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Original Research Article

EFFECTS OF IONTOPHORESIS VERSUS LOW-LEVEL LASER ON PAIN AND GRIP STRENGTH IN TENNIS ELBOW: AN EXPERIMENTAL COMPARATIVE STUDY

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ABSTRACT

Background: Iontophoresis and LASER therapy have been beneficial in the treatment of tennis elbow. This study was undertaken considering the dearth of literature available to compare the effects of Iontophoresis and Laser therapy.

Materials and mehodology: 60 subjects were randomly assigned to 2 groups. Group A was given Iontophoreis with 0.04% of dexamethasone sodium phosphate and group B was given LASER with a wavelength of 607nm and energy density of 7.2J/cm2. Pain on VAS and grip strength with a handheld dynamometer was assessed pre and post 6 treatment sessions.

Results: Both the groups showed improvement in pain and grip strength ($p<0.05$). However, Iontophoresis with 0.04% dexamethasone sodium phosphate showed better results.

Conclusion: Iontophoresis with 0.04% dexamethasone sodium phosphate and lowlevel LASER both are effective treatment modalities for the treatment of tennis elbow <6 weeks. However, Iontophoresis showed better improvement than LASER.

KEY WORDS: Tennis Elbow, Iontophoresis, LASER, Pain, Grip Strength.

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INTRODUCTION

The prevalence of tennis elbow in general population is approximately 1-1.3% in males and 1.1-4% in females [1]. The highest incidence of tennis elbow is associated with work related activities involving repetitive and forceful

activity of wrist extensors[2,3]. This repeated activity of wrist extensors especially the Extensor Carpi Radialis Longus (ECRL) and Brevis (ECRB) and the Extensor Digitorum (ED) can stress the musculotendinous junction and lead to tennis elbow [4,5,6].

Numerous studies have been undertaken to the most effective treatment for tennis elbow; however there has been no agreement on the most effective management [7,8]. Iontophoresis by its Greek derivative is a term used to indicate the transfer of ions into the body for therapeutic purposes. Electric current is used to promote delivery of medications and other solutions transcutaneously using DC of 0.1-0.2 mA/cm^2. Iontophoresis using corticosteroids has been recommended in the treatment of lateral epicondylitis compared to local injections namely non-invasive, painless, non-traumatic [9,10].

Low level laser therapy (LLLT) or low intensity laser therapy (LILT) have been majorly used in tissue healing and pain control [11]. There has been conflicting evidence regarding the efficacy of laser in tennis elbow [12-15]. Considering the dearth of literature available to compare the effects of Iontophoresis and Laser therapy, this study was undertaken to compare the effects of both on tennis elbow.

MATERIALS AND METHODOLOGY

An experimental comparative randomized study was conducted between 2 groups in a duration of 1 year and 6 months in a tertiary healthcare centre. 60 subjects in the age group of 20 to 50 years were included in the study. Ethical approval was obtained prior to the commencement of the study by the institutional review board. The subjects were randomly assigned into 2 groups- 30 subjects were assigned to the iontophoresis group and 30 to the group of therapeutic laser. Individuals were screened according to the following inclusion criteria: (1)Tennis elbow < 6 wks. (2) Patients willing to participate. (3) Both males and females. (4) Without pacemaker. Subjects excluded were- (1) patients with any neuro or sensory-motor deficit (2) Any other musculoskeletal impairment of the same limb (3) Cervical radiculopathy. An informed consent was taken prior to the study.

A blinded therapist assessed pain using the Visual Analogue Scale (VAS) and grip strength using the hand held dynamometer pre and post intervention in both the groups.

Iontophoresis Group A: The area to be treated was thoroughly cleaned with a gauze and alcohol wipe.

Both the electrodes were covered carefully in 6-8 folds of gauze taking care that no free threads were projecting out of the piece.

Dexamethasone sodium phosphate 0.04% was available in a 2ml vial that was emptied on the gauze piece completely.

The cathode was the active electrode and was placed over the tender area and fixed with adhesive tapes.

The inactive electrode was taped in the palmar aspect of the hand to complete the circuit. The machine was set on galvanic continuous current i.e. D.C with no reversal of polarity and cathode as active electrode.

Treatment was given for 10 minutes with amplitude not crossing 4mA. Stretching and eccentric drop down exercises were advised on day 2.

LASER Group B: Patient and the therapist wore goggles during the application of therapeutic LASER

The grid technique was used to irradiate the painful area. The probe was kept in contact with skin and LASER applied over 6 points covering the area of pain.

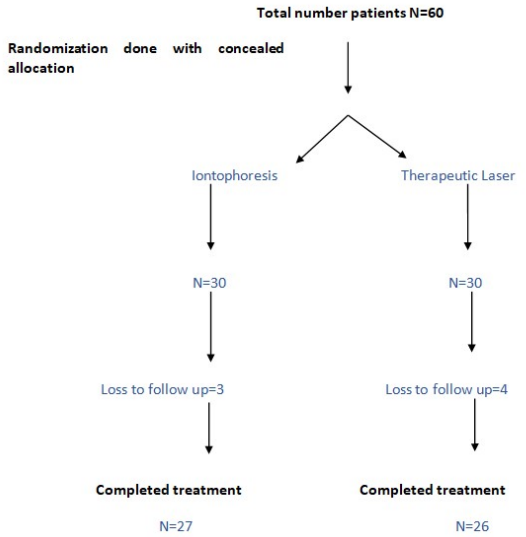
Each point was eradiated for 30 seconds so the total time for irradiation was 3 minutes.

Hence the energy density was calculated as follows:

Energy density= Energy in joules/ Spot size of treatment unit.

Thus the energy density=7.2 J/cm^2 (spot size 0.125cm^2)

The same blinded therapist again assessed the pain on VAS and grip strength with handheld dynamometer at the end of 6 treatment sessions. The exercise regimen remained same for both the groups. The patient was advised rest and avoidance of concentric activity of wrist extensors.



Characteristic	Iontophoresis	LASER
Number of patients	30	30
	Females = 23	Females = 23
	Males = 7	Males = 7
Mean Age (years)	37	35
Mean baseline VAS (cm)	6.29	6.57
Standard Deviation	1.23	1.17
Mean baseline grip strength (kg)	13.11	10.36
Standard Deviation	5.07	3.55

VAS (Iontophoresis)	Mean	Std. Deviation	P value
Pre	6.29	1.23	0
Post	0.77	0.8	

Grip Strength (Iontophoresis)	Mean	Std. Deviation	P value
Pre	13.11	5.07	0
Post	18.07	4.65	

VAS (LASER)	Mean	Std. Deviation	P value
Pre	6.57	1.17	0
Post	2.42	1.83	

Grip Strength (LASER)	Mean	Std. Deviation	P value
Pre	10.36	3.55	0
Post	12.66	4.71	

Inter Group (VAS)	Mean difference	Std. Deviation	P value
Iontophoresis	5.52	0.43	0
Laser	4.15	0.42	

Inter Group (Grip Strength)	Mean difference	Std. Deviation	P value
Iontophoresis	4.96	0.66	0
Laser	2.3	1.16	

DISCUSSION

The present study was undertaken to compare the effects of Iontophoresis with dexamethasone sodium phosphate versus therapeutic Laser in patients with tennis elbow.

There was an improvement with respect to pain in both the groups which was statistically significant $p< 0.05$ within both the groups. The within group analysis for improvement grip strength also procured similar results $p< 0.05$. However on comparing both the groups post intervention the group A: Iontophoresis with 0.04% dexamethasone sodium phosphate, showed a better result.

Reduction of pain post iontophoresis with dexamethasone sodium phosphate: Tennis elbow is usually caused by repetitive resisted activity of the wrist extensors [3]. It has been seen that repetitive resisted activity of wrist extensors leads to micro tears and overuse irritating the tendon and leading to inflammation [16]. In a study by Liebert et al, it was seen than eccentric loading of the extensor tendons gave rise to microtauma and subsequent inflammation [17].

Dexamethasone sodium phosphate is a corticosteroid; the corticosteroids are known to reduce pain by controlling inflammation [18]. Dexamethasone is a potent glucocorticoid and owing to its selective anti-inflammatory action, suppresses inflammation [19]. The suppression of inflammation is by blocking the cascade of inflammation early on by blocking the release of arachidonic acid [20].

Dexamethasone sodium phosphate was selected as it is the most studied and commonly available near the treatment centre. Also the

commercially available injectable form was of 0.04% of dexamethasone sodium phosphate in aqueous medium which was the desired composition. Thus for practical ease of administration Dex-Phos was used in the present study.

There have been studies that have evaluated the use of iontophoresis using dexamethasone sodium phosphate on tennis elbow. In a study by Nirschl et al in 2003 which was till date probably the largest trial with iontophoresis for tennis elbow demonstrated significant improvement [14]. Runeson and Haker et al found no significant improvement in iontophoresis group and hence refuted the use of corticosteroid in patients having tennis elbow [13]. Amalia et al in 2012 concluded that dexamethoasone via iontophoresis showed improvement in grip strength and had a better return to work than the baseline in lateral epiconylitis [21]. Abdelhamid et al in 2015 stated the use of 0.4% dexamethasone iontophoresis as a successful treatment modality for the treatment of tennis elbow [22].

In the present study the reduction of pain can be possibly attributed to the anti-inflammatory effect of dexamethasone sodium phosphate.

Since tennis elbow is a repetitive overuse disorder, the healing structures are stressed leading to a prolonged inflammatory response. Hence dexamethasone must have perhaps played a role in suppression of this inflammation leading to reduction of pain.

Warmth, itching, and tingling at the application site was reported by administration of dexamethasone sodium phosphate [23,24]. However none of the patients included in this study showed any such adverse reaction to ion tophoresis.

Improvement of grip strength post iontophoresis: It has been documented in several studies that grip strength reduces in patients having tennis elbow [25-27].

Gripping activities involve concentric contraction of wrist extensors to stabilize the wrist into slight extension for effective length tension relationship of the long flexors and eventually the intrinsic [28,29]. Also, since ECRB crosses both elbow and wrist, it acts eccentrically at boththe joints during lowering an object held in the hand, thus adding to the shearing stress placed on it. The eccentric compromise can lead to excessive stress and compromise in blood supply to the tendon increasing the pain during gripping.

Hence, in a patient with tennis elbow gripping activities are painful due to irritation of the inflamed extensor tendon. Thus the grip strength is reduced as compared to the normal side [30]. Secondly, inflammation causes reflex inhibition of the muscles due to the increased mechanosensitivity of afferents and the sensory units because of both the physical and chemical changes during inflammation. The sensory information can influence the motor responses by a feedback mechanism [31,32]. Thus the inhibition of common extensors due the inflammation in tennis elbow can also be a reason for the reduction in grip strength. Thirdly the psychological impact of pain also may lead to reduction of grip strength chiefly due to the apprehension or fear of pain.

The mechanism for improvement of grip strength is probably because dexamethasone sodium phosphate acts chiefly as an anti inflammatory [19,20]. The reduction in inflammation will eventually lead to reduction in pain. Thus it can be stated that the reduction in inflammation and pain can lead to improvement of grip strength with the mechanisms as discussed above. Also, there could be a reversal of the feedback causing the inhibition hence leading to better grip with that respect. Lastly reduced pain also contributes to a better function of the involved extremity and hence decreased apprehension or fear of pain. As discussed above the improvement of grip strength can be because of the above mentioned reasons, leading to a significantly improved grip post dexamethasone sodium phosphate. The number of treatments of dexamethasone iontophoresis for musculoskeletal disorders reported in the literature varies, depending on the disorder being treated, from 1 treatment session for delayed-onset muscle soreness to10 daily treatment session for shoulder girdle myofascial syndrome [33].

Reduction in pain due to LASER: Laser Therapy works on the principle of inducing a biological response through energy transfer, in that the photonic energy delivered into the

tissue by the laser modulates the biological processes within that tissue, and those within the biological system of which that tissue is a part. The Arndt-Schultz Law of Biomodulation infers that low dosages of photonic energy after a pre threshold stimulus will stimulate the biological processes, and higher dosages will inhibit them.

The wavelength at which the laser is emitted determines the effective depth of penetration within the tissue to which laser is delivered. Far-red to infra-red wavelengths (longer than 800nm) will penetrate deeper, and so are indicated for deeper acupuncture points and trigger points, and deeper tissue injuries. Visible red wavelengths (shorter than 800nm) do not penetrate as far, and are therefore more applicable to superficial tissue and treatment points [34].

The Laser unit used in the present study is a class 3A Laser with a power output of 5mW and a wavelength of 607nm as it was the unit that was available. Thus, for therapeutic effects, an energy density less <8J/cm^2 i.e. 7.2J/cm^2 was used. The grid technique was used to divide the area the painful area into 6 points for treatment. The Laser probe was kept in contact with the skin considering the advantages of the contact technique discussed below.

The contact method maximizes the irradiance or power density of the tissue surface. The light flux within the tissue is maintained so that better irradiance of the tissues is maintained according to the inverse square law. Lesser photons are reflected from the surface of the tissue. The exact mechanism of reduction of pain due to Laser is not yet clear. Anti inflammatory effect of therapeutic laser has been studied by Albertini [35] on rats showed a significant reduction in inflammation and oedema. In a study by Bjordal et al [36,37] and Aimbire et al [38] it was stated that there was reduction of pain due to the anti-inflammatory effects of Laser which stated that Prostaglandin E_2 concentrations were significantly reduced 75, 90, and 105 minutes after active LILT compared with concentrations before treatment. The above studies concluded that LILT can modulate inflammatory processes in a dosedependent manner and can be titrated to significantly reduce acute inflammatory pain in clinical settings. Photobiostimulatory effect of LILT though studied at a slightly higher frequency but within the visible radiation spectrum it can be said that a similar course of events could have occurred with 607 nm wavelength that was used and a 633nm wavelength that was studied. Karu et al suggested that a chain of signal transduction and amplification of takes place before a final photo response. The light after being absorbed by the tissues triggers a photobiological response in the respiratory chain and alters the membrane permeability which alters the Ca^{2+} flux which in turn affects the RNA and the DNA which in turn modulates cell proliferation i.e. biostimulation [39].

Accordingly Saperia used 633 nm wavelength Laser beam and demonstrated increase in collagen synthesis by activation of mRNA. Thus, acceleration of healing of the injured tissue is brought about by the photobiologic response to laser irradiation [40]. Another mechanism suggested by Walker discusses effect of Laser by stimulation of excretion of 5 hydroxy indolacetic acids which is a breakdown product of serotonin thus resulting in decreased pain due to direct absorption or stimulation of enzyme activity [41]. Thus the reduction in pain due to Laser can be due to the above discussed effects.

Improvement in grip strength: As discussed already in case of iontophoresis, the grip strength is reduced by 3 main reasons,

a) Because of pain during concentric activities of wrist extensors

b) Because of reflex inhibition due to inflammation

c) Because of apprehension of pain.

Thus it can be stated that Laser acts on improving grip strength by both actions i.e. dose dependent anti inflammatory and dose dependent bio-stimulatory. Reduction in pain and acceleration of healing of the injured tendon thus acts as a catalyst in improving the grip strength.

Comparison between Iontophoresis and LASER: The wavelength of the laser beam that was used was 607nm which is in the red zone of laser. This wavelength with said energy density i.e. 7.2J/cm^2 was effective to reduce pain and

improve grip strength individually but when compared with the iontophoresis group, the iontophoresis group was seen to better for both reducing pain and improving grip strength. The possible reasons for this could be the wavelength was probably not optimal for a marked improvement in the condition of the patient as was in the iontophoresis group. Another reason could be that the depth of penetration was not adequate for the anti inflammatory or Photobiostimulatory effect of Laser to occur at tissue level as did in dexamethasone sodium phosphate iontophoresis.

It was also observed that dominant extremity of most of the individuals was involved. It can thus be concluded that overuse of the dominant extremity lead to the occurrence of tennis elbow in this population.

CONCLUSION

Iontophoresis with 0.04% of dexamethasone sodium phosphate is effective in reducing pain and improving grip strength in patients with Tennis elbow in this study. Laser with λ 607nm and energy density of 7.2J/cm^2 is effective in reducing pain and improving grip strength in this study. Iontophoresis with Dexamethasone sodium phosphate 0.04% is a better modality to reduce pain and improve grip strength in patients with tennis elbow in this study.

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Conflicts of interest: **None**

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