Calcified tendinitis: a review

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Introduction

Calcified tendinitis is a common disorder. Many names have been used to describe it: some of them, such as 'calcific periarthritis', emphasise the extra-articular site of the deposit; others, such as 'periarticular apatite deposition', mention the nature of the compound found in the calcification; and more recent ones, such as 'calcifying tendinitis', emphasise the active process that might explain the deposition. Differentiated from arthritis at the end of the nineteenth century, this syndrome has only recently been related to the presence of apatite in tendon sheaths. It can affect almost any tendon at its insertion and is most common around the shoulder joint. Rheumatologists and radiologists have often described this shoulder abnormality, leading to its progressive differentiation from other painful shoulder syndromes.

This review will discuss calcific periarthritis of the shoulder as a model. Clinical features of the syndrome are variable and include pain and inflammation. The key diagnostic feature is the radiograph. Clinical evolution is simple and the condition often resolves spontaneously. Some cases are persistent and may require aggressive treatment, including surgery.

Numerous questions are still unanswered about this disorder, which is rarely associated with metabolic abnormalities of calcium and phosphorus. These include: (a) the nature of the mechanism leading to calcium salt deposition; (b) the frequent asymptomatic tolerance of such calcification, and, conversely, (c) the initiating agent of inflammatory flares; and (d) the way in which the material disperses.

Calcified tendinitis in clinical practice

**Clinical features**

According to Welfling calcific periarthritis is responsible for 7% of painful shoulder syndromes, which have various presentations.

1. Chronic symptoms—more or less severe pain; tenderness leading to various degrees of incapacitation. These symptoms induce the demand for radiographs, which reveal the presence of deposits.

2. Acute inflammatory crisis with severe pain, tenderness and local oedematous inflammation sometimes leading to restricted active and passive motion. Fever and malaise may be observed.

3. Totally asymptomatic deposits.

According to Bosworth et al., clinical symptoms occur in from 34% to 45% of patients in whom calcifications are found. Biochemical and haematological tests are not useful, and will only show non-specific evidence of inflammation.

**Radiological features**

Simple anteroposterior and lateral x-ray films are usually sufficient to see shoulder calcification, though special views in internal or external rotation may be necessary. Other techniques have been described to obtain better pick up, including xerography and scanning, but many small deposits are probably missed.

The calcification is usually in the supraspinatus tendon, and various appearances have been described. The deposits may be very thin, outlining the tendon sheath, or hazy, and they vary in density and definition (Fig. 1). Only in cases of disturbance of the calcium to phosphorus ratio—for example hyperparathyroidism secondary to renal failure—is there massive calcification. The size usually varies between a few millimetres and about 1.5 cm.

Calcification has been described near almost every joint although the precise intratendinous or paratendinous location of the stone is not always seen. The deposits may be multiple, which French authors identify as 'maladie des calcifications tendineuses multiples'. Bilateral calcification is seen in about half of shoulder cases and deposits are often seen in other locations—for example, near the hip joint—if other radiographs are taken.

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Sequential x-ray films may show static calcification, a growing deposit, change in the location, and even spontaneous disappearance without any acute clinical flare. During the inflammatory crisis, the calcifications usually follow a very well described course. They become less defined, more cloudy, and migrate into the bursa (Figs. 2 and 3); they may or may not disappear completely within a few days or weeks. The reappearance of calcification is not well substantiated (Fig. 4). Some authors emphasise the relation of the deposit to the bone surrounding the tendon insertion point. Destructive changes have been reported in advanced cases, and McCarty et al. have described a special syndrome associating a destructive arthropathy of the shoulder, apatite deposits, and high collagenase activities in the synovial fluid. They call it the 'Milwaukee shoulder syndrome'.

**DIFFERENTIAL DIAGNOSIS**
The diagnosis is usually easy. Other painful shoulder syndromes of osseous or articular origin present with different symptoms. Analysis of fluid and radiological investigations are also discriminative. Extra-articular ossification is radiologically different, the deposits being trabeculated, and articular chondrocalcinosis also appears quite different on a radiograph. Tendinous calcification containing calcium pyrophosphate dihydrate may be misleading but is usually associated with chondrocalcinosis.

**TREATMENT**
As both symptoms and deposits often disappear spontaneously, both clinician and patient should generally abstain from interfering. Analgesics and non-steroidal anti-inflammatory drugs (NSAID) are useful, as well as patience.

During an acute inflammatory crisis more powerful NSAID drugs such as indomethacin or phenylbutazone may prove necessary, and some authors recommend adding colchicine as in gout and pseudogout. Aspiration of fluid may also reduce symptoms. Local injections of corticosteroids are used by some clinicians, but may themselves cause microcrystal-induced inflammation, and the risk of infection must be taken into account. Lavage between attacks has been advocated, but does not always seem rewarding. Very painful resistant cases have received x-ray treatment. Calcium inhibitors have also been tried but the results are not convincing.

Surgery may prove successful, and a few well documented cases treated by surgical removal of the deposit have been described.

**LABORATORY INVESTIGATIONS**
The material aspirated from acutely painful shoulders has been studied thoroughly in a few cases, with interesting results. Firstly, they
allowed the identification of the material. Recent studies by our group have also isolated another compound, unidentified so far, which is different from stoichiometric apatite, and could be the result rather than the cause of the inflammation. The usual specimens obtained at operation consist of a gritty mass of sandy material or a toothpaste-like fluid. These have been recognised since Codman first described the calcifications, and in 1934 the deposits were described as 'a white amorphous mass composed of many small round or ovoid bodies'. Microscopically, at low magnification, calcifications appear as shiny amorphous coins (in a liquid phase).

Physical studies first used x-ray diffraction then infrared spectrometry. McCarty et al. and Thompson et al. identified an apatite compound by x-ray diffraction, and infrared spectrometry showed that it was a carbonated apatite. This has been confirmed by other physical means such as thermogravimetry. Our results are similar but it should be noted that all these methods consider the material as a whole and do not allow definition of individual particles.

Scanning electron microscopy allowed us to have a closer look at the external aspect of deposits; we observed an extremely heterogeneous material, composed of globular bodies looking like large rocky bulks engulfed in mortar (Fig. 5). Study of individual crystals needed even more sophisticated means. Transmission electron microscopy (TEM) allows the visualisation, on ultrathin sections, of dense globular structures among numerous isolated or clumped crystals (Fig. 6). Individual crystals may be seen in high resolution transmission electron microscopy. The crystals are much larger than classic apatite crystals, such as those observed in bone or dental enamel; some of them appear as homogeneous hexagons, the width and thickness of which can be measured. The parameters differ from one patient to another. Some of them have clear cut edges, while others seem to possess some sort of coating; defects can also be seen in several crystals (Fig. 7).

Interplanar spacings may sometimes be measured, and are consistent with these parameters in stoichiometric hydroxyapatite. These isolated crystals are, however, different from the globular material. Wavelength dispersive spectrometry in a scanning mode gave calcium to phosphorus molar ratios in both globules and isolated crystals not statistically different from control geological apatites, but similar microanalysis in a transmission mode provided lower ratios, with differences between the inside and outside of globular bodies. All these techniques identified the material of calcific deposits as calcium carbonate apatite, but the great heterogeneity of the material is a new feature that may open new fields of research. The differences observed between patients also deserves study.

The exact location of deposits is not well elucidated, but Wellfling describes some as intratendinous and some superficial.

Sandström described necrosis interpreted as being secondary to 'local anaemia and vascular changes', which favoured deposition of calcifying material. Uthhoff's group favour an active mechanism of calcification, with an initial cartilage degeneration of the tendon followed by calcification of the transformed tissue. They describe four stages in the calcifying process: precalcific phase; calcific phase; resorptive phase; and repair phase. These four patterns may occur concomitantly in an individual patient. This hypothesis would explain the heterogeneity and pleomorphic nature of the lesions, but the so-called 'resorptive phase' seems arguable, particularly because of the very small number of cells observed.

Using TEM, the same group studied the ultrastructural localisation of calcium in tendinitis. They found it in matrix vesicle-like structures seen either singly among collagen or in aggregates.

**Discussion**

New light should soon be shed on calcification in several aspects: (a) better identification of the calcifying processes; (b) more knowledge on epidemiology; (c) better definition of the nature of the compounds, hopefully leading to understanding of the aetiopathological mechanisms of the disease.

The identification of deposits has improved since the features of the condition have become recognised, and should be made even easier by further technical improvements allowing visualisation of tiny calcifications. This should help define the epidemiology and explain apparent differences in the incidence and age of onset between France and Britain. So far, only one epidemiological study has been performed in the United States. The existence of a possible genetic link should also be re-evaluated, in spite of...
of the negative results of the HLA studies already published.

Associations have been reported between calcifications and several diseases: diabetes, thyroid disorders, and others. A metabolic link was also noted between calcifications, uraemia, and haemodialysis. Finally, Bosworth suspected the influence of repetitive motion performed in a professional context. The relationship between shoulder use and the appearance of calcification is not well documented and should be re-examined.

The physicochemical findings in the past few years have been rewarding. In a recent review, Legeros brings many data favouring a calcium carbonate/apatite composition for heterotopic calcifications in man. Our results, however, made it obvious that there is a high degree of heterogeneity in these compounds and that the answer is probably not that simple. Every possible analytical and microscopical means should be used to study all types of calcification. It might be rewarding to compare idiopathic deposits with those found in other diseases such as hyperparathyroidism, hypervitaminosis D, collagen vascular disease, and the milk alkali syndrome. The exact incidence of other types of deposits such as pyrophosphate, reported in tendons by Gerster, should also be examined.

Several aetiopathological schemes have already been proposed. The classic hypothesis favours a local and initial necrosis of the tendon, leading to the deposition of calcified material. However, some calcifications obviously occur in the absence of any necrotic phenomenon. A more recent idea, based on histological and ultrastructural observations, suggests the occurrence of an initial cartilage metaplasia of the tendon, followed by an active multifocal and cell-mediated calcifying process. The intracellular or extracellular site of the first deposit is not completely clear and requires an ultrastructural or physical study of collagen fibres.

Some other mysterious features remain—for example, why should calcifications be most common around the supraspinatus tendon? How can the long-lasting tolerance of some deposits be explained, while others lead to acute crisis? What is the initiating mechanism in these acute episodes? Does it involve a modification of the physicochemical structure of the material or a change in its microenvironment? How is it that some pathological, and eventually painful, deposits disappear spontaneously?

Experimental models aid understanding of some of these problems. For instance, synthetic apatite crystals and/or natural apatites have phlogistic properties in inflammation models. A thorough study of the macrophage in such models might help us understand how calcified material can disappear. This could also be elucidated by metabolic studies if a dissolution process takes place in these phenomena.

More sophisticated models are obviously necessary, if not to explain all the mysterious events of this syndrome, at least to define new preventive or curative treatments, or both. Special care should, however, be taken in extrapolating such results to human disease.
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References

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