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Achilles Tendinopathy: Epidemiology, Diagnosis, and Treatment Strategies – A Review

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Abstract

This review presents a comprehensive synthesis of current knowledge on Achilles tendinopathy (AT), focusing on its epidemiology, diagnostic approaches, and available treatment strategies. AT is a common musculoskeletal disorder, particularly among athletes, with a multifactorial etiology and a clinical presentation that includes localized pain and functional impairment. While diagnosis is primarily clinical, imaging modalities such as ultrasound and MRI play an essential role in supporting clinical judgment and differentiating among tendon pathologies. The review identifies eccentric exercise as the most effective conservative treatment, often used in combination with extracorporeal shock wave therapy and pharmacological agents to enhance outcomes. Surgical intervention is considered in chronic or refractory cases and has shown favorable results in selected patients. Despite progress in understanding and managing AT, challenges remain in the form of inconsistent diagnostic criteria, variability in therapeutic outcomes, and limited high-quality evidence supporting newer pharmacological interventions. Emerging techniques in diagnostic imaging and rehabilitation continue to evolve, offering promising avenues for improving clinical outcomes. This review highlights the importance of individualized treatment approaches and identifies key areas for future research, such as the standardization of diagnostic measures, optimization of rehabilitation protocols, and evaluation of novel therapies. By consolidating the latest evidence, this article provides valuable insights for clinicians, researchers, and sports medicine professionals seeking effective, evidence-based strategies to manage and treat Achilles tendinopathy.

Keywords : Achilles tendinopathy; diagnosis; rehabilitation; eccentric exercise; imaging; conservative treatment; surgical management; sports medicine

Introduction

Brief introduction to Achilles tendinopathy.

Achilles tendinopathy (AT) is a common and painful overuse injury, particularly prevalent in athletes engaged in running and jumping sports (1). Tendinopathy is a common musculoskeletal disorder characterized by chronic inflammation and tissue degeneration, poses significant challenges in treatment due to poor innate healing ability (2). This condition not only causes pain but also alters the tendon’s structure, mechanical properties, and lower extremity function, leading to fear of movement and limitations in sport participation and performance. It can be categorized into insertional and noninsertional types, with symptoms including pain, edema, and decreased functionality. Diagnosis is primarily clinical, though

imaging can aid in differential diagnosis. Treatment should be individualized, addressing biomechanics and patient-specific factors (3). Non-operative treatments include physical therapy, extracorporeal shockwave therapy, and injectable agents, while operative options include percutaneous and open surgical procedures (4). A comprehensive approach focusing on progressive tendon loading is crucial for full recovery and minimizing reinjury risk (1). Preventive strategies emphasizing proper training techniques and load management are important in reducing incidence (3).

Achilles tendon injuries can be classified as acute ruptures or chronic overuse conditions, with acute injuries more common in younger individuals and chronic conditions in older patients (5). Chronic Achilles tendon ruptures, defined as untreated for over 4 weeks, result in higher healthcare costs compared to acute ruptures (6). Both acute and chronic conditions generally respond well to non-operative management, with only a small proportion requiring surgery (5). Early detection and appropriate classification of Achilles tendon injuries are crucial for effective treatment and resource allocation.

Prevalence and Epidemiology

Data on incidence among athletes and the general population.

Musculoskeletal injuries, including tendinopathy, are prevalent among athletes across various sports. A meta-analysis found the overall prevalence of AT in physical exercise to be 6%, with higher rates in older individuals and gymnasts (7). In collegiate athletes, ultrasound abnormalities were detected in 10.1% of Achilles tendons and 37.2% of patellar tendons, with abnormalities significantly associated with pain (8). Among youth basketball players, the season prevalence of patellar tendinopathy was 19%, with higher rates in males and those with previous anterior knee pain (9). A cross-sectional study of athletes from five sports found a high prevalence of musculoskeletal injuries, with age (≥30 years) positively associated with joint injuries, muscle injuries, and tendinopathy (10). Running-related musculoskeletal injuries (RRMIs) are common among runners, with overall injury incidence and prevalence rates of 40.2% and 44.6%, respectively. The knee, ankle, and lower leg are the most frequently affected areas, with AT, medial tibial stress syndrome, and patellofemoral pain syndrome being the most common specific injuries (11). A prospective cohort study focusing on AT found an incidence of 4.2% among recreational runners, with 27.7% being insertional AT and 63.8% midportion AT. The primary risk factor for developing AT was a history of AT in the past 12 months. Interestingly, runners participating in 10/10.55 km events were less likely to develop AT, while higher age was negatively associated with insertional AT. These findings highlight the importance of understanding injury patterns and risk factors.

Diagnosis

Diagnostic criteria – clinical symptoms and physical examination.

AT is characterized by localized pain and functional loss during tendon-loading activities. Diagnosis primarily relies on clinical symptoms and physical examination, with key elements including self-reported pain location, pain during loading activities, and symptom duration. (12). Initial tendon morphology and mechanical properties have been associated with patient-

reported symptoms and calf muscle function at baseline and follow-up, suggesting potential prognostic value (13). Objective tests involve tendon palpation, single-leg heel raises, and hopping. However, there is significant variation in diagnostic approaches and terminology. Ultrasound imaging can aid in differential diagnosis, distinguishing between conditions like enthesitis, midportion tendinopathy, and paratenonopathy (14). Diagnosis remains challenging, with no clear gold standard. A systematic review identified 233 unique outcome measures across nine core domains for assessing AT, highlighting the need for consensus on key measures (15). However, terminology remains inconsistent, with some terms implying inflammation when none may be present. A more uniform approach to classification based on anatomic location, symptoms, clinical findings, and histopathology is needed to improve diagnosis and guide treatment (14).

Imaging techniques (Ultrasound, MRI) for tendon assessment.

Ultrasound evaluation of the Achilles tendon is valuable for assessing various conditions, including inflammatory and non-inflammatory tendinopathies. Achilles enthesis thickening, increased vascularity, and calcaneal erosions can help distinguish between these conditions (16). However, the terminology used to describe Achilles tendon conditions is often inconsistent, highlighting the need for a more uniform classification system (14). Importantly, ultrasound screening of asymptomatic runners has demonstrated that pre-existing tendon abnormalities are associated with a higher risk of developing pain in both the Achilles and patellar tendons within one year after a marathon or half-marathon event (17). These findings underscore the potential of ultrasound as a diagnostic and predictive tool for Achilles tendon conditions.

MRI is a valuable tool for assessing AT and related conditions. It can effectively detect tendinopathy, full-thickness tears, and partial tears, with superior performance compared to ultrasound for partial tears and postoperative assessment (18). MRI can effectively identify microtears, which appear as focal fluid signals and may progress to partial or complete rupture. In post-treatment assessment, tendon morphology and tension should be prioritized over structural signal. Following surgical repair, fluid signal in the Achilles tendon is pathological and indicates re-rupture, while a higher signal is common and may persist for an extended period (19). MRI allows visualization of both soft tissue and intra-osseous changes in enthesitis, a key feature in spondyloarthritis and psoriatic arthritis (20). The OMERACT Heel Enthesitis MRI Scoring System (HEMRIS) has been developed to standardize assessment of enthesitis in clinical trials (20; 21). Advanced MRI techniques, such as ultrashort echo time magnetization transfer imaging, show promise in detecting early tendon changes caused by long-distance running (22). Novel MRI sequences, including diffusion tensor imaging and T2-mapping, may help detect and monitor Achilles tendon disorders before clinical manifestation (18).

Treatment and Rehabilitation

Conservative management

Conservative treatment methods for AT have shown promising results. Eccentric exercise is widely recognized as the gold standard and most effective conservative approach for both

midportion and insertional AT (23; 24). Other non-surgical treatments, such as extracorporeal shock wave therapy, can complement exercise-based interventions (24;25). Combined protocols, such as eccentric exercise with extracorporeal shock wave therapy, have shown even greater improvements in pain reduction, function, and patient satisfaction (24). While various conservative treatments exist, no single therapy is universally accepted for AT management (23). Surgical intervention is typically considered only after conservative treatments have failed for at least six months (25). Eccentric exercise (EE) has been shown to be effective in managing AT, particularly for pain reduction (26). However, combining EE with physical modalities does not provide additional benefits compared to EE alone (27). While EE based on Alfredson's protocol is supported by evidence, other exercise types like heavy slow resistance or Pilates may also be beneficial, though further research is needed (28). Interestingly, improvements in clinical outcomes following EE are not necessarily accompanied by changes in tendon thickness (29). This suggests that the relationship between tendon adaptation and symptom improvement is complex and not fully understood. Despite some limitations in study design and outcome measures, current evidence supports the use of EE as a primary treatment for AT, with potential for tailoring interventions to optimize tendon adaptation and function (26;29).

Extracorporeal shock wave therapy

Extracorporeal shock wave therapy (ESWT) has shown mixed results in treating AT. The biological mechanisms of ESWT involve enhancing angiogenesis, promoting cell proliferation and collagen formation, and controlling inflammation, ultimately facilitating tissue regeneration in tendinopathy (30). Sports-active patients demonstrated better long-term responses to ESWT compared to non-sports-active individuals (31). While both eccentric exercise and ESWT provide short-term benefits, eccentric exercise may offer superior long-term pain relief and increased tendon thickness and stiffness (32). One meta-analysis found ESWT significantly improved pain and functional outcomes compared to other non-surgical interventions (33). However, another systematic review concluded that the evidence for ESWT's efficacy was inconclusive due to low-quality studies (34). A randomized controlled trial comparing point-focused, line-focused, and placebo ESWT found no statistically significant benefit of ESWT over placebo, although all groups showed improvement (35). A systematic review of randomized controlled trials revealed moderate evidence supporting ESWT's effectiveness as an addition to tendon loading programs for mid-portion AT, but evidence was lacking for insertional AT (36). These conflicting results suggest that while ESWT may offer some benefits, more high-quality research is needed to determine its optimal use and effectiveness.

Pharmacological treatment

Various pharmacological AT treatments have been proposed, including non-steroidal anti-inflammatory drugs (NSAIDs), platelet-rich plasma, high-volume image-guided injections, hyaluronic acid, and prolotherapy. NSAIDs are among the pharmacological treatments proposed for AT, but there is no consensus on the best management approach (37). While oral NSAIDs are commonly prescribed, a study on topical diclofenac found no significant improvement compared to placebo in treating chronic AT (38). However, innovative delivery

methods, such as injectable celecoxib nanoparticle hydrogels, show promise in providing long-term anti-inflammatory effects and promoting tendon regeneration (39). A living systematic review and network meta-analysis found that all active treatments seemed superior to wait-and-see at 3 months for midportion AT, with no clinically relevant differences between active treatments at 3 or 12 months (40). Despite the various treatment options available, there is a lack of well-performed randomized controlled trials comparing different approaches, highlighting the need for further research to establish the most effective management strategies for AT (37).

Platelet-rich plasma

Recent studies have cast doubt on the efficacy of platelet-rich plasma (PRP) injections for treating AT. A large randomized clinical trial found no significant difference in function, quality of life, or pain between PRP and placebo injections at six months (41). Multiple meta-analyses have corroborated these findings, showing no substantial improvement in Victorian Institute of Sports Assessment-Achilles (VISA-A) scores or return to sport rates with PRP treatment (42; 43). While some studies reported short-term pain reduction, the overall evidence does not support PRP's effectiveness for chronic AT (42). Given the lack of clear clinical benefit and potential publication bias, researchers caution against the use of PRP for this condition and recommend further high-quality, standardized clinical trials to provide more definitive guidance (43).

Hyaluronic acid

Recent studies suggest that hyaluronic acid (HA) injections may be an effective treatment for AT and other tendinopathies. Various pharmacological approaches have been proposed, including hyaluronic acid (HA) injections, particularly low molecular weight HA (500-730 kDa) (44). HA has shown multiple benefits, including lubrication, anti-inflammatory effects, and stimulation of cellular activity, potentially aiding in tissue regeneration (45). HA's physical-chemical properties, including biocompatibility and viscoelasticity, contribute to tendon healing in preclinical studies, while clinical studies have shown promising results for various tendinopathies (46). A pilot study found that a single peri-tendinous HA injection significantly reduced pain and improved function in patients with non-insertional AT (47). Another study on recreational runners with AT reported improvements in clinical symptoms, functional performance, and viscoelastic properties following three sequential HA injections (48). A comprehensive review of HA injections for tendinopathies found that most studies support their use, particularly for pain reduction and functional improvement, with no severe adverse effects reported (49). However, further research is needed to optimize HA administration methods in tendinopathy treatment.

Surgical Treatment

Surgical interventions for AT have shown promising results in recent studies. While conservative management of AT is often the primary approach, surgical intervention may be necessary when non-operative treatments fail (50;51). For acute Achilles tendon ruptures, both conservative and operative treatments are viable options, with functional rehabilitation playing a crucial role in recovery (52). For insertional AT, various surgical techniques exist,

including endoscopic procedures like the SpeedBridge ”Snake Technique” (53), the central-splitting approach (54), fluoroscopic and endoscopic calcaneal exostosis resection with tendon debridement (55 and dorsally based closing wedge osteotomy of the calcaneus (56). The techniques demonstrated significant improvements in pain and function, with high rates of return to sports activities. The central-splitting approach provides excellent exposure to the diseased tendon and calcaneal exostosis, with high patient satisfaction rates (54).

For non-insertional AT, endoscopic debridement alone proved effective in improving clinical outcomes. Interestingly, the addition of platelet-rich plasma during endoscopic debridement did not enhance outcomes compared to debridement alone. All three studies reported low complication rates and high patient satisfaction. However, MRI findings post-surgery did not necessarily correlate with clinical outcomes (57). For athletes, operative intervention may improve strength, functional outcomes, and return-to-play time compared to nonoperative management. These surgical techniques offer viable options for patients with AT who have failed conservative management, with good functional outcomes and relatively quick return to activities. However, treatment decisions should consider factors such as age, injury chronicity, and medical history (58).

Conclusion and Future Directions

Summary and Key Findings

Achilles tendinopathy is a prevalent overuse injury, particularly affecting athletes engaged in running and jumping sports. It is classified into insertional and non-insertional types, with pain, swelling, and reduced functionality as key symptoms. Diagnosis relies on clinical assessment, supplemented by imaging techniques such as ultrasound and MRI to differentiate between tendinopathy subtypes and assess tendon integrity. A significant challenge in treating AT stems from its poor innate healing ability and the lack of a universally effective treatment strategy. Epidemiological data indicate that AT affects approximately 6% of physically active individuals, with higher incidence in older athletes and specific sports, such as gymnastics and basketball. Risk factors include previous AT, improper load management, and biomechanical abnormalities.

Treatment is typically conservative, with eccentric exercises being the gold standard, often combined with extracorporeal shock wave therapy (ESWT). However, the effectiveness of ESWT remains debated due to inconsistent study outcomes. Pharmacological treatments, including NSAIDs, platelet-rich plasma (PRP), and hyaluronic acid injections, have been explored, though PRP has not demonstrated significant benefits over placebo. Hyaluronic acid, on the other hand, shows promise in improving pain and function, but further research is needed. Surgical intervention is considered for cases unresponsive to conservative management, with techniques such as tendon debridement, calcaneal exostosis resection, and central-splitting procedures showing positive functional outcomes. However, MRI findings post-surgery do not always correlate with clinical improvements.

Table 1. Advantages and Disadvantages of Achilles Tendinopathy Therapies

Treatment Method	Effectiveness	Advantages	Disadvantages
Eccentric Exercises	High	Low cost	Requiers time and consistency
Shockwave Therapy (ESWT)	Variable	May support healing	Not always effective, expensive
Platelet-Rich Plasma (PRP) Injections	Low	Potential regenerative effect	Lack of strong evidence
Hyaluronic Acid Injections	Promising	Pain reduction, improved function	Further research needed
Surgical Treatment	Last resort	Good results in severe cases	Long recovery time

Potential areas for future research

Despite advancements in the understanding and management of Achilles tendinopathy, several areas require further investigation. One key area is the standardization of diagnostic criteria and outcome measures. Current diagnostic approaches lack consensus, with significant variability in clinical assessments and imaging interpretations. Developing a universally accepted classification system that incorporates anatomical location, clinical presentation, and imaging findings would enhance diagnostic accuracy and treatment efficacy. Further research should explore alternative exercise regimens to determine their comparative benefits. Additionally, the role of combined therapies, such as eccentric loading with ESWT or pharmacological agents, warrants further high-quality trials to establish evidence-based treatment guidelines.

While PRP has not demonstrated significant long-term benefits, hyaluronic acid injections have shown potential. Future studies should focus on optimizing dosage, injection techniques, and patient selection to determine their true clinical value. Similarly, the development of novel drug delivery systems, such as nanoparticle-based therapies, could enhance tendon healing while minimizing systemic side effects. Surgical techniques also require further refinement. Although various procedures have demonstrated positive functional outcomes, the correlation between postoperative imaging findings and clinical recovery remains inconsistent. Investigating biomarkers or advanced imaging modalities, such as diffusion tensor imaging or

T2 mapping, could provide a better understanding of tendon healing and guide post-surgical rehabilitation.

Finally, preventive strategies and risk factor modification deserve more attention. Large-scale longitudinal studies examining the impact of biomechanics, footwear, and training loads on Achilles tendon health could inform targeted prevention programs. Understanding the genetic and molecular factors influencing tendon degeneration may also open new avenues for personalized treatment approaches. By addressing these research gaps, future studies can contribute to more effective, individualized management of AT and improve long-term patient outcomes.

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