

The Lego Block Technique: A Novel Method of Shaping Autogenous Bone Graft for Narrow Glenoids with Severe Bone Defects in Reverse Shoulder Arthroplasty

Soo-Young Jeong, MD, Il-Han Joo, MD*, Bong Gun Lee, MD[†]

Department of Orthopedic Surgery, Nowon Eulji Medical Center, Eulji University School of Medicine, Seoul,

**Department of Orthopedic Surgery, Medi-In Hospital, Paju,*

[†]Department of Orthopedic Surgery, Hanyang University College of Medicine, Seoul, Korea

In cases with complex glenoid bone defects, bony increased-offset reverse shoulder arthroplasty can restore glenoid bone stock and improve stability using autografts harvested from the humeral head. However, conventional grafting methods may be insufficient when glenoid defects or deformities are complex. We present a novel bracket-shaped bone grafting technique applied in a patient with advanced rheumatoid arthritis and significant glenoid erosion. The graft was sculpted from the resected humeral head to match the glenoid defect in a Lego block-like fashion, resulting in stable fixation and favorable clinical outcomes.

Keywords: Reverse shoulder arthroplasty, Bony increased-offset, Glenoid bone defect, Glenoid deformity, Bone graft

The indications for reverse shoulder arthroplasty (RSA) have expanded in recent years, and it has shown superior outcomes compared to anatomical total shoulder arthroplasty (aTSA), particularly in cases with significant glenoid bone defects.^{1,2)} Although several studies have shown that aTSA provides greater range of motion (ROM) than RSA, in the presence of complex glenoid bone defects, higher rates of glenoid component loosening have been reported with aTSA.^{1,2)} By contrast, RSA offers better glenoid exposure and a wider range of reconstructive options for addressing such defects, which may be advantageous. Two primary methods are used to manage glenoid bone defects: (1) metallic increased-offset reverse shoulder arthroplasty (MIO-RSA) and (2) bony increased-offset reverse shoulder arthroplasty (BIO-RSA).

MIO-RSA achieves lateralization by using a thicker glenosphere or baseplate; however, when severe glenoid bone loss is managed with an excessively thick glenosphere or substantial baseplate augmentation, shear forces at the bone-implant interface may increase, thereby predisposing to glenoid component loosening.^{3,4)} In contrast, BIO-RSA involves harvesting a disk-shaped autograft from the humeral head and securing it beneath the baseplate to achieve lateralization. Once the bone graft successfully unites with the glenoid, it helps reduce torque forces on the glenosphere and contributes to joint stability.⁵⁾

Beyond lateralization, the bone graft can also restore glenoid inclination and version in cases of osteoarthritis, rheumatoid arthritis (RA), or cuff arthropathy, where glenoid wear and bone loss are significant. However, in cases of severe or multiplanar glenoid deformity, conventional rectangular or trapezoidal cylindrical bone grafts may be insufficient for appropriate correction or may not provide firm screw fixation, potentially compromising glenosphere stability.

In this report, we describe a case of BIO-RSA performed in a patient with a severe glenoid defect, in which a bone graft was crafted from the humeral head to pre-

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Correspondence to: Bong Gun Lee, MD

Department of Orthopedic Surgery, Hanyang University College of Medicine,
222-1 Wangsimni-ro, Seongdong-gu, Seoul 04763, Korea

Tel: +82-2-2290-8485, Fax: +82-2-2299-3774

E-mail: orthdr@naver.com

cisely match the defect geometry, similar to building with Lego blocks; at the final 18-month follow-up, the patient showed improvements in pain and ROM, and bone graft union was achieved.

TECHNIQUE

This report was approved by the Institutional Review Board (IRB No. 2025-08-036). As this report used fully anonymized data without identifiable information, the requirement for informed consent for both participation in the study and publication was waived in accordance with institutional guidelines.

A 67-year-old female with a 6-year history of RA presented with severe left shoulder pain and limited ROM. Preoperative plain radiographs showed findings consistent with advanced osteoarthritis, and computed tomography (CT) imaging revealed severe medial glenoid erosion with an anteroposterior (AP) diameter of only 13 mm (Fig. 1). Although magnetic resonance imaging did not show a massive rotator cuff tear, generalized thinning of the rotator cuff was noted, with Goutallier grade II fatty degeneration and moderate atrophy of the supraspinatus muscle.

Due to the severity of the glenoid bone defect, a TSA was deemed unsuitable. Therefore, a BIO-RSA using an Aequalis Reversed II prosthesis (Tornier) was planned

to reconstruct the glenoid bone stock and achieve stable fixation. Under general anesthesia, the patient was placed in the beach-chair position at 30°, and a deltopectoral approach was used. After the humeral head was dislocated from the joint, the surrounding osteophytes were thoroughly removed. Humeral osteotomy was then performed at an appropriate height with 20° of retroversion, followed by canal preparation.

For the glenoid, soft tissue and the labrum were excised, and bone fragments were removed to expose the glenoid surface. As the glenoid AP diameter was approximately 12–13 mm, an autogenous bone graft was prepared from the previously resected humeral head. When preparing the bone graft using the resected humeral head, we determined that a commonly used disk-shaped or trapezoid-shaped bone block would not be appropriate for this patient. A bone block was needed that could restore both the anterior and posterior glenoid defects, achieve lateralization of the glenosphere, and at the same time provide firm fixation. Therefore, we decided to create a 3-sided or bracket-shaped structure that could be fitted into the remaining glenoid, similar to assembling puzzle pieces or Lego blocks. Referring to the preoperative CT images, we harvested a bone block of the required thickness from the humeral head using a saw with a freehand technique. A central hole was then made using a central peg drill to al-

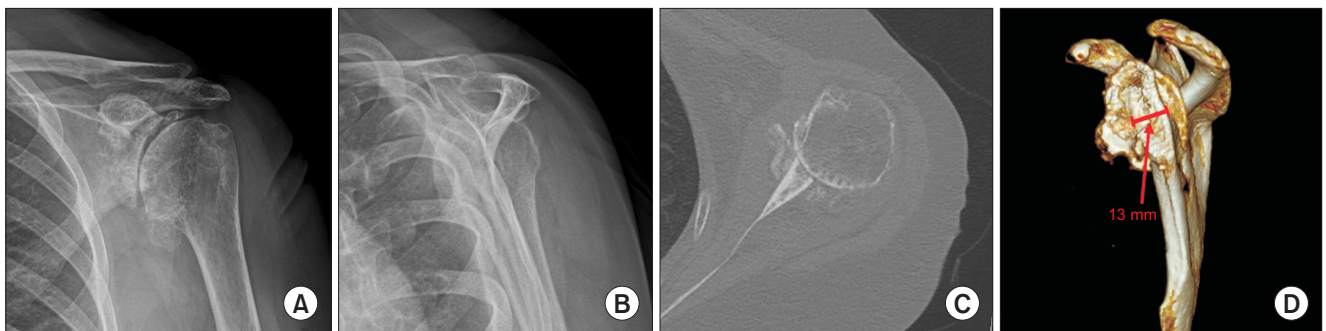


Fig. 1. (A, B) Preoperative radiographs showed joint space narrowing, subchondral sclerosis, and large osteophytes. (C, D) Computed tomography images showed the maximum glenoid anteroposterior diameter was only 13 mm due to bone defect.

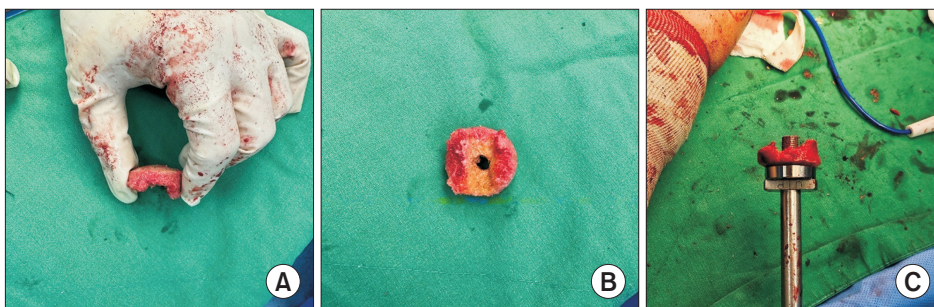


Fig. 2. (A, B) A bracket-shaped bone graft was sculpted from the autogenous humeral head. (C) The bone graft was mounted onto the peg of the glenoid baseplate and precisely fitted into the glenoid defect.

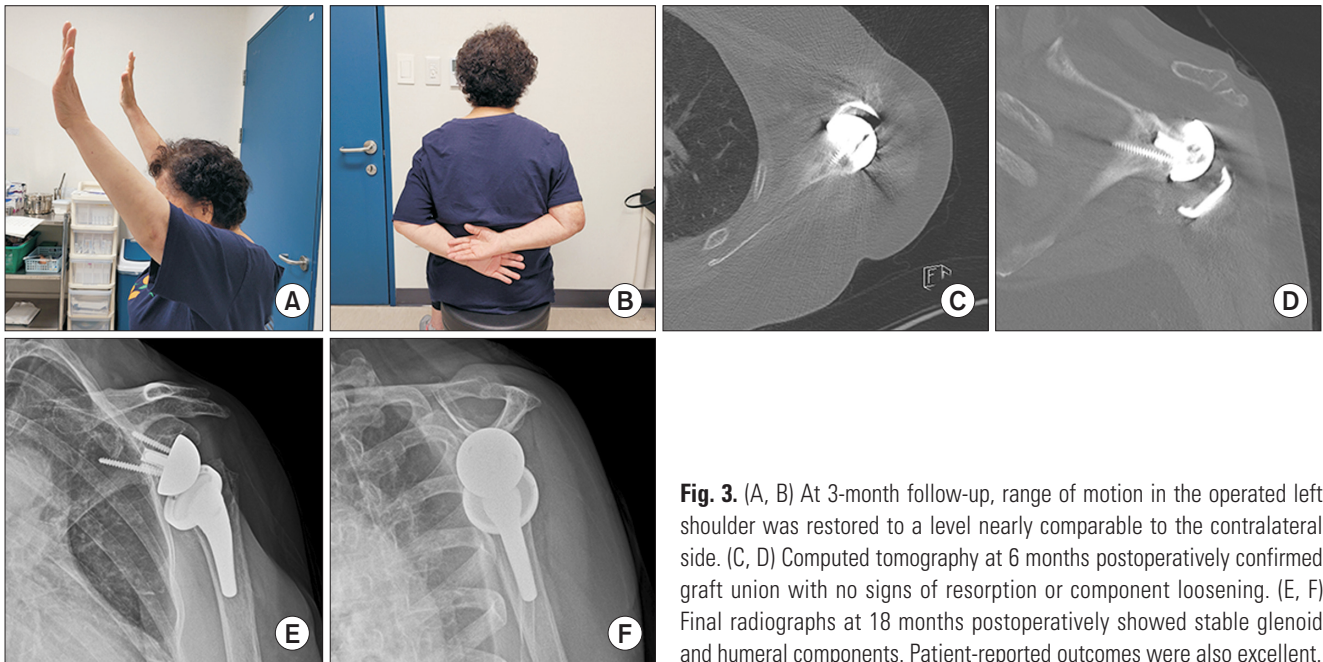


Fig. 3. (A, B) At 3-month follow-up, range of motion in the operated left shoulder was restored to a level nearly comparable to the contralateral side. (C, D) Computed tomography at 6 months postoperatively confirmed graft union with no signs of resorption or component loosening. (E, F) Final radiographs at 18 months postoperatively showed stable glenoid and humeral components. Patient-reported outcomes were also excellent.

low insertion of the baseplate's central peg. Subsequently, using a rongeur, we created a groove in the center of the bone block corresponding to the AP diameter of the glenoid, thereby shaping it into a bracket-like form (Fig. 2)

After confirming that the graft could fit firmly, it was mounted on the baseplate and inserted into the glenoid. The baseplate was fixed using 3 screws. After inserting a 36-mm glenosphere, the humeral component (stem: 70 mm, 132.5°; polyethylene thickness: 9 mm) was implanted with appropriate tension. The previously detached subscapularis was then repaired.

Given the patient's poor bone quality due to RA, an abduction brace was used for 8 weeks. postoperatively, followed by gradual rehabilitation starting with passive ROM exercises. At 3 months postoperatively, the patient demonstrated a ROM comparable to the contralateral shoulder; at 6 months, CT imaging showed complete graft union; and at 18 months, plain radiographs demonstrated stable glenosphere positioning (Fig. 3). Union was defined radiographically as continuity of at least 3 cortices on AP and lateral views. The patient was followed up for 18 months postoperatively, but has had difficulty continuing follow-up due to other general health issues. Nevertheless, at the final follow-up, the patient demonstrated favorable clinical outcomes: forward flexion improved from 90° to 130°, external rotation with the arm at the side from 30° to 50°, internal rotation to posterior from the buttock to L1, and the visual analog scale score decreased from 8 to 2. She also reported a high level of satisfaction with the surgery.

DISCUSSION

Boileau et al.⁵⁾ first reported short-term outcomes of BIO-RSA in 2011 and later presented 5- to 10-year follow-up data in 2020.⁶⁾ In that study, a total of 143 shoulders were ultimately analyzed. The results for ROM and subjective scoring were excellent. Most notably, complete union of the bone graft site was achieved in 96% of the cases. This finding is remarkable, as it indicates that even in the presence of a glenoid bone defect, it is possible to restore the glenoid to a surgically favorable form using a bone block graft of appropriate shape and size. It also suggests that RSA can be performed without the need for additional metallic augmentation, thereby offering shoulder surgeons a broader range of surgical options.

However, in that study, only simple rectangular or trapezoidal cylindrical bone grafts were used. It is questionable whether such a simple rectangular or trapezoidal bone graft would have been sufficient to adequately treat our patient's case. The case presented in this report was highly challenging, as preoperative evaluation suggested that there was only a single feasible point for inserting the central peg of the glenoid baseplate. However, building on Boileau's BIO-RSA, we further developed the technique by shaping the humeral-head autograft into a bracket-like construct, which provided graft stability and enabled firm baseplate fixation. Moreover, the bone block achieved contact not only with the articular surface but also with the anterior and posterior glenoid, potentially increasing

union rates.

Upon reviewing other literature, there were no techniques like ours, in which the bone block is crafted into a bracket shape and inserted into the glenoid in a Lego block-like fashion. Gutowski et al.⁷⁾ reported a single patient, bilateral case in which RSA was performed with a metallic augmented glenoid component planned using 3-dimensional (3D) software on 1 shoulder, and with a patient-specific, customized 3D-printed glenoid component on the contralateral side. Custom-made prostheses provide defect-specific shapes that are particularly suitable for extensive bone loss and obviate the risk of graft-resorption-related loosening inherent to bone grafting. However, they entail higher costs than conventional implants and may increase shear at the bone-implant interface due to greater lateralization of the center of rotation.

Franceschi et al.⁸⁾ introduced a bone autograft shaping technique for BIO-RSA in 2024. Although they also used a trapezoid-shaped bone graft, it is noteworthy that they utilized patient-specific instrumentation (PSI) software to create a 3D model of the scapula based on preoperative CT scans, allowing them to adjust the anterior and posterior thickness of the graft and to plan its size and shape through computer-assisted methods. The graft then was harvested and shaped using a freehand technique.

In our case, although we referred to preoperative CT for planning, we did not use 3D computer-assisted planning or PSI. Even with precise preoperative planning, some degree of error is inevitable when shaping the graft using a freehand technique. Our primary goal was to create a shape that would fit tightly to the glenoid AP diameter. For this reason, we believed that intraoperative measurements and judgment were more important than relying solely on preoperative planning.

Hendel et al.⁹⁾ have shown that PSI can improve glenosphere positioning, and a recent study by Yelton et al.¹⁰⁾ in 2024 reported that 3D planning alone (even without PSI) yields results comparable to PSI-assisted procedures. Therefore, we believe that incorporating PSI and 3D computer-assisted planning in this technique may allow more

precise bone graft shaping and facilitate screw positioning, potentially improving surgical outcomes.

This technique offers several advantages: (1) The Lego-like bone graft can be shaped in various ways to adapt to narrow or deformed glenoid defects, offering wide applicability. (2) It allows simultaneous correction of glenoid deformity and restoration of bone stock. (3) A tightly interlocking fit with the glenoid may provide sufficient initial stability, even when screw fixation is suboptimal. Technical tips for this procedure include: (1) The humeral head should be cut with sufficient thickness to ensure that the graft's cutting surfaces retain an adequate amount of cancellous bone. (2) Soft tissues, bone fragments, and osteophytes surrounding the glenoid should be meticulously debrided to obtain optimal graft fitting. (3) When creating the groove in the graft, it should be shaped to match the glenoid contour as closely as possible. If the groove is too wide, the graft may lack stability upon insertion; if too narrow, insertion may not be possible.

Lastly, we believe that combining this technique with PSI software and 3D computer-assisted planning could enable the creation of more precise and accurate bone blocks, facilitate optimal glenosphere positioning, and ultimately lead to improved clinical outcomes. In particular, this technique may be useful in shoulders with complex glenoid bone defects or deformity, including severe osteoarthritis, RA, post-infectious sequelae, and revision cases.

CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

ORCID

Soo-Young Jeong <https://orcid.org/0000-0002-4513-0461>
 Il-Han Joo <https://orcid.org/0000-0002-8513-0298>
 Bong Gun Lee <https://orcid.org/0000-0002-4003-5529>

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