TREATMENT OF ACHILLES TENDINITIS WITH CLASS IV INFRARED (980 NM) THERAPEUTIC LASER

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CLASS IV LASER THERAPY CASE REPORT

OBJECTIVE:
To describe the clinical management of Achilles tendinitis by using a "high-power" Class IV therapeutic laser.

CLINICAL FEATURES:
This is a case of a fifty-eight year old woman, 5'4", 155 lbs., presenting with bilateral Achilles tendon pain, the left foot for two years, the right for one year. She did not respond to physical therapy or steroid injections. Rest relieved the pain, weight bearing activity increased the pain. There was pain on palpation over her Achilles tendons. She showed decreased ankle dorsiflexion[1], and displayed genu valgum and foot pronation[10]. Resisted neutral position isometric dorsiflexion and active eccentric dorsiflexion exacerbated the pain. Passive eccentric dorsiflexion did not exacerbate the pain. The patient filled out a VAS describing her "worst" pain, "best" pain, and pain "now." This was filled out on each visit. The patient was accepted for laser therapy.

INTERVENTION AND OUTCOME:
The laser used was the Avicenna class IV infrared laser, model AVI HP-7 5, continuous wave (non-pulsing). The laser emits a visible red beam at 635 nm wavelengths, and an infrared laser beam at 980 nm wavelength[12]. The power used was 7.5 watts; the dose was 2250 joules; the area was 15 cm; the energy density was .5 w/cm^2; the treatment time was 5 minutes per side and the treatment distance was 2 cm. Treatment distance was ensured by securing the laser wand stylus to maintain the treatment distance. The stylus was kept in light contact with the patient. A swatch of cotton fabric was placed over the tendon with a 3x5 cm hole cut from it to allow for consistent laser treatment area. One open end was placed over the Achilles insertion, and extending proximally. The patient showed significant reduction in pain as indicated by the VAS scores, and significant increase in dorsiflexion flexibility as measured after four sessions with a goniometer.

CONCLUSION:
This case demonstrates the potential benefit of conservative management for Achilles tendinitis with the utilization of "high-power" Class IV therapeutic laser technology to decrease the symptoms associated with Achilles tendinitis.

KEY WORDS:
Class IV laser; Achilles tendonitis; laser therapy; Avicenna laser.

INTRODUCTION:
All providers of health care are under significant pressure to demonstrate efficacy of treatment the FDA provided clearance of the use of "Low-Level" Class III therapeutic lasers in 2002 and "High Power" Class IV therapeutic lasers in 2004. Since that time, the use of therapeutic lasers technology for the treatment of musculoskeletal conditions has grown in popularity. Although many articles have been written on the topic of laser therapy, and its application for somatic pain conditions, there is a lack of scientific papers that utilize any of the outcome assessments tar are required in today's evidence – based healthcare environment. This paper is the first in a series to utilize

generally accepted outcome assessments to determine the effectiveness of a “High-Power”, Class IV laser therapy treatment protocol in reducing the symptoms of chronic somatic pain. The Achilles tendon is the largest and strongest tendon in the body, and one of the most frequently injured tendons[1,2,17]. Risk factors include decreased dorsiflexion, hyperpronation, and presence of Haglund’s deformity, age, overuse and genetics.[1,2,11]. Generally, Haglund’s bump can cause direct mechanical pressure on the tendon during exercise. Age related loss of flexibility is a risk factor; most ruptures occur in athletes in their 30’s and 40’s, and Type O blood types have a congenitally higher risk of Achilles problems[2]. Systemic diseases such as Reiter’s syndrome can predispose one to Achilles tendon symptoms[2, 11].

Sudden pain slightly proximal to the calcaneal insertion is suggestive of major tear or rupture. Slowly occurring pain is indicative of tendonitis[8]. Michaud[10] states that the medial aspect of the Achilles tendon in those possessing forefoot valgus deformity is prone to injury during static standing. The everted calcaneous places a constant tensile strain in the medial aspect of the tendon. This prolonged traction produces vascular impairment that may predispose the tendon to subsequent degenerative changes.

Achilles tendinitis will respond to conservative care. This includes transverse friction massage, taping, use of orthotics and stretching[8,11, 16]. Insert ional Achilles tendon problems can benefit from transverse friction massage, non insertion can benefit from stretching of the triceps surae group[2, 8]. Phonophoresis with steroid gel, NSAIDS, and cortisone injections are also used[12, 13, 15]. Surgery or casting may be indicated for rupture or refractory cases[8, 9, 11].

Steroid injection has long been a method of treatment for tendinitis in general,, and Achilles tendinitis in particular. However, it is commonly known that steroid injections are injurious to tissue. Hays, et al.[13] recommends steroid injection for tendinitis except the Achilles tendon. Csizy and Hinterman[14] state that steroid injection increases the risk of tendon ruptures, and that despite this, clinicians routinely inject Achilles tendons. Rees, et al.,[15] stress the degenerative nature of tendon disorders as opposed to the inflammatory nature. Tam[4] reported on changes in PE2 synthesis into PE12 under influence of low level laser therapy (LLLT), and Bjordal[3] used microdialysis measurement of Achilles peritendinous prostaglandin E2 concentrations pre- and post- LLLT and found a decrease in PE2 concentrations after laser therapy, implying the presence of the inflammatory component of tendinitis along with the degenerative component. Mizutani, et al. also found decreased PGE2 levels post LLLT (830 nm, 10 treatments) and associated PGE2 levels with nociceptive pain[5].

Fillipin, et al., found using LLLT (904 nm wavelength, 5 joules/cm^2) markedly decreased histological abnormalities in rats with traumatized Achilles tendons as compared to the controls[18].

CASE REPORT:

A fifty-seven year old woman presented to this office with the complaint of Achilles tendon pain, bilaterally, the left of two years duration, and the right for one year. The pain was located over the insertion of eh Achilles tendon. She had a history of arthroscopic knee surgery, bilaterally, a thirty five year smoking habit. She had no history of foot or ankle injury. She could not recall any mechanism of onset. She had had a course of physical therapy, and two steroid injections in her left Achilles tendon, and one in her right. She said the first injections gave her two week’s relief, the second in her left one week. Weight bearing activity exacerbated the pain, rest relieved it. Pain levels were lower at commencement of activity, worsening with prolonged activity. NSAIDS did not relieve the pain. There was no pattern during the day related to her pain levels. The patient was 5’4”, 220 pounds. She ambulated with difficulty, slowly and looked to be in distress. Inspection revealed tenderness to palpation over the distal Achilles tendon. Her Q angle measured 20 degrees bilaterally, ands she displayed genu valgum. Her blood type is B positive[2]. Static stance showed a medial displacement of her Achilles tendon indicating pronation. Dorsiflexion was 10 degrees for both right and left. Algometric exam was inconclusive. The patient was presented with a 10 cm visual analog scale (VAS). The patient was asked to rate her pain in terms of “worst pain,” “best pain,” and “pain right now.” These pain ratings were as of her last steroid injection. The worst pain for her left was 8.5; right, 9. The best pain for her left was 5; her right, 6. At the time of exam, the left was 5; the right, 6. The patient was accepted for laser therapy.

The laser used was the Avicenna class IV infrared laser, model AVI HP-7 5, continuous wave (non-pulsing). The laser emits a visible red beam at 635 nm wavelength, and an infrared laser beam at 980 nm wavelength[12]. The power used was 7.5 watts; the dose was 2250 joules (150joules/cm^2); the area was 15 cm; the energy density was .5 w/cm^2; the treatment time was 5 minutes per side and the treatment distance was 2 cm. Treatment distance was ensured by securing the laser wand stylus to maintain the treatment distance. The stylus was kept in light contact with the patient. A swatch of cotton fabric was placed over the tendon with a 3x5 cm hole cut from it to allow for consistent laser treatment area. One open end was placed over the Achilles insertion and extending proximally.

The patient received four laser treatments over each Achilles tendon. VAS scores prior to the second session were:

Left: worst: 8; best: 6; now: 6
Right: worst: 3; best: 3; now: 3
Prior to the third session:
Left: worst: 5; best: 5; now: 5
Right: worst: 3; best: 1; now: 1
Prior to the fourth session:
Left: worst: 4; best: 0; now: 0.
Right: worst: 0; best: 0; now: 0.
One week later the patient scored her VAS.
Left: worst: 3; best: 0; now: 0.
Right: worst: 0; best: 0; now: 0.
Dorsiflexion was 15 for the left and 20 deg for the right.

DISCUSSION:

A review of the literature shows laser therapy enhances physiologic repair without toxicity, leading to local and systemic effects[32]. There are a number of physiological changes that take place under the influence of infrared radiation. The therapeutic effects are well known but not all the mechanisms are known. Infrared radiation may reduce pain and improve function through reduction of inflammation through its influence on prostaglandins. Prostaglandins are moderators of hormonal activity, and have a role in inflammation[29]. Bjordal, et al. measured the levels of prostaglandin E2 concentrations in the peritendinous areas of patients who had Achilles tendinitis. Measurements were taken pre- and post-treatment by LLLT (904 nm wavelength, 20mW/cm^2) and found to be lower after treatment, as were pain levels[3]. Tam[4] suggested that LLLT acts on prostaglandin synthesis, increasing the change of PG2 into PG12. PG12 is the main product of arachidonic acid in the endothelial cells and smooth muscle cells of vessel walls and that have a vasodilating and anti-inflammatory action. Mizutani, et al. also found decreased PGE2 levels post LLLT (830 nm, 10 treatments) and associated PGE2 levels with nociceptive pain[5]. Ferreira, et al. injected PG2 into Wistar rats to induce hyperalgesia and found that LLLT (632 nm wavelength, 2.5 J/cm^2) increased pain threshold (algometric examination) and reduced edematous tissue by 54% (using plethysmography). In addition , this study found that LLLT inhibits sensitization by its effect on nociceptors of the inflammatory process rather than an effect on opioid receptors[22]. Fillipin, et al., found using LLLT (904 nm wavelength, 5 joules/cm^2) markedly decreased histological abnormalities in rats with traumatized Achilles tendons as compared to the controls[18]. Laasko, et al. also induced inflammation in Wistar rats and found LLLT effective but that the effectiveness was dose-specific. A dose of 1 J/cm^2 was not effective, but that 2.5 J/cm^2 was. The control animals showed normal beta-endorphin containing lymphocytes, but no beta-endorphin containing lymphocytes in those irradiated at 2.5 J/cm^2 [21].

Giuliani, et al. described other models of pain and edema reduction. Acute and chronic inflammation was induced using injection of carrageenan and Complete Freund’s Adjuvant (CFA, a water oil emulsion containing inactivated mycobacteria used to boost immune system in animals and induce inflammation), respectively. Neuropathic pain was produced by sciatic nerve chronic constriction injury (CCI). Very low laser therapy (vLLLT) was used on the animals. It was found that vLLLT reduced edema and pain in the acute and chronic inflammation if laser was administered at acupuncture points. Spontaneous pain and thermal hyperalgesia were reduced in CCI rats treated with vLLLT. Their conclusion was that enkephalin mRNA level was strongly upregulated in the external layers of the dorsal horn of the spinal cord in the CFA and CCI, and that vLLLT increased the mRNA level in single neurons[20,29].

Infrared laser therapy has been shown to be effective on wound healing itself through its effect on blood flow by dilatation of blood vessels. Bjordal describes vessel dilation through its effect on synthesis of PG12[3]. Nitrosyl complexes of heme proteins, such as hemoglobin and cytochrome c are the primary chromophores of laser radiation. When irradiated they dissociated to produce free nitric oxide which may be responsible for blood vessel relaxation. Klebenov, et al. compared activity of wound exudate leukocytes (from rat skin) to see if laser – coherent light – and light emitting diode radiation (LED) – non-coherent light – had an effect on functional wound activity. It was that both the laser and LED radiation stimulated the transition from the inflammatory phase to the reparative (proliferative) phase. Vladimirov, et al. also describe the possible effects on leukocytes, fibroblasts, keratinocytes, and endotheliocytes. Molecularly, LLLI (sic) stimulates mitochondrial membrane potential (MMP), cytokine secretion and cell proliferation. Gavish, et al, used a 780 nm titanium-sapphire laser (2 J/cm^2) and measured MMP, cytokine gene expression, and subcelllular localization of promyelotic leukemia (PML, a cell-cycle marker) pre and post laser application. MMP increased; expression of interleukin-1 alpha , interleukin-6, and keratinocytes growth factor were transiently upregulated. However, the expression of the pro-inflammatory gene interleukin-1 beta was suppressed. The subnuclear distribution of PML was altered from discrete domains to its dispersed form within an hour after LLLI. These changes reflect an activated stage in cell cycle promoting proliferation and suppression of inflammation[20,27,30]. Laser light may membrane functional properties: changes in the activity of membrane ion pumps hence ion flow. Borotetto, et al also found mitochondrial membrane potential changes after laser irradiation for varying lengths of time (energy density 100 mJ/cm^2)[26,31].

Hopkins, et al demonstrated enhanced healing of superficial wounds using LLLT, (8 J/cm^2) in a triple-blind, sham controlled study of 22 subjects. Wound healing appeared to be enhance by facilitating fibroplasias and wound contraction[34]. Irradiation (at 660 nm) was found to induce angiogenesis in rats with partially ruptured Achilles tendon[23]. Blood vessel numbers were higher post-laser application. Although they dropped later, numbers were still higher than the control groups and their own pre-laser application.

Brossuea, et al. did a meta-analysis on laser trials and the effect on osteoarthritis (OA). They found that three trials showed no effect on pain levels, two showed beneficial effects, using VAS. In another with no VAS, significantly more patients reported pain relief. One study found significant increased knee range of motion. Lower dosage LLLT was found to be as effective as higher dosage in reducing pain and increasing range of motion. The implication to the authors of the study is that method of application may explain the inconsistent data. On another, Brosseau et al found that laser therapy was no more effective than placebo in providing symptomatic relief for OA in finger joints. These patients received three treatments per week for six weeks. The only differences found in finger range of motion were in carpometacarpal opposition and grip strength[24,25].

Some explanations are based on the light absorption by primary endogenous chromophores. These include hemoglobin (porphyrins), cytochrome c, mitochondrial enzymes, and flavins[3, 31].

Taking in to account the small doses of radiation appropriate for small animals, the material referenced above all involve “cold lasers” or “soft lasers.” The dosages delivered are in the range of .1 to 25 J/cm^2. The power ranges in the area of 1 W. The class IV laser is powered up to 7.5 W, and the dosage delivered in this case report was 150 J/cm^2. Tissues able to respond to laser therapy is limited by the penetration of the beam[12,32]. This may explain the positive response after only four sessions, compared to 10 or more in some of the studies[5,25]. The depth of biological response is dependent on total power density and power output…Since depth of penetration is dependent only on wavelength. Penetration is greater with longer wavelength, especially with the infrared wavelengths. The Avicenna class IV beam is 980 nm, while the others referenced have wavelengths that are shorter.[33]

The same depth value is achieved no matter the power; however, the energy density is much greater with the class IV than the class III models.

CONCLUSION:

Low-level laser therapy appears to be an effective tool in somatic pain and dysfunction. The physiological action of the laser is dependent on the power and wavelength of the laser, and the depth of biological action. The longer wavelength of the class IV laser means better penetration; the higher power delivers a dosage of energy an order of magnitude greater than the "cold laser." This suggests faster healing of wounds, and suppression of pain and swelling.

ABOUT THE AUTHOR

Dr. Koziej is a native of Dayton, OH and has practiced since 1996. He once rode his bicycle across America and has since remained physically fit. Today he helps competitive athletes and weekend warriors heal through his expertise in biomechanics. Dr. Koziej was one of the first in Kentucky to master Class IV Laser Therapy and utilizes it to complement his expertise in spinal adjusting techniques.

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