MLS® Laser Therapy in the treatment of patients affected by Tendinopathies

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ABSTRACT

Tendon diseases are widespread in the population and constitute a high percentage of the consultations to the physician for musculoskeletal disorders. They are painful, debilitating and negatively affect patient's quality of life. Some tendons are particularly vulnerable to degenerative pathology; these include the Achilles, elements of the rotator cuff, patella, foot extensors and tibialis posterior tendons.

Although tendinopathies are common, their treatment is not easy and often combined therapies are needed to alleviate symptoms, promote functional recovery and prevent recurrence. Among the resources available for treating tendinopathies, laser therapy showed to be effective in reducing pain and disability in some types of tendinopathy. This study aimed to evaluate the efficacy of a high power, dual wavelength NIR laser source in the treatment of patients affected by tendinopathies. Seventeen patients with symptomatic tendinopathies were enrolled for this study and divided into subgroups, based on anatomical district and anatomical structures affected by the disease. Patients were evaluated by Visual-Analogue Scale (VAS) before and after laser treatment, that was administered 3 times / week, for a total of ≈ 8 session/patient. At the end of the treatment, each subgroup showed an improvement in pain symptoms; considering all the patients, a 56,9% reduction in the mean VAS score was observed after laser treatment. In conclusion, our results suggest that MLS® therapy can be effectively applied for pain control and function improvement in patients affected by tendinopathies.

INTRODUCTION

Tendinopathies are common diseases with an incidence of about 30% of all physician examinations for musculoskeletal disorders [1]. Such conditions have an adverse impact on patient's quality of life, because of pain, stiffness and limitations of movements that can result. For these reasons, tendinopathies are responsible for hundred thousands of work hours lost. In the last years, the increase in sport activities, life expectancy, and other factors such as environment, diet, systemic diseases and some drug therapies have led to a rise in the incidence of tendinopathies, which therefore, nowadays, do not affect only athletes but also the general and elder population [2,3].

Although tendinopathies may involve tendons of any joint, the most affected are those of wrist and hand (for example, finger flexor tenosynovitis), elbow (epicondylitis, or tennis elbow), shoulder (cuff rotator tendinopathy), ankle (Achilles tendinopathy) and knee (patellar tendinitis and popliteal tendinitis) [4-6].

Physiologically, tendon is composed of densely arranged collagen fibers, elastin, proteoglycans, and lipids. These elements are produced by tenoblasts and tenocytes, elongated fibroblasts and fibrocytes, located among the collagen fibers, that represent about 90-95% of the cellular elements in the tendon. The remaining 5-10% includes chondrocytes, synovial cells, endothelial cells and smooth muscle cells. Tendon is sheathed by the epitenon, a particular connective tissue which contains the tendon neurovascular supply and facilitates the gliding of collagen bundles against one another during tendon movement. Muscular force is transmitted to the skeleton at the point where the tendon inserts into the bone. The osteotendinous junctions, as well as the musculotendinous junctions, are the areas most susceptible to mechanical stress and consequently to tendon injury [7,8].

Mechanical etiopathogenesis is, in fact, the most common cause of tendon pathologies; in particular, insertional tendinopathies, tenosynovitis, peritendinitis and tendinosis, also associated among them. These diseases may arise from an edematous injury to the microvasculature, following an acute trauma or, even more frequently, to repeated microtraumas of exogenous origin (exercise machines, footwear...) and /or endogenous (congenital abnormalities, primary or secondary skeletal disorders, functional overuse, leg length discrepancy, muscle tension).

Tendinopathies classification remains difficult and encompasses a variety of histopathologic entities. A possible classification is: (I) acute tendinitis alone: tendon injury with inflammation; (II) chronic tendinosis alone: tendon injury with degeneration at cellular level and no inflammation; (III) chronic tendinosis with acute tendinitis [9] Although cases of tendinopathies with true inflammatory component exist, often many patients have symptoms for a long time and wait for a long time before contacting the family doctor, so that, acute inflammation has probably subsided and it has been replaced by degeneration of collagen fiber structure. Histologic descriptions of tendinopathies have demonstrated disordered collagen arrangement together with non-collagenous matrix increase, cellular alterations and neo-angiogenesis [10]. This process seems to be one of the causes of pain symptoms: in Achilles tendinopathies, the presence of sensory nerves associated with new formed vessels could be responsible of the production of nociceptive and proinflammatory substances [11].

Since it is unclear if these chronic degenerative changes are preceded by an acute inflammatory response, the term tendinosis is more appropriate to describe these clinical aspects in absence of evidence of acute inflammation [12].

Conservative or physical therapies are generally accepted as the first line approach for managing tendinopathies with the purpose of alleviating symptoms, promoting functional recovery and prevent their recurrence [13-16]. These therapies can be used alone or combined with pharmacological agents. In the last few years, for example, the use of oral supplements has been proposed to support the physiological turnover of tendon tissue, in order to prevent inflammation and degeneration [17-20]. Surgical approaches are usually reserved for the most hostile cases, with conservative therapies failure for at least 6 months [21,22]. Physical therapies include eccentric exercises, electrotherapeutic modalities, such as Extracorporeal Shock Wave Therapy, soft tissue therapies, splints and orthosis. Among the resources available for treating tendinopathies within the field of physical therapy, laser therapy showed positive effects. In some in vivo studies on the efficacy of laser therapy in the treatment of Achilles tendinopathies, the following results have been reported: modulation of inflammatory response following trauma, analgesic effect, antioxidant effect, stimulation of healing process by increasing collagen I production and tenocyte proliferation [23]. However, relatively few controlled clinical studies on laser therapy applied to the management of tendinopathies have been reported and, sometimes, showing controversial results and methodological flaws.

The present study aimed to evaluate the effectiveness of a high power, dual wavelength NIR laser source in the treatment of patients affected by tendinopathies.

MATERIALS AND METHODS

Patients

Seventeen adult patients, 13 M and 4 F, mean age 47 yrs (range 15-80 yrs), were treated on an outpatient basis, with an average of 8 sessions/patient. The patients suffered from acute or chronic tendon diseases in the following anatomical districts: knee (5 patients: 3 Pes Anserine Tendinopathy -Gracilis, Sartorius and Semitendinosus tendons - and 2 patellar tendon), shoulder (4 patients: 2 acromioclavicular joint, 1 supraspinatus tendon and 1 long head of biceps tendon), ankle (3 patients: Achilles tendon) and foot (5 patients: 4 foot extensor tendon and 1 tibialis posterior tendon) see Fig. 1.

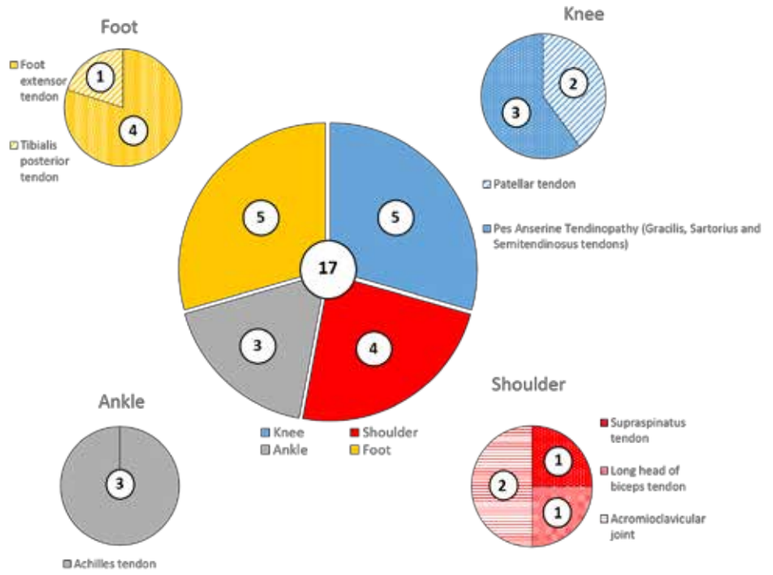


Fig 1: Distribution of tendon diseases according to the anatomical district (Big pie chart). Small pie charts show, within each district, the specific tendons involved.

Inclusion criteria required the presence of symptomatic tendinopathies assessed following clinical and instrumental evaluation. Exclusion criteria were: therapy with oral anticoagulants, non-compliant patients (cognitive impairment or psychiatric disorder), neoplastic pathology, skin diseases. Before treatment, all the patients were informed about the technique and laser beam properties, and they signed an informed consent to the treatment. The evaluation of each patient was performed by means of pain VAS scale [24]. The VAS is a visual analog test which evaluates the subjective painful symptomatology; the score ranges from 0 (lack of pain) to 10 (strogest imaginable pain). It was administered to the patients before and at the end of the whole treatment. The patients were treated 3 times / week, for a total of ≈ 8 session/patient.

Laser treatments

The laser source was a Multiwave Locked System laser (MLS®, ASA Srl, Vicenza, Italy). It is a commercially available laser source built in compliance with EC/EU rules, which received FDA approval and is widely used in clinics. MLS® laser is a class IV NIR laser with two synchronized sources (laser diodes). These emit at different wavelengths, peak power and emission mode. The first one is a pulsed 905 nm laser diode with 25 W peak optical power. The pulse frequency may be varied in the range 1-2000 Hz, thus varying the average power delivered to the tissue. The second laser diode (808 nm) may operate in continuous (power 1.1 W) or pulsed mode (repetition rate 1-2000 Hz, 550mW mean optical power, with a 50% duty ratio independently of the repetition rate). The two laser beams are emitted synchronously and the propagation axes are coincident.

Treatment modality

The patients received the following energy dose:
Knee: 5,27 J/cm^2
Shoulder: 5,63 J/cm^2
Ankle: 14,69 J/cm^2
Foot: 14,69 J/cm^2

Data Analysis

The data were analyzed using paired Student's t-test to compare the values found pre and post treatment in all the patients and into each subgroup. The level of significance was set at 0.05.

RESULTS

Seventeen patients affected by tendinopathies were enrolled in the study; one of them (patient affected by tibialis posterior tendinitis) underwent only the first session and decided to interrupt the treatment, therefore the related values were excluded. Patients consisted of 13 males and 4 females; mean age was 47,6 (15-80) (Table I). At the end of the treatment patients showed improvement in pain symptoms: mean value changed from 6,58 ± 2 to 3 ± 2,4, with a 56,9% reduction in the VAS score after treatment (Fig.2). In order to analyze the data in more detail, the patients were divided, as described in "Material and Methods" section, into subgroups based on anatomical district and anatomical structures affected by the disease (Table II). For each group, VAS score differences were evaluated. The score of patients affected by knee tendinopathies highlighted a statistically significant improvement (p< 0,005) at the end of the treatment compared to basal score; the mean value decreased from 6,8 ± 1,4 to 3 ± 2,2. Although in the other anatomical districts considered the mean changes in VAS score did not result statistically significant, however there was an improvement in pain symptoms and a corresponding decrease in the average VAS score. In particular, in patients affected by shoulder, ankle and foot tendinopathies the average score changed from 7,25 ± 1,5 to 3,5 ± 2,64; from 5,3 ± 2,5 to 2 ± 2,6 and from 7 ± 2,94 to 2,75 ± 3,2, respectively (Fig.3 and Table III).
In percentage, after treatment VAS score was reduced by 55% in the subgroup of patients affected by knee tendinopathies and by 51% in the subgroup of patients affected by shoulder tendinopathies. Higher percentages were found in the subgroups of patients affected by ankle and foot tendinopathies, where VAS

Table I - Group baseline characteristics

PATs. NUMBER	MEAN AGE	SEX	VAS Before treatment (mean)
17	47,6 (15-80)	13 M, 4 F	6,58 ± 2

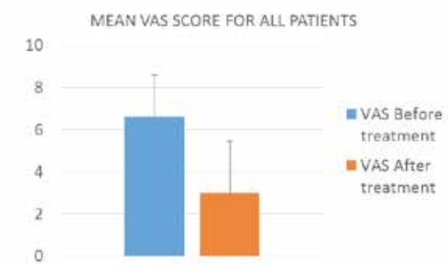
Table II - Subgroups baseline characteristics

ANATOMICAL DISTRICT	PATs. NUMBER	MEAN AGE	SEX	VAS Before treatment (mean)
KNEE	5	44,2	4 M, 1 F	6,8 ± 1,48
SHOULDER	4	53,25	4 M	7,25 ± 1,5
ANKLE	3	71,5	2 M, 1 F	7± 2,94
FOOT	5	37	3 M, 2 F	6,58 ± 2

Table III - Mean VAS Score for patients divided into subgroups before and after treatment application.

ANATOMICAL DISTRICT	VAS Before Treatment	VAS After Treatment
KNEE	6,8 ± 1,48	3 ± 2,2
SHOULDER	7,25 ± 1,5	3,5 ± 2,6
ANKLE	7 ± 2,94	2± 2,64
FOOT	6,58 ± 2	2,75 ± 3,2

Fig 2: Mean VAS Score for all patients before and after treatment application.



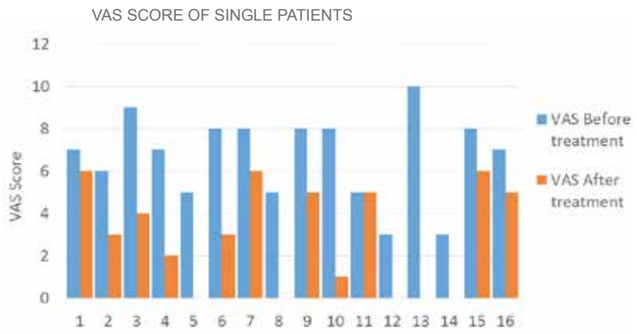


Fig 3: Mean VAS Score for patients divided into subgroups before and after treatment application.

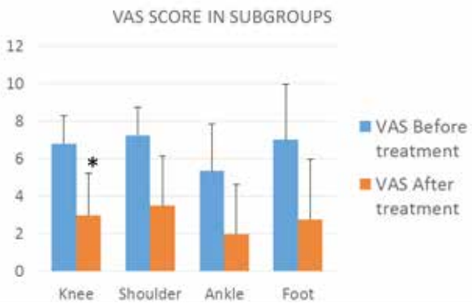


Fig 4:
VAS Score of single patients before and after treatment application.

scores decreased by 62% and 60%, respectively. No patients reported adverse events.

DISCUSSION

The results obtained in this study show that the treatment with a high power, dual wavelength NIR laser source is effective in inducing inhibition of pain referred by patients affected by tendinopathies. Since predisposing factors to pain and following rate of response to treatment are different depending on anatomical area, patients were divided into subgroups and results were evaluated considering the subgroup and the scores of each patient individually. The subgroup of patients affected by knee tendinopathies was the only subgroup where a significant change ($p < 0,005$) of VAS score was reported at the end of the treatment, compared to the basal score (from 6,8 ± 1,4 to 3 ± 2,2). It is important to point out that a patient of this subgroup (see fig. 4, patient 1) was affected by congenital joint laxity; therefore, at the end of the treatment, its score decreased only from 7 to 6 points of the VAS scale (Fig.4). Excluding the values of this patient, in the knee subgroup VAS score decreased from 6,75 ± 1,7 to 2,25 ± 1,7.

A positive result in terms of pain reduction, even though not statistically significant, was obtained also in the subgroup of patients affected by shoulder tendinopathies, where the mean VAS score decreased from 7,25 ± 1,5 to 3,5 ± 2,64. In this subgroup, the lack of statistical significance can be attributed to the small sample size and to a single patient poorly responsive to the treatment (see fig. 4, patient 7, VAS score from 8 to 6). During the treatment, this patient did not follow the doctor's advice and continued sport activity. This behavior partially nullified the effect of therapy and delayed the improvement of symptoms. (Fig.4).

Also in the subgroup of patients affected by ankle tendinopathies, the statistical significance was jeopardized by the small sample size and strongly affected by a single patient who did not report any improvement after the treatment (see fig. 4, patient 11). On the contrary, the other patients of this group had a strong improvement (5,5 ± 3,5 to 0,5 ± 0,7).

In the last subgroup, foot tendinopathies, one patient (affected by tibialis posterior tendinitis) did not finish the treatment, as mentioned above. Although variation was not significant, VAS score decreased from 7 ± 2,94 to 2,75 ± 3,2. In this subgroup half of the patients had excellent results (0 VAS score at the end of treatment) but the other half presented clinical complications (Fig.4). Indeed, a patient was affected by Sudeck's disease, an inflammatory disease of connective tissue that usually occurs after an injury in the arm, hand, shoulder, foot or leg and is characterized by the recurrence of pain, swelling, mobility disorders, skin changes, differences in temperature at the location of the wound after healing. The other patient had a not completely resorbed hematoma that obliged him to additional care (therapeutic massage). In conclusion, about the 70% patients had concrete improvements of symptoms after laser therapy, the 50% had very good results and almost the 30% of patients had excellent results. The patients who had no improvement (only 1) or only a slight improvement showed clinical complications or additional diseases associated with tendon diseases. These conditions would probably have required a therapeutic plan with a higher number of sessions to obtain the positive effects observed in other patients.

Despite the different problems of the patients enrolled and the small sample size, the findings here presented are in agreement with those obtained by other authors in literature, who reported that NIR laser treatment induced significant improvement in pain symptoms, range of motion and function. Tumilty et al. [23] reported that laser therapy promoted reduction of inflammation in the lateral epicondyle of the elbow: measurement of grip strength, a diagnostic tool in the assessment of patients with lateral epicondylitis, was significantly improved in treated patients compared to control group (WMD, weighted mean difference, 9.59 Kg). The same author demonstrated that NIR laser radiation (810 nm), used in combination with the application of an eccentric exercise program, led to clinical improvement in the patients affected by Achilles tendinopathy [25]. In a study of Stasinopoulos et al. [26], positive results induced by a 904 nm laser radiation in the treatment of tendinopathy were also observed in combination with an exercise program, highlighting the importance of combining different therapeutic tools.

Nevertheless, in literature are present several studies where no improvement of the symptoms was reported. Different methodologies and laser parameters, heterogeneity in terms of populations studied, physiotherapy intervention employed and, often, small sample size led to discrepancies among the results reported. Therefore, it is evident that further research is needed to obtain more accurate quantitative data and to establish a homogenous methodology for the use of laser therapy in the treatment of tendinopathies.

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