Imaging of calcific tendinopathy in atypical sites by ultrasound and conventional radiography: A pictorial essay

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Abstract
Calcific tendinopathy (CT) is a very common condition caused by the deposition of calcium hydroxyapatite crystals in tendons and it can be an incidental finding or associated with severe pain. CT can be easily detected by first level exams such as traditional radiography and ultrasound (US), which provide information on the site, extent and composition of the calcific formation. Classically, the most affected site is represented by the rotator cuff tendons, in particular the supraspinatus tendon. In this pictorial essay we illustrate various unusual localizations of CT detected by US and plain radiography, in order to provide an overview with the aim of preventing diagnostic delays and consequently CT complications.

Keywords: ultrasound; tendons; calcification; conventional radiography

Introduction
Calcific tendinopathy (CT) refers to the deposition of hydroxyapatite crystals in tendons affecting the pre-insertional portion of tendons, about 1.5 cm from their bone attachment (critical or crescent zone). The pathogenesis is still poorly understood. CT is probably due to a degenerative process caused by circumscribed hypoxic suffering, which first induces necrosis of tendon fibres and then stimulates a regenerative process characterized by metaplasia of tenocytes in chondrocytes [1].

Several studies have demonstrated that the regenerative process is due to a metachromasia of the tendons’ matrix, suggesting a fibrocartilaginous transformation with the finding of chondrocytes [2].

Uthoff divided the pathological process in three different stages of progression: in the first one, called pre-calcific, fibrocartilaginous metaplasia of tenocytes in chondrocytes occurs. The second phase, the calcific one, is in turn divided into three different moments: the formative, the resting and the resorptive phase. Into the first two stages the deposition of calcium crystals in matrix vesicles starts and the patient is generally asymptomatic, possibly feeling pain and functional limitation due to the enlargement of the tendon. The resorptive phase is characterised by the increase of blood vessels around the deposits of calcium and acute inflammatory reaction, which leads to macrophage and mononuclear giant cell infiltration, usually causing severe pain in patients. Ultimately, in the post-calcific phase, granulation tissue replaces the areas previously occupied by calcium deposits, resulting in the affected tendon’s healing [1].

Imaging Evaluation

Plain radiography
Imaging plays a vital role in the evaluation of CT and in this regard, plain radiography represents the fastest and most cost-effective way to determine the presence of tendon calcium deposits, their localization, size, exten-
sion and density. Deposits with a well-defined wall and homogeneous outline are associated with the formative or calcific Uthoff’s phases, more likely asymptomatic and found accidentally. Calcified deposits with poorly defined, blurred and inhomogeneous contours are typically related to the reabsorbing phase, usually associated to active inflammation and acute pain [3].

**Ultrasound**

Ultrasound (US) is considered the most useful and the method of choice for the assessment of CT, representing a supplement to conventional x-ray. The calcified deposit can be identified as a hyperechoic formation, with or without posterior acoustic shadowing, an element that can indirectly provide information on the calcification’s maturation state. Various ultrasound classifications of CT described in literature suggest that the presence of a strong shadow-cone indicates an early-stage calcification, while the uneven and blurred appearance or the absence of a shadow cone is an indirect sign of a resorptive phase [4].

For this purpose, the use of colour Doppler plays a pivotal role in identifying a possible blood overflow in the peri-calcific deposit region, thus suggesting the presence or absence of inflammation, typically associated with the resorptive phase and painful symptoms with functional limitation. Chiou et al observed a significant correlation between clinical symptoms (pain level) and colour flow signal intensity in patients with CT [5].

Furthermore, US examination is an excellent instrument for evaluating CT’s complications. During the resorptive phase the deposit may migrate into the surrounding tissues, causing inflammation and damage to adjacent structures. When soft deposits migrate in the bursa, it can be entirely filled with hyperechogenic fluid (“milk of calcium” appearance) that adheres to the bursa walls, making them thick and hyperechogenic. Rarely the calcific fragment can migrate to the near bone where, due to the enzymatic action, causes cortical erosion, lytic areas and inflammatory reaction of the bone marrow. US can detect the surface cortex interruption and demonstrate the continuity between the intratendon and intraosseous material (“comet-tail” appearance). Another extremely rare complication is intramuscular migration, where the calcification can be found inside the muscle with surrounding inflammation [6-8].

**Fig 1.** A 62-year-old patient with intense pain arising in the right arm. Conventional radiological examination (antero-posterior projection) shows a calcified formation at the humerus proximal third (arrowhead) (a, b). US confirms the presence of a coarse calcification of mature appearance (arrowhead) in the tendon of the pectoralis major, near the humeral insertion (c). US-guided percutaneous irrigation of calcific tendinopathy (US-PICT) is performed, with complete calcification dissolution and pain regression, as documented by the follow-up radiography (d).

**Fig 2.** A 60-year-old woman reports pain in her right arm after a muscle strain. US (a,b) shows an uneven calcification in the pre-insertional site of the pectoralis major tendon (highlighted in orange), with hyperechoic soft deposits migrated into the adjacent muscle (highlighted in green) suggestive for acute resorptive phase induced by a mechanical stress. The finding is confirmed by x-ray (c, d) showing the calcification (orange arrow and highlighting) and the small adjacent micro-calcific deposits (green arrow and highlighting).
US can also be used as an important real-time therapeutic tool in the procedure of US-guided tendon lavage, the so-called percutaneous irrigation of CT (US-PICT). It is a minimally invasive intervention involving the introduction of a needle into the calcific deposit, followed by a saline injection that melts the calcium and completed by the evacuation of the solution mixed with the calcific material [9].

In doubtful cases Computed Tomography or Magnetic Resonance Imaging may be useful – but not essential – imaging tools. In particular, Computed Tomography is helpful for evaluating osseous involvement, while Magnetic Resonance helps to estimate the extent of the soft tissues injuries and to exclude other causes of pain [3,10].

**Atypical calcific tendinopathy locations**

**Upper limbs**

Rotator Cuff is the most affected site, in particular the supraspinatus tendon, followed by the infraspinatus, the subscapularis and the teres minor [11]. Despite its high prevalence in the rotator cuff, any tendon may be affected, with similar pathogenetic mechanisms and appearance.

Atypical sites of CT around the shoulder involves pectoralis major tendon along its broad attachment (fig 1, fig 2) frequently associated with humeral cortex erosion at the site of insertion. In fact, the erosion is more frequent at areas of powerful traction, such as the osseous insertion of the pectoralis major and the gluteus maximus tendons [12].

Calcifications at the origin of long head of the biceps are less frequent and generally present an ovoid shape, with their position close to the upper glenoid being unchanged during external or internal rotation of the humerus [10]. Although in our knowledge only two cases have been described in literature, deltoid tendon should also be borne in mind as an atypical CT site (fig 3) [13].

Two cases of CT of the common extensor tendon have been described in literature (fig 4) [14] and one concerning the triceps brachii tendon, treated with percutaneous US-guided therapy (fig 5-7) [15].

**Fig 3.** A 54-year-old patient presents persistent pain in the left shoulder for one month, intensified in the last few days. US examination (a,b) shows an uneven calcification (arrowheads) close to the coracoid end of the acromioclavicular joint capsule, belonging to the deltoid’s tendon. The plain radiography (antero-posterior projection) (c,d) confirms the presence of a calcific formation near the acromioclavicular joint (arrowheads).

**Fig 4.** A 54-year-old patient reports pain in the left elbow, with clinical suspicion of epicondylitis. Preliminary radiographic examination (a,b) in the anteroposterior projection highlights a calcific deposit near the humeroradial joint (red rectangle). The following US confirms the presence of a 12 mm calcification in the common extensor tendon (arrowheads), which appears swollen, (c) associated with increased colour Doppler flow signal due to inflammatory aspects (d).
Fig 5. US examination of a 71-year-old patient claiming pain at the elbow showing a calcific conglomerate (arrow) in the triceps tendon, near the insertion, partly migrated into the olecranon with the typical “comet tail” appearance (arrowhead) (a) with concomitant increased blood flow detected at colour Doppler (arrow) (b). Note the fluid distension of the olecranon bursa with synovial thickening (star) (a,b).

Fig 6. A 53-year-old patient with constant ache in his left elbow. The radiography in the lateral projection (a,b) shows an elongated calcific formation near the elbow, extending cranially for 5 cm along the arm (arrowhead). The US completion (c,d) demonstrates a mature-looking calcification in the triceps tendon extended into the muscle belly and partially migrated into the olecranon bursa (arrowhead) with moderate inflammatory hyperaemia of the triceps detected at colour Doppler (d).

Fig 7. A 43-year-old patient reports pain in her left shoulder; US comparative analysis shows a centimetric calcification in the tendon of the long head of the left humeral triceps, near the scapular glenoid labrum (arrowhead). Note the different size of the muscle tendons (highlighted in pink): the left one, adjacent to the calcification, looks thickened, with inhomogeneous echogenicity, while the right one has a regular thin appearance.
In hand and wrist, the prevalence is about 2% where the flexor carpi ulnaris tendon, extensor carpi ulnaris tendon and the flexors and extensors of the fingers are the most affected locations [16].

**Lower limbs**

After shoulder, the hip is the second most common site of CT [14]. The tendons of the quadriceps femoris are the most involved, in particular the vastus lateralis tendon at its origin and the rectus femoris adjacent to its insertion on the superior acetabular lip. Hip muscles have been estimated to be involved in 5.4% of patients older than 15 years, in particular the gluteus maximus tendon. Because in this site CT is uncommon, it is often misdiagnosed and confused with other pathological entities (infection, inflammatory arthritis or radicular pain). The finding of a “comet-tail” appearance of calcium deposits near the insertion on the gluteal tubercle is diagnostic (fig 8) [17]. Thigh, knee and leg are rarely affected by calcific tendinopathy (fig 9) [18].

CT may involve the Achilles tendon, usually secondary to trauma. It is important to distinguish CT from calcific insertional tendinopathy, which manifests itself as a bone spur on the upper portion of the calcaneus and represents a distinct pathological entity, affecting mainly young athletes and older overweight subjects. Rarely the peroneus longus tendon is involved [14].

**Fig 8.** A 65-year-old patient with discomfort in the posterior portion of the right thigh. Preliminary conventional radiological examination (antero-posterior projection) (a,b) shows a calcified formation near the proximal third of the femur (green rectangle and arrow). US confirms the presence of a mature calcification in the gluteus maximus tendon, near the femoral insertion (green arrow) (c). After US-PICT, plain radiography demonstrates the complete calcification dissolution (d) and disappearance of pain.

**Fig 9.** US examination of a 57-year-old man claiming pain at the outer portion of the left knee, demonstrating a calcification of 28 mm in the distal portion of the biceps femoris tendon (arrowheads) (a), thick in appearance, with associated increase of the regional vascular signal of the power Doppler (b).
Already in 1970, Uhthoff reported the possibility of calcific deposits in ligaments, describing a similar etiological process to the CT [19]. The most frequent site of intraligamentous calcification is the medial collateral ligament (MCL) of the knee, which is often in differential diagnosis with the Pellegrini-Stieda disease, a post-traumatic ossification of the MCL due to repetitive micro or macro trauma (fig 10) [20].

Conclusion

The purpose of this pictorial essay is to illustrate the atypical sites of a common and well-known pathology such as CT, with specific attention to the contribution provided by ultrasound examination and plain radiography. The knowledge of these unusual locations can help physicians to establish a timely diagnosis, necessary for optimal patient care and life quality improvement.

Conflict of interest: none

References


