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Calcific Tendinitis: A Pictorial Review

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Abstract

Calcific tendinitis is caused by the pathologic deposition of calcium hydroxyapatite crystals in tendons and is a common cause of joint pain. The disease typically affects the shoulder and hip, with characteristic imaging findings; however, any joint can be involved. Occasionally, calcific tendinitis can mimic aggressive disorders, such as infection and neoplasm, especially on magnetic resonance imaging. Radiologists should be familiar with the imaging findings to distinguish calcific tendinitis from more aggressive processes. Image-guided percutaneous needle aspiration and steroid injection of calcific tendinitis are useful techniques performed by the radiologist for the treatment of symptomatic cases. Familiarity with these procedures and their imaging appearance is an important aspect in the management of this common disease.

Abrégé

La ténosite ossifiante se caractérise par le dépôt de cristaux d'hydroxyapatite de calcium dans les tendons et entraîne souvent des douleurs dans les articulations. L'affection touche principalement les épaules et les hanches, selon les résultats caractéristiques en imagerie; toutefois, toute articulation peut en être atteinte. Parfois, la ténosite ossifiante peut présenter les symptômes d'un trouble agressif comme une infection ou un néoplasme, surtout dans l'imagerie par résonance magnétique. Les radiologistes devraient se familiariser avec les résultats d'imagerie afin de distinguer la ténosite ossifiante de processus plus agressifs. L'aspiration à l'aiguille percutanée guidée par l'image et l'injection de stéroïdes sont des techniques utiles auxquelles ont recours les radiologistes pour traiter les cas symptomatiques. Une bonne connaissance de ces procédures et de leurs résultats d'imagerie représente un aspect important dans la gestion de cette affection courante.

Key Words: Tendinopathy; Calcinosis; Rotator cuff

Introduction

Calcific tendinitis is common and is related to the pathologic deposition of calcium hydroxyapatite crystals within the tendons. The process is unique and distinct from degenerative joint disease. In many cases, this calcification may be asymptomatic; however, calcific tendinitis can be an important cause of painful joints [1] and was said to account for 7% of shoulder pain [2]. Patients between 30 and 60 years of age are most typically affected by calcific tendinitis, slightly more frequently in women [2,3]. The shoulder and hip are the most commonly affected joints [4]. Multiple sites may be affected in the same patient, and calcific tendinitis may occur near any tendinous insertion in the body [5,6].

Calcific tendinitis is a dynamic process that evolves through several stages. Successive stages have been characterized as having distinct radiographic and pathologic features, which often correlate with clinical symptoms. When the calcifications are fluffy and amorphous, this can indicate the resorptive phase of calcific tendinitis, which is often associated with clinical symptoms of pain and reduced mobility. In this phase, patients may be suspected of having other pathology, such as septic arthritis or fracture. The imaging findings of calcific tendinitis in this stage may

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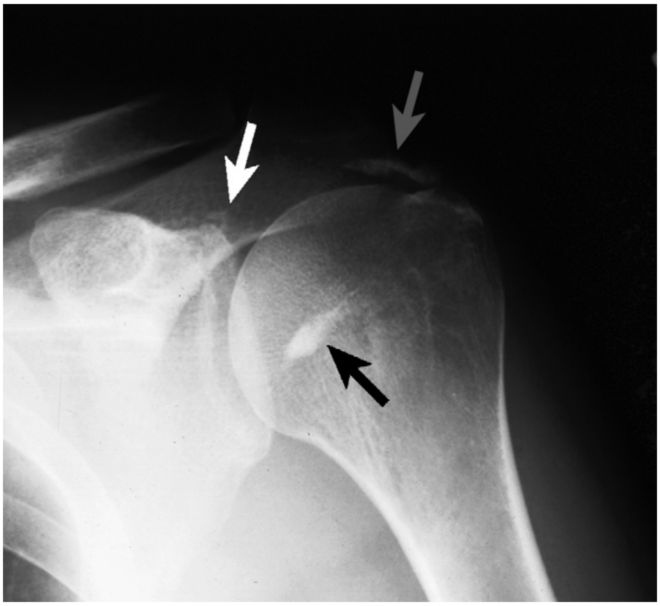

Figure 1. A 45-year-old asymptomatic woman. External rotation radiograph of the left shoulder demonstrates well-defined calcifications in the supraspinatus (grey arrow), subscapularis (black arrow), and long head of the biceps (white arrow) tendons.

include aggressive osseous changes as well as extensive soft-tissue oedema. These findings can be especially striking on cross-sectional modalities, such as computed tomography (CT) and magnetic resonance imaging (MRI). Visualizing tendon calcifications can prevent mistaking calcific tendinitis for more aggressive disorders. Radiographs can be especially helpful, even after initial imaging with MRI or CT [7].

Initial management of painful calcific tendinitis is typically conservative, because it is usually a self-limited condition. For cases in which conservative treatment has failed and symptoms significantly impact quality of life [8], invasive treatment may be pursued. Ultrasound or fluoroscopically guided needle aspiration is a minimally invasive interventional technique that radiologists can use for effective treatment of symptomatic calcific tendinitis [9].

Pathophysiology

The exact pathogenesis of calcific tendinitis remains unclear. Harvie et al [10] report an association with endocrine disorders of thyroid and estrogen metabolism, whereas Gohr et al [11] suggest that extracellular organelles called matrix vesicles may be the origin of the pathologic calcification. Other theories suggest that calcification occurs in the setting of tendon degeneration and necrosis [12], but more recent observations contradict this hypothesis. For example, the peak age incidence of calcific tendinitis tends to be earlier than that of degenerative tendinopathy [8,13]. Calcific tendinitis may resolve, whereas degenerative tendinopathy generally does not [1]. Calcific tendinitis appears to occur in viable, not necrotic, tissue, whereas dystrophic calcification occurs in necrotic tissue [7]. Also, calcium salts in degenerative tendinopathy have a different chemical composition than the mineralized deposits in calcific tendinitis, which contain poorly crystallized hydroxyapatite $[Ca_{10}(PO_4)_6(OH)_2]$ [14,15].

Results of current studies suggest that calcific tendinitis is a cell-mediated process, with 4 well-defined phases: formative, calcific, resorptive, and reparative [7]. In the initial, formative phase, for unknown reasons, possibly vascular or mechanical, a portion of the tendon undergoes fibrocartilaginous transformation. Calcification occurs and enlarges, becoming chalk-like in appearance. After this, the calcific deposit enters a resting period, the calcific phase, which may be painful and may cause mechanical symptoms if large. After a time, there may be an inflammatory reaction to the calcific deposits. This resorptive stage is often very painful. Vascular tissue develops at the periphery, and macrophages and multinuclear giant cells absorb the deposit. The deposit resembles toothpaste and may leak into nearby bursal spaces. In the fourth, reparative phase, after resorption, fibroblasts restore the normal tendon collagen pattern [7].

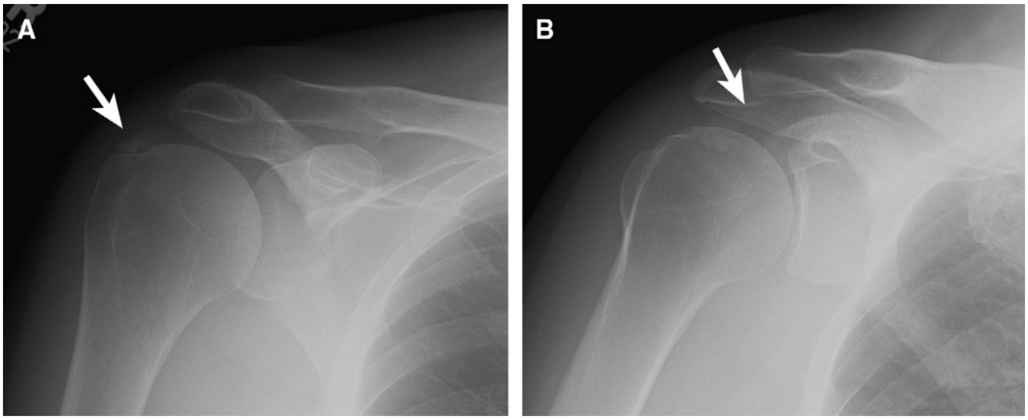

Figure 2. A 58-year-old man with right shoulder pain and resorptive phase of calcific tendinitis. (A) Internal and (B) external rotation views of the right shoulder demonstrate globular areas of hazy, ill-defined calcifications (arrows) in the region of the supraspinatus tendon.

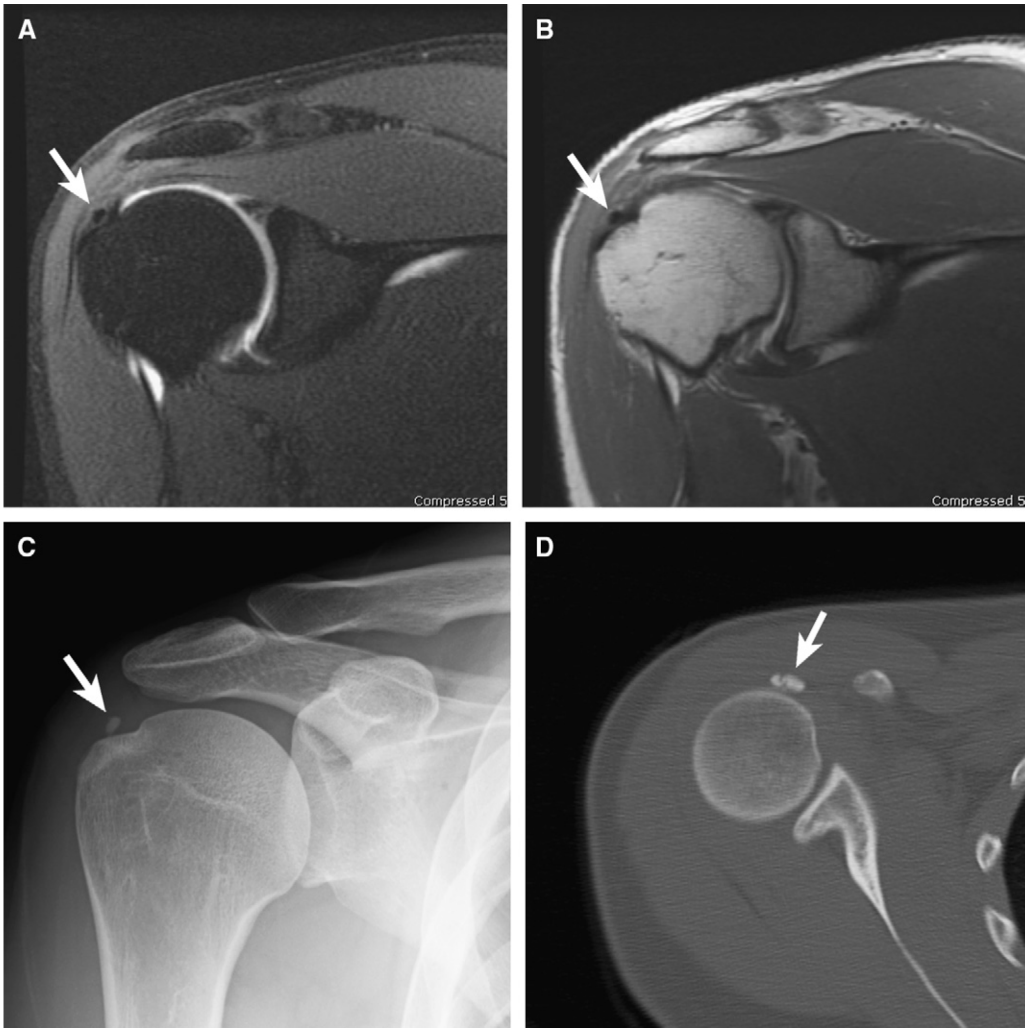

Figure 3. A 38-year-old woman with shoulder pain after a traumatic event. Coronal oblique (A) T2 fat saturation and (B) proton density (PD) weighted images show a focal area of low signal on both sequences at the insertion of the supraspinatus tendon (arrow). The calcification (arrows) is more conspicuous on the (C) AP radiograph and (D) axial CT image.

Imaging Evaluation

Radiographs

Radiography is the most practical modality for evaluating calcific tendinitis [5]. It is cost effective and useful, not only for determining the presence of calcium deposits but also for assessing their extent, delineation, and density [16]. Radiographic evidence of degenerative joint disease is usually absent [17]. Tendon calcifications are generally small, ranging in size from a few millimetres to a few centimetres [5]. Characterizing the shape and contour of the calcific deposit is important. Deposits with a well-defined, homogeneous contour are less likely to be symptomatic and may correlate with the formative or calcific phase of calcific tendinitis (Figure 1). Deposits with fluffy, hazy, ill-defined edges are often seen in patients with acute pain and may correlate with the resorptive phase of calcific tendinitis (Figure 2) [17].

CT

Calcific tendinitis may be encountered on CT, both as an incidental finding and on scans performed to evaluate joint pain. On CT, deposits that appear well defined on radiographs generally appear homogeneous [18]. CT is the modality best suited for evaluating osseous involvement, particularly if there are aggressive changes, for example, osseous erosion [19]. These changes are most often seen in the femur and humerus, with cortical erosion seen most commonly, followed by intramedullary extension [20,21]. CT may also be helpful for evaluating calcification in unusual locations, thereby localizing the disease to a tendon and confirming calcific tendinitis [22–25]. CT is the most accurate modality for predicting the consistency of calcific deposits [18], which may be important when planning intervention, for example, needle aspiration. Soft or semi-liquid calcifications can have a heterogeneous appearance on

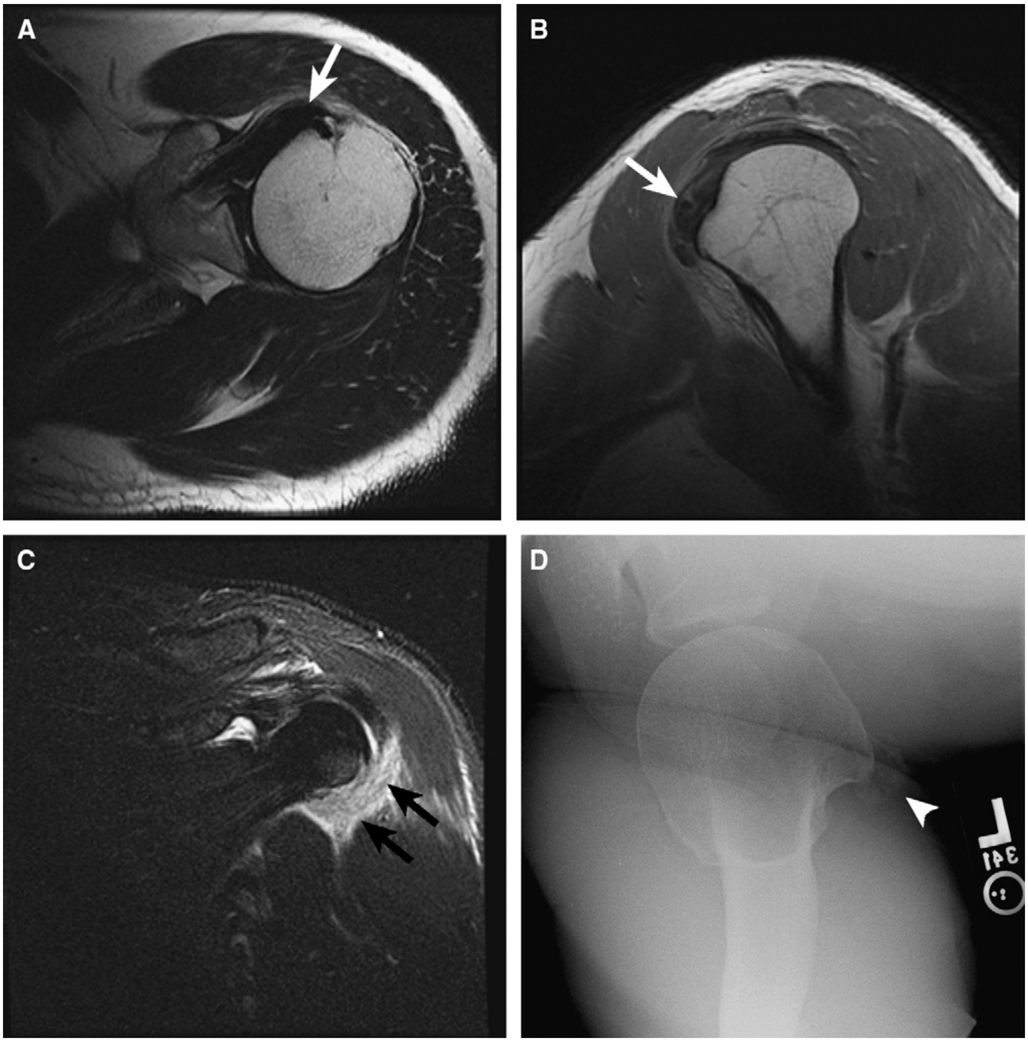

Figure 4. A 45-year-old man with acute left shoulder pain and limited range of motion. (A) Axial T2 and (B) sagittal oblique proton density MR images show ill-defined, globular, low-signal calcifications in the subscapularis tendon at its insertion onto the lesser tuberosity (white arrows). On the (C) coronal oblique T2 fat suppressed MR image, there is oedema in the soft tissues anterior to the humerus (black arrows). (D) An axillary view of the shoulder performed after the MRI confirms faint, amorphous calcifications adjacent to the lesser tuberosity (arrowhead).

CT, whereas hard or solid calcifications appear more homogeneous and have a higher density [18].

Ultrasound

Ultrasound is useful in evaluation of calcific tendinitis, particularly in the shoulder [22]. The real-time nature of sonography has led to its use in both diagnostic and therapeutic procedures [9,22,23]. Tendon calcification is seen as a hyperechoic focus, with or without posterior acoustic shadowing [24]. Sonography is reliable in detection and localization of rotator cuff calcifications but is unable to classify the pathophysiologic phase. Because of this limitation and the possibility of other pathologic conditions of bone, radiographs should be obtained in conjunction with ultrasound examination for calcific tendinitis [24].

MRI

MRI is also important in the evaluation of calcific tendinitis, because it helps to characterize the extent of the soft-tissue abnormalities and to exclude other causes of joint pain [21]. On MRI, calcifications appear as focal areas of low signal on all pulse sequences, typically located at or near the tendon insertion, although small deposits may be difficult to see by MRI [19,21]. Fluid sensitive MR images frequently show surrounding areas of increased signal intensity compatible with oedema, particularly if imaged during the resorptive phase. Occasionally, in our clinical experience, the extent of oedema can be extensive, mimicking infection or a focal mass. Whenever calcific tendinitis is suspected, comparison radiographs should be obtained, because they can be extremely helpful in demonstrating small tendon calcifications not well seen by MRI (Figures 3 and 4). Direct

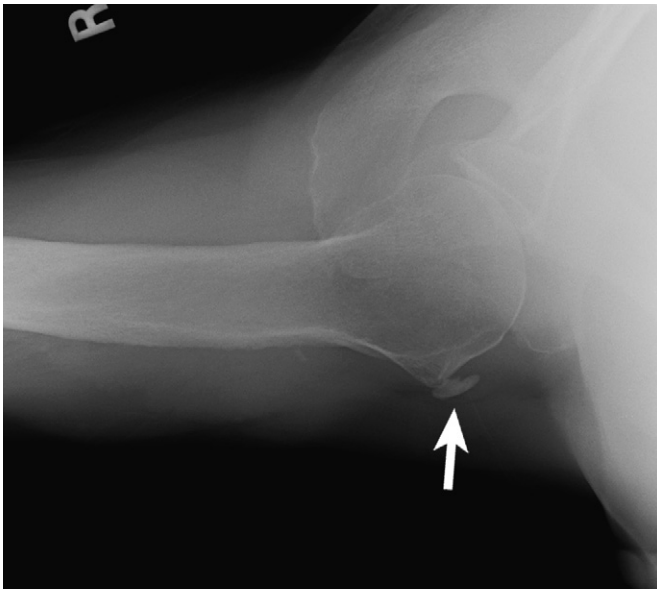

Figure 5. A 76-year-old man with right shoulder pain. An axillary view of the right shoulder demonstrates large curvilinear calcific density anterior to the lesser tuberosity (arrow), consistent with calcific tendinitis of the subscapularis tendon. Subscapularis calcifications may be difficult to visualize without an axillary view.

Figure 6. A 77-year-old man with acute left hip pain. Axial CT image shows a hazy area of amorphous density near the insertion site of the gluteus maximus tendon (arrow). Adjacent to this, there is erosion and disruption of the posterolateral cortex of the proximal femoral diaphysis, as well as a small amount of calcification within the medullary cavity.

magnetic resonance arthrography for calcific tendinitis of the shoulder was recently evaluated by Zubler et al [25] and was reported to be insufficient in the diagnosis of calcific tendinitis, because small calcific deposits may be difficult to visualize and lead to false-negative results, and normal hypointense areas within tendons may lead to false-positive results.

Site Specific Features

Shoulder

The shoulder is the most commonly affected joint by calcific tendinitis. The supraspinatus tendon is affected most often, followed with decreasing frequency by the infraspinatus, teres minor, and subscapularis tendons [3]. Anatomically, the areas that should be closely inspected are the insertions of the rotator cuff tendons on the humeral head: the supraspinatus, infraspinatus, and teres minor tendons on the greater tuberosity, and the subscapularis on the lesser tuberosity [26]. Bilateral involvement was reported in 20%–30% of patients [1,10,27]. Standard radiographic evaluation of the shoulder should include internal and external rotation anteroposterior (AP)

Figure 7. An 86-year-old man with calcific tendinitis of the right long finger. (A) Axial T1 MR image of the right hand at the level of the metacarpophalangeal (MCP) joints shows marked enlargement of the flexor tendon to the long finger (arrows), with oedema in the tendon and surrounding subcutaneous tissues. (B) Corresponding oblique hand radiograph shows focus of ill-defined calcification in the flexor tendon (arrow).

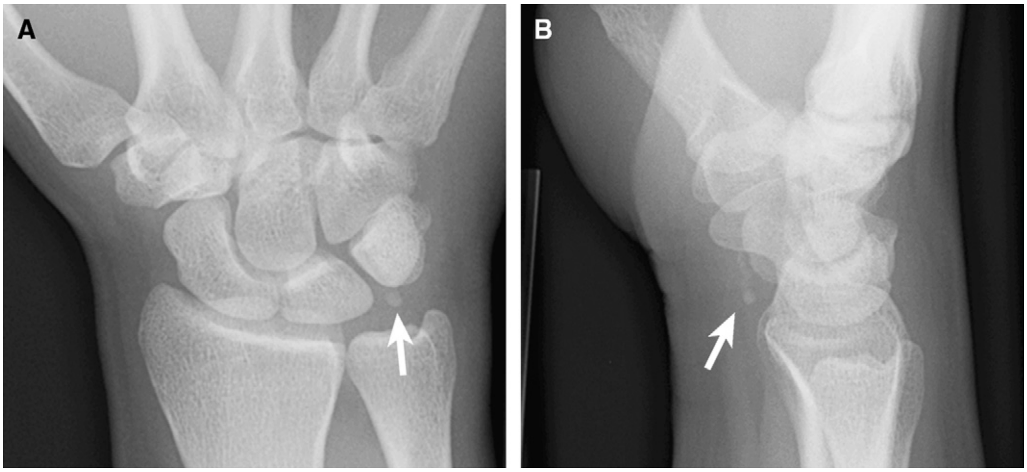

Figure 8. A 43-year-old woman with volar wrist pain. (A) AP and (B) lateral views of the wrist demonstrate several small calcifications (arrows) anterior to the pisiform at the distal attachment of the flexor carpi ulnaris tendon.

views to help visualize calcific deposits and their relationship to landmarks on the humeral head. An axillary view can be particularly helpful for visualizing subscapularis tendon calcification (Figure 5).

Hip

The hip joint is the second most common joint affected by calcific tendinitis. Deposits tend to occur near the insertions of the gluteal muscles on the greater trochanter and gluteal tuberosity [26,28]. The rectus femoris, hip abductors, or the vastus musculature may also be affected. Calcific tendinitis of the hip commonly results in pain in the posterolateral aspect of the thigh and can mimic radicular disc pain [29]. Occasionally, abrupt onset of pain may raise concern for fracture or septic arthritis. Standard AP radiographs of the hip are usually sufficient for diagnosis and most commonly demonstrate calcification over the greater trochanter, in the gluteus medius tendon. In more difficult cases, CT may be helpful in evaluating for osseous involvement, and MRI can demonstrate soft-tissue oedema, particularly in the resorptive phase of calcific tendinitis (Figure 6). MRI can lower suspicion for hip infection by showing the absence of joint effusion or marrow abnormality.

Other Anatomic Sites

Calcific tendinitis has been described in nearly every tendon in the body [6]. After the shoulder and hip, other common sites include the tendons of the hand and wrist, foot and ankle, and neck [4]. In many cases, oblique radiographs may be necessary to image calcification in smaller tendons in

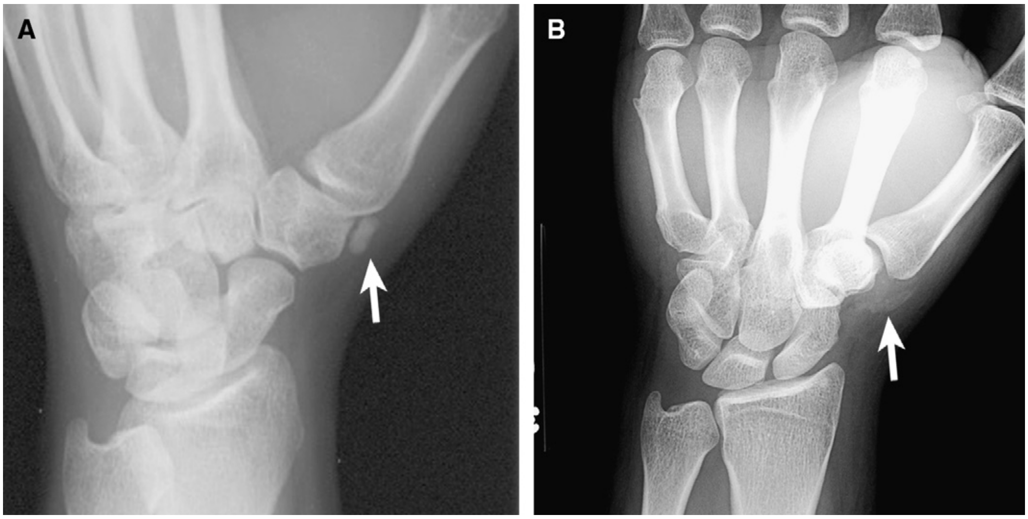

Figure 9. A 31-year-old man with right wrist pain after trauma. (A) Initial right wrist radiograph demonstrates a well-defined calcific density in the expected region of the abductor pollicis brevis tendon (arrow). The patient was not tender at this location. (B) Radiograph performed 3 months later shows a change in the appearance of the calcification from well defined to a hazy, amorphous density (arrow). The patient was symptomatic at this location, which indicates the resorptive phase of calcific tendinitis.

Figure 10. A 30-year-old man with nontraumatic right hip pain, suspicious for septic joint. (A) Coronal short tau inversion recovery (STIR) and (B) contrast-enhanced coronal T1 with fat saturation MR images demonstrate oedema and enhancement (white arrows) in the right hip soft tissues centered around a focal area of low signal (black arrows) in the gluteus medius tendon. Note there is no joint effusion. (C) AP radiograph of the right hip confirms ill-defined calcification at the greater trochanter (arrow). In this case, joint aspiration was prevented, and the patient improved with conservative management.

the hands and feet. Often, these areas will be imaged with MRI or CT first, because pain symptoms may prompt evaluation for indications other than calcific tendinitis. When the diagnosis is suspected, confirmatory radiographs should be obtained. Calcific tendinitis can also occur in unusual locations, and awareness of the anatomy of tendinous insertions can be helpful in recognizing calcific tendinitis when it occurs in atypical areas (Figures 7–9).

Pitfalls

Calcific tendinitis can have an aggressive appearance on imaging [21]. There can be extensive soft-tissue abnormalities surrounding the affected tendon. Osseous changes may be present, including aggressive features, such as cortical erosion, periosteal reaction, and soft-tissue calcification [21]. CT is the modality best suited for evaluating subtle areas of osseous involvement, although radiographs may often be satisfactory. The aggressive appearance should not be confused with infection or malignancies, such as a juxtacortical sarcoma [21]. Location within a tendon, the absence of joint fluid or soft-tissue mass, and relatively acute clinical presentation are factors that aid in distinguishing calcific tendinitis from other more aggressive entities (Figures 10 and 11) [21]. Calcific tendinitis, especially when it has aggressive osseous changes, can mimic entities such as infection and surface neoplasms (Figure 12) [21]. The presence of soft-tissue oedema, even with well-defined calcifications, can suggest the beginning of the painful, resorptive phase of calcific tendinitis. In cases in which biopsy cannot be avoided, it is crucial to communicate the suspected diagnosis of calcific tendinitis to the pathologist, who can identify chondroid metaplasia as a characteristic histologic component of calcific tendinitis and not inadvertently diagnose a chondroid neoplasm [21].

Figure 11. A 77-year-old man with acute left hip pain. (A) Initial AP left hip radiograph and (B) sagittally reformatted CT image show ill-defined density at the gluteal tuberosity (arrows). There is erosion of the posterolateral cortex of the proximal femoral diaphysis and a small amount of calcification within the medullary cavity. (C) Follow-up radiograph 6 months later demonstrates near-complete resolution of the abnormality.

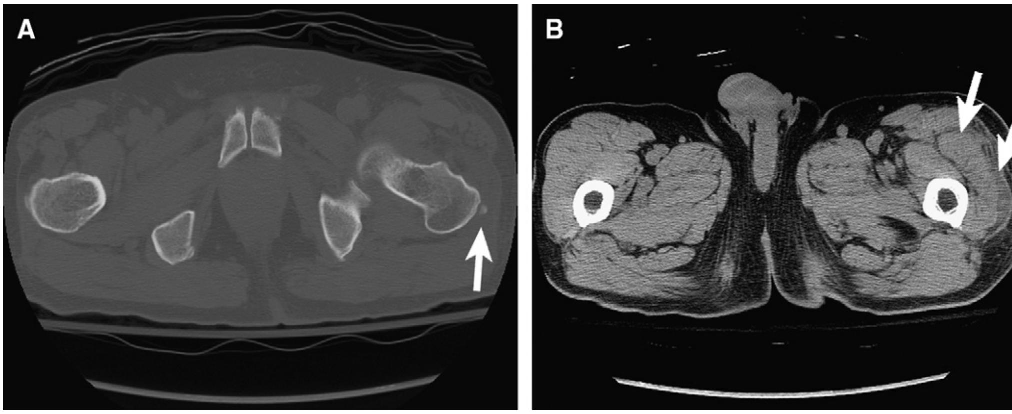

Figure 12. A 79-year-old man with left thigh pain. Axial CT images in (A) bone and (B) soft-tissue windows of the lower pelvis demonstrate a well-defined, 7-mm, calcific density adjacent to the left greater trochanter (arrow). Surrounding low-attenuation within the soft tissues of the left hip is compatible with oedema (arrows).

Treatment

The initial management of painful calcific tendinitis is typically conservative and involves nonsteroidal anti-inflammatory drugs, rest, and physical therapy. The process is self-limited, although many patients may not be able to tolerate the duration of time to resolution [9]. Invasive treatment is usually reserved for cases in which conservative treatment has failed and symptoms significantly impact quality of life [22]. Many successful treatment options have been described for calcific tendinitis, including extracorporeal shockwave lithotripsy, needle aspiration and steroid injection, and surgery [8,9,13,22]. Several studies demonstrated the effectiveness of fine needle aspiration, lavage, and/or steroid injection in both short- and long-term relief of symptoms [22]. A study by del Cura et al [9] reports that, 1 year after intervention, 91% of treated patients have resolution of symptoms and 89% have resolution of calcifications on radiographs. Other treatment methods, such as acetic acid iontophoresis and ultrasound therapy, have not proven to be more effective than physiotherapy or a placebo [9]. Extracorporeal shockwave lithotripsy treatment is effective in calcific tendinitis of the shoulder but is painful, expensive, and not widely available [9].

Ultrasound or fluoroscopically guided needle aspiration is a minimally invasive interventional technique that radiologists can use for treatment of symptomatic calcific tendinitis (Figure 13) [9]. In general, the calcific deposits are best approached from an anterior or inferior-superior direction, to ensure that the needle remains below the deposit (Figure 14) [9,22]. Unlike the fluoroscopic technique, with ultrasound guidance, treatment is best performed with the patient seated upright. For calcifications located in the supraspinatus and infraspinatus tendons, the patient's arm is best placed in internal rotation, with the hand behind the back. For subscapular calcifications, the arm is placed in external rotation,

Figure 13. A 56-year-old woman with recurrent painful calcific tendinitis flares in the right supraspinatus tendon. Digital fluoroscopic image shows aspiration of a calcific deposit localized to the supraspinatus tendon.

Figure 14. A 45-year-old woman with symptomatic calcific tendinitis of the supraspinatus tendon. Longitudinal sonographic image shows needle aspiration of a calcific deposit (arrow) in the supraspinatus tendon.

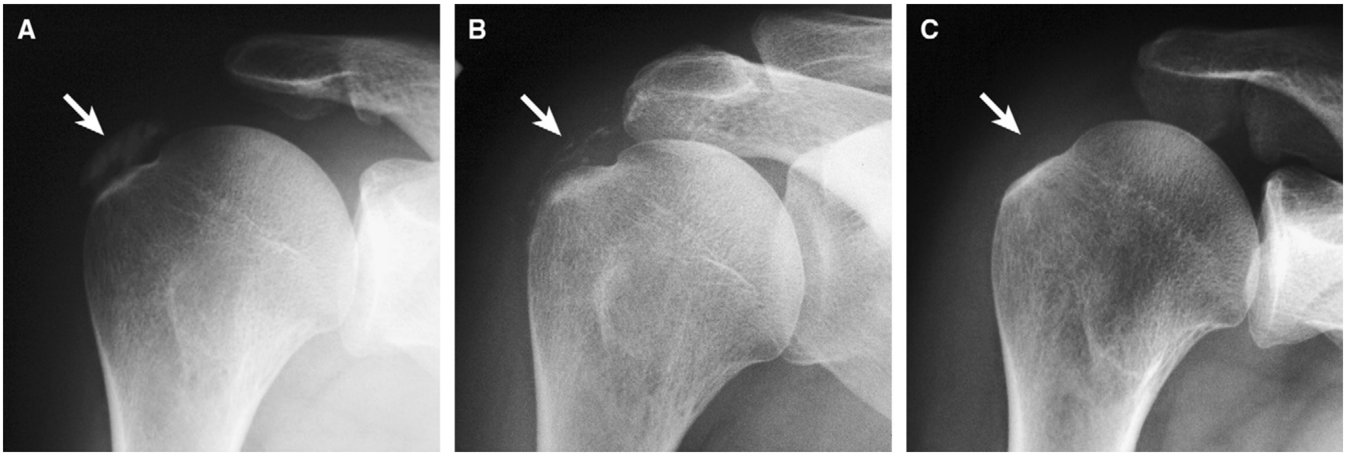

Figure 15. A 57-year-old man with improved symptoms after ultrasound-guided percutaneous needle aspiration. Radiographs obtained (A) before treatment, (B) 2 months after treatment, and (C) 1 year after treatment show radiographic resolution of supraspinatus calcific tendinitis (arrows).

with the hand supinated and resting on the thigh (Figures 15–17) [9,22].

Summary

Calcific tendinitis is a common cause of joint pain, with characteristic imaging findings. Radiography is the primary imaging modality used for evaluation and can usually localize the calcific deposits to a specific tendon, as well as characterize the phase of the disease. Occasionally, calcific tendinitis can present with aggressive osseous and soft-tissue changes, which mimic infection or neoplasm. The osseous findings are best evaluated with CT, and the soft-tissue abnormalities are best evaluated with MRI. In these instances, localizing the process to a tendinous insertion and visualizing the calcific deposits can lead to the correct diagnosis. Finally, ultrasound or fluoroscopically guided percutaneous needle aspiration and steroid injection of calcific tendinitis can be performed by the radiologist to treat symptomatic cases of this common disease.

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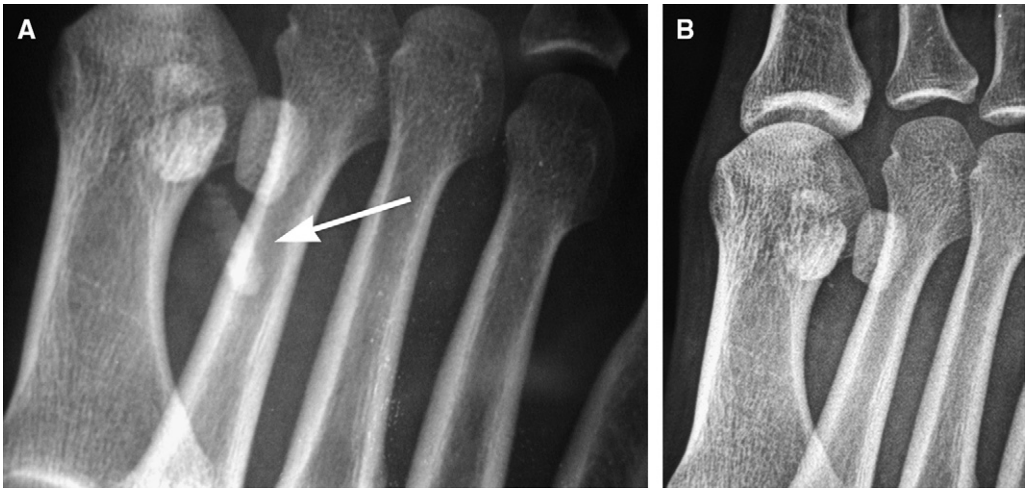

Figure 16. (A) A 53-year-old man with pain in the forefoot. Oblique radiograph of the foot shows a long calcification below the first metatarsal (arrow). Calcification was treated by means of sonographically guided lavage and aspiration. (B) Immediately after treatment, the calcification disappeared and symptoms resolved.

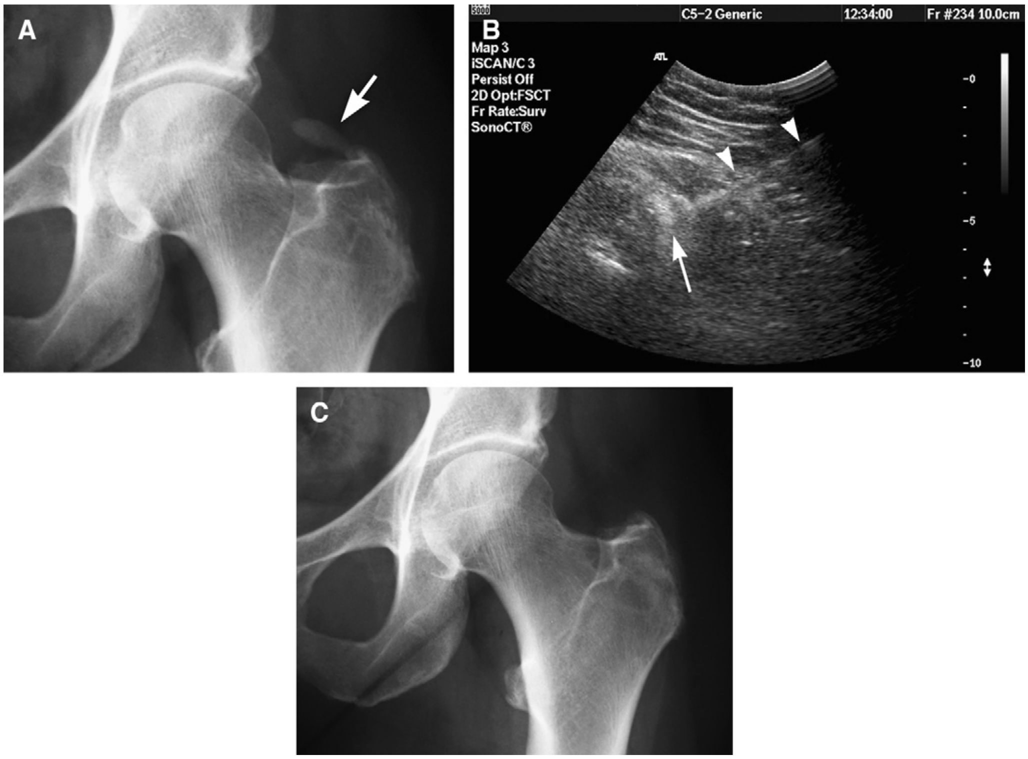

Figure 17. (A) A 57-year-old woman with pain in the left hip for the past 2 years. Radiograph shows calcific tendinitis next to the greater trochanter (arrow). (B) Calcification (arrow) was treated by means of sonographically guided lavage and aspiration by using a 20-gauge needle (arrowheads). (C) After treatment, the calcification disappeared and symptoms resolved.

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