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Osteochondritis dissecans of the glenoid: an analysis of grades, treatment, and outcomes

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Background: Osteochondritis dissecans (OCD) is an idiopathic disorder of subchondral bone that causes focal articular cartilage disruption with the potential long-term consequence of premature osteoarthritis. Glenoid OCD is exceedingly rare. This case series aims to identify the grades of glenoid OCD and report its grade-specific treatment with clinical, radiological, and functional outcomes.

Methods: Prospectively collected data of consecutive patients diagnosed with a symptomatic glenoid OCD, who had a minimum 2-year follow-up, following nonoperative or surgical treatment, was retrospectively analyzed. Osteochondral defects secondary to acute trauma, instability, and primary osteoarthritis were excluded. Pretreatment and posttreatment clinical, radiological, and sports participation data were collected. This included pretreatment MRI for grading of glenoid OCD according to the International Cartilage Research Society (ICRS) OCD staging system, and postoperative MRI for grading of articular cartilage repair using the MOCART (MRI observation of cartilage repair tissue) scoring system.

Results: The study identified 7 competitive overhead athletes with symptomatic unilateral glenoid OCD, with a post-treatment minimum 2-year follow-up. Of 4 patients with ICRS OCD I, 3 healed with nonoperative treatment, whereas 1 progressed to ICRS OCD II. This patient along with another 3 patients with unstable glenoid OCD underwent arthroscopic OCD excision with bone marrow stimulation cartilage repair. All patients improved following treatment and had full passive and active range of shoulder movements, with normal strength and stability at the 2- year follow-up. The mean MOCART score on MRI at 2 years for the 4 patients who underwent surgery was 82.5 (range, 75-90). MRI documented healing in all 3 patients with ICRS OCD I who underwent nonoperative treatment. All patients returned to the same or higher level of sport following treatment, with mean time to return to sports being 8.0 months (range, 6-11 months) for nonoperative treatment, and 6.8 months (range, 5-10 months) for operative treatment. This difference was not statistically significant (*P* value .55). No patient had recurrence of symptoms till latest follow-up.

Conclusion: Despite the glenoid being a concave non–weight-bearing articular surface, OCD at this site has pathological grades similar to other convex weight-bearing articular surfaces. Notwithstanding the limited number of cases, it would appear that ICRS OCD I can often be successfully treated with nonoperative treatment, whereas ICRS OCD II, III, IV, warrant operative treatment. Bone marrow stimulation is a safe and predictable option for glenoid OCD cartilage repair and allows athletes a quick and successful return to sports.

Osteochondritis dissecans (OCD) is an idiopathic disorder of subchondral bone that causes focal articular cartilage disruption or separation with the potential long-term consequence of premature osteoarthritis.[2,34] Glenoid OCD is rare. Only 1.6% of OCDs between the ages of 6 to 19 years occur in the shoulder joint, and of these, humeral head OCD is more common than glenoid OCD.[25] Reported almost exclusively in male overhead athletes as individual case reports,[1,5,8,11,15,18,21,26,37] these lesions have been treated with

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microfracture,[15] arthroscopic drilling,[5,8] fixation using autogenous osteochondral plugs,[37] and in situ suture anchor fixation following undersurface debridement using a trapdoor technique.[11] There is only one case reported in the literature that demonstrates a healed OCD lesion of the glenoid following nonoperative treatment.[18] Being distinctly uncommon, the natural history and grades of glenoid OCD has not been reported, there is no consensus for its management, and the prognosis with regards to return to sport is unknown.

The etiology of OCD is poorly understood and is probably multifactorial.[12] The primary pathology involves a focal area of subchondral bone that is subjected to repetitive microtrauma and an ischemic insult. In the early stages the subchondral bone is stable, the overlying articular cartilage is structurally intact, and the disease may be amenable to reversal.[12] If the subchondral bone does not heal, the fragment ultimately becomes unstable, leading to disruption of the overlying articular cartilage. With further progression of the disease, the fragment completely separates and results in a loose body. OCD typically occurs in convex articular surfaces such as the femoral condyles, talar dome, and capitellum, and at these sites, the grades of disease progression and treatment are extensively researched and published.[4,6,12,17,28,36,38,40] Similar grades in glenoid OCD have not been reported. Moreover, since only isolated cases of glenoid OCD treatment have been reported, there is uncertainty whether different grades of OCD at this concave non–weight-bearing articular surface should be treated similar to OCD occurring elsewhere.[3]

Ambiguity exists in literature because many authors have used the terms “OCD” and osteochondral defect interchangeably,[3,41] despite the fact that these are distinctly diverse pathologies. OCD following repetitive microtrauma and ischemic insult to the subchondral bone needs to be differentiated from osteochondral defects secondary to acute trauma or recurrent shoulder instability where the primary insult occurs to the articular cartilage and is often associated with labral tears and loose osteochondral fracture fragments. The treatment for glenoid osteochondral defects secondary to acute trauma or instability is well accepted[2]; however, there is no case series that defines treatment of glenoid OCD.

With glenoid OCD being increasingly identified in competitive overhead athletes, this potentially sports career-ending condition needs further characterization. This case series aims to identify the grades of glenoid OCD and report its grade-specific treatment with clinical, radiological, and functional outcomes. We hypothesized that glenoid OCD has grades similar to those noted in convex articular surfaces and should be treated with the same principles of nonoperative treatment for stable OCD, whereas surgical treatment for the advanced unstable lesions.

Methods

Study design and patient selection

This study is a retrospective analysis of prospectively collected data of consecutive patients diagnosed with a glenoid OCD at our shoulder service from January 2010 through March 2018. This study was approved by the institutional review board of our hospital. The inclusion criteria were patients diagnosed with a symptomatic glenoid OCD, and who underwent nonoperative or surgical treatment for the same, with a minimum 2-year follow-up. Exclusion criteria included patients with acute traumatic osteochondral fractures, osteochondral defects associated with anterior or posterior shoulder instability, iatrogenic osteochondral defects secondary to prominent metallic suture anchors, osteochondral defects associated with glenohumeral osteoarthritis and synovial disease such as inflammatory arthropathy or synovial osteochondromatosis.

Data collection

Clinical

Each glenoid OCD patient’s demographic data, history, and clinical findings were noted. These included details of sports participation, history of acute trauma, nature of symptoms including pain and locking, duration of symptoms prior to seeking medical consultation, prior treatment undertaken, and detailed clinical examination findings.

Radiological

Magnetic resonance imaging (MRI) was performed in each patient, whereas plain radiography, and computed tomography (CT) was performed in selected cases. MRI was used for detecting early stage OCD lesions, delineate the size and location of the lesion, presence of joint effusion, condition of subchondral bone, and discontinuity of the articular cartilage over the OCD lesion. Several other imaging characteristics that have been associated with OCD were determined, including bone marrow edema deep to the lesion, fluid signal at the interface between normal bone and the lesion, hypointense linear signal deep to the fluid signal, and cartilage edema or thickening.[7,9,19,22,24,27,30,32,35,39,42] MRI was also used to identify potentially unstable OCD lesions by detecting the following features: an underlying fluid-filled cyst >5 mm or multiple underlying cysts, breaks in the subchondral bone plate, or an osteochondral fracture line with T2 high signal intensity.[24] When further characterization was necessary, CT was performed to accurately identify fragmentation, separation, sclerosis, and secondary cystic changes of the subchondral bone[32] (Fig. 1). CT scan was also performed to detect and locate loose bodies within the shoulder joint. Most patients already had radiographs performed before referral. In case radiographs were performed after presentation, this was done primarily to determine physeal status in adolescent patients, or rule out features of dysplasia.

ICRS OCD grading

MRI grading of glenoid OCD was performed so as to classify each patient according to the International Cartilage Research Society (ICRS) OCD staging system.[20]

Treatment

Patients diagnosed with stable lesions (ICRS OCD I) were treated with nonoperative treatment, whereas unstable lesions (ICRS OCD II, III, IV) underwent surgical treatment. Nonoperative treatment included abstaining from aggravating movements and refraining from compressive or shear loading of the shoulder for a duration lasting 3 to 6 months, followed by rehabilitation including biomechanical corrections. Surgical treatment involved arthroscopic ICRS staging of the lesion, OCD excision with loose fragments removal, followed by bone marrow stimulation (BMS) using microfracture awls. All arthroscopic surgeries were performed in lateral decubitus position, and utilized standard 3 portals including the posterior, anterior, and antero-superior portal. We also harvested a 4.5 mm chondral biopsy from the articular cartilage adjoining the humeral head bare area in all patients who underwent surgery. This chondral biopsy was cryopreserved and was to be used for chondrocyte culture if BMS cartilage repair failed, and a subsequent autologous chondrocyte transplantation was necessitated as a revision procedure. All surgical procedures were performed by a single surgeon. Postoperatively, the arm was immobilized in a sling for 2 weeks, followed by physical therapy for

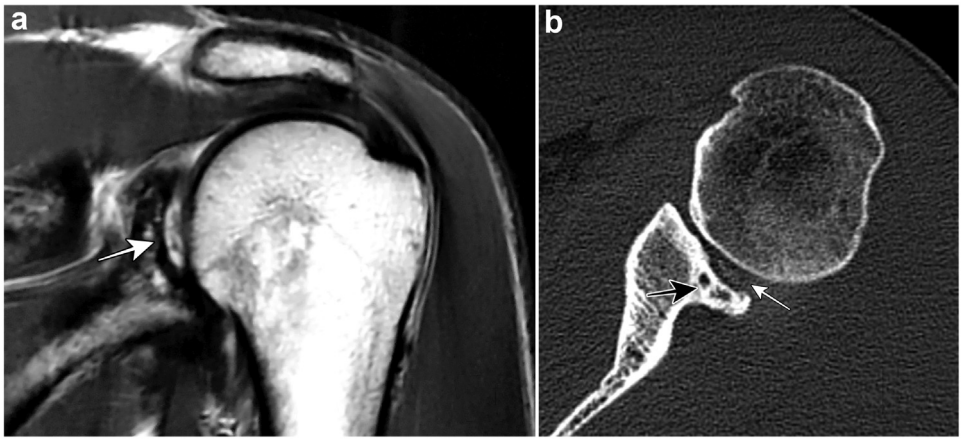

Figure 1 ICRS OCD III of glenoid in a 19-year-old male badminton player: (**a**) Coronal MRI reveals an ovoid cortical defect (*white arrow*) with circumferential disruption of articular cartilage with fluid interface surrounding the undisplaced "dead in situ" fragment. (**b**) Axial CT delineates the large area of cortical bone loss involving the posterior glenoid articular surface with subchondral cysts (*black arrow*) and residual bone fragment within the crater (*white arrow*).

12 weeks that primarily involved regaining shoulder range and strength without subjecting the glenohumeral joint to compressive and shear loads. All patients underwent a supervised rehabilitation program prior to return to sport.

Follow-up and outcomes

All patients serial postoperative clinical evaluations were analyzed and their clinical findings including pain, crepitus, range, strength, and stability were noted. Details of patient's sports participation, including time to return to sport, and level of participation following treatment, were noted. All patients had undergone an MRI at the 2-year follow-up. Postoperative MRI grading of articular cartilage repair was performed using the MOCART (MRI observation of cartilage repair tissue) scoring system.[29,31] ICRS OCD I treated with nonoperative treatment had undergone an additional CT scan and this was studied to determine subchondral bone healing.

Data analysis

The data collected contained a combination of numerical and categorical variables. The normal distribution of the numerical variables was first assessed by generating a probability plot. Independent t test and the one-way ANOVA test were used to determine the relation between categorical variables.

Results

We identified 7 patients with symptomatic glenoid OCD, who underwent nonoperative or surgical treatment for the same, with a minimum 2-year follow-up (range 24 – 56 months). There was no patient lost to follow-up during this period. The characteristics of the patients are presented in Table I.

The patients included 4 males and 3 females, with a mean age of 18.4 years (range 13-24 years). All 7 patients were competitive athletes at different levels involved in sports necessitating repeated overhead movements. All patients had unilateral disease in their dominant shoulder. Four had a definite history of shoulder overuse prior to the onset of pain due to intensive training that they were unaccustomed to. No patient had a history of significant trauma at the onset of symptoms. The predominant symptom was pain during sports training or participation especially in the overhead position. Most patients were able to continue playing the sport despite pain in the initial stages and presented from 1 to 13 months following the onset of symptoms. Only one patient complained of locking and this recent additional symptom, besides pain, prompted him to seek a medical opinion. On evaluation of passive range of motion, patients demonstrated loss of terminal external rotation ranging from 5-20^{o} at 90^{o} of shoulder abduction. All patients demonstrated normal strength and stability on clinical examination. Resisted terminal abduction and external rotation caused pain provocation in 6 patients. Resisted push-ups caused pain in 5 patients. The patient with repeated episodes of locking did not permit clinical tests since he was extremely apprehensive.

MRI revealed the diagnosis of glenoid OCD in each patient and was critical to determine articular cartilage continuity over the OCD lesion. In each of the 7 patients, the OCD was located at the posterior aspect of the glenoid. MRI also identified potentially unstable OCD lesions. Five patients underwent CT to study the subchondral bone and subchondral fracture in greater detail. The MRI grading of OCD for the 7 patients is described in Table II.

Three patients with ICRS OCD I underwent nonoperative treatment, whereas four patients with unstable or advanced glenoid OCD (1 ICRS OCD II, 1 ICRS OCD III, 2 ICRS OCD IV) underwent surgical treatment. The patient with ICRS OCD II presented initially as ICRS OCD I, was treated conservatively for 6 months, progressed to ICRS OCD II, and underwent surgery after failing a trial of nonoperative treatment [Fig. 2].

All patients improved following treatment and no intraoperative or postoperative complication was noted. No patient complained of residual pain at the latest follow-up, although 2 patients complained of a persistent painless crepitus in their shoulder that did not interfere with their sports participation. All patients had passive and active range of shoulder movements more than or equal to the opposite nondominant shoulder, with normal strength and stability at the 2-year follow-up. Resisted push-ups and resisted terminal abduction with external rotation was pain-free in all patients. All patients returned to the same or higher level of sport following treatment by the 2-year follow-up. The mean time to return to sports was 8.0 months (range, 6 to 11 months) for nonoperative treatment, and 6.8 months (range, 5 to 10 months) for operative treatment. This difference was not statistically significant (*P* value .55). No patient had recurrence of symptoms till latest follow-up, and no patient required revision surgery for any reason within this period.

Table I
Glenoid OCD—patient characteristics, treatment performed, functional outcomes, and radiological outcomes.

Case	Gender/age	Sport	Symptoms	Duration of symptoms	ICRS OCD grade	Treatment	Return to sport	Time to return to sport	Postop MOCART score
1	M/13 yr	Tennis	Pain	2 mo	I	Nonoperative	Yes	7 mo	NA
2	M/24 yr	Weight-lifting	Pain	13 mo	IV	Surgical	Yes	10 mo	85
3	M/19 yr	Badminton	Pain	9 mo	III	Surgical	Yes	5 mo	90
4	F/17 yr	Gymnastics	Pain	12 mo	II	Surgical	Yes	7 mo	75
5	F/15 yr	Badminton	Pain	7 mo	I	Nonoperative	Yes	11 mo	NA
6	M/20 yr	Cricket	Pain + Locking	4 mo	IV	Surgical	Yes	5 mo	80
7	F/21 yr	Tennis	Pain	1 mo	I	Nonoperative	Yes	6 mo	NA

Table II
MRI grading of glenoid OCD.

ICRS OCD stage	MRI grading of glenoid osteochondritis dissecans	No. of patients
I	Articular cartilage is structurally intact although it may be thickened or oedematous. Subchondral bone reveals bone marrow edema or hyperintense signal at lesion–bone interface.	3
II	Articular cartilage partially breached with fluid at lesion-bone interface.	1
III	Articular cartilage circumferentially disrupted with fluid interface surrounding lesion. Fragment undisplaced and “dead in situ”.	1
IV	Empty defects and defects with a displaced or loose osteochondral fragment.	2

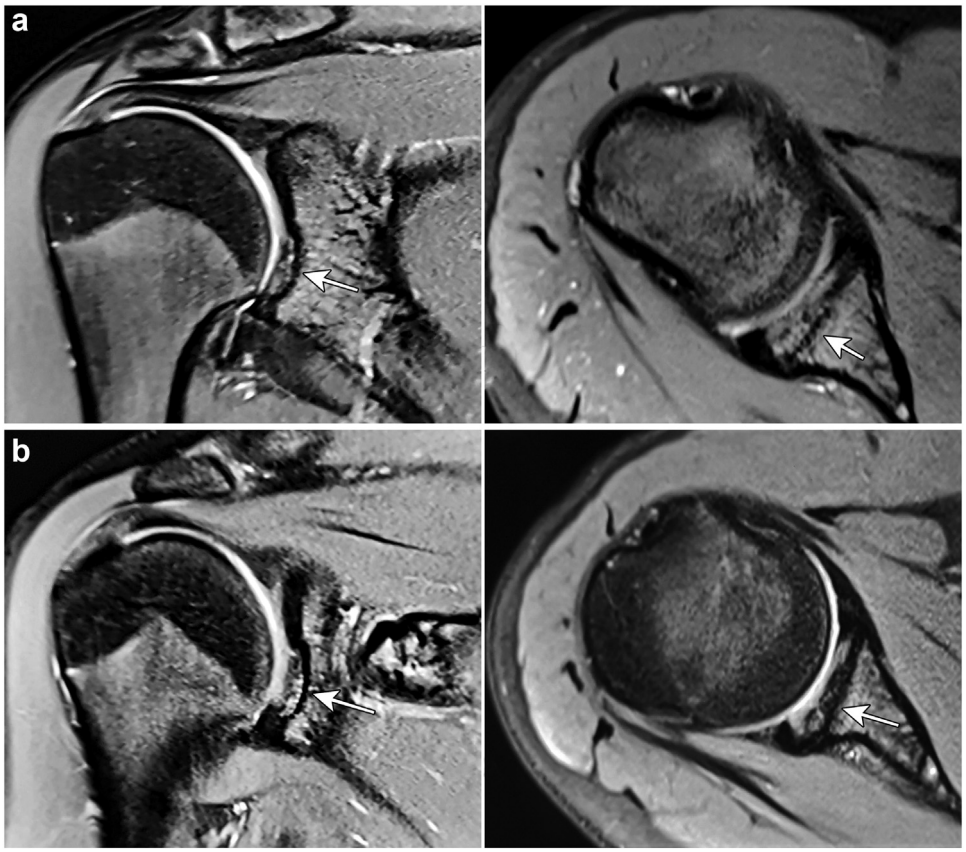

Figure 2 Progress of glenoid OCD from ICRS OCD I to ICRS OCD II in a 17-year-old female gymnast: (**a**) MRI at presentation revealed an ICRS OCD I glenoid with intact articular cartilage and stable subchondral changes. She had persistent symptoms despite 6 months of nonoperative treatment. (**b**) MRI after 6 months revealed progression to ICRS OCD II. The subchondral plate has fractured with fragmentation, the articular cartilage is partially breached, and hyperintense signal is noted at lesion-bone interface.

The mean MOCART score at the 2-year follow-up MRI for the 4 patients who underwent surgery was 82.5 (range, 75-90). In the 3 patients with ICRS OCD I who underwent nonoperative treatment, MRI at 2-year follow-up suggested healing. Subchondral bone healing was confirmed on CT in 2 of these patients (Fig. 3).

Discussion

The principle finding of this study is that glenoid OCD has grades of disease progression similar to OCD at convex weight-bearing articular surfaces and should be managed with the same grade-specific treatment as OCD occurring elsewhere.

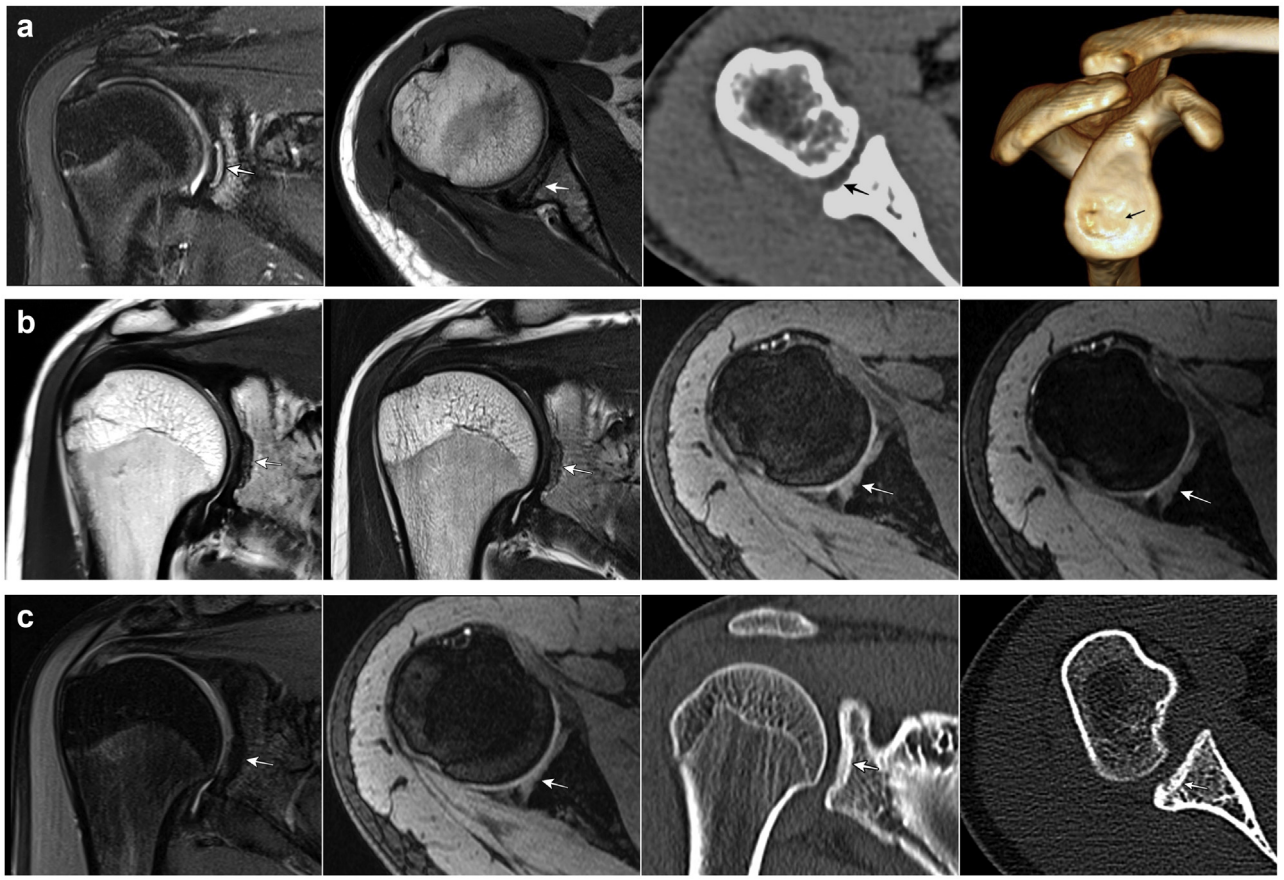

Figure 3 ICRS OCD I of glenoid in a 15-year-old female badminton player (**a**): MRI and CT are diagnostic of a "classical" postero-inferior glenoid OCD. Subchondral bone reveals bone marrow edema with hyperintense signal at lesion–bone interface. The articular cartilage is structurally intact. (**b**) MRI 11 months after initiation of nonoperative treatment reveals a stable healed OCD. The patient returned to sports. (**c**) MRI at 2-year follow-up reveals a completely healed OCD. CT confirms subchondral bone healing with remodeling.

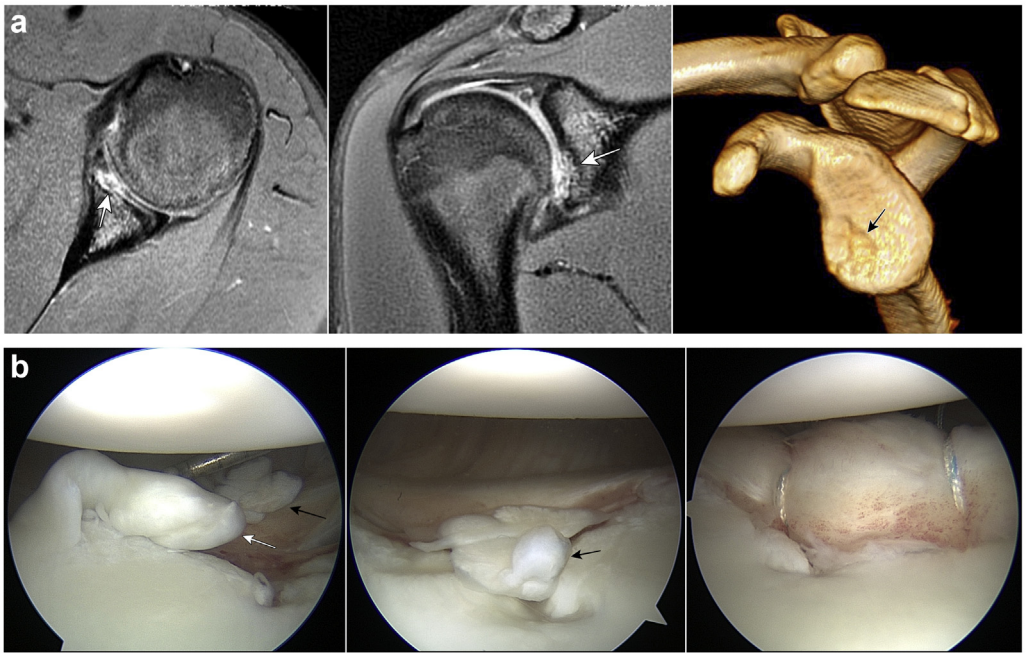

Figure 4 Osteochondral defect of glenoid secondary to shoulder instability in a patient having experienced 2 anterior shoulder dislocations. **a**: MRI and 3DCT images; **b**: arthroscopy images. The glenoid osteochondral defect is located anteriorly and is associated with an anterior labral tear. Lesions such as these need to be differentiated from "true" OCD and were excluded from this study.

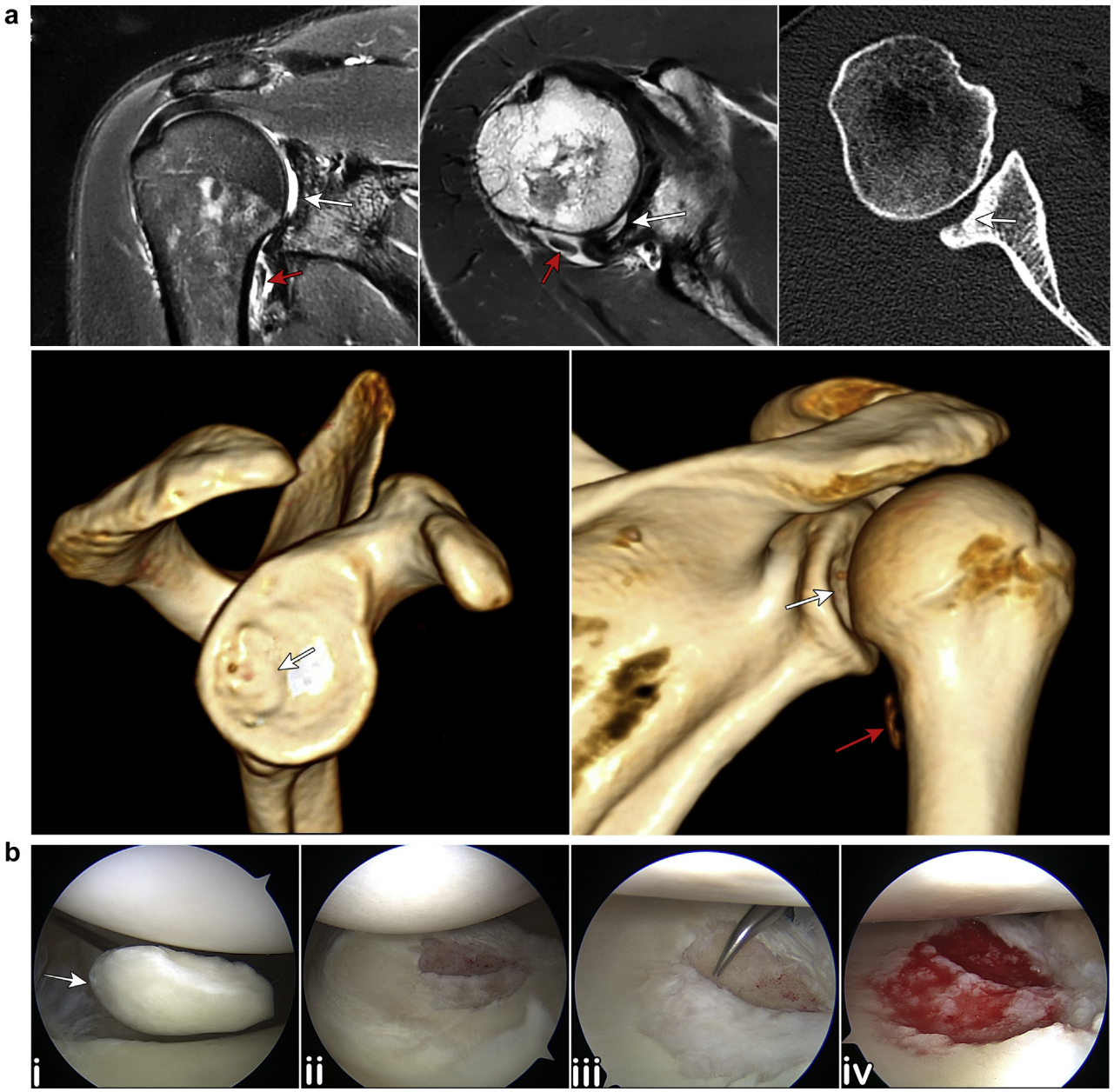

Figure 5 ICRS OCD IV of glenoid in a 20-year-old male cricket fast bowler who presented with pain and locking: (a) MRI and CT reveal an empty ovoid defect of glenoid (*white arrow*) with a displaced loose osteochondral fragment (*red arrow*). (**b**) The patient underwent arthroscopic loose fragment removal (i), the OCD defect was located at the "classical" posterior aspect of glenoid (ii), followed by bone marrow stimulation using microfracture awls (iii), and confirmation of clot formation over the articular cartilage defect (iv). (**c**) MRI at 3-month follow-up demonstrates cartilage fill within the OCD crater. The microfracture tract is still noted at this early phase (*arrow*). (**d**) MRI at 2-year follow-up reveals a successful cartilage repair with MOCART score of 80.

All our patients were young athletes involved in sports necessitating repetitive overhead movements. Our series had 4 males and 3 females and there was no male predominance as suggested by prior case reports.[1,5,8,11,15,18,21,26,37] Of the 7 OCDs in this series, 6 were adult onset, and in only one patient the proximal humeral physeal growth plate was still open. No patient had a history of acute injury, and 4 of the 7 athletes had a definite history of shoulder overuse associated with intensive overtraining. This reconfirms the perception that repetitive compressive forces across the glenohumeral joint in young athletes is an important etiological factor in glenoid OCD.[33]

Glenoid OCD is possibly not as rare as perceived. A high index of suspicion and a low threshold for requesting diagnostic MRI is necessary for early identification of these lesions. Most patients did not have dramatic symptoms and often continued to play with moderate disability for prolonged periods of time prior to seeking a medical opinion. Since the shoulder is not a weight-bearing joint, it would appear that these lesions do not cause significant disability until the more advanced stages of the disease. Moreover, the clinical signs are often innocuous and often do not suggest pathology of concern. We consistently found that resisted terminal abduction and external rotation, along with resisted push-ups caused pain

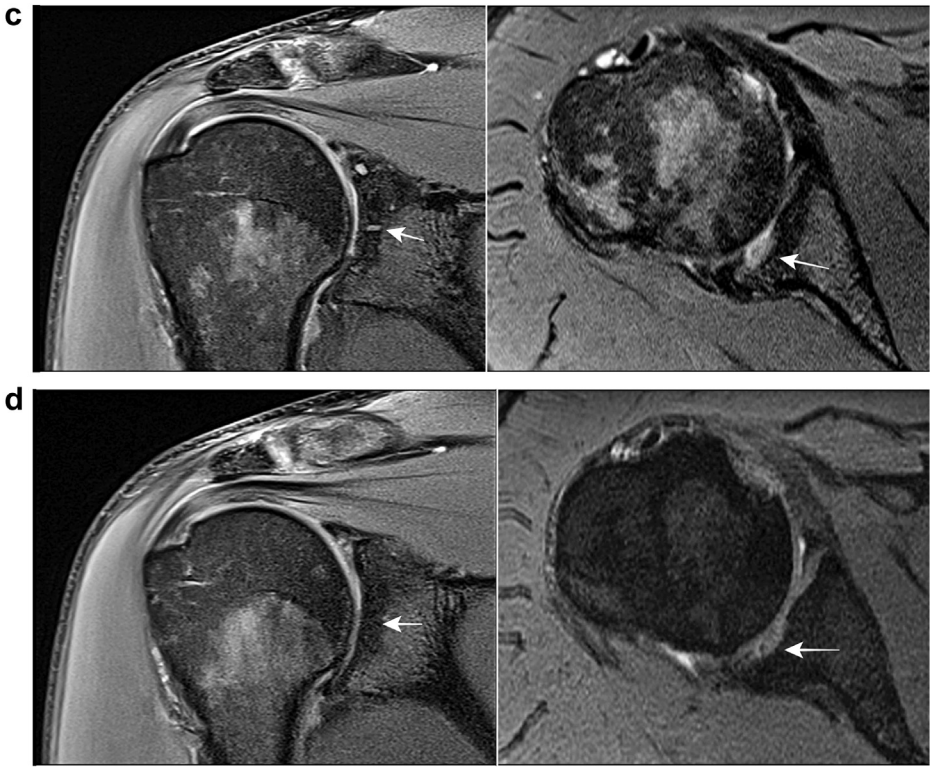

Figure 5 (*continued*).

provocation in most patients and advocate this as a sensitive, but not specific, clinical test to suspect glenoid OCD. Both these tests cause a load shift to the posterior pathological area of the glenoid and hence possibly elicit pain.

All 7 OCDs in this series were located at the posterior aspect of the glenoid, and similar to "classical OCD" of the medial femoral condyle of the knee, it would appear that this glenoid area is prone for this lesion. We also noted on MRI and arthroscopy that no patient had any concomitant significant tear of the glenoid labrum or rotator cuff. These two characteristic radiological features, along with the typical history of overhead repetitive overuse, in the absence of significant trauma preceding the symptoms, differentiates "true" OCD from the more common osteochondral defects secondary to anterior instability (Fig. 4).

MRI is important not only in diagnosing these lesions but also in planning management. Although severity of symptoms is a major determinant in deciding treatment for an OCD, articular cartilage continuity, and fragment stability are considered the more important factors in determining the course of action for an OCD.[7,9,19,22,27,42] In general, stable lesions with articular cartilage continuity may be reversible and may heal completely with nonoperative treatment, while unstable lesions with articular cartilage discontinuity require surgical treatment.[12,30,35] MRI can reliably detect articular cartilage disruption and predict OCD stability.[24] Subchondral fluid-filled cysts >5 mm or multiple underlying cysts, a peripheral rim of high signal intensity, breaks in the subchondral bone plate, an osteochondral fracture line with T2 high signal intensity, or a fluid-filled osteochondral defect are predictors of OCD instability.[24] However, MRI alone, at times, may not provide a reliable assessment of OCD lesion instability[23] and under such circumstances of uncertainty, CT may allow more accurate evaluation of the subchondral bone and suggest the best treatment option to pursue.[32,39] Since there are no defined MRI criteria to determine ICRS OCD grading for the glenoid, we graded our patients based on MRI into four categories using criteria well accepted in the knee and ankle.[10] Although the number of patients in this study were limited, we were able to document each of the ICRS OCD grades in glenoid OCD. It would appear that pathologically glenoid OCD is no different from OCD occurring at convex articular surfaces.

Three patients with ICRS OCD I were treated successfully with nonoperative treatment; however, one progressed to ICRS OCD II and warranted surgical treatment. This confirms the notion that as long as the lesion is stable with no break in the articular cartilage, healing can often occur, provided the repetitive compressive forces are stopped in time. Once articular cartilage discontinuity occurs, synovial fluid leaks behind the fragment resulting in the formation of a fibrous layer. This along with ensuing fragment instability prevents spontaneous healing and causes further progression of the disease. Hence ICRS OCD II, III, IV are indicated for surgical repair.

Although multiple cartilage repair options exist, we opted for BMS in view of its ease and safety.[16] The glenohumeral joint is non–weight-bearing and a fibrocartilage repair was deemed adequate. Since there are no long-term studies documenting the efficacy of BMS in glenoid OCD, we performed a chondral biopsy during the index procedure, and cryopreserved the chondrocytes for any possible future revision to ACI, in the event that BMS failed. In all 4 operated patients, the clinical outcomes following BMS were deemed successful and there was no recurrence of symptoms in any patient till latest follow-up. Moreover, postoperative MRI at minimum 2 years following surgery in each patient documented satisfactory cartilage repair with a mean MOCART score of 82.5 (Fig. 5). This is the first study to document the quality of cartilage repair in glenoid on postoperative MRI and encouraged with the

results of BMS in glenoid OCD, we have stopped performing a preemptive ACI chondral biopsy during the index procedure since the past 2 years.

The most important measure of outcome in athletes recovering from an injury is a return to the same preinjury level of sporting performance.[13] The short-term outcomes following grade-specific treatment for glenoid OCD are good and all patients returned to the same or higher level of sport by the 2-year follow-up. Although the mean time taken to return to sports was shorter with operative treatment (6.8 months, range 5 to 10 months) as compared to nonoperative treatment (8.0 months, range 6 to 11 months), this difference was not statistically significant. What is interesting to note, is that 3 cases of glenoid ICRS OCD I healed with nonoperative treatment and successfully returned to sports, something that is scarcely reported in literature. There was no statistically significant difference when we compared ICRS OCD grade with time to return to sport (*P* value 0.85).

This study has two limitations; that of sample size and duration of follow-up. A case series of 7 patients is inadequate to allow conclusions with statistical validity, especially since ICRS OCD stages II and III had only one patient each. However, glenoid OCD is distinctly uncommon and unless a multicentric pooling of subjects is performed, a larger number of study subjects is unlikely. BMS cartilage repair in the knee is notorious for good short-term results, with a decline in outcomes with longer follow-up.[14] It is possible that despite the shoulder joint being non–weight-bearing, the same may hold true for glenoid cartilage repair in the long term.

Conclusions

Glenoid OCD occurs in overhead athletes following repetitive overuse. Greater awareness, a high index of suspicion, and early MRI is likely to result in more of these lesions being identified. The stages of glenoid OCD are similar to those seen in the femoral condyles or talar dome. ICRS OCD I can often be treated successfully with nonoperative treatment, whereas ICRS OCD II, III, IV, warrant operative treatment. BMS is a safe and predictable option for glenoid cartilage repair that allows athletes a successful and quick return to sports. Postoperative MRI following BMS cartilage repair in glenoid reveals mean MOCART scores of 82.5. Despite the glenoid being a concave non–weight-bearing articular surface, OCD at this site behaves, and is to be treated similar to other convex weight-bearing articular surfaces.

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