Reverse Allograft-Prosthesis Composite with Pectoralis Major Transfer After Shoulder Osteosarcoma

A Case Report

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Abstract

Case report: We present a case of a 30-year-old man with proximal humerus osteosarcoma and periarticular soft-tissue involvement. Severe humeral and glenoid bone loss was observed, with nonfunctional deltoid after limb-sparing resection and a failed attempt of stabilization. The shoulder was reconstructed using a reverse allograft-prosthesis composite, with deltoid reconstruction by pectoralis major transfer.

Conclusions: To the best of our knowledge, this is the first time that this reconstruction technique has been reported in an oncological patient. Favorable clinical and radiological results were achieved at the 24-month follow-up.

The proximal humerus is one of the most common sites for a high-grade malignant bone tumor in adults[1]. In recent years, the amputation rate in such cases has been reduced to ~5%, which should be considered a great achievement. Because of this progress, limb-sparing resections have become the treatment of choice[2]. However, the reconstruction of

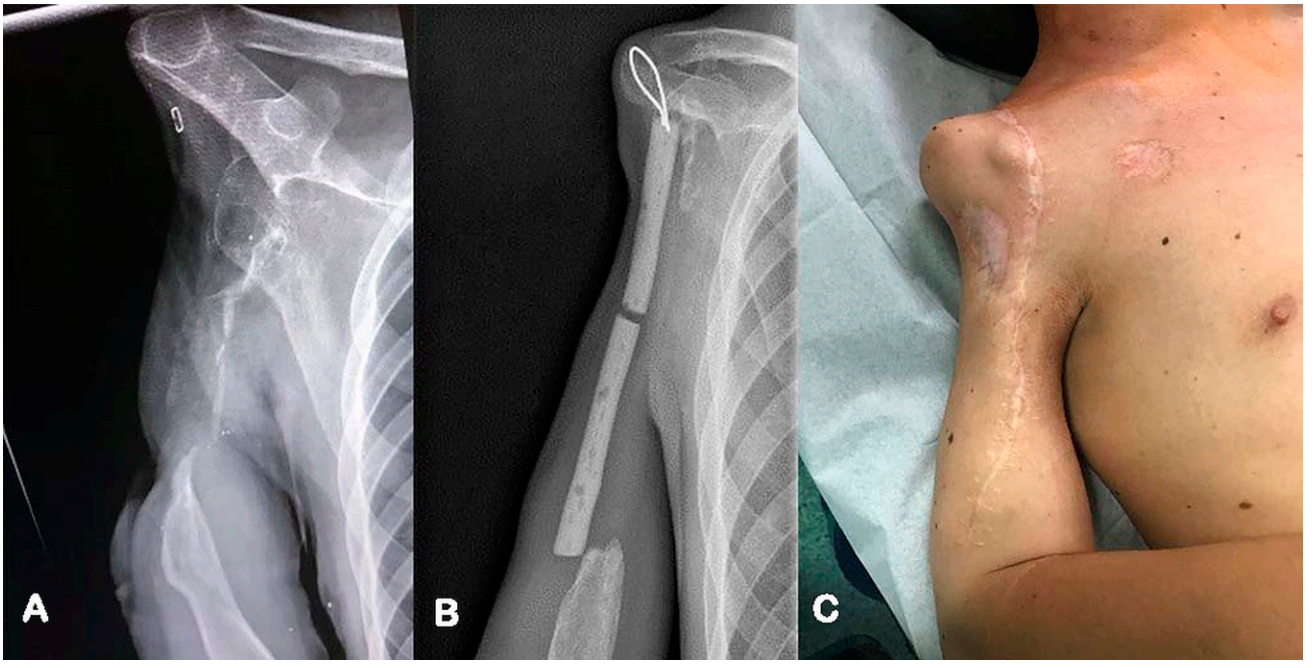

Fig. 1

Fig. 1-A Postoperative x-ray after the resection of the tumor (2009) shows a loss of 18 centimeters of humeral bone substance; **Fig. 1-B** anteroposterior view of the right humerus (2016) with the cement spacers; **Fig. 1-C** physical examination (2018) showing the deformity of the shoulder and the absence of deltoid muscle.

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the proximal humerus after a tumor resection remains a challenge for the orthopaedic surgeon because the glenohumeral joint functionality depends on a complex stabilization system, both static and dynamic, including the periarticular soft tissues that are often sacrificed during the resection.

Consequently, the joint function is impaired by a limitation of the articular range of motion and increased instability of the shoulder. Therefore, several treatments have been suggested to manage these reconstructive challenges, including allograft arthrodesis, fibular autograft arthrodesis, clavicular pro humeri reconstructions, osteoarticular allografts, anatomical and reverse prostheses, and allograft prosthetic composite (APC) reconstructions[3,4], but there is still no consensus on the gold standard.

The patient was informed that data concerning the case would be submitted for publication, and he provided consent.

Case Report

A 30-year-old, right-handed man—a high-performance athlete (indoor rower)—suffered a pathological fracture of the proximal right humerus in 2009, with a diagnosis of osteogenic osteosarcoma confirmed by biopsy. Neoadjuvant therapy treatment was completed (6 cycles), with a regimen of methotrexate, doxorubicin, and cisplatin. Afterward, a resection of the tumor was performed, removing the upper two-thirds of the humerus with a loss of 18 cm of bone substance, scapular glenoid and periarticular soft tissues (Fig. 1-A).

A biopsy confirmed the diagnosis of osteogenic osteosarcoma with soft-tissue extension and negative margins. In the evaluation of systemic disease, hepatic and right lung nodules were found. Regression and stabilization were achieved through neoadjuvant chemotherapy, but renal insufficiency developed. Because of this, adjuvant chemotherapy was not used.

An initial stabilization attempt was performed in 2016 through intramedullary nailing with graft and clavicle fixation, which developed an infection. Because of this, they were eventually removed and replaced with cement spacers with antibiotics (Fig. 1-B). At this point, the shoulder was also stabilized with an orthosis.

In 2018, after having resolved the infection, the deformity of the shoulder was observed by physical examination (Fig. 1-C). We noted a loss of the shoulder contour due to extensive bone resection and the absence of the deltoid muscle. The terminal branches of the brachial plexus were spared during the tumor resection, and the patient presented with a full range of elbow, wrist, and hand motion. However, shoulder movement was not possible because of the complete absence of the shoulder joint. The Shoulder Subjective Value (SSV) score was 10%, and the Disabilities of the Arm, Shoulder, and Hand (DASH) score was 63.3. In the same year, a reverse APC was performed, with the reconstruction of the deltoid using a pectoralis major transfer.

Initially, a reverse total shoulder arthroplasty (RTSA) with a metal back size 44 and a glenosphere 39 with an inferior

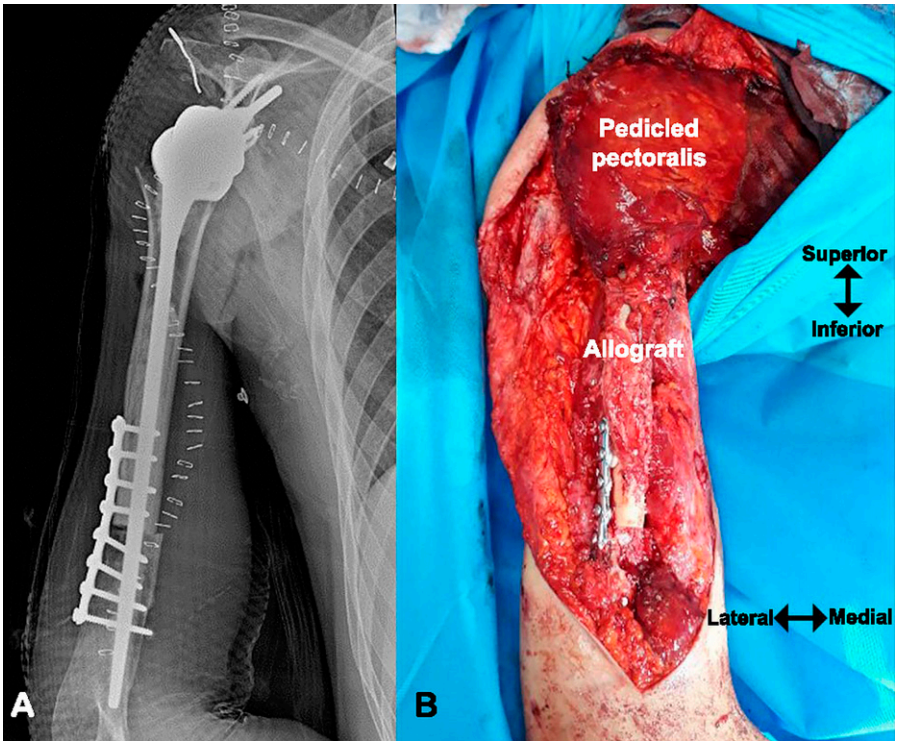

Fig. 2

Fig. 2-A Postoperative x-ray, showing the result of the reverse allograft prosthetic composite and a support lateral plate of 8 screws; **Fig. 2-B** the deltoid was reconstructed with a flip-flap pedicled pectoralis major transfer (the 3 bundles), with transosseous fixation.

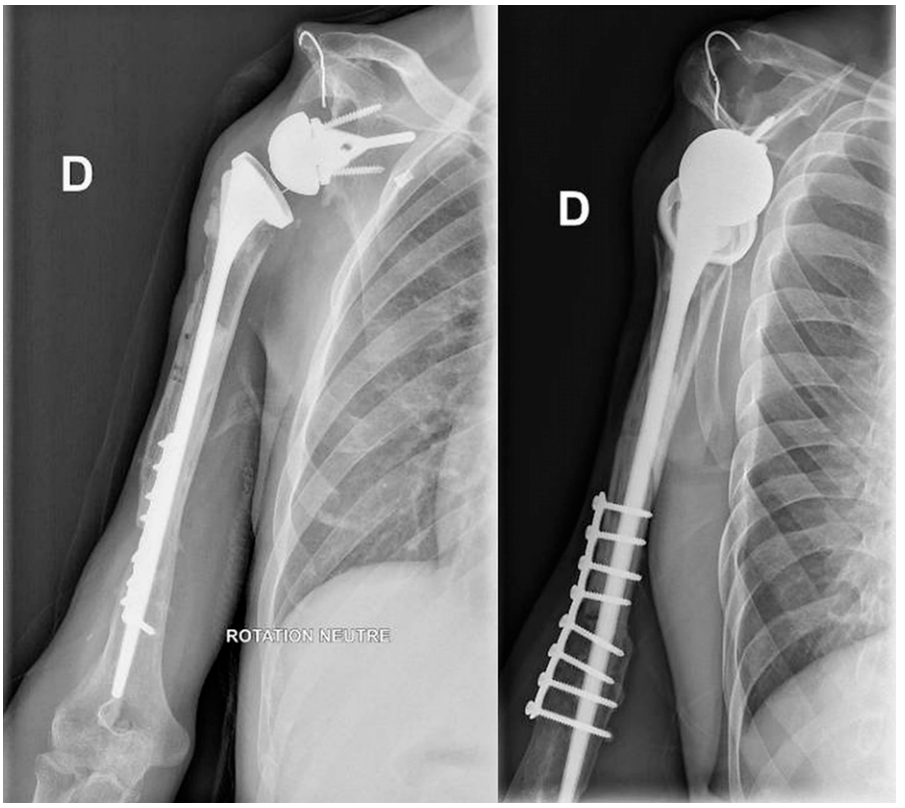

Fig. 3

Views of the right humerus postoperative follow-up, with the consolidation of the graft, without recurrences anteroposterior view (left); outlet view (right).

tilt of 5° was implanted. Then, a stem 270 size 8 cemented into a tibial bone allograft of 18 cm and into the proximal healthy part of the humerus was used to restore the length of the arm (a contralateral humerus scale was performed during the preoperative planning). Subsequently, a plate and 8 screws were used for fixation for the tibial allograft and native humerus (Fig. 2-A). The 3 deltoid bundles were reconstructed with a flip-flap pedicled pectoralis major transfer, with transosseous fixation (Fig. 2-B).

Finally, the shoulder was stabilized with an orthosis in neutral rotation. This was maintained for 6 weeks, and a passive range of motion was started for 2 months. Aquatherapy and active range of motion with reinforcement of the pectoralis major were started after 3 months.

After a 24-month postoperative follow-up, there was no recurrence of infection and no postoperative complication. The patient improved, without resting pain, with nonpainful passive and assisted active ranges. On examination, the shoulder contour was recovered and the joint was stable. The forward active elevation was 70°, and the active external rotation with the elbow at the side was 20°, with active internal rotation to L3 level. The patient presented a normal distal neurological state, a complete range of elbow motion, with normal pronosupination of the forearm, as well as a normal function of the hand. The SSV score was 60% and the DASH score was 37.6, presenting good functional capacity for daily life activities and low demand recreational activities. In the 24-month postoperative x-ray, we observed consolidation of the graft, without recurrences (Fig. 3).

Discussion

Tumors of the appendicular skeleton commonly affect the proximal humerus, and complete resection alters shoulder function. There is no consensus regarding the best reconstructive technique after proximal humerus resection. Many different options have been described, which should consider the following objectives[5]:

1. Stability of the glenohumeral joint, allowing the functionality of the elbow and the hand.
2. Pain control.
3. Restoration of passive and active mobility.

The APC can be used to reconstruct both the humeral and glenoid loss. Its benefits include avoidance of articular surface collapse (as in osteoarticular allograft cases), the potential repair of the soft tissues to the allograft, and the possibility of using any type of prosthetic design for reconstruction of the shoulder joint[6,7]. As the resection often compromises the rotator cuff function and implant fixation, the use of a reverse APC is particularly suitable in these circumstances, compensating both the cuff insufficiency and the glenoid and proximal humeral bone loss. In terms of survival and local recurrence of the RTSA, the

general results are comparable with those of the conventional prosthesis[8]. There is also no evidence of a specific perioperative complication with an acceptable rate of overall complications[9,10].

Nonunion is a problem associated with APC, and there are several options that might be used to help avoid nonunion. For example, the use of a longer unicortical plate or a dual orthogonal plating to help with rotational control[11], the use of a dovetail instead of a linear cut, and the addition of a strut allograft with cables to decrease the stress or a long stem that goes beyond the host bone-allograft junction[5]. In this case, a combination of these strategies was used to reduce the risk of nonunion.

Another major clinical problem is shoulder instability. Higher rates of instability have been reported using conventional endoprosthetic reconstruction (28-76%)[12-14]. On the contrary, in reverse APC reconstructions, the instability rates are lower (10-30%)[15,16].

We decided to use a reverse APC mainly because of its functional results. Historically, anatomic prostheses and APC anatomic reconstructions have had limited functional results, with active abduction and forward elevation lower than 90°[17]. However, in reverse APC, excellent results on active abduction and forward elevation (157° and 122°, respectively) have been reported[16-19].

Likewise, the lateralization of the center of rotation in RTSA offers different advantages to the traditional Grammont-style prosthesis, such as reducing the scapular notching, increasing the compression of the humeral component on the glenosphere, and improving the contour of the shoulder, thus increasing the prosthesis stability[20,21].

Altogether, the deltoid muscle is the main dynamic stabilizer and the functional motor that moves the shoulder with an RTSA. Hence, the absence of deltoid or deltoid paralysis has traditionally been a contraindication for RTSA because of shoulder dysfunction and instability[22]. Recently, Elhassan et al.[23] used the upper portion of the pectoralis major to recreate the anterior deltoid in patients with deltoid paralysis, thereby providing the same biomechanical advantages in RTSA. These authors demonstrated a significant improvement in terms of pain, SSV score, and DASH score. Furthermore, noticeable improvements were seen in the shoulder range of motion with a mean flexion of 83° and external rotation of 16°. In the presented case, the 3 deltoid bundles were reconstructed with a flip-flap pedicled pectoralis major transfer with transosseous fixation to obtain the biomechanical advantages of the deltoid muscle in RTSA, thus improving the functionality and quality of life of our patient.

Conclusion

Here, we have reported the case of a young and active patient with severe humeral and glenoid bone loss and nonfunctional deltoid after limb-sparing resection due to proximal humerus osteosarcoma and a failed attempt of stabilization. Following a reconstructive technique using reverse APC with a pectoral major transfer for deltoid reconstruction, favorable clinical and radiological outcomes were achieved at the 24-month follow-up. This is the first time that this reconstruction technique has been reported in an oncological patient. Based on our experience, we propose that the described approach is a therapeutic alternative in this complex situation. ■

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