

# ELASTOGRAPHY IN TA TIGHTNESS TO EVALUATE MUSCLE PHYSIOLOGY - A DIAGNOSTIC APPROACH

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## Abstract

Shear wave elastography is useful for treating the musculoskeletal system. This drug is used to treat tendonitis, ligamentitis, and muscle pain. In the human body, the Achilles tendon is the strongest. The quantity and incidence of Achilles tendon overuse injuries and total ruptures in developed countries has increased in recent decades, owing to the fact that most Achilles tendon injuries occur in sports and there has been a general increase in sporting activity. Tendinopathy is the most common clinical diagnosis for Achilles tendon overuse

injuries, and it is marked by pain and swelling in the Achilles tendon, as well as an inability to engage in strenuous activities. Nonoperative treatment is helpful for the majority of people with Achilles tendon injuries, and those who do not respond to nonoperative treatment require surgery. In sports that demand jumping, running, and fast turns, a complete rupture of the Achilles tendon is common. Blue, green, and yellow/red are the color associated with rigid, intermediate, and soft tissue, respectively. Colour mapping will help us in rehabilitation .

**Keywords:** Achilles tendon, elasticity imaging technique, foot injuries, ultrasonography, Achilles pathogenesis

## INTRODUCTION

The Achilles tendon connects the calcaneus to the gastrocnemius and soleus muscles, which are the calf's largest and strongest muscle group. Due to its restricted blood supply, the tendon is vulnerable to damage, especially when subjected to high forces.

Longitudinal arteries that run the length of the muscle complex provide blood supply to the tendon. The portion of the tendon with the weakest blood flow is about 2 to 6 cm above the calcaneus insertion. With age, the blood flow to this portion of the tendon decreases, exposing it to chronic inflammation and probable rupture. The Achilles tendon, the body's biggest tendon, is vulnerable to injury due to its limited blood supply and the mix of forces it is subjected to. The risk of Achilles tendon injury rises with age and increased exercise (particularly in high-velocity sports). Despite the fact that Achilles tendon diseases are becoming increasingly widespread as the US population ages and continues to be active, about one-fourth of cases go misdiagnosed. An injury's onset might be gradual or abrupt, and the recovery process can take a long time. To determine the proper diagnosis and develop a treatment plan, a thorough medical history and physical examination are essential. Ice, rest, and nonsteroidal anti-inflammatory medicines are the most common treatments for tendonitis, peritendonitis, tendinosis,

and retrocalcaneobursitis, however physical therapy, orthotics, and surgery may be required in persistent situations. Casting or surgery is required in patients with tendon rupture. Appropriate treatment frequently results in complete recovery.(1)

Around 10% of runners suffer from Achilles tendonitis, but it also affects dancers, gymnasts, and tennis players. Running produces forces of up to eight times the body's weight, placing the tendon under a lot of stress over time. Tendonitis in athletes is most usually caused by training errors such as poor running form or wearing ill-fitting shoes; however, hyperpronation of the foot and gastrocnemius-soleus complex contracture can also cause it. Abnormal biomechanics and friction from extrinsic or external pressure are suggested to be the causes of symptoms. People typically get Achilles tendonitis when they first begin participating in strenuous activities.(1)

Elastography-based imaging techniques for non-invasive evaluation of tissue mechanical properties have gotten a lot of press. These methods use changes in soft tissue elasticity to create qualitative and quantitative data that can be used to diagnose various disorders. Specific imaging modes that can detect tissue stiffness in response to a mechanical stimulus are used to collect measurements (compression or shear wave). Ultrasound-based treatments are particularly desirable due to a number of inherent benefits, including extensive availability, including at the bedside, and low cost. Using diverse stimulation methods, several ultrasonic elastography approaches have been developed. Shear wave imaging, which employs ultrasound-generated travelling shear waves stimuli, and strain imaging, which uses internal or external compression stimuli, can be classified into two groups. (2)

Elastography is a type of medical imaging that maps data on soft tissue stiffness. This approach is useful for evaluating deeper tissues that are difficult to reach with palpation. In the musculoskeletal sector, the elastography method has gained popularity in studies and clinical applications for the evaluation of tissue pathology, such as myopathies and viscoelastic characteristics of skeletal muscle, which can help improve understanding of the functional and biomechanical conduct of the body and provide objective proof of disease in various tissues. There are a variety of ultrasound elastography (UES) techniques available, each of which produces different methods for assessing tissue deformation. These have been classed based on how tissues are stressed or shifted, as well as the algorithm used to create the image. All UES approaches can be classified into one of two categories: quasi-static or dynamic. Techniques that apply an external force to the tissue are referred to as quasi-static approaches, such as strain elastography. Shear-wave, acoustic force of radiation, and transient elastography are examples of dynamic procedures in which the source of pressure is the same ultrasonic probe. UES strain, UES shear wave, transient, and acoustic radiation are the most often utilised approaches in clinical practise. All elastography imaging reports related results on an elastogram, which is a color coded representing the region of interest's variable stiffness. The elastogram is generally produced by the software and generally as portrayed in a semi-transparent overlay of the gray-scale ultra-sonographic picture. Most often, the user chooses the grey or colored scale encoding, i.e. red is selected for 'softer' tissue encoding, blue for 'hard' and yellow / green for 'intermediate rigidity'. (3)

## ETIOLOGY

Tendon Achilles overuse injuries are well- documented and very prevalent. Repetitive overloading of the Achilles tendon above its physiological threshold can result in sheath inflammation, body degeneration, or a combination of the two. The cause of Achilles tendinopathy is unknown at this time. Overuse, poor vascularity, lack of flexibility, genetic makeup, gender, endocrine or metabolic variables, and quinolone antibiotics have all been associated to tendinopathies. Excessive tendon loading during physical activity is now thought to be a major pathogenic trigger. If a tendon is repeatedly overloaded above its natural limit, it will respond by inflaming its sheath, degrading its body, or a combination of the two Even if within physiological limitations, repetitive microtrauma to the tendon without appropriate time for recovery and healing might result in tendinopathy. Due to their distinct individual contributions in force, microtrauma is linked to nonuniform tensions between the gastrocnemius and soleus. This causes aberrant load concentrations within the tendon, as well as frictional forces between the fibrils and localised fibre destruction. It's likely to be complex, with both intrinsic and extrinsic influences at play. Intrinsic or extrinsic variables, alone or in combination, can cause sports injuries. Vascularity, gastrocnemius soleus complex dysfunction, age, gender, body weight and height, pes cavus deformity, and lateral ankle instability are all considered inherent variables. Extrinsic factors that predispose to tendinopathy include changes in training patterns, poor technique, past injuries, footwear, and environmental factors such as training on hard, slippery, or slanting surfaces. In the case of acute damage, extrinsic causes predominate; however, overuse injuries and chronic tendon problems are frequently complex in nature Achilles tendinopathy is caused by a variety of factors. In epidemiological research, two-thirds of athletes with Achilles tendon issues had diverse patterns of lower extremity malalignment and biomechanical defects. In 60 percent of individuals with such problems. However, the processes through which these factors contribute to Achilles tendinopathy development are unknown. Hyperpronation of the foot is the most prevalent ankle misalignment. Athletes with Achilles tendinopathy had a lower subtalar joint mobility and a lower ankle joint range of motion than athletes with other symptoms. Achilles tendonopathy is also connected to forefoot varus, higher hindfoot inversion, and decreased ankle dorsiflexion with the knee in flexion. Excessive frontal hindfoot movement, particularly a lateral heel strike with excessive compensatory pronation, is thought to provide a "whipping action" on the Achilles tendon, placing it at risk for tendinopathy.(4-15)

## PATHOGENESIS

The pathophysiology of tendon Achilles difficulties is complicated by a number of factors, including tissue hypoxia, free radical changes caused by ischemia reperfusion damage, and exercise-induced hyperthermia. When a tendon is stretched above 4% of its initial length, it loses its elasticity and becomes more vulnerable to a collagen structural rupture. Type III collagen mRNA levels in the tendinopathic Achilles tendon can be significantly higher when compared to normal samples. The significance of this discovery is currently being debated. It's important to note that the majority of the following elements should be regarded associative rather than causative evidence, therefore their role in the disease's development is still up for debate (17-25).

We've seen a lot of tendon Achilles patients with various sorts of illness. Some ruptures occur without any warning signs or symptoms. Others describe weeks or months of pain and functional limitations prior to the rupture. Others show signs of peritendinitis, which is the most common cause of sports-related impairment. Many types of Achilles tendon illness that do not respond to conservative treatment are treated surgically because of the pain and dysfunction they cause. As a result, we've was able to investigate the histology of these various clinical complexes. We observed just a thickening of the peritendon that was adhering to normal tendon tissue when we looked at peritendinitis macroscopically (27-32).

The histologic examination revealed capillary proliferation in the peritendinous tissue, as well as the formation of inflammatory cells, indicating that the tendon and peritendinous tissue are adherent. The tendon itself was entirely normal in all of these situations. The macroscopic findings in other cases of peritendinitis revealed the existence of degenerative processes (tendinosis). The tendon was thicker, softer, and yellowish, and it had lost its lustre. Fibrillations and tiny areas of cleavage were identified in various portions of the tendon. Histologically, not only was peritendinous tissue inflammation visible, but there were also distinct areas of localised tendon degradation. The presence of a significant vascular proliferation on the peritendon, which had a tendency to invade the normal tendon, was of particular interest. (5)

## METHODOLOGY

The stiffness of tissue is transformed into a colour signal that is overlaid onto the B- mode image in elastography. Blue, green, and yellow/red are the colours associated with rigid, intermediate, and soft tissue, respectively. Color maps and colour ratios for key lower limb muscles (i.e., biceps femoris, medial gastrocnemius, rectus femoris, and tibialis anterior) were acquired and analysed during active voluntary contraction.

1] Arda et al conducted an experimental study on 127 healthy subjects and found that there were no significant difference between different sexes for masseter or gastrocnemius by taking elastography as a outcome measure.

2] Haneul lee et al conducted an experimental study on healthy individual and the result demonstrated that developed the program can increase the consistency and accuracy of quantitative evaluation of stiffness in shear wave elastography by taking ultrasound device .

3] Li-ning Zhang et al conducted a study on

26 healthy individuals and found that shear wave elastography can detect post operative changes in repaired achilles tendon, and that elasticity values determined by SWE are positively correlated with functional outcomes.

## CONCLUSION

According to our findings, shear wave elastography can provide biomechanical information for assessing the mechanical properties of healing Achilles tendon and forecasting Achilles tendon function. Tendon problems in the Achilles tendon are becoming more common .Color mapping will help out in Rehabilitation. SWE can detect changes in the stiffness of a healed Achilles tendon after surgery, and SWE elasticity values are significantly connected with functional outcomes.

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