

Reverse shoulder arthroplasty using a “L” shaped allograft for glenoid reconstruction in a patient with massive glenoid bone loss: case report

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Abstract. – Primary reverse total shoulder arthroplasty (RSA) has demonstrated to relieve pain, restore function and active elevation in patients with Cuff Tear Arthropathy. This condition of muscular imbalance could lead, in the long-term, to morphologic changes of the glenoid’s anatomy. Insufficient bone stock of glenoid is a major challenge and without reconstruction, may be inadequate to support a glenoid component. Many authors have proposed the use of a bone graft in these cases and different techniques have been described to reconstruct severe bone loss of the glenoid but no ideal approach has currently been identified. We report the use of a “L” shaped frozen allograft for glenoid reconstruction in a patient with massive, uncontained glenoid bone loss, undergoing a reverse shoulder arthroplasty in a “one step” procedure. At 1-year follow-up both x-rays and CT showed graft incorporation with no resorption of bone and the patient reported continued stability of the shoulder and a high-level of satisfaction in terms of pain and function.

Key Words:

Reverse shoulder arthroplasty, Allograft, Glenoid bone loss.

Introduction

In 1983, Neer et al described the clinical and pathological features of a condition called cuff tear arthropathy¹. This can result in some patients having end-stage osteoarthritic disease with concomitant pain and loss of function and independence. Primary reverse total shoulder arthroplasty has demonstrated to relieve pain, restore function and active elevation in these patients²⁻⁶. However, the long-term consequences of muscular imbalance are manifested in distinct morphologic changes of the glenoid’s anatomy. These

defects of the glenoid pose a difficult reconstructive problem for surgeons attempting to provide a stable glenoid with sufficient bone stock. Many authors described this situation in both native and revision glenoids⁷⁻¹¹. Different techniques have been described to reconstruct severe bone loss of the glenoid but no ideal approach has currently been identified^{6,7,10,12-20}. Structural allografts can be an option of treatment in these cases. In this article, we report the use of a “L” shaped frozen allograft for glenoid reconstruction in a patient with massive, uncontained glenoid bone loss, undergoing a reverse shoulder arthroplasty in a “one step” procedure.

Case Report

A 67-year-old right-handed man presented to the senior author (CFDB) in October 2012 with pain and function impairment of the right shoulder. The patient outlined his medical history beginning with symptoms 5 years prior. Unfortunately his pathology was understated, leaving him undiagnosed until this time. On examination, his right arm was held in internal rotation against his stomach, with swelling around his deltoid. His shoulder was tender to palpation, warm to touch and during range of motion (ROM) testing, severe restrictions and pain were exhibited, with a Constant Score of 15. He maintained full elbow, wrist, and hand ROM. Radiographs revealed CTA with grade E3 glenoid erosion according to Sirveaux classification⁵ and severe arthritis with erosion of the humeral head and AC joint. The MRI showed the joint swelling and a massive rotator cuff tear with a Goutallier²¹ grade 4 fatty degeneration of cuff muscles (Figure 1). We performed an arthrocentesis with aspiration of 60 cc of bloody joint fluid, analyzed to exam-

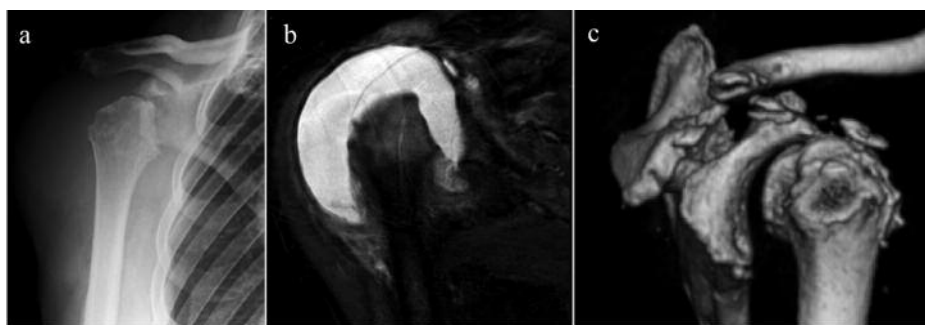


Figure 1. *A*, Preoperative x-ray *B*, MRI showing joint swelling *C*, 3d-CT scan showing erosion of the gleno-humeral joint.

ine possible causes of arthritis, such as infection, gout, MTB and rheumatoid disease. The patient did not exhibit any clinical, serologic, or culture evidence of infection at any time. The computed tomography with 3-dimensional reconstruction images showed the humeral head erosion and a large glenoid defect encompassing approximately 70% of the glenoid surface (Figure 1).

Because of the patient's age, persistent pain, recurrent instability and massive cuff tear, RSA was recommended. The large glenoid defect was also addressed to prevent instability of the prosthesis and to optimize the position of the baseplate. On the basis of the 3D CT Scan, a "L" shaped frozen allograft was used to restore the glenoid bone stock. A base plate was customized uniquely for this case by LIMA (Lima-LTO, San Daniele del Friuli, Italy), featuring a lengthened Trabecular Titanium central peg (18 mm) for fusing the allograft to the native glenoid in this "one step" procedure.

Surgical procedure was carried out in general anesthesia with the patient in the beach chair position. Anterior delto-pectoral approach was performed to expose the gleno-humeral joint. Total absence of the Subscapularis tendon was observed. After the arthrotomy, the shoulder joint was dislocated and a humeral head osteotomy with 10° retroversion was performed to achieve the optimal humeral implant stability. Thus, we performed a 360° glenoid capsulectomy, positioning a blunt Hohmann retractor under the lower rim of the glenoid, protecting the axillary nerve. A cortical-cancellous bone allograft was harvested from fresh-frozen femoral head. It was prepared to the exact shape of the glenoid defect using a base plate reamer (Figure 2). Meanwhile, a complete debridement of the glenoid was carried out and the sclerotic bone removed until slight bleeding, revealing a stable bone surface. Subsequently, the allograft was temporary positioned and fixed with two threaded guidewires.

We positioned the glenoid bone-prosthesis interface laterally with the graft to the level of the base of the coracoid. The contact surface between the allograft and the glenoid were perfectly reduced to permit axial compression. The allograft was "L" shaped such that the stronger calcar bone of the femoral neck was placed inferiorly to restore the inferior glenoid pillar. Graft and baseplate fixation were achieved using a lengthened Trabecular Titanium central peg (18 mm) and two cancellous screws 6.5 mm in diameter and 30 mm in length (Figure 2) to secure axial



Figure 2. *A*, preparation of the graft using a base plate reamer *B*, L shaped allograft *C*, baseplate and graft implantation.

compression of the construct on to the native glenoid. The superior screw was placed with an anterosuperior direction towards the base of the coracoid, while the inferior screw was placed perpendicular to the baseplate or parallel to the central peg. The 44-mm eccentric glenosphere was assembled with the base plate, lowering the COR by 4 mm. Covering and therefore protecting the glenoid implant, the humeral shaft was rotated externally. It was then prepared with rasps for non-cemented stem implantation of 14 mm diameter and short metal liner.

The implant was then reduced. Intraoperative stability and ROM were then assessed. A drain was used to reduce the risk of postoperative haematoma or seroma formation. The deltopectoral interval was not sutured and closure was initiated with the overlying fascial layer. All layers were then sutured. A 15° external rotation abduction sling was fitted immediately in the operating room.

The patient had an uncomplicated postoperative hospital course and the sling was maintained for the first 4 weeks. Physical therapy was performed with pendulums. Passive external rotation to 30° and passive forward elevation in the scapular plane to tolerance were permitted. At 4 weeks postoperatively, ROM was progressed to tolerance. At 8 weeks postoperatively, gentle and progressive strengthening commenced, progressing to terminal stretches.

At 1-year follow-up, the patient showed 150° abduction, 160° flexion, 15° of external rotation and internal rotation to L1 with a Constant score of 66. He reported continued stability of the right

shoulder and a high-level of satisfaction in terms of pain and function. At follow up, both x-rays and CT showed graft incorporation with no resorption of bone (Figure 3).

Discussion

We report the use of a RSA with reconstruction of the glenoid bone loss using a “L” shaped frozen allograft combined with a custom made base plate with a lengthened Trabecular Titanium central peg in a “one step” procedure.

Until recently, few options were available for treating rotator cuff deficient paraparetic shoulders. Hemiarthroplasty may provide some pain relief to these patients, but functional outcomes are poor. Other options, including fusion and resection arthroplasty, are far from ideal^{22,23}.

The reverse shoulder prosthesis developed by Grammont in 1985 has been shown to relieve pain and improve function in shoulder arthritis associated with massive rotator cuff tears. The survival rate in these cases have been reported to range from 89% to 91% at 10 years²⁴.

Many problems related to this prosthesis implantation can invalidate the clinical outcome and can lead to a failure. These are mainly related to the glenoid component with a high risk of mobilization due to shear forces. A good glenoid bone stock is mandatory to ensure the survival rate of the implant. Insufficient bone stock of glenoid is a major challenge and without reconstruction, may be inadequate to support a glenoid component. It can result from degenerative

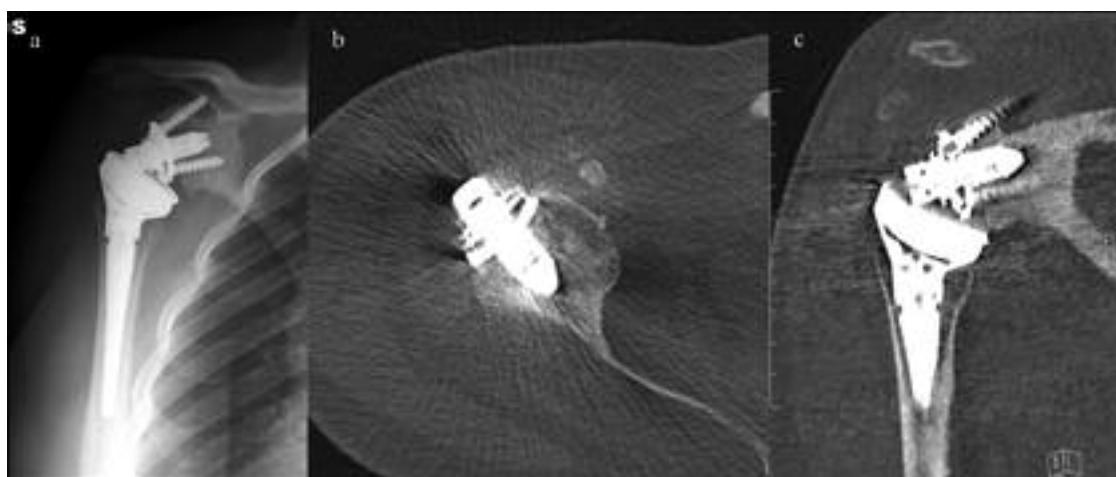


Figure 3. *A*, 1 year follow-up x-ray *B* and *C*. CT scan shows graft incorporation.

arthritis, component loosening or extraction and fracture. Approximately 15% of primary reconstructions will require bone grafting, and the rate is higher in case of revision surgeries²⁵.

Many authors have proposed the use of a bone graft in these cases to restore the glenoid surface^{1,25,26}. Minor glenoid deficiency can be overcome by a modified reaming technique in which a cannulated reamer is directed down the centerline of the scapular spine. This allows correction of 34 of 56 glenoid deficiencies in a recent case series. If eccentric reaming does not allow 80% bony coverage of the glenoid base plate, augmentation with humeral head bulk autograft provides satisfactory results²⁷.

For massive uncontained glenoid lesions and concomitant massive rotator cuff tear, a femoral neck allograft centrally packed with a humeral head autograft can be used to augment the glenoid bone stock for the glenosphere. The results of this technique have been reported in 5 patients with a minimum 1-year follow-up. Computed tomography scans at 6 months showed complete graft incorporation in all cases, but no pain or functional outcomes were reported²⁸.

Boileau et al proposed the routine use of bone grafting to improve the outcomes of reverse TSA. The technique is called bony increased-offset reverse shoulder arthroplasty, or Bio-RSA¹⁴. A cylinder of cancellous bone from the humeral head is cut with a guide to exactly match the size of the glenoid base plate. A central hole is then drilled in the disk of bone to allow it to slide over the central peg of the glenoid. By providing bony lateralization, this is hypothesized to reduce scapular notching, improve shoulder contour, and allow for a greater arc of motion. Once the graft incorporates, these benefits are achieved without increasing torque at the baseplate-bone interface, as it may occur with prosthetic lateralization.

Boileau et al reported their results with Bio-RSA in 42 patients with a minimum 2-year follow-up. Computed tomography and radiographic evaluations showed complete graft incorporation in 98% of the patients. In addition, 86% of the patients could internally rotate sufficiently to reach their back over the sacrum. Scapular notching occurred in only 19% of patients, as compared with the 50% to 90% reported in the literature²⁹. No graft resorption or glenoid loosening were observed during the short-term follow-up¹⁴.

When faced with glenoid deficiency in revision reverse TSA, the humeral head is absent, and an alternate source of bone graft is needed.

Satisfactory results have been obtained with the use of autologous iliac crest structural graft. Kelly et al first described the technique for using an iliac crest-glenoid baseplate composite. The baseplate is implanted directly onto the pelvis, and the iliac crest is then cut and fashioned to match the glenoid defect. They reported the results of this technique in 12 patients as part of a larger series of 30 revisions reverse TSAs. The Constant and American Shoulder and Elbow Surgeons scores improved significantly. Eighty percent of the patients were satisfied or very satisfied, according to authors' criteria³⁰.

Neyton et al reported 9 reverse TSAs using iliac crest autograft, 6 of which were revisions or conversions of conventional implants. At 2-year follow-up, 5 patients were pain free (visual analog scale score, 0/10), 1 patient had significant pain (visual analog scale score, 8/10), and 3 patients had moderate pain (visual analog scale score, 2-5/10). All patients could elevate the arm at at least 90°. According to authors' criteria, 4 patients were very satisfied, 3 were satisfied, and 2 were disappointed. No evidence of component loosening or graft failure was found¹⁰.

In our case, on the basis of the 3D CT Scan, we planned a "L" shaped frozen allograft to restore the glenoid bone stock. We decided to use a femoral allograft because, beside the risk of non-integration, it has superior structural properties compared to the iliac autograft used by other authors. Biomechanical studies have demonstrated that the compressive strength of a cortical femoral allograft is between 10 and 35 times more than that of an iliac graft³¹. Moreover using a frozen allograft allows choosing the size and the shape of the implant without the problem related to the autologous site morbidity.

A base plate was specifically customized for this case by LIMA Corporate (Udine, Italy), with a lengthened Trabecular Titanium central peg (18 mm) for directly synthesizing the allograft to the native glenoid in a "one step" procedure according to Norris et al. technique³².

We used a long-pegged option for the glenoid base plate to ensure that a minimum of native glenoid is accessed for immediate secure fixation and early ingrowth. We used 2 screws to secure the baseplate and to capture the best quality bone, in an attempt to prevent crowding, fracture of the allograft, or failure of the construct. This can be considered an area of concern of our technique although there are no data in the literature on the optimal number of screws to be used. The 3 columns

first proposed by Humphrey et al reliably identify areas of maximum scapula thickness³³.

We found that the inferior scapular pillar provides good fixation for the lower screw, and the coracoid base for fixation of the superior screw.

The goal of arthroplasty in case of massive glenoid bone loss is to create a stable construct resulting in pain-free, improved functionality of the shoulder joint. The use of an allograft construct appears to be a useful and flexible technique. It allows a 1-stage reconstruction of most massive uncontained glenoid defects and permits the implantation of RSA. At 1-year follow-up the patient presented a Constant score of 66, stability of the right shoulder and a high-level of satisfaction in terms of pain and function. At follow-up the x-rays and CT scan showed graft incorporation with no bone resorption (Figure 3). In literature there are few cases which report the use of RSA with femoral allograft used to fill up uncontained glenoid bone loss^{25,27}. The goal of any arthroplasty in cases of massive glenoid bone loss is to create a stable construct to allow the implantation of a viable prosthesis with the end result of pain-free, improved functionality of the shoulder joint. The use of a femoral allograft, reconstructed on the basis of the 3D CT Scan appears to be a useful technique that allows the 1-stage reconstruction of an uncontained glenoid defect and permits the implantation of RSA. The only limit is that it is a challenging procedure, for expert shoulder surgeons and its not easily reproducible.

Conflict of Interest

The Authors declare that there are no conflicts of interest.

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