



Rapidly destructive arthropathy of shoulder joint

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Background: Rapidly destructive arthropathy (RDA) of the shoulder is rare. Consequently, there are very few studies that have reported the characteristic findings of this disease. This study aimed to analyze the clinical, radiographic, and histologic features of patients with RDA of the shoulder.

Methods: In total, 9 cases (8 patients) were enrolled in this study. All patients were elderly women, with a mean age of 72.7 years (range, 57–78 years). The mean duration of symptoms was 4.1 months (range, 1.2–5.9 months). Reverse total shoulder arthroplasty and total shoulder arthroplasty were performed in 5 cases with massive rotator cuff tears and 4 without them, respectively.

Results: The mean duration of radiologically evident joint destruction after negative results on radiography was 3.1 months (range, 1.0–5.9 months). On plain radiography, humeral head flattening and collapse that appeared like cut grass were observed (100%). Relatively good preservation of the glenoid with a normal joint space was observed in 7 cases, whereas glenoid erosion was observed in 2 (22.2%). T1-weighted magnetic resonance imaging showed a subchondral fracture (100%) of low signal intensity with associated bone marrow edema. Histologically, chronic inflammation of the synovium and osteocytes in the lacunae, as well as callus formation, were observed along the subchondral fracture.

Conclusion: Flattening and collapse of the humeral head within an average of 4 months of symptom onset are characteristic of RDA of the shoulder. Bone marrow edema, joint effusion, and subchondral fracture on magnetic resonance imaging and fracture fragments and callus formation on histopathologic analysis were observed. Glenoid erosion was observed in 2 cases with arthrosis progression.

Level of evidence: Level IV; Cases Series; Treatment Study

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In 1970, Lequesne¹² reported unexpected rapidly destructive disease of the hip joint; since then, case reports on rapidly destructive arthropathy (RDA) of the hip joint have been frequently published.^{1,22} Paolaggi and Le Parc¹⁶ reported RDA of the shoulder joint for the first time in 1982, and Tokuya et al²² published a case report on subchondral insufficiency fracture of the humeral head and

glenoid in a patient with rapidly destructive arthrosis. However, RDA of the shoulder joint has rarely been reported compared with that of the hip joint.

Campion et al⁴ previously reported that idiopathic destructive arthritis of the shoulder is predominantly observed in elderly women, with clinical features of blood-stained effusion, rotator cuff rupture, and restriction of shoulder movements. Nguyen¹⁵ highlighted that rapidly destructive arthritis of the shoulder was also known as hemorrhagic shoulder of the elderly, Milwaukee shoulder syndrome (MSS), rapid destructive arthritis, apatite-associated arthritis, and idiopathic destructive arthritis. Furthermore, it has been reported that additional symptoms of joint instability, mild inflammation, and basic calcium phosphate crystals are observed. However, there have been very few reported cases of RDA, and therefore, they have not been evaluated in detail. Because of the unclear pathogenesis and clinical features of RDA, the diagnosis of this condition is difficult for many clinicians.

Postel and Kerboul¹⁹ defined rapid destruction as greater than 2 mm or 50% joint space narrowing in 1 year. Kekatpure et al⁹ analyzed 9 cases of rapid destruction of the humeral head in patients monitored with serial radiographs within 6 months of the initial symptoms, and they reported that destruction of the humeral head within 6 months of the initial symptoms and humeral head collapse with a unique pattern were clinical features of rapidly destructive arthrosis. Furthermore, pathologic findings of bone fragmentation and regeneration were observed in these patients. However, in that case series, patients with a history of shoulder surgery were not excluded.

Kekatpure et al⁹ reported no complications during the early or late postoperative period after total shoulder arthroplasty (SA) in patients with rapidly destructive arthrosis of the shoulder, although they did not mention the clinical outcomes. Overall, although either total SA or reverse total SA was performed in patients with rapidly progressive destructive arthrosis of the shoulder in the previous studies, none of these studies reported their clinical outcomes.

The purpose of this study was to analyze the characteristic clinical, radiographic, and histologic features of patients with RDA of the shoulder to differentiate it from MSS and osteonecrosis of the humeral head, such as in other destructive diseases, as well as to analyze the clinical outcomes following SA.

Materials and methods

Patient selection and methods

Informed consent was obtained from all participants. The cases of all patients who underwent SA performed by a single surgeon, including total shoulder and reverse SA, at our institution between August 2007 and August 2018 were retrospectively reviewed.

The inclusion criteria for this study were as follows: rapid destruction of the humeral head on plain radiography within 6 months of the onset of the initial symptoms and available magnetic resonance imaging (MRI) data during the same time points. Patients with a history of trauma, arthroscopic rotator cuff surgical procedures, rheumatoid arthritis, septic arthritis, avascular necrosis, neuropathic osteoarthropathy, or crystal arthropathy and patients with no initial plain radiography were excluded. During the study period, 391 patients underwent SA; of these patients, 8 were included in this study according to the inclusion and exclusion criteria.

Preoperative, intraoperative, and postoperative evaluations

Previous outpatient medical records were used to gather the following data: dominant arm; time of initial symptoms; and history of trauma, injection (needle-based) therapy, surgery, comorbidities, alcohol abuse, and steroid intake. Postoperative evaluations were performed in the outpatient department by analyzing outcomes at last follow-up. The visual analog scale (VAS) pain score was calculated the day before surgery and at last follow-up. In addition, shoulder range of motion, including forward flexion, external rotation at the side (ERs), and internal rotation posteriorly (IRp), was measured. For clinical outcomes, the Constant score and Shoulder Rating Scale of the University of California at Los Angeles (UCLA) score were evaluated on the day before surgery and at last follow-up.

Laboratory evaluation

To assess the possibility of infections, the preoperative differential white blood cell (WBC) count, erythrocyte sedimentation rate (ESR), and C-reactive protein (CRP) level were evaluated. In addition, intraoperative samples were sent for culture. To differentiate from rheumatoid arthritis, rheumatoid factor was evaluated. Finally, the presence of crystals was assessed for via microscopic evaluation of the joint fluid under polarized light.

Radiologic evaluation

Destruction of the humeral head and joint space narrowing were evaluated on preoperative serial plain radiographs. In addition, MRI was used for the assessment of the following: features of the humeral head, rotator cuff tears, joint effusion, and bone marrow edema. Bone marrow density was assessed to identify osteoporosis. Finally, postoperative follow-up radiographs were evaluated for the development of complications.

Histologic evaluation

Histologic evaluation of the resected specimens of the head of the humerus was performed to evaluate the following: osteonecrosis, acute or chronic inflammation, subchondral fracture, bone matrix regeneration, and the presence of crystals.

Table I Basic demographic data of patients

Case No.	Sex/age, yr	Laterality	Comorbidity	BMI, kg/m ²	Osteoporosis
1	F/57	R	Hypertension	21.6	No; osteopenia
2	F/78	R	Hypertension	22.8	Yes
3	F/76	R	Hypertension	19.4	Yes
4	F/66	L	Breast cancer	22.6	Yes
5	F/78	R	None	20.4	Yes
6/7*	F/76	R/L	Hypertension	30.3	Yes
8	F/71	L	None	25.6	Yes
9	F/77	R	Hypertension	23.1	No; osteopenia

BMI, body mass index; F, female; R, right; L, left.

* Cases 6 and 7 are the same patient with different sides affected.

Operative techniques

All surgical procedures were performed by a senior author according to the standard protocol, using the deltopectoral approach, with the patient in the 60° beach-chair position. On the basis of the integrity of the rotator cuff, reverse total SA was performed in 6 of 9 cases. The Aequalis system (Tornier, Montbonnot-Saint-Martin, France) and Equinoxe system (Exactech, Gainesville, FL, USA) were used (3 cases each). Total SA was performed in the remaining 3 cases, and the Aequalis system was used.

Postoperative rehabilitation

All patients underwent our standard rehabilitation program. Postoperatively, the shoulder was immobilized with a sling for 4 weeks, except when patients were exercising. The patients started passive pendulum exercises and passive forward flexion the day after surgery and active-assisted exercises in the fourth postoperative week within tolerable ranges. Muscle-strengthening exercises were initiated 3 months after surgery.

Statistical analysis

The Wilcoxon signed rank test was performed to compare the differences between the preoperative and postoperative data. Statistical significance was set at .05 with 95% confidence intervals. The SPSS software package (version 21.0; IBM, Armonk, NY, USA) was used for statistical analysis.

Results

A total of 9 cases (8 patients) in which SA was performed for RDA were included in this study. All patients were women (Table I). The mean age at the time of surgery was 72.7 years (range, 57-78 years), and the mean body mass index was 24 kg/m² (range, 19.4-30.3 kg/m²). None of the patients had a history of trauma or arthroscopic surgical procedures on the rotator cuff. The comorbidities included hypertension in 5 cases and breast cancer in 1, and there were no other significant medical histories. Similarly, none of the patients had a history of alcohol abuse, systemic steroid therapy, or injection therapy. The mean

duration from the onset of initial symptoms until humeral head destruction, as observed on serial plain radiographs, was 3.1 months (range, 1.0-5.9 months). The right shoulder (dominant) and left shoulder were affected in 6 and 3 cases, respectively, and both were involved in 1 case (11.1%). There were no cases in which joints other than the glenohumeral joint were affected.

Clinical findings

All patients complained of severe pain in the affected shoulder with a mean VAS score of 7.4 ± 1.1 during active motion. The VAS score at rest was 1.6 ± 1.3, with a mean pain duration of 4.1 months. The mean preoperative UCLA score and Constant score were 11.1 ± 3.4 and 20.8 ± 7.5, respectively. Pseudoparalysis was observed in 5 cases. The mean preoperative values for forward flexion, ERs, IRp, and abduction were 84.3° ± 27.6°, 14.3° ± 9.8°, 14.3° ± 13.1, and 92.9° ± 12.5°, respectively. The mean preoperative values for muscle strength for forward flexion, external rotation, internal rotation, and abduction were 2.0 ± 0.8 kg, 3.9 ± 0.6 kg, 5.5 ± 1.3 kg, and 2.6 ± 1.0 kg, respectively.

All the patients underwent SA; 4 underwent total SA, and the remaining 5 underwent reverse total SA. Total SA was performed if the patient had an intact rotator cuff or partial (small) tear of the rotator cuff, whereas reverse total SA was performed in cases of massive rotator cuff tears on the basis of the DeOrto and Cofield classification.¹

The mean follow-up period was 62.1 months (range, 13.5-125.3 months). The mean VAS scores during motion and at rest at final follow-up were 1.3 ± 0.9 ($P = .011$) and 0.1 ± 0.4 ($P = .026$), respectively, which were significant improvements over the respective preoperative values. Similarly, the mean UCLA and Constant scores improved postoperatively to 31.1 ± 1.4 ($P = .012$) and 86.0 ± 3.9 ($P = .012$), respectively. Mean range of motion for forward flexion, ERs, and abduction significantly improved to 149.4° ± 6.8°, 41.3° ± 11.2°, and 111.3° ± 14.6°, respectively ($P = .018$, $P = .017$, and $P = .045$, respectively). IRp also improved to a mean postoperative value of

Table II Preoperative laboratory findings

Case No.	WBC count, μL	ESR, mm/h	CRP level, mg/L	RF	Culture
1	6330	12	<0.5	Negative	No growth
2	7590	13	<0.5	Negative	No growth
3	4830	5	<0.5	Negative	No growth
4	7770	13	<0.5	Negative	No growth
5	6930	7	<0.5	Negative	No growth
6/7*	8920/5620	23/11	<0.5/<0.5	Negative	No growth
8	7930	20	<0.5	Negative	No growth
9	9820	17	<0.5	Negative	No growth

WBC, white blood cell; ESR, erythrocyte sedimentation rate; CRP, C-reactive protein; RF, rheumatoid factor.

* Cases 6 and 7 are the same patient with different sides affected.

T12.6 \pm T3.3; however, the difference was not statistically significant ($P = .141$). Likewise, mean muscle strength for forward flexion, external rotation, internal rotation, and abduction improved postoperatively to 8.3 \pm 2.1 kg, 8.3 \pm 1.6 kg, 8.9 \pm 2.2 kg, and 8.4 \pm 2.2 kg, respectively, although the differences were not statistically significant ($P = .066$, $P = .066$, $P = .144$, and $P = .066$, respectively).

No progression of bony destruction occurred in any of the patients at final follow-up. The humeral and glenoid components showed no evidence of loosening or osteolysis, with no component migration or radiolucent lines. One case of periprosthetic fracture was observed 8 years 4 months after SA, due to direct trauma from the operation. This patient underwent open reduction–internal fixation, which resulted in an observation of bone union through follow-up plain radiographs at 9 months postoperatively.

Laboratory findings

The mean preoperative WBC count (7300/ μL ; normal range, 4000–10,000/ μL), ESR (13.4 mm/h; normal range, 0–20 mm/h), and serum CRP level (<0.5 mg/L; normal range, 0 to <0.5 mg/L) were within the respective normal ranges (Table II). In addition, no bacterial growth in the intraoperative joint fluid culture was observed. Rheumatoid factor was negative in all patients.

Radiologic findings

On plain radiographs obtained immediately after the initial symptoms, the humeral head was stable without signs of destruction in all patients (Fig. 1, A). However, serial plain radiographs obtained within an average of 3.1 months of the initial symptoms revealed that the articular surface of the humeral head had collapsed and flattened and subchondral sclerosis became evident (Fig. 1, B). Collapse and flattening of the humeral head were observed, with small, scattered osseous fragmentation near the humeral head. Although the glenoid and joint space were relatively preserved in most cases, there were 2 cases of glenoid bone

destruction and joint space narrowing that also had severe progression of humeral head collapse (Fig. 2). Preoperative radiographs for all cases are presented in Supplementary Figures S1–S9.

MRI revealed extensive joint effusion and bone marrow edema in the humeral head in all 9 cases. In addition, we observed a case of a subchondral fracture characterized by the bone plate under the articular surface of the humeral head that showed low signal intensity with a serpiginous pattern on T1-weighted imaging and high signal intensity on T2-weighted imaging. Ill-defined marrow edema extended to the metaphysis of the humerus (Fig. 3). Furthermore, numerous fine fragments of the glenohumeral joint were observed, along with synovial debris. The associated findings included full-thickness rotator cuff tears in 5 cases, tendinosis of the supraspinatus in 1, partial tears in 2, and a small rotator cuff tear in 1. There were no marked marginal osteophytes on the humeral head. On plain radiography, glenoid destruction was not observed in 7 cases, except for mild arthritis. In terms of bone mineral density, 7 patients had osteoporosis and 2 had osteopenia (Table I).

Operative findings

The humeral heads were collapsed, and in most cases, the articular surfaces were flat. The resected humeral heads exhibited detachment of the articular cartilage, and fibrous tissues were partially observed. In cases of severe destruction, the entire articular surface was covered by fibrotic tissue.

Histologic findings

Histologically, the resected humeral heads showed the following: (1) lack of or thin articular cartilage and extensive fibrosis; (2) acute-on-chronic or chronic inflammation in the synovium and bone; (3) lacunar osteocytes; and (4) subchondral fracture fragments, as well as formation of new bone. Other pathologic abnormalities such as crystal depositions or osteonecrosis were not observed, and there was no evidence of sepsis in any of the specimens (Fig. 4).

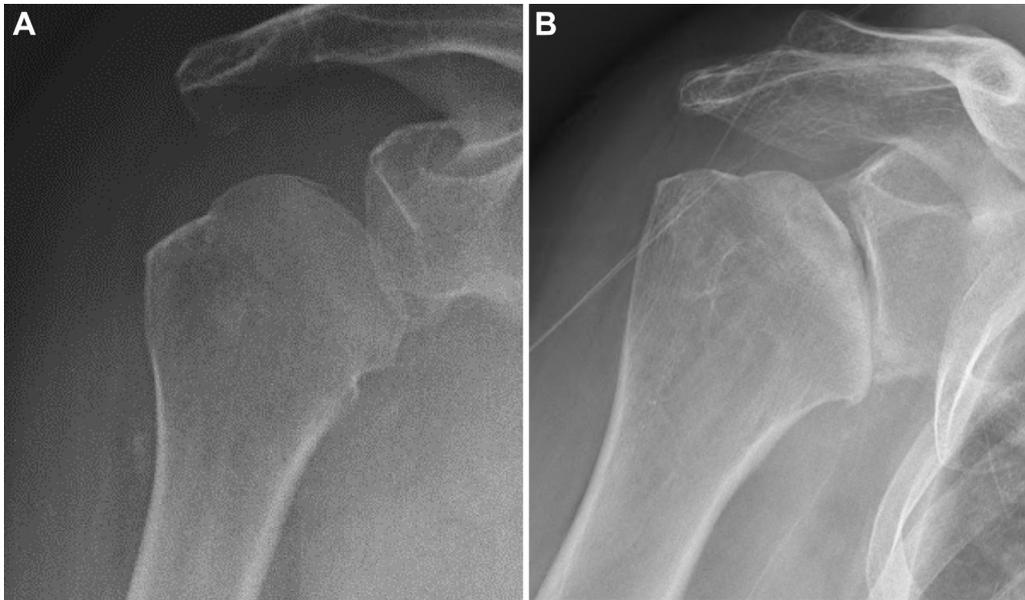


Figure 1 Serial preoperative radiographs of a 76-year-old female patient. (A) At the first visit, the humeral head showed no collapse. (B) Five weeks later, collapse of the humeral head had progressed.

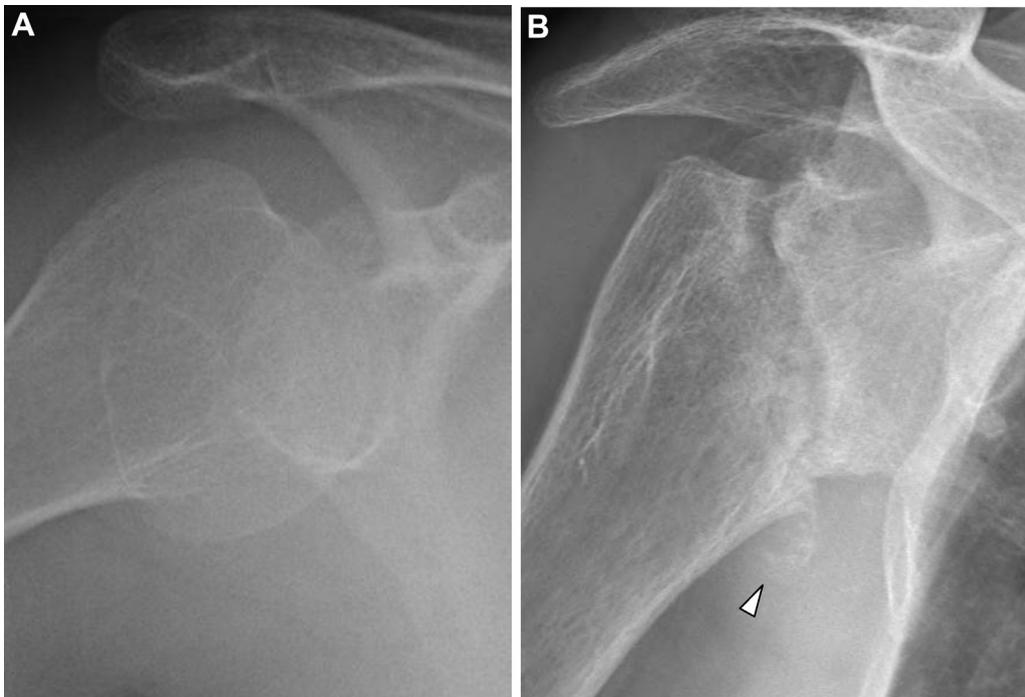


Figure 2 Severe bone destruction of the glenoid and scattered osseous fragments (*arrowhead*) around the joint in a 78-year-old female patient. (A) On the initial plain radiograph, initial collapse of the humeral head was observed but clear bone destruction was not observed. (B) Plain radiograph obtained 5.1 months after initial symptoms.

Discussion

Bock et al² retrospectively reviewed the cases of 23 patients with a mean age of 72 years with rapidly destructive hip disease and reported that the duration of symptoms ranged between 1 and 6 months and 74% of the patients were

women. Similarly, Kekatpure et al⁹ reported 9 cases of rapidly destructive arthrosis in the shoulder joint that occurred within 6 months, all patients in their study were women, and the mean age was 72 years. Consistent with these observations, all the patients in our study were elderly women and severe joint and bone destruction was observed

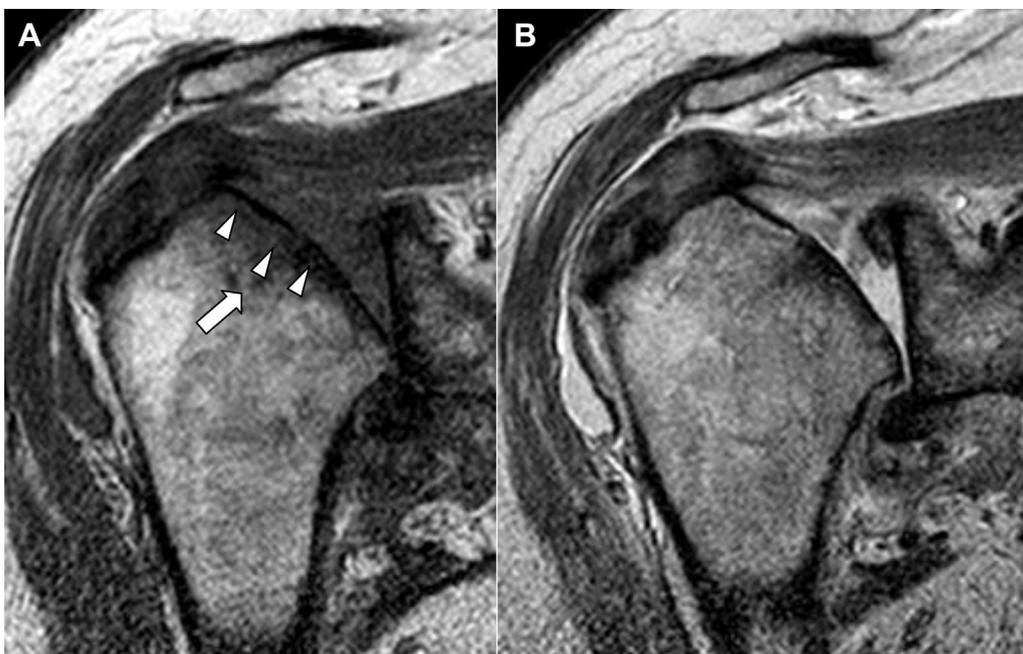


Figure 3 Magnetic resonance images in a 76-year-old female patient. (A) The T1-weighted coronal magnetic resonance image obtained 6 weeks after the onset of shoulder pain showed a bone marrow edema pattern in the humeral head. One should note the diffuse low signal intensity with associated serpiginous irregular (*arrow*), very low-signal intensity bands (*arrowheads*). (B) The T2-weighted coronal magnetic resonance image showed diffuse high signal intensity in the same area with the collapse of the humeral head and an intact rotator cuff.

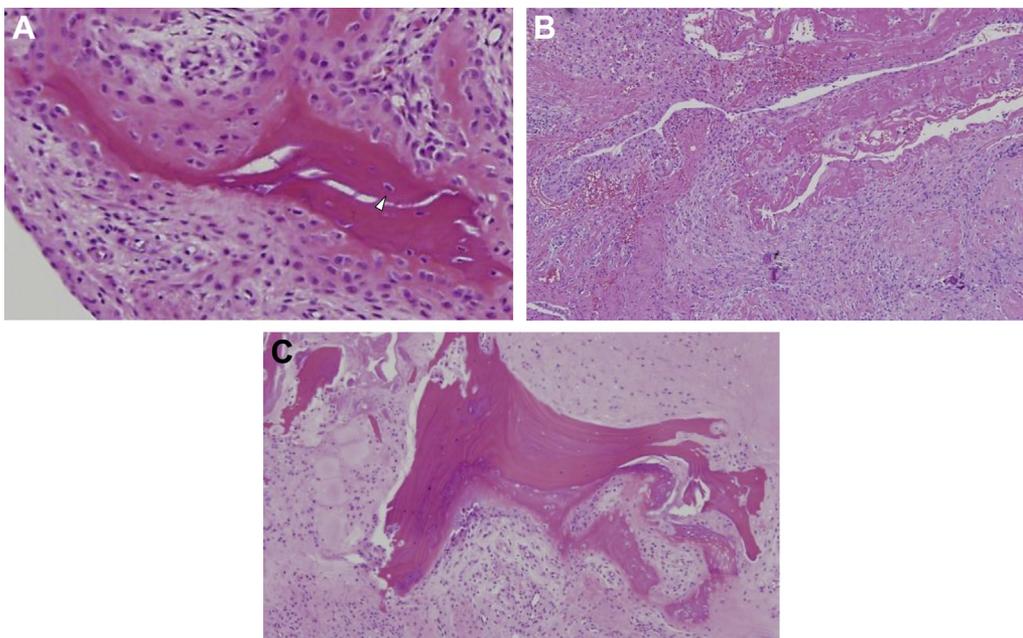


Figure 4 Histologic findings in a 71-year-old female patient (hematoxylin and eosin stain, original magnification x100). (A) Osteocytes were observed within the lacunae (*arrowhead*), and new bone formation, indicated by the osteoblasts, was observed surrounding the bone. (B) Chronic inflammation, indicated by the neutrophils, was observed. (C) Extensive fibrosis was observed.

on both serial plain radiography and serial MRI follow-up assessments that were performed within 6 months of the onset of the initial symptoms.

Shu et al²¹ reported that femoral head lucency and flattening, as well as articular joint space loss, were

observed in patients with rapidly progressive destructive arthritis of the hip, which was followed by complete destruction of the femoral head and erosion of the acetabulum within 5 months. Kekatpure et al⁹ observed complete destruction of the humeral head with a chopped pattern on

plain radiography in patients with rapidly destructive arthrosis of the shoulder. In our study, although no abnormal findings were observed on plain radiography immediately after the onset of the initial symptoms, serial follow-up examinations revealed a flattened humeral head and subchondral sclerosis. In severe cases, complete destruction of the humeral head in a cut-grass pattern, as well as tiny bone fragments around the narrowing joint space, was observed. Although the glenoid was preserved in most cases, there were 2 cases of glenoid bone destruction that accompanied the severe progression of humeral head collapse (about 5.1 and 5.8 months after symptom onset).

Mavrogenis et al¹³ suggested early MRI assessment for early diagnosis of rapidly destructive arthritis of the hip. In addition, they suggested that the subchondral fracture could be diagnosed by the hypointense, band-like lesion surrounded by extensive bone marrow edema near the articular surface. Flemming and Gustas-French⁶ showed that the MRI findings were similar in rapidly destructive osteoarthritis of the hip and shoulder, with large effusion and synovitis always being observed. Furthermore, bone marrow edema was more pronounced in the humeral head than in the glenoid, and subchondral insufficiency fracture was observed in the humeral head. Similarly, in our study, extensive joint effusion on MRI and marrow edema in the humeral head were observed in all cases. Glenoid arthritis was mild in most cases; however, it was severe in 2 cases with extensive progression of humeral head destruction.

Kekatpure et al⁹ reported that rotator cuff tendinosis and tear were observed in 22% and 78% of their rapidly destructive shoulder arthrosis cases, respectively. Massive tears occurred in 33% of the cases, although they were not chronic massive rotator cuff tears based on the evaluation of fatty degeneration. In our study, rotator cuff tendinosis was observed in 11% of the cases and pseudoparalysis and irreparable massive rotator cuff tears due to fatty degeneration were observed in 44%.

Mavrogenis et al¹³ observed extensive fibrosis of the joint capsule, disappearance of the cartilage, mild acute or chronic inflammation of the synovium, bone resorption by osteoclasts, and focal loci of osteonecrosis in the histologic sections of patients with rapidly destructive arthritis of the hip. The patients with advanced rapidly destructive arthritis demonstrated fragmented bone or cartilage debris in their bone marrow. Tokuya et al²² reported that the histologic features of rapidly destructive arthrosis of the humeral head included fragmented bone trabeculae, increased osteoclasts, and fracture callus formation. Similarly, in our study, subchondral fracture fragments, new bone formation, and osteocytes in the callus and lacunae were observed, indicating acute-on-chronic inflammation of the synovium or chronic inflammation.

RDA does not respond well to conservative treatment,^{17,23} and the treatment of choice is arthroplasty.^{9,13,21}

Flemming and Gustas-French⁶ suggested that patients with rapidly destructive osteoarthritis of the hip should undergo joint replacement before bone destruction of the acetabulum progresses in order to minimize the duration and complexity of the surgical procedure. In our study, severe progression of glenoid bone destruction was observed in 2 cases (22.2%). Therefore, it is important to differentiate RDA from other conditions that can cause RDA, such as MSS, osteonecrosis of the humeral head, septic arthritis, and rheumatoid arthritis, and to perform arthroplasty.¹⁸ The patients were screened for septic arthritis and rheumatoid arthritis using laboratory tests, including serologic markers (WBC count, ESR, and CRP level) and intraoperative culture tests. None of the patients fulfilled the diagnostic criteria for rheumatoid arthritis.

Dewachter et al⁵ reported that MSS occurs in elderly women, along with RDA, with characteristic rapid destruction of the glenohumeral joint and rotator cuff and noninflammatory joint effusion containing hydroxyapatite crystals. Nadarajah and Weichert¹⁴ reported that the characteristic findings included extensive cartilage calcification and diffuse intra-articular and capsular calcification that were observed on plain radiographs in patients with MSS. Santiago et al²⁰ suggested that MSS could be diagnosed on the basis of observation of calcium hydroxyapatite crystals via arthrocentesis. In our study, although tiny bone fragments were observed on plain radiographs, massive intra-articular calcification was not observed. In addition, hydroxyapatite crystals were not observed on joint fluid analyses.

Osteonecrosis of the humeral head is more common in male individuals and occurs more frequently in a relatively younger population (20-40 years),^{3,17} the most frequent cause being corticosteroid therapy.⁷ Hernigou et al⁸ reported that the mean durations between diagnosis and collapse in symptomatic stages 1 and 2 of osteonecrosis are 10 years and 3 years, respectively. Pivec et al¹⁷ reported that subchondral fracture can be observed via radiographic findings at the final stage of osteonecrosis. Complete destruction of the humeral head was not detected even at stage 4. The histopathologic signs of osteonecrosis include thinning of the trabeculae, empty Howship lacunae, and hematopoietic cell deficiency. Kim et al¹⁰ demonstrated that rapid progressive osteonecrosis of the humeral head could occur after arthroscopic rotator cuff repair, although it was rarely observed. Kekatpure et al⁹ noted that 1 of their 9 cases with rapid destruction of the humeral head involved a patient who had previously undergone arthroscopic rotator cuff repair. In our study, the mean age of patients at surgery was 72.7 years, which is higher than that of patients with osteonecrosis, and all patients were women. The crescent sign was recognized on initial plain radiography, which was performed within a month of initial symptom onset, and destruction of the humeral head occurred within 6 months of initial symptom onset. Both histologic findings (osteocytes in lacunae and callus formation) were present.

Furthermore, patients with a history of shoulder surgery were excluded from this study.

Yuasa et al²⁴ compared the midterm outcomes in 12 cases of rapidly destructive coxarthrosis of the hip and osteoarthritis after total hip arthroplasty; both groups demonstrated significantly improved clinical outcomes without any significant difference between the 2 groups. Kuo et al¹¹ reported good clinical and radiographic outcomes in patients with rapidly destructive osteoarthritis of the hip with a mean follow-up period of 6 years. Kekatpure et al⁹ reported that in their cohort of patients with rapidly destructive arthrosis of the shoulder with a mean follow-up period of 27.5 months after total SA, there were no post-operative clinical and radiologic complications. However, objective indices such as clinical scores, range of motion, and muscle strength were not evaluated. In our study, the clinical outcomes were assessed using the VAS score, Constant score, UCLA score, range of motion, and muscle strength; all of these outcomes exhibited significant improvements postoperatively.

Despite our interesting findings, there are a few limitations to this study. First, the number of patients in our cohort was relatively small. Second, because of the retrospective design of the study, it was difficult to understand the natural course of the disease. Third, bone turnover markers were not evaluated, and therefore, the pathogenesis of RDA could not be evaluated either. Fourth, glenoid destruction was observed in 2 cases but extra research about its cause was not conducted. Nonetheless, RDA is a rare disease, and there are few previous studies that have evaluated multiple patients and provided data on differentiating RDA from other diagnoses with similar characteristics.

Conclusion

The characteristic features of RDA of the shoulder include flattening of the humeral head within 6 months of the onset of the initial symptoms, along with collapse as the condition progresses. In elderly women with shoulder pain as the main symptom without abnormal findings on initial plain radiographs, it would help to recommend serial plain radiographic imaging with RDA as a differential diagnosis. If sclerosis or flattening of the humeral head is observed on plain radiography, early MRI and serologic marker tests should be performed to evaluate bone marrow edema or subchondral fracture and to rule out other diagnoses (MSS, osteonecrosis, septic arthritis, and rheumatoid arthritis), respectively, before therapeutic decisions are made. Common pathologic findings include both subchondral fracture fragments and new bone formation. Glenoid destruction can be seen in rare cases of severe progression of humeral head destruction in patients with RDA of the shoulder joint. SA should be performed as early as possible in these patients.

Disclaimer

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Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.jse.2019.04.035>.

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