

Imaging Techniques for Tendon And Ligaments: A Review Article

Suhas Tivaskar¹, Anand Bule², Juhi Barai³, Anurag Luharia⁴

^{1,4}Assistant Professor, MRIT (Medical Radiology and Imaging Technology), Department of Radiology, School of Allied Health Sciences, Jawaharlal Nehru Medical College, Datta Meghe Institute of Medical Sciences, Wardha, Maharashtra, India

^{2,3}UG Student, B.Sc. MRIT (Medical Radiology and Imaging Technology), Department of Radiology, School of Allied Health Science, Jawaharlal Nehru Medical College, Datta Meghe Institute of Medical Sciences, Wardha, Maharashtra, India

Abstract

In the evaluation of tendon pathology, imaging modalities play a vital role in diagnosing tendon pathology. These pathologies include some injuries, tears, inflammation action, etc., only Magnetic Resonance and Imaging Technology (MRI) and ultrasound with their ultra-special and exceptional results in outcomes. It is the most commonly used for the diagnosis of these diseases. Various tendon-related disorders can be examined easily by these imaging techniques. This pathology includes elbow tendon, shoulder rotator cut off, abductor of the hip, tendons of the patella, tendon anatomy its structure, and existing pathology in the Tendon. However, imaging hands and fingers are difficult, but physicians diagnose the disease using the patient's history and symptoms and imaging. This imaging was generally done by Ultrasound, not by M.R.I., as the Ultrasound was cheaper than M.R.I. Ultrasound has proven more beneficial with affordable prices and accurate results in the case of a finger. Still, when we talk about elbows, it also experiences pain and has the problem of Tendinopathy, discomfort, and disease known as Lateral Epicondylalgia, another name for Tennis Elbow. This is the most common problem as its cause and mechanism are known. It was so important to see the interrelationship between the factors and mechanisms. Tendon disorders are common in athletes. Problems may be ecstasy inflammation and degeneration. Ultrasound helps in the understanding of the anatomical structure and high-resolution image. Tendinosis and Tendinopathy are two classifications of Tendon pathology encompassing Automatic, deterioration, and overworked pathology. Secondly, in Spondylarthritis inflaming enthesitis, 'Tendinosis' is the same as Tendinitis, where the Tendon means the part of your body that joins a muscle to bone, which means Inflammation. There are many risk factors along with this pathology, even if it is fatal. Tendons and change with the time.

Keywords: Imaging, Magnetic Resonance Imaging, Tendinopathy, Ultrasound.

INTRODUCTION

The function of the Tendon is to connect the muscles to the bone as it has some extraordinary features. Ligaments are also one structure other than the Tendon. Both differ in function but have structural similarities. Tendon is made of collagen fiber, mainly collagen type one. Both differ in operation but have structural similarities. The process of a ligament is to connect bone to bone, but structure-wise, like tendons, collagen fiber ligaments have high concentrations of Proteoglycan and water content. Whereas it has low collagen content, its structure is non-uniform with various patterns (weaving, interlaced). The Ligament helps and limits the movement of the joint.

Tendinosis and Tendinopathy are two classifications of Tendon pathology encompassing Automatic, deterioration, and overworked pathology. Secondly, in Spondylarthritis inflaming enthesitis, 'Tendinosis' is the same as Tendinitis, where the Tendon means the part of your body that joins a muscle to bone, which means Inflammation.

Address for correspondence: Suhas Tivaskar
Jawaharlal Nehru Medical College, Datta Meghe Institute of Medical Sciences, Wardha, Maharashtra, India

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There are many risk factors along with this pathology, even if it is fatal. Tendons change with time. It varies due to age; this change includes decrement in water collagen fibers, leading to making prone and damaging. Magnetic Resonance Imaging and Ultrasound play the most important role in diagnosing any part of the body. The various disease of Tendinopathy and Tendinosis or any tear, whether it is of any type, is visualized in this imaging. Ultrasound and Magnetic Resonance Imaging are both preferred by patients as there is no use of ionizing radiation and hence have no hazardous effect on the human body. Compared to M.R.I., Ultrasound is mostly selected as it is less expensive and affordable to the common person. The problem or abnormality in tendons and ligaments generally happens to those who have some work of load or sportsman, especially athletes.[1]

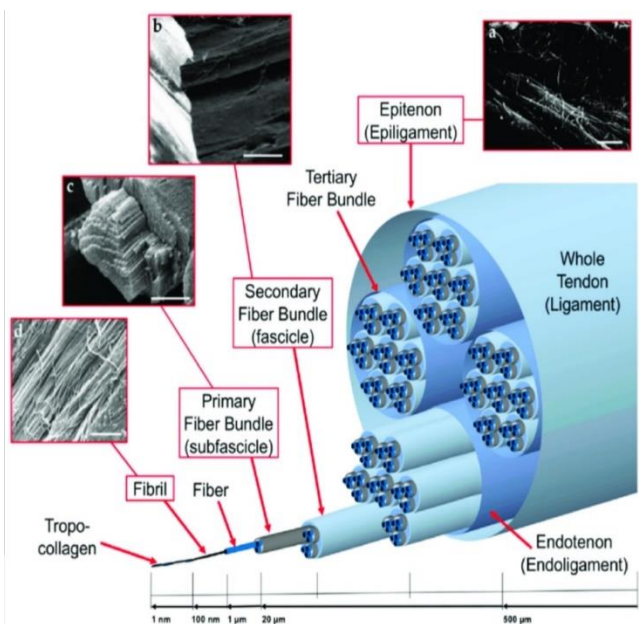


Fig 1: It is the image of the Hierarchical arrangement of collagen fibers of Tendons and Ligaments

THE STRUCTURE AND FUNCTION OF TENDON AND LIGAMENT:

Tendon is made of collagen fiber, mainly collagen type one. It is spread out in a Cross-Linked TRIPLE HELIX structure. Compactly bound water molecules bridged the strand of the helix. Stabilization of the structure and formation of molecules of water by hydrogen bonding. This all is constricted to the crosswise plane of the Tendon. It is a complex structure where the collagen macromolecules are grouped into fibrils. Then its fibers and fascicles. It is surrounded by vascularized connective tissue (Endo's Tendon). These all things together form the Tendon. The Tendon sheath comprises two coatings of the synovium; it generally surrounds the Tendon. The adaptations of fiber in the Tendon depend on the tension and strain. Some tendons have more complex structures like the Quadricep tendon,

and the Achilles tendon has fiber in the circumspect running bundle. The original form of the cross-linked triple helix gives high tensile stress in the normal conditions of the body without any pathology. This Tendon generally damages the sports personality due to increased pressure on the Tendon, causing Tendinopathy, rupture, strain, etc. The function of the Tendon is to connect the muscles to the bone as it has some extraordinary features. Ligaments are also one structure other than the Tendon. Both differ in function but have structural similarities. The process of a ligament is to connect bone to bone, but structure-wise, like tendons, collagen fiber ligaments have high concentrations of Proteoglycan and water content. Whereas it has low collagen content, its structure is non-uniform with various patterns (weaving, interlaced). Ligament helps limit the movement of joints. Therefore, injury of the Ligament is associated with the joint's injury depending on the joint's position and time of injury. There are many pathologies related to the damage of the Tendon and Ligament.[1]



Fig 2: In this Magnetic Resonance Imaging shows thickened and edematous Achilles' Tendon

TENDON AND LIGAMENT PATHOLOGY:

Tendinosis and Tendinopathy are the two classifications of tendon pathology. Encompassing automatic deterioration and worn-out pathology. Tendinosis and Tendinitis are degenerative pathologies. Tendinosis is the same as Tendinitis, where tendons mean the part of your body that joins a muscle to bone, and itis means inflammation tendinosis results in various risk factors. Tendon changes by age as the water content in their decreases in geriatrics. Which results in tendon damage. Tendon and abnormality can be occurred by endocrine abnormality. Destruction of the Tendon is associated with Myxoid, hypoxia, hyalin, and fatty. Fibrinoid or calcification destruction. These degenerative changes precede the development of rupture in the Tendon can call tendon tear. Acute trauma results in the destruction of ligaments. Damage in ligaments results in various damage,

including tearing collagen fiber. Some partial tear. Elongation and laxity may occur [1]

TECHNIQUE FOR TENDON IMAGING:

For the visualization of intramural structure, high-frequency transducers are essential for an ultrasound. At higher frequency, penetration is limited as on this depth, A1 frequency is dependent. A recommended frequency for the shoulder is 10-12 MHz. A linear transducer is always beneficial as it lines up perpendicular to the collagen fibre axis because the difficulty of Anisotropy of Tendon and Ligament can be evaluated better by this method as compared to M.R.I. (magnetic resonance imaging) and Ultrasound. Ultrasound proves more advantageous because it can envisage Tendon and ligaments from different angles. Conspicuity can be facilitated by using harmonic imaging in tendinopathy evaluation of Neovascularization permitted by power doppler. While using M.R.I. (magnetic resonance imaging) and Ultrasound, we have seen some comparisons in which users had already discussed the advantage of Ultrasound over M.R.I. Now about the disadvantage of Ultrasound over M.R.I. Ultrasound is needed for an Acoustic window. Ultrasound fails to visualize bone. Therefore, some tendons and ligaments are not visualized during an ultrasound, for example, A.C.L. (Anterior cruciate Ligament) and P.C.L. (Posterior Cruciate ligament), which are present in the knee joint, and some ligaments present in the pelvis region during diagnostic procedure imaging needed to focus on analog intraarticular destruction. In this situation, M.R.I. proves beneficial. The stronger magnetic field in M.R.I. results in a good caliber and high-resolution image [1]

IMAGING TECHNIQUES BY MRI:

For the evaluation of tendon pathology, M.R.I. is always preferred. It is mostly used because there is no ionizing radiation, but M.R.I. also has some hazardous effects. Therefore, it was denied by some patients. A tendon performs a critical role in the visualization in M.R.I. the relaxation period of T1 is comparatively short at 3-T. The dark signal void formation resulted from strong dipole interaction in conventional medical radiology and imaging technology. These signals are perceptible if tendons are inspected at 55° to the static magnetic field. That angle is known as colloquially. Fiber orientation is the one on which the T2 weighted imaging order is dependent other than T1. As we know, the accommodation of tendon fiber can change accordingly. This crisis is alleviated by imaging with enough long echo time. The first sign of abnormality is the increments in the weight of T2 signal intensity. Tendon Enlargement can be seen in M.R.I. imaging. In magnetic resonance imaging technology, fatty tissue looks lighter, and the fluid looks darker. Ligament occurs as an echogenic fibrillar structure.[2]

ULTRASOUND EXAMINATION TECHNIQUES:

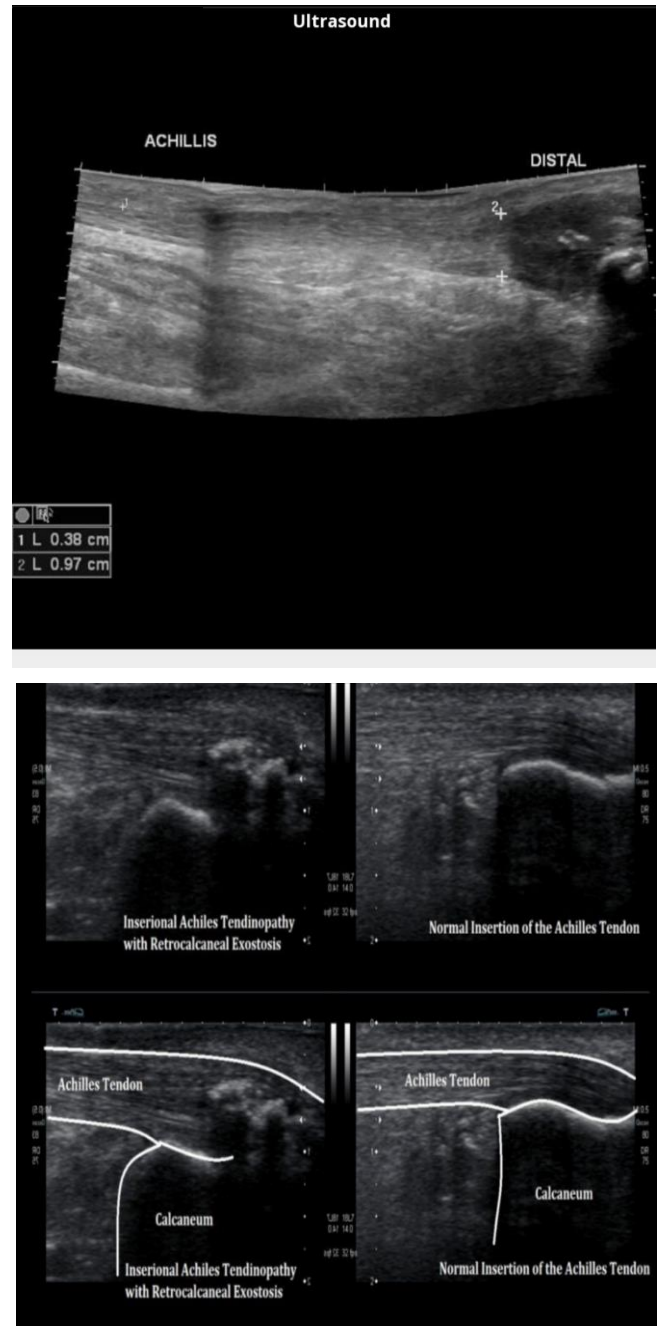


Fig 3: In the above image, ultrasound imaging of insertional Achilles Tendinopathy

Just like M.R.I. ionizing radiation are also not there in Ultrasound. As compared to M.R.I., Ultrasound is cheaper. It has made possible tendon imaging in any position, especially the erect position (weight-bearing), and at any angle the physician wants to diagnose the pathology. It cannot take images of deeper tendons and can't go through gas contain organization. It is proven useful for visualization of destruction in tendons fascicular structure [2]. For the examination of the hand snuff box. The transducer determines the space from proximal to distal and medial to lateral. Using

a transducer, we can have axial and longitudinal images of the extensor tendon, flexor tendons, numerical, and even median nerve.[3]

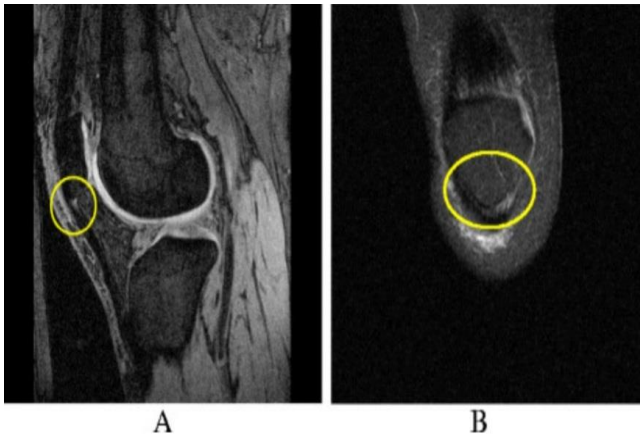


Fig 4: The imaging of Patellar Tendinopathy on M.R.I. Image A: Increased signal intensity at the proximal patellar Tendon on T1 weighted fat-saturated Sagittal M.R.I. Image B: Increased signal intensity at the proximal patellar Tendon on T2-weighted fat-saturated coronal M.R.I.

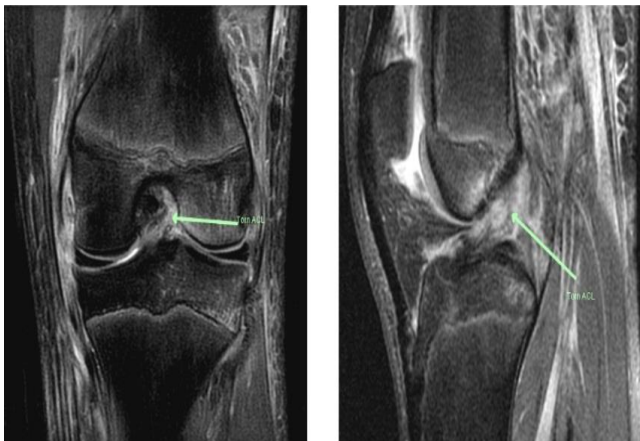


Fig 5: Image showing tear in the knee joint's A.C.L. (Anterior Cruciate ligament).

VERIFICATION OF PRECISION OF MRI AND ULTRASOUND:

TENDINOPATHY:

It is a chronic disease that occurs in the Tendon due to its destruction, overuse, and strain. It causes abnormality in the structure of collagen and cellularity. Its pain is more during movement and load. The affected side became weak. Treatment is required soon; delay in treatment results in severe damage. It may be present with Tendinosis. The chronic disease comes with chronic pain; in this case, it is the same [4]. Evidence of accuracy is less for the imaging of Tendinosis. The detection of Tendinosis is less specific in Ultrasound than in M.R.I. (magnetic resonance imaging). When we talk about Lateral epicondyle tendinosis, magnetic

resonance imaging is more accurate than ours. A mixed result is obtained in the case of imaging of the Achilles tendon by M.R.I. and Ultrasound. When it comes to the imaging of the Patellar Tendon, ultrasound imaging is more accurate than magnetic resonance imaging. For elbow (epicondylitis), M.R.I. is more accurate than ultrasound [1]

ANTERIOR CRUCIATE LIGAMENT TEARS:

Many studies have been carried out from the precise imaging of tendons. The Tendon of a Rotator cuff in shoulder imaging does not show much variation; it is done by Ultrasound or M.R.I. For the Gluteal Tendon, Ultrasound proves best for its imaging over magnetic resonance imaging technology. M.R.I. is proved more accurate than Ultrasound. Many studies were carried out to evaluate accuracy between M.R.I. and Ultrasound. For the foot and ankle tendon tear, Ultrasound proved more specific imaging over M.R.I. Tear in the achillea tendon can be precisely evaluated by M.R.I. technique over Ultrasound. For smaller Peroneal tendon M.R.I. fail in the sensitivity and specificity outcome, so Ultrasound is preferable to M.R.I. technology. As compared to M.R.I. and Ultrasound. M.R.I. proves precise for the evaluation of partial tear. Lateral epicondylar tears are more visible in M.R.I. [1-10].

ACHILLES TENDON TEAR:

Achilles' tendon tear shows the verification of Tendinosis. It can occur precipitously without any history of any activity that can cause it. The tear mostly occurs in the avascular part of it. Many types of tendons may occur in the Achilles tendon due to any strain load or overuse. Some fiber destruction is known as partial tear, indicating incomplete destruction [11-18]. For the breakage of the calcaneal Tendon, "HIPPOCRATES VIEW" was there. Precipitous treatment is necessary; it should be operated without delay [18].

DISCUSSION:

ABNORMAL TENDON AND LIGAMENT IMAGING:

When we have an Ultrasound of Tendinopathy, that can cause by any reason and can have any history. Having some abnormality is nothing but a change in its normal structure. So, in the Tendon, there is a change in its fibrillar organization of the order of lines and a reduction in echogenicity. Abnormality can also be seen if there is a change in its size. In Tendinosis, its size increases, or the Tendon's thickness increases. By using the Doppler study, we can visualize the Neovascularization of the Tendon, and sometimes calcification may occur. When there is a tear in the Tendon, it can be visible based on its type of chronic; Acute along with this fluid, namely Anechoic, is also visual, but due to this, Echogenicity of the Tendon may increase along with there is an increment in the level of difficulty to

evaluate the tendons. There is also another method of imaging during the contraction of the muscle, known as Dynamic Range. The evaluation of the intrasubstance tear from Doppler proves beneficial for this tendinopathy vessel. And when we talk about ligaments, if they're a sprain in the Ligament, broadening of the Ligament is shown in the ultrasound imaging. The hypochochriac area is formed due to tears that interfere with the fibers of the Ligament. If the abnormality is cured, the thickness caused remains the same, but the fluid vanishes off. The dynamic imaging method is capable of showing the laxity. The first appearance of the tendon abnormality is visible on the Gradient Echo images on magnetic resonance imaging by increasing the intensity of the signals. Improvement, or enhancement, can be seen in post-gadolinium photos. As we know, the broadening of tendons is visible in Ultrasound imagining. Teat and Tendinopathy can be seen in the association. While the imaging of ligament sprain, its characteristics are also similar. The fluid of the adjacent Ligament is visible on T2. The ligament pathology is visible and mostly broader than normal size. There is an increment in the intrasubstance signal. Laxity is also characteristic of the damaged Ligament. When the tears occur in the Ligament, the fluid is crossed over, and no proper differentiation is observed. There is also a change in the shape and size. There is thickening in the Ligament and sometimes thinning, or sometimes its shape becomes irregular, and this deformity occurs as time passes. [1,7]

FOOT AND ANKLE TENDON AND LIGAMENT:

The Gastrocnemius's and Soleus's Tendon form the Achilles Tendon. It is inserted into the posterior calcaneum. Its structure is like it is spiral around each other. Paratenon surrounded its concave anterior border. In between the Tendon and the calcaneum, there is the Retrocalcaneal bursa. At the same time, the Retro Achilles bursa is present in the posterior part. While on the medial side, there is a Plantaris Tendon. A tightly packed structure of fibrils of normal Achilles Tendon is seen in the U.S. (Ultrasound) image without using Doppler. Neovascularization and Fibrillar separation in the hypoechoogenicity are shown in Ultrasound imaging; when talking about M.R.I., there is an intermediate signal intensity on T1. Tears can also be seen on M.R.I. imaging. On the contrast-enhanced M.R.I., there is a visualization of the Tendon with a high signal that can be seen. Around the Achilles tendon, there is an Inflammation of Paratenon can be seen. The middle portion of the Achilles tendon is mostly get affected. The anterior part of the Tendon gets affected during Spondylarthritis. Achilles' Tendinopathy is not always symptomatic as sometimes it is asymptomatic.[1]

CONCLUSION:

Tendinosis and Tendinopathy are two classifications of

Tendon pathology encompassing Automatic, deterioration, and overworked pathology. Secondly, in Spondylarthritis inflaming enthesitis, 'Tendinosis' is the same as Tendinitis, where Tendon means the part of your body that joins a muscle to bone, which means Inflammation. There are many risk factors along with this pathology, even if it is fatal. Tendons change with time. It varies due to age; this change includes decrement in water collagen fibers, leading to making prone and damaging. Magnetic Resonance Imaging and Ultrasound play the most important role in diagnosing any part of the body, especially for evaluating the pathology in the Tendon and Ligament. Its normal phase and pathologic conditions are visible on M.R.I. and ultrasound imaging. It helps the physician to diagnose the pathology and cure it. Pathology includes elbow tendon, shoulder rotator cut off, abductor of the hip, tendons of the patella, tendon anatomy its structure, and existing pathology in the Tendon. However, imaging hands and fingers is difficult, but physicians diagnose the disease using the patient's history and symptoms and imaging. This imaging was generally done by Ultrasound and not by M.R.I. as the Ultrasound was cheaper than M.R.I. Ultrasound has proven more beneficial with affordable prices and accurate results in the case of a finger.

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