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Effect of High-Intensity Laser Treatments on Chronic Pain Related to Osteoarthritis in Former Professional Athletes: A Case Series

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Abstract

Background: We evaluated the use of a new higher intensity 42 Watt cold laser for treating chronic pain related to osteoarthritis (OA) in former NFL football players.

Methods: 39 consenting former NFL football players with OA underwent 1-3 treatment sessions lasting 10-20 min with a 42 Watt FDA-approved high-intensity cold laser (Phoenix thera-lase, Dallas, TX) at a wavelength of 1275 nm. We recorded their pain verbal rating scale (VRS) score at rest and with activity before and after each treatment using an 11-point VRS with 0=no pain to 10=worst pain imaginable. In addition, we assessed the duration of the pain-relieving effect produced by each laser treatment, as well as its effects on other OA-related symptoms.

Results: The chronic pain scores were significantly reduced both at rest and with activity after each treatment. Baseline VRS pain scores were 3.5 ± 2.9 at rest and 6.0 ± 2.6 with activity. After the initial treatment, the pain scores were reduced to 1.2 ±_1.8 ($p<0.01$) at rest and to 2.0 ± 2.0 ($p<0.01$) with activity. The overall beneficial effect was 7.2 ± 1.8 on a scale from 0=no relief to 10=complete relief, and the duration of the beneficial effect lasted 1-3 weeks in 64% of the players treated. Finally, 90% of the players would recommend the laser treatment to their colleagues.

Conclusion: High-intensity cold laser treatments reduced chronic OA-related pain in former NFL football players by ~67% at rest and with activity and the beneficial effect typically persisted for 1 week or longer after 1-3 treatments in the majority of these chronic pain patients.

Keywords: Osteoarthritis; Laser therapy; Cartilage; Haemoglobin

Introduction

Despite a perception that retired professional football players have poor health, there are surprisingly little supporting data. A study by Nicholas et al. [1] reported that most professional football players with long and fulfilling careers had no apparent long-term detrimental effects on physical or mental health scores. However, it is well-known that former professional football players are at increased risk of early onset osteoarthritis (OA) [2]. In a study involving over 2,500 retired football players, Golightly et al. [2] found that 41% reported the onset of arthritis under 60 years of age (compared with only 12% of non-football playing males in the USA). Common treatment options for OA include both opioid and non-opioid analgesics, as well as physiotherapy [3]. Unfortunately, the commonly prescribed analgesic drugs are associated with a variety of side effects that can adversely affect virtually every organ system in the body, especially in older patients with OA symptoms [4].

A wide variety of non-pharmacologic therapies (e.g., electro-stimulation, massage, aquatic therapy, exercise therapy, low-level laser therapy [LLLT]) have been proposed as alternatives to the current pharmacologic therapies. In an animal model of OA, both LLLT and an aquatic exercise program were reportedly effective in preventing cartilage degeneration [5]. Assis et al. [6] also reported that exercise training and LLLT were equi-effective in preventing cartilage degeneration and in modulating the inflammatory process induced by knee OA in rats. In a recent clinical study designed to determine the effects of adding LLLT to an exercise t program in older patients with knee OA, Youssef et al. [7] reported that the addition of LLLT was more effective than exercise alone in the treatment of chronic knee OA. Importantly, these investigators suggest that the beneficial effects of LLLT may be dependent on the intensity (power) level of the laser device. In another recent clinical study, it was reported that the addition of LLLT to standard conventional physical therapy in 100 elderly patients with OA significantly prolonged the time to needing knee replacement surgery [8]. These investigators concluded that LLLP should be incorporated into standard conservative treatment protocol for symptomatic OA involving the knee. However, a recent systemic review and meta-analysis by Huang et al [9] concluded that "current evidence did not support the effectiveness of LLLT" in patients with knee OA.

A sham-controlled, prospective safety and efficacy LLLT study was conducted by Basford and colleagues at the Mayo Clinic in patients with subacute musculoskeletal back pain using an infrared laser which produced 542 watts (<1 Watt) of power [10]. These patients underwent 12 treatment sessions over a 4-week period and the investigators concluded that the active (laser) group produced a 'moderate' reduction in pain while also improving two of the three key primary outcome measures, namely perception of clinical benefit and improvement in level of functionality. The manufacturer of the 542-watt laser [Phoenix Thera-Lase Systems, LLC (Dallas, TX)] has developed a more

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powerful 42 Watt high-intensity cold laser that functions at a longer infrared wavelength (namely, 1275 nm vs. 1060 nm) to reduce the light absorption by melanin and haemoglobin. These two modifications allow the laser beam to penetrate more deeply into the soft tissue. This non-contact, non-invasive cold laser emits photon energy particles which are absorbed by photoreceptors in the mitochondria of the cells (so-called photo biomodulation therapy) which stimulates ATP production, enhances tissue oxygenation, and increases blood flow [11]. These cellular effects of photo biomodulation can lead to reduced pain and inflammation.

Given the high incidence of OA in elite former football players and the report by Youssef et al. [7] suggesting that the beneficial effects of LLLT may be dependent on the intensity or power level of the laser device, we performed an evaluation of a high intensity laser (Phoenix Thera-Lase, Dallas, TX) device in 39 former elite NFL players with OA. The objective of this evaluation was to determine if high-intensity laser therapy (HILT) with the 42 watt Phoenix Thera-lase device could achieve a sustained reduction in joint pain at rest and with activity.

Case Series

A total of 39 otherwise healthy former elite NFL football players suffering from OA due to degenerative joint disease for 9 ± 11 yr (Table 1), were administered 1-3 laser treatments lasting an average of 10 to 20 min using c an FDA-approved class IV, non-invasive, 42 Watt, continuous diode cold laser manufactured by Phoenix Thera-Lase, Dallas, Texas (Model Sultra-3000). The participants provide their written informed consent to participate in this study and the consenting players completed a pre-treatment questionnaire assessing the specific location and the duration of their OA joint symptoms, the severity of their pain at rest and with physical activity (using an 11-point verbal analog scale (VAS) with 0=no pain and 10=worst pain imaginable), and their current use of pain-relieving medications. The overall beneficial effect of the laser treatment(s) was assessed on an 11-point VAS with 0= no relief to 10=complete relief of their joint symptoms after their last treatment session. The VAS pain scores before and after each treatment session were analyzed using paired sample t-test, with $p<0.05$ considered statistically-significant.

	Thera-Lase (n=39)
Gender (female/male) (n)	0/39
Age (yr)	65 ± 14
Height (Inches)	71± 5
Weight (Lbs.)	214 ± 41
Location of the pain (n)	
Ankles	1
Hands	1
Hip	6
knees	10
Low back	9
Mid back	2
Neck	2
Shoulder	6
S. Piriformis	1
Sciatic	1
Oral Treatment: NSAIDs (n)	
Naproxen	7
Ibuprofen	9
Aspirin	1
Celecoxib	1
Opioids	
Hydrocodone	1
Oxycodone	1
Vicodin	1
Other	
Allopurinol	1
Prednisone	1
None	12
No data	4
Total Treatments patients received (n)/%	
1 Treatment	39/100
2 Treatment	22/56.4
3 Treatment	17/43.6
Numbers (n), percentages (%), and mean values (± standard deviation)	

Table 1: Demographic characteristics, pain location, pain medication, pain scores for the thera-lase treatment group.

	Thera-Lase (n=39)
Pre-treatment pain scores (VRS)+	
at rest (Baseline)	3.5 ± 2.9
with activities (Baseline)	6 ± 2.6
Post-treatment pain scores	
First laser treatment at rest	1.2 ± 1.8*
Second laser treatment at rest	0.8± 1.6*
Third laser treatment at rest	0.7±1.4*
First laser treatment with activities	2 ± 2†
Second laser treatment with activities	1.6 ± 2†
Third laser treatment with activities	1.6± 2†
Time of the pain return to pre-treatment level (after laser) (n, %)	
12-24 Hours	1
2 Days	2
1-3 Weeks	25
No follow-up response to question (11, 28%)	
Would recommend the treatment to others (%)	
Yes	92
Maybe	8
+ Verbal analog scale (VRS): 0=no pain to 10=most severe pain imaginable; Numbers (n), percentages (%), and mean values (± standard deviation); * p-value <0.05 compared to baseline (pre-treatment pain at rest); † p-value <0.05 compared to baseline (pre-treatment pain with activities)	

Table 2: Pre-and post-treatment pain scores, treatment satisfaction for the Thera-Lase treatment group.

The laser technician administering the laser treatments conducted a brief interview with each subject to determine which specific area of their body that was responsible for their most bothersome joint pain symptoms. The designated body area(s) was treated with a series of 60 sec treatments located approximately 3-5" apart while holding the laser hand piece 12-16" from the skin surface to avoid overheating the treated area. Depending on the size of the painful area, treatment times varied from 10 min to 20 min. The former players were also asked to performed simple range of motion exercises involving the treated joint(s) before and after the treatment sessions. If the players were available, they were given the option of returning the following two days for a second and third treatment session. Each former player agreed to provide their assessment of the pain relief provided by the laser therapy after each treatment session and completed a follow-up questionnaire at 30 days following their last laser treatment which assessed the magnitude of their pain relief (on an 11-point VAS scale from 0=no relief to 10=complete relief) and the approximate duration of the pain-relieving effect.

After receiving these treatments, the former players were asked questions about their willingness to undergo laser treatments in the

future (and the amount of money they would be willing to pay out-of-pocket for a follow-up laser treatment). They were also asked if they would recommend the laser treatment to one of their colleagues with similar OA symptoms.

The mean pre-treatment (baseline) pain scores were 3.5 ± 2.9 at rest and 6.0 ± 2.6 with activity (Table 2). Excluding the two patients who reported no pain at rest (they were being treated primarily for 'numbness' in an extremity), the baseline pain score was 4.4 ± 2.5 at rest. After the first laser treatment session (lasting 13 ± 4 min), their VAS pain scores were reduced underwent a second treatment session (lasting 10 ± 4 min) ~24 hr after the initial treatment. The baseline VAS pain score prior to the second treatment was 2.3 ± 2.6 at rest and decreased to 0.8 ± 1.6 ($p<0.01$) and decreased from 4.1 to 1.6 ± 2 with activity. In the 17 former players who underwent a third treatment (lasting 10 ± 3 min) ~24 hours after the second treatment, the VAS score decreased from 1.5 ± 2.1 to 0.7 ± 1.4 ($p<0.05$) at rest and from 3.5 to 1.6 ± 2 with activity. The reduced level of pain after their last treatment session lasted 1 to 3 weeks in 64% of the players, and 51% of the players reported an increase in their overall level of physical activity. Only two players failed to achieve a significant reduction in their level of pain. The other beneficial effects reported on the follow-up evaluation included improved range of motion (63%), and reduced swelling (20%) and numbness (26%). When asked to assess the overall improvement in their level of pain after the laser treatment(s) on a VAS scale from 0=none to 10=complete relief, the mean score was 7.2 ± 1.8. Over 90% of the treated former players stated that they would recommend the laser treatment to others, and 85% stated that they would be willing to pay $60-$90 out-of-pocket to received follow-up laser treatments.

Discussion

Non-pharmacological analgesic techniques (e.g., electrostimulation, LLLT/HILT, physical therapy) can be employed as adjuvant to non-opioid drug therapies to improve chronic pain management and reduce opioid-related side effects [12]. Opioid-containing pain relieving medications commonly produce side effects, such as nausea, vomiting, constipation, ileus, bladder dysfunction, pruritus, sedation, visual hallucinations, ventilatory depression, as well as long-term physical dependence and addiction liability. Non-opioid pain-relievers (e.g., Acetaminophen, NSAIDs, COX-2 antagonists, Gabapentanoids) have more limited analgesic efficacy than opioid compounds and differing side effect profiles (e.g., gastrointestinal bleeding, potential renal and platelet dysfunction, changes in cognitive functioning, and potential metabolic interactions with other chronic medications) [4,12].

Previous studies suggested that LLLT was of limited benefit in patients with knee OA [9] and non-specific low back pain [10,13,14]. However, for patients with chronic joint and back pain not responding to non-opioid analgesics, HILT may represent a simple, non-invasive, and more cost-effective alternative to other non-invasive physiotherapy and electrostimulation modalities. Both transcutaneous and percutaneous electrical nerve stimulation, as well as acupuncture, can reduce the intensity of pain and opioid requirements when used as an adjuvant for treating patients with a wide variety of chronic pain syndromes [15,16]. However, the duration of the pain-relieving effect is limited and these therapies are labor-intensive and/or invasive. In contrast, HILT with the Phoenix thera-lase is simple to administer ("point-and-shoot") and is virtually free of any side effects. The only known side effect is transient skin discoloration (redness) and a burning sensation if the hand-held laser head comes in close proximity to the skin surface (<10 in).

This case series suggests that HILT with the 42 W Phoenix thera-lase was able to achieve a sustained reduction in joint pain due to degenerative OA in 74% of the former elite athletes after only 1-3 treatment sessions lasting 10 min to 25 min. The beneficial pain-relieving effect lasted for 1-4 weeks in the majority of the former players and was not mitigated by age, weight, height, or weight-to-height ratio. In contrast to the earlier version of this cold laser technology, the current Phoenix Thera-Lase device has >80 times more power and produces a greater and more sustained reduction in pain symptoms [10]. This laser is also more powerful than the other high intensity cold laser devices currently on the market (e.g., LightCure/LightForce [Newark, DE], Class IV, Wavelength: 980/810 nm, Laser Power: 0.5 W to 15 W; the K Laser [Franklin, TN], Class IV, Wavelength: 660/970 nm, Laser Power: 20 W). This case series also suggests that the beneficial effects of the Phoenix Thera-Lase treatments are cumulative, as has been reported with other non-pharmacologic analgesic therapies [15,16]. However, further research is required to determine the optimal treatment protocols for patients with chronic degenerative joint disease. Larger scale 'sham' controlled studies are needed to determine the effect of the more powerful Phoenix thera-lase treatments on pain scores and the need for both opioid and non-opioid analgesic medications. A preliminary study demonstrated that HILT may be capable of reducing postoperative opioid dependence in patients who had become dependent on opioid analgesic medication after surgery [17]. This novel therapy for opioid dependency could also be highly beneficial to all patients suffering from chronic pain, as well as society-at-large [12].

In summary, these preliminary findings suggest that this high-intensity Phoenix Thera-lase cold laser can be a valuable adjuvant to both pharmacologic and physiotherapy for the treatment of chronic pain secondary to OA in former professional athletes. Compared to previous findings with LLLT in patients with chronic OA-related pain due, HILT appears to produce a greater and more sustained reduction in joint pain.

Disclosure

This Case Series was conducted with the support of the administrative staff at the NFL Hall of Fame in Canton, Ohio, and the manufacturer of the high-intensity laser used to administer the laser treatments (Phoenix Thera-lase Systems. LLC, Dallas, TX).

Conflicts of Interest

Paul F. White was a non-paid consultant to Phoenix Thera-lase Systems, LLC. Hector Hernandez is a paid employee of Phoenix thera-lase Systems, LLC. Loani Elvir-Lazo, Xuezhao Cao reported no conflicts of interest.

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