PINNACLECARE

Medical Intelligence Report

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Topic: Conservative Therapies for Posterior Tibial Tendonitis

Conservative Therapies for Posterior Tibial Tendonitis

Background

Many athletes, whether recreational or professional, experience an injury at some point due to repetitive motion, trauma, and / or overuse. Dysfunction of the posterior tibial tendon is one such complication for athletes (Conti, 1994) and early diagnosis is important to prevent disability and increased time away from athletic pursuits.

As is the case with many types of injuries, there are several conservative treatment regimens, including NSAIDs, wearing a brace and physical therapy, among others, which often serve as the first line of treatment for some injuries. However, this report explores alternative conservative treatment modalities for tendon and ligament pain and complications in the ankle. Specifically, the effectiveness and safety of extracorporeal shock wave therapy (ESWT), including H-wave and transcutaneous electrical nerve stimulation (TENS), and platelet-rich plasma (PRP) therapy will be considered herein. To better understand how these treatment modalities may assist in the healing of tendon and ligaments of the ankle, the anatomy and physiology of these will be described first.

Posterior Tibial Tendonitis

The posterior tibial tendon is one of the major supporting structures of the foot (**Figure 1**), assisting it to function while walking and moving in a forward motion. This tendon, like its neighboring Achilles tendon, has an area of hypovascularity (reduced blood vessels), making it more susceptible to injury. Degeneration and inflammation of the posterior tibial tendon is unique, however, because it is often accompanied by progressive acquired flatfoot deformity in adults, which causes pain and weakness (Bubra, Keighley, Rateesh, & Carmody, 2015). If identified and treated in its early stages, progression to deformity and alterations in surrounding joints may be avoided (Bubra et al., 2015). The following definitions may be useful for better understanding and communicating about posterior tibial tendonitis:

> **Tendonitis (also spelled tendinitis) –** inflammation of the tendon resulting from micro-tears that happen when the musculotendinous unit is acutely overloaded with a tensile force that is too heavy and/or too sudden (Bass, 2012).
>
> **Tendinosis –** a chronic or recurring condition cause by repetitive trauma or an injury that has not healed
>
> **Posterior tibial tendon dysfunction (PTTD) –** a condition caused by changes in the tendon, impairing its ability to support the arch. This results in flattening of the foot ("Posterior Tibial Tendon Dysfunction (PTTD)," n.d.).

Importantly, while tendonitis is a common diagnosis, research suggests that in many instances what is thought to be tendonitis is usually tendinosis, or a condition that results from repetitive trauma (Bass, 2012). The most common cause of tendinosis results from repeated microtrauma

and as the tendon degenerates, it is replaced with ineffective fibrotic tissues (Yang, Rothrauff, & Tuan, 2013). For the sake of this report, the term “tendonitis” will be used, as it represents the diagnosis presented.

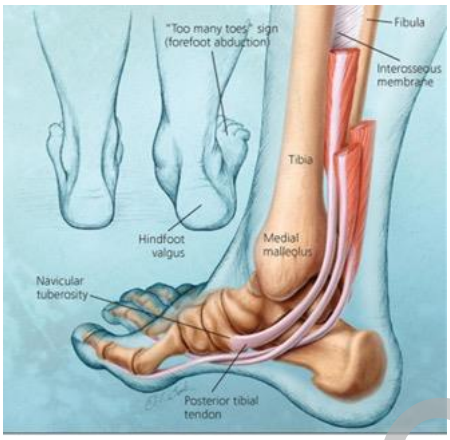

Figure 1. The posterior tibial tendon connects the posterior tibial muscle in the calf to the navicular tuberosity and cuneiform bone.

Diagnosis

Posterior tibial tendonitis may be diagnosed by a physical examination and confirmed by imaging. Staging of posterior tibial tendon dysfunction and acquired flatfoot deformity was first classified into three stages in 1989 by Johnson and Strom (Johnson & Strom, 1989) and later expanded upon in 1997 with a fourth stage by Myerson (Abousayed, et al., 2016). Bluman (Bluman, et al., 2007) and Raikin (Raikin, Winters, & Daniel, 2012) and their respective colleagues proposed more elaborate classification systems; however, the Johnson and Strom classification remains the most commonly cited among researchers and most accepted and widespread among ankle and foot surgeons (Abousayed et al., 2016). **Table 1** outlines the Johnson and Strom classification of posterior tibial tendon dysfunction (PTTD). Myerson then modified this original classification with a fourth stage that describes valgus deformity of the ankle associated with deltoid ligament insufficiency, which may be associated with lateral tibiotalar arthritis.

Table 1. Johnson and Strom classification of posterior tibial dysfunction.

Variable	Stage I Mild, medial pain	Stage II Moderate, medial pain	Stage III Severe, medial and lateral pain
Examination			
Swelling and tenderness	Mild swelling and tenderness along posterior tibial tendon	Moderate swelling and tenderness along posterior tibial tendon	Not much swelling but marked tenderness along posterior tibial tendon
Heel-rise test	Mild weakness	Marked weakness	Marked weakness
“Too many toes” sign	Absent	Present	Present
Deformity	Absent	Present (flexible)	Present (fixed)
Pathologic features	Normal tendon length, paratendinitis	Elongated with longitudinal tears	Disrupted with visible tears
Images	No changes	Gross deformity	Deformity and diffuse arthritic changes
Treatment	Conservative, tenosynovectomy	Flexor digitorum longus transfers	Triple arthrodesis

In stage I, physical examination by palpation may yield tenderness along the tendon and in particular behind and below the medial malleolus. As the disease progresses, swelling and pain may wane, suggesting a complete rupture of the tendon and subsequent flatfoot deformity (Bubra et al., 2015). From the posterior aspect, the medial (inner) arch may appear collapsed (**Figure 1**) due to weakness and result in forefoot abduction. Forefoot abduction is present if "too many toes" -- defined as more than one or two toes -- are visible along the lateral aspect of the affected foot (**Figure 1**).

To adequately diagnose PTTD, the provider will ask the individual to perform the single limb heel rise test. To this end, the affected individual will lift the unaffected foot off of the ground and attempt to rise onto the toes of the affected foot. While individuals with a fully functional posterior tibial tendon may complete 8-10 repetitions, those at Stage II are typically unable to complete more than one or a few unsupported heel rises.

Imaging techniques, including x-ray, ultrasound, and MRI may be used to confirm and verify staging and diagnosis. An x-ray may not be capable of detecting PTTD in its earlier stages, but arch collapse and joint degradation become evident and easily visualized in an x-ray as the disease progresses. Another method, ultrasonography, allows one to examine the size of the tendon, fluid levels, and to assess whether any degeneration exists. Some research suggests that the accuracy of results may vary based on the ultrasonographer (Bubra et al., 2015); however, a retrospective study published in 1996 by Miller et al. demonstrated that preoperative ultrasound effectively diagnosed inflammation, tears and ruptures in 17 patients, as corroborated by subsequent surgical findings (Miller, et al., 1996). Interestingly, of the 17 individuals described in Miller's study, two ruptures had been undiagnosed by MRI. Indeed, this finding was supported by a more recent study, which found that high-resolution ultrasound was slightly more accurate than MRI in the detection of posterior tibial tendon dysfunction (Arnoldner et al., 2015).

Diagnostic imaging may also uncover additional conditions leading to the pain experienced by the individual. For example, tenosynovitis, or inflammation of the tendon sheath lining, as well as small tears in nearby ligaments, such as the anterior talofibular ligament (ATFL), may also result from athletic activities that are strenuous on the ankle. It is not uncommon for individuals with chronic ankle pain to present with more than one isolated injury (DIGiovanni, Fraga, Cohen, & Shereff, 2000). To align with the presented diagnosis, tenosynovitis and ATFL will be described briefly herein.

Tenosynovitis

A sheath, called the synovium, wraps around tendons to protect them and provides synovial fluid to keep the tendon lubricated. Injury to the tendon, surrounding muscle, or bone may compromise sheath function, causing inadequate production of synovial fluid. As a result, tenosynovitis, or inflammation and swelling of the sheath may ensue. **Figure 2** depicts tendons with a health synovial lining (left) and those with tenosynovitis (right). Oftentimes, tenosynovitis is associated with repetitive-stress activities, prolonged physical activities, standing for long periods of time, and sudden sprains or strains.

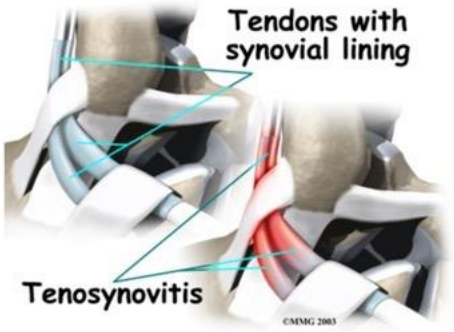

Figure 2. Tenosynovitis is inflammation of the protective sheath surrounding tendons, (adapted from https://eorthopod.com/peroneal-tendon/).

Like posterior tibial tendonitis, diagnosis of tenosynovitis may be confirmed by MRI or ultrasound. Treatment options include massage, stretching, ESWT and TENS, as well as nonsteroidal anti-inflammatory drugs or corticosteroid injections.

Anterior Talofibular Ligament (ATFL)

Ligaments are short bands of tough, yet flexible, fibrous connective tissue that connects two bones or cartilages. The ATFL is the most commonly injured ankle ligament (Martin et al., 2013). When a plantar-flexed foot is inverted as may be the case with PTTD, this ligament is particularly strained and therefore displays a higher propensity for injury (Kumai, et al., 2002). **Figure 3** demonstrates a partial tear in the ATFL.

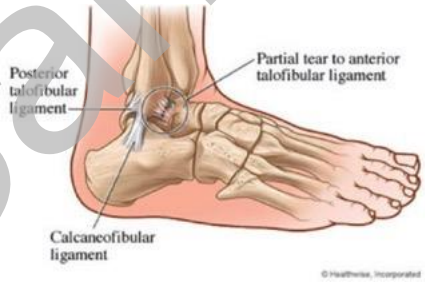

Figure 3. Partial tear in the anterior talofibular ligament (adapted from https://3dpt.com/fultz-injury/).

Treatment for ankle conditions must be individualized, based on the type of tear and the degree of deformity present. Non-surgical therapies are preferred for individuals presenting in early stages of the disease and may prevent progression of the condition. These treatment modalities include non-steroidal anti-inflammatory drugs, such as NSAIDs, rest and immobilization, and / or physical therapy or orthotic devices. In the next few sections of this report, alternative, non-invasive therapies will be discussed in detail with supporting evidence. However, those experiencing later stages of tibial tendonitis may require surgical intervention.

Extracorporeal Shock Wave Therapy (ESWT)

Extracorporeal shockwave therapy is a non-invasive technology that uses a transient set of acoustic pressure waves to produce energy outside of the body, but that deliver mechanical disturbance that propagates rapidly in the body's tissues. These waves of energy may be administered in high-energy pulses or low-energy pulses that are generated by electrohydraulic, electromagnetic, and piezoelectric principles (Wang, 2012). The waves are created by a hand-held device (**Figure 4**) and transmitted via a special probe targeted at the pathologic area to produce a targeted effect.

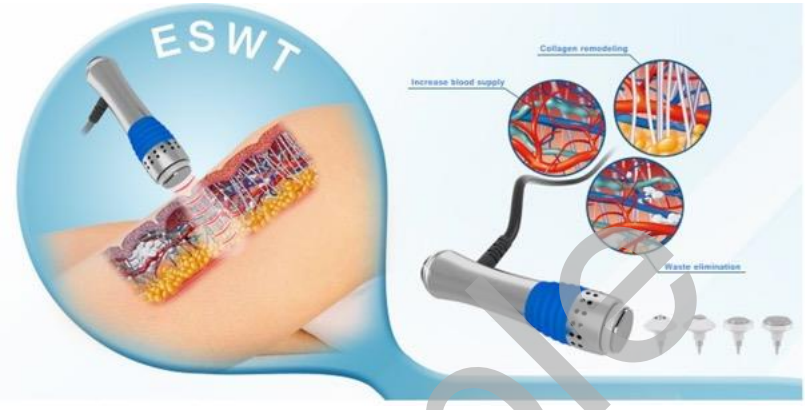

Figure 4. Cartoon depicting the breakdown and removal of waste and inflamed tissues, as well as revascularization and remodeling of these tissues following treatment with ESWT, (adapted from https://canberrapodiatry.com.au/shock-wave-therapy/).

The Energy Flux Density (EFD) (units mJ/mm^2) is used by physicians to measure the energy that flows through tissue at a perpendicular orientation. According to Loew and Rompe (1998), the usual EFD applied in clinical practice ranges from 0.001 to 0.4 mJ/mm^2 (Wang, 2012). A lower EFD has been considered by some to be "low-energy" ESWT, while a higher EFD has been defined as "high-energy" ESWT, but in a systematic review by Schmitz *et al.* (2015), the authors posit that the distinction be abandoned because there is no consensus in the scientific literature about the difference between "low-energy" and "high-energy" ESWT (Schmitz et al., 2015).

Regardless of energy level, or EFD, delivery of the pressure waves may be "focused" or "radial" (**Figure 5**) and will vary based on the size and shape of the probe (**Figure 4**, bottom right) that interfaces with the skin, as well as the angle at which the device is held during treatment.

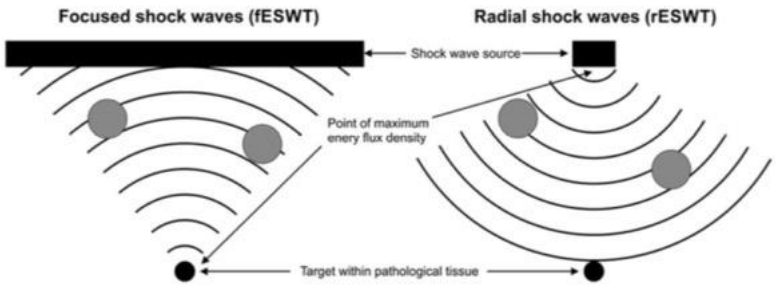

Figure 5. Focused and radial ESWT.

Shock wave therapy was first performed in 1980 to break apart kidney stones, a process called lithotripsy (Chaussy, Brendel, & Schmiedt, 1980; Tailly, 2013). However, over the past three decades, ESWT has been successfully used to manage a number of orthopedic conditions (Ioppolo, et al., 2014; Schmitz, Császár, et al., 2013; Speed, 2014). In contrast to lithotripsy, orthopedic shockwaves are not used to disintegrate tissue, but rather to promote interstitial and extracellular growth and tissue regeneration (Ogden, et al., 2001).

Specifically, ESWT has been found to benefit people with bone and soft tissue injuries. Indeed, it was observed that the treatment actually stimulated bone and tissue growth and repair. Using clinical and radiological measurements, one study found that bone union was achieved using ESWT in 85% of individuals with non-unions and 80% of factures (Moretti et al., 2009). Other studies have demonstrated similar findings in bone repair (Kertzman, et al., 2017; Xu et al., 2009).

Soft tissue injuries may also benefit from ESWT. As depicted in **Figure 4**, ESWT stimulates the disintegration and removal of built-up fibrotic tissue, as well as stimulate vascularization and tissue remodeling. Findings within the scientific literature support the use of ESWT in conjunction with physical therapy and strengthening exercises for treating tendinopathies.

Clinical Evidence for ESWT for Ligaments

In 1988 a study was produced by Akai and colleagues, who found a healing effect of directly applying electrical current to the ligaments of rabbits with a full-thickness defect of the patellar ligament (Akai, et al., 1988). Specifically, the authors reported that compared to the control group, those treated with electrical stimulation experienced restoration of tensile stiffness and modifying ratios of various collagen types favorably. Published early in the 21st century, McClure and colleagues reported that the use of ESWT improved the rate of ligament healing in horses, as determined by ultrasonography (McClure, et al., 2004).

Clinical Evidence of ESWT for Tendinopathies

There is a plethora of evidence suggesting ESWT is effective and safe for treatment of tendon diseases. However, at the time of this report, it appears that the peer-reviewed literature does not offer a study specifically focused on posterior tibial tendonitis. One study published in 2010 discusses the usefulness of ESWT for the treatment of medial tibial stress syndrome (MTSS), which is pain originating from the tibialis posterior muscle. Included in the study were 47 individuals with chronic recalcitrant MTSS who adhered to a home training program and who received repetitive low-energy radial ESWT (2000 shocks; 2.5 bars of pressure, which equals 0.1mJ/mm2; total EFD 200mJ/mm2; and no local anesthetic). A control group, consisting of an equal number of individuals with MTSS, also followed home training programs, but were not treated with ESWT. Interestingly, success rates as determined by a Likert scale were significantly greater for the group receiving ESWT intervention, compared to the control group, at 1-, 4-, and 15-months following baseline. Importantly, 15 months following baseline, roughly 85% of the ESWT-treated individuals were able to return to their preferred sport at their pre-injury level, while only 47% of those in the control group were able to return at their pre-injury level. The authors concluded that radial ESWT was effective in treating MTSS (Rompe, Cacchio, Furia, & Maffulli, 2010).

There are many articles presenting studies that have sought to evaluate the efficacy of ESWT on chronic Achilles tendinopathy. A review published in 2015 highlighted many of these studies and concluded that the data suggest a high level of evidence of the efficacy of ESWT (both radial and focused) for treating chronic Achilles tendinopathy. Moreover, the authors proposed that to date, ESWT was the most effective option for treating this type of tendinopathy (Gerdesmeyer et al., 2015). Importantly, several studies described within this review also allowed the authors to conclude that ESWT should be conducted in the absence of local anesthesia, as the application of local anesthetic decreased the effectiveness of ESWT treatment (Gerdesmeyer et al., 2015). This finding that anesthesia hinders efficacy of ESWT was corroborated by the findings presented in a systematic review of using ESWT for orthopedic issues by Schmitz and fellow researchers (Schmitz et al., 2015).

A randomized controlled trial examined the efficacy of either high-energy ESWT, low-energy ESWT, or placebo for treatment of chronic calcifying tendonitis of the rotator cuff in 144 participants. Individuals in the two ESWT groups received equal dosages of cumulative energy, and all three groups received two treatment sessions roughly two weeks apart, with physical therapy to follow (Gerdesmeyer et al., 2003). At the 6-month follow-up, compared to placebo, both high-energy and low-energy ESWT was associated with significant improvement in the 6-month mean Constant and Murley Scale (CMS) assessment score. Interestingly, those who experienced high-energy ESWT also reported significantly improved 6-month mean CMS scores compared to those who received low-energy ESWT, suggesting that at least in this application, high-energy ESWT may be superior to low-energy ESWT (Gerdesmeyer et al., 2003).

The clinical efficacy of ESWT for healing the lateral epicondylitis (LE) (tennis elbow) tendon has been established and compared to cryo-ultrasound, which is an alternative non-invasive treatment option that utilizes both cryotherapy and ultrasound. Using the visual analog scale (VAS) as well as other clinical outcome measures, the researchers measured pain in 80 individuals with LE to obtain a baseline, and then at 3-, 6-, and 12-months post-treatment with either 3 ESWT sessions at 48/72 hours intervals (n=40) or 12 cryo-ultrasound therapy sessions (4 sessions per week, n=40). Favoring the ESWT group, statistically significant differences in the VAS scores were observed between the two groups at both 6 and 12 months following intervention (Blum et al., 2008).

Finally, although the posterior tibial tendon was not included in the study, another peer-reviewed publication examined the effectiveness of ESWT on three major tendon diseases: tendonitis of the shoulder (n=129 individuals); chronic Achilles tendinopathy (n=102 individuals); and the LE of the elbow (n=80 individuals). The affected individuals received three ESWT treatment sessions on a monthly interval and were subsequently evaluated with several outcome measures at 1, 6, and 12 months following the intervention. In all instances, the mean scores on outcome assessments were statistically significant and clinically, individuals experienced near complete resolution of symptoms (Carulli et al., 2016).

Perhaps also of interest is a retrospective analysis of 44 individuals who had been treated with radial ESWT for finger tenosynovitis (trigger finger). The authors reported a significant reduction in pain scores and functional improvement and suggest that this may provide initial evidence for the efficacy of ESWT for treatment of tenosynovitis of the fingers (Malliaropoulos et al., 2016).

Procedure

Shock wave therapy is an out-patient treatment procedure that takes roughly 15 - 20 minutes per session. Treatment involves the application of a coupling gel, which enhances conduction of the shock waves, improving efficacy, to the skin around the affected area. Then, a noninvasive probe is applied to the skin, and typically moved in a circular motion over the affected area. A therapy is more successful when the individual receiving treatment is actively engaged and describing to the provider whether the probe is at the area of interest. There are several different instrument settings that will be considered by the provider (**Table 2**).

Table 2. ESWT Treatment Parameters (from van der Worp, van den Akker-Scheek, van Schie, & Zwerver, 2013).

Treatment parameters	Description
Maximal positive pressure	The maximal positive pressure that is reached
Focal zone	A 3-D ellipsoid where the pressure is above a certain value
Energy flux density	The amount of energy/surface unit (mJ/mm^2)
Time interval between treatments	
Number of impulses/treatment	
Impulse frequency	The number of shockwaves that is applied/second
Localization method	How the to-be-treated site is determined?
Anaesthesia	
Concurrent treatments/rest	

Animal studies have indicated that EFDs above 0.50 mJ/mm^2 should be avoided (van der Worp et al., 2013). The optimal quantity of impulses for treatment of tendinopathy is unclear, but one study showed that three treatments with 500 impulses were more effective than three treatments with 100 impulses in plantar fasciitis (Krischek, Rompe, Herbsthofer, & Nafe, 1998).

Avoiding anesthesia during ESWT will result in optimal efficacy. It has been determined in multiple studies that anesthesia reduces efficacy of ESWT.

Finally, for a short time following the first treatment of ESWT, the affected tendon is unable to bear as much of a load, so rest during this time is critically important. Indeed, one study revealed that compared to placebo, ESWT had no effect on pain management for actively competing athletes (Zwerver et al., 2011).

Risk Factors and Complications

Shockwave therapy has been associated with few complications. Indeed, the primary complications reported by individuals treated with ESWT are limited to pain during the procedure and hypersensitivity at the site of treatment.

It has been recommended that individuals with poor sensation (neuropathy) or hypersensitivity in the target area should not be treated with ESWT. Moreover, if an individual presents with

open sores, is pregnant, or has heart conditions or experiences seizures, ESWT may not be recommended.

H-Wave® Therapy

The H-Wave® (Electronic Waveform Lab, Inc., Huntington Beach, CA, USA) device generates electrical signals that stimulate smooth muscle cells in the lymphatic system, which is part of the immune system, and indirectly stimulates the fibers of the musculoskeletal system (Blum, et al., 2005). Chronic pain is believed to be reduced by a decrease in inflammation. A meta-analysis including 5 human studies that used the H-wave device from Electronic Waveform, Inc. measured effect size of each study regarding pain relief, intake of pain medications, and functionality (Blum et al., 2008). Effect size was defined as small if ≤0.20, moderate to large if around 0.50 and considered large if the value was ≥ 0.80 (Cohen, 1988). Moderate to large (effect size of 0.59) pain relief was achieved among individuals with various chronic soft tissue inflammation and neuropathic conditions who used the H-Wave device. Two of the studies yielded a moderate to large effect size with regard to reducing medication intake; and the H-Wave device offered a strong effect in terms of restoring functionality, with an effect size of 0.70 (Blum et al., 2008). Together, these findings allowed the authors to conclude that the H-Wave device was effective not only at pain reduction, but also at enabling individuals to return to activities that may have become more challenging prior to the H-Wave device treatment.

Transcutaneous Electrical Nerve Stimulation (TENS) Therapy

Transcutaneous electrical nerve stimulation (TENS) therapy uses electrical stimulation to excite sensory nerves, by either activating the pain/gate mechanism and / or the opioid system, each of which offer a reduction in perceived pain. Importantly, the term, “TENS” could represent any type of electrical stimulation administered through electrodes that are placed on the skin and that are used with the intent to relieve symptomatic pain.

As was the case with ESWT research on posterior tibial tendonitis, there is a dearth of research in the area of TENS and its efficacy on tendinopathy, and no apparent articles citing its effects on posterior tibial tendinopathy. However, a paper published in 2015 reported that burst TENS (applied for 30 minutes, 6 days, 100 Hz frequency, 2 Hz burst frequency, 200µs pulse duration, and 300ms pulse train duration) prevented production of collagen (Types III and I), which may increase the tendon’s resistance to stress and future ruptures, in the partially ruptured Achilles tendons of rats. However, microscopic analysis did not find an increase in vascularization or mast cell production (Folha et al., 2015).

A relatively recent systematic review evaluating the efficacy of TENS for rotator cuff tendinopathy concluded that a scarce number of studies, coupled with the high risk potential for bias within the six studies included, that no conclusions could be established (Desmeules et al., 2016). Indeed, the authors suggested that clinicians favor other evidence-based rehabilitation modalities with proven efficacy for treating those with rotator cuff tendinopathy.

Procedure

Similar to ESWT, a small handheld device is used to administer TENS. In contrast to ESWT, a TENS unit typically has two lead wires, each with a small electrode that is adhesive, so it may adhere to the skin. After the electrodes are adhering to the skin at the site of pain, the unit is turned on and the electrical pulses may be adjusted accordingly.

Platelet-Rich Plasma (PRP) Therapy

Platelet-Rich Plasma (PRP) therapy has become a more popular option for treating musculoskeletal injuries, including tendinopathy in recent years. In fact, in 2013, it was reported that roughly 86,000 athletes in the United States and Europe received PRP to treat chronic and acute muscle, ligament and tendon injuries (Wasterlain, et al., 2013). Produced in the bone marrow, platelets maintain tissue homeostasis and demonstrate healing capabilities through the release of bioactive growth factors. Plasma contains proteins, as well as cells, such as leukocytes neutrophils and monocytes which also release bioactive factors. Specifically, monocytes secrete platelet-activating factor, TGF-β, FGF, and EGF (Boswell, et al., 2012), which have been indicated in tendon repair (Molloy, et al., 2003). However, a recent article raises concern about the fact that these factors have also been implicated in tendinopathy, and suggests that their role is both spatially and temporally contextual (Andarawis-Puri, et al., 2015).

Many *in vitro* studies have demonstrated the anabolic, catabolic, and anti-inflammatory effects of PRP (Zhou & Wang, 2016). Fewer *in vivo* studies have been conducted, but on the whole, these animal studies suggested that PRP may improve repair in tendons with pathologic disease (Zhou & Wang, 2016).

A systematic review and meta-analysis assessing the efficacy of PRP injections for symptomatic tendinopathy was conducted by Miller and fellow colleagues and published in 2017. While none of the 16 randomized controlled studies included in the comprehensive analysis focused on tendinopathy of the posterior tibial tendon, each had a group of individuals who received a PRP injection, and a control group. Results of the analysis showed that compared to control, a moderate treatment effect was realized by PRP injections with regard to resolving symptomatic tendinopathy, as determined by an effect size of 0.47. Interestingly, subgroup analysis identified a higher proportion of females realizing superior treatment benefits with the PRP treatment modality (Miller, et al., 2017).

A case study published in 2017 demonstrated the efficacy of PRP treatment for a 50-year-old, active male with advanced posterior tibial tendonitis with a longitudinal tear at the level of the malleolus (“Does PRP Have Promise For Advanced Posterior Tibial Tendinopathy In Athletes? | Podiatry Today,” n.d.). In this particular case, an incision and subsequent debridement of the longitudinal tear was conducted, and part of the extracted PRP was placed into the tendon tissues, while the other half of the PRP was injected, both proximally and distally to the tear, where tendonitis had been visible by MRI. Five years following the debridement and PRP procedure, the individual reported being completely asymptomatic and actively engaged in competitive soccer. Moreover, an MRI showed a normal posterior tibial tendon (“Does PRP Have Promise For Advanced Posterior Tibial Tendinopathy In Athletes? | Podiatry Today,” n.d.).

Procedure

Platelet-rich plasma treatment is an in-office procedure involving a blood draw, preparation of the PRP and subsequent injection. Specifically, blood is taken from a vein, and processed in a centrifuge machine to concentrate the platelets and plasma. The skin overlying the affected joint is disinfected and a local anesthetic may be used to numb the injection site. As is the case with the other therapies included in this report, some believe the anesthetics decrease PRP efficacy (Kaux et al., 2015). Because the PRP stimulates a biological cascade, including the stimulation of inflammatory agents, the injection site may swell and be painful for a few days.

Conclusions

In summary, there is a growing amount of data suggesting that ESWT is a safe and effective method for treating tendon-related disease conditions. The procedure is short and there are very few reported side-effects.

Data surrounding H-Wave therapy seems to be confined to the use of the H-Wave® **(**Electronic Waveform Lab, Inc., Huntington Beach, CA, USA) device and there is far less on this non-surgical option than the others explored herein. Transcutaneous electrical nerve stimulation (TENS) works similarly to ESWT in that extracorporeal stimulation of the affected area is employed, but its mechanism of action is believed to modulate nerve stimulation to relieve pain.

Platelet-rich plasma therapy has shown effect in a case study of posterior tibial tendonitis and larger comparative studies of other tendinopathies.

This research allows for the conclusion that while some of these non-surgical treatment options for tendinopathies may be in their earlier stages of validation from a clinical prospective, particularly with regard to PTTD, there are certainly several alternative, conservative treatment modalities in addition to the basic NSAID, physical therapy, and strengthening exercises.

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