CHAPTER 30

RETROSPECTIVE STUDY ON THE USE OF THE ND:YAG CONTACT LASER IN SURGICAL CORRECTION OF PLANTAR HEEL SPUR SYNDROME

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Historically, various surgical techniques have been used in the treatment of heel spur syndrome. Contompasis[1] described heel spur syndrome as a combination of plantar stress, tendonitis, and fasciitis with or without a plantar spur. Most investigators agree that heel pain is most often the result of a biomechanical abnormality in the absence of arthritic disease. Heel pain may be caused by systemic conditions, but is more often caused by bursitis, fasciitis, tendonitis, heel spur formation, periostitis, nerve entrapment, abnormal foot mechanics, or a combination of these disorders. Fortunately, most investigators agree that approximately 85-90% of patients with plantar heel spur syndrome respond effectively to conservative treatment.[1-5] Heel spur surgery is indicated in more severe recalcitrant cases.

Historically, heel spur surgery has been categorized into the traditional open technique,[3] closed approach,[4] semi-closed approach,[3] and the more recently described endoscopic plantar fasciotomy.[6] A complete historical review has been outlined in the literature.[7]

Within the last decade, significant technological developments and many new techniques affecting surgery have occurred. Laser surgery is one of those developments. The podiatric surgeon should be cautious of over-stated claims on the value of laser surgery, and other technological developments in health-care, based solely on the availability of the technology. As physicians, we declare the quality of patient care based on our training and experiences, and not necessarily on the tools that are chosen by the surgeon. The ND:YAG Laser is simply another tool available to the surgeon which, when used properly, can be of benefit to the patient.

PURPOSE

The purpose of this paper is to investigate and report on a random sample of 50 cases utilizing the ND:YAG Contact Laser for surgical correction of plantar heel spur syndrome, over a three-and-a-half year period. The group of patients undergoing soft tissue dissection with the ND:YAG Contact Laser were compared to another group of 50 random cases utilizing the conventional sharp dissection during open heel spur syndrome surgery. Randomization was performed in an attempt to equate the two groups of patients. The null hypothesis test is either accepted or rejected, that is, there is no significant difference in the amount of postoperative bleeding and postoperative pain in comparing the two different soft tissue dissection techniques.

REVIEW OF LASER BIOPHYSICS

The word laser is an acronym for light amplification by the stimulated emission of radiation. Light is a bundle of energy with no mass. The smallest measurable unit of light (energy) is known as a photon. Figure 1 characterizes the four qualities of light (wave length, amplitude, frequency and velocity). An understanding of the fundamental properties of light waves is essential to understand how a laser functions.[8]

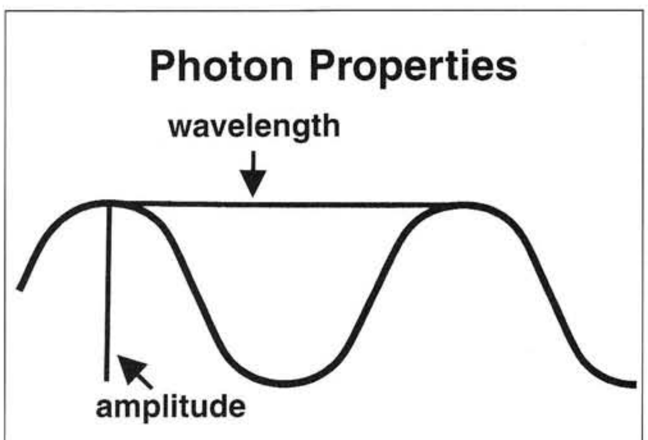


Figure 1. Characteristics of a wave showing photon properties.

Figure 2 illustrates the relationship of the ND:YAG Laser in the ultraviolet, visible, and

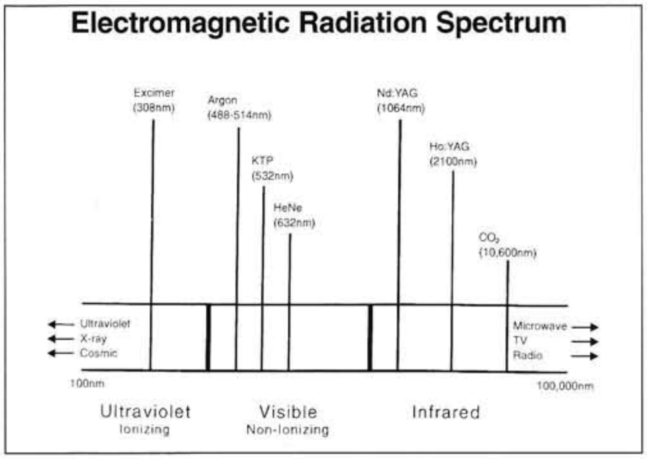


Figure 2. Ultraviolet, visible, and infrared electromagnetic spectrums.

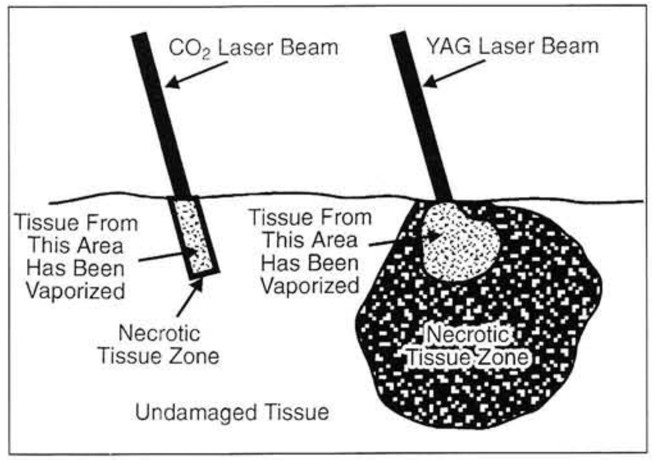


Figure 3. ND:YAG vs. CO2 Tissue Effects

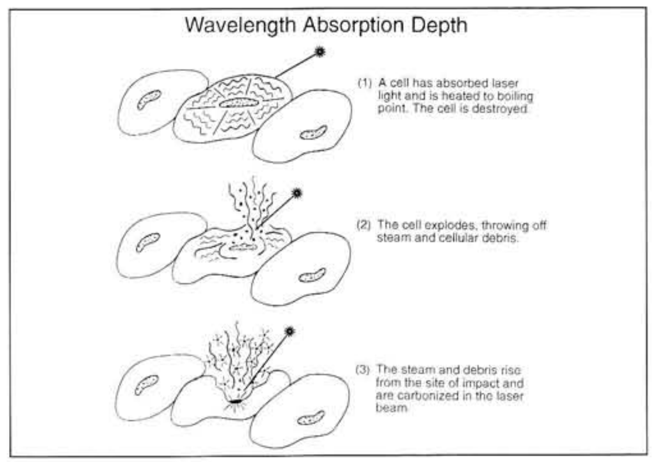


Figure 4. Effects of laser light at various power densities on living tissue.

infrared electromagnetic spectrums. The ND:YAG Laser is a laser medium which produces 1064nm light in the near infrared light electromagnetic spectrum. This can be of benefit to the surgeon at the surgical field, as a potentially high-powered source as the laser beam passes through various types of delivery systems.

In podiatric surgery, the ND:YAG Laser is utilized as a contact (non-divergent) fiber. The desired effect utilizing a contact probe or sapphire tip produces tissue effects only when the probe or tip touches tissue. This is in contrast to an open beam or non-contact laser beam, where divergence is characteristic. The ND:YAG Laser open beam has a thermal injury depth of 2-mm, and great care must be taken in its surgical use. In contrast, the CO2 laser has a thermal injury depth of 0.5 mm. In this study of the contact closed laser beam, utilizing a sapphire tip, the laser energy is expressed primarily as heat at the level of the tip, rather than an open beam. The desired effect can be obtained by varying the power density (watts/cm3) (Fig. 3).

Cells which absorb laser light are initially heated to a boiling point, thus destroying the cell. Additional laser power will cause the cell to explode, giving off steam and cellular debris. With increased power density, the laser beam will cause the steam and debris from the site of impact to be carbonized in the laser beam (Fig. 4).

MATERIALS AND METHODS

The ND:YAG contact laser was utilized in performing subcutaneous dissection for surgical correction of heel spur syndrome. In all cases, the skin incision was made with a sharp #10 blade to the superficial level of the dermis. Following the skin incision, the ND:YAG laser with a frosted tip was used at a setting of 10 to 14 watts/cm2 (Fig. 5). Dissection was accomplished using linear strokes in the conventional proximal to distal fashion throughout the procedure.

Intra-operative lavage with sterile water is important in controlling the thermal effect on the tissue. Palpation and direct visualization, following laser dissection by the surgeon, can help to determine the amount of thermal effect. Excessive thermal damage, with charring of tissues, can be determined by direct visualization.

The frosted tip was utilized rather than the non-frosted tip because of its coagulation capabilities. Frosted tips were utilized at higher power density settings where significant coagulation was desired, particularly in dissection of the plantar fascia. This provides a benefit of decreased postoperative pain and edema, by controlling hemostasis without the use of tourniquets or

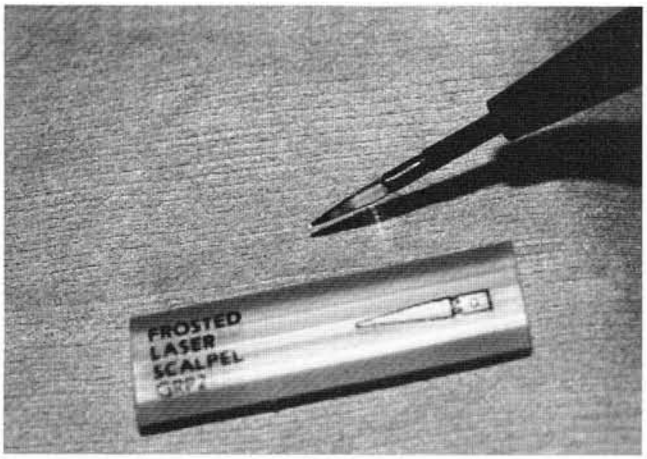


Figure 5. Frosted tip ND:YAG Laser.

electric cautery. Non-frosted tips were not utilized in this study, as they are more applicable for precise thermal laser dissection where the energy is focused at the tip of the laser, particularly for skin incisions.

In all cases, the procedure was either performed under IV sedation with local anesthetic infiltration, or under general anesthesia with local anesthetic infiltration. The local anesthetic consisted of a mixture of 0.5% marcaine plain, mixed half-and-half with 2% lidocaine with epinephrine (1:200,000) to provide additional hemostasis.

The ND:YAG laser was not used to dissect the plantar fascia directly off of the calcaneus, due to the higher incidence of postoperative periostitis secondary to the increased thermal effect. The use of a non-frosted or cutting laser scalpel tip has been proven to be more advantageous with laser dissection involving dissection around osseous structures. The benefits of laser dissection were noted, since significant coagulation and hemostasis was provided during the dissection process.

Following subcutaneous laser dissection and incision through the plantar fascia, the remaining portion of the plantar fascia was removed from the tuberosity of the calcaneus via a combination of soft and blunt dissection, utilizing the conventional open technique.

The surgeon must allow the soft tissue to undergo periods of thermal relaxation by removing the laser and irrigating with copious amounts of sterile water. This is also effective in preventing the adjacent tissues from being thermally injured, which may result in periostitis and increased postoperative swelling. Aggressive laser use without periods of relaxation can cause a thermal charring, postoperative fibrosis, and extensive scarring. It should be noted that the absorption of laser energy in the tissues involving the plantar fascia causes different surgical effects to take place at different levels of temperature. The actual thermal injury varies depending upon the power density in watts/cm2. Protein is denatured at 40-70 degrees centigrade. Tissues can be coagulated from 70-85 degrees centigrade. Vascularization occurs at 85-100 degrees centigrade, and vaporization of tissue at 100 degrees centigrade or more. Carbonization of tissues occurs at 400 degrees centigrade or more. Desired effects can be obtained by varying the power density, and great care must be utilized in avoiding excessive thermal injury. In all cases in the study, the ND:YAG laser was utilized for soft tissue dissection only, and conventional power equipment was utilized for resection or remodeling of bone.

A medial skin incision was used in the traditional dissection technique[2]. The key points to remember in this technique are to avoid the undermining of tissues, and to utilize sharp and blunt dissection to isolate the plantar fascia. A drain should be used with this procedure, due to the difficulty of acquiring adequate hemostasis, and the creation of a dead space following closure of the deeper layer of skin.

OPERATIVE TECHNIQUE

With the patient in a supine position, a 4-5cm medial skin incision is made overlying the medial process of the calcaneal tuberosity. The skin incision is placed parallel to the pitch of the calcaneus, and is confirmed by x-ray evaluation, palpation, and during the infiltration of the local anesthetic by sharp palpation with the needle, outlining the body of the calcaneus and the inferior calcaneal border. The incision is made over the medial process of the calcaneal tuberosity, extending distally between the medial band of the plantar fascia inferiorly, and the abductor hallucis muscle superiorly.

The incision is deepened through the superficial fascia to the level of the deep fascia, utilizing care to gain hemostasis. With the use of the ND:YAG laser there is little or no need for electrocautery or vessel ligation. Once the medial band of the deep fascia is identified, the abductor hallucis muscle belly is retracted superiorly, taking care to avoid trauma to the muscle belly. When anatomic dissection is appropriately performed, there is a natural separation between the aponeurosis and the abductor hallucis belly. The aponeurosis is identified and sharply dissected from the abductor hallucis and flexor digitorum brevis muscles. Once the aponeurosis is freed superiorly and inferiorly from the underlying bone, the superficial plantar structures are retracted with the long blade of an army-navy retractor, and the aponeurosis attachment to the calcaneus can be easily visualized.

A large straight hemostat is used to grasp the aponeurosis from the medial to lateral position, staying perpendicular to the structure and distal to the tuberosity of the calcaneus and calcaneal exostosis. While suspending the aponeurosis with the large straight hemostat, a subtotal fasciectomy can easily be performed, followed by easy visualization of the plantar calcaneal spur, if present. The plantar spur is removed with a bone rongeur followed by smoothing with a reciprocating rasp or rotary burr. The remaining bone is usually rasped smooth, taking care to avoid any channelling into the trabecular bone of the calcaneus to prevent a potential stress fracture. A small osteotome can also be used to resect the plantar spur, but should be used with great caution to avoid fracture of the calcaneus.

Following removal of the heel spur, the wound is irrigated with a copious amount of sterile water, followed by the placement of a closed-suction drain. The deep fascia is closed using a 3-0 or 4-0 absorbable horizontal mattress suture, followed by closure of the subcutaneous layer with 4-0 absorbable suture. The skin is closed with either 4-0 or 5-0 non-absorbable simple or vertical interrupted sutures, avoiding excessive tension on the suture line and postoperative wound dehiscence. A moist saline sponge, followed by a dry sterile compressive dressing, is applied. Postoperative instructions include rest, ice, elevation, and non weight-bearing on crutches for two weeks.

RESULTS AND FINDINGS

Following laser surgery, patients have decreased swelling, thus effecting the postoperative course with earlier ambulation and return to work. These findings were primarily based on a postoperative comparison of patients who underwent laser surgery on one foot for correction of plantar heel spur syndrome, and traditional surgery on the opposite foot.

Table 1 compares the amount of closed-suction drainage following surgery at 8 hour intervals postoperatively, comparing the effect of ND:YAG laser dissection to conventional dissection of the plantar fascia. The results clearly demonstrate that with laser dissection, there is decreased postoperative bleeding as evidenced by the amount of drainage reported on the input/output charting in the medical records.

Table 1

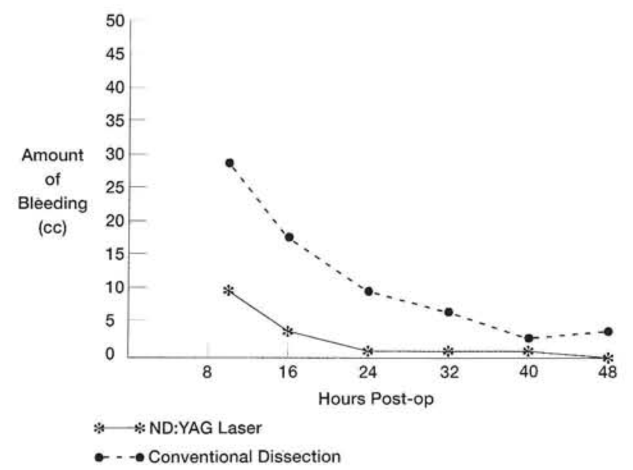
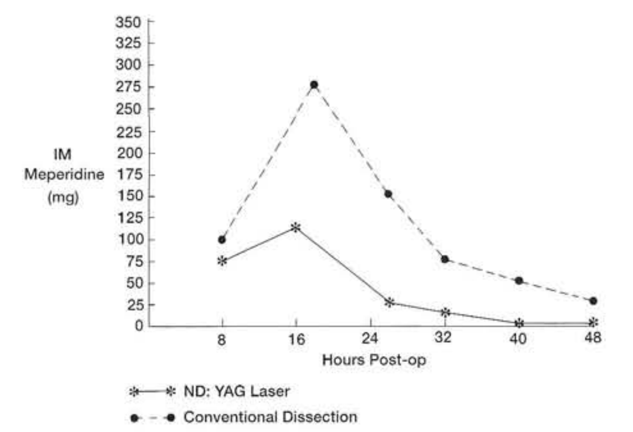


Table 2 outlines the amount of postoperative pain medications required over a 48 hour period, at 8 hour increments. The results clearly demonstrate that with the use of the ND:YAG laser, soft tissue dissection for plantar heel spur syndrome yields decreased postoperative pain, as evidenced by the use of less pain medications.

Table 2



DISCUSSION

Following laser surgery for correction of plantar heel spur syndrome, patients have decreased swelling and decreased postoperative pain, with earlier ambulation and return to work. In most cases, following the traditional open heel spur technique, patients complain of a higher incidence of postoperative swelling, pain, and difficulty with weight bearing for several weeks. In contrast, with the use of the ND:YAG laser, there is a significant decrease in pain and swelling and most patients are more willing to bear weight earlier postoperatively. However, ambulation prior to wound strengthening risks wound dehiscence.

Preliminary results in this comparison study demonstrate decreased postoperative bleeding with the ND:YAG laser. Additionally, with the use of the ND:YAG laser in comparison to conventional dissection is a decreased need for postoperative pain medication. There is hope that this study will stimulate interest in the use of laser technology in podiatric surgery, and aid in developing a research protocol for other studies which determine the effectiveness of this new technology.

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