Effects of Low Intensity Laser on the Healing of Sprained Lateral Collateral Ligament of the Ankle

Sherif D., BsC., PT and Balbaa A., PhD., RPT
Department of Physical Therapy for Muscloskeletal Disorders, Faculty of Physical Therapy, Cairo University.

ABSTRACT

Ankle sprain has been reported in literature as the most common injury. The ankle joint is one of the most common sites for acute musculoskeletal injuries, and because of its weight-bearing function and the construction of its articulation, the ankle is the most commonly injured among athletics. Sprain constitutes 85% of all ankle injuries. Purpose: This study was designed to evaluate the effect of low intensity (He-Ne) laser therapy on decreasing inflammation of the grade II sprain of the anterior talo-fibular ligament of the ankle joint. Low intensity (He-Ne) laser has been selected in this study because of its reported effects in relatively comparable cases. Methodology: Thirty subjects suffering from grade II ankle sprain evident in ultrasonography technique, participated in this study. They were randomly assigned into group (I) receiving low intensity (He-Ne) laser beam, and group (II) receiving sham laser beam. Subjects in both groups were evaluated pre, during and post experimentally for anterior talofibular ligament injury and its thickness by using utlra-sonography. Subjects in both groups received twelve sessions (one session every other day for four weeks). Results: Group one (I) showed, high significant difference concerning the decrease in thickness of the anterior talofibular ligament grade II sprain, in comparing pre, during, and post experimental evaluation. Group two (II) showed less significant difference concerning the decrease in thickness of the anterior talofibular ligament grade II sprain, in comparing pre, during, and post experimental evaluation. Comparison between results achieved in both groups showed highly significant difference in decreasing the thickness of the talofibular ligament grade II sprain in favor of group one.

Key wards: *Laser, ankle, ligament, healing.*

INTRODUCTION

Since the ankle joint bear body weight and is important for walking, it must be both stable and mobile, excessive inversion stress is the common cause of ankle lateral collateral ligaments sprain for tow anatomic reasons. The medical malleolus is shorter than the lateral one and the talus can thus be forced to invert further than it can evert. The ligamentous thickenings on the lateral side of the joint are separate, and are therefore not as strong s the massive deltoid ligament joint on the medial side. Ankle sprains range in severity from grade I to grade III. The grade I sprain is characterized by stretching of the anterior talofibular and calcaneofibular ligaments. In the grade II sprain, the anterior talofibular ligament tears partially, and the calcaneofibular ligament stretches. The grade III sprain is characterized by rupture of the anterior talofibular and calcaneofibular ligaments, with partial tearing of the posterior talofibular ligament[6,8]. There are three stages of the grade II ankle sprain acute, subacute and chronic. The acute stage begins immediately after injury and lasts 4 to 6 days, the subacute stage lasts 14 to 21 days

after the onset of injury, and the chronic stage is overlapping with the subacute stage around the 14th to 21st days after insult and lasts until there is no pain and there is functional use of the part[11,20].

Most of the treatment protocols for the grade II sprain of the anterior talofibular ligament of the ankle joint are consisting of, control pain, oedema, increase joint mobility, protection from further injuries, progressive function independence and these are carried out by rest, ice, compression, elevation, splinting and therapeutic exercises graduated from passive to active resisted exercise, then progressive functional training[19]. In conjunction with the mobilization techniques, the use of heating modalities, cryotherapy and iontophoresis or phonophresis with 10% hydrocortisone can be used to control the inflammatory reaction and oedema[18]. LILT has a wavelength-dependent capability to alter the cellular behavior in connective tissues in the absence of significant heating, which can be utilized in healing of the injured tissues[1].

The main physiological effects of LILT are, reducing the plasminogen activator activity in human periodontal ligament cells caused by trauma and so decrease the collagen breakdown[25]. Also, Stimulation of the fibroblast cells to produce collagen fibers and inducing increased DNA synthesis[7,24]. It can also increase the amount of the collagen by about 23% in the induced tenotomy and repair in the rabbit Achilles tendons, alter the mitochondrial reparation and promote the rate of ATP synthesis[5,26].

LILT has utilized large portions of the visible and infrared spectrums; initial research emphasized the visible light of inert gas lasers such as the helium neon (He-Ne), Ruby, argon and Drypton, more recently Gallium Arsenide (Ga As) and Gallium Arsenide (As Al As). Today (He-Ne) devices are still widely used, in practice laser therapy typically involved the delivery of ≤1-4 J/cm^2 to the treatment sites with lasers have output powers between 10-90 mW and wave length between 632.8nm to 904nm[1]. It was found that using of low intensity (He0Ne) laser in continuous form at wavelength 632.8 nm and out put power of 40mW and dosage / site of 2.5 J/cm^2 for 6 min on the affected area for 12 applications (3 times/ week) in the management of Achilles tendonitis provided good result in relieving pain and inflammation[21].

The evaluation of the thickness of the Anterior Talofibular Ligament (ATFL) grade II sprain of the ankle joint, can be carried out by using different modalities, such as MRI, stress-x Ray, and clinically. The MRI provide excellent diagnosis and can be used for following up of the healing progression of the sprained ligaments, while the stress-X Ray and the clinical diagnosis provide less advantage and we cannot rely accurately on them on the detection of the improvement of ligamentous healing[4]. Another recent modality used in diagnosis and follow up of the ligamentous injuries is the sonography technique which can detect accurately the injured area of the ligament and its size which appears as a thickened and heterogeneously hypoechoic structure[10].

Although low intensity laser therapy has been utilized in the treatment of many musculoskeletal disorders, joint diseases and other disorders, to our extent of knowledge it has not been used in treating ankle sprain. Laser may cause progression of healing through decreasing pain, inflammation, stimulate collagen synthesis through decreasing the collagen breakdown; stimulate synthesis needed to reconstruction of collagen fibers[9,25]. That is why this study was designed to evaluate the effect of low intensity (He-Ne) laser therapy on decreasing inflammation of

the grade II sprain of the anterior talo-fibular ligament of the ankle joint. Low intensity (He-Ne) laser has been selected in this study because of its reported effects in relatively comparable cases.

MATERIALS AND METHODS

This study was conducted between November 2002 and June 2003 at Al-Amria central Hospital in Alexandria, at the physical therapy outpatient clinic.

I) Patients Selection

Thirty subjects (11 males and 19 females) were enrolled in this study with age range from 20 to 40 years, recruited from an orthopedist with a diagnosis of Grade II ankle sprain confirmed by clinical and ultrasonographic examinations. Subjects were selected from the orthopedics outpatient clinic at Al-Amira central Hospital in Alexandria. The ultrasononography was performed in a private clinic at Al-Amria in Alexandria. Subjects participated in this study were randomly assigned into two groups:

Group (I) received active low intensity He-Ne laser therapy.

Group (II) received sham laser therapy.

Characteristics of the Study Subjects

1) Inclusion Criteria

- Subject with a diagnosis of grade II ankle sprain (within 48 hours) of the anterior talofibular ligament was included in the study.
- Subject should not engage in any activities that may cause further damage to the treated ligament.
- Subject's affected leg was put in a below knee posterior slab to limit the inversion and eversion movements of the ankle joint, and it was removed during laser treatment sessions and ultrasono-graphic examinations.

2) Exclusion Criteria

- Engaging in any organization sporting activities
- Taking any medications that may affect their results (Corticosteroides)
- Ankle surgeries
- History of metabolic or systemic disorders, such as (Diabetes Mellitus, Cancer, Acute hemorrhage)
- Subjects who missed two successive or separate sessions
- Pregnant women

Screening test

The subjects were fully acquainted with the details of the procedures, which were undertaken. Medical and surgical histories that may relate to this study were obtained from each subject. Each subject was evaluated to identify any significant problem in the ankle joint. Other tests included active and passive range of deformities.

Subjects were randomly assigned into too groups, Group (I) (GI= 15 patients) in the study group, receiving low intensity He-Ne laser beam therapy, and Group II (Group II = 15 patients) in the control group receiving sham laser beam.

II) Instrumentations

1. Laser therapy unit (He-Ne) 632.8nm. (ASA medical laser 00001745 class Type B – ITALY)
2. Ultrasonography unit. (SONOACE SA 3200 Medison Co. LTD – KOREA)

III) Procedures

Patients who fulfilled the criteria for inclusion were interviewed, the study aims and procedures were explained, then they signed the subject consent form.

1) Evaluation Procedures

Each patient who participated in the study from both groups underwent ultrasonographic assessment, performed by the same examiner for all subjects according to predetermined examination parameters. Each patient included in the study was scheduled to perform pre experimental ultrasonographic assessment one day before starting his/her treatment sessions with laser, after six sessions (after two weeks) and one day after the last session (after 4 weeks)[1].

Ultrasonographic assessment was performed on both the sound side and the affected side pre treatment for comparison. Then it was some unilaterally on the affected side only during treatment (after 2 week) and post treatment (after 4 weeks) to evaluate the progression of healing of the anterior talofibular ligament through detection of its thickness in millimeters[15]:

- The below knee posterior slab was removed.
- Patient assumed side-lying position and his/her affected leg behind him/her for ultrasonographic examination.
- All subjects were prepared for ultrasonographic examination, the site of lesion was per skin and also was cleaned by alcohol then gel applied.
- Evaluation sheets were designed for all patients to follow up the anterior talofibular ligament healing progression pre, during and post treatment through recording the ligamentous thickness detected by ultrasonography.

2) Treatment Procedures

Protective glasses were used by all subjects and physical therapist. Subjects were asked to avoid looking directly to the beam of laser to avoid any retinal hazards, and they should do comment at times about transient warmth or tingling at the treated site during or shortly after treatment[1]. Each patient in both groups received twenty sessions of laser therapy (one session every other day for four weeks)[21].

Group I (Study Group)

Each patient was treated according to the following protocol:

The below knee Posterior slab was removed. Patient was asked to assume side-lying position on the plinth with affected ankle behind him/ her and was adequately exposed.The lateral aspect of the affected ankle was directed upward and was cleaned thoroughly with alcohol and dried well thereafter. Subjects in the (Group I) received active low intensity (He-Ne) laser therapy with the following parameters.

- Wave length 632.8nm
- Out put power of 40mW
- Dosage / site of 2.5 J/cm2
- Regimen: for 6 min. for each session

Laser was then applied to the most painful area on the lateral side of the ankle joint point upon the injured anterior talofibular ligament using laser hand probe, which was applied in direct contact to the skin[21]. After each treatment session the below knee posterior slab was again fitted to the patient's affected ankle.

Group II (Control Group)

Each patient was treated with the same previously described protocol and parameters of application. The laser device was not active, and it was applied to the most painful area of the lateral side of the probe which was applied in direct contact to the skin (Simunovic, 1996). After each treatment session the below knee posterior slab was again fitted to the patient's affected ankle.

3) Statistical Procedures

Data Collection

Data have been collected from thirty subjects, age from 20-40 year (31.4+5.6), 11

males and 19 females. They have been randomly assigned into study group (G I) and control group (G II) Group one (G I = 15 subjects) received low intensity (He-Ne) laser therapy, and Group two (G II= 15 subjects) received sham laser beam. The anterior talofibular ligament thickness has been measured pre, during and post treatment for each patient by using ultrasonographic films to measure the degree of the ligamentous partial tear in millimeters during the treatment period. The scores from all patients in both the study group and control group were collected and have been utilized in statistical analysis.

Data Analysis

In this study it was required to identify the effect of low intensity (He-Ne) laser therapy (independent variable) on the promotion of healing of the anterior talofibular ligament of the ankle joint grade ll sprain (Dependent variable). Based on this, the statistical methods that have been used were:

1- Student's t-test: for testing statistical significant difference between means of the two groups.
2- Paired t-test: for testing statistical significant effect of treatment by calculation of the mean difference between two readings for the same person (before and after treatment).
3- Percentage change: to calculate the percent of improvement after intervention. It equals the difference between 2^{nd} reading – 1^{st} reading/ 1^{st} reading x 100.

(Statistics were done by computer using Epi-info. Software, version 6.04. A word processing, data base and statistics program (WHO, 2001)).

RESULTS

The differences between the two studied groups in the general characteristics concerning age and sex showed that there was no statistical significant difference between both groups in age or sex distribution (table 1).

The mean and standard deviation of age in years were 31.33 (±5.74) for group (I) and 31.4 (±5.54) for group (II). The percentage of sex distribution has been 40% males and 60% females for group (I) where has been 33.3 % males and 66.7% females for groups (II) Fig (1).

The dependent variable (ARGL thickness) has been compared to identify the difference between the pre experimental, during and post experimental values for each group.

In group one (I) the paired t-test showed highly significant differences in the thickness of the ATFL of the affected side. Pre, during (after 2 weeks) and post treatment (after 4 weeks) compared to each other and to the sound side.

While in group two (II) the paired t-test showed less significant differences in the thickness of the ATFL of the affected side, pre, during and post treatment compared to each other and to the sound side.

Table (1): Comparison between the two studied groups in general characteristics.

Variables	Group (1) n=15		Group (2) n=15		P
	Mean	SD	Mean	SD	
Age (years)	31.33	5.74	31.4	5.54	T=0.03 P>0.05
Sex ♂	40		33.3		X^2 = 014 P>0.05
♀ (%)	60		66.7		

P<0.05

As shown in table (2) there was no significant difference between groups in mean thickness of ATFL of the sound and affected side pre treatment, while the difference was highly significant after treatment both after 2 weeks and 4 weeks in favor of group (I). The results in group (I) showed that, the mean and standard deviation of ATFL thickness of the sound side was 2.72 (±0.98), while the mean and standard deviation of ATFL thickness of the affected side pre treatment was 6.35 (±0.83). They have been decreased to 4.63 (±0.88) after 2 weeks of treatment, and more decrease has been achieved 2.95 (±0.83) after 4 weeks of treatment (fig 2).

In group (II) the results showed that, the mean and standard deviation of ATFL thickness, of the sound (±0.64), while the mean and standard deviation of ATFL thickness of the affected side pre treatment have been 6.37 (±0.59). They have been decreased to 5.78 (± 0.64) after 2 weeks of treatment, and decreased to 5.02 (±0.53) after 4 weeks of treatment (fig 2).

Table (2): Comparison between the mean thickness of ATFL in the studied groups pre, during, and post treatment.

ATFL thickness	Group I		Group II		t-test	P
	Mean	SD	Mean	SD		
Of sound side	2.72	0.98	2.35	0.64	1.23	>0.05
Of affected side pre treatment	6.35	0.83	6.37	0.59	0.08	>0.05
Of affected side during (after 2 weeks) treatment	4.63	0.88	5.78	0.64	4.09	<0.01
Of affected post (after 4 weeks) treatment	2.95	0.83	5.02	0.53	8.17	<0.01

P<0.05

In order to compare the results achieved in group (I) (study group) and group (II) (control group), student's t-test has been performed to test the mean difference change in the mean thickness of ATFL after treatment in relation to pre treatment thickness (table 3) and in relation to sound side (table 4). The results in group (I) showed that, the mean difference in the ATFL mean thickness after 2 weeks of treatment in relation to pre treatment thickness was (-1.33), and it has been increased to (-3) after 4 weeks of treatment in relation to pre treatment thickness (table 3). And the mean difference was (3.63) and it has been decreased to (1.91) after 2 weeks of treatment and farther decrease has been achieved (0.25) after 4 weeks of treatment in relation to the sound side thickness (table 4). While the results in group (II) showed that the mean difference in the ATFL mean thickness after 2 weeks of treatment in relation to pre treatment thickness was (-0.07), and it has been increased to (-0.88) after 4 weeks of treatment in relation to pre treatment thickness (table 3). The mean the mean difference in the ATFL mean thickness pre treatment in relation to sound side thickness was (4.03), and it has been decreased to (3.43) after 2 weeks of treatment and decreased to (2.67) after 4 weeks of treatment in relation to sound side thickness (table 4).

In order to compare the percentage of improvement of the ATFL thickness after treatment, the percentage change test has been performed. This test has measured the percentage change in the mean difference of

the ATFL mean thickness after treatment in relation to pre treatment thickness (table 3) and in relation to sound side thickness (table 4).

The results in group one (I) showed that, the percent of change in the mean difference of the ATFL mean thickness after 2 weeks of treatment in relation to pre treatment thickness was (-26.77%) and it has been increased to (-53.53%) after 4 weeks of treatment in relation to pre treatment thickness (table 3) (fig 3). And the percent of change in the mean difference of the ATFL mean thickness pre treatment in relation to sound side thickness was (150.39%) and it has been decreased to (82.6%) after 2 weeks of treatment, and farther decrease has been achieved (11.29%) after 4 weeks of treatment in relation to the sound side thickness (table 4) (fig 4). While the results in group (II) showed that the percentage of change in the mean difference of the ATFL mean thickness after 2 weeks of treatment in relation to pre treatment thickness was (-9.35%) and it has been increased to (-20.53%) after 4 weeks of treatment in relation to ore treatment thickness (table 3) (fig 3).

And the percent of change in the mean difference of the ATFL mean thickness pre treatment in relation to the sound side thickness was (184.29%) and it has been decreased to (157.99%) after 2 weeks of treatment and decreased to (122.8%) after 4 weeks of treatment in relation to the sound side thickness (table 4) (fig 4).

Table (3): Mean difference and the percentage change in mean thickness of ATFL after treatment in relation to pretreatment thickness in both groups.

ATFL thickness	Group I		Group II		t	P
	Mean	Percentage of improvement %	Mean	Percentage of improvement %		
after 2 weeks of treatment and pretreatment	-1.33	-26.77	-0.07	-9.35	6.38	<0.001
after 4 weeks of treatment and 2 weeks of treatment	-1.33	-35.53	-0.33	-12.49	3.55	<0.01
after 4 weeks of treatment and pretreatment	-3	-53.53	-0.88	-20.53	9.9.1	<0.0001

P<0.05

Table (4): Mean difference and the percentage change in mean thickness of ATFL after treatment in relation to sound side thickness in both groups.

ATFL thickness	Group I		Group II		t	P
	Mean	Percentage of improvement %	Mean	Percentage of improvement %		
Pretreatment thickness- sound side thickness	3.63	150.39	4.03	184.29	1.46	>0.05
after 2 weeks of treatment sound side thickness	1.91	82.6	3.43	157.99	4.87	<0.001
after 4 weeks of treatment sound side thickness	0.25	11.29	2.67	122.8	14.55	<0.0001

P<0.05

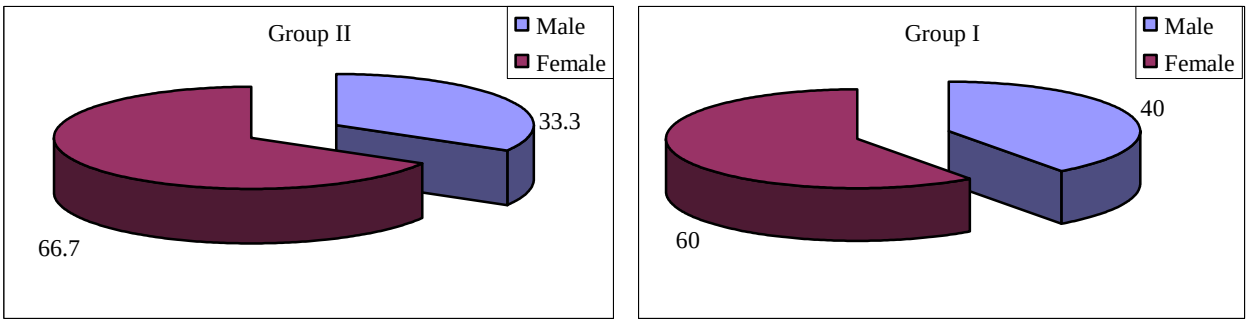

Fig. (1): Comparison between the two studied groups in general characteristics of Subjects.

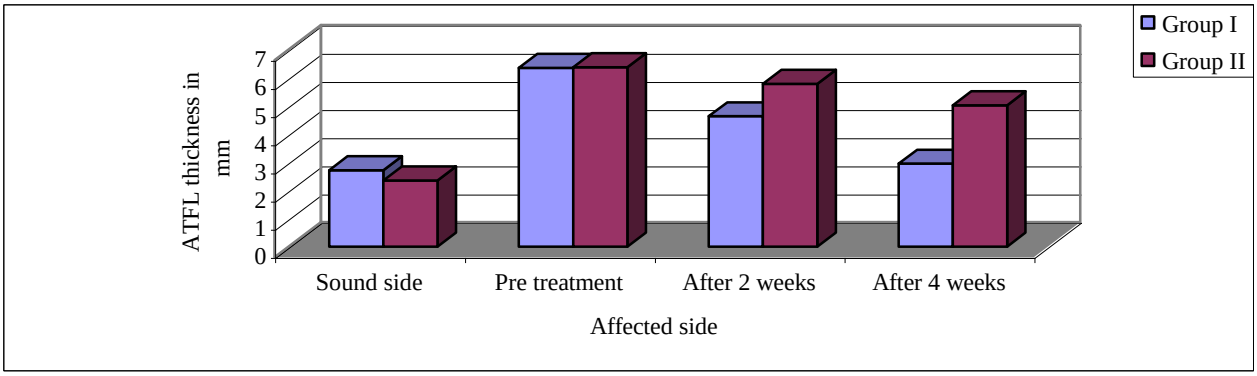

Fig. (2): Comparison between the mean thickness of ATFL in the studied groups pre, in between and post treatment.

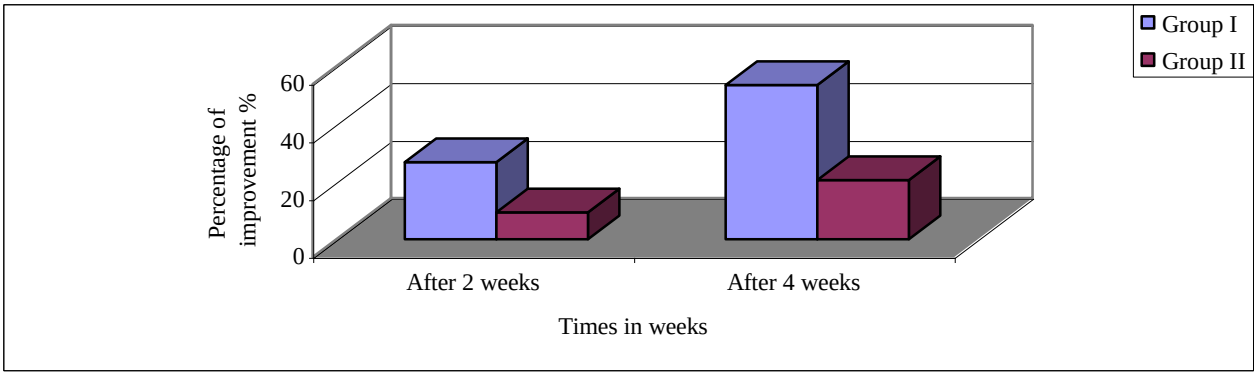

Fig. (3): The percentage of improvement in ATFL thickness on follow up in the studied groups in relation to pre treatment thickness.

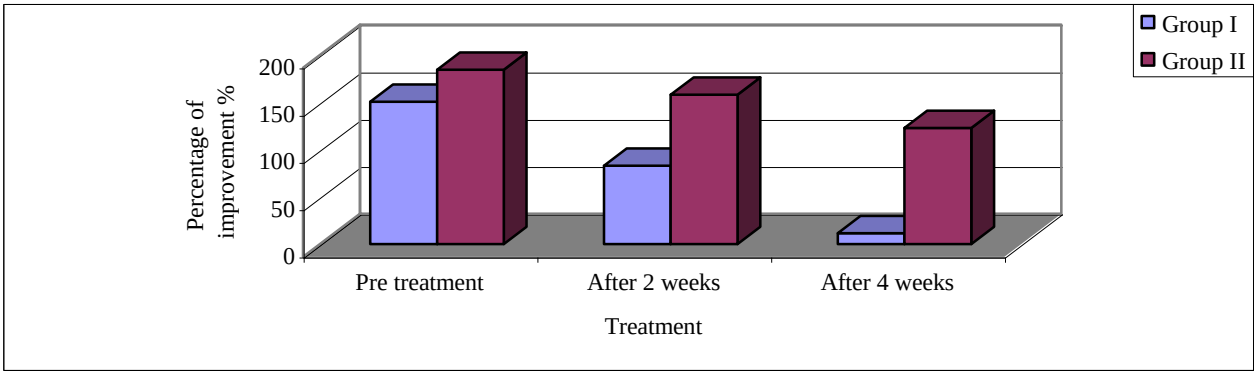

Fig. (4): Percentage of improvement in ATFL thickness on follow up in the studied groups in relation to sound side.

DISCUSSION

The purpose of this study was to examine the effect of low intensity (He-Ne) laser on decreasing inflammation of the grade II sprain of the anterior talofibular ligament of the ankle joint. This was performed by comparing the results achieved from two groups of patients, Group one (I) received active low intensity (He-Ne) laser beam, Group (II) received sham (inactive) low intensity (He-Ne) laser bean with the same parameters and protocol of application.

The measured parameter was the ligamentous thickness in millimeters of the grade II sprain of the anterior talofibular ligament of the ankle joint, which was confirmed by the usage of the ultrasonography technique.

Results revealed that the low intensity (He-Ne) laser therapy was found to be effective in decreasing the inflammation of the grade II sprain of the anterior talofibular ligament of the ankle joint.

The results of the current study were shown to be supported by the results achieved by Simunovic (1996)[21] who examined the effect of low intensity (He-Ne) laser in the musculoskeletal disorders such as Achilles tendinitis. And it was found that the low intensity (He-Ne) laser was effective in decreasing the inflammation, improving the microcirculation, improving oxygen supply to the hypoxic cells and at the same time removing the collected waste products, that improved the regeneration of the cells of the injured Achilles tendon.

For instant, the results obtained by Reddy and Stehno (1998)[13] and, Gum and Reedy (1997)[5] who investigated the effect of the low intensity (He-Ne) laser therapy on the acceleration of healing of experimentally tentomized and repaired rabbit Achilles tendons, and on the collagen production. Authors concluded that, the low intensity (He-Ne) laser therapy was found to increase collagen concentration by about 26% confirmed by biochemical analyses, indicating a more rapid healing progression in the treating tendons compared to control group.

Sequential extractions of collagen from regenerating tendon tissue in another study revealed that the low intensity (He-Ne) laser photostimulated tendons has 32% and 33% greater concentration of the neutral salt soluble collagen and insoluble collagen, respectively, than control tendons, suggesting an accelerated production of collagen with laser photostimulation[12].

These results are closely related to the results obtained from this study using the low intensity (He-Ne) laser therapy in the mechanically stretched periodontal ligament cells in human by Yasuhito et al. (1997)[25]. The authors concluded that, the periodontal ligament cells showed marked elevation in the plasminogen activator activity in response to mechanical stretching, this plasminogen activator converts the plasminogen present in the extracellular matrix into plasmin, which in turn activates the collagenase enzyme causing collagen break down. And it was found that low intensity laser irradiation significantly inhibits the increased plasminogen activator activity induced in human periodontal ligament cells in response to a mechanical tension force.

On the other hand the results of the current study contradict the results achieved by Vecchio et al. (1993)[23] who examined the effect of low intensity laser therapy on the rotator cuff tendinitis and concluded that the low intensity laser was not effective in decreasing the inflammatory reaction of the rotator cuff caused by trauma. Another study which was carried out by Debra et al. (1986)[3] who examined the effect of low intensity (He-Ne) laser therapy on the induced soft tissue trauma (vastus lateralis muscle) in rats. And it was found that there was no effect on the inflammatory process and muscle regeneration by laser treatment. It was reported the (He-Ne) laser's light is directly absorbed into the epidermis to a depth of 0.8-1.2 mm. Indirect effect of laser penetration have been reported up to a depth of 2-2.5 cm, and with deeper lesions, laser may be ineffective or very weak. The use of different laser parameters such as power, wavelength, wave from, dosage/ site, duration and number of applications would affect different results[1].

The non-convincing results of low intensity (He-Ne) laser in decreasing the inflammatory soft tissue conditions in some studies did not negate its effect in rapid decreasing of inflammation of injured ligaments and tendons depending upon parameters used in applications.

The available explanation that might be related to the effectiveness of low intensity (He-Ne) laser in the promotion of ligaments recover and in decreasing inflammation after traumatic injuries in the current study, might be related to its previously reported physiological effects. It was found that, the low intensity (He-Ne) laser therapy (wave length 632.8 mm) have been reported to have a biostimulation effect on different cells and sub-cell organelles, enhance ATP production in fibroblasts localized this effect to the mitochondria, increase the cyclic AMP and DNA production, increase the release of growth factors in fibroblasts for production of collagen fibers after injury and it was also reported as a strong anti-inflammatory agent[1,17,22].

The clinical stages for the grade II sprain of the ankle joint consist of three stages, the acute stage (inflammatory stage), which begins immediately after injury and lasts 4 to 6 days, clinically there is inflammation, pain, swelling and loss of function. The subacute stage (healing stage), the resolution and repair of the injuired site begins, this stage lasts and additional 10 to 17 days, clinically inflammation decreases or absent and pain decreases. The chronic stage (maturation and remodeling stage), there is no inflammation, and when testing range of motion, the patient does not fell pain until after resistance from the tissue is met and over preasure is applied to the shortened or weakned structure. The restoration of function begins in this stage[11,20].

The results of the present study have suggested more rapid recovery from the partially teared anterior talofibular ligament of the ankle joint with observed decrease in the inflammatory process following trauma. Indicating more rapid return to moral level of patient's activities. And this can therefore be related to the ability of the low intensity (He-Ne) laser radiation to decrease pain, inflammation, stimulate fibroblasts for new collagen production to enhance the ligament healing and decrease the collagen breakdown caused by trauma.

Low intensity (He-Ne) laser can be expected to add to the effect of different forms of therapeutic modalities used in the treatment of ankle sprain. Among these modalities, which are reported to be commonly used in the treatment of grade II ankle sprain are, healing modalities such as (infra-red and short wave diathermy), ice packs, lontophoresis or phonophoresis with 10% hydrocorison, because of their known therapeutic effect on reducing pain and inflammation[18,19].

Below knee posterior slab was applied to each subject involved in this study, which can be removed during laser treatment and ultrasonographic examination and returned to limit eversion and inversion movements of the ankle joint for further injury and to reserve the gained ligamentous recovery during treatment period[8].

The use of ultrasonography technique in addition to its low costs provided a very good choice in the diagnosis and follow up of the partial tear grade II sprain of the anterior talofibular ligament and its size in millimeters, which appeared as a thickened and heterogeneously hypoechoic structure, in addition its low costs[10,15]. The magnetic resonance imagining (MRI) provides excellent technique for diagnosis and follow up of the healing progression of the sprained ligaments of the ankle joint[2,16]. But its costs are very high. More recently and effectively is the use of the kinematics MRI, which may help to differentiate from Kinematic MRI of the ankle often complements the diagnostic findings provided by routine MR imaging of the ankle sprains but also its costs are very high[14].

Conclusion

It was concluded that low intensity (He-Ne) laser therapy was found beneficial in decreasing the inflammation of the grade II sprain of the anterior talofibular ligament of the ankle joint speeding the recovery and returning to sports activities.

It is recommended to utilize the low intensity (He-Ne) laser therapy as a part of physical therapy program for treatment of the grade II sprain of the anterior talofibular ligament of the ankle joint.

Recommendation

1- It is recommended to investigate the long term effects of low intensity (He-Ne) laser in promotion of healing in case of grade II sprain of the anterior talofibular ligament of the ankle joints.
2- It is recommended to compare the effect of low intensity (He-Ne) laser with other forms of therapeutic interventions such as cold packs, ultrasound, and mechanical loading by using electrical stimulation.
3- It is recommended to study combined effect of low intensity (He-Ne) laser with these different forms of treatment on grade II sprain of the anterior talofibular ligament.
4- It is recommended to select other laser parameters, techniques and types for comparison.

REFERENCES

1- Basford, J.R.: Low intensity laser therapy: still not an established clinical tool. Laser surge med. 16: 331-342, 1995.
2- Consuelo, T.L. and Helnam, C.A.: Lateral collateral ligaments of the ankle joint, ultrasonographic and M R Imaging findings, Radiology 138: 166, 1999.
3- Debra, J.K., Michael, F., Steven, A.S. and Theresa, M.: Use of He-Ne laser for treatment of soft tissue trauma: Evaluation by Gallium-67 citrate scanning. Jost Vol. 8, No. 2-93: 96, 1986.
4- Forbes, J.R., Helms, C.A. and Janzen, D.L.: Acute pes anserine bursitis: MR imagining Radiology 194: 525, 1995.
5- Gum, S.L. and Reddy, G.K.: Combined ultrasound, electrical stimulation, and laser, promote collagen synthesis with moderate changes in tendon biomechanics. Am J Phys Med Rehabil. 76(4): 288-296, 1997.
6- Hoppenfied, S.: Physical examination of the foot and ankle P. 197 in Hoppenfied S (ed.): Physical examination of the spine and extremities. Appleton-century –crofts, New York, 1976.
7- Loveschall, H. and Arenholt, B.: Effect of low level diode laser irradiation of human oral mucosa fibroblasts in vitro. Lasers surg med 14: 347-354, 1994.
8- Michael, W., Tim, U.H.L. and Leland, C.: Management of ankle sprains. Am Fam Phy: 63: 93-104, 2001.
9- Pinheiro, A.L. and Cavalcanit, E.T.: Low lever laser therapy in the management of disorders of the maxillofacial region.. J. Clin. Laser Med. Surg. 15(4): 181-183, 1997.
10- Ptasznik, R.: The value of sonography in the diagnosis of musculoskeletal disorders A J R Am J Roentgenol 93: 815-830, 1999.
11- Rebaman, L.W.: Ankle injuries: clinical observation. J. orthop sports phys ther 8(3): 153, 1986.
12- Reddy, G.K., Gum, S., Stehno, L. and Enwemeka, C.S.: Biochemistry and biomechanics of healing tendon: Part II effects of combined laser therapy and electrical stimulation. Med Sci sport Exerc 30(6): 794-800, 1998.
13- Reddy, G.K., Stehno, B.L.: Laser photostimulation of collagen production in healing rabbit Achilles tendons. Laser in surgery and medicine, 22(5): 281-287, 19987.
14- Richard, D. and Andersen, A.: Kinematic MRI of the ankle joint AJR Am J Roentgenol., 1493-1499, 2001.
15- Ridvan, A. and Sedat, Y.: Ultrasonography for anterior talofibular ligament.
16- Robert, E.W.: The value of MR Imagining in the diagnosis of traumatic rupture of the anterior cruciate ligament of the knee. AJR Am J 164: 461-470, 2000.
17- Rami, D., Moshe, N.I. and Michael, S.: Effect of low power He-Ne laser on fracture healing in Rats. Laser Surg. Med., 19: 458-464. 1996.
18- Roy, S. and Irwin, R.: Sports medicine: Prevention, Evaluation, Management, and Rehab. Rentic- Hall, Englewood Cliff S N J, 1983.
19- Sims, D.: Effects of positioning on ankle edema. J Orthop Sports Phys Ther., 8(1): 30, 1986.
20- Smith, R.W. and Reischl, S.F.: Treatment of ankle sprains in young athletes. Am J Sports Med., 14(4): 163-167, 1996.
21- Simunovic, Z.: Low level laser therapy with trigger points teach. J. Clin. Laser Med. Surg.,14(6): 465,1996.
22- Subkova, S.M., Buliakova, N.V., Mikhailik, L.V., Varakina, N.I. and Azarova, V.S.A.: Comparative analysis of the action of red and infrared laser radiation and ultrasound on the regeneration of locally irradiated skeletal muscle and on immune system function in the Rat, Vopr. Kurartol. Fizioter. Lech. Fiz. Kult., (6), 1998.
23- Vecchio, P., Cave, M., King, V., Adebajo, A.O., Smith, M. and Hazleman, B.L.: A double blind study of the effectiveness of low laser treatment of rotator cuff tendinitis, Dr. J Rheumatal; 32(8): 740-742, 1993.
24- Webb, C., Mary, D. and Lewis, W.: Stimulatory effect of 660 nm low level laser

energy on hypertrophic scar-derived fibroblasts. Laser in surgery and medicine 22: 294-301, 1998.
25- Yasuhito, O., Noriyoshi, S. and Yoshimitsu, A.: Low energy diode laser irradiation reduced plasminogen activator activity in human periodonatal ligament cells. Laser in surgery and Medicine 21: 456-463, 1997.
26- Yuji, M. and Tsunenori, A.: Effect of low-intensity Argon Laser irradiation on mitochondrial respiration Laser in surgery and medicine 15: 191-199, 1994.

الملخص العربي

تأثير الليزر المنخفض الشدة على تحفيز التئام تمزق الرباط العقبي الشظوي الأمامي لمفصل الكاحل

يعد تمزق الأربطة الخارجية لمفصل الكاحل من أكثر الإصابات شيوعاً وخاصة بين الرياضيين. وقد هدفت هذه الدراسة إلى بيان أثر الهليوم نيون ليزر المنخفض الشدة على تحفيز التئام تمزق الدرجة الثانية للرباط العقبي الشظوي الأمامي لمفصل الكاحل .
ولقد اشتملت هذه الدراسة على خمسة أبواب :
الباب الأول : وهو مقدمة البحث والتي تتضمن تحديد المشكلة ، وهدف البحث ، فرضه ، وطريقة جمع المعلومات وإحصائها .
الباب الثاني : وهو مراجعة الأبحاث العلمية المرتبطة بموضوع البحث والتي تضمنت مراجعة النواحي والتشريحية والميكانيكية لمفصل الكاحل . ودرجات تمزق الأربطة الخارجية للمفصل وأسبابها. ثم تم إلقاء الضوء على مختلف وسائل العلاج الطبيعي والطبي والجراحي المستخدمة في علاج هذه الحالات كما تم تناول أسس العلاج باستخدام الهليوم نيون ليزر المنخفض الشدة لتحفيز التئام تمزق الدرجة الثانية للرباط العقبي الشظوي الأمامي لمفصل الكاحل . وهو أسلوب العلاج الذي تناوله هذا البحث بالدراسة .
الباب الثالث : في هذا الباب تم تناول التجربة العلمية التي أجريت في هذه الدراسة على عينة مكونة من ثلاثين مريضاً يعانون من تمزق الدرجة الثانية للرباط العقبي الشظوي الأمامي لمفصل الكاحل . والذين تم تقسيمهم عشوائياً إلى مجموعتين، المجموعة الأولى تم علاجها باستخدام جهاز الهليوم نيون ليزر المنخفض الشدة ، والمجموعة الثانية تم علاجها باستخدام نفس الجهاز ولكن تم إيقافه عن العمل (أي لا يخرج أشعة ليزر) . وقد تم تقييم جميع المرضى المشاركين لمعرفة مدى التقدم من عدمه لالتئام تمزق الدرجة الثانية للرباط العقبي الشظوي الأمامي لمفصل الكاحل باستخدام جهاز الموجات فوق الصوتية التشخيصي . وقد نفذ هذا التقييم قبل إجراء التجربة وخلالها وبعد الانتهاء منها لكل من المرضى المشاركين في كلتا المجموعتين . وقد تمت مقارنة التقييم قبل وخلال وبعد الدراسة في كل من المجموعتين على حدى ، وفيما بين المجموعتين .
الباب الرابع : اشتمل هذا الباب على نتائج التجربة والتي أوضحت وجود فروق ذات دلالة إحصائية لصالح المجموعة الأولى تمثلت في سرعة تحفيز التئام تمزق الدرجة الثانية للرباط العقبي الشظوي الأمامي لمفصل الكاحل وكذلك عدم وجود فروق ذات دلالة إحصائية للمجموعة الثانية فيما يتعلق بنفس الإصابة .
الباب الخامس : في هذا الباب تم مناقشة ما توصل إليه البحث من نتائج ومقارنتها بنتائج الأبحاث الأخرى المنشورة في الدوريات العلمية. وتم وضع بعض التوصيات المقترحة لدراسات مستقبلية .
وقد أوضحت الدراسة أنه يمكن استخدام الهليوم نيون ليزر المنخفض الشدة كجزء من البرنامج العلاجي لتحفيز عملية التئام تمزق الدرجة الثانية للرباط العقبي الشظوي الأمامي لمفصل الكاحل . وذلك لما أوضحه من فاعلية في علاج هذه الإصابة بدرجة تجعله يمكن الوثوق به .