

# Extracorporeal Shock Wave Versus Interferential Current in Tennis Elbow

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## ABSTRACT

**Objective:** The purpose of this study was to compare between the effects of Extracorporeal Shock Wave Therapy (ESWT) and Interferential Therapy (IFC) in improving pain intensity, disability and grip strength in patients with Tennis Elbow (TE).

**Setting:** A physical therapy outpatient clinic.

**Participants:** Seventy-two participants with TE completed the program and were randomly assigned into three groups. Pain Duration was more than 12 weeks.

**Interventions:** Group 1 (n=24, mean age=40.41±3.91 years) received ESWT and exercises. Group 2 (n=24, mean age=44.72±7.10 years) received IFC and exercises. Group 3 (n=24, mean age=49.01±3.61years) received exercises. All subjects received three visits a week for four weeks.

**Materials:** Visual analog scale, the disabilities of the arm, shoulder and hand questionnaire and the hand dynamometer were used to measure pain intensity, disability and grip strength before and after 4 weeks of intervention.

**Results:** There were statistically significant improvements in all dependent variables. Also, subjects who received ESWT and exercises had the most significant effects. ESWT may be more effective than IFC in treating TE by reducing pain intensity, disability and increasing grip strength.

**Conclusion:** ESWT improved pain, function and disability better than IFC in patients with TE.

## Introduction

Tennis Elbow (TE) encompasses pain and tenderness due to overuse or injury of the extensor wrist tendons [1]. It is a degenerative rather than inflammatory tendinopathy causing persistent elbow pain [2]. Moreover, TE usually affects 4-7 per 1000 individuals [3]. A typical episode lasts 6-24 months and recurrence is common. They also reported that conditions that are not resolved within six months of the onset, may need surgical interventions. Modalities include but are not limited to acupuncture, splinting, therapeutic exercises, shock wave therapy, laser, ultrasound, transcutaneous electrical nerve stimulation, manipulation, and manual therapy [4,5]. Unfortunately, there is no consensus on the optimum intervention strategy for TE. As such, research for new effective interventions for TE is warranted. Extracorporeal Shock

Wave Therapy (ESWT) is used to treat many musculoskeletal disorders such as plantar fasciitis, calcific tendinitis of the shoulder, epicondylitis, patellar tendinopathy, Achilles's tendinopathy, non-union and delayed union of long bone fracture [6]. ESWT may impede progression of OA, improve function, and depress chondro protective effects in animals [7,8]. A few researchers elucidated that ESWT reduced pain and improved knee functions in patients with knee OA [9,10]. Therefore, ESWT has been suggested effective for TE. Interferential Current (IFC) has been used for treating musculoskeletal disorders for its analgesic, anti-inflammatory, sympatholytic, local vasodilating, and muscle stimulating effects [11]. IFC is also used to reduce pain in sports injuries, arthritis, low back pain, Osgood-Schlatter disease, rheumatoid arthritis,

and muscular pain [12]. However, there has been little research comparing between ESWT and IFC in patients with knee OA. Also, little is known about the efficacy of these two therapies in treating TE. The purpose of this study was to determine the effectiveness of ESWT compared with IFC for patients with TE.

## Methods

### Design

This study was a randomized controlled trial with subjects randomly assigned to one of three intervention groups:

- a) Group 1 received ESWT and exercises,
- b) Group 2 received IFC and exercises, while
- c) Group 3 received only exercises.

The examiner made group comparisons at the initial visit and after 4 weeks. The duration of the interventions was 4 weeks per participant. Each participant received one session per week for 4 weeks and 3 sessions per week for four weeks in the second group. The therapist who did the testing and data analyses was not aware of group allocation. However, the treating therapist was aware of group allocation.

### Participants

Eighty-eight participants with TE who visited the outpatient setting for a minimum of 3 months pain duration participated in the study. All participants signed informed consent forms detailing procedure and risks involved with participating in this research. Inclusion criteria included subjects with lateral elbow and forearm pain that lasted for more than six weeks. Subjects had a medical diagnosis of TE by a physician. Subjects experienced less pain during resistance of supination with the elbow in 90° of flexion rather than in full extension. Patients also had to complain of increased tenderness upon extending the wrist against resistance with the forearm in supination. The exclusion criteria for the study were bilateral TE, systemic metabolic diseases, elbow surgery, medial epicondylopathy, radial nerve entrapment, carpal tunnel syndrome, chronic inflammatory and neoplastic disease; other criteria included: radial tunnel syndrome, cervical radiculopathy, thoracic outlet syndrome, dysfunction in the shoulder, and treatment with corticosteroid or local anesthetic injection in the previous three months. Also, subjects with any contraindication for the physical therapy modalities were excluded. Participants were asked to refrain from receiving other forms of physical therapy and analgesics during the study.

### Measurements

A 10<sup>cm</sup> Visual Analog Scale (VAS) was used to measure pain intensity during rest, activity of the painful elbow, and nighttime. It has an excellent test-retest reliability of 0.95 [13]. The disabilities

of the arm, shoulder and hand (DASH) self-report questionnaire was also used to measure disability. It is a valid and reliable 30 items questionnaire where 1 point was given for performance of the specific activity without difficulty and 5 points for disability [14]. The total score ranged between 30 (best) and 150 (worst). Handheld dynamometer (Jamar, J.A. Preston Co., MI) was also used as a valid and reliable tool to measure hand grip strength [15]. The assessor used the mean of three measurements. The Shock Master was used to produce shock waves. It is a low to medium-energy range. Evotron RFL0300 (Swiss Tech Medical AG, Switzerland) was used to deliver shock waves. It has a depth of penetration between 0 to 30 mm. Pulse rates were 60, 120, 180, 240 impulses per minute. Also, the SONOSTIM (Class 1-type BF, Norm: 601-1) was used to produce IFC.

### Interventions

Patients signed an informed consent before data collection. The research therapist examined all participants to check for inclusion and exclusion criteria and was not aware of the intervention assignments. He tested the participants at both the baseline and final sessions. Another therapist performed all interventions. All subjects received three sessions per week for four weeks. Patients in the first group received a total of four sessions of ESWT. They received one session a week for four weeks. The patient was placed in supine lying position with knees bent to 90°. The therapist applied 1,000 pulses of shockwave with an energy dose of 0.05 mJ/mm<sup>2</sup>. He directed it to over the common extensor tendon and the other electrode proximal to the olecranon. Participants in the second group received the IFC. The therapist placed the four electrodes around the elbow so that each channel runs perpendicular to the other and the two current crosses at a midpoint in the center of the elbow.

He adjusted the intensity in the tactile sensation threshold. IFC was conducted with following characteristics: isoplanar vector field with 6:6 sweep mode; carrier frequency 4 kHz; beat frequency 100 Hz; and sweep frequency 150 Hz. The duration of the stimulation was 20 minutes. The therapist increased the current amplitude until the participant felt a strong but comfortable tingling. He increased the intensity until the participant reached the previous sensation in case of sensory habituation. Participants in the third group received therapeutic exercises. Also, participants of the first and second group received the same therapeutic exercises. Exercises were progressive eccentric exercises of the wrist extensors and stretching exercises of the extensor carpi radialis brevis for 20 minutes. Eccentric exercises were done by asking the subject to put the elbow in extension, forearm in pronation, the wrist in extension, and the hand hanging over the edge of the bed.

Then, the therapist asked the subject to bend the wrist slowly while counting to 30 and then return to the starting position with the assistance of the other hand. The therapist asked the subjects

to exercise within their pain tolerance. Stretching exercises were done by asking each subject to maintain the elbow in full extension, forearm in full pronation, and the wrist in flexion and ulnar deviation within pain tolerance for 45 seconds. The therapist asked participants to record frequency and repetition of each exercise to measure adherence to exercises. The therapist asked each subject to avoid activities that may irritate the elbow such as shaking hands, grasping, or lifting. The therapist advised the subjects not to take pain medications one week before the visits. The therapist also instructed the subjects to do the home exercises on the days they do not come to the clinic.

### Data Analysis

All statistical tests were performed using SPSS for windows

Version 20 (Chicago, IL, USA). Mann-Whitney U test was used to compare between both groups. Kruskal-Wallis test was also used to analyze differences among the groups.

### Results

Eighty-eight participants eligible for inclusion visited the clinic within the study period. Seventy-two participants completed the study and were randomly assigned to one of the three groups:

- ESWT and therapeutic exercises [14 men, 10 women]
- IFC and therapeutic exercises [11 men, 13 women] and
- Therapeutic exercises [10 men, 14 women]. Patient flow through the study is shown in the CONSORT flow chart (Figure 1).

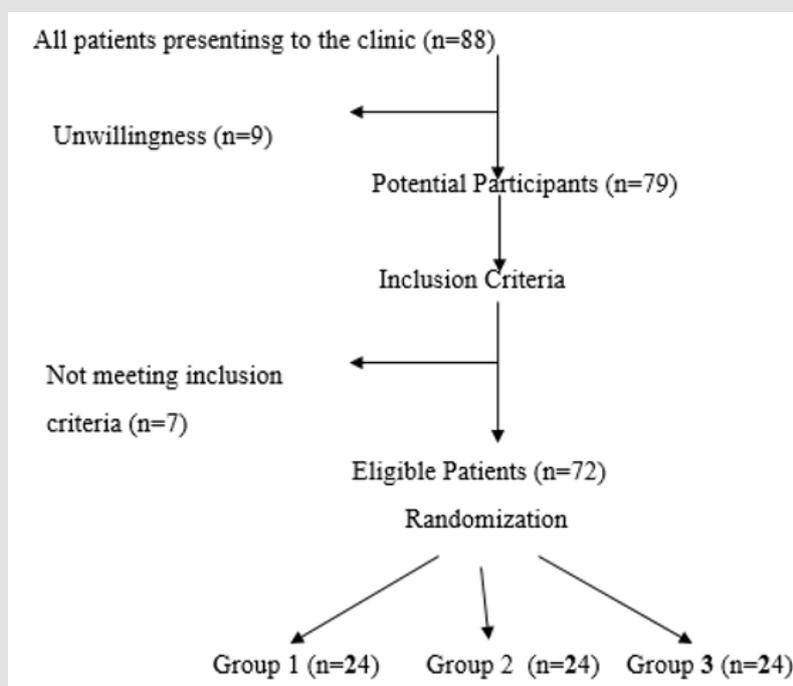


Figure 1: Flow chart detailing the study.

The mean age of the subjects was about 42 years, and the mean duration of TE pain was about 3.75 months. TE was in the dominant arm in 90% of patients. There were no statistically significant differences among the groups for age, dominant hand and symptom duration ( $p > 0.05$ ). The author also did not find significant differences for baseline values of pain (during rest, activity, or nighttime), DASH and grip strength among the groups

(Table 1). There were statistically significant differences for the values of pain (during rest, activity, nighttime), disability and grip strength on the epicondyle among all groups at four weeks (Table 2). Pain intensity, disability and grip strength improved in all groups at the end of the intervention. Patients in Group 1 had lower pain during rest, activity, and nighttime, disability and higher grip strength when compared with Group 2 or Group 3 subjects.

**Table 1:** Age, pain duration and outcome parameters at baseline for both groups.

Dependent Variables	Group	Mean $\pm$ Standard deviation	P
Age	1	40.41 $\pm$ 3.91	0.085
	2	44.72 $\pm$ 7.10	
	3	49.01 $\pm$ 3.61	
Pain duration (months)	1	4.11 $\pm$ 1.07	0.241
	2	3.22 $\pm$ 1.60	
	3	3.92 $\pm$ 2.77	
Rest pain (VAS)	1	4.24 $\pm$ 3.89	0.694
	2	3.26 $\pm$ 2.57	
	3	4.74 $\pm$ 5.62	
Activity pain (VAS)	1	2.27 $\pm$ 2.47	0.44
	2	4.25 $\pm$ 3.31	
	3	4.32 $\pm$ 2.91	
Night pain (VAS)	1	7.23 $\pm$ 2.45	0.053
	2	6.48 $\pm$ 1.65	
	3	6.37 $\pm$ 3.18	
DASH	1	44.16 $\pm$ 10.49	0.47
	2	52.24 $\pm$ 7.24	
	3	65.16 $\pm$ 8.31	
Grip Strength	1	38.60 $\pm$ 09.22	0.62
	2	34.72 $\pm$ 10.32	
	3	33.53 $\pm$ 10.32	

**Table 2:** The changes of rest pain, activity pain, night pain, DASH and grip strength within the groups after the interventions.

	Group 1		Group 2		Group 3		P
	Before	After	Before	After	Before	After	
Rest pain (VAS)	4.32 $\pm$ 3.75	1.05 $\pm$ 2.15*	3.25 $\pm$ 2.26	1.74 $\pm$ 1.52*	4.64 $\pm$ 5.11	2.03 $\pm$ 1.41*	0.001
Activity pain (VAS)	3.41 $\pm$ 2.71	0.34 $\pm$ 1.63*	3.36 $\pm$ 3.21	1.24 $\pm$ 1.12*	4.52 $\pm$ 2.60	2.41 $\pm$ 2.01*	0.013
Night pain (VAS)	7.21 $\pm$ 2.34	2.58 $\pm$ 1.24*	5.26 $\pm$ 1.42	3.17 $\pm$ 0.64*	6.37 $\pm$ 3.62	3.18 $\pm$ 2.21*	0.0001
DASH	45.13 $\pm$ 10.17	35.16 $\pm$ 10.14*	52.11 $\pm$ 6.21	53.36 $\pm$ 6.12*	58.31 $\pm$ 7.31	51.32 $\pm$ 8.01*	0.001
Grip strength	33.66 $\pm$ 11.12	42.73 $\pm$ 11.13	36.32 $\pm$ 11.12	42.18 $\pm$ 11.13	35.63 $\pm$ 10.12	38.01 $\pm$ 11.05	0.011

Note: Data presented as mean  $\pm$  SD.

\* Significant p 0.05

## Discussion

The purpose of this study was to compare between the efficacy of ESWT and IFC in terms of pain intensity, disability and grip strength in patients with TE. The results showed that ESWT and IFC were effective for improving pain, disability and grip strength. They also demonstrated that patients who received ESWT had the most favorable outcomes. ESWT consists of bursts of the same alternating high frequency current, interspersed with a cut off phase, during which heat can be dissipated in the tissues. ESWT uses electrical energy to direct a series of magnetic pulses through injured tissues whereby each magnetic pulse induces a tiny electrical signal that stimulates cellular repair [16]. ESWT is

effective for healing soft-tissue wounds; suppressing inflammatory responses at the cell membrane level to reduce pain and increase mobility [16]. The mechanism of this method is not yet completely understood. ESWT may alleviate pain by over stimulating the axons (gate-control theory) and increasing the pain threshold [17]. Also, it may induce the release of endorphins [18]. Besides, it may reduce substance P in the target tissue and the dorsal root ganglia cells and selective destruction of unmyelinated nerve fibers within the focal zone of ESWT [19].

IFC is commonly used to reduce discomfort, muscle incitement, increases blood flow and decreases of edema [20]. Various authors reported that IFC are successful in the reduction of pain in various

musculoskeletal issues [21-23]. Its produces low-recurrence (0–250 Hz) give impact inside the tissue through the obstruction of 2 higher freq. (4000 Hz) and acts fundamentally on the sensitive (nerve) tissues with the most grounded impacts prone to be those which are an immediate consequence of such stimulation [20]. IFC has been shown to increase production of endogenous opioids, at a spinal level to hinder the reduce pain transmission [22-24]. In this study, patients in group 2 (IFC and conservative program) showed improvement in all parameters. There is widespread use of electrical stimulation to reduce pain. However, there are a few research for using IFC. IFC is based on the creation of a low frequency current effect in deep tissues by two medium-frequency alternative currents at different frequencies. Since the skin resistance decreases with the increasing current frequency, IFC may exert its effect on deeper tissue planes without patient discomfort [25].

IFC allows an increased dosage applied in a greater depth because of the body tissue's better tolerance of medium-frequency currents. IFC could stimulate local nerve cells that can have an analgesic effect due to blocking the transmission of the pain signals or by stimulating the release of endorphins [26]. IFC has been used for patients with low back pain and OA. However, Fuentes et al. conducted a meta-analysis and found that IFC is not better than placebo or any other modality when presented as an isolated treatment in musculoskeletal pain [27]. They proposed that therapists may use it as part of a multi-modal treatment plan. Therefore, the author used exercises along with the IFC for participants with TE. Our results were supported by Zhou and associates who found that ESWT reduced pain and neuralgia in diabetic rats [28]. Our results also agreed with those of Yan et al. who conducted a meta-analysis comparing between ESWT and ultrasound in TE [29]. Yan et al reported that the ESWT had significant difference in decrease of pain values measured by visual analogue scale at 1 month, 3 months, and 6 months follow-ups, and raised grip strength compared with the group that received ultrasound [29]. The findings of this trial also agreed with those of Mohamed and Ammar who demonstrated that the group that received ESWT had the greatest improvement in pain intensity, cervical range of motion and neck disability in patients with Mechanical neck pain [30].

This was also supported by the findings of Ji et al. [31] who concluded that ESWT was effective in reducing pain and increasing pressure thresholds in 22 patients with myofascial pain syndrome of the upper trapezius. Results of this study also agreed with those of Jeon et al. [32] who concluded that ESWT and transcutaneous electrical nerve stimulations were equally effective in improving pain and pressure threshold in 30 patients with myofascial pain syndromes of the upper trapezius. Moreover, the results of this study concurred with those of Ozkut et al, Rompe et al, Rasmussen et al and Razavipour et al. Ozkut et al found that the mean grip strength of the affected extremities was 82.1% of the normal side

at the end of 12 months after treatment with ESWT. At final follow-up, 75% stated that the treatment was beneficial [33]. Whereas Rompe et al conducted a placebo-controlled trial in tennis elbow of at least 12 months' duration [34]. In another study, Rasmussen et al. found that ESWT reduced pain and improved function in patients with chronic Achilles' tendinopathy [35]. Razavipour et al. demonstrated that the ESWT reduced the mean score of VAS pain score from  $7.25 \pm 1.54$ cm before treatment to  $2.76 \pm 2.08$ cm after the end of treatment ( $P < 0.001$ ). Moreover, it also reduced the Quick Dash score significantly from  $25.20 \pm 5.31$  before treatment to  $8.69 \pm 8.32$  after the treatment ( $P < 0.001$ ) [36]. The present study findings were also supported by Ahadi et al 2019 who concluded that ESWT improved pain intensity, pain threshold, grip strength and function in TE [37].

The present study findings agreed with those of Cheing et al. who found significant improvement in patients with frozen shoulder [38]. Also, the results are in accordance with those of Burch et al. who reported a reduction of more than 20% in the WOMAC pain subscale in patients with Osgood Schlatter disease who received IFC and muscle stimulation after 2 weeks of treatment [39]. Burch et al. said that IFC provides better pain relief and allows the underlying OA condition to be more comfortably treated with patterned muscle stimulation. Furthermore, Atamaz and colleagues showed that IFC would reduce pain more effectively than other electrotherapy modalities [40]. The beneficiary effects of IFC in improving pain and disability have been evaluated in some other disease and have been demonstrated [41,42]. On the other hand, our results did not concur with those of Nazligul et al. who failed to find any additional benefit for IFC in treating subacromial impingement syndrome [43]. Our results also disagreed with Gundog et al. who stated that IFC were not effective for pain relief in Osgood Schlatter disease of the knee at one month and 3 months follow up [44]. The author results also agree with those of Al Sawalha who proposed that IFT improves outcomes of patients with Tennis elbow [45]. The results also were supported by Alborno et al. who found significant between-group differences were found for IFC on pain perception by VAS ( $p = 0.032$ ) and disability level by ODQ ( $p = 0.002$ ) in chronic low back. All subjects received up to 10 treatment sessions of 25 minutes over a two-week period and completed the intervention and follow-up [46].

This study has some limitations. Placebo effects were not evaluated since no control groups were included in this research. The sample size was relatively small to detect differences between groups. Further, the follow-up period was short to demonstrate whether the improvements in each group are sustained in long-term. The author did not evaluate parameters such as intensity and treatment intervals affecting the treatment effects. Also, the daily living activities of the patients could not be completely controlled. Last but not least, objective laboratory tests of lactic acid, prostaglandin E, substance P and akinin were not taken. Based

on the results of this randomized, clinical trial, ESWT may be more effective than IFC in reducing pain and disability and improving function in patients with TE.

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## Competing Interest

The author declares that he has no competing interests.

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