Intramuscular migration of calcific tendinopathy in the rotator cuff: ultrasound appearance and a review of the literature

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Abstract Calcific tendinopathy of the shoulder is a common condition caused by calcium hydroxyapatite crystals, affecting the tendons of the rotator cuff. Among uncommon complication, one is the migration of the calcium in the subacromion-subdeltoid bursa. More rare is the intraosseous migration. We present four cases of an even more rare condition, not well described in literature yet, the intramuscular migration of calcium.

Keywords Calcific tendinopathy · Intramuscular migration · Shoulder pain · Ultrasound · Calcium hydroxyapatite crystal deposition disease · Rotator cuff

Riassunto La tendinopatia calcifica della spalla è una condizione comune causata da cristalli di idrossiapatite di calcio, che colpisce i tendini della cuffia dei rotatori. Tra le complicanze non comuni, una è la migrazione di calcio nella borsa subacromion-subdeltoidale. Più rara è la migrazione intraossea. Presentiamo quattro casi di una condizione ancora più rara, poco descritta in letteratura, la migrazione intramuscolare di calcio.

Introduction

Calcific tendinopathy of the shoulder is a common disorder, with prevalence up to 7.5 % of adults, mainly affecting women during the fifth decade of life. Other names have been given to this pathology, such as calcific tendinosis, calcifying tendinitis, tendinous calcifications, calcium hydroxyapatite crystal deposition disease, etc. [1–4].

This condition typically affects the rotator cuff and is due to deposition of calcium hydroxyapatite crystals within the tendons. The supraspinatus is the most involved one (80 %), followed by the infraspinatus (15 %) and subscapularis (5 %), but other site may be affected, even outside the shoulder. The exact pathogenesis is still not well known. Some authors suggest that there may be an association with hormonal disorders [1–3].

Uthoff et al. described four stages of this pathology: precalcific, calcific, resorptive and postcalcific. In the first phase, on an intact tendon, in less perfused areas, hypoxia may be the cause of a fibrocartilaginous metaplasia and cellular necrosis that leads to the formation of the calcification. Then, in the resorptive stage, there is an increased vasculature within the tendon and macrophages remove the calcium deposits: in this stage calcium may migrate in adjacent structures. In the last phase, postcalcific, after resorption fibroblasts try to repair the tendon by a self-healing process [5].

Clinically, calcifying tendinopathy may be asymptomatic. In the calcific phase it may be painful and cause mechanical symptoms, like impingement, when the calcification is large. Commonly the most painful phase is the resorptive one, with an acute syndrome and a very limited range of motion.

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For the diagnosis usually radiography is enough, showing the calcification, its extent, shape and contour [1–5].

Ultrasound (US) is useful too in the evaluation of calcific tendinosis. At US, calcifications appear as hyperechoic foci. Three types have been described, based on the percentage—in decreasing order—of calcium in the deposits [1]. Type I is rich in calcium. Its appearance is hyperechoic with well-defined acoustic shadowing and corresponds to the first, formative phase. Type II is hyperechoic, with a faint acoustic shadow. Type III is similar to the previous one, except the fact it has no acoustic shadow. The last two types usually correspond to the resorptive phase in which the calcium deposit may be semiliquid; therefore these calcification are also defined “slurry” Furthermore, type III calcifications may be isoechoic to tendons: to avoid misinterpretation is important to check the loss in the normal fibrillar tendon pattern, associated with the presence of amorphous hyperechoic foci. A second way is to take advantage of anisotropy: a tendon appear artifactually hypoechoic when the sound beam is not perpendicular to its fibers, so that the calcific deposits become more visible [1, 6].

Other imaging modalities, like CT and MRI, are usually not needed. These could be helpful in case of osseous involvement. CT is the best modality to evaluate erosion and demonstrate calcification and its consistency [1, 2, 7, 8].

MRI can be useful and is superior in evaluating marrow involvement, although intratendinous calcification may be difficult to see. On MRI calcium deposits appear as area of low signal on all pulse sequences [1, 2, 8–10].

Calcium migration from tendons to the contiguous structures is an uncommon complication of calcific tendinopathy, but well described in literature. In the shoulder, usually the calcification moves to the sub-bursal space or inside the subacromion-subdeltoid bursa, a condition that can be very painful, with an acute onset. Rarely, calcification may migrate to the bones, typically the humeral head, causing erosion [1, 7, 8].

We describe an even more rare condition, the intramuscular migration of calcium, with an emphasis on its US characteristics.

Case reports

Case-1

A 50-year-old woman with a history of right shoulder pain and calcific tendinosis of the supraspinatus, in absence of any specific trauma, referred to our attention for the worsening and change of symptoms: comparing to the previous symptomatology, pain was localized in the

infraspinous fossa, and she complained severe limitation during extra-rotation of the arm.

One year before a previous US examination showed the presence of a 20 mm calcification in the supraspinatus tendon, in the insertional region.

At our US evaluation, performed with an iU22 system (Philips Medical Systems, Bothell, WA) and a 12–5 MHz linear transducer, the calcification in the supraspinatus was still present. It was a type III. Posteriorly, it was possible to see it continuing into the infraspinatus muscle, superficial to its intramuscular aponeurosis. Inside the muscle the calcification was a type III too, with a dimension of approximately 50 × 10 mm (Fig. 1; Movie 1).

Dynamic scanning during extra-rotation of the arm showed an incomplete gliding of the infraspinatus tendon.

X-ray confirmed the presence of the calcification (Fig. 2).

Patient at first was treated in a conservative way. Two months later, for the persistence of pain and functional limitation, the Orthopaedist chose to remove the calcification arthroscopically. Before it, MRI was requested: it confirmed the presence of the calcium deposits, slightly reduced (Fig. 3). Arthroscopic surgery was carried out to remove the calcification and bursectomy was done as well.

Then she started physiotherapy and gradually regained normal mobility of the shoulder.

Three months later there was no trace of the calcium deposits at a follow-up US examination.

Case-2

A 55-year-old woman presented with chronic pain over the posterior aspect of the right shoulder. No traumas were reported. In the last month she experienced a marked limitation in shoulder movements, mainly extra-rotation. She had not done any previous diagnostic exam of the shoulder.

US exam was made with a MyLab40 system (Esaote Biomedica, Genoa, Italy) and a 12–5 MHz linear transducer.

It showed an inhomogeneous calcification (20 mm) of the infraspinatus tendon (type II) that extended for a further 30 mm in the muscular belly of the infraspinatus, deep to the central aponeurosis of the muscle, in part with a faint acoustic shadowing (type II) and mainly with a well-defined shadow (type I) (Fig. 4). In this case too dynamic scanning showed a limitation similar to the one described in case-1.

X-ray was performed. Radiographic findings are described in Fig. 5.

She was treated in a conservative way. Two months later she reported to feel better, chose to stop therapy and she refused to have any further examination, included MRI, which was requested to corroborate the diagnosis and to check if the calcification was reduced.

Fig. 1 Case-1. US scans. On the *left* footprint of the supraspinatus. There is a type III calcification (*arrow*) within the tendon and in the sub-bursal space. On the *center* and on the *right* infraspinatus muscle, respectively short and long axis. There is an intramuscular calcification (*arrow*)

Fig. 2 Case-1. X-ray confirms the presence of the calcification. *Left* AP view. *Right* Y view

Fig. 3 Case-1. MRI acquired 2 months later. Sagittal T2 sequences. Calcification was reduced

Fig. 4 Case-2. *Left* footprint of the infraspinatus. There is a type II calcification within the tendon. On the *centre* and on the *right* infraspinatus muscle, respectively short and long axis. There is an

intramuscular calcification, in part with a faint shadow, in part with a well-defined acoustic shadow

Fig. 5 Case-2. X-ray AP. *Left* intrarotation. Calcium deposits can be seen over the greater tuberosity. *Right* neutral position. In intrarotation and in neutral position of the shoulder a faint ill-defined opacity can be seen below the coracoid process, consistent with the intramuscular calcification seen at US scans

Even if we could not demonstrate a reduction of the calcification at imaging, the clinical improvement was likely related to a resorption of the calcium deposits.

Case-3

A 40-year-old man complained a history of atraumatic and persistent right shoulder pain and a limitation in abduction, with the clinical suspect of adhesive capsulitis.

No other radiological exams were made before.

US examination was performed with an Antares system (Siemens Medical Systems, Issaquah, WA) and a 13–5 MHz linear transducer.

It showed a type III calcification in the footprint of the supraspinatus. A proximal US scan, with the trapezium as an acoustic window, demonstrated a widespread involvement of the muscular belly of the supraspinatus (type III calcification) (Fig. 6).

X-ray confirmed US findings (Fig. 6).

After 3 months the symptomatology improved and the calcium deposits were partially reabsorbed. Three months later patient referred only some sporadic pain.

Case-4

A 61-year-old woman was evaluated with US for a sharp acute shoulder pain, not related to a trauma. She referred chronic, mild left shoulder pain since the last year so she had an US evaluation 9 months before, in which a type I 13 mm calcification within the subscapularis tendon was demonstrated.

Clinically the anterior deltoid area of the left shoulder was swollen compared to the right one (Fig. 7). Both active and passive movements of the shoulder were painful and limited; the intra-rotation of her left arm was the most severe.

US exam was performed with a Toshiba Viamo system (Toshiba Medical Systems Corporation, Otawara, Japan) and an 11–4 MHz linear transducer (PLT-704AT).

Fig. 6 Case-3. *Left* US scan of the supraspinatus muscle, short axis. *Center* US scan of the supraspinatus muscle, long axis. *Right* X-ray confirms the presence of the calcification

Fig. 7 Case-4. Clinical appearance at inspection. The anterior deltoid region of the left shoulder is swollen

There was a calcification of the subscapularis tendon, mixed type (in part with no acoustic shadow, in part with it, in part with a faint one). The calcification migrated to the surrounding tissue, including the subacromion-subdeltoid bursa and medially to the myotendinous junction of the subscapularis (Figs. 7–9). During scanning the pressure of the probe over the subscapularis region was painful.

Due to involvement of the bursa and the pain related to the bursitis, the calcification deposits were directly removed by US-guided percutaneous treatment. After 2 months she referred to be asymptomatic and the range of motion of the shoulder returned to the normality.

Discussion

Intramuscular migration of calcium deposits is rare. To our knowledge there are only few cases reported in literature of this disorder, but in no one its appearance with US was described.

The pathogenesis is not clear. Recently Pereira et al. retrospectively reviewed the radiology report databases of three affiliated institutions for shoulder MRI examinations obtained over a 7-year period, founding eleven patients with a muscular migration of rotator cuff calcific tendinosis [9]. They hypothesize that the migration may be related to intrasubstance delaminating-type tendon tears that provide a pathway for the calcifications, although such tears in their series were not clearly visualized. In our patients, with US we were not able to demonstrate any intrasubstance tendon tears.

Clinically, all of our four patients presented with a severe limitation, both active and passive, in shoulder range of motion and acute atraumatic pain, a clinical pattern that may be mistaken for adhesive capsulitis. The movement more involved was directly linked to the location of the calcification: in case of the infraspinatus extra-rotation of the arm was seriously limited, in case of the supraspinatus the abduction of the arm, in case of the subscapularis the intra-rotation of the arm, while in adhesive capsulitis shoulder limitation is usually global. The patients had chronic atraumatic shoulder pain and presented to our attention to have an US examination because of its worsening. Pain may be important in the differential diagnosis with adhesive capsulitis: in our experience in calcific tendinopathy during the resorptive phase it is usually more intense than in the former condition, especially if the migration involves the subacromion-subdeltoid bursa.

Intramuscular migration of calcifications can be misleading at imaging; we believe that some elements are useful for the diagnosis, which may be achieved with US and X-ray.

Fig. 8 Case-4. Three US scans, from cranial (*left*), to caudal (*right*), in the long axis of the subscapularis, with the patient in extra-rotation of the arm. There are inhomogeneous calcium deposits extending in

the subacromion-subdeltoid bursa and medially to the myotendinous junction of the subscapularis. All the three type of calcification are simultaneously present

Fig. 9 Case-4. Three US scans, from lateral (*left*), to medial (*right*), in the short axis of the subscapularis with the patient in extra-rotation of the arm. Findings correspond to those in Fig. 8

A story of calcific tendinopathy and its previous demonstration (by US or other radiological imaging modalities) may help the diagnosis. Only two of our patients had done a previous US examination, 9 months and 1 year before, in which calcifications were only localized at the level of the tendon.

X-ray can identify and confirm the presence of the calcium deposits, but with US is possible to recognize its location and extent as well as the continuity between the intramuscular and the intratendinous part of the calcification (see Movie 1), which we believe is necessary for the diagnosis. At US intramuscular calcifications have the same characteristics described for calcific tendinosis and can be divided in three types too, related to their amount of calcium. The echotexture of a normal muscular belly is relatively hypoechoic, due to its muscle fascicles, which are surrounded by linear hyperechoic fibroadipose septa, therefore the hyperechoic calcifications can be easily visualised with sonography.

Hyperemia on color and power Doppler may be present and correlates with the patients' symptoms. Extended field-of-view imaging may allow more accurate measurement in case of large calcifications.

Sonopalpation, the application of local pressure with the probe at specific anatomical region, is useful: sonographic tenderness during the examination at the site of the intramuscular calcification, reproducing the patient's pain, supports the diagnosis.

Dynamic scanning during shoulder movements may also show an incomplete gliding of the involved tendon and muscular belly due to the calcific deposits.

In doubtful cases, for example when the continuity between the intramuscular and the tendinous calcification cannot be clearly demonstrated, a confirmation with other imaging modalities, such as CT or MRI, can be helpful.

CT can clearly depict the calcific deposits; its drawbacks are ionizing radiation and high cost.

MRI has no ionizing radiation but has high cost too, and intratendinous calcification may not be appreciated. However, Pereira et al. suggest that MRI is the modality of choice to assess muscle involvement in calcific tendinopathy [9]. It is important to remark that intramuscular calcification may create an inflammatory response, with a diffuse muscular oedema involving the muscle of the rotator cuff: this appearance at MRI may be misleading:

Mileto et al. reported an intramuscular migration of calcium in the supraspinatus simulating a Parsonage–Turner syndrome. Therefore, they suggest, to avoid misinterpretation, to have radiography for shoulder pain before MRI examination [10].

Three of our patients improved clinically with conservative treatment and in two of them the results were satisfactory. In one, for persisting pain and functional limitation, the Orthopaedist chose to confirm the diagnosis and the extent of the calcification with MRI and to remove it by surgery.

In Pereira's study, follow-up information was available in five subjects: two of which underwent arthroscopic surgery after the failure of conservative therapy [9]. Vinanti et al. reported to have treated this disease surgically in one patient [11]; Wang et al. treated one patient with an intramuscular calcification of the subscapularis through ultrasound guided needling [12]. In the case report presented by Mileto et al. the patient was treated conservatively [10]. Other studies must be done to determine which may be the best management in case of intramuscular calcification; we think that the approach might be the same of calcific tendinosis: personalize the therapy for every single patient, starting with a conservative approach.

In conclusion, we presented four cases of this rare pathology, with an emphasis on US appearance. Although in previous studies sonography was not considered, ours demonstrate its role in depicting the intramuscular calcification. At US is necessary to show its continuity with a calcific deposit in the tendon. Moreover, sonopalpation and dynamic imaging, which are unique features of US, help during the sonographic examination.

US findings need correlation with clinical data and results of other imaging studies.

We think that US and X-ray may be enough for the diagnosis, linked to a strict follow-up with a progressive improvement in the symptomatology.

In one of our patient MRI was useful to confirm US findings and to plan surgical treatment.

We recommend, during an US examination of the shoulder and in particular in calcific tendinopathy, to check systematically not only the tendons, but also the muscle bellies of the rotator cuff. Further investigations should be done to understand the pathomechanism of the disorder and to confirm the imaging modalities needed for the diagnostic process.

Compliance with ethical standards

Conflict of interest The authors have no conflict of interest.

Informed consent All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2000. All patients provided written informed consent for enrolment in the study and for the inclusion in this article of information that could potentially lead to their identification.

Human and animal studies The study was conducted in accordance with all institutional and national guidelines for the care and use of laboratory animals.

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