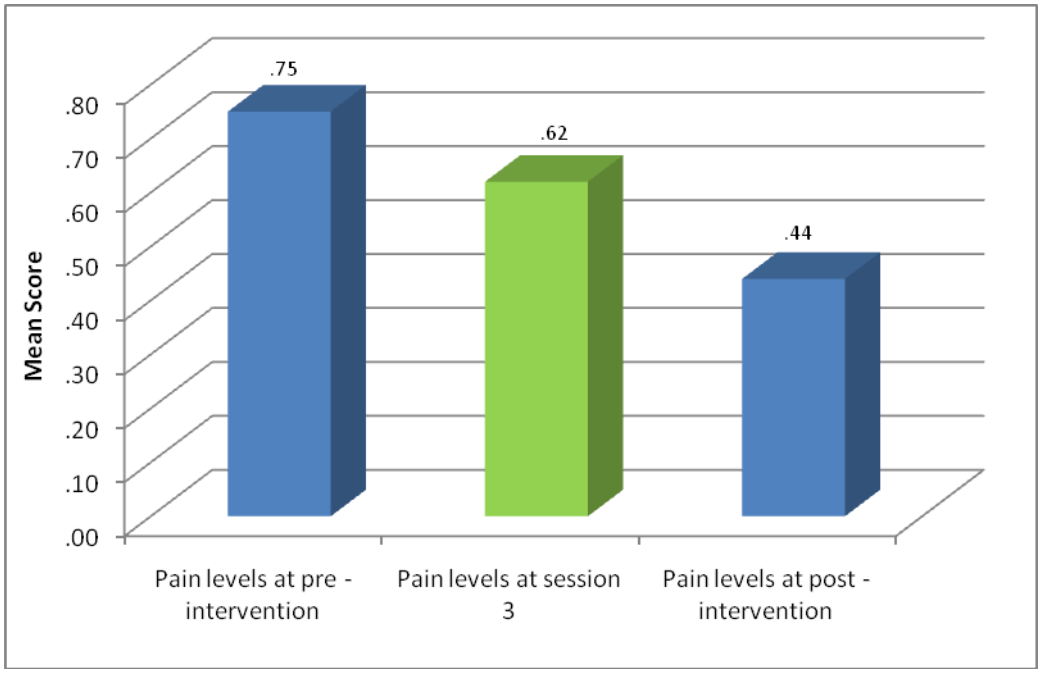

Figure 4.3 : Pain levels for the IFC group

The results indicate a decrease in the mean pain score values, with the decrease being almost linear in nature. From pre-intervention to post intervention there was a statistically significant difference with p-values < 0,05. Similar results were observed as for the TENS group.

4.4 OBJECTIVE 2 : To measure the Range of Movement at the affected wrist following the use of TENS or IFC

The figures that follow indicate the comparison between the pre-intervention (session 1) and post intervention (session 6) for each group comparing active and passive movement. It was found that the post intervention scores for all of the variables are greater than the pre-intervention values. This was true for both the groups. The Kolmogorov-Smirnov Test indicated that all of the variables follow normal distribution patterns for each group. Hence, ANOVA was used to determine if there was any significant difference between the groups for each visit.

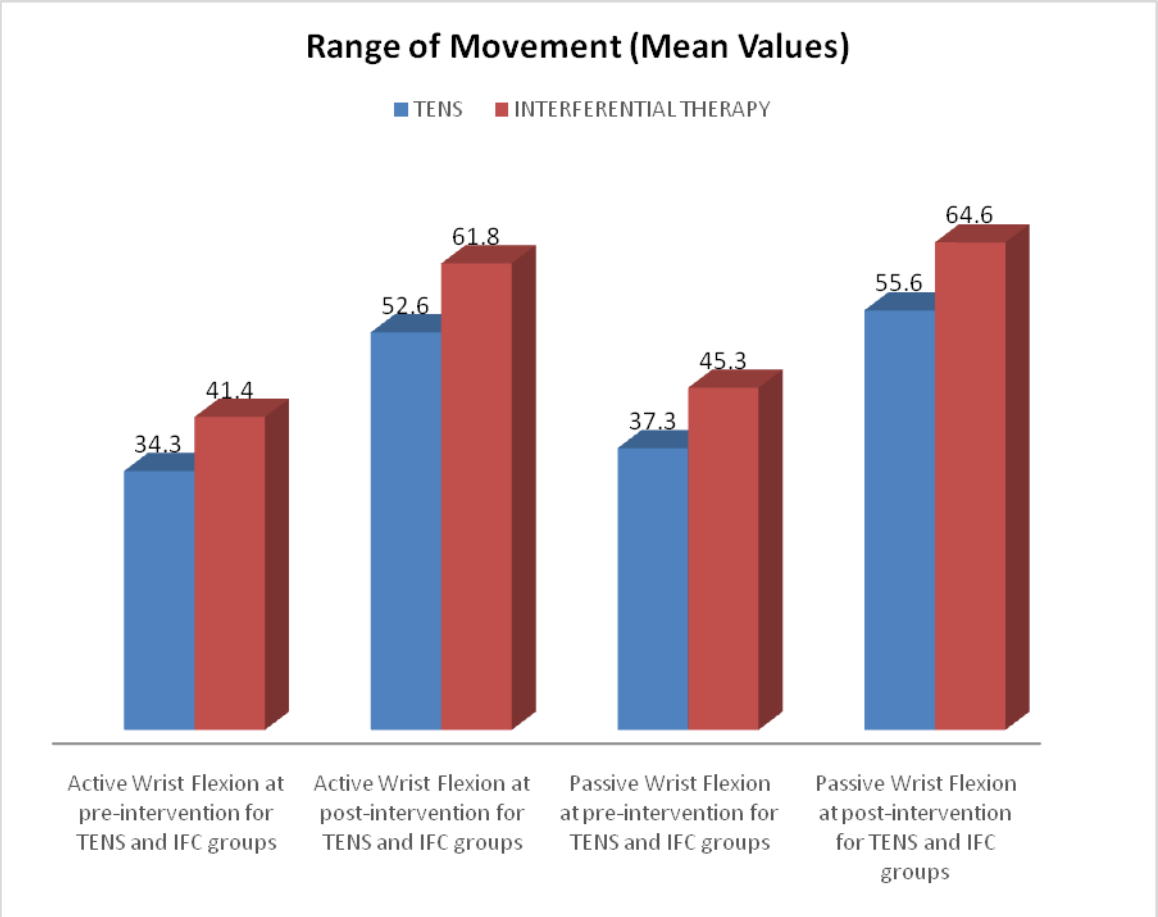

Figure 4.4 : Wrist Flexion Movement at the pre-intervention and post intervention TENS and IFC groups

The Tens Group Comparisons:

The difference between pre–intervention and post intervention scores were statistically significant ($p < 0.001$) for active and passive wrist flexion.

The Interferential Group Comparisons:

The difference between pre–intervention and post intervention scores were statistically significant ($p < 0.001$) for active and passive wrist flexion.

Tens Group versus Interferential Group Comparisons:

There was no statistical significant difference between the TENS and IFC groups for pre-intervention active wrist flexion ($p > 0.05$).

Post intervention scores, found a greater increase in active wrist flexion in the IFC group compared to TENS. This was statistically significant ($p = 0.034$)

Passive wrist flexion scores in the IFC group was greater than TENS at pre-intervention, however this was statistically non significant ($p = 0.05$). Post intervention, the scores for this variable were greater in the IFC group with a statistically significant p-value of 0.032.

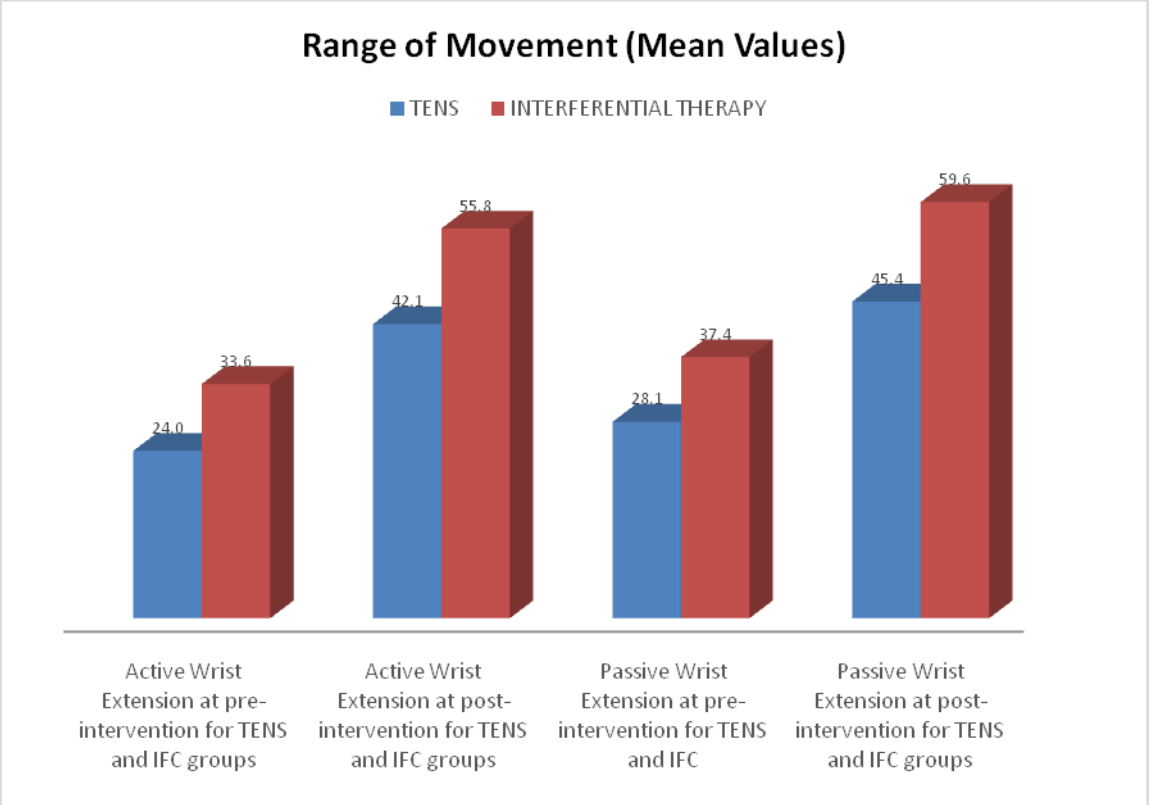

Figure 4.5 : Wrist Extension Movement at the pre-intervention and post intervention TENS and IFC groups

The Tens Group Comparisons:

The difference between pre – intervention and post intervention scores were statistically significant ($p < 0.001$) for active and passive wrist extension.

The Interferential Group Comparisons:

The difference between pre–intervention and post intervention scores were statistically significant ($p < 0.001$), for active and passive wrist extension.

Tens Group versus Interferential Group Comparisons:

There was a statistically significant difference between the TENS and IFC groups for pre-intervention active wrist extension ($p = 0.041$). The IFC group had a higher range of movement score than the TENS group.

There was a statistically significant difference between the TENS and IFC groups for post intervention active wrist extension ($p = 0.009$). The IFC group had a higher range of movement score than the TENS group.

There was no statistically significant difference in passive wrist extension scores between the IFC and TENS groups at pre-intervention ($p > 0.05$). Post intervention, the scores for this variable were greater in the IFC group with a statistically significant p-value of 0.009.

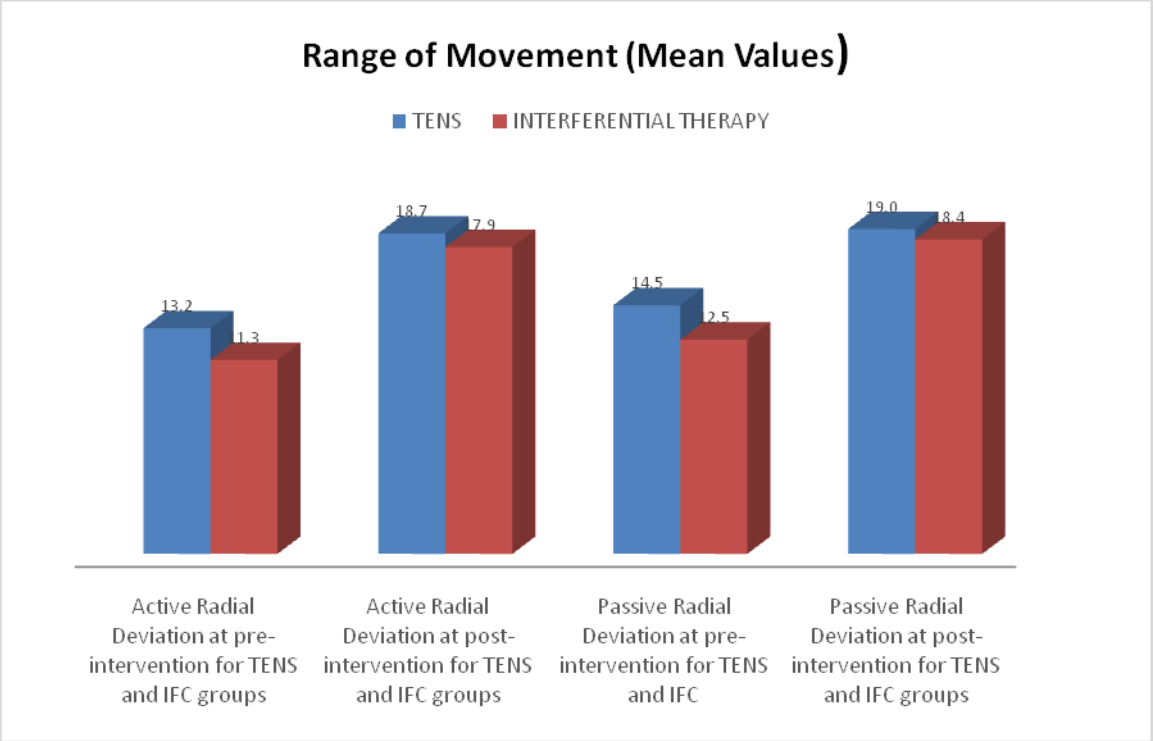

Figure 4.6 : Radial Deviation Movement at the pre-intervention and post intervention TENS and IFC groups

The Tens Group Comparisons:

The difference between pre–intervention and post intervention scores were statistically significant ($p < 0.001$) for active and passive wrist radial deviation.

The Interferential Group Comparisons:

The difference between pre–intervention and post intervention scores were statistically significant ($p < 0.001$) for active and passive wrist radial deviation.

Tens Group versus Interferential Group Comparisons:

The comparisons of scores for TENS versus IFC for active radial deviation at pre-intervention and post intervention found no statistically significant differences ($p > 0.05$). This was similar for passive radial deviation.

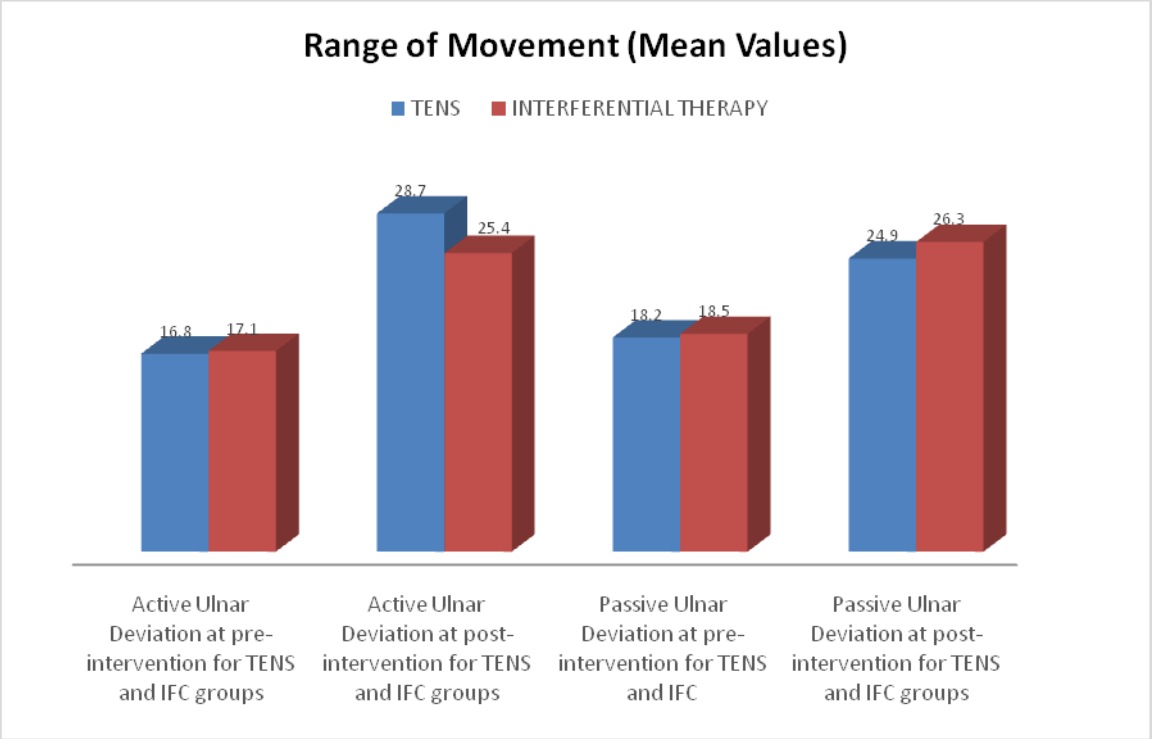

Figure 4.7 : Ulnar Deviation Movement at the pre-intervention and post intervention TENS and IFC groups

The Tens Group Comparisons:

The difference between pre–intervention and post intervention scores were statistically significant ($p = 0.041$) for active wrist ulnar deviation and ($p < 0.001$) for passive.

The Interferential Group Comparisons:

The difference between pre–intervention and post intervention scores were statistically significant ($p < 0.001$) for active and passive wrist ulnar deviation.

Tens Group versus Interferential Group Comparisons:

The comparisons of scores for TENS versus IFC for active ulnar deviation at pre-intervention and post intervention found no statistically significant differences ($p > 0.05$). This was similar for passive ulnar deviation.

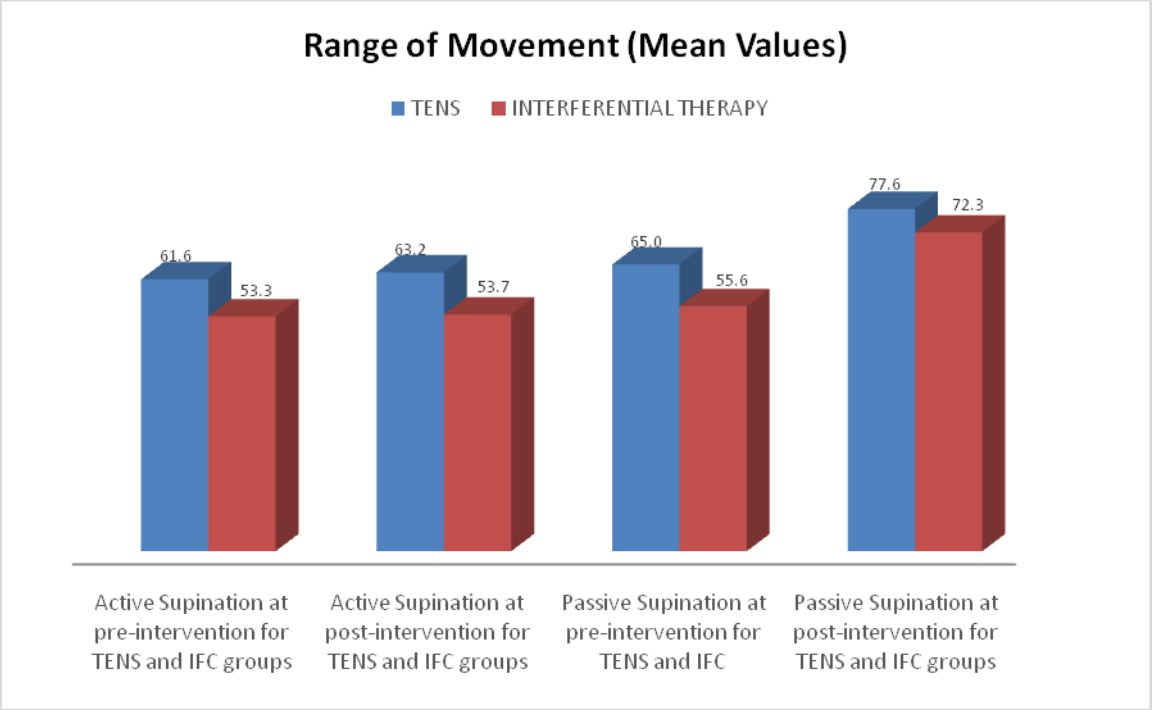

Figure 4.8 : Supination Movement at the pre-intervention and post intervention TENS and IFC groups

The Tens Group Comparisons:

The difference between pre–intervention and post intervention scores were statistically significant ($p = 0.001$) for active wrist supination and ($p < 0.002$) for passive.

The Interferential Group Comparisons:

The difference between pre–intervention and post intervention scores were statistically significant ($p < 0.001$) for active and passive wrist supination.

Tens Group versus Interferential Group Comparisons:

The comparisons of scores for TENS versus IFC for active supination at pre-intervention and post intervention found no statistically significant differences ($p > 0.05$). This was similar for passive supination.

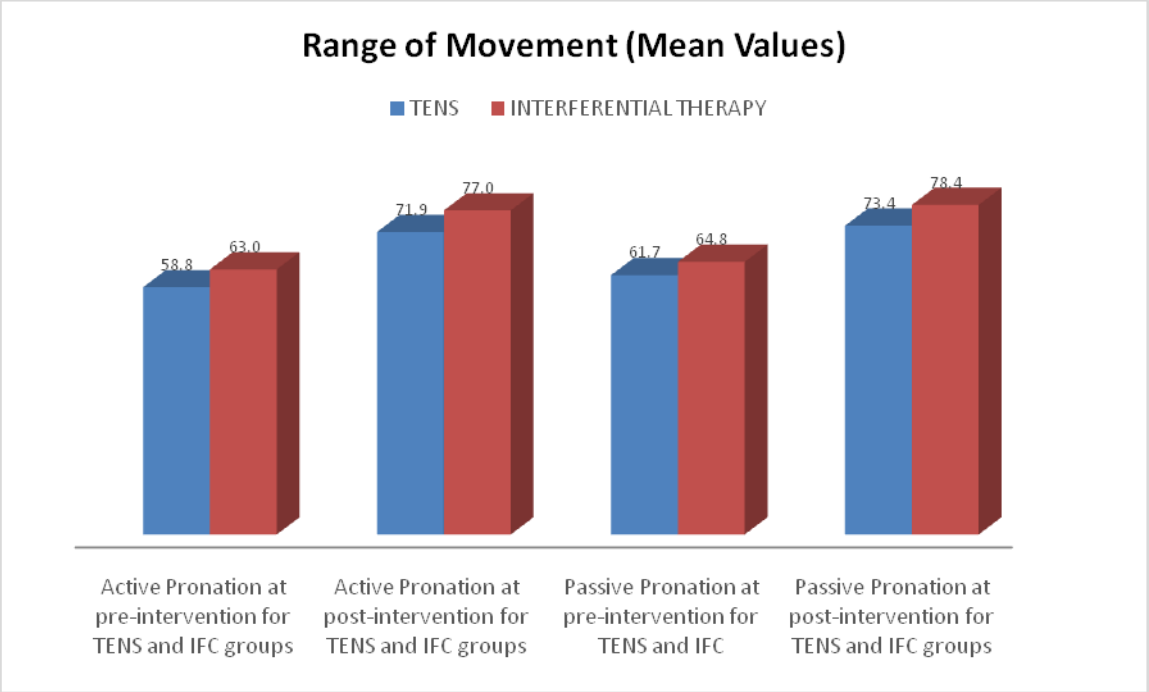

Figure 4.9 : Pronation Movement at the pre-intervention and post intervention TENS and IFC groups

The Tens Group Comparisons:

The difference between pre–intervention and post intervention scores were statistically significant ($p < 0.001$) for active and passive wrist pronation.

The Interferential Group Comparisons:

The difference between pre–intervention and post intervention scores were statistically significant ($p < 0.001$) for active wrist pronation and ($p = 0.001$) for passive wrist pronation.

Tens Group versus Interferential Group Comparisons:

The comparisons of scores for TENS versus IFC for active supination at pre-intervention and post intervention found no statistically significant differences ($p > 0.05$) This was similar for passive supination.

4.5 OBJECTIVE 3 : To measure Muscle Grip Strength of the affected wrist following the use of TENS or IFC

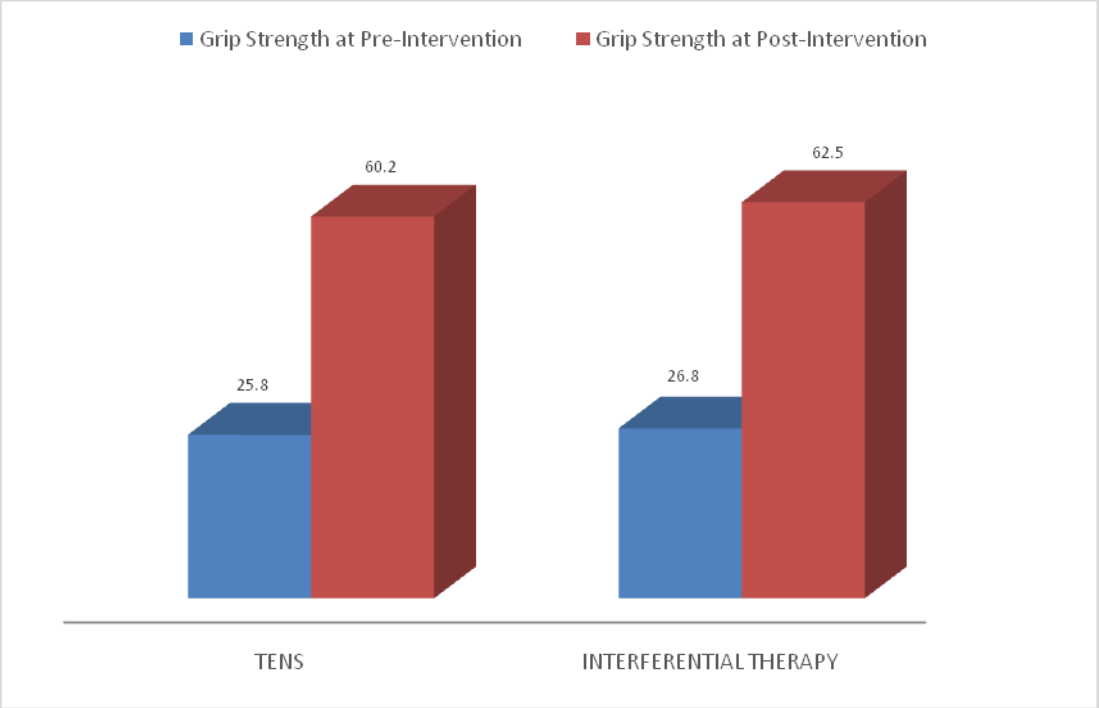

Figure 4.10 : Grip Strength at the pre-intervention and post intervention TENS and IFC groups

The Tens Group Comparisons:

The difference between pre–intervention and post intervention scores were statistically significant ($p < 0.001$) for grip strength at the affected hand

The Interferential Group Comparisons:

The difference between pre–intervention and post intervention scores were statistically significant ($p < 0.001$) for grip strength at the affected hand

Tens Group versus Interferential Group Comparisons:

The comparisons of scores for TENS versus IFC for grip strength at pre-intervention and post intervention found no statistically significant differences ($p > 0.05$).

4.6 OBJECTIVE 4 : To determine whether there was an improvement in functional ability of the affected hand/upper limb following the use of TENS or IFC

The functional ability of the patients was assessed using activities from the PRWE. The difficulty level in completing the activity was recorded at the baseline (session 1) and compared to session 6.

Table 4.3 : Difficulty experienced during activities in the TENS group at Pre-intervention (session 1) and Post intervention (session 6) six (N=20)

ACTIVITY	Pre-intervention (session 1) – N(%)			Post – intervention (session 6) – N(%)		
	Least Difficult	Difficult	Most Difficult	Least Difficult	Difficult	Most Difficult
Turning a door knob	30	45	25	95	5	0
Using a knife	10	45	45	65	35	0
Fastening buttons	65	15	20	100	0	0
Pushing up from a chair	15	40	45	45	50	5
Carrying a 5kg object	0	0	100	5	45	50
Using toilet paper	75	15	10	100	0	0
Personal care activities	20	45	35	95	5	0
Household work	0	55	45	75	25	0
At work (occupation)	20	45	35	40	55	5

***Values presented in percentages.**

The following apply for Session 1 :

- 70% found the activity of ***turning the door knob*** difficult. This had reduced to 5% by visit 6 with 95% indicating that it was now least difficult. This was a statistically significant difference, $p < 0.001$

- 90% found the activity of ***using a knife*** difficult. This had reduced to 35% by visit 6 with 65% indicating that it was now least difficult. This was a statistically significant difference, $p < 0.001$

- 35% found the activity of ***fastening buttons*** difficult. By visit 6, a 100% indicated that it was now least difficult. This was a statistically significant difference, $p = 0.008$.

- 85% found the activity of ***pushing up from a chair*** difficult. This had reduced to 55% by visit 6 with 45% indicating that it was now least difficult. This was a statistically significant difference, $p < 0.001$

- 100% found the activity of ***carrying a 5kg object*** most difficult. By visit 6, this had reduced to 50% with 45% indicating less difficulty. This was a statistically significant difference, $p = 0.001$

- 25% found the activity of ***using toilet paper*** difficult. By visit 6, a 100% reported least difficulty. This was a statistically significant difference, $p = 0.031$.

- 80% found ***personal care activities*** difficult. By visit 6, 95% reported least difficulty. This was a statistically significant difference, $p < 0.001$

- 100% found ***household work*** difficult. By visit 6, this was reduced to 25%. This was a statistically significant difference, $p < 0.001$

- 80% found difficulty ***at work***. By visit 6, this was reduced to 60%. This was a statistically significant difference, $p = 0.001$

Table 4.4 : Difficulties experienced during activities in the IFC group at Pre-intervention (session 1) and Post intervention (session 6) (N=20)

ACTIVITY	Pre-intervention (session 1) – N(%)			Post – intervention (session 6) – N(%)		
	Least Difficult	Difficult	Most Difficult	Least Difficult	Difficult	Most Difficult
Turning a door knob	20	60	15	90	5	0
Using a knife	0	55	45	80	15	5
Fastening buttons	60	40	0	100	0	0
Pushing up from a chair	15	20	65	45	55	0
Carrying a 5kg object	0	0	90	5	60	25
Using toilet paper	75	20	5	100	0	0
Personal care activities	20	65	15	95	5	0
Household work	5	60	35	70	30	0
At work (occupation)	30	35	35	75	25	0

***Values presented in percentages.**

The following applied to session 1 :

- 75% found the activity of ***turning the door knob*** difficult. This had reduced to 5% by visit 6 with 95% indicating that it was now least difficult. This was a statistically significant difference, $p < 0.001$.

- 100% found the activity of ***using a knife*** difficult. This had reduced to 20% by visit 6 with 80% indicating that it was now least difficult. This was a statistically significant difference, $p < 0.001$.

- 40% found the activity of ***fastening buttons*** difficult. By visit 6, a 100% indicated that it was now least difficult. This was a statistically significant difference, $p = 0.004$.

- 85% found the activity of ***pushing up from a chair*** difficult. This had reduced to 55% by visit 6 with 45% indicating that it was now least difficult. This was a statistically significant difference, $p < 0.001$.

- 90% found the activity of ***carrying a 5kg object*** most difficult. This had reduced to 25% by visit 6 with 60% indicating less difficulty. This was a statistically significant difference, $p < 0.001$.

- 25% found the activity of ***using toilet paper*** difficult. By visit 6, a 100% reported least difficulty. This was a statistically significant difference, $p = 0.031$.

- 80% found ***personal care activities*** difficult. By visit 6, 95% reported least difficulty. This was a statistically significant difference, $p < 0.001$.

- 95% found ***household work*** difficult. By visit 6, this was reduced to 30%. This was a statistically significant difference, $p < 0.001$.

- 70% found difficulty ***at work***. By visit 6, this was reduced to 25%. This was a statistically significant difference, $p < 0.001$.

CHAPTER 5. DISCUSSION

5.1 Introduction

Distal radius fractures are common in the paediatric and elderly populations however it also has a significant impact on young adults, health and well being. Over the past forty years the prevalence of this injury has increased with 640 000 cases reported in the United States alone, in 2001 (Nellans et al, 2012).

Thus the aim of this study was to investigate the effectiveness of two types of electrotherapy, Transcutaneous Electrical Nerve Stimulation (TENS) and Interferential Current (IFC), in reducing pain following a distal radius fracture, thereby hastening recovery of the affected limb so that patients can return to their normal activities. The two modalities investigated in this study to reduce pain, TENS and IFC, have a plethora of studies that support their effectiveness in reducing pain however on reviewing the literature no study of this nature has been done in South Africa.

The results will be discussed in relation to the objectives of this study :

1. To determine whether there was a decrease in the level of pain following the use of
   TENS or IFC.
2. To measure the range of movement (ROM) at the affected wrist following the use of TENS or IFC.
3. To measure muscle grip strength of the affected hand following the use of TENS or IFC.
4. To determine whether there was an improvement in functional ability of the affected
   hand/upper limb following the use of TENS or IFC.

5.2 Patient Characteristics

The inclusion criterion regarding age was 18-60 years, however it was noted from previous studies that the paediatric and elderly population are more at risk for DRF's. In this study the mean age range was 40.93, (SD - 11,35), with 15 (37.5%) males and 25

(62.5%) females. There was no significant relationship found between age and gender amongst the participants between the two groups. This result was in keeping with Nellans et al (2012), who reported that in the age group 19-49 years, the incidence rates of DRF's between men and women was almost identical. The adult population has been regarded as having a low risk for DRF's, however the complications after a DRF in the adult population can result in long term disability in an individual who was previously young and healthy (Nellans et al, 2012).

5.3. OBJECTIVE 1 : To determine whether there was a decrease in the level of pain following the use of TENS or IFC

Pain was recorded at pre-intervention, during intervention and post intervention and between these sessions there was a statistically significant decrease in pain in both the TENS and IFC groups. There was no statistically significant difference in pain levels comparatively between the TENS and IFC groups.

TENS was found to be effective in reducing pain in this study with its mechanism of action postulated in many studies based on scientific evidence. Two theories on the mechanism of action of TENS are dominant stating it stimulates the body's pain centres, via the peripheral nervous system, which results in an increased release of endogenous opioids in the central nervous system. The increase in opioids release prevents transmission and perception of noxious stimuli from the periphery. The second is the related to the gate-control theory where in the presence of nociceptive pain, unmyelinated C-fibres are stimulated at the periphery, allowing pain transmission to the brain. When TENS is applied at the periphery, it stimulates myelinated nerve fibres, which blocks the transmission of pain through the C-fibres. TENS was found to be effective in post-operative pain relief, chronic pain, ischemic pain, peripheral neuropathy, musculoskeletal disorders, arthritis, inflammatory conditions, and decreased time taken to return to Activities of Daily Living like return to work and social activities (DeSantana et al, 2008; Dewan et al, 2011; Johnson et al, 2003; Peacock, 2013; Rakel et al, 2015; Sluka et al, 2003; Vladimir et al, 2010; White et al, 2001; Wright et al, 2001).

IFC was found to be effective in reducing pain in this study with its mechanism of action related to the use of stimulation frequencies that stimulate deeper tissues but there is less discomfort on the skin surface. In theory IFC stimulates muscle fibres, thereby improving blood flow in the muscle 'promoting the healing process.' The analgesics effect of IFC has also been related to the gate control theory and suppression of the descending pain pathways in a similar manner as for TENS (Almeida et al, 2003; Dewan et al, 2011; Fuentes et al, 2010; Johnson et al, 2003; Jorge et al, 2006; White et al, 2001; Wright et al, 2001).

The findings of this study are in keeping with a study by Jarit et al (2003) where IFC was used as an intervention after knee surgery which resulted in a decrease in pain within 24 hours of using IFC and by week seven participants reported no pain. As pain was decreased in the IFC group, these participants were able to tolerate more physical rehabilitation and as such the ROM and the knee was increased as compared to the control group. These participants could thus return to normal ADL'S sooner. Also these participants required less sessions of physical therapy and took less pain medication which led to a decrease in medical costs. The control group (placebo IFC) experienced pain till week nine. An important point considered in this study, is that all baseline values for pain, differed in the intervention group as pain is a subjective measurement.

When IFC and TENS were compared in a study by Cheing et al (2003) similar results were found to this study, where both modalities were effective in reducing experimentally induced pain and increased heat pain threshold. The heat pain induced in this study was similar in nature to acute pain, however the study concluded there was a need for more experimental research comparing TENS and IFC in managing clinical pain. Johnson et al (2003) investigated the analgesic effect of TENS and IFC in experimentally induced ischemic pain. They found that there was no difference in the magnitude of decrease of pain between the TENS and IFC. They suggested that if both types of electroanalgesia is equally effective in managing pain, TENS is the more cost effective of the two modalities.

Dewan et al (2011) investigated the use of TENS and IFC in decreasing pain in patients with adhesive capsulitis. This condition results in a decrease range of movement, pain and muscle weakness at the shoulder joint. The findings of this investigation were

similar to this study where after ten sessions of TENS and IFC, pain was decreased and shoulder range of movement had increased in the participants. However, the IFC group presented with better results compared to the TENS group. Many studies have found that IFC has been effective in the management of chronic and acute pain. However some systematic reviews have reported that IFC alone as an intervention to decrease pain was ineffective but as a co-intervention was found to be effective. However these studies presented with clinical heterogeneity and varied methodological limitations. Hence it is still unknown whether IFC is superior to other interventions in producing an increased analgesic effect as conclusive statements could not be made from these studies (Fuentes et al, 2010; White et al, 2001).

Conflicting studies still exist with regards to the analgesic effects of TENS and IFC because of the different procedures in which TENS and IFC is applied, dosage and outcome measurements recordings differ in studies. Some studies used controlled groups that received sham electrotherapy and others didn't while blinding of the investigators was not constant in studies. The investigators knowledge and perceptions about the intervention been applied may bias the outcome as well as the treatment time and the amount of sessions received with TENS and IFC. Some studies used clinical trials while others were laboratory studies where pain was induced. In clinical trials, problems arise with patient recruitment, withdrawal and non-adherence, placebo interventions in clinical trials are not considered ethical, and pain is influenced by cognitive and affective elements the patient is experiencing. With experimentally studies, induced pain is controlled with regards to duration and intensity, whereas clinical pain fluctuates in duration, intensity and quantity. (DeSantana et al, 2008; Fuentes et al, 2010; White et al, 2001).

5.4 OBJECTIVE 2 : To measure the Range of Movement at the affected wrist following the use of TENS or IFC

A consequence of fractures and immobilisation is loss of range of movement due to connective tissue changes. Physiotherapeutic intervention focuses on restoring active and passive range of movement at the affected joint to decrease impairments and improve

function with regards to ADL's, work and leisure activities. However, in the presence of pain the patient will be hesitant to move a joint through its full range of movement (Glasgow et al, 2010). The wrist movements measured in this study were flexion, extension, radial and ulna deviation, supination and pronation. In the TENS group all movements significantly increased between pre and post intervention and these findings were the same for the IFC group. However comparison between the groups, found higher ROM scores for wrist flexion and extension in the IFC group, post intervention. A deduction from the present study is that a reduction in pain, enhanced recovery of ROM.

A systematic review by Michlovitz et al (2004), investigated interventions utilised to improve ROM following a period of immobilisation. The findings were :

- Casts or splinting – there was moderate support of this intervention maybe time consuming and not cost effective.
- Steroid injections combined with an exercise programme supervised by a physiotherapist, were found to be effective.
- Passive exercises – there was moderate evidence that this intervention alone was useful in increasing range of movement.

The conclusions of the review, was more studies needs to be conducted investigating the different interventions comparing their efficacies. In the South African public sector, casting/splinting and steroid injections are expensive and may not be available. Each patient would require their own cast/splint, and these are not re-usable for another patient similar to the use of steroid injections, they are patient specific. In this study, the interventions used was TENS and IFC in conjunction with exercise and was found to be effective in increasing ROM over a two-three period. This treatment regime can be repeatedly used on many patients in a safe and cost effective manner.

The findings of this study were similar to Cheing et al (2005) where the use of ice therapy and/or pulsed electromagnetic field (PEMF) and exercises were administered to reduce pain and swelling following a DRF. The mechanism of action of ice therapy is similar to that of TENS and IFC as it involves gate control theory of pain. The mechanism of action of PEMF is induction of changes in the cell environment, enabling restoration of function and integrity of injured tissues. The post intervention measurements for the variables of pain and ROM at the wrist were taken after 3 sessions

(5 days after removal of POP cast) of intervention and the findings were pain scores were significantly reduced in the group that received ice therapy, PEMF and exercises in comparison to other groups. This group also had a significant increase in flexion and ulnar deviation movements at the wrist. Compared to the control groups, the addition of PEMF and ice therapy to exercises impacted on reduction of pain and improvement of ROM. In the present study the ROM of all active movements at the wrist significantly improved possible due the longer period between pre-intervention and post intervention scores. Post intervention scores were recorded between 4-9 weeks post removal of POP cast and after 6 sessions of intervention in contrast to the study by Cheing et al (2005).

5.5 OBJECTIVE 3 : To measure Muscle Grip Strength of the affected wrist following the use of TENS or IFC

Kitahara et al (2003), investigated muscle function of the forearm of six healthy individuals, following immobilisation for 21 days. Muscle strength decreased by 17.9% after 21 days, probably due to changes in 'motor unit recruitment pattern.'

In this study, baseline values for muscle strength was measured between 4-9 weeks immobilisation and at pre-intervention level the average recording of muscle strength was 26.3. The cross sectional area (CSA) of muscle decreases as the period of immobilisation increases leading to a decrease in muscle strength, however exercises helps to increase the CSA of muscle (Kitahara et al, 2003). At post intervention there was significant changes in muscle strength at the hand across both groups with an average muscle strength score of 61.3mmhg that was statistically significant. The findings of this study with regards to muscle strength are attributed to the patient's ability to exercise because if pain is managed effectively patients will be less reluctant to exercise or move the joint, which directly impacts on improvement of hand strength. Rakel et al (2015), found that the use of TENS following knee arthroplasty, reduced pain during movements of the knee. The knee is a weight bearing joint as opposed to the wrist joint and TENS was effective in pain reduction. The findings of the present study were similar as TENS reduced pain scores and improved ROM at the wrist joint.

5.6 OBJECTIVE 4 : To determine whether there was an improvement in functional ability of the affected hand/upper limb following the use of TENS or IFC

Difficulty in performing activities of the PRWE significantly improved in both groups however few studies have investigated functional disability following a DRF. The findings of this study were similar to those of MacDermid et al (2003) where lifting heavy objects, and work was found to be difficult task for patients following a DRF while fastening buttons in both studies was found to be the least difficult task. Fastening buttons requires fine motor skills, and unless the median nerve was compromised by the DRF this activity should be unaffected. Conflicting results with this study, was that at two months, bathroom hygiene was still moderately difficult. Complete comparisons between the present study and the MacDermid et al (2003) study, could not be made because baseline values for the PRWE was recorded immediately after the patients fracture occurred and they had been treated by a doctor. The baseline values in this study was taken between 4-9 weeks post fracture.

However important points can be noted that reflect on patients functional ability between the studies. In the presence of wrist impairments, many patients use compensatory methods to complete tasks, hence the difference in difficulty or disability reported for the different activities in the PRWE. The activities of daily living differs from person to person, hence certain activities may not apply to a specific sample group. The importance of disability scores, may help the physiotherapist in determining the best intervention/approach in treatment of the patient. If baseline scores poorly improve, then the therapist needs to assess whether there's a physical component or a cognitive or social reason (MacDermid et al, 2003).

The findings of this study were similar to Adedoyin et al (2005) who combined TENS and IFC with exercise in the treatment of knee osteoarthritis. Participants were randomly assigned to three groups; TENS and exercises, IFC and exercises and exercises only. The study found that pain levels and function improved in all three groups with significant difference between the TENS and IFC similar to the findings of the present study.

CHAPTER 6. CONCLUSION

The objectives of the study were :

1. To determine whether there is a decrease in the level of pain following the use of TENS or IFC.
2. To measure the range of movement (ROM) at the affected wrist following the use of TENS or IFC.
3. To measure muscle grip strength of the affected hand following the use of TENS or IFC.
4. To determine whether there is an improvement in functional ability of the affected hand/upper limb following the use of TENS or IFC.

With regards to pain, both TENS and IFC were equally effective in reducing pain following a distal radius fracture. There was significant improvement in range of movement, functional ability and grip strength of the affected hand.

TENS and IFC is commonly used to manage pain in many musculoskeletal disorders. The findings of this study reflect that TENS and IFC is also effective for the management of pain after a DRF. If pain is managed at the onset of the rehabilitation programme, patient's fear of movement can be inhibited thereby improving the patient's ability to exercise the affected limb. Exercise is imperative following a period of immobilisation of a limb, as structures that have shortened need to be stretched. If pain is managed efficiently, conditions like Chronic Regional Pain Syndrome or joint contractures can be avoided.

If recovery following a DRF is facilitated by the use of TENS and IFC, patients will spend less time attending hospitals for consultation with doctors, physiotherapists and other health professionals. This will decrease monetary cost to the patient as well as time away from his occupation or other responsibilities / activities of daily living. If patients recover in a shorter time period following their DRF, the state will save on payment of temporary disability grants.

6.1 Significance of the Study

In the South African setting, TENS or IFC can be effectively utilised to manage pain following a DRF, thereby decreasing the need for analgesics which are expensive and not always available to patients in the public setting. Apart from availability, the use of analgesics has many side effects. Considering the period of immobility and the period of rehabilitation, a patient many consume analgesics for a period of 2 – 3 months which may have other harmful effects on the body, e.g. damage to the liver.

As observed by the researcher, currently in the public sector, there is a process whereby a patient may receive a temporary disability grant for the period of time that he/she is incapacitated and unable to return to work. If patient's recovery following a DRF, is hastened, the period for which this grant is allocated will be reduced. This will decrease cost with regards to temporary disability grants.

After a DRF the patients affected forearm is immobilised, usually for a period of 4-6 weeks, depending on the healing of the fracture. Physiotherapy needs to effective and timeous, to facilitate functional recovery as early as possible, so this patient may return to his occupation and other ADL'S as early as possible. As observed by the researcher, many patients in the public sector do not have permanent contractual jobs. If they are absent from their occupation for prolonged periods of time, they may lose their jobs and this could result in increased unemployment.

Budget constraints are not uncommon in the public sector. TENS has been found to be equally efficient as IFC in reducing pain. A TENS unit is almost 3 times cheaper than an IFC unit. A TENS unit costs between R1000 – R5000 and the standard unit is usually battery operated while the average price of an IFC unit is between R15000 – R25000 and requires electricity. TENS units are cheaper to maintain as opposed to an Interferential unit and are mobile and easy to use. Patients may be able to take the unit home, as part of their home programme, thereby hastening their recovery and reducing the amount of sessions of physiotherapy required in the hospital. Many patients, who live in the KZN province, stem from a disadvantaged background and have no electricity in their homes. TENS can be easily utilised by these patients because it is battery operated. Transport costs are an important reason why many patients can't regularly attend physiotherapy and

this may be reduced if patients are able to use the TENS units at home, rather than attending physiotherapy sessions at the hospital.

6.2 Study Limitations

- The intervention period was limited to two – three weeks, as patients could not afford to attend physiotherapy on regular basis and this was noted with the number of patients lost to follow up, as well as refusing consent to participate in the study. Thus, a small sample size was obtained.
- The variable of pain was assessed using the VNRS. This study did not assess or evaluate psychological, cognitive and environmental factors that influence the level of pain experienced by a patient following a fracture. Although TENS and IFC are effective in reducing physical pain, the bio-psychosocial model needs to be adopted in treatment of pain following an injury.

Baseline values for pain, ROM, grip strength and functional ability were taken at different time intervals for the patients in the study. The period / time of immobilisation differed amongst patients.

6.3 Recommendations for Future Research

- More randomised control studies need to be done to establish the analgesic effect of TENS and IFC on larger sample sizes and different pathology.
- Questionnaires used in future studies should measure functional outcome using patient specific activity of daily living tailored to the South African setting.
- Pain needs to be assessed or evaluated using the biopsychosocial approach which incorporates cognitive and affective aspects of pain.

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APPENDIX 1

UNIVERSITY OF
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07 December 2010

Mrs S Moodley
School of Occupational Therapy
WESTVILLE CAMPUS

Dear Mrs Moodley

PROTOCOL: The Effectiveness of Transcutaneous Electrical Nerve Stimulation (TENS) versus Interferential Current (IFC) in the Treatment of Pain Post Distal Radius and/or Ulna Fractures
ETHICAL APPROVAL NUMBER: HSS/1438/2010 M: Faculty of Health Sciences

In response to your application dated 03 December 2010, Student Number: **9901145** the Humanities & Social Sciences Ethics Committee has considered the abovementioned application and the protocol has been given **FULL APPROVAL.**

PLEASE NOTE: Research data should be securely stored in the school/department for a period of 5 years.

I take this opportunity of wishing you everything of the best with your study.

Yours faithfully

.....
Professor Steve Collings (Chair)
HUMANITIES & SOCIAL SCIENCES RESEARCH ETHICS COMMITTEE

SC/sn

cc: P Rangiah (Supervisor)
cc: Mr. S Reddy

APPENDIX 2

health

Department:
Health
PROVINCE OF KWAZULU-NATAL

Health Research & Knowledge Management sub-component
10 – 103 Natalia Building, 330 Langalibalele Street
Private Bag x9051
Pietermaritzburg
3200
Tel.: 033 – 3953189
Fax.: 033 – 394 3782
Email.: hrkm@kznhealth.gov.za
www.kznhealth.gov.za

Reference : **HRKM55/11**
Enquiries : **Mrs G Khumalo**
Telephone : 033 – 3953189

26 April 2011

Dear Mrs S Moodley

Subject: Approval of a Research Proposal

1. The research proposal titled **'The effectiveness of Transcutaneous Electrical Nerve Stimulation (TENS) versus Interferential Current (IFC) in the treatment of pain post Distal Radius and / or Ulna Fractures'** was reviewed by the KwaZulu-Natal Department of Health.
   The proposal is hereby **approved** for research to be undertaken at **King Edward VIII, RK Khan and Addington Hospitals.**

2. You are requested to take note of the following:
   a. Make the necessary arrangement with the identified facility before commencing with your research project.
   b. Provide an interim progress report and final report (electronic and hard copies) when your research is complete.

3. Your final report must be posted to **HEALTH RESEARCH AND KNOWLEDGE MANAGEMENT, 10-102, PRIVATE BAG X9051, PIETERMARITZBURG, 3200** and e-mail an electronic copy to hrkm@kznhealth.gov.za

For any additional information please contact Mrs G Khumalo on 033-3953189.

Yours Sincerely

Mrs E Shyman
Interim Chairperson, Health Research Committee
KwaZulu-Natal Department of Health
Date: 05/05/2011

APPENDIX 3

DEPARTMENT OF HEALTH

PROVINCE OF KWAZULU-NATAL

ADDINGTON HOSPITAL
OFFICE OF THE MEDICAL MANAGER
Erskine Terrace, South Beach
P. O. Box 977, Durban, 4000
Tel.: 031 327568, Fax: 031 3272387
Email.:clive.rangiah@kznhealth.gov.za

09 April 2011

Enquiries: Dr S Rangiah
Ref: Physio/res/smoodley

Ms S Moodley
Physiotherapy Department
Addington Hospital
Durban

RE: PERMISSION TO CONDUCT RESEARCH AT ADDINGTON HOSPITAL

I have pleasure in informing you that permission has been granted to you by Addington Hospital to conduct research on **"The effectiveness of transcutaneous electrical nerve stimulation vs interferential therapy in reducing pain following a distal radius and / or ulna fracture".**

Please note the following:

1. Please ensure that you adhere to all the policies, procedures, protocols and guidelines of the Department of Health with regards to this research.
2. This research will only commence once this office has received confirmation from the Provincial Health Research Committee in the KZN Department of Health.
3. Please ensure this office is informed before you commence your research.
4. The hospital and the department of health will not provide any resources for this research.
5. You will be expected to provide feedback on your findings to the hospital.

Thank you,

.....
Dr S. Rangiah
BSc,BMedSc,MMedSc,MBCHB,MFamMed
Principal Specialist
Acting Medical Manager

APPENDIX 4

HEALTH
KwaZulu-Natal

KING EDWARD VIII HOSPITAL
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Enq.:Miss. R.Khuzwayo
Ref.: KE 2/7/1/ (13/2011)
Research Programming

25 February 2011

Mrs. S. Moodley
School of Occupational Therapy
Westville Campus
UNIVERSITY OF KWAZULU-NATAL

Dear Mrs. Moodley

Protocol : "The effectiveness of Transcutaneous Electrical Nerve Stimulation (TENS) versus Interferential Current (IFC) in the Treatment of Pain Post Distal Radius and /or Ulna Fractures"

Permission to conduct research at King Edward VIII Hospital is provisionally granted, pending approval by the Provincial Health Research Committee, KZN Department of Health.

Kindly note the following:-

- The research will only commence once confirmation from the Provincial Health Research Committee in the KZN Department of Health has been received.
- Signing of an indemnity form at Room 8, CEO Complex before commencement with your study.
- King Edward VIII Hospital received full acknowledgment in the study on all Publications and reports and also kindly present a copy of the publication or report on completion.

The Management of King Edward VIII Hospital reserves the right to terminate the permission for the study should circumstances so dictate.

Yours faithfully

SUPPORTED/~~NOT SUPPORTED~~

DR. O.S.B. BALOYI
MEDICAL MANAGER

28/02/2011.
DATE

REF.NO :

Appendix 5a

QUESTIONNAIRE (English)

(Participant to be interviewed by Researcher)

PART A

BIOGRAPHICAL DETAILS

Age: _____

1. Gender

1.1 Male ☐

1.2 Female ☐

2. What is your marital status?

2.1 Married ☐

2.2 Single ☐

2.3 Divorced ☐

3. What is your Occupation?

3.1 Employed ☐

3.2 Unemployed ☐

3.3 Retired ☐

4. What is your highest educational level/qualification?

4.1 No formal education ☐

4.2 Finished Primary School ☐

4.3 Finished High School ☐

4.4 Tertiary education ☐

5. Do you have or had any of the following?

5.1 Diabetes ☐

5.2 Arthritis ☐

5.3 Hypertension ☐

5.4 Previous Surgery/Illness ☐

If yes, then describe?

_____

5.5 Previous Injuries to your body? ☐

If yes, then describe?

_____

6. Which hand dominant are you?

6.1 Left ☐

6.2 Right ☐

6.3 Ambidextrous ☐

7. How long ago did the fracture occur?

7.1 Four – Five weeks ☐

7.2 Six – Seven weeks ☐

7.3 Eight – Nine weeks ☐

7.4 Other – Specify _____

8. Were you able to perform all Activities of Daily Living (ADL's) before the fracture?

8.1 Complete use of the hand for functional activities ☐

8.2 Unable to use the hand sometimes for functional activities ☐

8.3 Unable to use the hand for any funtional activites ☐

9. Did you experience pain in the affected hand before the fracture? Y ☐ N ☐

10. How often do you have pain?

10.1 All the time ☐

10.2 Sometimes ☐

10.3Only at rest/night ☐

10.4Only during movement/activity ☐

PART B

PAIN AT REST AND DURING ACTIVITIES

Using the scale provided rate your pain (out of ten) during the following.

1. At rest
2. When doing a task with repeated wrist movements
3. When lifting a heavy object
4. When it is at its worst

VISIT 1	VISIT 3	VISIT 6

PART C

ASSESSMENT OF PAIN BEFORE AND AFTER TREATMENT

DATE																		
VISIT	1			2			3			4			5			6		
	P	B	A	P	B	A	P	B	A	P	B	A	P	B	A	P	B	A

KEY :

P – How would you describe your pain relief from your last treatment session to date?

1. Pain relief lasted < 1 hour
2. Pain relief lasted between 0-1 hour
3. Pain relief lasted between 1-2 hours
4. Pain relief lasted between 2-3 hours
5. Pain relief lasted between 3-4 hours
6. Pain relief lasted between 4-5 hours
7. Pain relief was > 5 hours
8. There was no relief of pain
9. Pain became worse.

Record of Pain (out of ten):

B – Before Treatment

A – After Treatment

PART D

DIFFICULTY EXPERIENCED DURING ACTIVITIES WITH / WITHOUT PAIN AND/OR STIFFNESS

Rate the amount of difficulty you experience during the following activities

QUESTIONS	NOT SURE		LEAST DIFFICULT		DIFFICULT		MOST DIFFICULT		PAIN AND/OR STIFFNESS	
	1ST	6TH	1ST	6TH	1ST	6TH	1ST	6TH	P	S
1. Turn a door knob using the affected hand.										
2. Cut meat using a knife in my affected hand										
3. Fasten buttons on my shirt										
4. Use my affected hand to push from a chair										
5. Carry a 5kg object in my affected hand										
6. Use toilet tissue with my affected hand										
7. Personal care activities (dressing, washing)										
8. Household work (cleaning, maintenance)										
9. Work (your job or usual everyday work)										
10. Recreational activities										

KEY :

Difficulty experienced due to **P – pain** and/or **S- stiffness**

PART E

SENSATION TEST

	ABSENT	PRESENT
FINE TOUCH		

DATA COLLECTION SHEET FOR RANGE OF MOVEMENT AND GRIP STRENGTH

		RANGE OF MOVEMENT								PASSIVE MVT.	GRIP STRENGTH
		BEFORE TREATMENT				AFTER TREATMENT					
		3 READINGS			AVG.	3 READINGS			AVG		
FIRST VISIT DATE :	FLEXION										
	EXTENSION										
	RADIAL DEVIATION										
	ULNA DEVIATION										
	SUPINATION										
	PRONATION										
THIRD VISIT DATE :	FLEXION										
	EXTENSION										
	RADIAL DEVIATION										
	ULNA DEVIATION										
	SUPINATION										
	PRONATION										

		RANGE OF MOVEMENT									
		BEFORE TREATMENT				AFTER TREATMENT				PASSIVE MVT.	GRIP STRENGTH
		3 READINGS			AVG.	3 READINGS			AVG		
SIXTH VISIT **DATE :**	FLEXION										
	EXTENSION										
	RADIAL DEVIATION										
	ULNA DEVIATION										
	SUPINATION										
	PRONATION										

PART TWO : TREATMENT RECORD

DATE						
VISIT	**1**	**2**	**3**	**4**	**5**	**6**
TENS						
IFC						
INTENSITY						
EXERCISES						

✓ - indicates treatment administered

A - Exercises 1.1 to 1.5 as per exercise sheet - pages 35 - 38

B - Exercises 1.1 to 1.5 as per exercise sheet - page 39

C - Exercises 1.1 to 1.5 as per exercise sheet - pages 40 - 41

INTENSITY - Refers to the level at which the individual patients feels the “tingling sensation” produced by the TENS/IFC.

Appendix 5b

QUESTIONNAIRE (zulu)

(Patient to be interviewed by a Physiotherapist fluent in Zulu)

PART A

IMININIGWANE

Iminyaka: _____

1. Ubulili

1.1 Owesilisa ☐

1.2 Owesifazane ☐

2. Ushadile?

2.1 Ushadile ☐

2.2 Awushadile ☐

2.3 Uhlukanisile ☐

3. Uyasebenza?

3.1 Ngiyasebenza ☐

3.2 Angisebenzi ☐

3.3 Umhlalaphansi ☐

4. Imfundo ephakeme / amabanga emfundo?

4.1 Angifundile ☐

4.2 Ngiqede amabanga aphansi ☐

4.3 Ngiqede amabanga aphezulu ☐

4.4 Ngiqede imfundo ephakeme ☐

5. Yisiphi isifo esikuphethe kulezi ezilandelayo?

5.1 Ushukela ☐

5.2 Amathambo ☐

5.3 iHigh blood pressure ☐

5.4 Ukuhlinzwa ☐

Chaza _____

5.5 Wake walimala ngokudlule? ☐

Chaza_____

6. Isiphi isandla osisebenzisayo?

6.1 Esokunxele ☐

6.2 Esokudla ☐

6.3 Zombili ☐

7. Waphuka nini?

7.1 Amaviki amane kuya kwamahlanu ☐

7.2 Amaviki ayisithupha kuya kwayisikhombisa ☐

7.3 Amaviki ayisishagalombili kuya kwayisishagalolunye ☐

7.4 Okunye _____

8. Ngaphambi kokuba wephuke isandla sasisebenza kanjani?

8.1 Isandla sasisebenza kahle ☐

8.2 Sasingasebenzi kahle ☐

8.3 Asikaze sisebenze kahle ☐

9. Ubuhlungu ubuzwa nini?

9.1 Ngezikhathi Zonke ☐

9.2 Ngezinye izikhathi ngiyabuzwa ubuhlungu ngezinye ngingabuzwa ☐

9.3 Uma ngiphumule kuphela ☐

9.4 Uma ngisinyakasiza noma ngenza umsebenzi ☐

10. **Sensation Tests:**

	ANGIKUZWA	NGIYAKUZWA
SHISA		
BANDA		
“CIJILE” HLABA		
NDIKINDIKI		

PART B

CHAZA UBUHLUNGU OBUZWAYO UMA UNGENZI LUTHO NOMA WENZA UMUSEBENZI

Usebenzisa lokhu okukhombisiwe chaza ubuhlungu obuzwayo

1. Lapho uphumule
2. Lapho wenza okuthile unyakazisa isihlakala ngokuphindiwe

3. Ngesikhathi uphakamisa into esindayo
4. Lapho kwakunzima kakhulu

PART C

UBUNZIMA UMA WENZA IZINTO

Chaza ubunzima obuzwayo uma wenza lokhu okulandelayo

FIRST VISIT SIXTH VISIT

1. Phendula isibambo sesicabha usebenzisa isandla esithintekile

1.1 Angazi ☐ ☐

1.2 Kancane ubunzima ☐ ☐

1.3 Kunzima ☐ ☐

1.4 Kunzima Kakhulu ☐ ☐

2. Sika inyanga usebenzisa ummese esandleni sami esithintekile

2.1 Angazi ☐ ☐

2.2 Kancane ubunzima ☐ ☐

2.3 Kunzima ☐ ☐

2.4 Kunzima Kakhulu

3. Fasa izinkinobho eshethini lami

3.1 Angazi

3.2 Kancane ubunzima

3.3 Kunzima

3.4 Kunzima Kakhulu

4. Sebenzisa isandla sami esithintekile ukuzimelela lapho ngisukuma esihlalweni

4.1 Angazi

4.2 Kancane ubunzima

4.3 Kunzima

4.4 Kunzima Kakhulu

5. Thatha into enesisindo esingama 5kg ngesandla esithintekile

5.1 Angazi

5.2 Kancane ubunzima

5.3 Kunzima

5.4 Kunzima Kakhulu

6. Sebenzisa ipheshana lasendlini encane ngesandla esiothintekile

6.1 Angazi

6.2 Kancane ubunzima

6.3 Kunzima

6.4 Kunzima Kakhulu

7. Izinto zokuzinakekela (ukugqoka, ukuwasha)

7.1 Angazi

7.2 Kancane ubunzima

7.3 Kunzima

7.4 Kunzima Kakhulu

8. Umsebenzi wasendlini (ukuhlanza indlu, ukunakekela izinto ezisetshenziswa endlini)

8.1 Angazi

8.2 Kancane ubunzima

8.3 Kunzima

8.4 Kunzima Kakhulu

9. Umsebenzi (Umsebenzi wakho noma umsebenzi ojwayelekile wansuku zonke)

9.1 Angazi

9.2 Kancane ubunzima

9.3 Kunzima

9.4 Kunzima Kakhulu

10. Izinto zokuncebeleka

10.1 Angazi

10.2 Kancane ubunzima

10.3 Kunzima

10.4 Kunzima Kakhulu

PART D

DATA COLLECTION SHEET FOR RANGE OF MOVEMENT AND GRIP STRENGTH

		RANGE OF MOVEMENT									**GRIP STRENGTH**
		BEFORE TREATMENT				AFTER TREATMENT				PASSIVE	
	MOVEMENT	3 READINGS			AVG.	3 READINGS			AVG.	MVT.	
FIRST VISIT DATE :	FLEXION										
	EXTENSION										
	RADIAL DEVIATION										
	ULNAR DEVIATION										
	SUPINATION										
	PRONATION										
THIRD VISIT DATE :	FLEXION										
	EXTENSION										
	RADIAL DEVIATION										
	ULNAR DEVIATION										
	SUPINATION										
	PRONATION										
SIXTH VISIT DATE :	FLEXION										
	EXTENSION										
	RADIAL DEVIATION										
	ULNAR DEVIATION										
	SUPINATION										
	PRONATION										

PART TWO : TREATMENT RECORD

DATE						
VISIT	**1**	**2**	**3**	**4**	**5**	**6**
TENS						
IFC						
EXERCISES						
DURATION						

APPENDIX 6

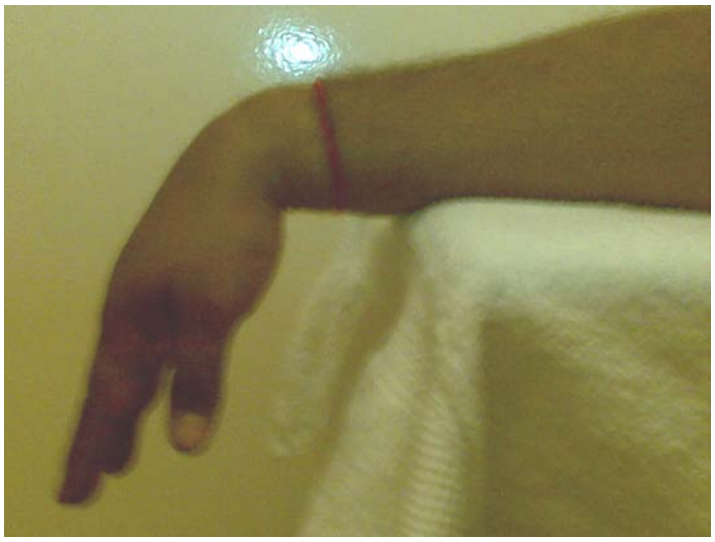
EXERCISE PROGRAMME FOR DISTAL RADIUS AND/OR ULNA FRACTURES (www.ehow.com)

Starting position: To perform the following exercises, sit on a chair or stool at a table, with your affected hand resting on the table.

1. The following exercises must be done everyday, as prescribed, from the first visit with the physiotherapist.

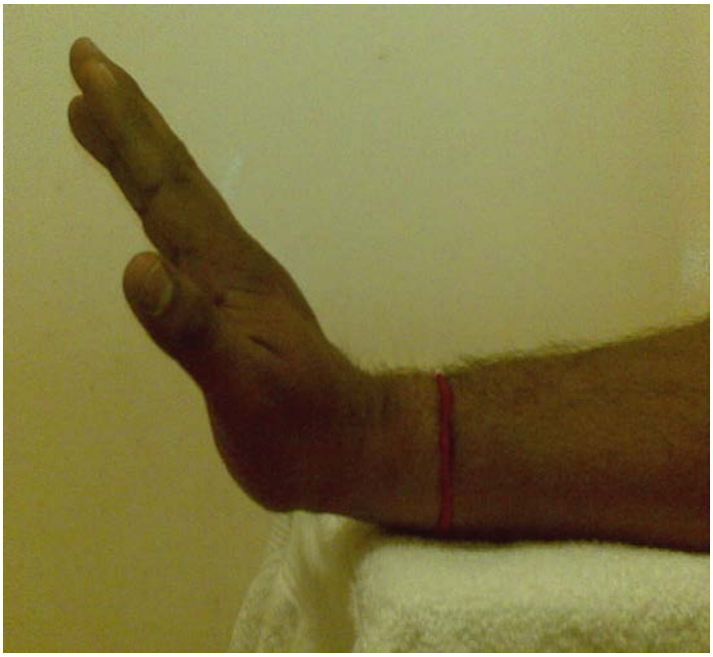
1.1. WRIST FLEXION (bending of the wrist downwards)

Your affected limb should be resting on the table, with the hand over the edge of the table in neutral and the palm facing downward to the floor. Bend your wrist towards the floor and then bring it back up to the original position. There should be no movements occurring at the elbow and shoulder. Repeat this exercise 10 times and twice a day.



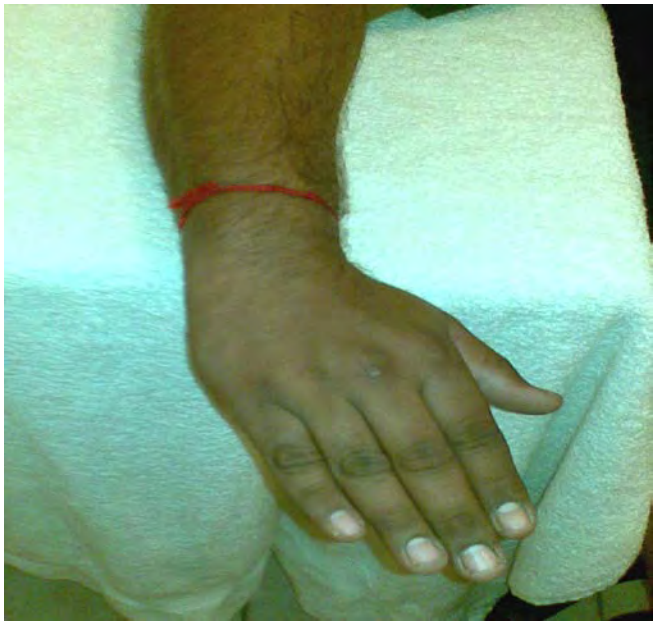
1.2. WRIST EXTENSION (bending of the wrist upwards)

Your affected limb should be resting on the table, with the hand over the edge of the table in neutral and the palm facing upward. Bend your wrist upwards and then bring it back up to the original position. There should be no movements occurring at the elbow and shoulder. Repeat this exercise 10 times and twice a day.



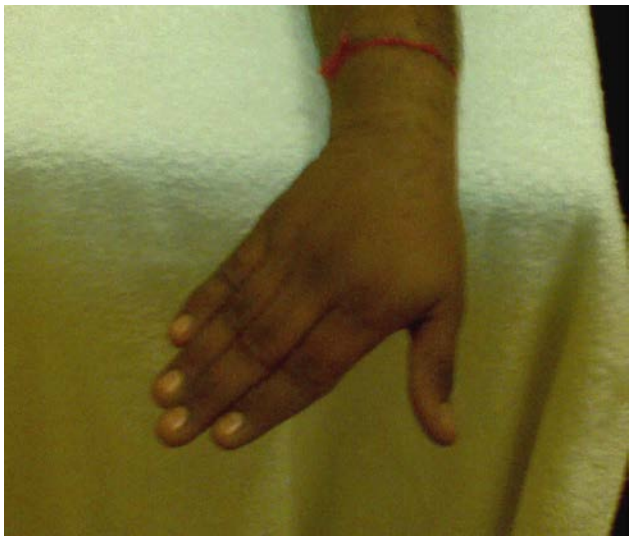
1.3. RADIAL DEVIATION (Moving sideward toward the thumb)

Your affected limb should be resting on the table, with the hand over the edge of the table. Bend your wrist towards the floor. In this bent position move your wrist sideward in the direction of the thumb and then bring it back to the original position. There should be no movements occurring at the elbow and shoulder. Repeat this exercise 10 times and twice a day.



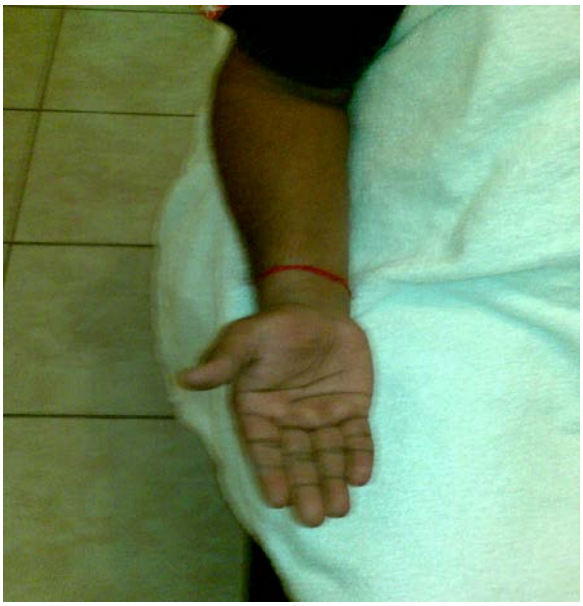
1.4. ULNAR DEVIATION (Moving sideward toward the little finger)

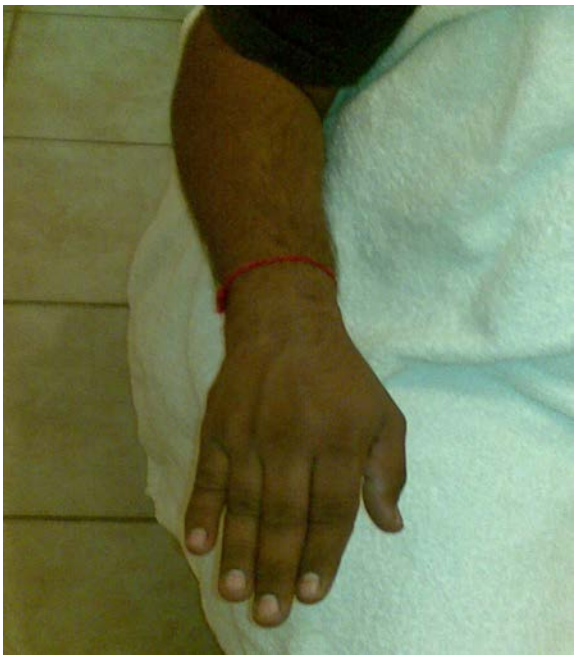
Your affected limb should be resting on the table, with the hand over the edge of the table. Bend your wrist towards the floor. In this bent position move your wrist sideward in the direction of the little finger and then bring it back to the original position. There should be no movements occurring at the elbow and shoulder. Repeat this exercise 10 times and twice a day.



1.5. SUPINATION AND PRONATION (Rotation of the forearm)

Take your affected limb of the table. Bend your elbow to 90 and press your arm against your side. Hold your hand with the palm facing down and your fingers open. Turn your hand as much as you can, so that your palm faces upward. Then turn your hand back to the original position. Your elbow and shoulder should not move and should remain pressed against your body during the exercise. Repeat this movement 10 times and twice daily.

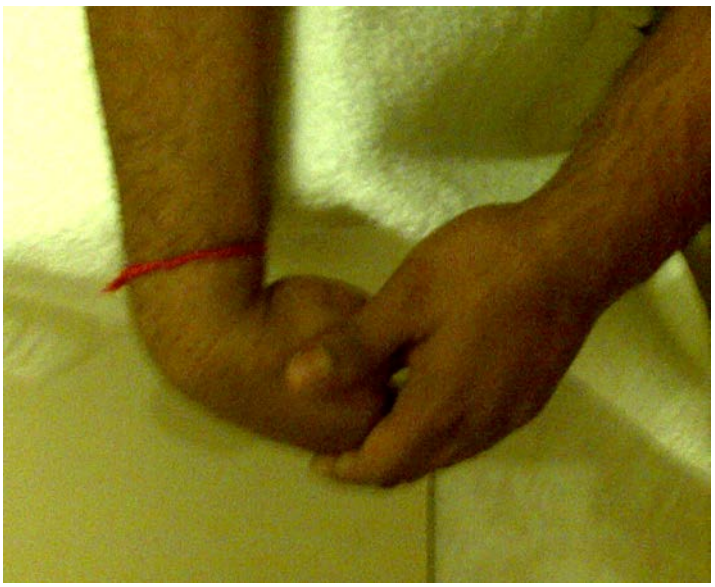




2. The following exercises will begin from your second session

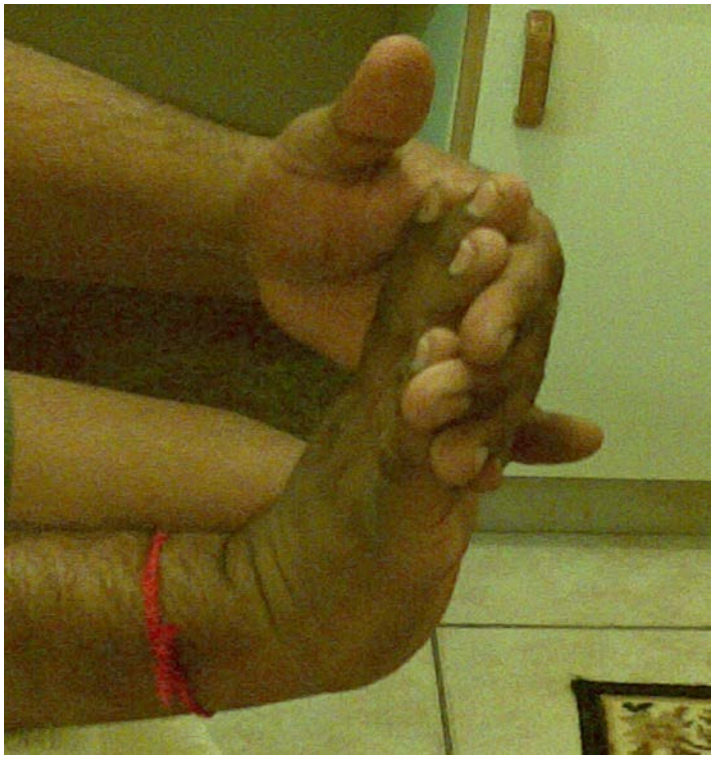
2.1 WRIST FLEXOR STRETCH (bending of the wrist downwards)

Your affected limb should be resting on the table, with the hand over the edge of the table in neutral and the palm facing downward to the floor. Place your unaffected hand over your affected hand and bend your wrist towards the floor. The unaffected hand should push down on the affected hand. Hold this position for 5 seconds and then bring it back up to the original position. There should be no movements occurring at the affected elbow and shoulder. Repeat this exercise 10 times and twice a day.



2.2 WRIST EXTENSOR STRETCH (bending of the wrist upwards)

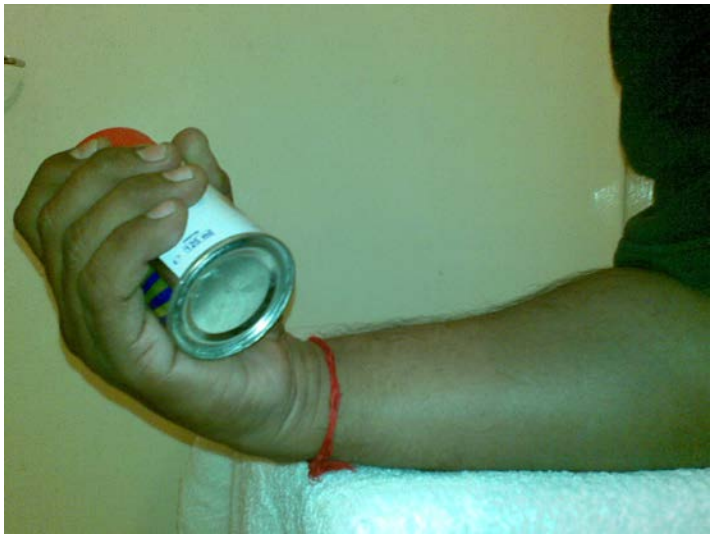
Your affected limb should be resting on the table, with the hand over the edge of the table in neutral and the palm facing downward to the floor. Place your unaffected hand on the palmar surface of your affected hand and bend your wrist upwards. The unaffected hand should push back on the affected hand. Hold this position for 5 seconds and then bring it back up to the original position. There should be no movements occurring at the affected elbow and shoulder. Repeat this exercise 10 times and twice a day.



3. These exercises will begin at the third session with the physiotherapist.

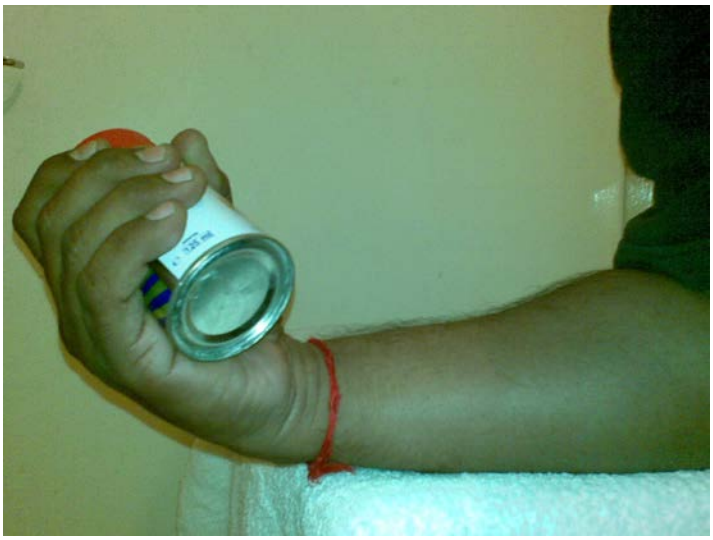
3.1 WRIST FLEXOR STRENGTHENING

Your affected limb should be resting on the table, with the hand over the edge of the table in neutral, with a 500g weight in your hand. Bend your wrist towards the floor and then bring it back up to the original position. There should be no movements occurring at the elbow and shoulder. Repeat this exercise 10 times and twice a day.



3.2 WRIST EXTENSOR STRENGTHENING

Your affected limb should be resting on the table, with the hand over the edge of the table in neutral and the palm facing upward with a 500g weight. Bend your wrist upwards and then bring it back up to the original position. There should be no movements occurring at the elbow and shoulder. Repeat this exercise 10 times and twice a day.



3.3 PRONATOR AND SUPINATOR STRENGTHENING

Take your affected limb of the table. Bend your elbow to 90 and press your arm against your side. Hold your hand with the palm facing down with a 500g weight. Turn your hand as much as you can, so that your palm faces upward. Then turn your hand back to the original position. Your elbow and shoulder should not move and should remain pressed against your body during the exercise. Repeat this movement 10 times and twice daily.