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Contents

Treatment of Chronic Craniofacial Pain with Mphi Laser and Orthotic

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ABSTRACT

Laser therapy has become an increasingly adopted method of physical medicine to help accelerate healing and reduce pain. Treatment of craniofacial pain using laser therapy has also been vastly researched. The purpose of this study was to determine whether the treatment protocol we use is efficacious in decreasing the painful symptoms of craniofacial pain immediately after treatment. 65 patients (age range 13 to 65) were treated with a dual wavelength NIR laser source. In this Multiwave Loked System (MLS®) laser the two emissions at 808 nm and 905 nm, respectively, with continuous chopped and pulsed delivery, are synchronized. TM joints, masseters, trapezius muscles, and cervical area were treated. The patients were asked to state their overall pain level pre and post treatment using the Visual Analog Scale (VAS). This was then converted into a percentage for ease of documentation. A comparison of pre and post VAS scales showed a 49.9% decrease in pain after the first treatment, 25.2% decrease after the second treatment and 9.0% decrease after the third treatment. In conclusion, the protocol used in the study provided a clinically relevant decrease in craniofacial pain, and a treatment duration of 8 minutes per session could be adapted to the normal clinical setting.

INTRODUCTION

Laser therapy has become an increasingly adopted method of physical medicine as an adjunct, or as a sole therapy, to treat many diseases. While it has not become mainstream yet, many clinicians are turning to laser therapy as a primary tool of treatment due to its low side effects and also ease of use. There has been extensive research done on the effects and efficacy of Low Level Laser Therapy (LLLT). As of date, over 3,900 articles can be found through PubMed on LLLT and its effectiveness toward treating various pathologies. There are many peripheral benefits to LLLT. Lievens [1] demonstrated that LLLT shortens the time and also improves the quality of tissue repair. This is achieved through an increase of microcirculation in the irradiated area, which in turn improves tissue nutrition while decreasing edema by easing the balance of hydrostatic filtration and absorption pressures. Rochkind [2], Enwemeka [3], and Efendiev [4] showed that reparation is significantly quicker and quality of tissue reparation is significantly superior when compared to non-irradiated control groups. There have also been many articles, which have shown that LLLT can be effective in treating TMJ pathologies (capsulitis, arthralgia and osteoarthritis) and related craniofacial pain (myalgia and cervicalgia). Bezuur and Hansen [5] showed that 80% of their study population base of 27 patients demonstrated complete resolution of chronic TMJ pain and, to a lesser extent, myofascial pain reduction with consecutive treatment over 5 days. This, however, did not document long-term benefits to the population base. Bradley [6] showed in a larger study that acute jaw pain can be effectively treated with LLLT as a sole therapy, and in more chronic cases, is an effective adjunct therapy to more traditional treatments such as occlusal splints. The study also demonstrated that, for cases of osteoarthritis, laser therapy was almost as effective as intra-articular steroids, without the risks of steroid use. Kim [7] compared the effectiveness of bite splints to laser therapy. Kim showed that in a two and four week span, the laser group showed more significant resolution of symptoms as compared to the bite splint group. However, conventional wisdom states that the bite splint would take longer to become effective. No long-term effects were noted in the study. Lopez [8] demonstrated the effects of dual treatment through the use of bite splints and LLLT. In their study of 168 patients with concurrent treatment through the use of bite splints and LLLT, they showed that, after 10 LLLT treatments, 90% of patients had shown improvement. Temporomandibular joint (TMJ) tomographic x-rays were taken pretreatment and at 6 months in treatment. They demonstrated that the healing had advanced to a stage usually seen after 12 to 18 months of

treatment using a bite splint solely. 88 patients were treated for pain in the jaw muscles, showing a reduction in pain; however, this was temporary, lasting at most 6 hours. The authors concluded that the wavelength used was effective as a complementary method to bite splints, however, it was not optimal for myogenic pain. Conti [9] demonstrated through their double blind study that low doses of LLLT would show statistically significant results for arthrogenous pain, however, the same energy dose in the myogenic group provided very little relief from pain. The conclusion was that higher doses were needed to treat myogenic pain. Sanseverino [10] demonstrated the validity of this conclusion by applying a higher dose to painful points of masticatory muscles. In this study, there was a significant improvement in painful areas with the laser group. In regards to the treatment of acute and chronic TMJ pathologies using LLLT, Salmos-Brito [11] demonstrated that both groups benefitted in terms of pain reduction and maximum mouth opening from the use of LLLT. They found, however, that acute conditions responded more completely to LLLT, in regards to pain reduction and maximum mouth opening, when compared to patients with chronic TMJ pathologies. Pereira [12] showed that both red awnd infrared laser emissions were successful in reducing facial pain up to 180 days after treatment. However, these treatments were localized to one point per application of therapy and treatment was only applied to points that were tender. Therefore, an extensive palpation exam is needed before each treatment with treatment times varying depending on amount of palpation points that are tender. Again, a specific clinically relevant protocol to treat patients was not well established. Likewise, Ahrari [13] showed in a double blind study that treating myogenous TMD decreased pain and increased function. This study, however, was again limited as the treatment time was 3 sessions over a 4 week period, and palpation of many points was done at each visit to determine the areas to be treated. This length of treatment does not show great clinical relevance as it would be impractical in the clinical setting.

The problems with most LLLT studies of TMJ pathologies and related craniofacial pain are two-fold. First, the treatment time per visit is extensive and includes many treatments. This approach does not lend itself toward effective clinical use of LLLT for the average clinician, as it takes a lot of doctor and patient time. Secondly, most of the previous studies have focused primarily on the TMJ and masticatory muscle pain, while excluding other related myalgias.

There is also an ongoing debate as to what wavelength is most effective in treating pain. Ortutay [14] compared 13 different wavelengths (604-1219 nm) and showed that as long as dosage was controlled, the same pain alleviation was achieved regardless of wavelength. However, his study focused solely on lasers that emitted only one wavelength.

As of date, there are no established protocols for LLLT treatment of TMJ capsulitis, arthralgia, osteoarthritis and resultant other myalgias, especially in terms of an effective protocol to be used in a clinical setting. The purpose of this study was to determine whether the protocol we used for the treatment of patients suffering from TMJ capsulitis, arthralgia and/or facial myalgia produced an immediate relief of painful symptoms in the patient.

MATERIALS AND METHODS

The study group consisted of 35 women with mean age of 41.5 (+13.6) with a range from 13-65 years of age. Patients were collected from 2 independent clinical sites, in San Diego CA and St. Charles, IL. However, the protocols for laser treatment were identical. All patients complained of symptoms of TMJ pain, masseter pain, cervical pain, and/or shoulder pain. They had been previously diagnosed with TMJ pathologies ranging from capsulitis to osteoarthritis. The exam consisted of using muscle palpation, clinical exam, Joint Vibration Analysis (JVA) and Cone Beam Computed Tomography (CBCT) or Tomograms. All patients were being concurrently treated with functional orthotics as they were in active therapy for their varying TMJ pathologies. The types of orthotics used were a mandibular positioned day appliance for waking hours and a maxillary positioned night appliance for sleep. The positions were taken at the minimum speaking space using the phonetic "S" technique during the day orthotic and the maximum speaking space using the same phonetic "S" technique for the night orthotic, as described by Singh [15].

The laser therapy was administered by using a Multiwave Locked System (MLS®) laser (model Mphi, ASAlaser, Vicenza, Italy) which is significantly different than other laser delivery systems: it combines and synchronizes a pulsed emission at 905 nm and a continuous chopped emission at 808 nm wavelength.

MLS® laser therapy was applied with the following protocols:

- Cervical region- 1 minute at an intensity of 50% and a frequency of 700 Hz. Continuous vertical movement was performed from the base of the skull to the start of the upper back. Total of 16.4 J applied (Figure 1).
- Upper Trapezius region- 1 minute 30 seconds at an intensity of 50% and a frequency of 700 Hz. Continuous horizontal movement was performed from the spine at the base of the

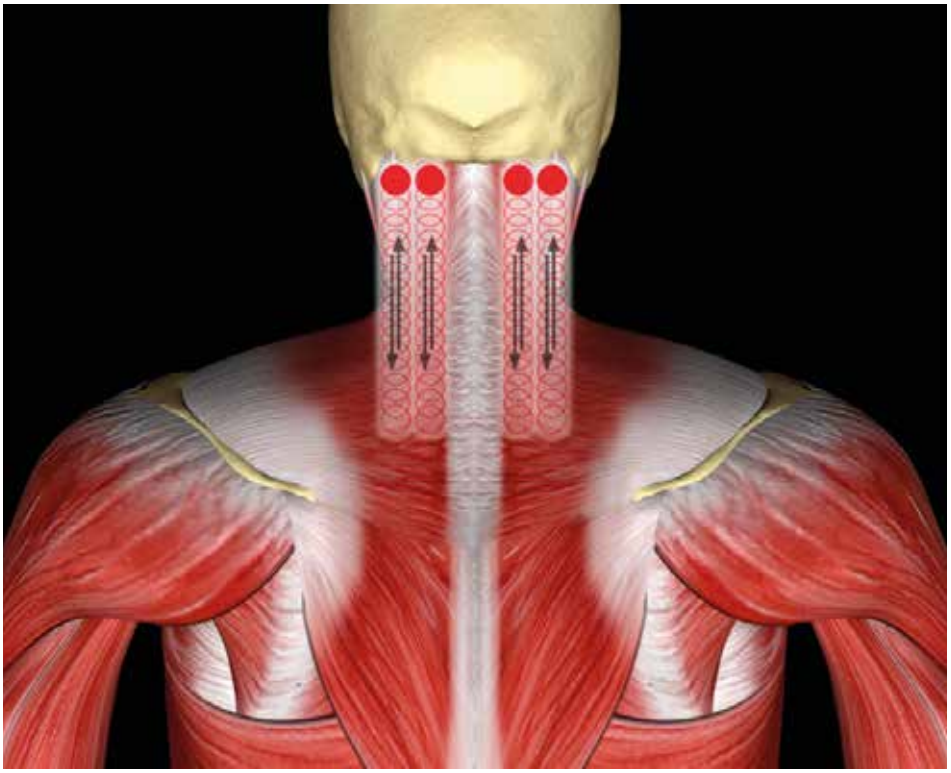
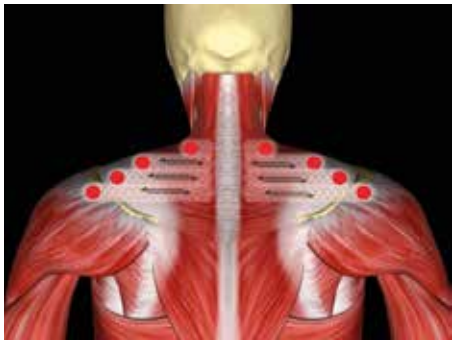


Figure 1



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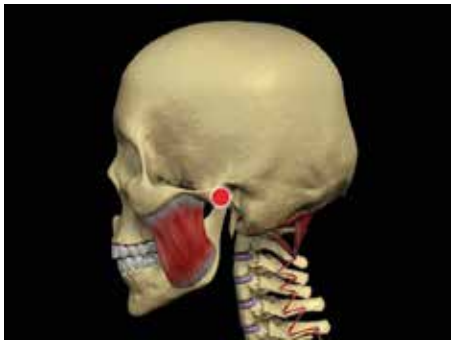

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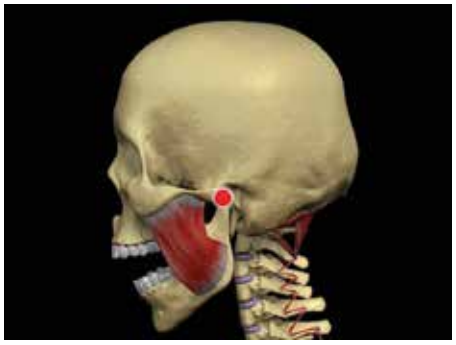

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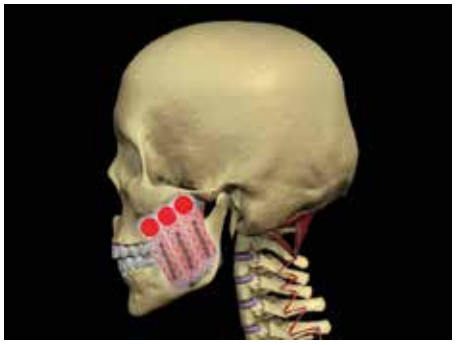

Figure 5

cervical region to the acromion. Total of 24.6 J applied (Figure 2).

- TMJ Lateral Capsule - 30 seconds at an intensity of 50% and a frequency of 350 Hz. Continuous circular movements around the lateral pole of the TM joint. Total of 7.7 J applied (Figure 3).
- TMJ Posterior Joint Space - 30 seconds at an intensity of 50% and a frequency of 350 Hz. The patient rested their incisors on a bite block and the laser was continuously moved in circles around the posterior TM joint space. Total of 7.7 J applied (Figure 4).
- Masseter muscles - 30 seconds at an intensity of 50% and a frequency of 350 Hz. Continuous vertical movements were made along the path of the masseter muscles. Total of 7.7 J applied (Figure 5).

RESULTS

The reductions in pain were cumulative; therefore, the second treatment reduction was applied to the residual pain after the first treatment and the third treatment reduction was applied to the residual pain after the first and second treatment. When evaluating the percent reduction of painful symptoms after conversion from before and after VAS scores, it was noted that the percent reduction in pain after the initial treatment was 49.9% while the percent reduction in pain following the second treatment was 25.2% and the percent reduction in pain following the 3rd treatment was 9.0%. The non-parametric Wilcoxon Rank-Sum Test was applied to the data due to its non-normality (See Table I).

The Wilcoxon Rank - Sum Test showed a significant reduction from the first to second application ($p < 0.001$) and a smaller, yet still statistically very relevant reduction from the second to the third application ($p < 0.01$). This suggests a process of diminishing returns through subsequent treatments, however, it also shows that a variable number of treatments is justified.

Reduction of Discomfort	After 1st Tx Residual	After 2nd Tx Residual	After 3rd Tx Residual
mean Confidence Interval Std Dev	49.9% 43.3 - 57.5 23.06	25.2% 18.2 - 32.2 21.22	9.0% 2.8 - 15.2 18.65
Wilcoxon Rank p <		1st to 2nd 0.001	2nd to 3rd 0.01

Table I

It should be noted that 12 patients stated upon the follow-up appointment that they continued to experience a decrease in pain for about 2 hours after treatment. However, this decrease in pain was not an object of the study and therefore was not considered in the analysis.
One patient experienced slight dizziness within the first hour after laser treatment was accomplished. No other side effects were noted following treatment. None of the patients stated that she did not feel some relief from the treatment.

DISCUSSION

For many years LLLT has been widely used to treat joint and muscle diseases of different origins. The MLS® laser was chosen as laser source because it combines two different infrared emissions at wavelengths of 808 and 905 nm, respectively. The 808 nm radiation is absorbed by the cytochrome oxidase and it is known that the consequent enzyme activation promotes the production of ATP [16]. It has been demonstrated on animal models that exposure to 905 nm radiation significantly increases the activity of complexes I, II, III, IV of the respiratory chain and succinate dehydrogenase, thus leading to the synthesis of ATP [17]. In summary, both the emissions of the MLS® laser favor the production of ATP, acting synergistically on the main biochemical pathways of cellular energy metabolism. ATP availability is necessary for all the biological functions, but particularly important for muscle homeostasis that needs to be restored in TMD.

Moreover, recent results of in vitro studies demonstrated that MLS® laser favors muscle cell maturation, enhances phosphatase activity, increases the production of the NLRP10 protein, which exerts significant anti-inflammatory activity through inhibition of conversion from pro-interleukin-1β to interleukin-1β, one of the most important mediators of inflammation [18].
Along with using the MLS® laser, the specific protocol was both clinically applicable and successful in decreasing the VAS and resultant pain of the patient. While most studies have concentrated only on treating myofascial points, the correlation between jaw/facial musculature inflammation and neck/shoulder pain have also been established. This is the result of forward head posture associated with TMJ capsulitis. Olmos [19] showed that patients with TMJ capsulitis presented with forward head posture and that after treatment and a reduction of inflammation, the statistical analysis showed a return of 4.43 inches of a more normal, more erect head posture. If the neck and shoulder muscles are involved in TMJ pathology, then it stands to reason that they should also be included in treatment for the patient to receive maximum benefits. Simmons [20] found occipital cephalgia is a primary symptom of TMJ inflammation occurring on average 94% of the time at the insertion of the extensor muscles of the neck and shoulders, right at their insertions to the occiput.
There were certain limitations to this study. Due to the study being done entirely in a private practice setting, there was no placebo group and treatment with the laser was done concurrently with orthotic treatment to decompress the TM joints. The size of the sample group was also smaller, although large enough to achieve statistical significance. Finally, due to the typical prevalence of females to seek treatment for TMJ pathologies, this group was also entirely female. A follow up study is indicated with a larger sample size, more diverse sample group, along with a blinded placebo added.

Based on the results of the study, the protocol described has been shown to be an effective treatment to aid in the reduction of craniofacial pain. The success of the therapy results from anti-inflammatory and analgesic properties of the 808 nm and 905 nm emissions of the laser. The 12 subjects, that found a resulting decrease in pain in the hours, after treatment benefited of the anti-inflammatory action

CONCLUSION

This study demonstrates that MLS® therapy can be an effective supplement to the clinical setting. While many studies

have shown LLLT to be effective, many have used protocols that were not clinically relevant, such as extended treatment time or treatment for many consecutive days. In the typical clinical setting, long treatment times are impractical. Thus the 8 minute treatment time, in conjunction with showing an immediate reduction in painful symptoms, demonstrates that the protocol can be implemented into a clinical practice.

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Management of chronic Achilles tendinopathy with High Intensity Laser Therapy (HILT®) and eccentric exercises.

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ABSTRACT

Achilles tendinopathies are classic pathologies due to functional overuse that mostly affect sportspeople and that are characterized by degenerative rather than inflammatory alterations. They present risk factors which can be related to intrinsic features of the subject or independent from these. Achilles tendinopathies classify in insertional tendinopathies and non insertional tendinopathies. Non insertional tendinopathies are localized in the area between 2 and 6 cm from the calcaneus insertion and they are the most frequent ones. Insertional tendinopathies are instead localized within 2 cm from the insertion and they are frequently accompanied by posterior calcaneal and/or superficial bursitis. Among the recommended treatments, the eccentric exercises present the major evidences in literature. In this clinical study we selected 20 patients affected by Achilles tendinopathy and we divided them into two homogenous groups. In group A all patients have been treated with High Intensity Laser Therapy (HILT®) combined with eccentric exercises, while in group B patients have carried out eccentric exercises combined with a HILT® placebo. From the analysis of the data obtained through pain VAS scale and functionality VISA-A scale, it emerged that both groups obtained a progressive pain decrease and functionality increase. However, the group A (HILT® + eccentric exercises) achieved statistically better results compared to group B (eccentric exercises + placebo HILT®) with a pain decrease equal to 74% against 57% and a functionality increase equal to 90% against 64%. In conclusion, our clinical study pointed out that HILT® combined with eccentric exercises is able to achieve better results in respect to eccentric exercises alone.

INTRODUCTION

Achilles tendon is the thickest and strongest tendon of the human body. It connects the triceps surae muscle to calcaneus. Achilles tendinopathy is a classic pathology due to functional overuse, where repeated micro traumas determine tendon structural alterations which reduce the mechanical resistance of the tendon by exposing it to additional lesions [1,2].

Achilles tendinopathy has an high incidence in sportspeople, especially in running (11% of all sport- specific pathologies), dancing (9%), tennis (2-4%) and soccer (2,4%). On the other hand, in adult population it has a prevalence of 2,35 cases every 1000 requests of medical consultation [1,3].

The risk factors for Achilles tendinopathy can be divided into intrinsic factors if related to individual features and extrinsic factors if independent of the subject characteristics [2]. The main intrinsic factors are: poor vascularisation of Achilles tendon in its mid-portion, advanced age, overweight, postural or plantar defects, lower limbs dismetries, deficiency and asymmetry of muscle strength and elasticity, previous trauma. The main extrinsic factors are: incorrect training or working techniques, inadequate footwear, extremely hard playing fields or working surfaces, abuse of toxic drugs for tendons (chinolonics, corticosteroids).

From a pathological and anatomical point of view, Achilles tendinopathies classify in two categories [4]:

1. Insertional tendinopathy
2. Non insertional tendinopathy

Insertional tendinopathy [1,3] is localized in an area within 2 cm from the calcaneus insertion. It has a prevalence of 20-25% and it is characterized by insertional degeneration with thickening, micro calcifications and partial lesions. Frequently it is accompanied by superficial and/or posterior calcaneal bursitis.

The main causing factor of this kind of tendinopathy is the functional overuse in presence of foot supination or Pes Cavus. In the 25% of cases it is also present the Haglund's, deformity which consists in the alteration of the postero-superior prominence of the calcaneus. This deformity can determine an impingement

syndrome with posterior calcaneal bursa and with Achilles tendon in its ventral part during repeated flexion-extensions ankle movements.

Non insertional tendinopathy [1,3] or mid-portion tendinopathy is instead localized in the portion included between 2 cm and 6 cm from the insertion on the calcaneus, a portion that is affected by a minor blood supply. This typology of chronic tendinopathy is the most frequent one (55-65%) and potentially the most dangerous one because it is associated with a greater incidence of Achilles tendon rupture. Non insertional tendinopathy is characterized by tendon degeneration (or *Tendinosis*) without evidence of inflammation in the tendon context. Tendinosis appears with tendon thickening, disorganization of collagen fibers, non-collagenous matrix increase, cellularity alterations, neoangiogenesis, partial lesions of longitudinal type or more frequently ovalar [4]. Tendinosis is often accompanied by *Paratendinopathy* with paratenon inflammation, swelling and - in most chronicized forms - adhesions that limit the regular flowage of the tendon in its sheath. Neoangiogenesis phenomenon occurs in about 70% of symptomatic tendons [5]. *Neoangiogenesis* consists in the formation of new vessels accompanied by sensory nerves which starting from paratenon go deep into the tendon, mainly in its ventral portion.

Typical symptoms of Achilles tendinopathies are pain during and after physical activity, *tenderness on palpation and morning stiffness*.

The cause of pain in Achilles tendinopathies is still a subject of debate [6]. The mainly validated theory attributes the reason to the presence of sensory nerves that accompany new formed vessels during neoangiogenesis and that produce nociceptive and pro-inflammatory substances (Glutamic Acid and Substance P in particular).

The *conservative treatment* is the first approach to chronic Achilles tendinopathies, while surgery is reserved in case of conservative therapies failure for at least 6 months [7,8]. Among conservative treatments eccentric exercises have strong evidence especially in non insertional tendinopathies. There are several eccentric protocols among which the *Halfredson H.* [9] protocol is the most known. Among the instrumental therapies *Extracorporeal Shock Wave Therapy* has shown a moderate scientific evidence on Achilles tendinopathies, thanks to its known direct and indirect mechanical effects. Some protocols associate Extracorporeal Shock Wave Therapy to eccentric exercises with better results compared to single therapies.

Some randomized controlled studies on the animal highlight the therapeutic effects of *Low Level Laser Therapy* (LLLT) on Achilles tendinopathies [10]: modulation of inflammatory response following trauma, analgesic effect, antioxidant effect, effect stimulating the healing process by increasing collagen production (type I in particular) and tenocyte proliferation. Other conservative therapies like injections, orthoses, NSAIDs, cryotherapy, currently have limited evidence levels [7,8].

High Intensity Laser Therapy (HILT®) is a more recent methodology [11]. This technique comes from the awareness of Low Level Laser Therapy limits, like the limited penetrance inside the tissues and the inability of obtaining an efficient photomechanical effect. HILT® is indeed able to transmit elevated amounts of energy in the deepest tissues and induce photomechanical effects, thanks to high peak levels. Recent randomized controlled studies in literature highlight HILT® beneficial effects on some musculoskeletal apparatus pathologies like myofascial pain [12], subacromial impingement syndrome, gonarthrosis [13], low back pain [14] and Bell paralysis [15]. However there are not evidences yet about HILT® efficacy on Achilles tendinopathies. Purpose of this study is evaluating efficacy of HILT® combined with eccentric exercises on Achilles Tendinopathies.

MATERIALS AND METHOD

We selected 20 patients (16 males and 4 females; average age 40/41; range 24-57 years-old) affected by Achilles Tendinopathy. 14 patients were affected by *non insertional tendinopathy* (12 males and 2 females), 6 patients presented insertional tendinopathy (4 males and 2 females). The patients have been divided into two groups (A and B) homogenous for pathology, age and sex (Table I).

In *group A* all patients have been treated with 10 daily sessions of HILT® for two consecutive weeks, in association with an eccentric exercises program to do at home every day for 4 weeks.

The patients of *group B* have been treated with the same eccentric protocol as the patients of group A in association with 10 sessions of HILT® placebo (carried out without laser dispensing, but only with guide light).

Group	Age and Sex	Pathology	VAS at T0	VISA-A at T0
A	40,7 ± 11,96; 8♀,2♂	7 non insertional; 3 insertional	5,53 ±0,36	44,2 ±3,65
B	40,7 ± 11,96; 8♀,2♂	7 non insertional; 3 insertional	5,26 ±0,67	45,2 ±3,16

Table I: basal values (at T0) of the two groups.

The evaluation of each patient has been realized by means of pain VAS scale and functionality VISA-A scale. The VAS is a visual analog test which evaluates the subjective painful symptomatology. The score varies between 0 (lack of pain) and 10 (biggest imaginable pain). The VISA-A scale is a specific test for Achilles tendinopathies. It consists in 8 questions regarding pain, function and functional activities. The score varies between 0 (biggest limitation) and 100 (asymptomatic patient).

VAS and VISA-A have been carried out before the therapy (T0), two weeks after (T1) and 4 weeks after the beginning of the therapy (T2).

Data have been analyzed through Microsoft Office Excel software, considering them statistically significant with a value of P<0,05 and highly significant with P<0,001.

Hilterapia® protocol

In the present study all patients have been treated with SH1 device (ASA Srl, Arcugnano [VI], Italy). The patients of group A have carried out 10 daily sessions with the following parameters: fluence 760 mJ/cm^2, frequency 20 Hz and 2000 J of total energy. The scanning speed was slow. The patients of group B have been subjected to 10 daily sessions by only using the guide light of SH1 device (helium-neon source).

Eccentric exercises protocol

The patients of both groups have carried out at home 30 daily repetitions of eccentric exercises for 4 weeks. The exercises consisted in slow flexion-extensions of the ankles on a rung, followed by stretching exercises.

RESULTS

VAS Scale: Both groups highlighted a progressive pain decrease, with significantly reduced (P<0,001) VAS scores in respect to basal value both at T1 and T2 (Figure 1). The mean scores of the two groups before the treatment (5,53±0,36 in group A and 5,26±0,67 in group B) did not highlight significant differences (P=0,22). At T1 the scores were 1,82±0,32 for group A and 3,92±0,53 for group B, with a highly significant difference between the two groups (P<0,001) in favor of group A; at T2 the scores were respectively 1,4±0,37 for group A and 2,25±0,33 for group B, again with a highly significant difference between the two groups (P<0,001) in favor of group A.

In percentage terms, in group A VAS score was reduced by 67,1% at T1 and 73,6% at T2; in group B the decrease was equal to 31,2% at T1 and 57,2% at T2.

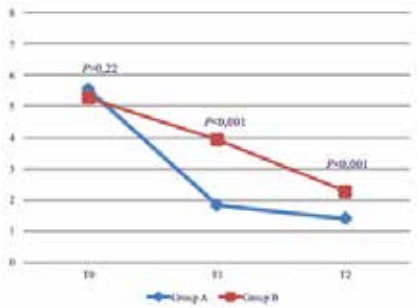

Figure 1: Mean values of VAS score.

VISA-A Scale: Functional scores examined with VISA-A scale also highlighted for both groups a highly significant improvement (P<0,001) in the mean scores both at T1 and T0 (Figure 2) in respect to basal score (T0). The mean scores of the two groups before the treatment (44,2±3,65 in group A and 45,2±3,16 in group B) did not highlight significant differences (P=0,34). At T1 the scores were 78,3±6,01 in group A against 59,8±4,34 of group B, with a highly significant difference (P<0,001) in favor of group A. The same happend at T2 with mean values of 84,1±3,75 in group A and 74,7±3,59 in group B. Therefore the differences between the two groups at T2 were highly significant (P<0,001).

In percentage terms, at T1 the VISA-A scores increase was equal to 77,15% in group A and 32,3% in group B. At T2 the increase was equal to 90,3% in group A and 63,9% in group B.

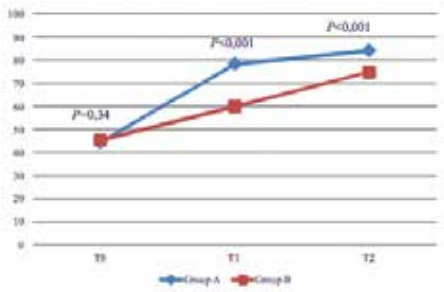

Figure 2: Mean values of VISA-A score.

DISCUSSION AND CONCLUSIONS

The greater knowledge of anatomic and etiopathological aspects of tendinopathies has, over the last few years, allowed the abandonment of the term Tendinitis in favor of the term Tendinosis, underlining the fact that chronic tendon pathology is characterized more by histological and biomechanical alterations rather than an inflammatory component. In parallel, it has been clearly highlighted that pain perception in tendinopathies is not much linked to tissues inflammation, but more to the presence of new formed sensory nerve endings that produce nociceptive and pro-inflammatory substances. Tendinopathy treatment has also conformed to these "new" concepts, being seen more and more like a multimodal treatment oriented to stimulation of tendon regeneration and painful stimulus inhibition. In this sense the eccentric exercises protocols have been shown to have positive effects on tendon structure, its mechanical resistance and on the reduction of nociceptors [9].

In this clinical study we have therefore focused our attention on chronic Achilles tendinopathies treatment with HILT® combined with eccentric exercises, compared to eccentric exercises alone.

From the obtained data we can highlight that group B, treated with eccentric exercises alone, had a progressive and gradual pain decrease and functionality increase with a slow and constant trend.

After two weeks of treatment, the VAS mean score decreased by 31,2% and mean VISA-A score increased by 32,3%; after four weeks VAS score reduced by 57,2% and VISA-A score increased by 63,9%.
Different trend had the data obtained from the group of patients treated with eccentric exercises combined with HILT® (group A). After two weeks VAS score decrease and VISA-A score increase were more sudden (VAS –67,1%; VISA-A +77,15%), highlighting that the combination of High Intensity Laser Therapy with eccentric exercises allowed to achieve significantly better results. Between two and four weeks the trend of VAS decrease and VISA-A increase curve proved to be more similar to that of group B. That happened because in that period the patients of group A carried out only eccentric exercises, as well as those of group B.
In conclusion, according to the current scientific evidences the eccentric exercises play an essential role in Achilles tendinopathy healing process. Our study has confirmed this evidence and furthermore has highlighted that by associating eccentric exercise with HILT® therapy it is possible to reduce pain in a stronger and more precocious way and, at the same time, significantly increase functionality in patients affected by Achilles tendinopathy.
However, we believe that the achieved results are preliminary, being necessary the using of a larger population and a longer follow-up.

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Laserpuncture with MLS® (Multiwave Locked System) system Mphi: safety and clinical efficacy in joint disease, preliminary data.

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ABSTRACT

The article discusses preliminary results of laser acupuncture with Multiwave Locked System in osteoarticular diseases. Laser acupuncture is a modern technique to stimulate acupoints without needling. The effects of laserpuncture on 67 adult outpatients are discussed. Laser acupuncture showed to be a safe and painless tool to manage osteoarticular pain. Parameters, dosages and modality are discussed: laserpuncture needs lower frequency and lower dosage than other laser's therapy protocols. Our results suggest that laserpuncture with MLS® could be a good non-pharmacological treatment in the management of chronic pain.

INTRODUCTION

Acupuncture is considered an excellent tool for non-pharmacological treatment and control of pain in osteoarthritic disease: mechanisms of action are well known and have been studied for decades by the international scientific community [1,2]. Acupuncture uses the stimulation of specific points on the body, which vary according to the situation, to get through local and general reactions, a reaction of reduction of pain and to facilitate recovery. The most classic form of point stimulation uses needles (characteristic and very thin needles). The acupuncture point was recently defined as NAU ("Neural Acupuncture Unit"), which corresponds to a set of concentrated neuronal and neuroactive components, present in the skin, muscle and connective tissue [3,4].

Explained from the point of view of Western medicine acupuncture is a technique of peripheral sensory stimulation (via activation of peripheral A-delta and C fibers) applied at specific points, acupuncture points and/or trigger points, which activates the nerve pain pathways, causes the release of pain-killing substances and causes a rebalancing of muscle contractility and of sympathetic nervous system . The WHO documents, milestones in the literature on acupuncture, show the pathological situations in which acupuncture has proven to be effective, mainly in headache, knee pain, back pain, cervicalgia, epicondylitis, shoulder pain, rheumatoid arthritis [5,6].

The use of laser light to stimulate the acupuncture points is carried out by about 3 decades [7]. In the scientific literature (PubMed), there are over 500 works on laser - acupuncture, which show that it is a form of effective points stimulation. Laserpuncture consists in the treatment of acupoints with the laser light beam and it is defined as "stimulation of traditional acupuncture points with low intensity laser irradiation, which does not induce heat". In the Western world it is little known that pioneers doctors of laserpuncture are just from China.

The light beam generated by the laser device is directly applied to the skin at the level of trigger points (acupuncture "ASHI" points) and to the specific acupoints and meridians according to the syndromes identified by Traditional Chinese Medicine. The points of laserpuncture are in fact selected using the same selection rules of classical acupuncture. The scientific literature on laser acupuncture is quite extensive although not conclusive, and it is not yet clear whether there are differences between laser puncture and needle puncture [8-10]. The stimulation of acupoints with a laser beam seems to have an effect similar to classic acupuncture, both at clinical and neuro-molecular level. The effects of laserpuncture are in fact partly due to peripheral nerve stimulation, to the modulation of afferent input on second-order neurons and spinal analgesia increase by endogenous opioid, through the action of central mechanisms. The laser also acts at the cellular and local level with evidence of modulation of immune processes. Some reports suggest that laserpuncture can be even more effective than traditional acupuncture. In fact, the laserpuncture combines the effects of acupuncture to the effects of biostimulation of the laser beam.

The "photo-bio-stimulation" of specific laser wavelengths on the acupoint can cause biochemical changes, electrochemical and structural properties at the cellular level, triggering additional factors on the outcome of the disease.
However, many questions still remain, mainly related to the instrumental parameters to be used in the technical practice. There are recognized international organizations that offer laser therapy recommendations. For example The "World Association for Laser Therapy" (WALT) [11] suggests doses ranging from 2 to 16 Joules for laser treatments. The "Australian Medical Acupuncture College" established [12] that "the energy density for optimal laserpuncture and biostimulation, based on current clinical experience , is 4 J/cm^2". The most important determinant of the effectiveness of laserpuncture is the depth of action, and the technical parameters have been recently established [13].The depth of action of the beam depends (besides the characteristics of the subject) on wavelength, dosage, beam intensity, energy density, dose range (which varies in the literature between 0,001 J/cm^2 and 10 J/cm^2), continuous or pulsed laser emission. Tuner and Hode, both appraised researchers on laser therapy, have recently stated that "dose is a very complicated issue. It is a matter of wavelength, power density, type of tissue, condition of the tissue, chronic or acute problem, pigmentation, treatment technique, and so forth" [14]. Still Tuner and Hode say "anyone who studies the literature carefully can become confused. Some wavelengths achieve the best effects on This and That, while others have poorer effects or none at all. Some doses lead to beneficial effects, but when the dose is increased, the effects wear off . If we treat a condition, some of the parameters we want to influence may be affected, but perhaps not all. If we administer treatment from a distance, we do not get the same effects as if we treat analysis or in contact with pressure. Some frequencies produces effects on pain, others on edema. What are we to believe? And what do we do to find the best dose, wavelength, and so forth?".
Good experimental data seem achieved when two different wavelengths are combined together, with a so-called two-color laser [15]. The continuous emission simulates the continuous presence of the needle, while the pulsed emission allows a greater depth of action and a bio-stimulating effect. Only recent research has begun to explore the possibility of using high-intensity laseracupuncture to replay the stimulation of the needle [16]. At the state of the art today, the optimal power of the laser beam in the laser acupuncture lies between 5-500mW, and the therapeutic effect of laser-puncture is obtained for wavelengths between 600 and 1000 nm. With the red laser (600-700 nm) there is a little of penetration through the skin and is usable to treat the surface points (Jing Well points) like those of the tip of the fingers and toes, while the IR laser (800-1000) are used for the deeper points, on the arms, legs, trunk and ASHI points.

A laser beam of 5-20 mW directly on the skin produces no pain, no heat or other sensations. The optimal frequency of stimulation for the laserpuncture is very low (10 Hz) and continuous or pulsed emission mode evokes different reactions [17]. The other parameter is the treatment time of each point, which is a function of the laser power and of the type of disease. In general, the higher the laser power the shorter is the treatment time, more time is needed for the treatment of joint pain compared to the soft tissues and more time is needed in chronic conditions compared to acute situations. The dosage is expressed in J/ cm^2 (density): 1W = 1J/sec. Knowing the type of laser we can calculate the necessary time of application. To decide about the dose one must take into account the diameter of the area in cm^2. For laserpuncture we requires the handpiece in contact with the skin, with a few millimeters beam diameter. The acupuncture points are then treated with different doses depending upon the location and depth of the point to be treated. In the literature dosages vary from 0.2-0.5 J/cm^2 up to 4-8 J/cm^2, with time exposure variables based on the laser type. The dose must be adjusted in relation to the assessment of the disease and the individual response. Laser acupuncture is applied in acute and chronic painful conditions, neck pain and low back pain, shoulder pain, joint pain from osteoarthritis of the hip, knee, hand, foot, epicondylitis, carpal tunnel syndrome, and in general in all the fields of application of somatic, auricular and microsystems acupuncture. Use of laserpuncture has greatly increased in recent years due to its painless nature and the absence of side effects [18-20].
The laser physiotherapy is considered to be a secure and non-hazardous tool. Many types of lasers have been used over time to stimulate acupuncture points. A new laser is the Multiwave Locked System (MLS®) [21,22], in which the laser diode differs from the other for the simultaneous emission of two wavelengths, different for both wavelength and for emission modes: a continuous emission of 808 nm , and a 905 nm pulsed emission.
The continuous emission has a prevalent anti-inflammatory effect, while the pulsed emission has a predominant analgesic effect: the synchronized double emission causes a reinforcing effect between the two actions, resulting in rapid physiological effects and symptoms relief. The effect of the MLS® pulse was initially tested in vitro on cell cultures, afterwards in vivo in animals and finally on controlled clinical trials.
The laser MLS® has multiple demonstrations of experimental and clinical effectiveness in many diseases and musculoskeletal affections, using established protocols on the basis of experimental and clinical data.

RATIONALE OF THE STUDY

The present study concerns the safety, feasibility and effectiveness of

laserpuncture, using the MLS® laser instrument, type Mphi.
1) The first objective was to evaluate the safety of treatment with laserpuncture using MLS® (in terms of adverse reactions, side effects, both local or general effects).
2) The second objective was to evaluate the clinical efficacy of the treatment and the degree of patient satisfaction.

CASE STUDIES AND METHODS

67 adults patients were treated on an outpatient basis, 28 M and 39 F, mean age 64 aa (range 35-78 aa.) for a total of 402 sessions (mean 6 sessions/patient). The patients suffered from acute or chronic muscle-skeletal diseases, in painful phase: 18 neck pain, 16 low back pain, 13 knee pain, 14 shoulder, 6 arthrosis / arthritis hands.
Before treatment, all the patients were informed of the technique and the specificity of the laser beam, and expressed written informed consent to treatment. The evaluation parameter, which tests the most important symptom in all painful conditions was the Visual Analogue Scale (VAS). It was administered to the subjects before treatment, after 3 laser sessions, at the end of treatment and at follow-up three months after, by telephone interview which consists of four response options: 1 - not satisfied, 2- not very satisfied, 3 - satisfied, 4 - very satisfied.
The treatment was done on an outpatient basis. The patients were treated 3 times / week, every other day, for 2 weeks, for a total of 6 sessions.
The treatment was carried out with laser Multiwave Locked System, Mphi model, with handle in contact, tailored specifically for laserpuncture . The instrument dispense simultaneously two laser rays, with 808 nm and 905 nm wavelength.

The source of 808 nm has a maximum power of 1,000 mW, continuous emission frequency ranging from 1 Hz to 2Khz , while the 905 nm source has a maximum power of 25 W and frequency adjustable from 1 Hz to 2kH. By manually adjusting the parameters it is possible to give the exactly measured J/cm^2, to tailor treatment according to the disease and the site of the chosen points. The intensity of the treatment was set to 50% of the maximum power of the source MLS®.

Treatment protocol used:

For all diseases, ASHI points and points deep the energy delivered was 4-8 J/cm^2, while on the most superficial or very sensitive points, we limited to an energy up to 0.5 J/cm^2. In any case the frequency was always set to 10 Hz. The treatment, for purposes of study, has been globally simplified: “standard” groups of points for each disease were used, while only a few other points were customized in relation to the syndrome and involved meridians.

For patients with neck pain also with shoulders irradiation, with frequent flare-ups of chronic pain relieved by rest and heat: 10 UB, 20 GB, 11 UB, 21 GB, 15 and 16 SJ, and the painful points. The lower extremities bilaterally 59-60 UB, 34-38 GB, Kid 3 or 3 Liv, plus 3 SI in the upper limb .

For patients with low back pain: the sensitive points on the internal branch of the Urinary Bladder meridian, from 21 UB to 34 UB, axial points of DUmai, ASHI points , lateral points on the external branch of the Urinary bladder meridian (50- 54 UB) and 30 GB. On the lower limbs, bilateral: 40 UB, 59-60 UB, 3Kid, and 34-38 GB, plus 3 SI for the upper limb.
Patients with knee pain: always ASHI points, then 34 GB, 34 ST, 35 ST, 36 St, 10 Kid, 9 SP, 8 Kid, 8 Liv, and " eye of the knee ", and ro Ting point. Limbs below 60 UB, 3 Kid, 3 Liv.

For patients with shoulder pain syndrome: ASHI points, and items related to the meridians involved, depending on the pain of the involved movement (anteflexion, retroflexion, abduction, rotation).
Generally 11/10/13 SI, SJ 13-14, 15 LI, 21 GB, bilateral distal point 38 St.

For patients with arthrosis / arthritis in the hand, depending on the affected joint: Lu 9-10 on the thumb, on thumb and index LI points 2-3-4-5, and 2-3-4-5 SI on wrist and little finger. "Extra meridian" points in the palmar surface of the proximal interphalangeal joints, face dorsal interdigital tissue, the dorsal surface of each finger on the proximal interphalangeal joint were treated. In any case the point 4 LI was treated.

RESULTS

Average initial VAS value of patients was 7.4 ± 2.9 (range 4.6-8.1), after 3 sessions it was 5.6 (range 4.9-6.3), and at the end of treatment was found to be 3.2 (range 1.2-4.3). At follow-up three months the pain as measured by VAS was 2.3 (see Fig. 1).

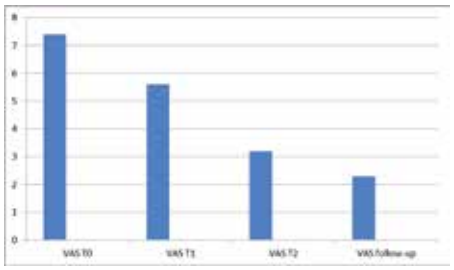

Figure 1 Trend of pain measured with Visual Analogue Scale: before treatment (T0), after 3 sessions (T1), at the end of treatment after 6 sessions (T2), and control at three months.

We found an improvement in variable 61/67 patients (91,04% of patients). At follow-up, the patients answers showed 6 pts.(8,9%) as not satisfied of the treatment, 7 pts. (10,4%) were a little satisfied, 22 pts. (32,8%) said to be satisfied, and 32 pts. (47,7%) resulted very satisfied (see table).

Patient's opinion	Number (tot. 67)
Not satisfied	6 (8,9 %)
A little satisfied	7 (10,4 %)
Satisfied	22 (32,8%)
Very satisfied	32 (47,7%)

Table I: Follow-up telephone questionnaire answers of the treated patients.

No patients reported adverse events, neither local nor general.

DISCUSSION

Although for many years laserpuncture has been used as an alternative to classical acupuncture and there are empirically found interesting results, clinical studies on laserpuncture are relatively few. The most recent publications focus on the effects of brain and autonomic system by the stimulation of certain single points with laserpuncture, getting exciting effects, but still far from the clinic. Furthermore, since the laser instrument market is in continuous innovation, studies concern always new lasers with different emission frequencies and different powers. While reading literature it is difficult to orient ourselves in the standard parameters to be used; probably more than one type of laser is useful to effectively stimulate acupoints, with agreement, however, on the use of low-frequency stimulation and low power.

Our data confirm the results of other studies on the clinical efficacy of laserpuncture [20,23,24]. We obtained a reduction in VAS, from a pre-treatment value of 7.4 ± 2.9 to a value of 2.3 at follow-up to three months. Patient satisfaction has been remarkable: the answers were a 19.5 % non/ little satisfied, and 80.5 % of satisfied/ very satisfied.

In our study we used a laser (MLS®, Mphi) with a dual source which allows a simultaneous emission of two different wavelengths, always in the range of wavelength that were considered effective in the scientific literature. It is possible that this type of stimulation, while allowing a continuous stimulation (such as that of the needle) and a stimulation pulse (which allows to a greater depth of action of the radius) will lead to greater clinical efficacy of the treatment.

The combined emission represents a stimulus that the cell perceives as "different" in the two separate emissions, i.e. a stimulus that induces new and particular characteristic effects, and that cannot otherwise be obtained when the two emissions are used separately.

As in the rest of the literature reviewed, no adverse events occurred.

CONCLUSIONS

The high number of sessions and the clinical variability of the cases treated by laserpuncture allow to first detect the extreme security of MLS®, as no patient had general adverse or skin reactions. In relation to the effectiveness we can give a positive opinion. Probably with further research and discussion on the most appropriate dosages, the results may be even better. Compared to the classical acupuncture we can identify, as measured to data, that the effects of the laser beam appear to be comparable, from the clinical point of view, to the classical acupuncture. Laserpuncture is a safe, non-invasive treatment, non-binding for the patient, thus avoiding the complications of skin puncture. The laser-acupuncture could achieve greater popularity, as acceptable also by patients with needle fear.

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Hilterapia® - high intensity laser therapy in the treatment of severe tendon and ligament injuries.

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ABSTRACT

Laser radiation is absorbed in metabolically active chromophores located in tissue and inside the cells. Photothermal interaction at the tissue level is controlled especially by absorption by target molecules. Temperature changes over time depend on the method used to transfer laser energy to the tissues and especially on the duration and energy of the pulses.

The emission of Nd:YAG (neodymium-doped yttrium aluminium garnet) laser has a wavelength of 1064 nm, that is weakly absorbed by natural chromophores of the skin and subcutaneous tissue. That is why it is able to penetrate deeply in the tissues. Pulses with peak power up to 3000 W, with a duration of approx.

90-120 μs, do not cause any damage to cells because the interval between the pulses lasts long enough for heat dissipation, avoiding harmful effects.

This report describes the results of a pilot study on a set of 7 patients affected by severe tendon and ligament injuries. The treatment consisted in two sessions of Hilterapia® per week, with a total number of 12-24 sessions. The purpose of the work was to objectify the effect of Hilterapia® in the treatment of severe tendon and ligament lesions by assessment of thermal parameter changes as recorded by thermovision, structural changes detected by musculoskeletal sonography, degree of pain using Visual Analog Scale (VAS) and musculoskeletal changes before and after the series of Hilterapia® sessions.

The results showed that Hilterapia® promoted normalisation of temperature patterns in most cases, reparation of tendon and ligament structures in all cases, reduction of pain and the improved musculoskeletal condition in all cases.

INTRODUCTION

Laser radiation is absorbed in metabolically active chromophores located in tissues, cells and intracellular organelles, such as mitochondria. The absorption depends on quality and quantity of chromophore molecules present in tissues [1].

Biochemical processes probably play an important role in antinflammatory, antiedema, analgesic, and biostimulating effects associated with laser radiation. An important role is played by the key elements of the cell redox system, such as cytochromes, nicotin coenzymes and flavoproteins, together with additional molecules. Radiation-induced alteration of stereochemical conformation can result in increased cellular energy metabolism with an up to 200% increase of the ATP concentration [2-4].

Photons can be able to optimize the function of the sodium-potassium pump at the level of cellular membranes, increasing protein synthesis and significantly increasing the number of mitosis [1].

Photothermic interaction at the tissue level is controlled by absorption in the target molecules. Temperature changes over time depend on the method used to transfer laser energy to the tissues and especially on the duration and energy of the pulses.

Nd:YAG (neodymium-doped yttrium aluminium garnet) laser emission has a wavelength of 1064 nm, that is weakly absorbed by natural chromophores of skin and subcutaneous tissues, such as melanin, haemoglobin, water, aromatic amino acids, nicotine coenzymes, flavins, and molecules containing tetrapyrol rings. This characteristics allows a deep penetration in the tissues. The use of a pulsed source (frequency 10-30 Hz) with an interval between the pulses that lasts long enough for heat dissipation, allows to transfer to the tissue high energy density (peak power up to 3000 W) preventing thermal damage.

This paper reports about the results of a pilot study aimed to evaluate the efficacy of Hilterapia® in the treatment of severe tendon and ligament injuries. The effect of laser treatment was assessed by thermal parameter changes as recorded by thermovision, structural changes detected by musculoskeletal sonography, degree of pain using Visual Analog Scale (VAS) and musculoskeletal changes before and after the period of therapy.

MATERIALS AND METHOD

Patients

7 patients, 13-63 years old, mean age 45.3 years, 5 male, 2 female, were admitted for treatment in the period 2/5/2011-12/9/2013. They suffered for severe tendon and ligament injuries: ruptured triceps tendon, partial rupture of Achilles tendon (2x), fibrillar degeneration of Achilles tendon, subachillar bursitis and partial abruption of Achilles tendon insertion, partial rupture of medial collateral ligament (MCL), partial rupture of the lateral and medial meniscus and MCL.

Before treatment, the patients were assessed by musculoskeletal examination, thermography, musculoskeletal sonography and VAS.

Thermography

Thermovision system Fluke Ti32 was used to perform thermovision recordings at 0.05°C resolution. Before each examination, the patient was equilibrated in a darkened room for 15 minutes at a temperature of 23+/-1°C. Thermal recordings were rendered under standard recording conditions, with a perpendicular angle of the thermovision camera with respect to the viewed area, in standard positions and projections. The recorded values were analyzed based on the values of absolute temperature parameters (Tmax, Tmin, Tav, Tmed), where a side difference of 0.5°C and higher was considered significant, as well as on the basis of the assessment of thermal images in each projection [5-11].

Musculoskeletal sonography

Musculoskeletal sonography was performed using the MyLab Gold Esaote ultrasound system with 5-12 MHz resolution, using spatial compounding to increase the image structure resolution [11-15].

Treatment

The patients were subjected to two sessions of Hilterapia® (HIRO 3.0 model, ASA s.r.l., Vicenza, Italy) per week, with a total of 12-24 sessions. The treatment parameter used in the study are reported in Tab. 1

Reduction of Discomfort	Step	Fluence (dose)	Frequency	Energy	Time
Initial Phase (Fast scan)	1	510mJ/cm²	30Hz	166 Joule	
	2	710mJ/cm²	25Hz	166 Joule	
	3	970mJ/cm²	20Hz	166 Joule	
Intermediate Phase (for trigger points if present)	1	360mJ/cm²	15Hz		6 sec
	2	510mJ/cm²	15Hz		6 sec
	3	610mJ/cm²	14Hz		6 sec
	4	360mJ/cm²	16Hz		7 sec
Final Phase (Slow scan)	1	510mJ/cm²	30Hz	166 Joule	
	2	710mJ/cm²	25Hz	166 Joule	
	3	970mJ/cm²	20Hz	166 Joule	
				TOT 1000J	

The efficacy of the therapy was evaluated by assessing the functional changes determined by musculoskeletal examination, thermal parameter changes as recorded by thermovision, structural changes detected by musculoskeletal sonography, degree of pain using VAS following the series of Hilterapia® sessions.

RESULTS

Patient 1

Rupture of the left triceps tendon above the olecranon insertion following a fall in January 2012. Surgery in May 2012. The tendon failed to heal after surgery, repeated surgery was performed in September 2012. Even after this surgery, the tendon was not functional. The patient was examined in our clinic in November 2012. Increased thermal activity 1.8°C in posterior-anterior (PA) view (Fig. 1a), lateral view (Fig. 1b) and medial view (Fig. 1c) was observed on the thermovision focused on the insertion of the triceps tendon above the olecranon. Musculoskeletal sonography was used to find the disrupted fibrillar structure of the tendon (Fig. 1d). At the time of the examination, the degree of pain was 9 on the VAS scale.

The patient was treated using Hilterapia®, 2 sessions per week, for a period of 9 weeks, i.e. a total of 18 applications.

After treatment, the thermal activity was reduced in PA view to 1.0°C (1a), lateral view to 0.5°C (1b), medial view to 0.7°C (1c).

Sonography showed partial restoration of the fibrillar structure (Fig. 1d). The function of the tendon was restored. VAS pain was reduced to 5.

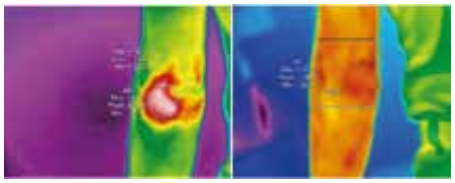

Fig. 1a. Pre- and post-therapy thermogram in PA view.

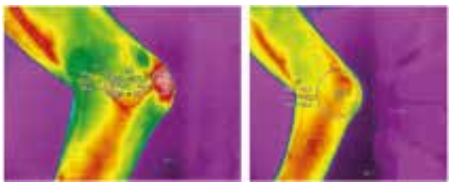

Fig. 1b. Pre- and post-therapy thermogram in lateral view.

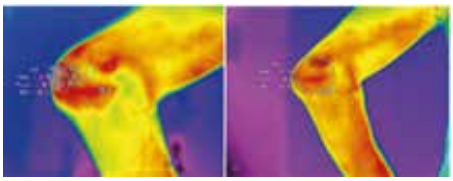

Fig. 1c. Pre- and post-therapy thermogram in medial view.

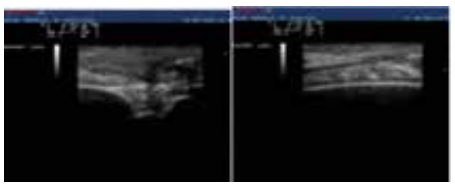

Fig. 1d. Pre- and post-therapy ultrasound.

Patient 2

One year ago, the patient felt pain and had swelling in both Achilles tendons several days after having bicycled up a steep hill. After one month, the pain and swelling in the right Achilles tendon were reduced, but on the left side the pain and swelling persisted. Magnetic Resonance Imaging (MRI) showed the partial rupture of the left Achilles tendon with almost complete granulation - mucoid degeneration.

The patient was examined in our clinic in June 2011. The initial thermogram showed a focus of increased thermal activity + 1.6°C in the left Achilles tendon (Fig. 2a). Initial sonography determined the width of the tendon at the location of the lesion at

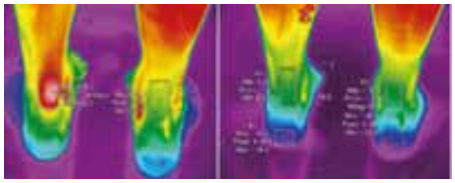

Fig. 2a. Pre- and post-therapy thermogram

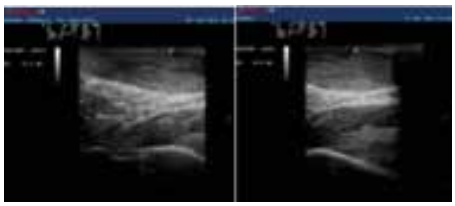

Fig. 2b. Pre- and post-therapy ultrasound.

15.4 mm with mucoid degeneration and hypoechoic longitudinal fissure (Fig. 2b). At the time of examination, the degree of pain was 8 on the VAS scale.

Upon starting the treatment, the patient received Hilterapia®, 2 sessions per week for a period of 12 weeks, with a total number of 24 applications.

After treatment, the thermal activity was reduced to 0.4°C (Fig. 2a). The tendon width was reduced to 14.4 mm, without hypoechoic fissure, partially fibrillarised (Fig. 2b). Tendon function was restored, and the VAS index was reduced to 1.

Patient 3

Pain in the right Achilles tendon dating back to six months before, started playing tennis with shoes that rub excessively at the tendon The patient was examined in our clinic in November 2011. The initial thermogram found a hypothermic area - 0.9°C (3a) above the right Achilles tendon as a result of nociceptive sympathetic efferent activity. Initial sonography determined a tendon width of 8.4 mm with loss of fibrillarity in the upper half (3b). VAS index before therapy was 7.

Upon starting the treatment, the patient received Hilterapia® 2 sessions per week for a period of 8 weeks, with total number of 16 applications. After treatment, the hypothermic area above the right Achilles

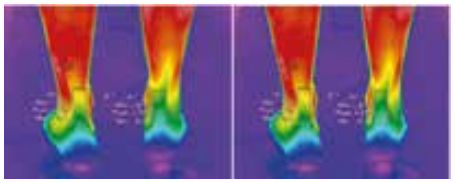

Fig. 3a. Pre- and post-therapy thermogram.

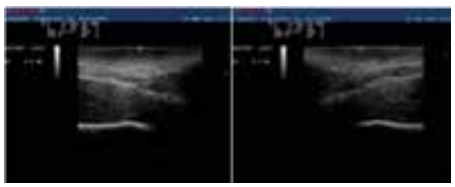

Fig. No. 3b. Pre- and post-therapy ultrasound.

tendon persisted with unchanged intensity - 0.9°C (Fig. 3a). The tendon width on final sonography was 6.6 mm. Fibrillarity was mostly restored (Fig. 3b). Tendon function was restored. VAS pain was reduced to 1.

Patient 4

The patient fell from a ladder 3 weeks before the examination in our clinic, in May 2011. Since the fall, the patient felt pain in the left Achilles tendon and in the posterior aspect of the foot. During the examination an extensive haematoma was present and the patient had pain when walking. Upon examination the patient was proposed a surgical intervention which he refused.

Increased thermal activity was found on initial thermovision examination above the insertion of the left Achilles tendon + 0.9°C (4a). Sonography determined a 70% rupture of the Achilles tendon. Only the surface part was compact (4b.). VAS pain level was 9.

Upon starting the treatment, the patient received Hilterapia® 2 or 3 sessions x per week for a period of 9 weeks, with a total number of 20 applications.

After treatment the increased thermal activity above the Achilles tendon persisted at an unchanged intensity + 0.9°C (4a). On sonography, we observed the restored continuity of the tendon. Fibrillarity was not fully restored (4b). The function of the tendon was restored. VAS pain level was 3.

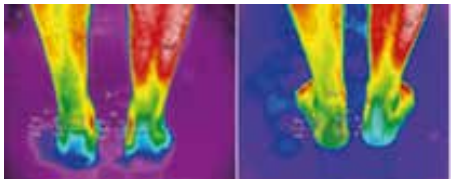

Fig. 4a. Pre- and post-therapy thermogram.

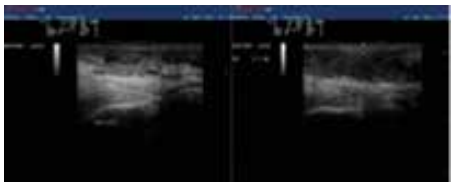

Fig. 4b. Pre- and post-therapy ultrasound.

Patient 5

The patient was examined in our clinic in May 2012. He complained of pain in both Achilles tendons and under the heel following exercise

Before treatment, plantar (5a) and dorsal (5b) thermograms showed a thermal increase of + 0.4°C in the heel area. Pre-treatment sonography (5c) was used to determine the fluid collection in the subachilleal bursa and a small abruption on calcaneus. VAS pain was at 7. The patient was put under treatment. Hilterapia® was applied 2 sessions per week, for 8 weeks, with a total of 16 applications.

After treatment, the thermal activity in the plantar and dorsal aspects was reduced to + 0.1°C. The function of the tendon was restored. VAS pain was reduced to 0.

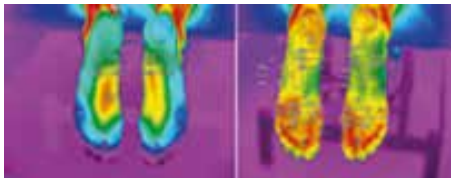

Fig. 5a. Pre- and post-therapy plantar thermogram.

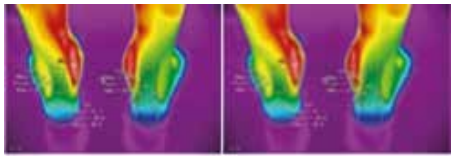

Fig. 5b. Initial and final dorsal thermogram.

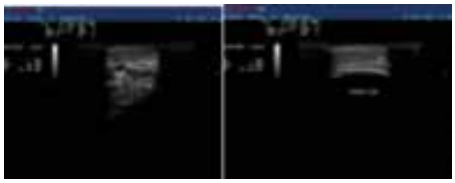

Fig. 5c. Pre- and post-therapy ultrasound.

Patient 6

At judo practice, the patient hooked his right foot with the opponent; he then had the feeling of cracking in the knee. When the patient was examined (November 2013) the pain was localized in the knee, with swelling and limited motion.

Pre-treatment assessment by thermovision demonstrated significant hyperthermia at the right medial condyle of the femur + 2.1°C, lateral femoral condyle and right tibia + 1.6°C (6a).

Pre-treatment sonography showed rupture of the deep layer of the medial collateral ligament (MCL) in the area over the medial femoral condyle and hypoechoic effusion in the suprapatellar recess (6c). The degree of pain was 8 on the VAS scale.

The patient was treated with Hilterapia® for a period of 6 weeks, with a total number of 12 applications (2 sessions/week).

After treatment, the final thermovision assessment demonstrated a reduction of temperature to 1.1 °C over the right medial femoral condyle, to + 0.7°C as regards lateral femoral condyle and right tibia (6a).

Post-trestment ultrasound showed reduced hypoechoic effusion in the suprapatellar recess, narrowing of the deep layer of MCL (1 mm) over the medial joint gap, echo-architecture was restored (6d). The function was partially restored. VAS pain was reduced to 4.

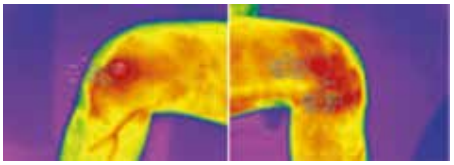

Fig. 6a. Pre-treatment medial and lateral thermogram.

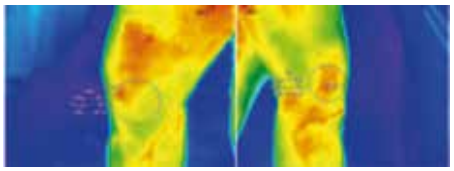

Fig. 6b. Post-treatment medial and lateral thermogram.

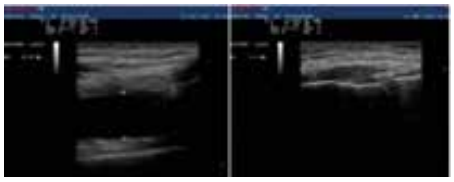

Fig. 6c. Pre-treatment sonographs.

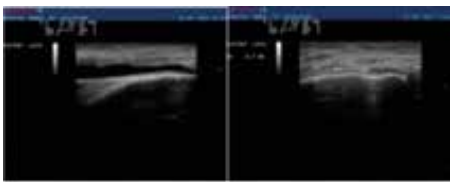

Fig. 6d. Post-treatment sonographs.

Patient 7

The patient first felt pain in the right knee and then fell down. She was transported in the regional hospital. MRI was performed, finding a vertical lesion of the posterior horn of the medial meniscus (MM), unstable vertical rupture of the body of lateral meniscus (LM), grade III, oblique lesion of the MM, grade III, posterior lesion of the anterior horn of LM, partial to subtotal rupture of the anterior cruciate ligament (ACL), hypergranulation of the posterior collateral ligament (PCL), ventral shifting of the tibial condyle with respect to femur by 7 mm, subcortical to cortical fracture in the dorsal aspect of the lateral

condyle of tibia without dislocation, elongation of patellar ligament.
The patient was examined in our clinic in in 2013. Initial thermograms showed foci with increased temperature in the AP view on the right side of the knee + 2.1°C and in lateral view, always on the right side + 1.7 °C (Fig. 7a). Initial sonography found longitudinal lesion of the medial collateral ligament (MCL), subcutaneous lesion in the adipose layer above lateral collateral ligament (LCL) (Fig. 7c). VAS scale before treatment was 8. The patient was treated with Hilterapia® for a period of 6 weeks, with a total number of 12 applications. After treatment,

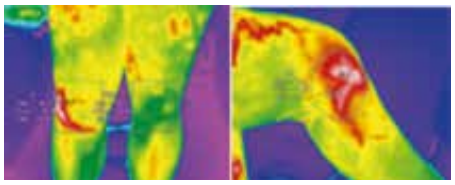

Fig. 7a. Pre-treatment thermograms, anterior and lateral.

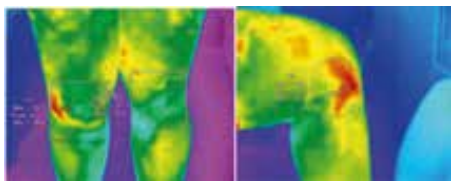

Fig. 7b. Post-treatment thermograms, anterior and lateral.

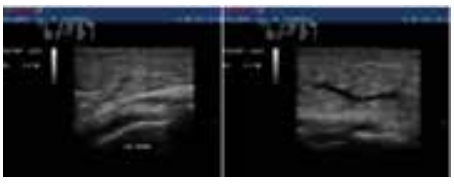

Fig. 7c. Pre-treatment sonographs.

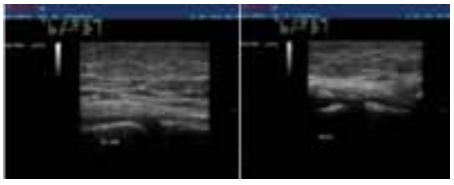

Fig. 7d. Post-treatment sonographs.

the thermovision assessment showed a reduction of temperature to + 0.7°C in PA view on the right part of the knee and to + 0.8°C in the right lateral view (Fig. 7b). Final sonography showed normalisation of the echo-structure of the medial collateral ligament (MCL) and lateral subdermal layer (Fig. 7d). The function was restored. VAS pain was reduced to 2.

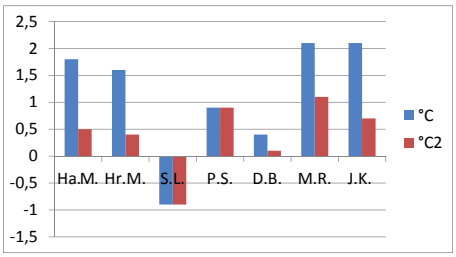

Fig 8. Effect of Hilterapia® on the thermal parameters.

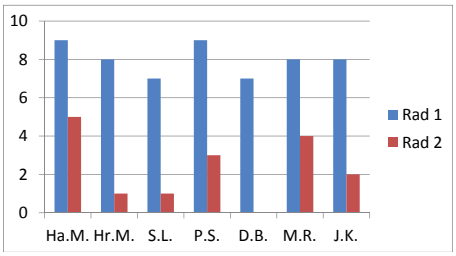

Fig. 9. Effect of Hilterapia® on pain.

DISCUSSION

Thermography is a diagnostic technique widely used and accepted. In our clinic, we have been performing the thermovision assessment of locomotory apparatus for research and clinical purposes for 29 years. Over this period, we performed and analysed more than 34,000 thermovision recordings of various parts of the locomotory apparatus. By thermography, we have repeatedly objectified the effectiveness of different physical and rehabilitation therapy options [16-29]. Over the last 10 years, we have complemented the thermovision examinations with ultrasound examinations. This provides us with information on the pathophysiology of pain as well as on the structural damage. Since 2010, we have had the opportunity to use Hilterapia®, an advanced system of NIR laser therapy. Over this time, we have used this system on more than 500 patients with different injuries to soft tissues of the locomotor apparatus. The effectiveness of this therapy has been objectified by clinical examination, VAS assessment, and by the use of imaging methods (X-Ray, MRI, Ultrasound, Thermography). Vervainioti, while observing patients with low back pain, found greater effectiveness in the improvement of pain symptoms and support of healing with simultaneous use of HILT, compared to the only standard physical therapy approach [30]. Viliani supported the importance of laser therapy and laser-puncture in the management of arthropathies and musculoskeletal problems in haemophiliac patients [31]. To evaluate the effectiveness of Hilterapia® in our study, we chose severe ligament and tendon lesions, many of which would be indicated for surgical repair, and in some of them even repeated surgery failed to restore the structural functionality. The objective was to assess the possibility to use Hilterapia® as an alternative therapy to surgical repair for several types of damage to the soft tissues of the locomotor system. In agreement with the findings of other [30,31] the results of the present study demonstrated the efficacy of Hilterapia® in the management of musculoskeletal diseases.

CONCLUSION

In the presented cases of severe tendon and ligament lesions we observed the effectiveness of Hilterapia®

- in reducing temperature alteration and, in most cases, normalising the temperature patterns
- promoting repair in tendon and ligament structures in all cases
- reducing pain in all cases
- favouring restoration of the function in all cases.

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Fields of application and effects of laser therapy in veterinary: an overview on some case reports.

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In recent years, the use of laser therapy has had a significant expansion in the veterinary field. Laser therapy, having achieved remarkable results in the field of human health, has also been applied to the veterinary field with equal success and its use is extending to all domestic species and even exotic animals.

The situation is constantly changing, since in addition to the application of laser therapy in different therapeutic areas, it was necessary to evaluate the differences among the species in order to optimize treatment protocols.

The passage from the human to the veterinary physiotherapy was the first step towards an increasing amount of applications: arthritis, neurology, dermatology and the most diverse fields of application, of course in different species, as clearly demonstrated by the case reports described by many colleagues who use almost daily laser therapy.

MLS® Laser therapy has proven its effectiveness in different situations: the synergistic effect of the two wavelengths has proven a very valuable asset in counteract diseases characterized by inflammation and pain, promoting tissue repair and homeostasis. Thanks to these characteristics MLS® therapy may be applied to manage many different diseases.

The laser-tissue interaction can induce photochemical, photothermal and photomechanical effects.

It has been demonstrated by many studies that these effects can interfere with molecular and cellular mechanisms, thus affecting biological processes such as inflammation and pain transmission, improving the symptomatology and accelerating healing.

After two/three applications, a very high percentage of patients treated for joint diseases significantly improved, as demonstrated by clinical cases found at asaveterinary.com.

Moreover, in dermatology, the effect of tissue repair and regeneration, that the literature attributed, at least in part, to the laser-induced increase in ATP synthesis, in many cases shortens 30% - 40% the time required for wound healing by second intention.
An interesting case report has shown promising results by applying the laser therapy to help fracture repair: improvement in the formation of bone callus, reduction of pain and inflammation have been observed, with consequent reduction in the recovery time.
In the field of neurology, the conservative treatment of hernia/disc protrusion has shown a marked improvement in the patient, with reduced symptoms after 3-4 applications.

Even in the field of equine excellent results have been obtained: in addition to "classical" cases with inflammatory lesions in the distal part of the limbs, it has been observed that in pathologies related to tendon injuries, there is a strong stimulation of new functional tissue formation, without abnormal scarring, which can then give rise to adherences and functional reduction of the affected part.

Furthermore, specialists in various fields and cooperating with ASA are studying protocols for exotic animals, mammals, reptiles and birds, protocols for dermatology and increasingly specific therapeutic protocols for the treatment of stomatitis / gingivitis in cats.

The development of clinical protocols is the result of collaboration between specialists in different disciplines, ASA Research Division and the Joint Laboratory with the Department of Experimental and Clinical Biomedical Sciences, University of Florence, and includes the study, both in vitro and in vivo, of action mechanisms that are the basis of therapeutic effects and clinical validation of the treatment effectiveness.

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The aim of "Energy for Health" is to spread the results of research on the application of laser and magnetic field in biology and medicine. The journal will publish studies which involve basic research and clinical trials: laser-tissue interaction, effects of laser and electromagnetic field on cells.
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ACKNOWLEDGEMENTS

Concise acknowledgements may be addressed to persons, public and private organizations, companies.

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1. Boyle WJ, Simonet WS, Lacey DL. Osteoclast differentiation and activation. Nature, 2003, 423: 337-342.

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2. Michaeli W. Extrusion Dies. Hanser Publishers, Munich, Vienna, New York, 1984.

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