CHAPTER 13

Technological Overview of Bipolar Radiofrequency Coblation and Its Utility in the Foot and Ankle

Caitlyn Lee, DPM

INTRODUCTION

Radiofrequency coblation has been an emerging treatment modality in the medical field since its inception in unblocking coronary arteries for cardiac surgery. Since then, it has been frequently used in a plethora of medical specialties including oncology, dermatology, otolaryngology, orthopedics, and podiatry. Initially used in 1996 for arthroscopic orthopedic surgery for injured athletes, coblation wands demonstrated efficacious results for the use of tendinosis, specifically for plantar fasciitis, Achilles, peroneal, and posterior tibial tendons (1). In fact, coblation wands have also been used in the debridement of foot wounds.

OVERVIEW OF TECHNOLOGY

Traditional electrosurgical devices utilize high temperatures (400-600°C) to cauterize tissue. However, the employment of such high temperatures presents its own challenges as it also damages surrounding normal, healthy tissue. Coblation stems from the idea of controlled ablation, a process of soft tissue dissolution using bipolar radiofrequency through a conductive medium such as normal saline (0.9% NaCl) with minimal heat (40-70°C). Through the use of two closely positioned electrodes, bipolar frequency is then used to treat the area. Electric current rapidly travels through the normal saline solution from one electrode through the tissue to the second electrode. As the electric current travels through normal saline, the high energy from the current results in the separation of Na and Cl ions. These ions then directly break the surrounding molecular bonds in tissue resulting in their dissolution. This article will provide further insight on the direct application of this technology on health outcomes.

Bipolar radiofrequency is effective due to the formation of plasma within tissue. Plasma, a form of ionized gas, is formed within the saline solution, which ultimately cultivates an environment conducive to breaking organic molecular bonds within soft tissue resulting in its dissolution. Plasma generation is divided into five distinct stages. The first stage, vapor gas piston formation, leads to an increase in surface temperature due to the transition from nucleate to film boiling. Film boiling refers to the concept of a surface, such as the coblation wand, being heated to such an extensive degree that any liquid it comes into contact with will vaporize, bypassing the nucleate or bubble boiling stage. The second stage, called vapor film pulsation, is when tissue ablation occurs. The third stage is characterized by the decrease in amplitude of the current across the electrodes. The fourth stage draws an end to the electron energy at the metal electrode surface. The final stage is the thermal dissipation of energy caused by recombination of plasma ions, atoms, and molecules. The culmination of these stages demonstrate the benefits of using bipolar radiofrequency coblation intermittently in order to maintain a constant vapor film pulsation that is essential for tissue ablation. Plasma ablation of these tissues is a purely chemical process, not a thermal one. Plasma generates free radicals that cause protein degradation leading to volumetric tissue removal with minimal damage to the surrounding tissues (2).

LITERATURE REVIEW

Tendinosis is a chronic degenerative condition without the presence of inflammatory cells. Histologically, these tendons show fibroblastic hypertrophy, disorganized collagen, and chaotic vascular hyperplasia with avascular tendon fascicles (1). The avascular nature of the tendon makes it difficult for tenocytes to repair and remodel the impaired areas. For this reason, stimulating organized angiogenic healing would be the optimal treatment for this condition. The literature has shown that an acupuncture technique along with radiofrequency has successfully promoted angiogenesis. In the foot and ankle, this treatment is achieved through bipolar radiofrequency wand devices.

Plantar fasciitis is one of the most common causes of heel pain and approximately 2 million Americans are treated for this condition per year. Non-surgical treatment is usually the first line of therapy, however persistent and chronic plantar fasciitis can pose a great problem to the podiatric surgeon. Treating the etiology of this heel pain using Topaz bipolar radiofrequency has shown promise. Sean et al (3) studied 14 patients with plantar fasciitis who failed conservative treatment and underwent treatment with the Topaz Microdebrider device (ArthroCare). The patients were evaluated preoperatively and then postoperatively at 3 and 6 months with AOFAS ankle-hindfoot and Short Form 36 scores (SF-36). A total of 14 patients reported good to excellent satisfaction at their 6-month follow-up and the patients reported that their expectations had been met from the procedure.

The study by Sean et al showed good short-term results for this treatment, but there has also been good 1 year results noted in a study performed by Tay et al (4). In this prospective non-randomized trial, 48 patients with recalcitrant plantar fasciitis were treated with Topaz microdebrider device either percutaneously or open. Patients were followed postoperatively at 3, 6, and 12 months using a pain visual analog scale (VAS), the AOFAS hindfoot scale, and SF-36 scores. At the 1-year follow-up, the AOFAS scores in both groups improved significantly. The open group had a more significant improvement in the VAS score than the closed group at 1-year follow-up.

Tendinopathy in the foot and ankle is not isolated to the plantar fascia, it is also commonly seen in the Achilles, tibialis posterior, and peroneal tendons. Radiofrequency coblation for these tendons has shown similar success. Yeap et al retrospectively reviewed 16 feet with chronic tendinosis of the foot and ankle that were treated with radiofrequency coblation (5). In this study, there was a significant reduction in pain at 3 months postoperatively and a VAS score of 0 at 6 months in 63% of the patients. AOFAS scores were significantly improved at both 3 and 6 months. The SF-36 scores for bodily pain also improved significantly in this study.

Aside from treating tendonitis in the foot and ankle, radiofrequency coblation has been used as a novel tool in surgical wound debridement. This technology is especially useful in preserving the underlying healthy tissue in wound beds while actively getting rid of the biofilms and bacterial colonization on the surface of the wound. This separates it from the increasingly popular hydrosurgical systems that are used for wound debridement. With these pressurized hydrosurgical systems, with each pass there is trauma to the wound bed, which can induce intense bleeding. With coblation, each pass results in uniform tissue destruction with less bleeding, allowing the surgeon to precisely control the extent of debridement. Indications for the use of coblation include burns, diabetic foot ulcers, traumatic wounds, and venous leg ulcers (6).

In conclusion, the use of bipolar radiofrequency coblation technology has been shown to play a pivotal role in a wide variety of settings, ranging from cardiac surgery to cosmetic procedures by leveraging the effects of plasma on tissue. This technology is especially promising in the foot and ankle, specifically on recalcitrant plantar fasciitis, tendinosis, and even wounds. It is not only favorable for being minimally invasive, but also because of its established good results. The application of this technology in the foot and ankle was first used in plantar fasciitis, but has grown to include tendons and its use for the podiatric surgeon may still be growing.

REFERENCES

1. Tasto J. The use of bipolar radiofrequency microtenotomy in the treatment of chronic tendinosis of the foot and ankle. Techniques Foot Ankle Surg 2006;5:110-6.
2. Thiagarajan B. Use of Coblation technology. In Otolaryngology. 2016.
3. Sean NY, Singh I, Wai CK. Radiofrequency microtenotomy for the treatment of plantar fasciitis shows good early results. Foot Ankle Surg 2010;16:174 -7.
4. Tay KS, Ng YC, Singh IR, Chong KW. Open technique is more effective than percutaneous technique for TOPAZ radiofrequency coblation for plantar fasciitis. Foot Ankle Surg 2012;18:287-92.
5. Yeap EJ, Chong KW, Yeo W, Rikhraj IS. Radiofrequency coblation for chronic foot and ankle tendinosis. J Orthop Surg 2009;17:325-30.
6. Trial C, Brancati A, Marnet O, Téot L. Coblation technology for surgical wound debridement: principal, experimental data, and technical data. Int J Low Extrem Wounds 2012;11:286-92.