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Treating Tendinopathies and Plantar Fasciitis: Current Approaches and Future Trends

White Paper

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Prevalence and Etiology of Tendinopathies and Plantar Fasciitis

Tendon pathologies are responsible for a variety of major problems in both sporting and generally active populations. Approximately 9.1-10.9% of all runners will experience Achilles tendinopathy[1], and 12-14% of all volleyball and basketball players complain of patellar tendon pain during participation[1-3], while in comparison, upper extremity tendon pain is more common in the general population than in athletes. Over 1 million physician visits occur annually in the United States resulting from patients affected by plantar fasciitis.[4, 5] Gabel et al reported that 1-2% of the entire population complains of forearm extensor tendon pain at some point, and that these injuries increase in frequency as we age[6]. Another prevalent source of pain in the aging population stems from rotator cuff (RC) tendinitis, which may even progress to rotator cuff tears if left untreated.[7] Herein, we aim to discuss the most clinically effective and efficient treatment options for plantar fasciitis and common tendinopathies built on current evidence-based medical research.

There are several theories regarding the etiology of tendinopathies. The first is referred to as the extrinsic theory, in which the tendon experiences increased strain which leads to tissue damage, fibroplasia, scar tissue formation and weakened tissue tensile strength. This weakened tissue ultimately leads to overloading and failure (rupture). The second theory is the intrinsic theory, which describes the tendon as metabolically active tissue that requires vascularity for proper function and healing. [7] Specific tendons in the body (i.e., RC, extensor carpi radialis brevis, Achilles, and patellar tendons) have compromised vascular supply which leads to healing difficulty, predisposes them to degeneration, and ultimately leads to tendon failure.[8] Finally, the neural theory of tendinopathy proposes that injury/alterations to nerves which innervate the tendons and associated muscles significantly contributes to the development and persistence of tendinopathy. This theory posits that the substance P released during mast cell degranulation acts as a nociceptive neurotransmitter.[9, 10] Increased levels of substance P has been documented in various tendinopathies,[11] which has been hypothesized to increase susceptibility to chronic tendon pain.

Tendinopathy Treatment Strategies

The key to successful treatment of tendon conditions is a thorough examination, accurate differential diagnosis of the tendon injury type, and the development of a comprehensive treatment program. Tendon injury types have been widely categorized into the following categories: tendinitis for an acute episode, tendinosis for chronic degenerative conditions, and tendinopathy for symptomatic tendon pain.[12] This differential diagnosis of tendinopathy between inflammatory (tendinitis) versus degenerative (tendinosis) is critical as this differentiation guides the development of an appropriate treatment plan.

Treatment programs should be multi-modal, joint specific, and adjusted to patient healing through a continual and ongoing assessment of symptoms and function. While the treatment of inflamed tissue is the cornerstone of all programs, external factors (i.e., biomechanical overloading, training, psychosocial and lifestyle activities) that have contributed to the tendinopathy must be considered. Effective education, management of expectations, and patient compliance to the treatment plan are essential to optimizing recovery. Successful treatment programs for tendinopathy consist of a combination of activity modification, exercise, range of motion (ROM)/stretching, soft tissue mobilization, specific therapeutic modalities, and a home exercise program. Activity modification, specifically a reduction in type, frequency, and/or intensity of activities should be the first line of any treatment program.[13]

Exercise Therapy

Eccentric exercise has been historically beneficial in the treatment of tendinopathies through facilitation of tendon remodeling.[14-19] Elite level soccer players with Achilles tendinopathy demonstrated increased collagen synthesis, decreased pain, and full return to play following a 12-week eccentric exercise program completed twice per day.[14] Another study revealed a 12-week eccentric heel raise program generated reduced pain, increased strength, and successful return to running when compared to a conservative therapy in athletes with Achilles tendinopathy.[15]

Alternatively, recent studies have reported improved efficacy in therapeutic programs that have shifted from sole reliance on eccentric exercises to programs that utilize heavy slow resistance training (HSR). HSR utilizes heavier loads (70% of a 1 repetition maximum) across a longer duration (6 seconds per repetition) during common exercises like the leg press, squat, or deadlift.[20] HSR is believed to enhance collagen synthesis and mechanical stiffness of the tendon. Previous studies on the use of HSR have shown improved function and decreased pain in patients with Achilles or patellar tendinopathy. HSR has also been shown to have higher patient satisfaction ratings when compared to eccentric exercise.[21-23] Additionally, the use of Flywheel or inertial training has become increasingly popular in the last 5 years. This method of training allows for the generation of kinetic energy through maximal concentric effort, followed by an eccentric overload. While still early, emerging data suggests the use of flywheel training in both prevention and rehabilitation of lower body tendinopathy to be promising.[24, 25] Lastly, isometric exercise has also been shown to be effective in short term pain relief specifically in cases of patellar tendinopathy. These exercises are considered safe to be used within the competitive season.[25]

Alternative Non-Surgical Therapy Options

Clinicians commonly employ non-exercise therapies in attempts to reduce pain, inflammation, and improve functional impairments in tendinopathy patients. Two of the recently preferred modalities utilized in physical therapy are photobiomodulation therapy and extracorporeal shockwave therapy. Both modalities have shown a promising potential in supporting the treatment of tendinopathies and plantar fasciitis, with increased efficacy/synergy when used in combination[26].

Photobiomodulation is the use of light in the form of an LED or a laser to penetrate tissue with the goal of increasing blood flow, reducing inflammation, and reducing healing times. While there still is some debate, the most accepted mechanism of action of photobiomodulation is driven by the increase of ATP production. This occurs when light is absorbed by cytochrome c oxidase which then increases the production of ATP and releases Nitric Oxide, thus leading to increased blood flow.[27] However, these cellular responses respond in a biphasic fashion to dose (i.e., too much or too little can be undesirable/ineffective)[28]. Multiple factors determine the "dose" that are delivered to the target tissue: wavelength, irradiance/power density (mW/cm2), and fluence/energy density (J/cm2). The wavelengths with the best tissue penetration into tendon tissue in the near infrared spectrum range from 800 to 1100 nm. Commercially available therapy units are segregated into separate classes based on power; Class 3B lasers (≤0.5W) and Class 4 (> 0.5W). Photobiomodulation therapy is widely used in physical therapy, chiropractic and orthopedic clinical environments for stimulating tissue repair, enhancing blood flow, and reducing pain. Class 4 lasers, with their higher power, are employed for deeper tissue penetration to treat hard to reach musculoskeletal conditions, effectively reducing pain and helping to accelerate the repair process in tissues including muscles, tendons, and ligaments. These Class IV lasers (e.g., Lightforce XPi and XLi by Chattanooga) benefit from the convenience of decreased treatment times, as they are able to achieve sufficient energy in a shorter time due to their increased power.

Recent studies have also shown higher power densities being consistent with a pain relief mechanism.[29, 30] Several clinical studies have shown photobiomodulation to have positive effects in both pain relief as well as improved function for the treatment of tendon pathologies.[31-34] Since tendons are considered comparatively poorly vascularized and heavily rely upon synovial fluid diffusion to provide nutrition, photobiomodulation is particularly advantageous by increasing blood flow and cellular infiltration to the impaired tendon helping to improve clinical outcomes[35]. The authors of this paper have seen tremendous benefits when using laser therapy.

Extracorporeal shockwave therapy (ESWT) is another non-invasive therapy that uses acoustic waves (a.k.a. shockwaves) to disrupt tissue and induce a healing response.[36, 37] Radial Pressure Wave (RPW) therapy and Focused Shockwave (FSW) therapy are both non-invasive treatments used in physical therapy, chiropractic, and orthopedics but differ primarily in their depth of penetration. RPW therapy generates shockwaves that spread out radially, offering a broader treatment area, making it well-suited for treating superficial musculoskeletal conditions such as plantar fasciitis, tennis elbow, patellar tendinopathies, and Achilles tendonitis .[36, 38-41] Other conditions for which RPW is an effective treatment include reduction of muscle pain/aches, temporary increases to blood flow, and activation of connective tissue. In contrast, FSW therapy produces high-energy shockwaves that, as the name implies, are focused thus enabling better tissue penetration. FSW has demonstrated effectiveness in treatment of conditions such as plantar fasciitis.

While ESWT was only approved by the United States Food and Drug Administration in 2000, it has been shown to increase organized type I collagen production (a key component of musculoskeletal tissues and a load bearing constituent of healthy tendon tissue), increase neovascularization (essential for local nutrient delivery to healing tissues), and modulate the inflammatory response in tendons (which can block and/or delay the tissue formation process).[38, 42-44] ESWT has been shown to regulate nitric oxide production, increase bone morphogenic protein, increase transforming growth factor beta 1 (TGF- β1), and increase vascular endothelial growth factor expression.[38] Notably, ESWT has demonstrated benefit when used as an adjunct to tendon loading programs.[45] Like photobiomodulation, it is important to use enough energy ("dose") to create the effect in the target tissue.[46]

The combined use of both these emerging modalities has demonstrated increased clinical efficacy beyond application of either therapy in isolation.[26, 47] [48] One study looked at using this combination, demonstrating that when used together the outcomes were improved over when each modality was used independently.[26] This combination therapy, if used correctly, can improve upon the existing treatment protocols used in rehabilitation of tendinopathies and plantar fasciitis. Studies are currently underway to investigate this further.[49]

Treatment Variations Between Anatomical Locations

Treatment of Lateral Epicondylitis

One of the most common upper extremity tendinopathies is lateral epicondylitis, affecting the common extensor tendon near its origin at the lateral epicondyle.[6] This occurs most often in amateur tennis players and with occupations that may require repetitive gripping. Both eccentric and concentric exercise of the wrist extensors have been demonstrated to be beneficial in treating this condition. Treatment should also consist of soft tissue mobilization and stretching of the wrist extensors all in conjunction with the utilization of extracorporeal shockwave and deep tissue laser therapy. Patient education and activity modifications to limit the amount of gripping and repetitive activity can also help alleviate symptoms and improve activity tolerance.

Treatment of Rotator Cuff Tendinopathy

Rotator cuff tendinopathy, primarily supraspinatus tendinosis, is another common upper extremity tendon condition frequently seen in the aging population. Key considerations when treating supraspinatus tendinosis include optimizing glenohumeral joint and capsular mobility, correcting postural biomechanics, restoring glenohumeral joint dynamic stabilization, and activity modifications. Emphasizing inferior capsule mobility, scapular position/control, and external rotation to internal rotation strength ratios are essential to restoring glenohumeral joint control. Laser therapy utilizing a Class IV deep tissue laser can be used to help modulate pain as well as promote tendon repair[50] through increasing blood flow to the area through the release of nitric oxide (which is responsible for vasodilation).

Patellar and Achilles Tendinopathies

Patellar and Achilles tendinopathies are common in sports that require running, cutting, and jumping activities and are often triggered by acute increases in training load. Patellar tendinopathies are frequently found in younger athletes. This condition is commonly induced by increased or abrupt loading beyond the tendon's capacity, resulting in load-related-pain isolated within the tendon typically experienced at the end range of knee flexion or extension. Risk factors include prior history, quadriceps tightness, increased age, sex (female > male), history of anterior cruciate ligament (ACL) reconstruction using a bone-patellar tendon-bone (BPTB) graft, nutrition, genetics, and the presence of metabolic disease. Treatment strategies should aim to address any deficiencies in active dorsiflexion and plantar flexion of the ipsilateral ankle, which increases the mechanical load and onus placed on the affected knee joint. Discrepancies with Quadriceps/Hamstring and Quadriceps/Glute strength ratios are also often seen and require targeted therapeutic programs. Deficit strengthening exercises can benefit from augmentation with a Class IV deep tissue laser (3 times per week for 4-6 weeks as symptoms persist) or ESWT (3-5 sessions, 5-10min/session as patient tolerates).

Plantar Fasciitis

Plantar fasciitis, characterized by pain in the heel and along the arch of the foot, is a prevalent condition affecting both active individuals and the general population. The incorporation of FSW therapy is instrumental in treating plantar fasciitis, offering deep tissue penetration that stimulates tissue repair and reduces pain through its targeted acoustic waves. FSW therapy effectively disrupts pain mediators and enhances blood circulation, facilitating the repair of the damaged tissue underlying patient pain in this condition. Concurrently, photobiomodulation therapy (laser therapy) has demonstrated clinically relevant improvements in pain and functional recovery.[51] Laser therapy received a grade B recommendation in the newly released 2023 American Physical Therapy Association clinical practice guidelines for managing plantar fasciitis[52]. The synergistic use of FSW and PBM, alongside traditional treatments such as stretching, strengthening exercises, biomechanical analysis and taping/orthotic support, presents a comprehensive approach to managing plantar fasciitis. This multimodal strategy ensures a holistic treatment pathway, addressing both the symptoms and underlying causes of the condition, thereby optimizing patient outcomes and recovery times.

Conclusion

In summary, tendinopathies and plantar fasciitis are common in both athletes and the general population, across a variety of sports and activities at all levels of participation. Tendinopathy treatment should combine a complete and accurate examination, activity modification, and both exercise and non-exercise therapies. Progressive loading has ultimately been shown to be more important than the type of exercise employed. Return-to-sport considerations should include gradual progression of activities with careful attention to avoid acute spikes in the volume or intensity of activities. Technologies like photobiomodulation and extracorporeal shockwave therapy are proving to be inherently useful in the successful management of plantar fasciitis and a wide variety of tendon pathologies serving to enhance treatment effectiveness and improve outcomes.

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