Noninsertional Achilles Tendinopathy: Pathology and Management

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Many patients present to their physician's office with the chief complaint of pain at the Achilles tendon. This review discusses the pathology, diagnosis, and treatment of Achilles tendinopathy. Achilles tendinopathy is generally caused by chronic stress to the tendon, leading to a defective arrangement of collagen fibers in the Achilles tendon. This then results in pain and limited function. Ultrasound imaging can help identify the abnormal portion of the tendon. Various treatments are available for Achilles tendinopathy, the most current of which are discussed in this article. Appropriate treatment can potentially lead to a full recovery.

Introduction

Pain in the Achilles tendon is quite common in individuals who participate in sports [1]. It is also common, however, in nonathletic individuals, particularly in persons of middle age who are of heavier weight [2]. Treating this condition can be very challenging. It is seen most commonly in the mid-portion of the tendon but also occurs at the bone-tendon junction. Unfortunately, no consistent, standardized approach to managing this condition has been shown to be highly reliable and effective. This review discusses current thinking about the nature of the problem and approaches to its management.

Anatomy of the Achilles Tendon

The Achilles tendon originates from the merging of the soleus muscle with the two bellies of the gastrocnemius, and inserts distally onto the calcaneus. Histologically, the tendon is made up primarily of type I collagen surrounded by an extracellular matrix of water, proteoglycans, and proteins, such as elastin. The collagen fibers are arranged in parallel and, at rest, have a compact wavy pattern, termed "crimp." The tendon is also intermixed with a limited vascular supply, lymph channels, and neural receptors [3]. It receives blood supply from three sources [4]: 1) proximally, from the musculotendinous junction, 2) throughout its entire length, through the surrounding paratenon (the most important blood supply to the tendon), and 3) distally, from vessels supplying the area of the calcaneotendinous insertion. The area of the tendon approximately 2 to 6 cm above the insertion into the calcaneus has relatively poor blood supply, resulting in limited reparative ability at times of stress or injury [5].

Function of the Achilles Tendon

The Achilles tendon functions to absorb the load of the body's weight during ambulation, and to flex the ankle joint. Studies have shown that the tendon experiences forces as high as 12.5 times body weight during sprinting [6]. These loads are applied to the tendon through the contraction of the gastrocsoleus complex. As these muscles contract, the tension on the collagen fibers causes them to "uncrimp," thereby leading to a lengthening of the tendon. In addition, the cross-sectional area of the tendon increases. As the contraction increases, force is applied to the calcaneus and, once the force is great enough, the ankle plantar-flexes, resulting in a shortening of the Achilles tendon. Relaxation of the calf muscles will result in a momentary shortening of the tendon, followed by lengthening as the ankle dorsiflexes. Once maximal dorsiflexion occurs, there will be a brief lengthening (caused by isometric contraction of the calf muscles) followed by shortening as the ankle once again plantar-flexes. This pattern of repetitive lengthening and shortening while under load places the tendon at risk for injury. Excessive loading of the tendon, combined with an inadequate reparative response is the most common factor contributing to the development of chronic injury to the Achilles tendon. This type of injury is referred to as *tendinopathy* [7].

Pathology

The pathologic changes that occur to an Achilles tendon under repetitive stress will initially be a disruption of collagen fibers that have been unable to adapt to the persistent demand. This results in a cascade of events that, if left unchecked, will ultimately lead to significant pain and dysfunction. Repetitive loading leads to tendon degeneration, manifested as loss of normal collagen patterns and replacement of normal tissue with disorganized arrays of collagen and proliferative extracellular matrix. The tendon becomes infiltrated with mucoid material, calcification, fibrocartilage, and lipid droplets. Biomechanically, these tendons lose their normal elasticity and their tensile strength is diminished. Studies have demonstrated that, at least in certain cases, there is increased vascularity in the abnormal regions of the tendon. It is not clear, however, whether this is a cause of pain or a marker of the underlying pathology [8].

Clinical Characteristics

The major clinical characteristic of Achilles tendinopathy is pain, which has several features. Most patients will complain of pain in the back of the heel upon arising after sleeping. Pain can be produced with walking, especially up hills or down stairs. Also, running and jumping may be impossible due to the pain.

On physical examination, the typical finding is a thickened, tender nodule in the proximal one third of the tendon. Careful palpation will often reveal that the tendon is actually most tender on one side than the other. The patient will have pain attempting a single-legged heel raise on the affected extremity. Manual muscle testing, however, will usually not be limited because the forces required to generate pain need to be higher than what is generated manually [9••].

Diagnostic Imaging

Achilles tendinopathy is usually clinically diagnosed; however, imaging may be helpful to clarify the nature of the injury. MRI findings in Achilles tendinopathy can range from normal to a markedly abnormal signal, particularly on T2-weighted images. Our preferred imaging modality is diagnostic ultrasound [8]. This is because ultrasound can be performed in the office, and the patient's feedback can be used to guide the scan to the area of pain. MRI can demonstrate abnormalities (even in structures other than the Achilles) that do not correlate with the patient's pain, making it difficult to determine clinical significance. In painful Achilles tendinopathy, sonography will demonstrate tendon thickening and a heterogeneous appearance of the tendon, as compared with the normal homogeneous pattern of linearly oriented striations. Often, a thin hypoechoic interstitial tear will be seen at the site of maximal tenderness. Color Doppler will often reveal increased blood flow within the tendon, a finding not normally seen in healthy tendons [10]. Clinical presentation in conjunction with imaging can be used to clarify the nature of the injury.

Treatment

If treatment is undertaken early in the course of painful Achilles tendinopathy, the chances of resolution are much higher. In this phase, the body's own reparative process may be able to repair the damage and allow for pain-free return to activity; therefore, it is important to discontinue all painful activities. If simply walking is painful, then immobilization in a controlled ankle motion walker for a brief period is recommended. A night splint may be helpful in alleviating pain that occurs when stepping out of bed in the morning.

Adequate regeneration and remodeling of collagen is best achieved through protected loading of the tendon [11]. Newly formed collagen will align itself along lines of stress; thus, a prolonged period of complete rest will actually result in poorly aligned collagen and impaired healing. Protected loading and stress to the tendon are ideal. This should begin with a program of stretching, which can be accomplished both actively and passively.

Passive stretching is done by pulling the ankle into dorsiflexion, both with the knee flexed and with it extended. Typically, patients are instructed to hold the stretch for a count of 10 seconds and repeat for 10 repetitions five to eight times per day. It is important to perform these stretches multiple times throughout the day to continuously stress the tendon and prevent the formation of adhesions.

Active stretching takes several forms. The first is through isometric contraction of the calf muscles. Cyriax and Cyriax [12] were two of the first to discuss the value of using isometric contractions to treat tendinosis. Isometric contractions are performed by locking the ankle and knee joints into one stable position and then maximally contracting the calf muscles. Good clinical results have been seen utilizing maximal isometric contractions (MIC) at varying joint angles and musculotendinous lengths. Initially, MICs are performed in an actively insufficient position (musculotendinous complex is on slack) and gradually taken to a passively insufficient position (musculotendinous complex is on stretch). Progression from a shortened to a lengthened position is based upon the patient's tolerance of pain. Once the patient can tolerate the discomfort level of the MIC at one position, the musculotendinous complex is moved to a more lengthened position and the MICs are performed in this range. This progression continues until the MICs are performed with the musculotendinous complex maximally lengthened. Patients are continuously evaluated by a physical therapist to ensure appropriate progression.

The next level of active stretching is through eccentric loading. There is increasing evidence in the literature suggesting that this may be an effective treatment, and possible prevention strategy, for chronic Achilles tendinopathy [9••]. It is interesting to note the very

movement/muscular contractions (eccentric) that are believed to be associated with the injury mechanism may actually enhance its healing. The difference, however, is that done therapeutically, these movements are performed in a slow, controlled fashion. It is when these movements are performed with ballistic forces, such as jumping and running, that the injury occurs [13].

Alfredson et al. [14] showed excellent results with a 12-week, heavy-load, eccentric calf muscle training regimen for 15 recreational athletes diagnosed with chronic Achilles tendinopathy (greater than 18.3 months' duration) when compared with a control group treated with conventional means. Fahlström et al. [15] used a larger sample to study the effects of a 12-week, heavy-load, eccentric calf muscle training regimen. Seventy-eight patients with chronic mid-portion (2–6 cm) Achilles tendinopathy and 31 patients with chronic insertional Achilles tendinopathy were examined. The study revealed good clinical results for patients with mid-portion Achilles tendinopathy (90 of the 101 patients were back to their preinjury level training regimen). However, only 10 of the 31 insertional Achilles tendinosis patients returned to preinjury training levels; the other 21 patients underwent surgery. Surgery revealed a mixture of pathological findings indicating that there were other sources of pain, such as bursa and bone, besides the tendinotic tissue.

The exact reason as to why eccentric training has proven to be beneficial for chronic noninsertional Achilles tendinopathy is not clear; however, there are a few suggested theories. Eccentric loading may disrupt the extracellular matrix and the irregularly arranged collagen fibers. This may then stimulate tissue regeneration, which will then heal microscopic tears and align newly formed collagen more parallel to the lines of stress imposed by the eccentric loading [16•,17]. Eccentrically loading a tendon also lengthens it to a point of maximizing the optimum angle for torque generation. This will provide protection against future eccentric loads [14,15,17–19].

Nonsteroidal anti-inflammatory drugs (NSAIDs)

Because tendinopathy of the Achilles does not involve an inflammatory process, drugs that reduce inflammation will have no positive influence on healing the condition. In fact, there is increasing evidence that NSAIDs may actually retard the healing of injured tendons [20]. Therefore, the use of NSAIDs should have little or no role in the treatment of Achilles tendinopathy [20,21]. Additionally, peritendinous injections of corticosteroids appear to relieve short-term pain but have not been shown to relieve pain in the long-term [22].

Interventional treatments

Sclerosing injections

Alfredson and Cook [9••] have been strong proponents of the concept that neovascularization contributes greatly as a cause of the pain in Achilles tendinopathy. How or why these vessels cause pain has not been fully explained. One theory is that the vessels are actually markers for nerve fibers traveling with them, and that these nerve fibers may actually be what cause the pain. Alfredson and Cook have published several articles reporting on the effectiveness of sclerosing injections, using the sclerosing agent polidocanol to treat Achilles tendinopathy as well as other tendinopathies [2,9••,14]. The theory behind sclerosing injections is that either the neovascularization or the proliferation of specific nerve fibers in the tendon leads to increased pain, and that injecting a sclerosing agent should decrease the patient's pain level. In one study in which 400 Achilles tendons were treated, good results were obtained, with only two complications. After 2 weeks, maximal tendon loading was allowed. Alfredson's and Cook's recommendation is to perform sclerosing injections if eccentric training has failed [9••].

Topical glyceryl trinitrate

Topical glyceryl trinitrate has been investigated as treatment in conjunction with an eccentric exercise program. Topical glyceryl trinitrate can be applied as a patch each day for 6 months. In comparison with placebo, pain in the Achilles tendon was reduced at 12 and 24 weeks and outcomes at 6 months were also improved [23].

Extracorporeal shock wave therapy

There have been no randomized controlled trials evaluating the effectiveness of extracorporeal shock wave therapy in the treatment of Achilles tendinopathy [24]. However, this therapy has been tried in other tendons and, when compared with placebo, has been shown to have some benefit [25]. Future studies will need to be done to determine if extracorporeal shock wave therapy is of benefit in the Achilles tendon.

Percutaneous longitudinal tenotomy

When there is a singular nodular lesion within the body of the Achilles tendon, Testa et al. [26] have advocated performing ultrasound-guided percutaneous longitudinal tenotomy. In 2002, they reported results of this procedure after it was performed on 63 patients. Of those patients, 47 had good or excellent results and were able to return to sports. The authors indicate that these results are comparable with open exploration of the tendon. Therefore, they advocate this procedure before performing more invasive surgery.

A related technique that the review's lead author (McShane) uses is to perform the ultrasound-guided longitudinal tenotomy with a needle rather than a scalpel. In this procedure, the abnormal area of the tendon is visualized with ultrasound and, after a local anesthetic has been administered, a 20-g spinal needle is guided down to the abnormal area of the tendon and repeatedly passed through the thickened nodule. The principle behind this technique is to disrupt the abnormal connective tissue and stimulate a healing response. Following the procedure, a protocol of

specific MICs, eccentric exercises, stretches, and transverse friction massage are begun. Results of this procedure have been very promising (unpublished data), and complications have been few. Determining the real efficacy of this treatment is the subject of ongoing research.

Open surgical correction

When nonoperative approaches [27] fail to resolve the pain and dysfunction, surgery may be required [28•]. Surgical techniques involve either performing a longitudinal tenotomy alone, or performing the tenotomy along with removal of abnormal tissue. In either procedure, stripping the paratenon may or may not be performed. In tendons with more extensive pathology, transfer of another tendon to fill the defect may be necessary. In a critical review of the literature reporting outcomes after Achilles tendon surgery, Tallon et al. [29] found that reported success rates ranged from 36% to 94% and averaged 77%. However, the analysis also found that better reported outcomes corresponded with worse methodological quality of the study. The authors also commented that success rates over 70% are "not always observed in clinical practice" [29].

Conclusions

Achilles tendinopathy is a condition that causes many patients significant pain and disability. However, the sports medicine physician has a variety of options available to treat tendinopathy. Initial efforts at treatment should focus on avoiding aggravating activities so that healing can begin. Mobilizing the tissue through stretching, deep friction massage, and eccentric loading should occur early. The majority of patients will have resolution of their symptoms with these measures. If, however, pain persists, interventional options exist. These include injection of sclerosing agents into areas of neovascularity and percutaneous longitudinal tenotomy. In severe or recalcitrant cases, surgical options are available. Research into understanding tendinopathy and developing newer and more effective treatment strategies continues, with the hope that one day this condition will be considered easily curable.

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