

**EFFECTIVENESS OF TAPING ALONG WITH CONVENTIONAL  
PHYSIOTHERAPY FOR PATIENT WITH TENNIS ELBOW  
ATTENDED AT CRP**

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Bachelor of Science in Physiotherapy (B.Sc. PT)

Session: 2006-2007

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**EFFECTIVENESS OF TAPING ALONG WITH CONVENTIONAL  
PHYSIOTHERAPY FOR PATIENT WITH TENNIS ELBOW  
ATTENDED AT CRP**

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## **Declaration**

I declare that the work presented here is my own. All source used have been cited appropriately. Any mistakes or inaccuracies are my own. I also declare that for any publication, presentation or dissemination of the study. I would be bound to take written consent from my supervisor.

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## Abbreviations

<b>&amp;:</b>	And
<b>CRP:</b>	Center for Rehabilitation of Paralyzed
<b>Df:</b>	Degrees of freedom
<b>DTFM:</b>	Deep Transverse Friction Massage
<b>ECRB:</b>	Extensor Carpi Radialis Brevis
<b>ECRL:</b>	Extensor Carpi Radialis Longus
<b>ECU:</b>	Extensor Carpi Ulnaris
<b>EDC:</b>	Extensor Digitorum Communis
<b>LE:</b>	Lateral Epicondylitis
<b>MHZ:</b>	Mega Hertz
<b>MRI:</b>	Magnetic Resonance Imaging
<b>MWM:</b>	Movement with Mobilization
<b>nm:</b>	Nanometer
<b>NSAID:</b>	Non Steroidal Anti Inflammatory Drug
<b>POP:</b>	Plaster of Paris
<b>RCT:</b>	Randomize Control Trial
<b>ROM:</b>	Range of Motion
<b>TENS:</b>	Transcutaneous Electrical Nerve Stimulation
<b>UK:</b>	United Kingdom
<b>US:</b>	Ultrasound
<b>VAS:</b>	Visual Analogue Scale

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## Abstract

*Purpose:* The purpose of the study is to find out the effectiveness of taping with conventional physiotherapy compare to only conventional physiotherapy for tennis elbow. *Objectives:* To compare pain intensity at rest, at forceful wrist extension, during forceful grip, during cozen test, at resisted middle finger extension, during palpation at affected site before and after conventional physiotherapy with taping and conventional physiotherapy alone in patients with tennis elbow. *Methodology:* 7 patients with tennis elbow were selected and randomly assigned to taping with conventional physiotherapy group and 7 patients to the only conventional physiotherapy group for this randomize control trial study. The study was conducted at musculoskeletal department of CRP, savar. Visual analogue scale was used to measure pain intensity in different functional position. Unrelated “t” test was used to compare the result. *Results:* Following treatment the study found that the experimental group showed a significant improvement in case of pain at forceful wrist extension ( $p<0.05$ ), pain during forceful grip ( $p<0.05$ ), pain on cozen test ( $p<0.05$ ), pain on forceful middle finger extension ( $p<0.025$ ) & pain during palpation ( $p<0.025$ ). Only in case of resting pain, reduction of pain intensity was not found to be significant. *Conclusion:* This experimental study shows that taping with conventional physiotherapy is more effective than conventional physiotherapy alone for patients with tennis elbow.

*Key words:* Tennis elbow, taping, conventional physiotherapy.

### **1.1 Background**

Upper limb plays an important role in everyone's daily life and hand is the effectors organ of the upper limb which supports it mechanically and allows it to adopt the optional position for any given action from the functional point of view (Puranik, 2009). Among the upper limb conditions, tennis elbow is one of the most significantly occurred conditions (Jones, 2009). According to Ebnezar (2003), a painful elbow syndrome comprises lateral, medial and posterior elbow symptoms; among them the one significantly noticed is the lateral tennis elbow which results from repetitive stress.

Lateral epicondylitis is a painful and debilitating musculoskeletal condition characterized by lateral elbow pain, impacts substantially on society and challenges the healthcare industry (Bisset et al, 2005). Lateral epicondylitis or tennis elbow has been recognized for over 100 years and is an enthesopathy of the common extensor origin at the elbow (Crowther et al, 2002). The name lateral epicondylitis came from the writer's cramp and first distinguished by Mr. Runge in 1873 (Sharath, 2005). The term tennis elbow was introduced in 1882 by Morris, but the condition was described in detail by Momberg in 1910 (Zeisig, 2008).

In both developed and developing countries in the world, rheumatic diseases is one of the largest health problems. In Bangladesh, a study on prevalence of rheumatic diseases in the adult population showed that the prevalence of musculoskeletal complaints was 26.1% and the incidence of tennis elbow is 2.77% (Hasan et al, 2009). Tennis elbow is the most commonly diagnosed elbow condition and affects about 1-3% of the population in Canada (Amro et al, 2010). The prevalence of tennis elbow in Sweden is 1% to 3%, which increases to 19% in men between 40 and 50 years of age (Labelle et al, 1992). The incidence rate increases to 10 percent in women with the age range between 42 to 46 years. The incidence of lateral elbow pain in general practice is four to seven per 1,000 persons per year in the United Kingdom, the Netherlands, and Scandinavia (Buchbinder et al, 2007). It is reported that 7.4% of

industrial workers and 40% to 50% of tennis players in the USA are affected with tennis elbow (Labelle et al, 1992).

Tennis elbow affects 1% to 3% of the adult population (Shamsoddini et al, 2010) and only 5% of people relate to tennis suffering from tennis elbow (Sharath, 2005). It is a misnomer, often seen in non tennis players, although elbow pain is found in up to 50% of tennis players, where tennis elbow is encountered in 75–80% of cases and the incidence in general practice is 4–7 per 1000 per year, with 15% of workers involved in highly repetitive jobs reporting the condition (Jones, 2009).

In the study of rehabilitation, tennis elbow is a frequently employed clinical model of musculoskeletal pain (Shamsoddini et al, 2010), treated by many physical therapists in a variety of clinical settings and the successful conservative treatment of lateral epicondylitis generally aims to relieve pain, control inflammation, promote healing, improve local and general fitness, and control force loads (Noteboom et al, 1994).

It is proposed the application of tape is a means, aims to alleviate pain, improve muscle function, and restore functional movements. Taping facilitates the compliance to exercise rehabilitation programs by minimizing the aggravation of symptoms during performance of therapeutic exercise (Vicenzino et al, 2003). The objective of taping is to support a weakened part of body without limiting its function, by preventing movements that would stress the weakened area and the primary purpose is to provide semi rigid or rigid splint around a joint or surrounding tissue (Sharath, 2005).

Lateral epicondylitis is a condition of chronic musculoskeletal pain state and dysfunction of the muscle system (Vicenzino et al, 2003). Taping is not a substitute for treatment and rehabilitation, but is an adjunct to the total injury care program (Macdonald, 1994). There are several taping techniques established by different authors for different purposes. Mc Connell taping is one of them, which mainly aims to reduce pain, to improve function & biomechanics (Alam, 2008). Diamond tape could be used to facilitate the pain-free implementation of upper limb activities and exercise rehabilitation program for chronic lateral epicondylitis. Mc-Connell is the originator of this mode of taping, who stated that the main mechanism of action of this treatment

is to provide pain relief that allows for improved movement and function. The taping technique for the tennis elbow is considered a useful adjunct to exercise and effective in reducing pain with improving forearm muscle activity (Vicenzino et al, 2003).

## **1.2 Rationale**

Lateral epicondylitis or tennis elbow is a painful debilitating condition of elbow, which creates disturbance in functional activities. Literature suggests that pain and dysfunction is very common in lateral epicondylitis which can interfere with the person's ability to function at work & recreation and imposes a financial cost on the community. So it is very important to manage the cases with tennis elbow. In Bangladesh, tennis elbow represents a challenge to the clinician, because considering the context of our country patients often struggle to follow the evidenced based treatment recommended for tennis elbow.

Prevalence of tennis elbow is higher among the workers of highly repetitive jobs. In our country, people's low socio-demographic status and occupational stress accentuates the repetitive micro trauma of lateral epicondylitis, which leads the condition to a chronic inflammatory state. There are many physical therapy techniques exist for the treatment and rehabilitation of tennis elbow and some researches suggests that taping is one of the important interventions for this condition which reduces the stress of forearm extensor and lateral epicondyle during activity and protects from further injury.

The purpose of this study is to compare the effectiveness of taping with conventional physiotherapy and conventional physiotherapy alone for the patient with tennis elbow. There were some research articles published about physiotherapy intervention for patient with tennis elbow, but taping for tennis elbow is not so focused among them and only a very few research articles published regarding taping for tennis elbow. So, in this study "the comparison between the effectiveness of taping with conventional physiotherapy and conventional physiotherapy alone in patients with tennis elbow" will give the evidence for effectiveness of taping in patient with tennis elbow. However, research helps to improve the knowledge of health professionals, as well as develops the profession. The results of the study may help to guide physiotherapists to give best treatment in patient with tennis elbow, which will be beneficial for both the patient with tennis elbow and for developing the field of physiotherapy profession.

### **1.3 Aim**

The aim of this study is to compare the effectiveness of combined therapy including taping in combination with conventional physiotherapy versus conventional physiotherapy alone in patient with lateral epicondylitis.

### **1.4 Objectives**

- To compare pain intensity at rest before and after conventional physiotherapy with taping and conventional physiotherapy alone in patients with tennis elbow.
- To compare pain intensity at forceful wrist extension before and after conventional physiotherapy with taping and conventional physiotherapy alone in patients with tennis elbow.
- To compare pain intensity during a strong grip before and after conventional physiotherapy with taping and conventional physiotherapy alone in patients with tennis elbow.
- To compare pain intensity during a cozen test before and after conventional physiotherapy with taping and conventional physiotherapy alone in patients with tennis elbow.
- To compare pain intensity at resisted middle finger extension before and after conventional physiotherapy with taping and conventional physiotherapy alone in patients with tennis elbow.
- To compare pain intensity during palpation of affected side before and after conventional physiotherapy with taping and conventional physiotherapy alone in patients with tennis elbow.

### **1.5 Hypothesis**

- Taping with conventional physiotherapy is more effective than conventional physiotherapy alone for the treatment of patient with tennis elbow.

### **1.6 Null hypothesis**

- Taping with conventional physiotherapy is no more effective than conventional physiotherapy alone for the treatment of patient with tennis elbow.

## **1.7 List of variables**

**Dependent variable:** Tennis elbow

**Independent variable:** Conventional physiotherapy, Taping.

## **1.8 Operational definition**

**Tennis elbow:** Tennis elbow or lateral epicondylitis is a clinical condition characterized by pain and tenderness over the lateral side of elbow, difficulties in functional activities and with positive Mill's test, Cozen test or resisted middle finger extension test when examined clinically.

**Conventional physiotherapy:** Physiotherapeutic interventions that are widely accepted and commonly practiced by medical community.

**Taping:** Taping is a therapeutic procedure, performed by using tape, attached to the skin, to physically keep the muscles in place or joints in certain position, aims to reduce pain, enhance recovery, prevent overuse and further injury.



According to Kesson & Atkin (1998), the term tennis elbow encompasses a strain of the wrist extensor muscles, found in their common extensor origin at the anterolateral aspect of lateral epicondyle of the humerus. Vicenzino & Wright (1995) stated many analogous terms of tennis elbow, such as lateral elbow pain, lateral epicondylitis, rowing elbow, tendonitis of the common extensor origin, and peritendonitis of the elbow. Sharath (2005) suggested that, it is a pathological condition that commonly involves the tissue at tendinous origin of extensor carpi radialis brevis (ECRB), characterized by repetitive microtear and fibrosis and is also seen in the musculotendinous structure of the extensor carpi radialis longus (ECRL), extensor carpi ulnaris (ECU) and extensor digitorum communis (EDC).

Cyriax (1936) have classified tennis elbow on the basis of severity as follows- acute, following indirect trauma, where the disability results from an acute pain. The second type is subacute, which is the typical variety with gradual onset followed by vigorous exercise with the arm. The third one is chronic occupational type and one or more months may be required for full development. Another type is tennis elbow following direct trauma, which is not so common and the severity of which resembles the chronic variety. Kesson & Atkin (1998) discusses four types of tennis elbow according to the site of involvement -

Type 1: inflammation at the supracondylar ridge

Type 2: tenoperiosteal junction

Type 3: body of the tendon

Type 4: muscle belly.

Among these types, type 2 is the most disabling variant and occurs frequently.

Alam (2008) stated that the commonest causative factor is found at over-use of elbow or repetitive concentric and eccentric contractions of the extensor muscles, which results biomechanical positional fault as a consequences of chronic overload of repetitive stresses (heavy lifting, repetitive hammering, scissoring, twisting, and in tennis players with backhand stroke & inadequate forearm extensor power and

endurance). According to Zeisig (2008), microtrauma can occur due to fatigue after repetitive loads and can even occur if the loads are within the strength limits. Puranik (2009) stated that the possible etiologies are inflammation of the radial humeral bursa, synovium, periosteum and the annular ligament. Hutson (2001) reported that, in case of tennis players overload relates to the shake frequency, incorrect technique, particularly on the backhand and muscle imbalance or loss of flexibility.

Mackay et al (2003) also found the link of lateral epicondylitis with chronic overuse injuries and Zeisig (2008) proposed that the mechanism of overuse injury accentuates from cumulative microtrauma that involves and weakens the structural and vascular elements of the tendon. Shamsoddini et al (2010) suggested that the basic pathological process involves the origin of common extensor tendon. Thomson et al (1932) stated that tearing at the tendon followed by production of inflammatory exudates results excessive fibrin formation that develops formation of fibrous tissue adhesion and finally results pain on being stretched and impairment of function.

Thomas (2010) stated that the symptoms of tennis elbow encompass various deformities and inflammations of the tissues and bones comprising the structure of elbow. Noteboom et al (1994) proposed that the anterior aspect of the lateral epicondyle and the lateral forearm exhibits significant tenderness. Zeisig (2008) have suggested that the most painful position is with straight elbow, and the second most painful position is maximal flexion of elbow, pain increases during gripping activities. Brukner & Khan (1993) stated that the onset of pain may be acute or gradual. Stasinopoulos & Johnson (2004) stated that the pain, decreased grip strength and difficulties in activities of daily living are the common complaints. Zeisig (2008) proposed that stiffness may appear after remaining the elbow in one position for a prolonged period of time, especially after sleeping or carrying load.

Mackay et al (2003) suggested that tennis elbow is generally diagnosed on clinical grounds and it is important to establish a robust, objective diagnosis for the management of tennis elbow properly. Vicenzino et al (2003) stated that the condition lateral epicondylitis is simple to identify with the key physical examination features that are reproduction of pain on direct palpation over the lateral epicondyle and pain provocation tests of forearm extensor muscle function. The two outcome measures

that are frequently used and positive in the majority of cases are pressure pain thresholds and pain-free grip strength.

There are several special tests for diagnosing tennis elbow, such as cozen test, Mills test, middle finger extension test (Magee, 1987), resisted wrist extension test (Ebnezar, 2003), resisted radial deviation test, palpation test (Kesson & Atkin, 1998). According to Hutson (2001), routine radiology or other forms of imaging is not so necessary, although radiographs may show faint calcification in the tendon in 7% of the cases and clinical ultrasound may be useful before surgery is considered.

Vicenzino & Wright (1995) present that it is a challenge to the clinician to treat tennis elbow, because many of the commonly used treatments are not supported by research. Jones (2009) stated that, a large number of treatments including physiotherapy have been proposed in respect of lack of understanding regarding its aetiology. Up to 30% of patients with tennis elbow are referred to physiotherapy in their primary care. Ebnezar (2003) divided the physiotherapy treatment for tennis elbow according to the acute and post acute phase. Amro et al (2010) have stated the traditional interventions, including NSAID, corticosteroid injection, cryotherapy in the acute stage, followed by heat in the more chronic stage, friction massage, rest, ultrasound (US), acupuncture, electrical stimulation, laser, counterforce bracing, shock wave therapy, lateral extensor release, progressive strengthening; and stretching exercise therapy. Dunkow et al (2004) have suggested the initial treatment with rest, modification of activity, local splints, and steroid injection is effective enough for tennis elbow.

According to Zeisig (2008), as the symptoms become aggravated with activity, rest is an useful for pain relief. Corrigan & Maitland (1983) stated that, it is essential to explain to the patient that the condition is self limiting over a long period of time and that other treatments will not often be helpful unless activity is curtailed. Ebnezar (2003) stated that an above elbow POP splint with elbow in 90 degree flexion and supination and the wrist in slight dorsiflexion is recommended for sound immobilization. According to Noteboom et al (1994), for both acute and chronic phases of tennis elbow, cold application, either with ice massage, ice packs, or ethyl chloride spray is widely used.

Alam (2008) have stated that several authors have developed numerous manual therapy techniques for managing the cases of tennis elbow; procedure and indication of these different techniques vary with each author. According to Vicenzino et al (2007), Mulligan's Mobilization with Movement (MWM) produces its effects on tennis elbow by correcting positional faults of joints that occur as a result of injury or strain. Thomas (2010) claimed that deep transverse friction massage (DTFM) acts by mobilizing the soft tissues that acts by releasing and stretching the impaired tissue causing dysfunction. Brosseau et al (cited in Thomas, 2010) did a study on deep transverse friction massage for treating tendinitis and found that DTFM is effective for promoting rehabilitation. According to Joshi & Kotwal (1999), Manipulation is effective in cases where active use of extensor muscles produces pain and Alam (2008) states Mills manipulation acts by rupturing the adhesions to elongate the scar tissue. Stasinopoulos & Johnson (2004) did a literature review that purposes to describe Cyriax approach, its effectiveness and use in the treatment of tennis elbow and claimed that deep transverse friction in combination with mills manipulation is successful enough for treating tennis elbow.

Joshi & Kotwal (1999) states that gentle effleurage and kneading massage during the first two weeks and friction massage after 2-3 weeks is greatly helpful for managing tennis elbow. According to Corrigan & Maitland (1983), mobilization technique is effective to regain normal range of motion in case of loss of full passive extension and accessory movements.

Jones (2009) included ultrasound, laser therapy or electromagnetic field therapy in electrotherapeutic interventions for tennis elbow. Thomas (2010) states that therapeutic ultrasound (US) is most frequently used tool in physiotherapy departments. Jones (2009) found that under half of physiotherapists use pulsed and continuous ultrasound for treating tennis elbow. Puranik (2009) states that application of continuous or pulsed mode upon tissue increases blood flow and reduce muscle spasm, increases extensibility of collagen fibers and decreases inflammatory response. According to Zeisig (2008), application of shock wave therapy with single pulsed acoustic wave is helpful to reduce pain and to progress healing process. Jones (2009) found that about 10% of physiotherapists use pulsed shortwave diathermy in the treatment of tennis elbow. Puranik (2009) have found that, it is proved that low level

laser therapy is very beneficial for enhancing healing process. Jones (2009) stated that laser therapy is not so significantly used by physiotherapists in the UK for managing tennis elbow. Zeisig (2008) states that TENS (percutaneous electrical stimulation) acts to activate pain relieving systems in tennis elbow. Noteboom et al. (1994) suggests that, both superficial and deep heating modalities such as hot packs, whirlpool, and ultrasound are effective in both subacute and chronic phases.

According to Jones (2009), in about 21% of cases of tennis elbow, orthotic devices (For example, braces or epicondylar clasps) are prescribed. Biomechanical effect of forearm bracing is to reduce stress by producing direct effect on the origin of extensor carpi radialis brevis and Noteboom et al (1994) suggested that tennis elbow strap or counterforce armband are the most commonly used braces. Thomson et al (1932) stated that strapping completely around the forearm is helpful in daily living activities as it acts by reducing stress on the common extensor tendon.

According to Jones (2009), taping is used in associate with exercise program by many physiotherapists in the purpose of restoring functional movement patterns by relieving pain. Vicenzino et al's (2003) small study demonstrated that taping may be useful as an adjunct to exercise. When comparing specific diamond taping over the elbow, compared with placebo taping and a control group, diamond taping had a positive effect of the order of 20% on pain free grip strength and pain pressure threshold.

According to Jones (2009), physiotherapists use acupuncture commonly for treating the cases of chronic tennis elbow. Corrigan & Maitland (1983) stated that NSAIDs are added in treatment to reduce the given inflammatory response of this disorder. According to Dunkow et al (2004), almost 40% of patients relieve their symptoms through the application of steroid injection. Corrigan & Maitland (1983) state that an injection of corticosteroid is usually the quickest and most effective method of treatment but it must be accurately placed.

Jones (2009) found exercise is used as a co-intervention, although it is one of the most commonly used treatments in tennis elbow management and particularly progressive stretching exercises are commonly used. Zeisig (2008) included stretching exercises as one of the standard physiotherapy treatment for tennis elbow. Noteboom (1994)

suggested that, strengthening programs including combination of isometric, isotonic, and isokinetic exercises should be initiated early in the treatment to assist the appropriate tissue remodeling. Zeisig (2008) states that eccentric exercise is often used in chronic painful tendons. Svenlov & Adolfsons study (cited in Jones, 2009) of 3 months of eccentric exercise compared with daily stretches, found that the eccentric training program produces significant improvements in grip strength, with complete resolution of symptoms in about 86% cases.

According to Vicenzino (2003), the primary objectives of rehabilitation are pain relief and restoration of muscle condition; progressive resistance exercise program that is one of the components of rehabilitation program is helpful for restoration of muscle condition of upper limb. Corrigan & Maitland (1983) suggests that any provoking cause, such as poor sporting technique should be corrected. A support for the forearm is made of calico with Velcro strap is useful that should only be worn during activities of forearm. Vicenzino (2003) suggests that it is important to rest from those activities that aggravate the pain in the initial stages of rehabilitation (including treatments used in rehabilitation).

Dunkow et al (2004) found that, 90% of patients respond to conservative treatment. Patients who fail to respond to conservative measures may require surgery and it is proposed that up to 8% of patients require surgery. According to Ebnezar (2003), many operations available for lateral epicondylitis, including tenotomy of the extensor tendon, percutaneous release of epicondylar muscles, Bosworth technique. The surgeries are indicated if there is severe pain for 6 weeks at least, marked and failure to respond to restricted activity or immobilization for at least two weeks.

According to Macdonald (1994), therapeutic taping is a procedure of application of adhesive tape, in order to provide support and protection to soft tissues and joints and to minimize swelling and pain after injury. According to Vicenzino et al (2003), there are two explanations of mechanism of action taping, one relates to a mechanical effect on the muscles of the forearm and another possible mechanism relates to its neurophysiologic effects. Shamsoddini et al (2010) describes the neurophysiologic effects of taping, that the tape produces an effect on grip strength by altering pain perception, facilitating large afferent fibers and by stimulating endogenous processes

of pain inhibition. Macdonald (1994) suggested that taping acts through proprioceptive stimulation which regulates the tone of muscle and provides stability.

Sharath (2005) found that taping is useful for many reasons, such as to prevent injury, to limit extremes of ROM, to apply compression aims to decrease pain, swelling and spasm, to immobilize or resist the involved area so that healing can promote. Alam (2008) states that Mc Connell taping mainly aims to control the fascia directly, establish proper structural alignment, improve muscular recruitment for enhancing static & dynamic neuro-muscular retraining by balancing the tissue length or tension relationship & motor control.

Macdonald (1994) suggests that, strongest adhesion is achieved by shaving the skin, applying tap adherent, e.g. tincture of benjoin, and then applying non stretch zinc oxide tape. It is proposed that, 3 days as the maximum time for that to be left on the skin, but it is also suggested for up to 24 hours. Alam (2008) suggested that, tape is applied across the joint in several layers and is positioned to provide outside support and restrict forces that would apply stress on an injured part.

There are several evidence based taping techniques available for tennis elbow, which are established by different authors, such as McConnell's unloading taping, taping technique established by Macdonald, Mulligan's taping technique, Kinesio taping etc. For the purpose of this study only the McConnell's diamond taping is described.

According to Vicenzino (2003), Diamond taping procedure is one of McConnell's deloading procedures in which the soft tissues are drawn in towards the area of pain at the lateral epicondyle in a manner described below- Patient in Supine lying position. Elbow Small amount of flexion in most cases. The tape will reduce motion at end of range so if extension is especially a problem for the client then tape should be applied in more flexion and if the client has problems mostly at end of range of flexion, the tape should be applied more in extension. Therapist stands by side of treatment table facing cephalic. The centre of the diamond is located over the painful region. The tape should start apply by distally anchoring it on or close to the midline of the forearm, then run the tape on a diagonal across the longitudinal axis of the forearm and anchor the starting part of the tape to the client's skin with therapists thumb, with the other

hand apply a tensing force longitudinally along the direction of the tape. Before laying the tape down onto the skin it is needed to make sure that the underlying skin is moved in towards the painful region and this should be done by using the index finger of the hand that is anchoring the tape to the skin and the tape will be orientated on the skin. There should be an orange peel effect present with puckering of the skin inside the diamond. The tape always should be laid down in a cephalad direction along the long axis of the arm. McConnell's diamond taping is mainly indicated for those cases where lateral elbow pain is present much of the time and this technique is particularly useful for resting pain or pain at night.

Macdonald (1994) stated that tape is the medicine and tension is the dose. It has been used since the beginning of 19<sup>th</sup> century to support joints and prevent injuries in athletics. According to Sharath (2005), although the biomechanical support of tape is limited but clinically it is useful in rehabilitation after injury or surgery. Different taping techniques are useful for the purpose of injury prevention, treatment and rehabilitation (Macdonald 1994).

Proper taping technique is closely related with improving function and injury prevention as it is described earlier that different literature shows that taping improves grip strength, decreases pain, as well as reduces the features of lateral epicondylitis. From this research, it is expected to explore the effectiveness of taping in improving grip strength, decreasing pain and reducing the features of tennis elbow.



This research was a quantitative evaluation of the comparison between the exercise programs combined with taping and exercise along for pain management of the patients with tennis elbow. To identify the effectiveness of this treatment approach Visual Analogue Scale (VAS) was used as measurement tools for measuring the pain intensity in several functional positions.

### **3.1 Study design**

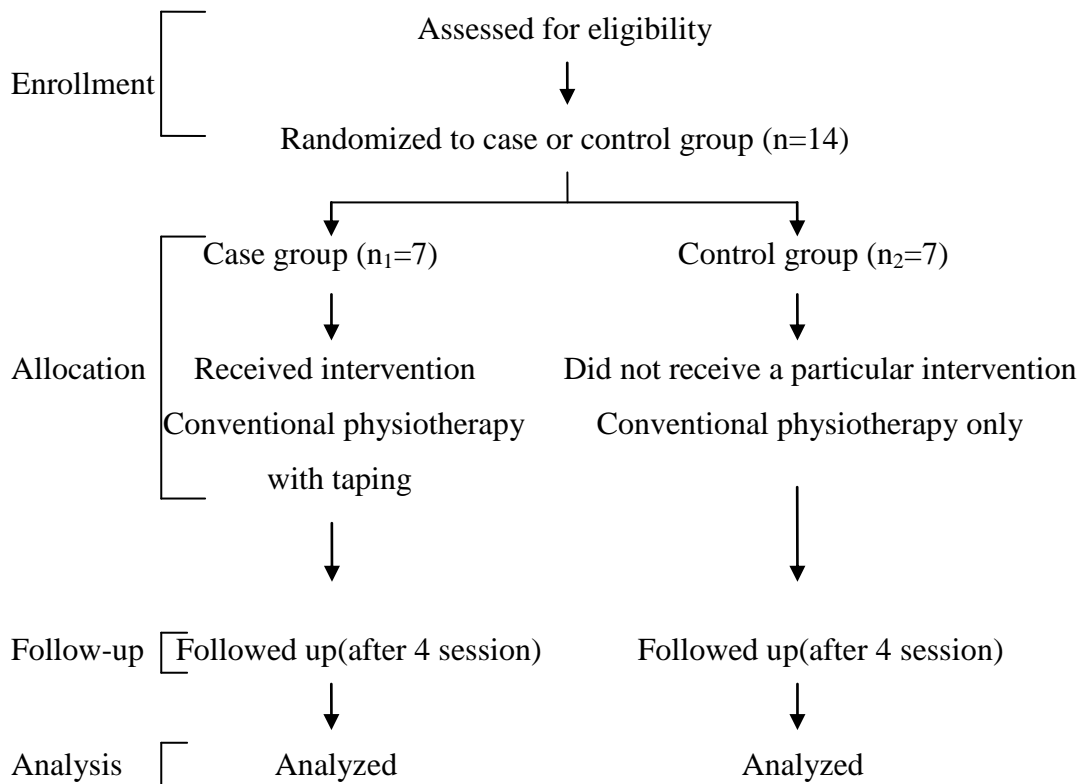
The study was conducted by using a quantitative true experimental design with two different subject groups. True experimental design is a method of testing hypothesis by which cause and effect can be established.

The study was true experimental between different subject designs. Both groups received a common treatment regimen except one intervention. Only the experimental group received the tapping while in control group only conventional physiotherapy treatment program was given.

A pre test (before intervention) and post test (after intervention) was administered with each subject of both groups to compare the pain effects before and after the treatment. The design could be shown by-

r    o    x    o (experimental group)  
r    o            o (control group)

## Flowchart of the phases of randomized controlled trial



A flowchart for a randomized controlled trial of a treatment program including conventional physiotherapy with taping for patient with tennis elbow.

### 3.2 Study area

Physiotherapy musculoskeletal outdoor department of Centre for Rehabilitation of the Paralyzed (Savar).

### 3.3 Study Population

A population refers to the entire group of people or items that meet the criteria set by the researcher. The populations of this study were the tennis elbow patients.

### 3.4 Sample selection

Subjects, who met the inclusion criteria, were taken as sample in this study. Fourteen patients with tennis elbow were selected from outdoor musculoskeletal physiotherapy department of CRP (Savar). When the samples were collected, the researcher

randomly assigned the participants into experimental and control group, because it improves internal validity of experimental research. The samples were given numerical number such as 1, 2, 3, 4 etc. then the researcher randomly selected the odd number samples and even number samples for the control and experimental group. Total 14 samples included in this study, among them 7 patients were selected for the experimental group (received tapping with conventional physiotherapy) and rest 7 patients were selected for control group (conventional physiotherapy only).

### **3.5 Inclusion criteria**

- The participants were those individuals who continued physiotherapy treatment and completed at least four sessions.
- Subject who had no history of taking physiotherapy intervention, oral NSAID or corticosteroid injection previously.
- The participants who had no any deformity of the affected elbow and wrist.
- Voluntary participants.
- Age group: 20-60 years old of both sexes.

### **3.6 Exclusion criteria**

- Subjects who had not completed four session of physiotherapy treatment.
- Patients with clinical disorder which may become worsen with tapping, such as skin disease, dermatitis, eczema.
- Subjects who had any deformity in the affected sided elbow and wrist.
- Subjects who were unwillingness to participate.

### **3.7 Pilot study**

Pilot study is a preliminary run of the main study to highlight any problems which can then be corrected and it is important always to run some pilot study before beginning the experiment. So, the researcher performed a pilot study before beginning the main study and the aim of this pilot study was to define the list of conventional physiotherapy treatment is provided by musculoskeletal department of CRP for managing the case of tennis elbow. Researcher took one week for pilot study and visited the CRP musculoskeletal department of physiotherapy and consulted with relevant qualified physiotherapist to identify the conventional physiotherapy used for

tennis elbow. The researcher formulated a list of evidence based physiotherapy interventions of tennis elbow and provided those to the physiotherapist to mark the interventions commonly used as conventional physiotherapy for tennis elbow. After finishing the pilot study, researcher became able to find out the conventional physiotherapy interventions used for tennis elbow and their frequency of use, with the consent of eight clinical physiotherapist. Cryotherapy, stretching & strengthening exercise of wrist extensor group muscle, deep transverse friction massage, ultrasound were the most commonly used interventions, the frequency of use was 100%, eccentric exercise, manipulation, myofascial release, oral NSAID were the second most commonly used interventions and the frequency was 75-99%, movement with mobilization, effleurage & kneading massage, corticosteroid injection were the partially used interventions and the frequency of use was 25-49%.

### **3.8 Method of data collection**

#### **3.8.1 Data collection tools**

A written questionnaire, pen, paper and adhesive therapeutic tapes were used as data collection tools in this study.

#### **3.8.2 Questionnaire**

The questionnaire was developed under the advice and permission of the supervisor following certain guidelines. There were six close ended questions with visual analogue scale (VAS) and each question was formulated to identify the change of pain with each activity and all questions were related to pain and disability.

#### **3.8.3 Measurement tool**

Visual Analogue Scale (VAS)-In this study researcher used visual analogue scale for measuring the intensity of pain. The VAS is a simple and accurate way of subjectively assessing pain along a continuous visual spectrum. VAS consists of a straight line on which the individual being assessed marks the level of pain. The ends of the straight line are the extreme limits of pain with 0 representing no pain and 10 representing the worst pain ever experienced. According to Myles (1999: 1517), the visual analog scale (VAS) is a tool widely used to measure pain and a change in the visual analog scale score represents a relative change in the magnitude of pain sensation.

### **3.8.4 Data collection procedure**

The study procedure was conducted through assessing the patient, initial recording, treatment and final recording. After screening the patient at department, the patients were assessed by qualified physiotherapist. Four sessions of treatment was provided for every subject.

Fourteen subjects were chosen for data collection according to the inclusion criteria. The researcher divide all participants into two groups and coded C1 (7) for control group and E1 (7) for experimental group. Experimental group received conventional physiotherapy with taping and control group received only conventional physiotherapy.

Data was gathered through a pre-test, intervention and post-test and the data was collected by using a written questionnaire form which was formatted by the researcher. Pre test was performed before beginning the treatment and the intensity of pain was noted with VAS score on questionnaire form. The same procedure was performed to take post-test at the end of four session of treatment. Researcher gave the assessment form to each subject before starting treatment and after four session of treatment and instructed to put mark on the line of VAS according to their intensity of pain. The researcher collected the data both in experimental and control group in front of the qualified physiotherapist in order to reduce the biasness.

At the end of the study, specific test was performed for statistical analysis.

### **3.8.5 Intervention**

A common intervention program was executed for both groups as conventional physiotherapy, it includes- cryotherapy, stretching & strengthening exercise of wrist extensor group muscle, deep transverse friction massage and ultrasound, which are the most frequently, used interventions. In this study, the experimental group was treated with taping in addition with conventional physiotherapy. Researcher applied the taping technique and the conventional physiotherapies were given by clinical physiotherapist. Before applying the taping technique, researcher herself has developed competency in application of tape for tennis elbow. After that researcher applied the tape under a strict protocol (described pp.13,14). Each group got 4 sessions of treatment, where the experimental group was provided with taping for 4

times. There is no evidence of exact repetition for tennis elbow taping, but in practice expert opinion suggests that 4 session of taping is minimal enough for patients with tennis elbow to complete the healing process.

### **3.9 Ethical consideration**

Research proposal was submitted for approval to the administrative bodies of ethical committee of CRP. Again before beginning the data collection, researcher was obtained the permission from the concerned authorities ensuring the safety of the participants. In order to eliminate ethical claims, the participants were set free to receive treatment for other purposes as usual. Each participant was informed about the study before beginning and given written consent.

### **3.10 Informed Consent**

The researcher obtained consent to participate from every subject. A signed informed consent form was received from each participant. The participants were informed that they have the right to meet with outdoor doctor if they think that the treatment is not enough to control the condition or if the condition become worsen. The participants were also informed that they were completely free to decline answering any question during the study and were free to withdraw their consent and terminate participation at any time. Withdrawal of participation from the study would not affect their treatment in the physiotherapy department and they would still get the same facilities. Every subject had the opportunity to discuss their problem with the senior authority or administration of CRP and have any questioned answer to their satisfaction.

### **3.11 Data analysis**

In order to ensure that the research have some values, the meaning of collected data has to be presented in ways that other research workers can understand. In other words the researcher has to make sense of the results. As the result came from an experiment in this research, data analysis was done with statistical analysis.

All participants were code according to group to maintain participant's confidentiality. All subjects of both experimental and control group score their pain intensity on visual analogue scale before starting treatment and after completing

treatment. Reduction of pain intensity for both groups is the difference between pre-test and post-test score.

Experimental studies with the different subject design where two groups are used and each tested in two different conditions and the data is interval or ratio should be analyzed with unrelated 't' test. As it was experimental and had unmatched groups of different subjects, who was randomly assigned to conventional physiotherapy with tapping and only conventional physiotherapy group and the measurement of the outcome came from collecting VAS score, with considering interval or ratio data, so the parametric unrelated 't' test was used in this study to calculate the level of significance. Unrelated 't' test and mean difference was calculated to test the hypothesis on the basis of following assumptions-

- Data were ratio
- Two different set of subjects in two conditions

The 't' formula-

$$t = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{\frac{\left(\sum X_1^2 - \frac{(\sum X_1)^2}{n_1}\right) + \left(\sum X_2^2 - \frac{(\sum X_2)^2}{n_2}\right)}{(n_1 - 1) + (n_2 - 1)} \times \sqrt{\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}}$$

Where

$\bar{x}_1$  = mean of scores from treatment group

$\bar{x}_2$  = mean of scores from control group

$\sum X_1^2$  = the square of the each individual score from treatment group totaled

$\sum X_2^2$  = the square of the each individual score from control group totaled

$(\sum X_1)^2$  = the total of the individual score from treatment group squared

$(\sum X_2)^2$  = the total of the individual score from control group squared

$n_1$  = number of subjects from treatment group

$n_2$  = number of subjects from control group

### 3.12 Significant level

In order to find out the significance of the study, the researcher calculated the ‘p’ value. The p values refer the probability of the results for experimental study. The word probability refers to the accuracy of the findings. A p value is called level of significance for an experiment and a p value of <0.05 was accepted as significant result for health service research. If the p value is equal or smaller than the significant levels, the results are said to be significant.

Calculating the degree of freedom from the formula:

$$\text{Degrees of freedom (df)} = (n_1-1) + (n_2-1) = (7-1) + (7-1) = 12$$

Df	.1	.05	.025	.01	.005	.0005
12	1.356	1.782	2.179	2.681	3.055	4.318

**Table-1:** Level of significance for one tailed hypothesis

### 3.13 Elimination of confounding variables

Confounding variable has an effect on the study variables which can affect the result of the study. There were some confounding variables in this study such as patient’s age, history of taking recent physiotherapy intervention, oral NSAID, steroid injection or other treatment which could influence the result of the study. Researcher found no significant difference between the mean age of two groups and the mean age of control group was 41year and mean age of trial group was 43year, so there was no effect of age which can influence the result. To control the confounding variables, researcher set the inclusion criteria as to include only those subjects who have no history of taking recent physiotherapy intervention, oral NSAID, steroid injection or other treatment.

### 3.14 Limitations of the study

- The main limitation of this study was its short duration.
- The study was conducted with 14 patients of tennis elbow, which was a very small number of samples in both groups and was not sufficient enough for the study to generalize the wider population of this condition.

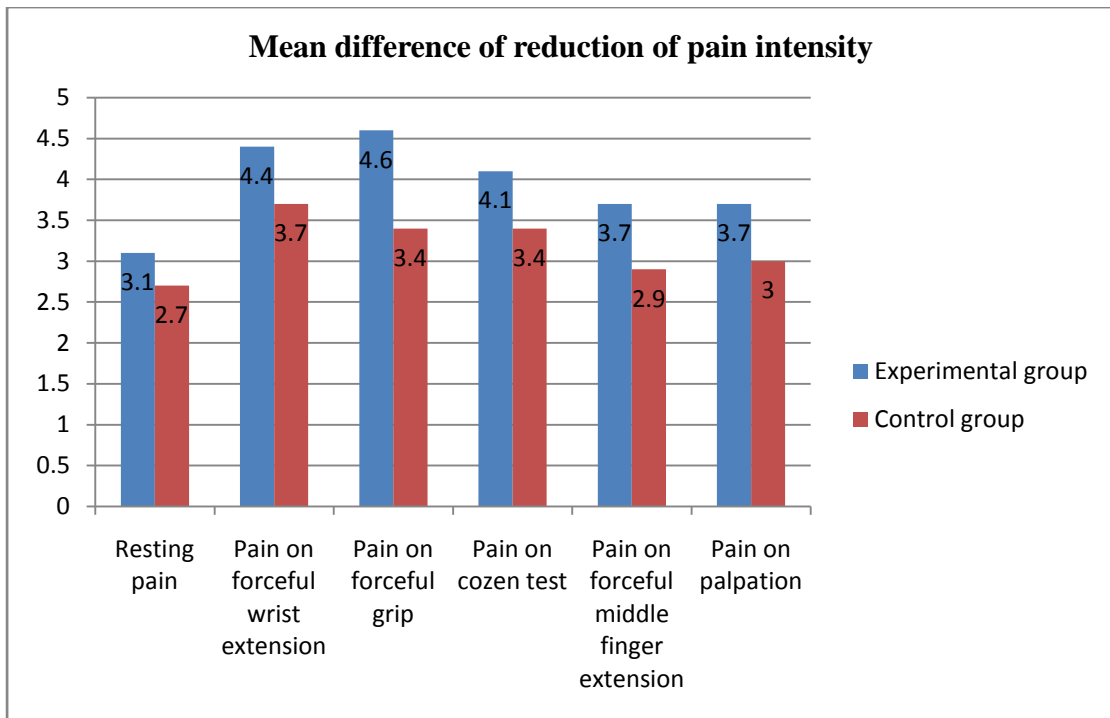


- It is limited by the fact daily activities of the subject were not monitored which could have influenced. Researcher only explored the effect of taping after 4 sessions, so the long term effect of taping was not explored in this study.
- The research was carried out in CRP Savar such a small environment, so it was difficult to keep confidential the aims of the study for blinding procedure. Therefore, blinding was not used in this study.
- There was no available research done in this area in Bangladesh. So, relevant information about tennis elbow patient with specific intervention for Bangladesh was very limited in this study.

14 patients with tennis elbow were enrolled in the study. 7 in the taping with conventional physiotherapy treatment group (experimental group) and 7 in the only conventional physiotherapy treatment group (control group). The all subjects of both experimental and control group scored their pain on visual analogue scale before and after completing treatment.

Name of the variables	Experimental group	Control group
Resting pain	3.1	2.7
Pain on forceful wrist extension	4.4	3.7
Pain on forceful grip	4.6	3.4
Pain on cozen test	4.1	3.4
Pain on forceful middle finger extension	3.7	2.9
Pain on palpation	3.7	3.0

**Table-2:** Mean difference of reduction of pain intensity between pre-test and post-test in experimental and control group



**Figure-1:** Mean difference of reduction of pain intensity between pre-test and post-test in experimental and control group.

**Resting pain:** Reduction of pain scores in taping with conventional physiotherapy treatment group and only conventional physiotherapy treatment group for resting pain were differences between pre-test and post-test pain scores.

Experimental group			Control group		
Subjects	Pain scores (X <sub>1</sub> )	X <sub>1</sub> <sup>2</sup>	Subjects	Pain scores (X <sub>2</sub> )	X <sub>2</sub> <sup>2</sup>
E <sub>1</sub>	4	16	C <sub>1</sub>	3	9
E <sub>2</sub>	3	9	C <sub>2</sub>	2	4
E <sub>3</sub>	3	9	C <sub>3</sub>	3	9
E <sub>4</sub>	3	9	C <sub>4</sub>	3	9
E <sub>5</sub>	3	9	C <sub>5</sub>	3	9
E <sub>6</sub>	2	4	C <sub>6</sub>	2	4
E <sub>7</sub>	4	16	C <sub>7</sub>	3	9
	∑ X <sub>1</sub> =22	∑ X <sub>1</sub> <sup>2</sup> =72		∑ X <sub>2</sub> =19	∑ X <sub>2</sub> <sup>2</sup> =53

**Table-3:** Reduction of resting pain in experimental and control group

$$\bar{x}_1=3.1$$

$$\sum X_1^2=72$$

$$(\sum X_1)^2=484$$

$$n_1=7$$

$$\bar{x}_2=2.7$$

$$\sum X_2^2=53$$

$$(\sum X_2)^2=361$$

$$n_2=7$$

Calculating the degree of freedom from the formula

$$df = (n_1-1) + (n_2-1)$$

$$= (7-1) + (7-1)$$

$$= 12$$

Now 't' formula-

$$t = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{\frac{\left(\sum X_1^2 - \frac{(\sum X_1)^2}{n_1}\right) + \left(\sum X_2^2 - \frac{(\sum X_2)^2}{n_2}\right)}{(n_1 - 1) + (n_2 - 1)} \times \sqrt{\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}}$$

$$t = \frac{3.1 - 2.7}{\sqrt{\frac{\left(72 - \frac{484}{7}\right) + \left(53 - \frac{361}{7}\right)}{(7 - 1) + (7 - 1)} \times \sqrt{\left(\frac{1}{7} + \frac{1}{7}\right)}}$$

$$t = 1.319$$

There are some critical values for the independent 't' test. These values have given a range between 1.356 to 4.318 for degrees of freedom 12. The first one refers to 10%, second one 5%, third one 2.5%, fourth 1%, fifth 0.5% and the sixth 0.05% significant level. When 't' value is equal to or larger than the associated critical 't' value, the result is said to be significant.

Variables in the study statistically significant or not significant at the following level of significance:

No.	Variables	Calculated 't' value	P value	Significant or not significant
1.	Resting pain	1.319		Not significant
2.	Pain on forceful wrist extension	2.000	<0.05	Significant
3.	Pain on forceful grip	1.876	<0.05	Significant
4.	Pain on cozen test	1.798	<0.05	Significant
5.	Pain on forceful middle finger extension	2.197	<0.025	Significant
6.	Pain on palpation	2.485	<0.025	Significant

**Table-9:** Variables in this study with level of significance

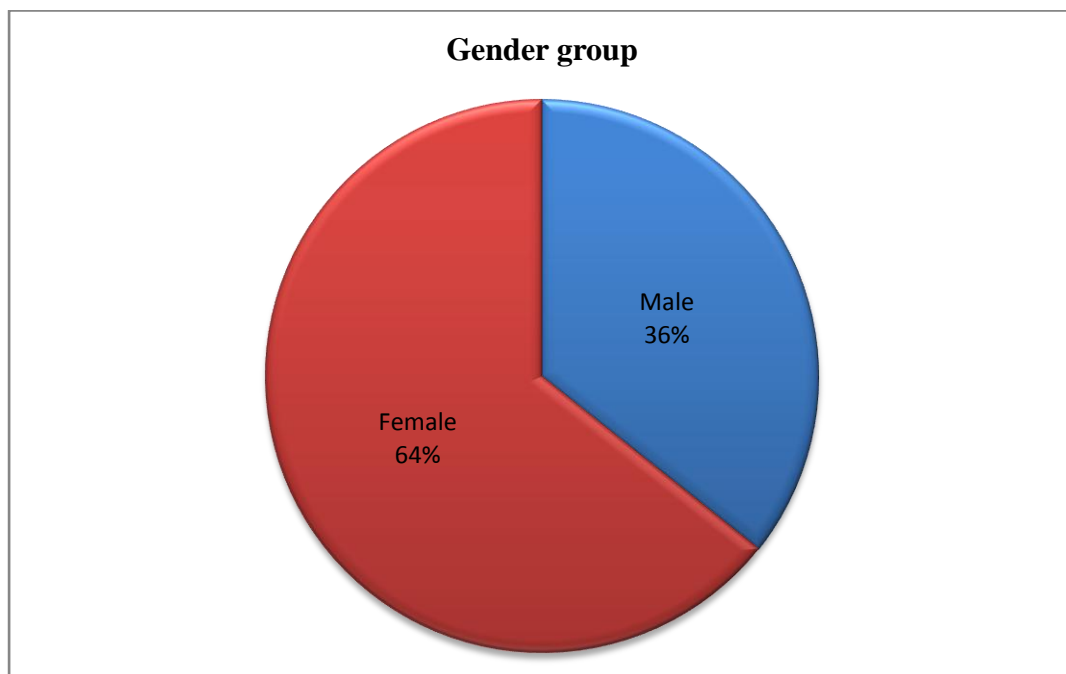
### Mean age of the participants

Experimental group		Control group	
Subjects	Age (year)	Subjects	Age (year)
E1	40	C1	45
E2	42	C2	35
E3	40	C3	45
E4	45	C4	50
E5	50	C5	40
E6	48	C6	35
E7	38	C7	40
Mean age	43 year	Mean age	41 year

**Table-10:** Mean age of the participants of experimental and control group

### Sex of the participants

14 patients with tennis elbow were included as sample of the study, among them almost 36% (n=5) were male and about 64% (n=9) were female.



**Figure-2:** Involvement of sex

## **Interpretation of results**

The researcher interprets the result based on VAS score using the values that come from this comparative study.

### **Resting pain**

14 patients were enrolled and 7 patients among them were assigned to active intervention. The rest of 7 patients were assigned to the controlled group. Mean difference of reduction of pain intensity between experimental and control group was 3.1 and 2.7. Using unrelated 't' test on the data of resting pain ( $t=1.319$ ,  $df=12$ ) the result was found not to be significant for one tailed hypothesis. So this result suggests that following application of treatment the experimental group showed no significant improvement in case of resting pain.

### **Pain on forceful wrist extension**

The 't' value of reduction of pain intensity for pain on forceful wrist extension is 2.000. Mean difference of reduction of pain intensity for experimental group was found 4.4 and for control group it was found 3.7. Using unrelated 't' test on the data of pain on forceful wrist extension ( $t=2.000$ ,  $df=12$ ,  $p<0.05$ ) the result was found to be significant for one tailed hypothesis. The 't' has an associated probability level of less than 5%, which means that the probability of random error is less than 5 in 100. Therefore this study can say that the result is significant in case of pain on forceful wrist extension. So this result suggests that there is more significant improvement in pain on forceful wrist extension when using conventional physiotherapy with taping than only conventional physiotherapy for patient with tennis elbow.

### **Pain on forceful grip**

The 't' value of reduction of pain intensity for pain on forceful grip is 1.876. Mean difference of reduction of pain intensity for experimental group was found 4.5 and for control group it was found 3.4. Using unrelated 't' test on the data of pain on forceful wrist extension ( $t=1.876$ ,  $df=12$ ,  $p<0.05$ ) the result was found to be significant for one tailed hypothesis. The 't' has an associated probability level of less than 5%, which means that the probability of random error is less than 5 in 100. Therefore this study can say that the result is significant in case of pain on forceful grip. So this result



suggests that there is more significant improvement in pain on forceful grip when using conventional physiotherapy with taping than only conventional physiotherapy for patient with tennis elbow.

#### **Pain on cozen test**

The 't' value of reduction of pain intensity for pain on cozen test is 1.798. Mean difference of reduction of pain intensity for experimental group was found 4.1 and for control group it was found 3.4. Using unrelated 't' test on the data of pain on cozen test ( $t=1.798$ ,  $df=12$ ,  $p<0.05$ ) the result was found to be significant for one tailed hypothesis. The 't' has an associated probability level of less than 5%, which means that the probability of random error is less than 5 in 100. Therefore this study can say that the result is significant in case of pain on cozen test. So this result suggests that there is more significant improvement in pain on cozen test when using conventional physiotherapy with taping than only conventional physiotherapy for patient with tennis elbow.

#### **Pain on forceful middle finger extension**

The 't' value of reduction of pain intensity for pain on forceful middle finger extension is 2.197. Mean difference of reduction of pain intensity for experimental group was found 3.7 and for control group it was found 2.8. Using unrelated 't' test on the data of pain on cozen test ( $t=2.197$ ,  $df=12$ ,  $p<0.025$ ) the result was found to be significant for one tailed hypothesis. The 't' has an associated probability level of less than 2.5%, which means that the probability of random error is less than 2.5 in 100. Therefore this study can say that the result is significant in case of pain on forceful middle finger extension. So this result suggests that there is more significant improvement in pain on forceful middle finger extension when using conventional physiotherapy with taping than only conventional physiotherapy for patient with tennis elbow.

#### **Pain on palpation**

The 't' value of reduction of pain intensity for pain on palpation is 2.485. Mean difference of reduction of pain intensity for experimental group was found 3.7 and for control group it was found 3.0. Using unrelated 't' test on the data of pain on cozen test ( $t=2.485$ ,  $df=12$ ,  $p<0.025$ ) the result was found to be significant for one tailed

hypothesis. The 't' has an associated probability level of less than 2.5%, which means that the probability of random error is less than 2.5 in 100. Therefore this study can say that the result is significant in case of pain on palpation. So this result suggests that there is more significant improvement in pain on palpation when using conventional physiotherapy with taping than only conventional physiotherapy for patient with tennis elbow.

### **Summary of the results**

Using the unrelated 't' test, it was found that significant pain reduction in all variables except resting pain, were greater in experimental group (Conventional physiotherapy with taping) than the control group (Only conventional physiotherapy). The results are statistical significant decrease of pain on forceful wrist extension ( $p < 0.05$ ), pain on forceful grip ( $p < 0.05$ ), pain on cozen test ( $p < 0.05$ ), pain on forceful middle finger extension ( $p < 0.025$ ), pain on palpation ( $p < 0.025$ ) and a small but not statistically significant decrease of resting pain. So, the combined treatment of conventional physiotherapy with taping is more effective than conventional physiotherapy alone for reducing the features of patient with tennis elbow. As in this study majority of domain showed significant level of 'p' value, this means that experimental hypothesis for this study is supported and the null hypothesis is rejected.

The purpose of this study was to evaluate the effectiveness of taping with conventional physiotherapy compare to only conventional physiotherapy for tennis elbow. In this experimental study 14 patients with tennis elbow were randomly assigned to the experimental group and to the control group. Among these 14 patients, 7 patients were included in the experimental group who received taping with conventional physiotherapy and the rest of the 7 patients were included in the control group, who received conventional physiotherapy only. Each group attended for 4 sessions of treatment within two weeks in the physiotherapy outdoor department of CRP Savar in order to demonstrate the improvement. The outcome was measured by using visual analogue scale for pain intensity in different functional position. The researcher found a statistical significant decrease of pain on forceful wrist extension ( $p < 0.05$ ), pain on forceful grip ( $p < 0.05$ ), pain on cozen test ( $p < 0.05$ ), pain on forceful middle finger extension ( $p < 0.025$ ), pain on palpation ( $p < 0.025$ ) and a small but not statistically significant decrease of resting pain.

Shamsoddin et al (2010) conducted a study on ‘Initial effect of taping technique on wrist extension and grip strength and pain of Individuals with lateral epicondylitis’, to find out the initial effect of taping technique on wrist extension and grip strength and pain on Individuals with tennis elbow. They included 15 patients (10 men and 5 women with 42-53 years) on their dominant arm, measured grip strength and pain, before and immediately after application of tape as outcome measures. They used hand-held dynamometer and jammarm dynamometer for the evaluation of wrist extension and grip strength and visual analog scale (VAS) for pain. They concluded that Taping technique has an impressive effect on wrist extension and grip strength and pain in individuals with tennis elbow. Therefore, it is recommended for functional rehabilitation.

Vicenzino et al (2003) did an experimental study on sixteen participants with chronic lateral epicondylalgia participated in a placebo control study of an elbow taping technique and outcome measures were pain-free grip strength and pressure pain threshold. Results showed that the taping technique significantly improved pain-free

grip strength by 24% from baseline ( $P = .028$ ). The treatment effect was greater than that for placebo and control conditions. Changes in pressure pain threshold (19%), although positive, were not statistically significant. This preliminary study demonstrated an initial ameliorative effect of a taping technique for lateral epicondylalgia and suggests that it should be considered as an adjunct in the management of this condition.

Amro et al (2010) studied an experimental design study to investigate the effect of a combination of taping, Mulligan's movement with mobilization and traditional treatment compared with that of traditional treatment alone in patients with lateral epicondylitis, aimed to reduce pain, increase grip strength, and improve activities of daily living. A total of 34 patients aged between 16 and 69 years underwent 11 sessions of a combination of Mulligan techniques and traditional treatment (experimental group,  $n=17$ ) or traditional treatment only (control group,  $n=17$ ). Outcome was measured by using visual analogue scale, maximum grip strength, and Patient-Rated Tennis Elbow Evaluation. Analysis showed mean improvement in visual analogue scale and maximum grip strength was significantly greater in the experimental group than that in the control group. This study showed that the combination of taping & Mulligan's movement with mobilization techniques with traditional treatment leads to better outcomes in treatment of lateral epicondylitis than traditional treatment alone.

Sharath (2005) did a study aimed to determine the combined effect of wrist manipulation and elbow taping in patients with tennis elbow. 30 individuals were randomly assigned into experimental and control group. The measurement tools used were hand held dynamometer, visual analogue scale and 6-point scale of global improvement. Results showed mean improvement in dynamometer, significant improvement in VAS score after 3 weeks but no significant improvement found after 6 week intervention with  $p<0.01$ . 6-point scale of global improvement showed significant improvement with  $p<0.001$ .

The result of this experimental study have identified the effectiveness of conventional physiotherapy with taping are better treatment than the conventional physiotherapy alone for reducing pain and disability in tennis elbow patient. Participants in the conventional physiotherapy with taping group showed a greater benefit than those in the only conventional physiotherapy group, which indicate that the conventional physiotherapy with taping can be an effective therapeutic approach for patient with tennis elbow.

Taping technique is used along with conventional physiotherapy that aims to reduce pain on lateral epicondyle, to facilitate rehabilitation program. It is a cost effective treatment alternative for many common injuries & overuse syndrome which is effective for restoring the joint play and for establishing proper structural alignment. So it may become helpful for patients with tennis elbow to determine taping with conventional physiotherapy as intervention for reducing the features of tennis elbow. From this research the researcher wishes to explore the effectiveness of taping along with conventional physiotherapy to reduce the features of patient with tennis elbow, which will be helpful to facilitate their rehabilitation and to enhance functional activities.

As a consequence of this researcher it is recommended to do further study including comparison of the conventional physiotherapy and taping with conventional physiotherapy alone to assess the effectiveness of these interventions with well-controlled blinding procedure. It is also is recommended to include the functional outcome assessment of patient and to identify the average number of sessions that are needed to be discharged from treatment to validate the treatment technique.

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## APPENDIX

### Appendix-A

#### মৌখিক অনুমতিপত্র

আসসালামুআলাইকুম / নমস্কার। আমি নুসরাত জাহান, বাংলাদেশ হেলথ প্রফেশনস ইনস্টিটিউট এর বি.এস.সি ইন ফিজিওথেরাপী কোর্সের ৪র্থ বর্ষের একজন ছাত্রী। এই প্রতিষ্ঠানটি ঢাকা বিশ্ববিদ্যালয় এর চিকিৎসা বিভাগের অন্তর্ভুক্ত। অধ্যয়নের অংশ হিসাবে আমাকে একটি গবেষণা সম্পাদন করতে হবে যা কনুইয়ের “লেটারাল এপিকন্ডাইলাইটিস” অথবা টেনিস এলবো এর ক্ষেত্রে ট্যাপিং এবং টেনিস এলবো এর জন্য গতানুগতিক ফিজিওথেরাপী চিকিৎসা এর সমন্বিত চিকিৎসা পদ্ধতির কার্যকারিতা সম্পর্কিত গবেষণা।

এই অধ্যয়ন এর লক্ষ্য হল কনুই এর “লেটারাল এপিকন্ডাইলাইটিস” অথবা টেনিস এলবো এর ক্ষেত্রে ট্যাপিং এবং টেনিস এলবো এর জন্য গতানুগতিক ফিজিওথেরাপী চিকিৎসা এর সমন্বিত চিকিৎসা পদ্ধতির কার্যকর কিনা তা খুঁজে বের করা। “লেটারাল এপিকন্ডাইলাইটিস” অথবা টেনিস এলবো তে আক্রান্ত রোগীরা হবেন এই গবেষণার অংশগ্রহনকারী। গবেষণাটি সম্পাদন করার জন্য বিশ্রামে থাকাকালীন কনুই এর ব্যাথা, বলপূর্বক কজি সোজা করার সময় কনুইয়ের ব্যাথা, বলপূর্বক হাত মুষ্টি করার সময় কনুইয়ের ব্যাথা, আক্রান্ত স্থানে হাত দিয়ে অনুভব করার সময় কনুইয়ের ব্যাথা সম্পর্কিত তথ্য সংগ্রহ করা হবে। নিম্নোক্ত তথ্যাদি পাঠ করার পর এই অধ্যয়নে অংশগ্রহনে আপনি আমন্ত্রিত।

অধ্যয়নে অংশগ্রহনকারীগণ অত্র বিভাগে তার নিয়মিত চিকিৎসা যথানিয়মে গ্রহণ করতে পারবেন। এই অধ্যয়নের জন্য রোগীকে দুইবার উপস্থিত থাকতে হবে। এই গবেষণা পরীক্ষামূলক পদ্ধতিসহ চিকিৎসা প্রণালী এবং তার ফলাফল অনুসরণ করবে। বহির্বিভাগের চিকিৎসা নেওয়া ছাড়াও অংশগ্রহনকারীদের নির্দেশনা অনুসারে বাসার কিছু থেরাপী এবং উপদেশ মেনে চলতে হবে। টেনিস এলবো- এ আক্রান্ত রোগীদের গবেষণার উদ্দেশ্যে চিকিৎসার পূর্বে এবং পরেও দুইবার পর্যবেক্ষন করা হবে। আশা করা হচ্ছে এই অধ্যয়নের ফলাফল- টেনিস এলবো-তে আক্রান্ত রোগীদের চিকিৎসা নির্ণয়ের ক্ষেত্রে উল্লেখযোগ্য ভূমিকা রাখবে।

অংশগ্রহনকারী যে কোন মূল্যে সম্মতি প্রত্যাহার এবং গবেষণায় অংশগ্রহণে অনিয়মিত হবার ব্যাপারে সম্পূর্ণ অধিকার রাখে। এই গবেষণার প্রাপ্ত তথ্য সম্পূর্ণভাবে গোপনীয় থাকবে এবং গবেষণার ফল প্রকাশের সময় উক্ত অংশগ্রহনকারীকে ব্যক্তিগত ভাবে চিহ্নিত করা হবে না।

আপনি কি এই অধ্যয়নে অংশগ্রহনে সম্মতি প্রদান করছেন?

হ্যাঁ

না

রোগীর স্বাক্ষর.....তারিখ.....

গবেষকের স্বাক্ষর.....তারিখ.....

স্বাক্ষীর স্বাক্ষর.....তারিখ.....

### **Inform consent**

Assalamu-alaikum/Namasker. I am Nusrat Zahan, a student of B.Sc. in Physiotherapy at Bangladesh Health Professions Institute (BHPI), CRP. The institute is the affiliated with the faculty of Medicine, University of Dhaka.

However, to the fulfillment of my degree, I shall have to conduct a research. That is why, I am going to conduct a research with the entitled “Effectiveness of taping in combination with conventional physiotherapy for tennis elbow”.

Through this study, I will see the efficacy of taping along with existing physiotherapy for the case of tennis elbow. The patients with tennis elbow will be the participants of my study. To carry out the research, I need to collect data from patients about lateral elbow pain at rest, on forceful grip and pain on functional activities.

Considering the area of my research, you have been met the inclusion criteria of the research, therefore I would like to invite you as a subject of the study. You will participate in the research in terms of exploring some issues, related with my research after application of tape or without application of tape. Taping is a safe intervention for tennis elbow through which, I believe there will be no harm.

I just want to meet you two sessions as per convenient for you and me. Each session will consist of maximum 30 minutes. You will be assessed at the beginning of first session and after twelve days of first session.

Your participation in this study is voluntary and you may withdraw yourself at any time during this study without any negative consequences. You also have the right not to answer a particular question that you don't like or do not want to answer during interview.

If you have any query about the study or your right as a participant, you may contact with Nusrat Zahan, researcher and/or Nasirul Islam, Assistant professor, BHPI, CRP, Savar, Dhaka-1343.

Do you have any questions before I start?

So may I have your consent to proceed with the interview?

YES  NO

Signature of the Interviewer \_\_\_\_\_

I ..... declare that I am giving my consent to participating in the study after being informed about all the above information in details.

Signed (Client's Signature) .....Date.....  
Signed (Investigator's Signature) .....Date.....  
Signed (Witness's Signature) .....Date.....

## Questionnaire (Bangla)

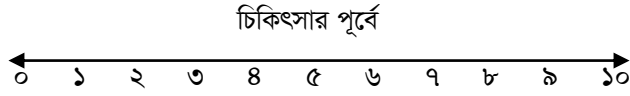
এই প্রশ্নপত্র শুধুমাত্র কন্ট্রোল এর লেটারাল এপিকন্ডাইলাইটিস অথবা টেনিস এলবো এর ব্যাথা নিরূপনের জন্য করা হয়েছে।

রোগীর নাম : পেশা :  
বয়স : ঠিকানা :  
পুরুষ/মহিলা : তারিখ :

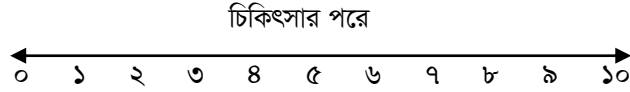
(এই প্রশ্নপত্র টেনিস এলবো এর ব্যাথা নিরূপনের জন্য)

প্রত্যেক প্রশ্নে একটি করে লম্বা দাগ দেয়া আছে। এই দাগের বাম দিকের শেষ বিন্দু 'কোন ব্যাথা নেই' এবং ডান দিকের শেষ বিন্দু 'অসহনীয় ব্যাথা' নির্দেশ করে। যখন আপনি এই প্রশ্নপত্র পূরণ করবেন তখন আপনার ব্যাথা কতটুকু তীব্র তা অনুযায়ী এই দাগ ভরাট করবেন।

১। স্বাভাবিক বিশ্রামে থাকাকালীন আপনার কন্ট্রোল এর ব্যাথা কতটুকু তীব্র হয়?

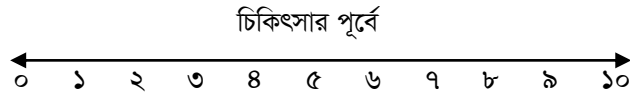


এখানে শূন্য (০) হচ্ছে কোন ব্যাথা নেই এবং দশ (১০) হচ্ছে তীব্র ব্যাথা।

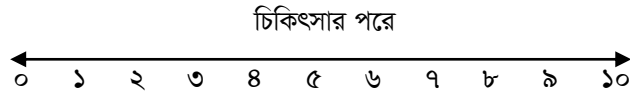


এখানে শূন্য (০) হচ্ছে কোন ব্যাথা নেই এবং দশ (১০) হচ্ছে তীব্র ব্যাথা।

২। বলপূর্বক কজি সোজা করার সময় আপনার কন্ট্রোল এর ব্যাথা কতটুকু তীব্র হয়?

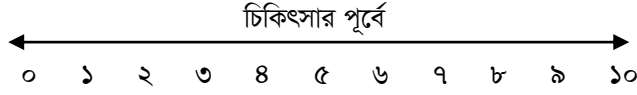


এখানে শূন্য (০) হচ্ছে কোন ব্যাথা নেই এবং দশ (১০) হচ্ছে তীব্র ব্যাথা।

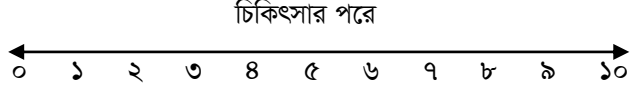


এখানে শূন্য (০) হচ্ছে কোন ব্যাথা নেই এবং দশ (১০) হচ্ছে তীব্র ব্যাথা।

৩। বলপূর্বক হাত মুষ্টি করার সময় আপনার কনুইয়ের ব্যাথা কতটুকু তীব্র হয়?



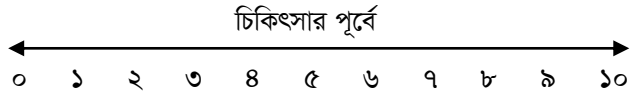
এখানে শূন্য (০) হচ্ছে কোন ব্যাথা নেই এবং দশ (১০) হচ্ছে তীব্র ব্যাথা।



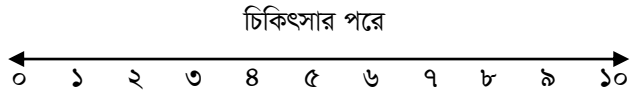
এখানে শূন্য (০) হচ্ছে কোন ব্যাথা নেই এবং দশ (১০) হচ্ছে তীব্র ব্যাথা।

৪। বলপূর্বক হাত মুষ্টি করে কনুই থেকে কজির উপর পর্যন্ত অংশ উপর করে এবং কজি রেডিয়াসের দিকে বাকিয়ে

সোজা করার সময় (কোজেন টেস্ট) আপনার ব্যাথা কতটুকু তীব্র হয়?

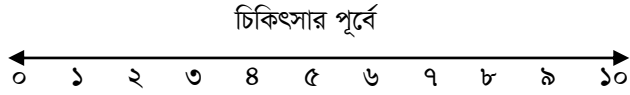


এখানে শূন্য (০) হচ্ছে কোন ব্যাথা নেই এবং দশ (১০) হচ্ছে তীব্র ব্যাথা।

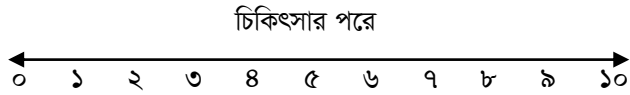


এখানে শূন্য (০) হচ্ছে কোন ব্যাথা নেই এবং দশ (১০) হচ্ছে তীব্র ব্যাথা।

৫। বলপূর্বক হাতের তৃতীয় আঙ্গুল সোজা রেখে উপরের দিকে উঠানোর সময় আপনার ব্যাথা কতটুকু তীব্র হয়?

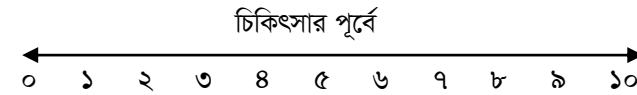


এখানে শূন্য (০) হচ্ছে কোন ব্যাথা নেই এবং দশ (১০) হচ্ছে তীব্র ব্যাথা।

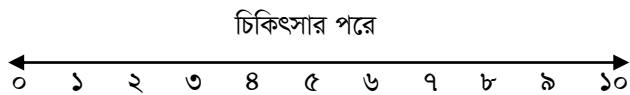


এখানে শূন্য (০) হচ্ছে কোন ব্যাথা নেই এবং দশ (১০) হচ্ছে তীব্র ব্যাথা।

৬। আক্রান্ত স্থানে হাত দিয়ে অনুভব করার সময় আপনার ব্যাথা কতটুকু তীব্র হয়?



এখানে শূন্য (০) হচ্ছে কোন ব্যাথা নেই এবং দশ (১০) হচ্ছে তীব্র ব্যাথা।



এখানে শূন্য (০) হচ্ছে কোন ব্যাথা নেই এবং দশ (১০) হচ্ছে তীব্র ব্যাথা।

তারিখঃ.....

গবেষকের স্বাক্ষর.....

## Questionnaire (English)

Code No.

This questionnaire is developed to measure the pain of the patient with tennis elbow.

Patients name:

Occupation:

Age:

Address:

Sex:

Date:

This questionnaire is designed for tennis elbow patients. With each question there is a long line. The line represents pain situation. The left hand end represents no pain and right hand end represents severe pain. Please a mark on the line where you feel it shows how much pain you have.

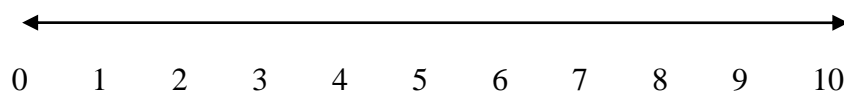
1. How severe your pain is at resting position?

Pre treatment



A Zero (0) means no pain and Ten (10) means extreme pain

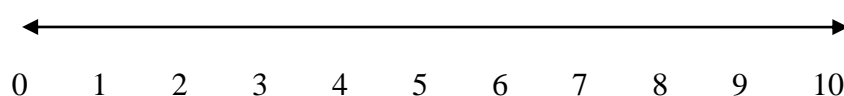
Post treatment



A Zero (0) means no pain and Ten (10) means extreme pain

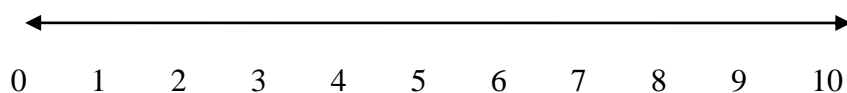
2. How severe is your pain during forceful wrist extension?

Pre treatment



A Zero (0) means no pain and Ten (10) means extreme pain

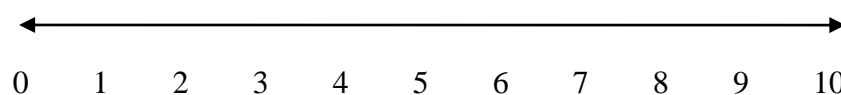
Post treatment



A Zero (0) means no pain and Ten (10) means extreme pain

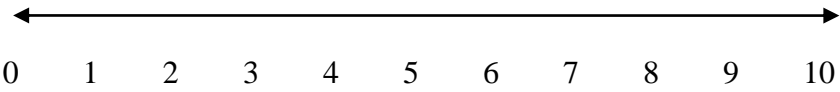
3. How severe is your pain during a strong grasp?

Pre treatment



A Zero (0) means no pain and Ten (10) means extreme pain

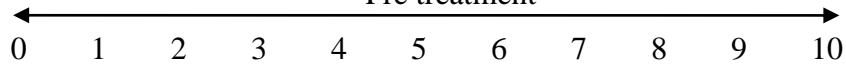
Post treatment



A Zero (0) means no pain and Ten (10) means extreme pain

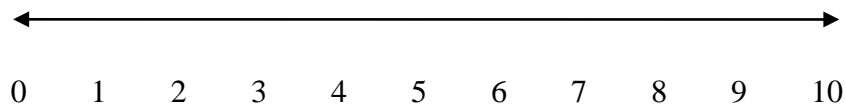
4. How severe is your pain when making a fist with pronation of forearm, and radial deviation and extension of wrist while the examiner resists the motion (cozen test)?

Pre treatment



A Zero (0) means no pain and Ten (10) means extreme pain

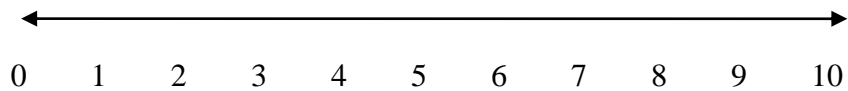
Post treatment



A Zero (0) means no pain and Ten (10) means extreme pain

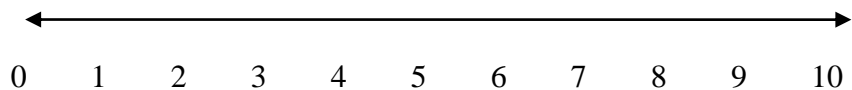
5. How severe is your pain during forceful middle finger extension?

Pre treatment



A Zero (0) means no pain and Ten (10) means extreme pain

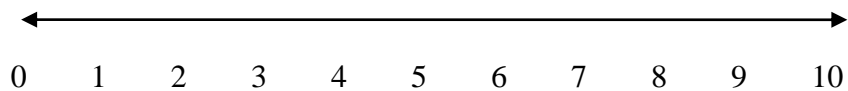
Post treatment



A Zero (0) means no pain and Ten (10) means extreme pain

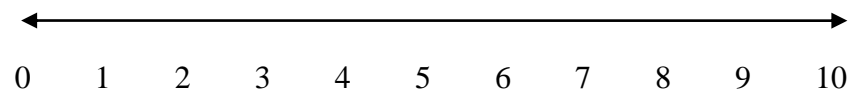
6. How severe is your pain on palpation to the affected side?

Pre treatment



A Zero (0) means no pain and Ten (10) means extreme pain

Post treatment



A Zero (0) means no pain and Ten (10) means extreme pain

Date: .....

Signature of Examiner:.....

### Permission Letter

To

The Head of the Department,  
Department of Physiotherapy,  
Center for the Rehabilitation of the Paralyzed (CRP),  
Savar, Dhaka.

Sub: Prayer for getting permission of the data collection in respect to conduct the research project.

Sir,

I beg most respectfully to state that, I am a student of 4<sup>th</sup> year, B.Sc. in Physiotherapy at Bangladesh Health Professions Institute (BHPI). As a part of my course curriculum I need to conduct a research project. My research topic is, 'Effectiveness of taping in combination with conventional physiotherapy for tennis elbow'. In this research my participants will be those who are clinically diagnosed as 'Tennis elbow' or 'Lateral epicondylitis'. For the purpose of conducting the research project, I need your kind permission to collect data and my selected place is Musculoskeletal Outdoor Physiotherapy department of CRP, Savar. From this research, we will be able to know the effectiveness of taping in tennis elbow. Here I want to assure you that my treatment program will not do any harm to the patient.

I therefore pray and hope that, you would be kind enough to give me the permission to conduct this research successfully in your department and oblige thereby.

Your most obedient pupil,

Nusrat Zahan  
Nusrat Zahan,

B. Sc. in Physiotherapy,

4<sup>th</sup> year, Roll: 16.

Dated: .....

Savar, Dhaka.

Accepted,  
DAB 19-06-12  
Md. Saifurab Hossain  
Assistant Prof. & Head of PT  
Physiotherapy Dept.  
CRP, Savar-1343.



## Appendix-B

**Pain on forceful wrist extension:** Reduction of pain scores in taping with conventional physiotherapy treatment group and only conventional physiotherapy treatment group for pain on forceful wrist extension were differences between pre-test and post-test pain scores.

Experimental group			Control group		
Subjects	Pain scores (X <sub>1</sub> )	X <sub>1</sub> <sup>2</sup>	Subjects	Pain scores (X <sub>2</sub> )	X <sub>2</sub> <sup>2</sup>
E <sub>1</sub>	5	25	C <sub>1</sub>	3	9
E <sub>2</sub>	4	16	C <sub>2</sub>	4	16
E <sub>3</sub>	5	25	C <sub>3</sub>	4	16
E <sub>4</sub>	4	16	C <sub>4</sub>	5	25
E <sub>5</sub>	4	16	C <sub>5</sub>	3	9
E <sub>6</sub>	4	16	C <sub>6</sub>	3	9
E <sub>7</sub>	5	25	C <sub>7</sub>	4	16
	∑ X <sub>1</sub> =31	∑ X <sub>1</sub> <sup>2</sup> =139		∑ X <sub>2</sub> =26	∑ X <sub>2</sub> <sup>2</sup> =100

**Table-4:** Reduction of pain on forceful wrist extension in experimental and control group

$$\bar{x}_1 = 4.4$$

$$\sum X_1^2 = 139$$

$$(\sum X_1)^2 = 961$$

$$n_1 = 7$$

$$\bar{x}_2 = 3.7$$

$$\sum X_2^2 = 100$$

$$(\sum X_2)^2 = 676$$

$$n_2 = 7$$

Calculating the degree of freedom from the formula

$$df = (n_1 - 1) + (n_2 - 1)$$

$$= (7 - 1) + (7 - 1)$$

$$= 12$$

Now 't' formula-

$$t = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{\frac{\left(\sum X_1^2 - \frac{(\sum X_1)^2}{n_1}\right) + \left(\sum X_2^2 - \frac{(\sum X_2)^2}{n_2}\right)}{(n_1 - 1) + (n_2 - 1)} \times \sqrt{\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}}$$

$$t = \frac{4.4 - 3.7}{\sqrt{\frac{\left(139 - \frac{961}{7}\right) + \left(100 - \frac{676}{7}\right)}{(7 - 1) + (7 - 1)} \times \sqrt{\left(\frac{1}{7} + \frac{1}{7}\right)}}$$

$$t = 2.000418$$

**Pain on forceful grip:** Reduction of pain scores in taping with conventional physiotherapy treatment group and only conventional physiotherapy treatment group for pain on forceful grip were differences between pre-test and post-test pain scores.

Experimental group			Control group		
Subjects	Pain scores (X <sub>1</sub> )	X <sub>1</sub> <sup>2</sup>	Subjects	Pain scores (X <sub>2</sub> )	X <sub>2</sub> <sup>2</sup>
E <sub>1</sub>	5	25	C <sub>1</sub>	3	9
E <sub>2</sub>	5	25	C <sub>2</sub>	4	16
E <sub>3</sub>	4	16	C <sub>3</sub>	3	9
E <sub>4</sub>	4	16	C <sub>4</sub>	4	16
E <sub>5</sub>	5	25	C <sub>5</sub>	4	16
E <sub>6</sub>	5	25	C <sub>6</sub>	3	9
E <sub>7</sub>	4	16	C <sub>7</sub>	3	9
	∑ X <sub>1</sub> =32	∑ X <sub>1</sub> <sup>2</sup> =148		∑ X <sub>2</sub> =24	∑ X <sub>2</sub> <sup>2</sup> =84

**Table-5:** Reduction of pain on forceful grip on experimental and control group

$$\bar{x}_1=4.6$$

$$\sum X_1^2=148$$

$$(\sum X_1)^2=1024$$

$$n_1=7$$

$$\bar{x}_2=3.4$$

$$\sum X_2^2=84$$

$$(\sum X_2)^2=576$$

$$n_2=7$$

Calculating the degree of freedom from the formula

$$df = (n_1-1) + (n_2-1)$$

$$= (7-1) + (7-1)$$

$$= 12$$

Now 't' formula-

$$t = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{\frac{\left(\sum X_1^2 - \frac{(\sum X_1)^2}{n_1}\right) + \left(\sum X_2^2 - \frac{(\sum X_2)^2}{n_2}\right)}{(n_1 - 1) + (n_2 - 1)} \times \sqrt{\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}}$$

$$t = \frac{0.87}{\sqrt{\frac{7.285714285 + 1.714285714}{(7 - 1) + (7 - 1)} \times \sqrt{\left(\frac{1}{7} + \frac{1}{7}\right)}}$$

$$t = 1.8764$$

**Pain on cozen test:** Reduction of pain scores in taping with conventional physiotherapy treatment group and only conventional physiotherapy treatment group for pain on cozen test were differences between pre-test and post-test pain scores.

Experimental group			Control group		
Subjects	Pain scores (X <sub>1</sub> )	X <sub>1</sub> <sup>2</sup>	Subjects	Pain scores (X <sub>2</sub> )	X <sub>2</sub> <sup>2</sup>
E <sub>1</sub>	5	25	C <sub>1</sub>	4	16
E <sub>2</sub>	4	16	C <sub>2</sub>	4	16
E <sub>3</sub>	3	9	C <sub>3</sub>	3	9
E <sub>4</sub>	4	16	C <sub>4</sub>	3	9
E <sub>5</sub>	4	16	C <sub>5</sub>	4	16
E <sub>6</sub>	5	25	C <sub>6</sub>	4	16
E <sub>7</sub>	4	16	C <sub>7</sub>	2	4
	∑ X <sub>1</sub> =29	∑ X <sub>1</sub> <sup>2</sup> =123		∑ X <sub>2</sub> =24	∑ X <sub>2</sub> <sup>2</sup> =86

**Table-6:** Reduction of pain during cozen test on experimental and control group

$$\bar{x}_1=4.1$$

$$\sum X_1^2=123$$

$$(\sum X_1)^2=841$$

$$n_1=7$$

$$\bar{x}_2=3.4$$

$$\sum X_2^2=86$$

$$(\sum X_2)^2=576$$

$$n_2=7$$

Calculating the degree of freedom from the formula

$$df = (n_1-1) + (n_2-1)$$

$$= (7-1) + (7-1)$$

$$= 12$$

Now 't' formula-

$$t = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{\frac{\left(\sum X_1^2 - \frac{(\sum X_1)^2}{n_1}\right) + \left(\sum X_2^2 - \frac{(\sum X_2)^2}{n_2}\right)}{(n_1 - 1) + (n_2 - 1)} \times \sqrt{\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}}$$

$$t = \frac{4.14 - 3.43}{\sqrt{\frac{\left(123 - \frac{841}{7}\right) + \left(86 - \frac{576}{7}\right)}{(7 - 1) + (7 - 1)} \times \sqrt{\left(\frac{1}{7} + \frac{1}{7}\right)}}$$

$$t = 1.7977198$$

**Pain on forceful middle finger extension:** Reduction of pain scores in taping with conventional physiotherapy treatment group and only conventional physiotherapy treatment group for pain on forceful middle finger extension were differences between pre-test and post-test pain scores.

Experimental group			Control group		
Subjects	Pain scores (X <sub>1</sub> )	X <sub>1</sub> <sup>2</sup>	Subjects	Pain scores (X <sub>2</sub> )	X <sub>2</sub> <sup>2</sup>
E <sub>1</sub>	4	16	C <sub>1</sub>	3	9
E <sub>2</sub>	4	16	C <sub>2</sub>	3	9
E <sub>3</sub>	4	16	C <sub>3</sub>	2	4
E <sub>4</sub>	3	9	C <sub>4</sub>	4	16
E <sub>5</sub>	3	9	C <sub>5</sub>	3	9
E <sub>6</sub>	3	9	C <sub>6</sub>	2	4
E <sub>7</sub>	5	25	C <sub>7</sub>	3	9
	∑ X <sub>1</sub> =26	∑ X <sub>1</sub> <sup>2</sup> =100		∑ X <sub>2</sub> =20	∑ X <sub>2</sub> <sup>2</sup> =60

**Table-7:** Reduction of pain during forceful middle finger extension on experimental and control group

$$\bar{x}_1=3.7$$

$$\sum X_1^2=100$$

$$(\sum X_1)^2=676$$

$$n_1=7$$

$$\bar{x}_2 =2.9$$

$$\sum X_2^2=60$$

$$(\sum X_2)^2=400$$

$$n_2=7$$

Calculating the degree of freedom from the formula

$$df = (n_1-1) + (n_2-1)$$

$$= (7-1) + (7-1)$$

$$= 12$$

Now 't' formula-

$$t = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{\frac{\left(\sum X_1^2 - \frac{(\sum X_1)^2}{n_1}\right) + \left(\sum X_2^2 - \frac{(\sum X_2)^2}{n_2}\right)}{(n_1 - 1) + (n_2 - 1)} \times \sqrt{\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}}$$

$$t = \frac{3.71 - 2.86}{\sqrt{\frac{\left(100 - \frac{676}{7}\right) + \left(60 - \frac{400}{7}\right)}{(7 - 1) + (7 - 1)} \times \sqrt{\left(\frac{1}{7} + \frac{1}{7}\right)}}$$

$$t = 2.1971823$$



**Pain on palpation:** Reduction of pain scores in taping with conventional physiotherapy treatment group and only conventional physiotherapy treatment group for pain on palpation were differences between pre-test and post-test pain scores.

Experimental group			Control group		
Subjects	Pain scores (X <sub>1</sub> )	X <sub>1</sub> <sup>2</sup>	Subjects	Pain scores (X <sub>2</sub> )	X <sub>2</sub> <sup>2</sup>
E <sub>1</sub>	4	16	C <sub>1</sub>	3	9
E <sub>2</sub>	3	9	C <sub>2</sub>	3	9
E <sub>3</sub>	4	16	C <sub>3</sub>	2	4
E <sub>4</sub>	3	9	C <sub>4</sub>	3	9
E <sub>5</sub>	4	16	C <sub>5</sub>	3	9
E <sub>6</sub>	4	16	C <sub>6</sub>	4	16
E <sub>7</sub>	4	16	C <sub>7</sub>	3	9
	∑ X <sub>1</sub> =26	∑ X <sub>1</sub> <sup>2</sup> =98		∑ X <sub>2</sub> =21	∑ X <sub>2</sub> <sup>2</sup> =65

**Table-8:** Reduction of pain on palpation on experimental and control group

$$\bar{x}_1=3.7$$

$$\sum X_1^2=98$$

$$(\sum X_1)^2=676$$

$$n_1=7$$

$$\bar{x}_2 =3.00$$

$$\sum X_2^2=65$$

$$(\sum X_2)^2=441$$

$$n_2=7$$

Calculating the degree of freedom from the formula

$$df = (n_1-1) + (n_2-1)$$

$$= (7-1) + (7-1)$$

$$= 12$$

Now 't' formula-

$$t = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{\frac{\left(\sum X_1^2 - \frac{(\sum X_1)^2}{n_1}\right) + \left(\sum X_2^2 - \frac{(\sum X_2)^2}{n_2}\right)}{(n_1 - 1) + (n_2 - 1)} \times \sqrt{\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}}$$

$$t = \frac{3.71 - 3.00}{\sqrt{\frac{\left(98 - \frac{676}{7}\right) + \left(65 - \frac{441}{7}\right)}{(7 - 1) + (7 - 1)} \times \sqrt{\left(\frac{1}{7} + \frac{1}{7}\right)}}$$

$$t = 2.485$$

**Table A2.5** Critical values of  $t$  (related and unrelated  $t$  tests) at various levels of probability. For your  $t$  value to be significant at a particular probability level, it should be *equal to or larger than* critical values associated with the  $df$  in your study (Reproduced from Lindley DV, Scott WF (1984) *New Cambridge Elementary Statistical Tables*, 10th edn. Cambridge University Press, with permission.)

df	Level of significance for one-tailed test					
	.10	.05	.025	.01	.005	.0005
	Level of significance for two-tailed test					
	.20	.10	.05	.02	.01	.001
1	3.078	6.314	12.706	31.821	63.657	636.619
2	1.886	2.920	4.303	6.965	9.925	31.598
3	1.638	2.353	3.182	4.541	5.841	12.941
4	1.533	2.132	2.776	3.747	4.604	8.610
5	1.476	2.015	2.571	3.365	4.032	6.859
6	1.440	1.943	2.447	3.143	3.707	5.959
7	1.415	1.895	2.365	2.998	3.499	5.405
8	1.397	1.860	2.306	2.896	3.355	5.041
9	1.383	1.833	2.262	2.821	3.250	4.781
10	1.372	1.812	2.228	2.764	3.169	4.587
11	1.363	1.796	2.201	2.718	3.106	4.437
12	1.356	1.782	2.179	2.681	3.055	4.318
13	1.350	1.771	2.160	2.650	3.012	4.221
14	1.345	1.761	2.145	2.624	2.977	4.140
15	1.341	1.753	2.131	2.602	2.947	4.073
16	1.337	1.746	2.120	2.583	2.921	4.015
17	1.333	1.740	2.110	2.567	2.898	3.965
18	1.330	1.734	2.101	2.552	2.878	3.922
19	1.328	1.729	2.093	2.539	2.861	3.883
20	1.325	1.725	2.086	2.528	2.845	3.850
21	1.323	1.721	2.080	2.518	2.831	3.819
22	1.321	1.717	2.074	2.508	2.819	3.792
23	1.319	1.714	2.069	2.500	2.807	3.767
24	1.318	1.711	2.064	2.492	2.797	3.745
25	1.316	1.708	2.060	2.485	2.787	3.725
26	1.315	1.706	2.056	2.479	2.779	3.707
27	1.314	1.703	2.052	2.473	2.771	3.690
28	1.313	1.701	2.048	2.467	2.763	3.674
29	1.311	1.699	2.045	2.462	2.756	3.659
30	1.310	1.697	2.042	2.457	2.750	3.646
40	1.303	1.684	2.021	2.423	2.704	3.551
60	1.296	1.671	2.000	2.390	2.660	3.460
120	1.289	1.658	1.980	2.358	2.617	3.373
	1.282	1.645	1.960	2.326	2.576	3.291

*NB* When there is no exact  $df$  use the next lowest number, except for very large  $dfs$  (well over 120), when you should use the infinity row. This is marked