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Arthroscopic glenoid reconstruction for glenoid bone loss in recurrent anterior glenohumeral instability, using osteochondral autograft from the contralateral lateral femoral condyle: a new technique and case report

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Many surgeons have recognized that significant glenoid bone loss is one of the major risk factors for recurrence of anterior glenohumeral instability after arthroscopic soft tissue stabilization.[4,5] Glenoid reconstruction with bone graft has been recommended in patients with large glenoid bone loss.[5,19,22] Several operative procedures have been described to restore the anatomy of the glenoid.

Operative treatments for anterior shoulder instability with significant glenoid bone loss can be classified into 4 types: coracoid transfers, bone grafting, osteochondral allograft, and osteochondral autograft.[25] Glenoid restoration techniques that include the use of a tricortical iliac crest graft or the transfer of the coracoid process may be followed by osteoarthritis.[14] Fresh osteochondral allograft supplies articular cartilage replacement with the possibility of graft resorption. Osteochondral autograft also provides articular cartilage replacement, and moreover, does not have the risk of antigenicity. Although distal clavicular autograft[25] is the only procedure reported for osteochondral autograft thus far, it sacrifices the acromioclavicular joint. We thought that it would be desirable to harvest an articular cartilage with bone at the nonarticular surface as an osteochondral autograft. We present a technique for all-arthroscopic glenoid reconstruction for glenoid bone loss in recurrent anterior glenohumeral instability by using a nonarticular osteochondral autograft that does not constitute the original joint surface.

Case report

An 18-year-old right-handed girl had a history of recurrent dislocation of her right shoulder. The first dislocation occurred 18 months prior while playing dodgeball, and she underwent reduction via a bonesetter. Thereafter, she complained of instability on active elevation or external rotation of the shoulder. She presented to our clinic with right shoulder pain and more than 10 episodes of dislocation of the right shoulder 1 year from the initial dislocation.

At the time of presentation, she showed apprehension at 90° of abduction and positive results on a relocation test and anterior drawer test. Plain radiographs showed subluxation of the humeral head and glenoid bone loss. Three-dimensional reconstructed computed tomography (3DCT) showed 36.9% glenoid bone loss on the en face view by using the best-fit circle method[24] (Fig. 1). The Hill-Sachs lesion (HSL) was measured as 22.0 mm width and 7.5 mm depth on 3DCT. According to the glenoid track concept,[27] this was an off-track HSL.[11] The patient subsequently underwent all-arthroscopic glenoid reconstruction using osteochondral autograft from the contralateral lateral femoral condyle.

Surgical technique and operative findings

Examination under general anesthesia confirmed full range of motion and anteroinferior instability. The patient was placed in the

Institutional Review Board approval was not required for this case report. The patient gave informed consent for her case to be published.

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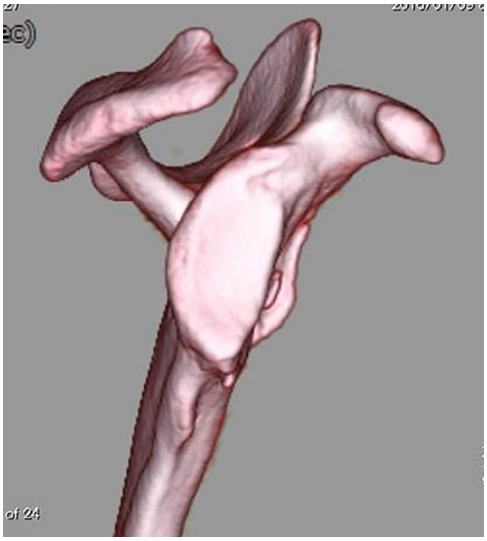

Figure 1 Preoperative 3-dimensional reconstructed computed tomography en face view of the right glenoid shows glenoid defect (bone loss, 36.9%).

beach chair position, and the shoulder, arm, and contralateral knee were prepared and draped in the standard sterile fashion. The arm was secured and held by the arm holder during the procedure.

A 30° arthroscope was inserted into the glenohumeral joint through a posterior portal. An anterior portal and anterolateral portal were established through the rotator interval. A motorized shaver was introduced through the anterior portal, and the rotator interval was débrided until the coracoid could be seen. The glenoid defect, HSL, and other intra-articular pathology were assessed with the probe. A large and deep HSL that engaged with the glenoid was observed. A large bony defect was found at the anteroinferior part of the glenoid (Fig. 2). The anteroinferior glenohumeral ligament (AIGHL) complex was almost detached from the anterior glenoid rim and had lost its tension. Adhesions between the AIGHL and glenoid rim were completely released.

The glenoid was prepared with an arthroscopic rasp and motorized shaver to create a healthy base for graft healing. The I portal was established with an outside-in technique using a spinal needle through the lateral side of the conjoint tendon from the apex of the anterior axillary fold, as described by Lafosse et al.[13] A suture anchor was inserted through the I portal into the lowest point of the bone

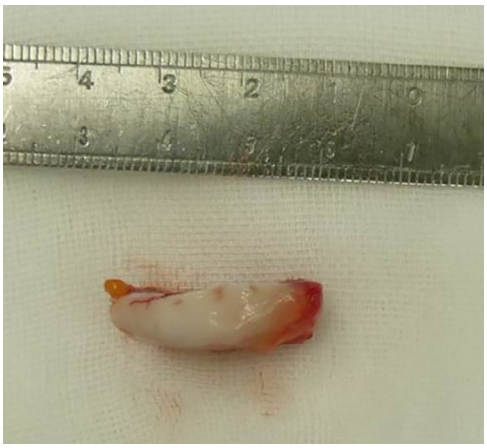

Figure 3 The osteochondral autograft was 20 mm long, 12 mm wide, and 7 mm deep. This graft was harvested from the lateral portion of the contralateral lateral femoral condyle vertex in the transverse plane to reduce the influence of harvesting.

defect of the glenoid to prepare for a Bankart repair. The anchor's suture was passed through the AIGHL for Bankart repair after graft fixation. The vertical length of the bone defect was measured.

A vertical incision was made at the lateral aspect of the contralateral patella. The skin and fascia were divided, and the lateral femoral condyle was exposed. The height of the graft was adjusted to the same height of the glenoid deficiency. The graft was harvested from the lateral portion of the vertex of the lateral condyle, including the cartilage surface and lateral wall, by using an osteotome. The graft was 20 mm long, 12 mm wide, and 7 mm deep (Fig. 3). The autograft was contoured to fit the joint surface and to restore the original shape of the glenoid.

The graft, gripped by the grasper, was inserted into the joint through the expanded anterior portal. A 70° arthroscope was used to visualize the junction of the graft and bone defect. The graft was guided to the most suitable place for joint surface reconstruction and was fixed with 2 Herbert screws anteriorly to posteriorly (Fig. 4). Because the articular cartilage of the femoral condyle covers from the patellofemoral joint surface to a part of the lateral wall, this osteochondral autograft has an articular cartilage not only at the glenoid surface but also at the distal part of the anterior wall of the reconstructed glenoid. One of the screws was inserted superolaterally, from the anterior cartilage side of the graft, and the other inferomedially, from the anterior bony side. The previous suture was

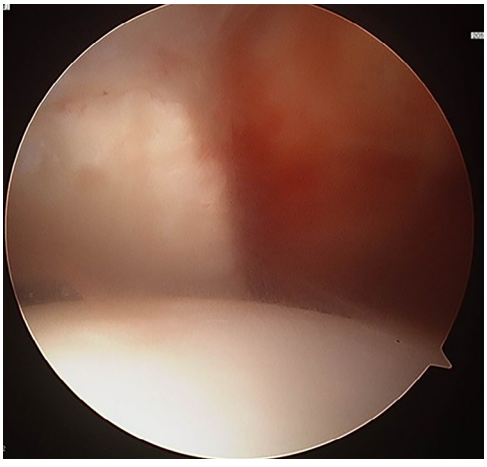

Figure 2 Arthroscopic view from the anterolateral portal shows significant bone loss of the glenoid.

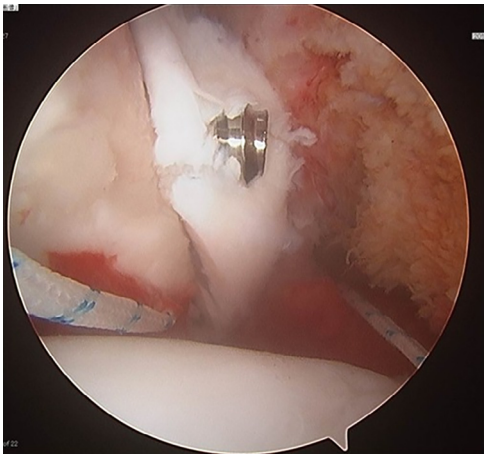

Figure 4 The osteochondral autograft was fixed with a Herbert screw. The lower suture for the Bankart repair is visible.

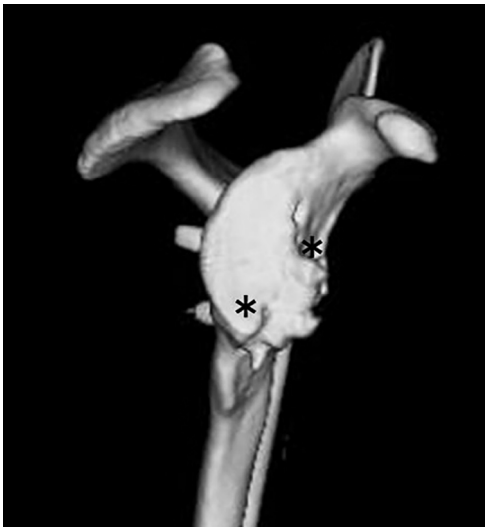

Figure 5 Postoperative 3-dimensional reconstructed computed tomography en face view of right glenoid shows the incorporated remodeled bone graft (bone loss, 11.4%). The *asterisks* mark the anchor holes for the Bankart repair.

tied, and another suture anchor was inserted above the reconstructed region to complete the Bankart repair. The former screw therefore became the intra-articular screw, and the latter screw became the extra-articular screw. After these procedures, the HSL no longer engaged with the reconstructed glenoid. The skin was closed, and a sterile dressing was applied.

Rehabilitation protocol

The shoulder was maintained in a shoulder immobilizer for 4 weeks postoperatively. Other joint exercises were immediately allowed. Pendulum exercise was started at 3 weeks, passive and assisted active joint exercises were started at 4 weeks, and active motion was allowed after 5 weeks. After 8 weeks, the patient began strengthening exercises of the rotator cuff. Return to full activity was allowed after 6 months.

Follow-up evaluation

The most recent clinical examination, 9 months after surgery, showed that the Constant score increased from 54 points preoperatively to 79 points postoperatively, the Rowe score increased from 15 to 95 points, and Japan Shoulder Society-Shoulder Instability Score improved from 34 to 94 points. Her right shoulder had a normal range of motion, there were no episodes of recurrence at the shoulder, and no symptoms of her left knee.

Preoperative and postoperative 3DCT showed that glenoid bone loss decreased from 36.9% to 11.4% at 7 months after surgery (Fig. 5). The CT scan showed a stable autograft, no signs of osteolysis or gap between the autograft and glenoid, and bone formation of the donor site (Fig. 6). The Herbert screws were both protruding posteriorly but were asymptomatic. Because we could not evaluate the survival of the graft cartilage on diagnostic imaging, we decided to perform second-look arthroscopy (Fig. 7) and remove the intra-articular screw to prevent issues within the joint in case of subsequent graft complications. Stability of the transplanted cartilage and repaired AIGHL were confirmed.

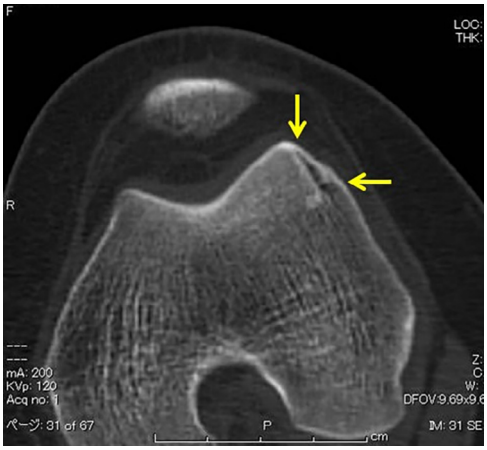

Figure 6 Follow-up 3-dimensional reconstructed computed tomography scan shows the donor site and bone formation (*arrows*).

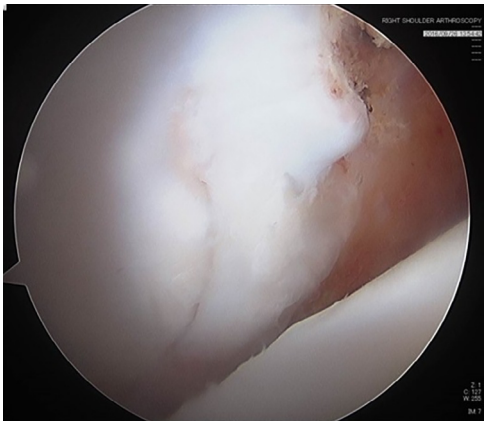

Figure 7 Second-look arthroscopy shows stability of the transplanted cartilage and the repaired Bankart lesion.

Discussion

We performed a new technique of all-arthroscopic glenoid reconstruction for glenoid bone loss in a patient with recurrent anterior glenohumeral instability by using an osteochondral autograft from nonarticular joint surface of the lateral femoral condyle.

Glenoid reconstruction is required in patients with bone loss involving more than 20% to 25% of the glenoid surface.[5,15,19,22] Many techniques have been described to reconstruct glenoid bone loss and are divided into 4 procedures.

The first procedure is a coracoid transfer procedure, either open or arthroscopic, represented by Latarjet or Bristow. Transfer of the coracoid has been used for more than 50 years, with excellent results in shoulder stability and function.[19,23] However, these nonanatomic procedures that transfer the coracoid process carry some risks, including loss of motion, graft nonunion, and secondary osteoarthritic changes.[2]

The second procedure is bone grafting mainly using an autologous iliac crest.[26] Compared with coracoid transfers, these autologous iliac crest grafting procedures are more anatomic, especially in arthroscopic surgery, and are able to preserve soft tissue. Although coracoid transfers and autologous bone grafts are able to reconstruct the glenoid bone stock, articular cartilage is not reconstituted. Thus, potential osteoarthritis is a concern.[14] In long-term radiographic follow-up, the prevalence of postoperative arthritis was 40%,[12]

62%,[1] and 47%[20] with the operative procedures of Bristow, Latarjet, and iliac bone grafting, respectively.

The third reconstruction procedure is osteochondral allograft. A distal tibia osteochondral allograft is a potential graft option for glenoid reconstruction because the distal tibia may have a similar radius of curvature (ROC) as the glenoid.[3,8,9] However, Noonan et al[16] described that tibial plafond and iliac crest allografts more adequately restore depth compared with standard Latarjet reconstruction, whereas congruent arc Latarjet reconstruction more closely restored native glenoid coronal ROC. Decker et al[8] found that although the distal tibia has similar ROC measurements as the glenoid, randomly pairing a distal tibia allograft to a glenoid results in a ROC match within 3 mm in only 22%. Therefore, what the best graft is to reconstruct anterior glenoid bone loss remains controversial.

The fourth procedure of reconstruction for glenoid bone loss is autograft osteochondral reconstruction. Tokish et al[25] proposed the distal clavicular autograft for reconstruction of glenoid bone loss. Distal clavicle excision is a common surgical procedure for the treatment of acromioclavicular joint pathology, and systematic analysis has suggested that open and arthroscopic excisions of the distal clavicle both have high rates of positive outcomes.[17] However, complications associated with open distal clavicle resection have been described, including infections, scar hypertrophy, stiffness, and residual pain.[7,18,21]

Because the femoral condyle is often used as a donor site for osteochondral grafting, we decided to use it as the donor site. To our knowledge, this is the first reported case introducing a new glenoid reconstruction procedure for glenoid bone loss in a patient with recurrent anterior glenohumeral instability using an osteochondral autograft from the femoral condyle. We harvested the most proximal lateral femoral condyle as a graft, because the proximal femoral condyle is slightly flat, nonweight bearing, and the long axis of the lateral condyle is slightly longer than the long axis of the medial condyle in general. Because the cartilage surface of the lateral femoral condyle becomes wider toward the distal portion, the graft was harvested from the contralateral lateral femoral condyle to provide a wider cartilage surface to the inferior glenoid. Moreover, we took the graft from the lateral portion of the lateral condyle vertex in the transverse plane. The harvest site was located outside of the patellofemoral joint and was thus considered to have minimal effect on joint function.

Three factors are believed to be related to osseous stability: the depth, curved articular surface, and arc length of the glenoid.[28] To recreate the glenoid depth and arc length, the graft should be osteotomized from lateral to medial in the anteroposterior direction, thereby adjusting the inclination of the graft. If needed, the graft can be contoured in 3 dimensions with a power burr to fit the shape of the glenoid.[6] In addition, to recreate curved articular surface of the glenoid, the cartilage surface of the graft, especially corresponding to anterior and inferior areas of the glenoid where demonstrated the smallest radii for cartilage,[29] needs to be shaped slightly with a scalpel because the lateral femoral condyle is a convex surface.

This patient had not only a large glenoid defect but also a large HSL. Although Denard et al[10] indicated that the HSL was significantly larger if the time from dislocation until reduction exceeded 5 hours, we could not elucidate why she had a large HSL because the treatment she had received was unclear. Regarding HSL, Yamamoto et al[27] introduced a new concept—the glenoid track—to evaluate whether there is a risk on engagement of the HSL and the glenoid rim. Giacomo et al[11] developed a method that uses the concept of the glenoid track to determine whether a HSL will engage the anterior glenoid rim. An HSL that engages is called an "off-track" HSL; an HSL that does not engage is an "on-track" lesion. According to this evaluation method, the preoperative HSL was determined to be an off-track lesion, which would become an on-track lesion after the glenoid reconstruction if the width of the osteochondral graft exceeded 4.38 mm. Therefore, we did not perform any additional treatment for the HSL, and the engagement did not occur as we expected in our patient. However, if the HSL remains off-track even after the osteochondral autograft, then a remplissage procedure also needs to be performed.

Conclusion

We performed all-arthroscopic glenoid reconstruction using an osteochondral autograft from the contralateral lateral nonarticular femoral condyle, which does not form the original joint surface. In the present procedure, the recovery ratio of the glenoid depends on the width of the lateral aspect of the lateral femoral condyle. Accordingly, the bone defect rate that can be restored is limited. Stability was obtained in this case, however, if off-track lesions remain after the osteochondral autograft, additional treatment for HSL, such as remplissage procedure, is necessary. Longer follow-up and further biomechanical studies are necessary to evaluate graft congruence, graft outcomes and survival, and complication rates, including donor site complications. In summary, this case report presents a new alternative to current techniques that combines AIGHL repair with glenoid reconstruction using nonarticular osteochondral autograft from the knee.

Disclaimer

The authors, their immediate families, and any research foundation with which they are affiliated have not received any financial payments or other benefits from any commercial entity related to the subject of this article.

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