The Efficacy of LightForce™ EX Class IV Laser in the Reduction of Pressure Point Tenderness, VAS pain measurements, and Size of Upper Trapezius Trigger Points

Cara Bowling and Kimberly McCorkle

Advisor: Dana Underkofler, D.C.

ABSTRACT

Purpose. To investigate the efficacy of treating upper trapezius trigger points with the LightForce™ EX class IV laser.

Method. 40 patients with upper trapezius trigger points were randomly assigned to the laser treatment group (n = 20) or sham laser treatment group (n = 20). The circumference of the trigger point to be treated on each patient was outlined with grease pen. The trigger point circumference was measured immediately before and immediately after treatment. An algometer was then used to measure the pounds per square inch required to facilitate a pain response in the patient before and after treatment. The patient was asked to describe their pain using the visual analogue scale before and after treatment. Each patient underwent time with the laser placed over the trigger point with or without the laser being activated depending on assigned group status.

Results. The change in trigger point size decreased with treatment significantly when compared to the non-treatment group. The reported visual analogue scale and algometer readings were not statistically significant between the treatment and non-treatment groups.

Conclusion. The results of this study are inconclusive. Further investigations into the effects of class IV laser treatment on upper trapezius trigger points are needed.

INTRODUCTION

Trigger points are often involved in a variety of musculoskeletal conditions. They represent a hyperirritable area of localized contraction of a small number of muscle fibers and are frequently a contributor to myofascial and muscular pain.[1,2,3] The most common sites are in the muscles involved in maintaining posture, such as the upper trapezius. Trigger points have been treated in various ways including manual therapy, chiropractic care, acupuncture, and more recently with laser therapy.[4,5] Light has been shown to trigger the rearrangement of cellular metabolism and can activate DNA/RNA synthesis, increased cAMP levels, protein and collagen synthesis, and cellular proliferation.[6] This can result in normalization and healing of chronically irritated or damaged tissues.[7,8] Laser irradiation may also inhibit the irritability of a myofascial trigger point.

Much research has been done to evaluate the effectiveness of low level laser (class I, II, and III) therapy on a variety of musculoskeletal conditions, but little research has been done in evaluating the therapeutic benefits of similar conditions with class IV lasers. Class IV lasers emit a much larger therapeutic dose and are capable of penetrating deeper into the target tissue while covering a larger surface area.[9,10] In doing so, class IV lasers are anticipated to induce rapid clinical responses.[11] The purpose of this study was to assess the effects of class IV laser treatment on trigger points in the upper trapezius. Variables that were measured included subjective pain levels associated with the trigger point, algometric pressure-pain threshold, and size of the trigger point pre and post laser therapy.

METHODS

Forty healthy volunteers (males = 19, females = 21) were recruited for participation in this study. The mean age of the participants was 24.85 ± 2.50 years. Institutional review board approval was obtained prior to volunteer recruitment, and written informed consent was obtained from all participants.

Volunteers were excluded if they (1) were a pregnant female; (2) had a pacemaker; (3) had tattoos on or around the treatment site; (4) had a recent corticosteroid injection in the upper extremity; (5) were currently taking immune-suppressing drugs or medications that cause heat or photosensitivity; (6) had surgical hardware or implants near the area of treatment; (7) had areas in the upper extremity without sensation; (8) had sustained a neck or upper back trauma in the previous month; or (9) had a history of the following conditions: cancer, diabetes, multiple sclerosis, kidney disease, meningitis, encephalitis, anemia or any other bleeding disorder.

Pre treatment protocols:
The first examiner located the most painful trigger point in the upper trapeziums of the participants by finger palpation. Once located, the trigger point was outlined using a red grease-marking pen and was then measured (in centimeters) using a small plastic ruler. Pressure pain threshold was then measured with a digital algometer used perpendicular to the upper trapezium trigger point. The participants were instructed to inform the

examiner at the exact moment they experienced any pain or discomfort while downward pressure was applied to the trigger point with the digital algometer. Downward pressure with the algometer was ceased when the participant admitted to feeling pain or discomfort. Digitized measurements in pounds per square inch were recorded. The participants were then asked to rate the pain or discomfort on a 0-10 VAS, with a rating of 0 being a complete absence of symptoms and a rating of 10 being the most severe. The VAS measurements were recorded and the participants were randomly assigned to one of two groups: treatment vs. non-treatment.

Treatment protocols:
All participants were blinded to the treatment order. Each participant was individually treated, either by receiving laser treatment or a sham treatment, behind a curtain. All participants wore protective goggles and were given instructions that the laser may produce a sensation of warmth. Participants in the treatment group received laser treatment to the most painful trigger point of the upper trapezium using the LightForce™ EX class IV laser's automated protocols for pain associated with sprain/strain of the upper spine. Laser treatment was administered by a second examiner who was certified to safely operate a class IV laser. The unit volume was turned off to blind the participants to the treatment order. The finger-switch CW (continuous wave) operating mode and a steady aiming beam (650 nm) mode were employed to deliver a 15-Watt laser treatment. Treatment times ranged from 5-7 minutes and were dependent on the participant's height (short, medium, tall), body type (small, medium, large), and skin type (light, medium, dark). A grid application pattern was utilized directly over the marked trigger point as well as one inch surrounding the trigger point. Minimal yet equal pressures were applied by the second examiner throughout the duration of the laser treatment using the LightForce™ EX laser's massage ball applicator.
Participants in the non-treatment group received a sham dose of laser therapy using the identical application procedures as the treatment group, but the laser delivered no power.

Post treatment protocols:
The outlined trigger points were reassessed using the same pre-treatment protocols. The trigger point was measured in centimeters and perpendicular pressure was applied with the digital algometer. Downward pressure was discontinued once the participant admitted to feeling pain or discomfort, and VAS pain measurements were recorded. Statistical analyses were then made using SPSS for Windows (version 20). Forced entry and backward linear regression were used to predict patients' change in algometer measurements, change in trigger point size, and change in VAS readings pre and post treatment.

RESULTS

Within this sample of 40 students, 50.0% of participants were randomly assigned to the treatment group. Demographic and test variables were assessed (Table 1). Of the demographic characteristics examined, including age, gender, skin type, height, and body type, no differences existed between the two treatment groups. Average age was very similar among the two groups and gender was evenly distributed with 47.5% of the

sample male. Dark skin, short height, tall height, and large body type were each present in ≤10% of the sample.

Significant differences existed for treatment time between treatment groups; the treatment groups received significantly more treatment time compared to the non-treatment group. Post-trigger point sizes (see Figure 1) and post-VAS readings (see Figure 2) were both significant, indicating a likely significant regression model in further analyses. Although pre-VAS readings were also significant, a model was still warranted due to the drop in VAS readings post treatment. Algometer readings, though not significant in initial tests, were modeled for other potentially significant contributing factors (see Figure 3).

Table 1. Sample characteristics

	Sample (mean, SD)	**Treatment Group (mean, SD)**	**No Treatment Group (mean, SD)**	**t or χ^2; p**
Age	24.85 (2.50)	25.35 (2.98)	24.35 (1.84)	t=-1.28; p>.05
Treatment (seconds)	295.98 (56.61)	342.10 (26.13)	249.85 (37.62)	t=-9.01; p<.05
Pre-algometer	3.87 (1.34)	3.77 (1.32)	3.97 (1.39)	t=.48; p>.05
Post-algometer	4.223 (1.45)	3.96 (1.46)	4.49 (1.42)	t=1.15; p>.05
Pre-trigger point	5.10 (0.89)	5.05 (1.04)	5.16 (0.74)	t=.37; p>.05
Post-trigger point	4.67 (1.09)	4.23 (1.24)	5.11 (0.71)	t=2.73; p<.05
Pre-VAS	3.43 (1.53)	2.95 (1.32)	3.90 (1.62)	t=2.04; p<.05
Post-VAS	2.28 (1.38)	1.85 (1.27)	2.70 (1.38)	t=2.03; p<.05
Gender (%)				χ^2=.90; p>.05
Male	47.5	40.0	55.0	
Female	52.5	60.0	45.0	
Skin type (%)				χ^2=.60; p>.05
Light	52.5	45.0	60.0	
Medium	42.5	50.0	35.0	
Dark	5.0	5.0	5.0	
Height (%)				χ^2=.36; p>.05
Short	7.5	10.0	5.0	
Medium	82.5	80.0	85.0	
Tall	10.0	10.0	10.0	
Body type (%)				χ^2=1.04; p>.05
Small	37.5	35.0	35.0	
Medium	60.0	65.0	60.0	
Large	2.5	0	5.0	

Forced entry and backward linear regression were used to predict patients' change in algometer measurements, change in trigger point size, and change in VAS readings. Change in algometer measurements, change in trigger point size, and change in VAS variables were created by subtracting post-treatment readings from pre-treatment readings to determine if level of pain, size of trigger point, or VAS readings changed

after class IV laser treatment was provided. Each model consisted of the same independent and control variables; treatment group was the independent variable and skin type, height, body type, and length of treatment were controlled for in the models. Both forced entry and backward linear regression models were non-significant for change in algometer measurements. Change in algometer measurements could not be predicted by LightForce™ EX class IV laser treatment of upper trapezius trigger points for this study.

The forced entry model for change in trigger point sizes, which contained all aforementioned variables, was significant ($F(5,34)=2.67$; $p=.039$). However, no single variable contributed significantly to the model (Table 2).

Table 2. Forced entry linear regression predicting change in trigger point sizes

	ß	Standard Error	t-statistic	p
Constant	.406	1.189	.341	.735
Treatment	-.865	.596	-1.450	.156
Skin type	-.358	.229	-1.559	.128
Height	-.509	.414	-1.230	.227
Body type	-.111	.316	-.350	.728
Treatment time	-.001	.006	.224	.824

A backward linear regression revealed the best model for explaining change in trigger points with the least amount of error in the model included only treatment ($F(1,38)=8.25$; $p=.007$). Though the overall amount of variance explained in change in trigger point sizes is reduced by 1.9% (Δ Adjusted-R^2 =.019) between the first and last models, model 5 produced the most parsimonious prediction model for change in trigger point sizes (Table 3). The choice to use Model 5 is confirmed with a Partial F-test comparing the full and reduced models ($F(1,37)=4.90$; $p>.05$). The equation for this model is:

Change in trigger point size = -.05 -.770(Treatment)

Table 3. Backward linear regression models predicting change in trigger point sizes

	R	R^2	Adj-R^2	F-statistic	p
Model 1	.531	.282	.176	2.670	.039
Model 2	.530	.281	.199	3.417	.018
Model 3	.528	.279	.219	4.646	.008
Model 4	.480	.230	.188	5.525	.008
Model 5	.422	.178	.157	8.252	.007

*Each model removed a variable in the following order until the best model was achieved: length of treatment; body type; skin type; and height.

With 15.7% of the variance in change in trigger point sizes explained by treatment of trigger points using LightForce™ EX class IV laser for the population, there remain

unmeasured variables contributing to the treatment of these patients. Though the remaining variables contributed some explanation in the variance in trigger point sizes (<2%) in Model 1, none of these variables were significant contributors (p>.05) to the model and therefore are dropped from the predictive model.

The forced entry model for change in VAS readings was non-significant (F(5,34)=2.109; p=.101). Backward linear regression revealed the best model for predicting change in VAS included treatment category, skin type, and treatment time (F(3,36)=3.431; p=.027) (Table 4). The choice to use Model 3 over Model 1 is confirmed using a Partial F-test (F(1,35)=0.14; p>.05). Treatment category, skin type, and treatment time predict 15.8% of the variance in change in VAS readings.

Table 4. Forced entry linear regression predicting change in VAS readings

	ß	Standard Error	t-statistic	p
Constant	2.281	1.283	1.778	.084
Treatment	1.378	.565	2.439	.020
Skin type	-.465	.273	-1.707	.097
Treatment time	-.013	.005	-2.587	.014

Table 5. Backward linear regression models predicting change in VAS readings

	R	R^2	Adj-R^2	F-statistic	p
Model 1	.478	.229	.116	2.019	.101
Model 2	.478	.229	.141	2.596	.053
Model 3	.472	.222	.158	3.431	.027

Figure 1: Change in trigger point measurements by treatment group

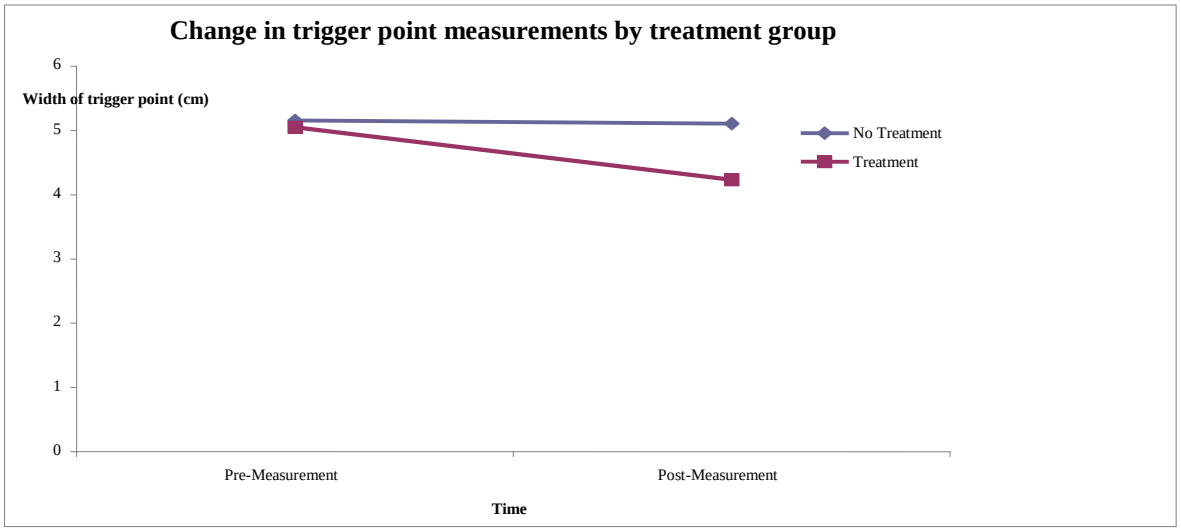


Figure 2: Change in VAS readings by treatment group

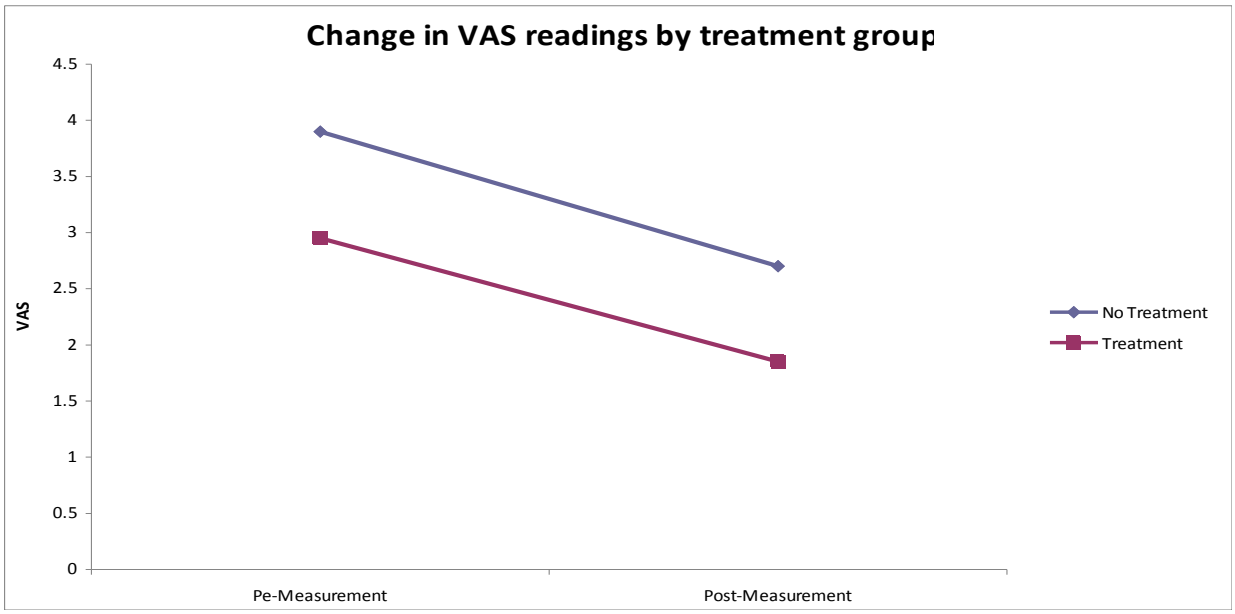
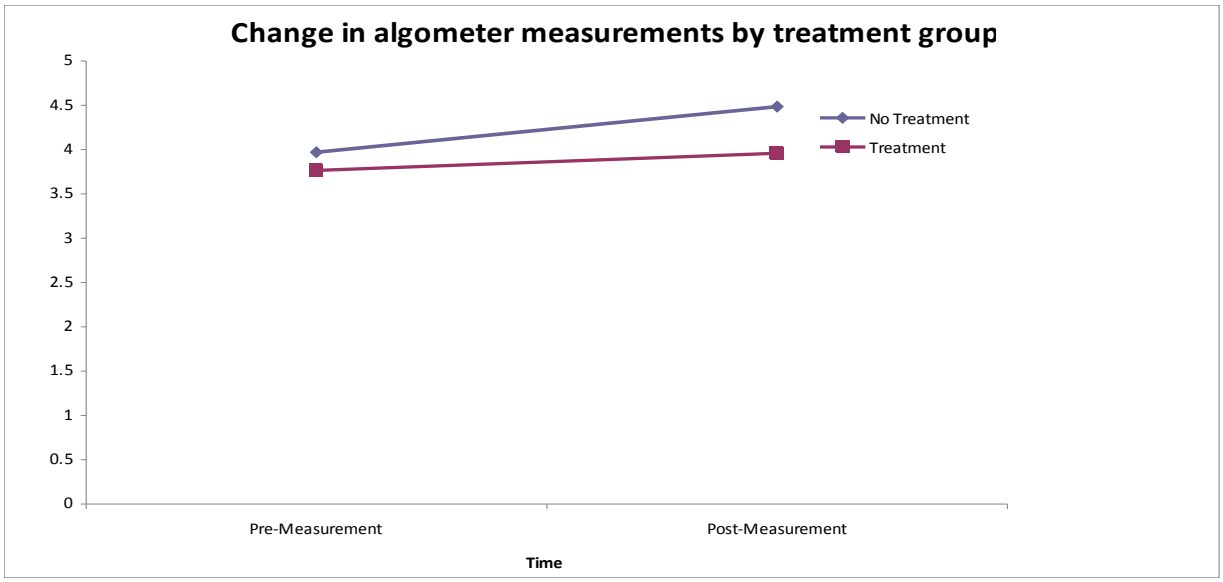


Figure 3: Change in algometer measurements by treatment group



DISCUSSION

Algometer Measurements and VAS:
The changes in algometer readings before and after treatment were insignificant in this study. Algometer readings increased for both treatment and non-treatment groups. Changes in VAS before and after laser and sham treatments also decreased; however, the

results were shown to be insignificant after analyses of this study's data. These factors could be due to nociceptive inhibition by mechanoreceptor afferents (A-beta fibers) during the application of the laser and sham treatments. The LightForce™ EX laser massage ball may have stimulated corpuscular mechanoreceptors in the muscles of the upper trapezium during laser application, regardless of the laser's emission. Corpuscular mechanoreceptors are thought to be associated with A-beta fibers.[2,10,12] Therefore, inhibition of nociceptors of the upper trapezium trigger points during this study was likely caused by mechanoreceptor influences on the nervous system[13] rather than a placebo response.

There have been reports of absent or limited therapeutic effects of laser treatment after a certain laser wattage on musculoskeletal conditions.[9,14] High wattage laser treatments have been shown to promote pain sensations by decreasing local vascularity and by over-heating of the superficial tissues.[10] Each participant in this study randomly assigned to the treatment group received 15-Watts of laser therapy, which may have exceeded a therapeutic dose for treatment of upper trapezium trigger points. Other reports conclude that a pulsed beam is more effective than a continuous beam, which was employed in this study, at treating trigger points and pain associated with musculoskeletal conditions.[5,10,15] It has also been postulated that variations of the pulsation rate will improve clinical outcomes by not allowing the human body to adapt to and become less responsive to a steady stimulus.[11]

Some studies have shown that there may be a timing component with a laser's therapeutic effect in that the major analgesic effects of laser treatment may not be evident immediately. Sometimes the benefits may be perceived within 5-20 minutes [4,14,16] but other times significant changes may not be perceived until 48 hours later.[10]

Trigger Point Size:
In this study, the change in trigger point size before and after laser treatment was significant when compared to the sham treatment group. The size of the trigger points in the sham treatment group remained unchanged, whereas the trigger points in the treatment group decreased in size after laser application. Trigger points are associated with local ischemia and hypoxia which results in elevated levels of sensitizing substances such as bradykinin, protons, serotonin, and norepinephrine, etc. in active trigger points.[1] Laser therapy has been shown to increase local blood flow, increase the release of endorphins, and decrease the production and release of nociceptive receptors such as bradykinin and prostaglandins.[7,9,17] An increase in local blood flow to the areas of an active trigger point can contribute to oxygenation of the tissues and allow the musculature to expel these inflammatory and sensitizing substances. By doing so, it can be assumed that the tension within the trigger point can be released in order to restore a more uniform length in the affected muscle fibers.[1] These factors are plausible explanations for the decrease in trigger point size in the laser treatment group.

Limitations and Future Studies:
A limitation of this study was the lack of follow-up data to investigate a potential timing component of laser treatment to upper trapezium trigger points and therapeutic effects.

Another limitation of this study was its small sample size (n = 40). A larger sample size would likely have lead to a more inclusive representation of the population with myofascial upper trapezius trigger points. A larger sample size could also more accurately reflect therapeutic benefits of class IV laser therapy on myofascial pain associated with upper trapezius trigger points. Future studies should incorporate a larger sample size, use of pulsed wave, lower beam wattage, and post-treatment measurements at least 24 hours after laser therapy.

CONCLUSION

Our results are inconclusive in the efficacy of class IV laser therapy in the treatment of upper trapezius trigger points. Although algometer readings increased and VAS measurements decreased after application of laser treatment, the results remained insignificant in comparison to the sham treatment. The most significant result of this study was the overall decrease in size of the trigger point after class IV laser application. In future studies, the application of class IV laser treatment should employ a pulsed wave and lower beam wattage to investigate a higher therapeutic effect.

REFERENCES

1. Lo WLA. The Role of Myofascial Trigger Points in Muscular Pain. SportEx dynamics. October 2010;26:23-27.

2. Travell J, Simons DG. *Myofascial pain and dysfunction: the trigger point manual*. Baltimore (Md): Williams and Wilkens; 1983.

3. Rickards LD. *The effectiveness of non-invasive treatments for active myofascial trigger point pain: a systematic review of the literature*. Int J Osteopath Med 2006;9:120-36.

4. Vernon H, Schneider M. *Chiropractic Management of Myofascial Trigger Points and Myofascial Pain Syndrome: A Systematic Review of the Literature.* J Manip and Phys Therapeutics. January 2009;32(1):14-24.

5. Beckerman H et al. *The Efficacy of Laser Therapy for Musculoskeletal and Skin Disorders: A Criteria-Based Meta-analysis of Randomized Clinical Trials.* Phys Ther. July 1992;72(7):483-491.

6. Bukowski EL. Electromagnetic radiation: laser, ultraviolet, and diathermy. Modalities for Therapeutic Intervention, 4th ed, F.A. Davis Company, 2005. 141-164.

7. Bjordal JM et al. *A randomized, placebo controlled trial of low level laser therapy for activated Achilles tendinitis with microdialysis measurement of peritendinous prostaglandin E_2 concentrations.* Br J Sports Med. 2006;40:76-80.

8. Armagan O et al. *Long-term efficacy of low level laser therapy in women with fibromyalgia: A placebo-controlled study.* J Back and Msk Rehab. 2006;19:135-140.

9. Larkin K et al. *Limb Blood Flow After Class 4 Laser Therapy*. J Athl Training. April 2012;47(2):178-183.

10. Parr JJ, Larkin KA, Borsa PA. *Effects of Class IV Laser Therapy on Exercise-Induced Muscle Injury.* Ath Training and Sports Health Care. 2010;2(6):267-276.

11. Harrington P, Vickers J. *Class IV Therapy Lasers Maximize Primary Biostimulative Effects.* Practical Pain Management. September 2008:70-72.

12. Martin J, Jessell T. *Modality coding in the somatic sensory system.* In: Kandel E, Schwartz J, Jessell T, eds. Principles of neural science. 3rd ed. New York: Elsevier; 1991. p.341-52.

13. Gillette R. *Potential antinociceptive effects of high level somatic stimulation-chiropractic manipulation therapy may coactivate both tonic and phasic analgesic systems. Some recent evidence.* Trans Pac Consortium Res 1986; 1:A4(1)-A4(9).

14. Santamato et al. *Short-term Effects of High-Intensity Laser Therapy Versus Ultrasound Therapy in the Treatment of People With Subacromial Impingement Syndrome: A Randomized Clinical Trial*. Phys Ther. July 2009;89(7):643-652.

15. Hopkins JT et al. *Low-Level Laser Therapy Facilitates Superficial Wound Healing in Humans: A Triple-Blind, Sham-Controlled Study*. J Ath Training. September 2004;39(3):223-229.

16. Pozza DH et al. *Analgesic action of laser therapy (LLLT) in an animal model*. Med Oral Patol Oral Cir Bucal. October 2008;13(10):E648-52.

17. Kai-Hua C, Chang-Zern H, Fang-Chuan K, Hung-Chih H, Yueh-Ling H. *Electrophysiologic Effects of a Therapeutic Laser of Myofascial Trigger Spots of Rabbit Skeletal Muscles*. American Journal of Physical Medicine & Rehabilitation. December 2008;87(12):1006-1014.