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REVIEW ARTICLE

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Rapid destructive arthritis of the shoulder

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Abstract Rapid destructive arthritis of the shoulder, although uncommon, has received much attention in the recent medical literature. It has been described by several authors under varied names: hemorrhagic shoulder of the elderly, Milwaukee shoulder syndrome, rapid destructive arthritis of the shoulder, apatite-associated destructive arthritis and idiopathic destructive arthritis of the shoulder. This particular form of arthritis affects mainly elderly patients, predominantly women, with limited pain, rotator cuff tear, joint instability, voluminous mildly inflammatory, blood-stained effusion, basic calcium phosphate crystals, and marked joint and bone destruction.

Key words Rapid destructive arthritis of the shoulder · Apatite-associated destructive arthritis · Milwaukee shoulder syndrome

Introduction

Rapid destructive arthritis (RDA) of the shoulder, although uncommon, has received much attention in recent medical literature. It has been described under various names, but all previously reported cases share many clinical, radiological, and laboratory features in common. It affects elderly patients, predominantly females, with rapid development of joint destruction in the presence of a large noninflammatory effusion, often blood-stained, containing large amounts of hydroxyapatite crystals. Radiologically, it bears resemblance to neuropathic and neuropathic-like arthropathies, and its etiology remains unclear.

In this paper, the clinical and radiological features of this disorder are described, and current views on its pathogenesis are discussed.

Clinical features

RDA of the shoulder was perhaps described first by Smith and Adams in the nineteenth century [1]. In 1967, deSeze, under the diagnosis "hemorrhagic shoulder of the elderly," described 30 cases with two sorts of arthrosis: the first with rapid loss of active movement followed by blood-stained joint effusion and degenerative changes of the glenohumeral joint, and the second type with more chronic, large joint effusion and marked rotator cuff attrition causing disability of function [2]. In 1977 Lambeley et al. [3] reported nine other cases with a spectrum of radiologic features ranging from osteoarthritic changes of the glenohumeral joint to destructive lesions of the humeral head, acromion, and sometimes clavicle and glenoid. In 1981, McCarty et al. [4] described, under the title "Milwaukee shoulder syndrome," four patients with painful shoulders and rotator cuff rupture. Analysis of the joint fluid, which was blood-stained in two cases, revealed large amounts of hydroxyapatite crystals and high levels of activated collagenase. In 1982, under the name "rapid destructive arthritis of the shoulder," Lequesne et al. [5] described six elderly female patients with similar clinical and radiological pictures, including osteolysis of 24–100% of the articular surface within a 6-month period, rotator cuff disintegration, and often blood-stained joint effusions. In 1984, using the designation "apatite associated destructive arthritis," Dieppe et al. [6] reported 12 patients with destructive arthritis of the shoulders (n=10), knees (n=7), hips (n=3), and mid-tarsal joints (n=2). Clinically, patients had joint instability and large noninflammatory effusions, which were blood-stained in 8 of 21 samples. Campion et al. [7] recently used the

term "idiopathic destructive arthritis of the shoulder" to designate a severe destructive arthritis of the shoulder of unknown etiology. They compared this disorder with pyrophosphate arthropathy, neuropathic arthropathy, and rheumatoid arthritis in terms of radiological, clinical, and laboratory findings. Although there was overlap in the two groups of patients in this study, several findings seem to define this entity: elderly patients, predominantly female, with rotator cuff rupture, joint instability, voluminous blood-stained effusions, basic calcium phosphate (BCP) crystals (hydroxyapatite, octacalcium phosphate, tricalcium phosphate), little inflammation, and marked bone and cartilage destruction. Campion thought that similar pictures could result from a variety of starting points and that similar patterns of mechanism may be involved.

Patients with RDA of the shoulder are usually female (80%) and over 70 years of age, with the age range going from 53 to 90 years. Most patients have symptoms dating from several years back, but others have marked deterioration over a span of less than a year. Both shoulders are involved in 64% of cases, with greater involvement of the dominant side. Mild to moderate pain may occur, especially after joint use, and pain may be severe even at rest. Physical examination reveals a markedly restricted painful shoulder with evidence of rotator cuff rupture and severe instability. Large cool joint effusions of 40–250 ml, often blood-stained (80%), are usually present. One of our patients yielded 1500 ml blood-stained fluid on aspiration. Occasionally there is rupture of the shoulder joint with drainage of blood-stained fluid into the periarticular soft tissue lasting for weeks or months [8].

Although shoulder involvement predominates, knees and hips are also affected. The knees are involved together with the shoulders in 50% of cases [9]. Other joints such as elbows, ankles, wrists, and intertarsal joints are less often affected. Analysis of synovial fluid aspirate reveals large concentrations of BCP, and in about 10%, pyrophosphate crystals are also seen [9]. The total white cell count is usually low (less than 2000 cells/ml) with a predominance of mononuclear cells, but there may at times be as many as 50000 cells/ml [10]. Occasionally, neutrophils may predominate [10]. Low levels of collagenolytic activity were found in at least one synovial fluid sample from half of the patients studied by McCarty et al. [8]. Particulate collagens and elevated neutral protease activity were also found in the synovial fluid [8]. Synovial biopsies showed increased numbers of villi, focal synovial living cell hyperplasia, a few giant cells, fibrin, and BCP crystal deposits [6, 7]. Crystals have been observed within membrane-bound phagosomes of synovial cells on electron microscopy study [9].

Pathogenesis

Periarticular and articular tissues are common sites for the deposition of crystal salts with different forms and chemical structures [11–14]. In osteoarthritic cartilage three distinct types of calcification are observed: microcrystals within mineral nodules, most commonly near the area adjoining the subchondral bone; dense cuboidal-shaped crystals of the apatite family, found with high density in the pericellular matrix containing cell debris around the surface chondrocytes; and fine, needle-shaped hydroxyapatite crystal clusters seen on the cartilage surface in the amorphous zone [9, 15]. These latter crystals are also seen in the synovium, and they resemble those found in the synovial fluid [9]. Calcium pyrophosphate crystals are also deposited in the osteoarthritic cartilage in about 11% of cases, whereas fine needle-shaped hydroxyapatite crystals are found in 56% of cases [16]. Cuboidal-shaped crystals have also been described in the superficial zone of elderly normal cartilage [14].

The metabolic derangements responsible for the hydroxyapatite crystal deposition are poorly understood. It has been postulated that inorganic pyrophosphate may accumulate in excess in the cartilage as a result of increased nucleotide turnover secondary to chondrocyte proliferation or injury [17]. In the study of the relationship between purine catabolic enzymes and arthropathies associated with calcium crystal deposition disease, Wortmann et al. [18] found that the levels of synovial fluid 5'-nucleotides (5NT) and nucleoside triphosphate pyrophosphohydrolase (NTPPPPH) in osteoarthritic patients were increased when hydroxyapatite crystals were present, with even higher elevations when there was existence of both hydroxyapatite crystals and pyrophosphate crystals in the synovial fluid.

The presence of hydroxyapatite crystals in the synovial fluid of patients with osteoarthritis was first reported in 1976 [19]. Subsequent studies revealed these crystals in joint fluid in 50–60% of patients with osteoarthritis [20–22], and they are commonly seen with pyrophosphate crystals in osteoarthritic knee joints [23–25]. The role of hydroxyapatite crystals in RDA of the shoulder is still controversial. Dieppe and Watt [26] suggested that deposition of crystals is a secondary, opportunistic event in damaged cartilage, but the crystals may further contribute to the joint pathology. Other authors postulated that hydroxyapatite crystals, phagocytosed by synoviocytes and chondrocytes, activate the release of collagenase and neutral protease [27, 28]. These proteolytic enzymes then digest connective tissue matrix, leading to joint destruction with the release of additional crystals from cartilage and bone, and of particulate collagen into joint space, thereby aggravating the destructive process [27]. A relationship between both the presence and concentration of hydroxyapatite and the severity of joint damage has also been recognized [29].

The stimulation of cytokines by hydroxyapatite crystals has not been thoroughly studied [9, 30]. In the study of monocyte–crystals interaction, Dayer et al. [31] found that synthetic pyrophosphate crystals and, to a lesser extent, synthetic hydroxyapatite crystals stimulate interleukin (IL-1) release from monocytes; both crystals also directly induce collagenase and prostaglandin E_2 secretion by chondrocytes [31]. IL-1 has been implicated in cartilage and bone degradation in inflammatory and noninflammatory arthritides [32–34].

The study of crystal-induced disease has been hampered by problems in terminology, and this has been compounded by the occurrence of crystals in otherwise "nondiseased" tissues and the marked variability in the associated syndromes [35]. Likewise, hydroxyapatite-associated disorders are varied, including calcific periarthritis, calcinosis, acute arthritis, and asymptomatic [9, 36]. The deposited hydroxyapatite crystals in the cartilage may be among several biophysical and biochemical factors noxious to the environment of the chondrocytes, leading to degradative changes [7, 8]. RDA of the shoulder may represent a peculiar form of osteoarthritis with atrophic and destructive changes. Hoffman and Reginato [10], however, thought that it is a unique entity rather than a sequel of osteoarthritis, the reasons being threefold: (1) primary osteoarthritis is infrequent in the shoulder, (2) high levels of activated collagenase-neutral protease and fragments of collagen are found in the synovial fluid of patients with severe hydroxyapatite arthropathy, and (3) synovial membrane tissue culture exposed to hydroxyapatite release these enzymes, underscoring the destructive potential of abnormally stimulated synovial living cells. The relationship between hydroxyapatite and osteoarthritis is difficult to elucidate because the prevalence of hydroxyapatite deposition in normal aging cartilage is not known and because of the evolving concepts of the entity of osteoarthritis [37–39]. In addition, the reasons why hydroxyapatite crystals cause morbidity at some times and remain latent at other times are mysterious. Possible factors are the quantity, size, surfaces, chemical nature, surface-coating proteins of the crystals, and the interaction between different types of crystals in the milieu [40, 41].

Radiologic features

Early radiographic changes consist of a high-riding humeral head due to rotator cuff tear, with mild subchondral bone sclerosis and narrowing of the glenohumeral joint space, but with little or no osteophytosis (Fig. 1). These changes may stabilize or show minimal cartilage erosions for several years, followed by sudden deterioration in a dramatic fashion (Figs. 2–4). The bones on both sides of the joint are severely damaged, with extension into the undersurface of the acromion, the coracoid process, and the distal clavicle (Figs. 5, 6). Pseudoarthrosis between the humeral head, coracoid, and acromion is common. In the knees, the lateral femorotibial compartment is involved in 39%, and the medial femorotibial compartment in 31%, with joint space narrowing, subchondral bone sclerosis, and erosion, but with little or no osteophytosis.

In one of our patients, calcifications were deposited in the suprapatellar soft tissue of both knees. These calcifications induced inflammatory changes in the adjacent soft tissue and resolved over a period of 1 year. Other involved joints also show atrophic and destructive features [6].

RDA of the shoulder usually occurs without known precipitating factors. In 25% of cases, it is preceded by overuse or trauma, including recurrent subluxation, a fall on outstretched hands, professional wrestling, jackhammer operation, or a motor vehicle accident [9]. The patient in case 4 suffered anterior subluxation of the humeral head, and the patient in case 2 had fallen on his outstretched hands.

Radiologically, RDA may mimic other destructive arthritides of the shoulder, including neuropathic arthropathy, pyrophosphate arthropathy, dialysis arthropathy, rheumatoid arthritis and infectious arthritis. Early radiographic changes in neuropathic arthropathy resemble those of osteoarthritis with subchondral bone sclerosis, joint space narrowing, and osteophytosis. Later, persistent joint effusion and fractures and fragmentation of articular bones with osseous debris point to the possibility of neuropathic arthropathy. Syringomyelia is a leading cause of neuropathic arthropathy of the shoulder. The neuropathic form of pyrophosphate arthropathy is associated with rapid and marked subchondral bone collapse

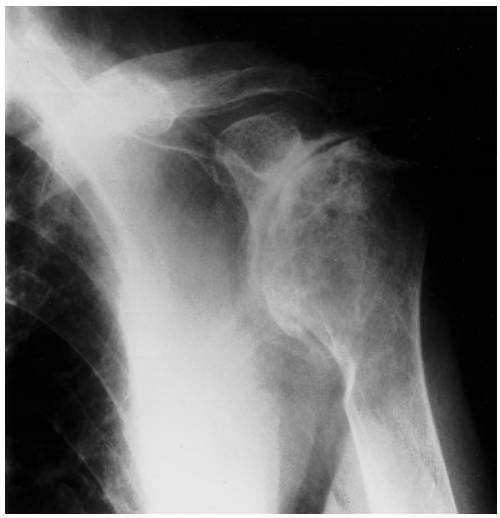


Fig. 1 Case 1: a 50-year-old woman. Left shoulder radiograph showing erosion of the humeral head and the humeral shaft with narrowing of the gleno-humeral joint space

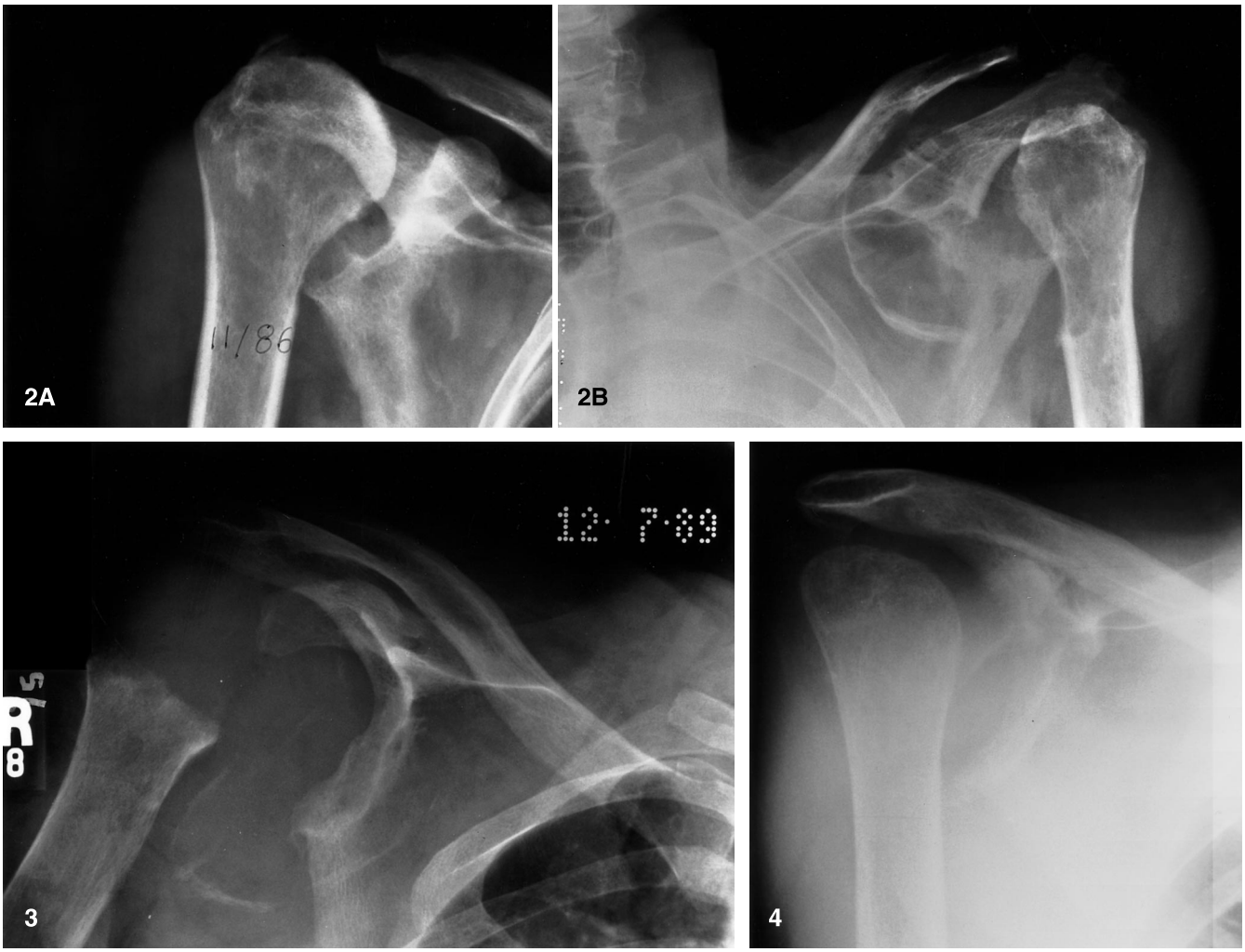
and fragmentation and the appearance of intra-articular osseous bodies. In contrast to the hypertrophic changes of pyrophosphate arthropathy, RDA is usually associated with atrophic destructive bony changes with little or no osteophytosis [7]. In 20–30% of long-term dialysis patients, erosive arthropathy develops [42]. Destructive changes affect the spine, small and large peripheral joints, including shoulder, hip, knee, and wrist. In the shoulder joint, early articular lesion usually involves the lateral superior aspect of the humeral head, and these changes are usually associated with radiolucencies in the humeral head [43, 44]. In later stages, extensive atrophic destructive changes of the glenohumeral joint may develop, simulating RDA. The pathophysiology of dialysis arthropathy is probably multifactorial. Amyloid β_2-microglobulin deposits, crystal deposition, aluminum, and secondary hyperparathyroidism are potential factors [44].

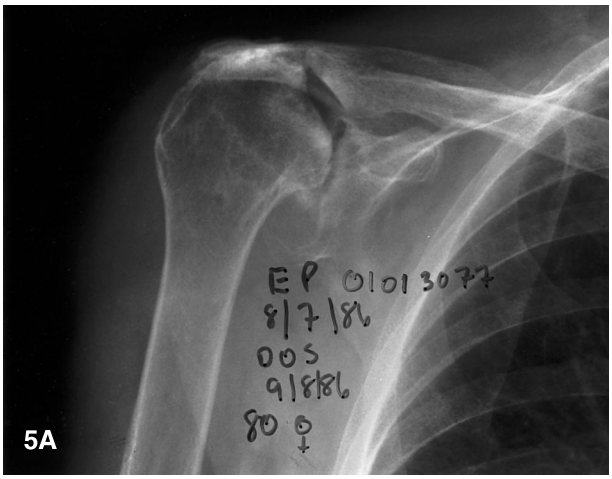
The patient with rheumatoid arthritis may present with pain, tenderness and restricted motion of the shoulders, joint effusion, and subacromial bursitis. Diffuse loss of the glenohumeral joint space will develop secondary to progressive destruction of humeral subchondral bone and glenoid cavity. Opposing contact surfaces of the humerus and glenoid may develop secondary osteoarthritic changes. Erosive lesions caused by inflamed synovial tissues involve both the glenoid and the humerus, especially on the superior lateral aspect of the humeral head with deformity, flattening of the articular surface,

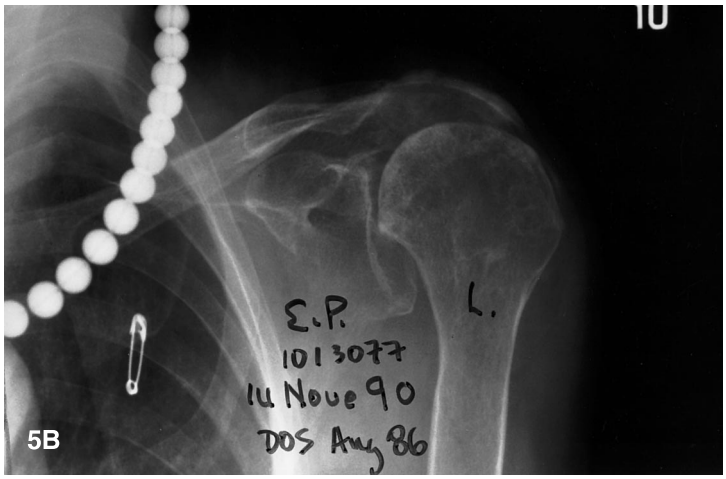
Fig. 2A, B Case 2: a 55-year-old man. **A** Right shoulder radiograph showing upward displacement of the humeral head with mild subchondral and medial metaphyseal erosion. Destructive lesions of the glenoid cavity and distal clavicle are present. **B** Left shoulder radiograph showing marked destruction of the humeral metaphysis and humeral head. Destructive changes of the distal clavicle and erosion of the glenoid are seen. Note calcification of the joint capsule and joint effusion. Three years earlier, the patient had mild osteoarthritic changes of the glenohumeral joints

Fig. 3 Case 3: a 72-year-old woman. Right shoulder radiograph showing osteolysis of the humeral head, destruction of the glenoid, and curvilinear calcification of the distended capsule. Approximately 3 years earlier, this shoulder was radiographically normal

Fig. 4 Case 4: a 67-year-old man. Right shoulder radiograph showing marked destruction of the humeral head and the glenoid







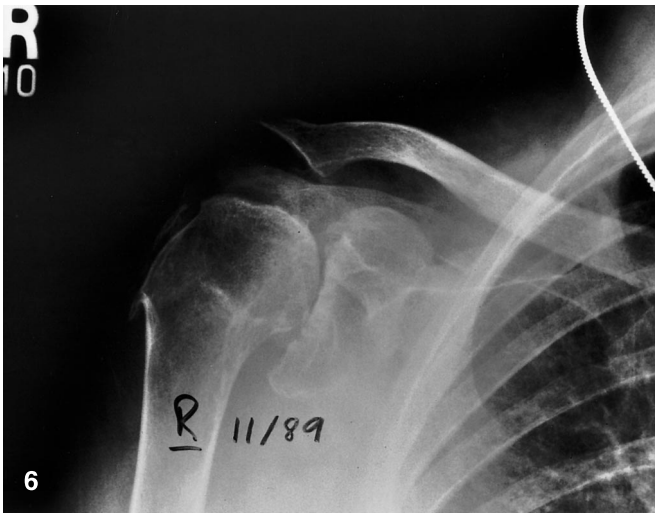


Fig. 5A, B Case 5: a 80-year-old woman. **A** Right shoulder radiograph showing erosion of the glenoid and high riding of the eroded humeral head. Note pseudarthrosis between the humeral head, the acromion, and the clavicle. **B** Left shoulder radiograph showing mild erosion of the glenoid, the humeral metaphysis, and upward displacement of the eroded humeral head. Contour defects of the distal clavicle and acromion are present

Fig. 6 Case 6: a 68-year-old woman. Right radiograph showing erosion of the glenoid and upward displacement of the eroded humeral head. Contour defect of the distal clavicle is present. Note an oblong ossified body lateral to the humeral head

and rupture of the rotator cuff at a later stage. The diffuse joint space involvement and the clinical and immunological information help one to arrive at the correct diagnosis. Septic arthritis of the shoulder is uncommon in the elderly in a previously normal joint. It may be associated with gross destruction of cartilage and articular bone, and eventually fibrous or bony ankylosis.

RDA of the shoulder is a fascinating form of destructive arthritis which bears resemblance to neuropathic and neuropathic-like arthropathies. This arthropathy is remarkable for its radiographic features, which are destructive and atrophic, and its clinical manifestation, which is more or less distinctive. Further studies are needed for the elucidation of its mysterious etiology and pathogenesis.

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