Noninsertional Achilles Tendinopathy Pathologic Background and Clinical Examination

Mindi Feilmeier, DPM

KEYWORDS

• Achilles • Tendinopathy • Tendinosis

KEY POINTS

- Achilles tendinopathy includes a spectrum of histologic pathologic findings ranging from acute inflammation to chronic degeneration and fiber rupture.
- Tendinopathy is a clinically diagnosed condition with specific clinical cues leading to accurate diagnosis.

INTRODUCTION

The term tendinopathy includes a series of pathologies, all of which have a combination of pain, swelling, and impaired performance.[1] Most authorities advocate the use of the term tendinopathy to encompass each of the subclasses of Achilles tendon pathology. The terms tendinosis, tendinitis, and peritendinitis are all within the main heading of tendinopathy, and this terminology provides a more accurate understanding of the condition and highlights the uniformity of clinical findings while distinguishing the individual histopathological findings of each condition.[2,3] Understanding both the clinical features and the underlying histopathology leads to a more accurate clinical diagnosis and subsequent treatment selection.

This is an important distinction, because the misuse of the term tendinitis in the clinical diagnosis and treatment of these disorders can lead to the underestimation of chronic degenerative nature of many tendinopathies, which may affect the treatment selection.[2] Specifically, treating the chronic degenerative forms of tendinosis with immobilization and anti-inflammatory medications commonly used for acute inflammatory processes may lead to treatment failures and have the potential to drive

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College of Podiatric Medicine and Surgery, Des Moines University, 3200 Grand Avenue, Des Moines, IA 50312, USA
E-mail address: Mindi.Feilmeier@dmu.edu

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unnecessary surgery.[4] The treatment of these pathologies, namely noninsertional tendinosis, will be discussed in subsequent articles and is guided by an understanding of the underlying pathologic process.

The basic etiology of the Achilles tendinopathy is known to be multifactorial. The pathophysiology of chronic Achilles tendinopathy is thought to involve the cellular and molecular response to microscopic tearing of the tendon when forces beyond the elastic capabilities of the tendon are applied to the tissues leading to chronic degeneration. Histologic examination of the affected tissue demonstrates an irregular shape and a higher rate of apoptosis.[5–7] Although inflammation occurs around the tendon, biopsies demonstrate no inflammatory cells infiltrating the tendon. Tendinopathy is understood as a failed healing response within the extracellular matrix that is mediated by a cascade of proinflammatory molecules that include interleukin-1B, prostaglandin E2, and nitric oxide.[8,9] In patients who develop tendinopathy, these mediators induce apoptosis, signal pain responses, and increase the production of matrix metalloproteinases (MMPs).[7] This response leads to degeneration of the tendon, rather than signaling a repair process.[8,10]

Histologic evaluation of tissue taken from ruptured Achilles tendons has been shown to contain more degeneration than those taken from patients with tendinopathy and uninvolved controls.[11,12] A similar study revealed that almost all of the Achilles tendons operated on for rupture showed signs of hypoxic degenerative tendinopathy, calcifying tendinopathy, mucoid degeneration, or tendolipamatosis.[13] In a large retrospective case-control study by Tallon and colleagues,[14] no spontaneous Achilles tendon ruptures were found in patients with healthy tendons. It is important to note, however, that Achilles tendon ruptures can take place suddenly without any preceding signs or symptoms.[12]

Because the Achilles tendon is the strongest and thickest tendon in the body and is subjected to unique forces during the activities of living, it is highly subject to tendinopathy, which can ultimately result in chronic degenerative changes, as well as calcification and mucoidlike degeneration, leading to Achilles tendinosis.[12] Because of the unique anatomy of the Achilles tendon, including its rotational change with spiraling proximal to its insertion, the Achilles is under significant biomechanical strain 2 to 6 cm proximal to its insertion into the calcaneus. While the degeneration at this area has been attributed to avascularity, this may not be the case, as discussed in this issue (see Paul Dayton's article, "Anatomic, Vascular, and Mechanical Overview of the Achilles Tendon," in this issue).

As noted previously, several theories exist regarding the etiology of Achilles tendinopathy. These include overuse, poor tissue vascularity, mechanical imbalances of the extremity, and a genetic predisposition.[4,15,16] Tendinopathy secondary to overuse is thought to arise from repetitive microtrauma in the central portion of the tendon. A retrospective case-control study identified several patient factors that were more likely to be associated with Achilles tendinopathy: hypertension, diabetes, obesity, and a previous exposure to steroids or estrogen. Each of these factors has the potential to decrease the microvascularity of tendons and as such have been postulated to play a role in the development of Achilles tendinopathy.[17] Other studies have found advancing age, previous injury, exposure to quinolone antibiotics, and endocrine and metabolic abnormalities to be associated with Achilles tendinopathy.[18–20] From a biomechanical standpoint, Williams and colleagues[21] found patients with Achilles tendinopathy to have decreased tibial external rotation during running, which was attributed to an imbalance of muscle forces in the transverse-plane of motion that increases the strain on the Achilles tendon. Finally, the gene for matrix metalloprotease-3 (MMP-3) is involved in the homeostasis of the ground substance surrounding

tendons. Variants in the gene are potential genetic contributions to the development of tendinopathy.[7,22,23]

Vascular ingrowth, known as neovascularization, and neural ingrowth have been associated with Achilles tendinosis as well. Several investigators have reported an increase in tendon thickness, which is associated with clinical symptoms and impaired function, to be accompanied by an increase in neovessels.[8,24–28] Studies have found that after conservative treatment for Achilles tendinopathy as the tendon size decreases, returning to a more normal size, and as function increases, there is an associated decrease in the number of vessels identified at the area by power Doppler.[29] These findings are contrary to previously held beliefs that a decrease in blood flow is a cause of chronic Achilles tendinosis and is an important concept when selecting treatment options.[30]

In a series of patients with Achilles tendinopathy, Alfredson and collegues[31] used a microcatheter and microdialysis to sample the environment within and around the Achilles tendon. Their findings showed no change in the levels of prostaglandin E2, a marker of inflammation, compared with controls. They did find an increase in concentration of glutamate, a neurotransmitter associated with pain.[31] Scott and colleagues[32] demonstrated a statistically higher level of immunoreactivity for vesicular glutamate transporter VGluT2 in tendons with tendinosis compared with normal tendons and that the VGluT2 was expressed by tenocytes. These findings suggest that free glutamate may be produced and released by the tenocytes and this may impact apocrine and paracrine functions that play a role in the development of tendinosis. Several roles that glutamate may play include tenocyte proliferation and apoptosis, as well as extracellular metabolism, nociception, and blood flow.[32]

Others studies have identified that in patients with Achilles tendinopathy there are also higher levels of lactate, increased expression of enzymes producing acetylcholine and catecholamines, increased substance P, and increased neurokinin-1 (NK-1).[31,33–37] All of these substances are hypothesized to contribute to the pathophysiology of tendinopathy. High lactate levels suggest the presence of ischemia or anaerobic conditions within the tendon in Achilles tendinopathy. Acetylcholine has vasoactive, trophic, and pain-modulating effects that could contribute to tendinopathy. Autocrine/paracrine effects between the diseased tenocytes could increase muscularinic receptors on those cells and increase the production of acetylcholine.[35] Substance P has been associated with pain transmission, cell growth, and angiogenesis, and the organization of tendon and NK-1 receptors are the preferred receptor for substance P, therefore interactions between the 2 may influence tendon repair.[36,37] Currently, the specific contributions of these mechanisms to tendinopathy are not understood completely. Further research may prove to identify additional treatment options for this pathology by focusing on these cellular effects.

Achilles tendinopathy is common among athletes, especially those who are active runners.[38] Force through the Achilles tendon during exercise can approach 12 times body weight, making the Achilles vulnerable to repetitive stress injury.[39] Additionally, there may be a contribution of poor training technique, increased mileage, and an imbalance between muscle power and tendon elasticity.[10,40] Late in the stance phase just before heel lift, the knee is in maximal extension and the ankle is in dorsiflexion. This is the point at which the gastrocsoleus is subjected to the maximal stretching force and therefore there is increased incidence of foot and ankle compensations causing potential symptoms and pathology.[41] The high forces of training as well as excessive weight and explosive activities, combined with the unique structure and function of the Achilles can lead to midsubstance tendinosis. When the tendon is placed into a situation in which the chronic load results in continued strain beyond

the elastic limits, the collagen fibers are damaged and fail to repair themselves and degeneration ensues.

CLINICAL PRESENTATION

The history of Achilles tendinopathy is often typical, with subjective complaints of pain localized to the Achilles region, typically 2 to 6 cm proximal to the insertion into the calcaneus, and morning stiffness.[42] Patients may complain of noticing increased swelling and/or a "bump" on the back of the Achilles region, although this is not always present. Pain quality can range from sharp, to dull and burning. Oftentimes there is an accompanying increase in activity associated with the symptoms. The differential diagnosis of Achilles tendinopathy includes many pathologies, including retrocalcaneal bursitis, os trigonum, tarsal tunnel syndrome, posterior tibial tendon pathology, arthritic conditions, and stress fracture.[42] The Victorian Institute of Sport Assessment-Achilles (VISA-A) questionnaire is a valid, reliable, and easy to administer measure of the severity of Achilles tendinopathy and appears to be suitable for both clinical rating and quantitative research.[43] Completion of this questionnaire by the patient can be an additional useful source in information that the clinician can use to make the diagnosis of Achilles tendinopathy.

CLINICAL EXAMINATION

The clinical examination of a patient presenting with symptoms consistent with Achilles tendinopathy should involve both lower extremities. Oftentimes there are subtle changes in the tendon that may not be appreciated unless compared with the contralateral limb. The examination should include muscle strength testing of bilateral superficial posterior muscle groups and an assessment of ankle and subtalar joint range of motion as well as foot position in stance and gait. Equinus due to a gastrocnemius contracture has been associated with the development of Achilles tendinopathy.[44–47] On the contrary, Mahieu and colleagues[48] found that decreased plantarflexion strength and an increased amount of dorsiflexion excursion were significant predictors of Achilles tendon overuse injuries. It is imperative to perform a through clinical examination identifying all biomechanical and musculoskeletal abnormalities because the findings will help to direct treatment recommendations.

Specific findings that have been associated with Achilles tendinopathy include tendon thickening, crepitus, pain on palpation, positive arc sign, and positive Royal London Hospital test. Additionally, there may be difficulty or pain associated with a single-legged heel raise and the hop tests, as well as symptoms with passive stretch of the Achilles.[38,42] When tendon thickening is present, this is most likely a result of the poor reparative process and collagen disarray associated with chronic changes, as noted previously. Crepitus on examination is indicative of paratendinitis, where a fibrous exudate fills the tendon sheath after acute edema and hyperemia of the paratenon with the infiltration of inflammatory cells.[15,49,50]

ARC SIGN

The arc sign is performed by the clinician identifying the intratendinous thickening or swelling of the tendon by palpation and asking the patient to actively dorsiflex and plantarflex the ankle. A positive arc sign is present when the swelling or thickening is visualized to move relative to the malleoli during the active movement.[49] If the thickened portion is not observed to move with active contraction, this is thought to be more indicative of paratendinous (peritendinitis) thickening rather than tendon degeneration.

ROYAL LONDON HOSPITAL TEST

This test is performed with the clinician palpating the tendon to identify an area of local tenderness while the ankle is initially in a neutral or slightly plantarflexed position. The patient is then asked to actively dorsiflex and plantarflex the ankle. A positive finding is when palpation of the tender area of the tendon at rest results in significantly less or no pain at the same location when the ankle is maximally dorsiflexed.[49]

Reiman and colleagues[51] performed a systematic review with meta-analysis of the literature related to the utility of clinical measures for the diagnosis of Achilles tendon injuries. Based on their inclusion criteria, 2 studies were identified that looked at Achilles tendinopathy.[42,49] They found that the subjective measures of pain and morning stiffness, combined with the arc sign, Royal London Hospital test, crepitus, single-legged heel raise, and the presence of tendon thickening when seen together in the same patient could confirm tendinosis of the Achilles. They did caution against using any of these measures independently for diagnosis, as a single finding was unable to consistently confirm the diagnosis.[51] Hutchison and colleagues[42] found high sensitivity (0.780, 0.58–0.94) for self-reported pain, and high sensitivity (0.886, 0.75–0.98) for morning stiffness in their series. Pooled data from the 2 studies found high specificity for palpation (0.81, 0.65–0.91), the arc sign (0.88, 0.74–0.96), and the Royal London Hospital test (0.86, 0.72–0.95), thus the recommendation to combine the subjective and clinical findings to increase the diagnostic ability. They also found the remaining examinations in the examination section to be specific, although not sensitive; however, these were not studied by Maffuli and colleagues.[49]

In their study, Mafulli and colleagues[49] also performed sonographic assessment of the Achilles as a part of the diagnostic workup and all subjects had a histologic diagnosis of Achilles tendinopathy confirmed postoperatively. They concluded in patients with tendinopathy of the Achilles tendon with a tender area of intratendinous swelling that moves with the tendon and whose tenderness significantly decreases or disappears when the tendon is put under tension, a clinical diagnosis of tendinopathy can be formulated, with a high positive predictive chance that the tendon will show ultrasonographic and histologic features of tendinopathy.

In conclusion, tendinopathy consists of several anatomic and histologic findings ranging from paratendinous inflammation to noninflammatory tendon fiber degeneration. Knowledge of the mechanical, structural, and histologic components of this spectrum of disease is vital for proper diagnosis and treatment selection. Clinical examination is the cornerstone of diagnosis with imaging rarely needed, as noted in previous articles. Treatment should be focused on both the structural tendon changes and the potential mechanical causes of inflammation and degeneration.

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