Use of Fresh Osteochondral Glenoid Allograft to Treat Posteroinferior Bone Loss in Chronic Posterior Shoulder Instability

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Abstract

We report our experience with the use of fresh glenoid osteochondral allograft in the treatment of a chronic posttraumatic posterior subluxation of the shoulder associated with glenoid bone loss in a 54-year-old recreational football player.

Based on the pathoanatomy of the lesion and availability of a bone bank providing fresh allograft, we opted for an open anatomic reconstruction using a fresh glenoid allograft. A posterior approach was used; the prepared allograft was placed in the appropriate anatomic position and fixed with 2 small fragment screws with washers. At 2-year follow-up, the clinical outcome is excellent.

This procedure may represent an effective option for the treatment of chronic posterior shoulder instability due to glenoid bone loss. However, the long-term efficacy and the progression of glenohumeral osteoarthritis need to be evaluated.

Posterior glenohumeral dislocation is a rare condition, accounting for less than 3% of all shoulder dislocations.[1] However, this may not be an accurate representation of their prevalence if we consider the large number of unrecognized cases, with a study showing this number as high as 79%.[2]

Acute posterior dislocations are commonly related to trauma, usually an axial load to the arm in adduction and internal rotation, or seizures, during which the shoulder internal rotator muscles, twice more powerful than the external rotators, force the humeral head to translate and dislocate posteriorly.

The first episode of posterior dislocation may lead to soft tissue or bony injuries, such as reverse Bankart lesion, reverse Hill-Sachs lesion or glenoid fracture, which may predispose to further instability of the glenohumeral joint. In a study by Saupe and colleagues[3] on 36 patients with clinically documented first-time traumatic posterior dislocations, magnetic resonance imaging (MRI) revealed that reverse Hill-Sachs lesions had occurred in 86% of patients, reverse Bankart lesions in 52%, posterior labrum sleeve avulsion in 48%, and reverse bony-Bankart in 31%.

A variety of treatments have been described to address the underlying pathoanatomy of the injury ranging from soft tissue procedures, such as labral repair, capsulorrhaphy, or subscapularis transfer (McLaughlin procedure[4]), to bone reconstruction procedures including iliac crest grafting and glenoid or humeral osteotomy. Studies show that isolated soft tissue procedures result in high recurrence rates and recognition of glenoid bone loss is essential for the success of treatment.[5-7] It has been demonstrated that bone loss of 25% of the anterior glenoid surface leads to significant biomechanical alterations of the glenohumeral joint resulting in recurrent anterior instability[6,8]; unfortunately, there are no published studies that demonstrate the threshold of bony injury that results in recurrent posterior instability. Techniques that have been described for bony reconstruction of the glenoid include coracoid transfer,[9] iliac crest autograft,[10-12] or distal tibia allograft.[13] The use of fresh allograft has been largely investigated and described as an effective procedure in the treatment of osteochondral defects of the knee, with long-term favorable outcomes and survival of the grafts.[14] In this article we describe the use of a fresh glenoid osteochondral allograft for the treatment of posteroinferior glenoid bone loss in a patient with chronic posterior instability. To our knowledge, no illustration of this technique has been described in the literature.

The patient provided written informed consent for print and electronic publication of this case report.

Case Report

A 54-year-old right-hand dominant man was seen for the first time in the orthopedic ambulatory clinic in September 2008 with right shoulder pain and limited range of motion (ROM). He reported direct trauma to his right shoulder during a football game 4 months earlier. He had history of idiopathic seizure disorder arisen at the age of 7, but he had been seizure-free for 30 years. Despite this, he had no history of previous shoulder dislocation.

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He presented to our clinic with pain localized on the lateral aspect of the shoulder, aggravated with forward elevation and internal rotation. Physical examination revealed asymmetry of the shoulders, with supraspinatus and infraspinatus atrophy. There was no tenderness on the acromioclavicular joint. Active and passive elevation were approximately 110°, external rotation was limited to 20°, and internal rotation was possible to sacroiliac joint. Rotator cuff testing demonstrated weakness of the supraspinatus muscle, while subscapularis strength was normal and impingement tests negative. There was no evidence of multidirectional instability or abnormal anterior translation, but he did have a positive posterior apprehension test. Radiographic evaluation (**Figure 1A, 1B**) showed non-concentric glenohumeral joint alignment with static posterior subluxation and marked irregularity of the posterior aspect of the glenoid with joint depression and bone loss. An associated focal osteochondral lesion on the anterior humeral head was noticed, mild secondary osteoarthritis at the glenohumeral joint with early osteophyte development was also present.

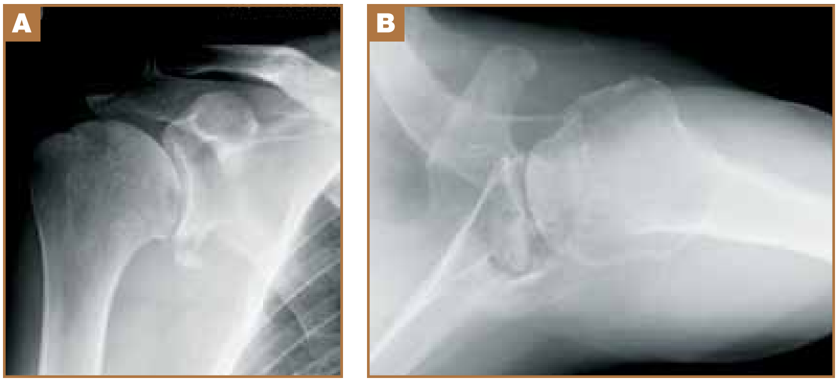

Figure 1. Preoperative radiographic images in AP (A) and axillary view (B) showing non-concentric glenohumeral joint alignment with static posterior subluxation. Marked irregularity of the posterior aspect of the glenoid with joint depression and bone loss are also evident.

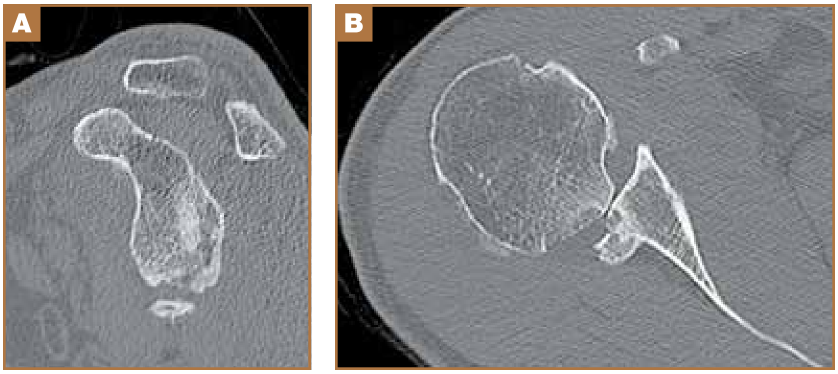

Figure 2. Preoperative CT images including sagittal (A) and axial (B) views demonstrating a reverse bony-Bankart and a reverse Hill-Sachs lesion; the humeral head was posteriorly subluxed with less than 50% articulating with the glenoid surface.

The MRI exam showed a partial thickness tear of supraspinatus, a shallow focal osteochondral defect of the humeral head and posterior glenoid abnormality. A computed tomography (CT) scan was performed to assess the amount of bone loss and evaluate the joint congruency in order to plan the appropriate surgical treatment. The CT scan (**Figure 2A, 2B**) showed a reverse bony-Bankart with evidence of fragmentation inferiorly and a reverse Hill-Sachs measuring approximately 2.3 cm in craniocaudal dimension and 5 mm in depth; the humeral head was posteriorly subluxed with less than 50% articulating with the glenoid surface, predominantly with the fractured portion of the posterior glenoid.

Based on the pathoanatomy of the lesion and availability of bone bank providing fresh allograft we opted for an open anatomic reconstruction using a fresh glenoid allograft. As per protocol, harvesting, processing, and testing of donor tissue were done adhering to the guidelines established by the American Association of Tissue Banks, Canadian Standards Association, and Health Canada Guidance Document Donor was identified through the MORE (Multiple Organ Retrieval and Exchange) program of Ontario. To maximize cartilage quality, the donor chosen was younger than 30 years old and the graft procured within 24 hours of death. The graft was processed, stored at refrigerated temperatures (2°-10°C), and transplanted within 14 days following recovery.

We used a posterior approach with a longitudinal incision extending from the posterolateral aspect of the acromion to the axillary fold. The deltoid was split in line with its fibers and the interval between infraspinatus and teres minor was reached. The infraspinatus was retracted superiorly, the inferior third of the tendon detached from the posterior aspect of the humerus in order to allow a better exposure of the posterior capsule and posterior glenoid. The tendon was tagged for later repair. Through a longitudinal capsulotomy, the joint was exposed and the posterior glenoid fragment was identified and evaluated. A combination of Fukuda Retractor (Smith & Nephew Inc, Andover, Massachusetts) placed intra-articularly and Hohmann Retractor (Innomed Orthopedic Instruments, Savannah, Georgia) inferiorly allowed adequate visualization of the glenohumeral joint. The fragment, which had healed medially and inferiorly, appeared split and the residual articular surface had significant cartilage loss. The fragment was therefore removed with an osteotome and the posterior glenoid was prepared to accept the allograft. The right glenoid allograft was prepared on a separate table, sized to accurately fit the bone loss and provisionally tried against the defect,

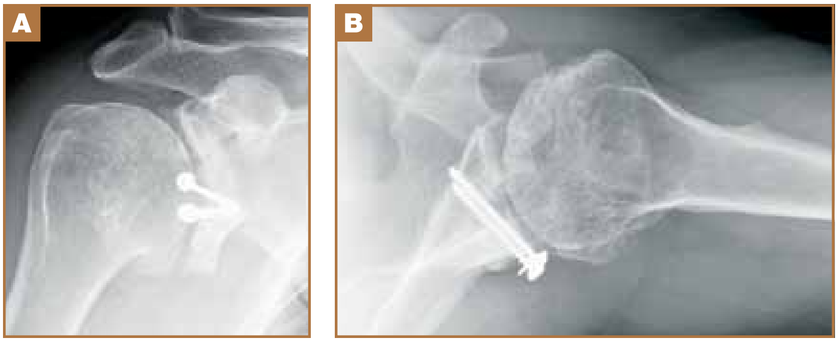

Figure 3. Radiographs in AP (A) and axillary (B) view at 24 months follow-up: concentric glenohumeral joint alignment, no signs of graft osteolysis, moderate glenohumeral osteoarthritis.

Figure 4. Clinical outcome at 24 months follow-up: full forward flexion (A), abduction and external rotation (B), and limitation in internal rotation to thoracolumbar level (C).

making adjustments with an oscillating saw.

The prepared allograft was placed in the appropriate anatomic position and fixed with 2 cancellous screws (26 mm length) with washer; the first was a partially threaded 3.5 mm screw used to obtain compression, the second a fully threaded 3.5 mm cancellous screw to obtain a good fixation. Intraoperative fluoroscopic images ensured the proper placement of the allograft. After the shoulder was reduced, we irrigated copiously, sutured the posterior labrum and tightened the capsule using a combination of suture anchors and nonabsorbable sutures. The inferior aspect of the infraspinatus was reattached and the wound was closed in standard fashion. The shoulder was immobilized in an external rotation brace. The first phase of rehabilitation included passive and active assisted ROM exercises, avoiding internal rotation for the first 2 weeks. After 2 weeks the use of the brace was discontinued, while full ROM exercises were initiated at 6 weeks. At 8 weeks a rotator cuff and periscapular muscle strengthening program was initiated. After 6 months the patient was cleared for all activities.

The patient experienced a seizure 7 days after surgery but the radiographic study did not show any changes in the alignment and fixation, compared with the postoperative radiographs. After a neurological consultation was obtained, blood tests were ordered and revealed low serum levels of phenytoin. A new therapeutic regimen was therefore started and since then he had no other episodes of seizure.

At 24 months follow-up, the patient had no limitation in daily activity and no recurrence of posterior instability. Radiographs showed concentric glenohumeral joint alignment with no signs of pseudoarthrosis or osteolysis but did show moderate glenohumeral osteoarthritis (**Figure 3A, 3B**). ROM in elevation, abduction, and external rotation was complete, while internal rotation was limited to thoracolumbar level (**Figure 4A-4C**). Strength testing showed 5/5 for resisted forward flexion, abduction, external and internal rotation. The patient was fully satisfied.

Discussion

Large bone loss leads to alterations of the normal shape and concavity of the glenoid reducing the effectiveness of the concavity-compression mechanism, compromising the ability of the shoulder to center the humeral head in the glenoid.[15] Rowe and colleagues[16] originally described bone loss as significant when 30% of the articular surface is involved. Lo and colleagues[8] introduced the concept of inverted pear glenoid in anterior instability, describing a significant amount of bone loss occurring in presence of 25% to 27% reduction of width of the inferior glenoid; unfortunately, similar studies for posterior instability have not been published. However, in patients presenting with this condition, a bone grafting procedure would restore the normal articular arc of the glenoid providing stability to the shoulder.

The treatment of glenoid bone loss in anterior and posterior instability is therefore a challenge and many techniques have been described. For the treatment of posterior shoulder instability, good results have been reported with the use of an iliac crest autograft. Barbier and colleagues[10] reported satisfactory results in 80% of cases at 3 years mean follow-up, but 37.5% of patients (3 out of 8) presented a loss in external rotation of 20° on average, compared with the opposite side. Similarly, Servien and colleagues[11] presented good results at 6 years follow-up with recurrence in 4.6%, including 1 episode of redislocation and 2 with positive apprehension out of 21 patients. However, despite the good results, concerns remain with the use of an iliac crest graft in relation to a non-anatomic repair of the defect and non-reconstruction of the chondral surface leading to degenerative changes of the glenohumeral joint. Glenoid reconstruction with osteochondral allograft presents advantages related to the reconstitution of the glenoid arc and chondral surface. Cartilage is a relatively immunoprivileged tissue because of its avascularity and characteristic configuration of the hyaline matrix imbedding chondrocytes. While the viable chondrocytes survive transplantation and support the hyaline matrix, the host bone replaces the underlying bone by a process of creeping substitution, providing mechanical stability.[17,18]

Lexer[19] first described the use of fresh allograft in 1908, transplanting an entire knee joint from a fresh amputation. The modern use of fresh osteochondral allograft in clinical practice started in the 1970s for the treatment of osteochondral lesions of the knee.[20] Recently, this has been expanded to other joints, including hip[21,22] and ankle.[23,24]

The use of fresh allograft is mainly limited by availability. Other difficulties include the ability to harvest the graft within 24 hours postmortem, process, store, and transplant into the patient within a maximum of 14 days after retrieval.[14]

The risk for disease transmission (HIV, Hepatitis B and C) is similar to that of homologous blood transfusion, although lower estimates have been published.[25] On the other hand, it has been recognized that fresh allograft offers superior chondrocyte viability (30%-90%) when harvested within 24 hours of donor death and preserved at 4°C, compared with frozen or cryopreserved allograft.[26,27] Williams and colleagues[28] demonstrated that chondrocyte viability and viable cell density remain unchanged after storage for 7 and 14 days before declining at 28 days. The cartilage matrix was preserved over 28 days and no significant differences were seen with regard to glycosaminoglycan content and biomechanical properties.

Chondrocyte viability is the key for the success of the procedure, with early failures related to lack of viable chondrocytes.[29] Precise sizing and fitting are also essential, providing the mechanical stability of the implant by promoting bone growth and integration.[29,30] Late failure has been demonstrated to be related to less stable implants.[29] The current literature shows good long-term outcomes when used for femoral condyle and tibial plateau defects, with survival of the implants at 15 years. Gross and colleagues[14] reported survival rates of 95% at 5 years, 85% at 10 years, and 74% at 15 years for femoral condyle fresh osteochondral allograft, and rates of 95% at 5 years, 80% at 10 years, and 65% at 15 years for tibial plateau. Another study has shown long-term chondrocyte viability at 25 years follow-up.[31]

The assessment and treatment of concomitant lesions—reverse Bankart, reverse Hill-Sachs, posterior labrum sleeve avulsion—is also essential for the success of the procedure. In our case, the patient had a reverse Hill-Sachs measuring approximately 2.3 cm in craniocaudal dimension and 5 mm in depth. Reverse Hill-Sachs lesions require an appropriate management according to size of the defect. For anterior instability, biomechanical studies have shown that humeral defects involving as little as the 12.5% of the articular surface result in significant biomechanical changes of the glenohumeral joint.[32,33] Treatment options include subscapularis tendon transfer,[4] bone grafting,[34] and arthroplasty in presence of a defect involving more than 45% of the joint surface.[35] Due to the shallow depth of the defect in our case we felt that tightening of the posteroinferior capsule would be sufficient to prevent engagement of the lesion. In addition, the glenoid bone graft, extending the articular arc, prevents the reverse Hill-Sachs lesion from engaging the posterior glenoid rim.

Although no description on the use of fresh glenoid allograft for chronic posterior instability exists, the use of fresh osteochondral allograft has been widely investigated and documented as an effective procedure in the treatment of osteochondral defects of the knee. The fresh glenoid allograft provides several advantages related to an accurate fitting of the graft, restoration of the glenoid arc and chondral surface, and absence of donor-site morbidity. Moreover, fresh allograft offers superior chondrocyte viability compared to frozen or cryopreserved allograft. Current limits are related to the presence of an established well-organized program, enabling harvesting the graft within 24 hours postmortem.

In conclusion, this procedure may represent an effective option for the treatment of chronic posterior instability due to glenoid bone loss. In the case we reported, the clinical outcome at 2 years follow-up is excellent. However, the long-term efficacy and the progression of glenohumeral osteoarthritis need to be studied.

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