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Effect of Eccentric Exercise in Tennis Elbow - An Interventional Study

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Abstract: ***Tennis elbow is an overuse injury involving the extensor muscles that originate from the lateral epicondyler region of the humerus mainly at their musculotendinosus junction. . It is very common in individuals whose jobs necessitate frequent rotary motion of the forearm (e.g., tennis players and carpenters). Tennis elbow is a syndrome characterized by an insidious onset of elbow pain brought on by wrist extension with pronation or supination and aggravated by gripping. The commonly affected arm is the dominant arm. Men and women are equally affected. This is an interventional study. The aim of the study was To study the effect of Eccentric exercise for Wrist extensors in subjects with tennis elbow. 28 patients with tennis elbow were taken for the study that fulfills the criteria. They were divided into 2 groups. Group A (Interventional Group) & Group B (Control Group). Group A was treated with Eccentric exercise and Conventional Physiotherapy and Group B was treated with Conventional Physiotherapy only. Subjects of both groups were treated for 8 weeks, 1 session / day, 6 days/ week. An assessment for outcome measures (Pain, Maximal Isometric Grip Strength & Function) was done prior to starting of the treatment and after 8 weeks of treatment. The analysis was done by using software SPSS Version 16.Wilcoxon signed rank test was used for within Group Analysis and Mann Whitney U test was used for between Group Analyses. Group A showed significant improvement in Pain (p<0.0001), Maximal Isometric Grip Strength (p<0.0001) and Function (p<0.0001) than Group B. Thus, it can be concluded that Eccentric exercise is more effective in reducing Pain, improving grip Strength and Function in patients with tennis elbow.***

Keywords: tennis elbow, eccentric exercise, ultrasound, stretching exercise

1. Introduction

Tennis elbow is one of the most common lesions of the arm. That is characterized by pain at the lateral epicondyle aggravated by resisted muscle contraction of the extensor carpi radials brevis**.** It is an overuse injury involving the extensor muscles that originate from the lateral epicondylar region of the humerus, with highest incidence is in the musculotendinous junction of the extensor carpi radialis brevis.

Many sufferers of this condition who present to clinics for treatment do not play tennis, making the term 'tennis elbow' inappropriate for them. It is generally work related or sport related pain disorder of the forearm. Repetitive extension- flexion or pronation-supination activity leads to overuse injury. Overuse is encountered when the body's physiological ability to heal lags behind the micro trauma caused by repetitive motion. It is also seen that flexibility deficiencies in the forearm extensor muscle or inadequate forearm extensor power and endurance to withstand normal forceful repetitive movements is also one of the causes of Tennis elbow.

It is very common in individuals whose jobs necessitate frequent rotatory motion of the forearm (e.g., tennis players and carpenters). It is commonly due to more quick, monotonous, cyclic eccentric contractions and wrist griping activities.

Repetitive work tasks such as computers key boarding or pulling weeds in a garden which require repeated wrist extension, twisting a screw driver, lifting heavy luggage with the palm down, tightly grasping a heavy briefcase, shaking hands, knitting, , handwriting, driving a car etc.

The commonly affected arm is the dominant arm, with a prevalence of 1–3% in the general population. The annual incidence of Tennis elbow in general practice is 4-7 cases per 1000 patients, with a peak in patients 35-54 years of age. Men and women are equally affected.

In literature, more than 40 different methods have been documented for the treatment of tennis elbow. Conventional treatment for tennis elbow has focused primarily on the pain management by anti-inflammatory medication, ultrasound, phonophoresis or iontophoresis. Various treatments have been attempted for tennis elbow including corticosteroid injection, drug therapies, laser, electrical stimulation, ergonomics, counterforce bracing, acupuncture, and splintage. Surgical treatment is indicated in 5–10% of patients who did not improve from their symptoms with conservative treatment approach.

Recently, isolated eccentric training was also shown to be effective in treating chronic lateral epicondylosis. Eccentric exercise involves dynamic loading of a muscle beyond its force-producing capacity, causing physical lengthening of the muscle as it attempts to control the load, as when lowering a weight.

Eccentric actions are still showing greater force values than Concentric. Although the reasons that may explain these discrepancies are still not well understood, higher maximal forces developed during eccentric contractions seems to be related with muscle viscoelastic properties associated with motor unit activation. However, interpretation of these results should be done with caution since variables like exercise type and participants characteristics may influence the outcomes.

2. Methodology

28 patients both male and female between the ages of 30-50 years, with unilateral side (dominant side) tennis elbow, participated in the study that were referred to an outpatient physical therapy clinic for evaluation and interventions. Patients were included in the study if there is local tenderness on palpation over ECRB tendon at the lateral epicondyle and Tennis elbow pain > 6 weeks at the time of presentation and patients who diagnosed with tennis elbow by medical expert and also Patients whose ability to understand Patient rated tennis elbow scale and Visual Analogue Scale. Subjects, who have any injury or disease around the shoulder, elbow & wrist on affected side, cervical radiculopathy, Local steroid injections and any neurological deficits, are excluded from the study. A predetermined schedule of conventional assignments to treatment and control groups was followed.

- The protocol for this study was approved by the Govt. Physiotherapy College, Civil Hospital, Ahmadabad.
- After patients signed consent form to participate in the study, they were conveniently assigned to a interventional and control group.
- There is no financial burden on the patients.
- Ethical approval was taken for the present study from the institutional ethics committee.

3. Procedure

Patients with unilateral tennis elbow pain were assessed for pain, Grip strength and function before and after the treatment. Pain was measured with VAS scale, grip strength was measured with jammer hand held dynamo meter and function was measured with PRTEE (patient rated tennis elbow evaluation).

Subjects in the interventional group received eccentric exercise and conventional physiotherapy exercise which includes active exercise, stretching exercise and ultrasound therapy.

Subjects in control group received conventional treatment only.

3.1 Exercise program

1) Eccentric exercise

Eccentric strengthening exercise was performed with free weights which were decided by the 10 RM (repetition maximum) with patient in the seated position with full elbow extension, forearm pronation and maximum wrist extension. From this position, the patient slowly lowers wrist into flexion for a count of 30, use the contra lateral hand to return the wrist to maximum extension. Patients were instructed to continue the exercise even when they experience mild discomfort and to stop the exercise if the pain worsens and becomes disabling. For whom the eccentric exercise could be performed without minor discomfort or pain, the load was increased using free weights based on the patients 10RM (Repetition Maximum).3 sets of ten repetitions were performed during each treatment with 1 minute of rest interval between each set with Frequency of once in a day, 6 days/week for duration of 8 weeks.

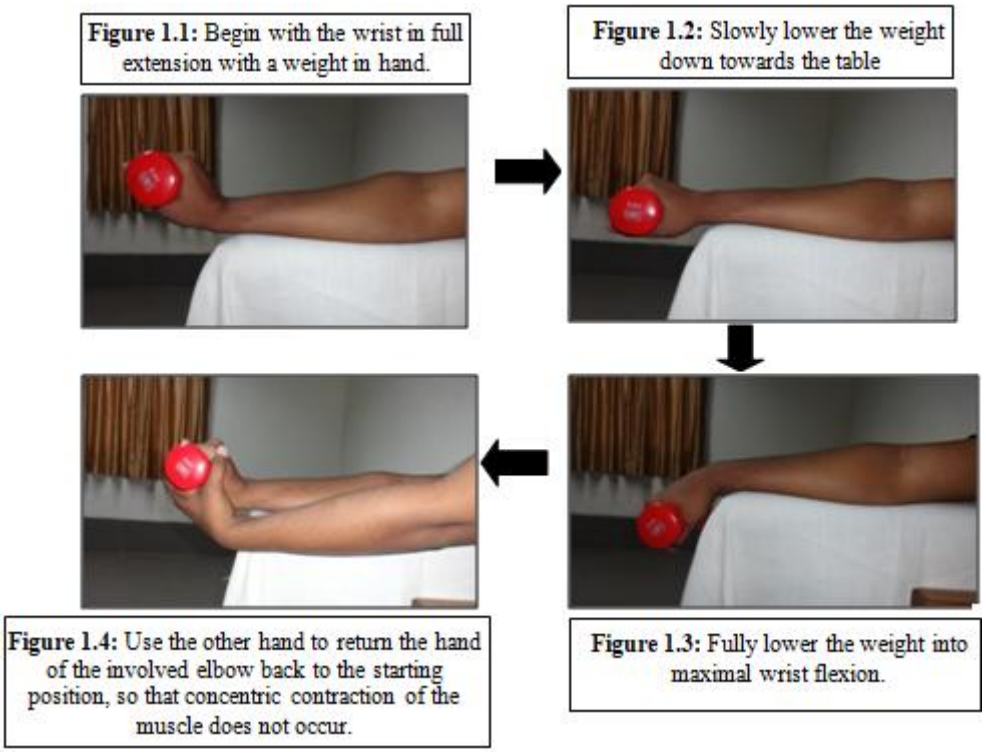


Figure 1: Eccentric Exercise

Ultrasound Therapy Procedure:

Ultrasound therapy was given around the origin of extensor carpi radialis brevis on Lateral Epicondyle of affected elbow with forearm in 90 degree of flexion with full support of pillow beneath it. Treatment was in a pulsed mode with an on: off ratio of 1:4 and a frequency of 1 MHz

and will be given using ultrasonic coupling medium. The intensity given was 1 W/cm^2 and treatment time for 8 minutes during the course of treatment.

Figure 2: Ultrasound therapy

Stretching Exercise

Subject in supine lying position. Static stretching to forearm extensors was applied slowly with the elbow in extension, forearm in pronation, wrist in flexion and ulnar deviation according to patient's tolerance and for wrist flexors, supinate the forearm, extend and radially deviate the forearm. This position should be held for 30–45 seconds with 3 sets of 6-10 repetition with 3 minutes rest interval.

Figure 3.1: Stretching of wrist extensors

Figure 3.2: Stretching of wrist flexors

4: Active range of motion exercise

Active range of motion exercise was given with patient in supine position with elbow supported on plinth. Patient was asked to move the wrist in flexion and Extension in full range with 3 sets of 10 repetitions. Speed and rhythm was slow at starting of exercise and was increased according to tolerance of the patient.

Figure 4.1: Active ROM exercise of wrist flexion

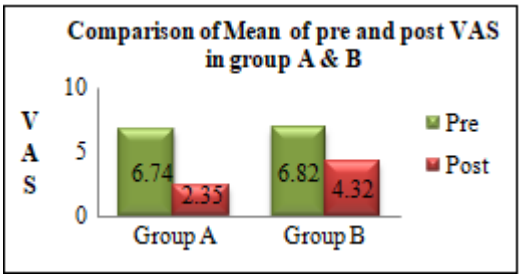
Figure 4.2: Active ROM exercise of wrist extension

4. Results

28 patients were conveniently divided into 2 groups, Interventional group and Control group with each having 14 subjects. Statistical analysis was done by using SPSS V.16. Wilcoxon Signed Rank Test was used for within group analysis and Mann- Whitney U test was used for between group analysis.

Table 1: Shows mean difference between Pre and Post pain score as on VAS in group A and B (Wilcoxon Signed Rank Test)

Groups	Pre treatment		Post treatment		W value	P value
	Mean	±SD	Mean	±SD		
Group A	6.74	1.01	2.35	0.78	105	0.001
Group B	6.82	0.96	4.32	0.75		0.001

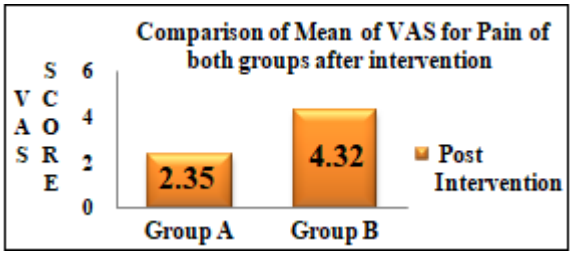


Graph 1: Shows Mean pain score (VAS) of Group A and Group B before and after the intervention

For Group A & B, within group comparison with Wilcoxon Ranked Sign Test yielded p - Value 0.001 and W= 105 (T=0.00, n=14) in both groups, indicative of significant difference. Both the groups improved significantly in terms of pain after intervention.

Table 2: Showing mean change in VAS for both the group after intervention (Mann -Whitney U Test)

Groups	Mean of Post treatment score	±SD	U value	p value
Group A	2.35	0.79	2.50	0.0001
Group B	4.32	0.73		

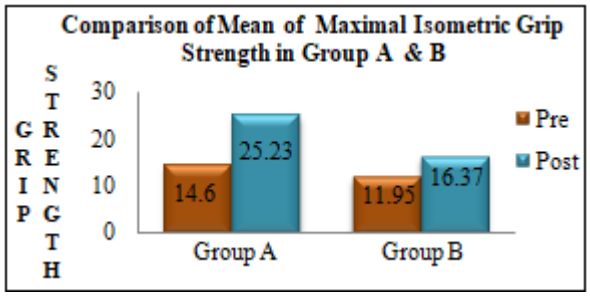


Graph 2: Shows Mean of VAS for pain of both groups after intervention

The two-tailed Mann-Whitney U Test yielded p value is 0.0001, indicative of significant difference, U=2.50. Study group receiving Eccentric exercise and conventional exercise improved much better than conventional therapy alone in terms of Pain.

Table 3: Shows mean difference between Pre and Post Maximal Isometric Grip strength in group A and B (Wilcoxon Signed Rank Test)

Groups	Pre treatment		Post treatment		W value	P value
	Mean	±SD	Mean	±SD		
Group A	14.06	2.56	25.23	7.33	-105	0.001
Group B	11.95	2.63	16.37	2.98		0.001

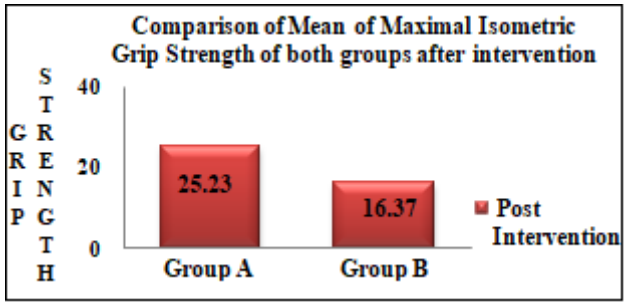


Graph 3: Shows Mean score of grip strength in Group A and Group B before and after the intervention

For Group A & B, within group comparison with Wilcoxon Ranked Sign Test yielded p- Value 0.001 and W= -105 (T=0.00, n=13) in both groups, indicative of significant difference. Both the groups improved significantly in terms of grip strength after intervention.

Table 4: Showing Mean change in Maximal Isometric Grip Strength in both the group after intervention (Mann - Whitney U Test)

Groups	Mean of Post treatment score	±SD	U value	p value
Group A	25.23	8.42	1.00	0.0001
Group B	16.37	3.02		

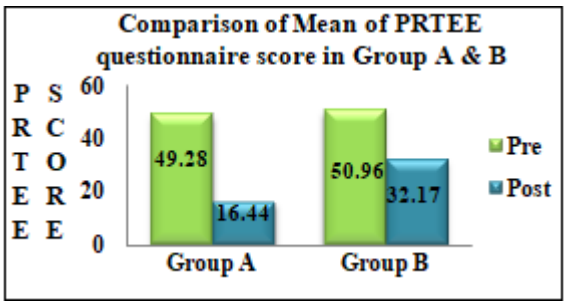


Graph 4: Shows Mean of Maximal Isometric Grip Strength of both groups after intervention

The two-tailed Mann-Whitney U Test yielded p value is 0.0001, indicative of significant difference, U=1.00. Study group receiving Eccentric exercise and conventional exercise improved much better than conventional therapy alone in terms of Maximal Isometric Grip Strength.

Table 5: Shows mean difference between Pre and Post PRTEE questionnaire score in group A and B (Wilcoxon Signed Rank Test)

Groups	Pre treatment		Post treatment		W value	P value
	Mean	±SD	Mean	±SD		
Group A	49.28	8.23	16.44	5.44	105	0.001
Group B	50.96	8.02	32.17	7.06		0.001

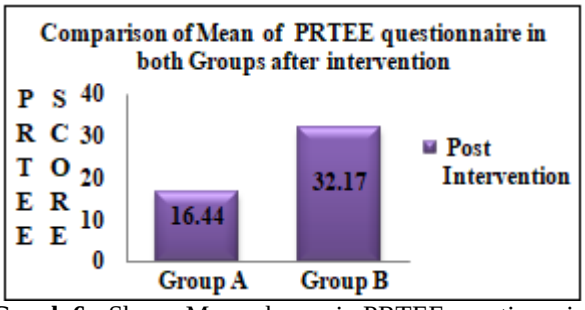


Graph 5: Shows Mean score of PRTEE questionnaire in Group A and Group B before and after the intervention

For Group A & B, within group comparison with Wilcoxon Ranked Sign Test yielded p Value 0.001 and W=105 (T=0.00, n=13) in both groups, indicative of significant difference. Both the groups improved significantly in terms of function after intervention.

Table 6: Showing mean change in PRTEE questionnaire score in both the groups after intervention (Mann -Whitney U Test)

Groups	Mean of Post treatment score	±SD	U value	p value
Group A	16.44	5.48	8.00	0.0001
Group B	32.17	6.85		



Graph 6: Shows Mean change in PRTEE questionnaire score in both the groups after intervention

The two-tailed Mann-Whitney U Test yielded p value is 0.0001, indicative of significant difference, U=8.00. Study group receiving Eccentric exercise and conventional exercise improved much better than conventional therapy alone in terms of Function.

5. Discussion

The goal of the present study was to find out the additional effect of Eccentric exercise on Pain, Maximal Isometric Grip Strength and Function in subjects with Tennis elbow.

The major findings of the study were that the patients undergone Eccentric exercise gained significantly greater improvement in Pain, Maximal Isometric Grip Strength and Function as compared to the patients undergone Conventional physiotherapy alone.

The Eccentric Exercise program introduced in this study proved to be an effective method of treating chronic lateral epicondylosis. All outcome measures for chronic lateral epicondylosis were markedly improved with the addition of an Eccentric wrist extensor exercise to standard physical therapy, compared with physical therapy without the isolated eccentric exercise. This exercise with the use of dumbbells provides a practical means of adding isolated eccentric training to the treatment of chronic Tennis elbow. A prescription of 3 sets of 15 repetitions daily for approximately 8 weeks appeared to be an effective treatment in the majority of patients.

It has been theorized that **Eccentric Exercise may inhibit** the production of agents responsible for producing pain in tendinosis. Tendinosis pain is also associated with **Neovascularization.** Eccentric exercise may halt the growth of blood vessels in tendinosis and subsequently relieve some of the associated pain.

Normal tendons and ligaments consist mostly of Type I collagen, with smaller amounts of Type III collagen. When tendinosis was developed, some of collagen is injured and breaks down. **In chronic tendinosis** the body is not able to repair the collagen properly. The tenocytes cultured from tendinosis continue to produce abnormal collagen outside of the body; the tenocytes produced collagen with abnormally high Type III to Type I ratios.

Eccentric training was found to **increase collagen synthesis**, whereas this was unchanged in the healthy tendons. Specifically there was increased peritendinous Type I collagen, which is the main type of collagen in normal tendons, and this occurred without a corresponding increase in collagen degradation. These changes corresponded with a **decrease in pain levels**. **Eccentric exercise may increase the mass of the tendon** because of the enhanced deposition of type I collagen. The stimulation of type I collagen production may be of particular benefit because fibroblasts from areas of tendinosis normally synthesize a greater proportion of mechanically inferior type III collagen than their healthy counterparts. Thus, Eccentric exercise may serve to strengthen the tendon and protect it from subsequent overuse.

It was claimed that **Eccentric Training results in tendon strengthening by stimulating mechanoreceptors** in tenocytes to produce collagen, which is the key cellular mechanism that determines recovery from tendon injuries. In addition, eccentric training may induce a response that normalizes the high concentrations of glycosaminoglycans. It may also improve collagen alignment of the tendon and stimulate collagen cross-linkage formation, both of which **improve tensile strength of tendon**.

Mechanical loading during Eccentric exercise accelerates tenocytes metabolism and **may speed repair**.

Additionally characteristics of a **patient's occupation** affect the ability to work. Different types of work in PRTEE questionnaire noted within each group was important. In the experiment group, significant improvement occurs in functional outcome. Hence improvement in ability to do their usual work occurs than control group.

Literature suggests that **Stretching Exercises** are the main components of exercise programme, because tendons must **not only be strong but also flexible**. The positive effects of exercise program for tendon injuries may be attributable to the effect of stretching and strengthening exercise, with a lengthening of the muscle-tendon unit and consequently less strain experienced during joint motion and the effects of loading within the muscle-tendon unit, with hypertrophy and **increased tensile strength of the tendon**.

According to CA Speed (2001) pain relief by Ultrasound occurs by directly influencing the transmission of painful impulses by eliciting changes within the nerve fibers and elevating pain threshold, whereas indirect pain reduction occurs as a result of increased blood flow and increased capillary permeability to the affected area.

Ultrasound has a thermal effect also. These are changes within the tissue as a direct result of elevation of temperature of ultrasound. Heat production is related to the amount attenuation of the sound waves in the tissues. The process involved in attenuation & scattering creates friction between the molecules, resulting in temperature increase. Mild heating can also have the effect of reducing pain and muscle spasm and promoting healing process. Thermal & Non thermal effects are not exclusive to each other.[31]

Ultrasound accelerated fibrinolysis, stimulation of macrophage-derived fibroblast mitogenic factors, heightened fibroblast recruitment, accelerated angiogenesis, increased matrix synthesis, denser collagen fibrils, and increased tissue tensile strength. Ultrasound promotes and accelerates tissue healing and repair.

6. Conclusion

The result of the present study of Eccentric exercise on tennis elbow shows **improvement** in terms of pain, isometric grip strength and function.

Hence, it can be concluded that, Eccentric exercise along with Conventional physiotherapy is more effective in improving Pain, Maximal Isometric Grip strength and function in patients with tennis elbow.

7. Acknowledgment

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