CASE SERIES

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DISTAL RADIUS RESECTION AND REPLACEMENT WITH FIBULAR GRAFT IN BONE TUMORS: SERIES OF THREE CASES WITH LONG-TERM FOLLOW-UP AND CRITICAL ANALYSIS OF COMPLICATIONS

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Abstract. *The distal radius is a rare location for primary or metastatic bone tumors. Reconstruction of this bone after en bloc resection is a daunting challenge. Herein, we present three cases of distal radius resection due to bone tumors, with replacement of the resected bone using a fibular graft, and long-term follow-up. Moreover, we made a critical analysis of the reported complications after treatment. We hope this article and our comments will be helpful to surgeons who work in this area.*

Key words: *distal radius, bone tumors, fibular graft, complications*

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INTRODUCTION

Tumors of the distal radius are rare. It is not a predilection site for any particular entity except for the giant cell tumor of bone (GCTB), which is the third most common location; the malignant lesions of the distal radius are extremely rare [1, 2]. The treatment of recurrent radial GCTB or malignant lesions of this bone is a real challenge, aiming for complete tumor removal and low risk for future recurrence, as well as preserving limb function [3, 4]. En bloc resection followed by wrist reconstruction is accepted as effective. Different options, such as arthroplasty, osteoarticular allografts, a tri-cortical iliac graft, structural allografts, allograft arthrodesis, ulna translocation with wrist arthrodesis, and vascularized or nonvascularized fibular autografts with or without arthrodesis, have been proposed after wide resection of the distal radius [3, 5-7]. The safe oncological surgical margins of the tumor were determined through plain radiography and/or MRI. The safe surgical margin was considered at least 2.5 cm from the bone involvement, and the required length of the proximal fibular allograft for distal radius reconstruction was established based on this [8, 9].

Herein, we present three cases of distal radius resection with fibular graft reconstruction and long-term follow-up and our critical analysis of the complications.

CASES PRESENTATION

Case 1

A 49-year-old male with primary education coming from a rural community presented with a painful mass in his right forearm, with a duration of about six months and no history of trauma. Clinical examination revealed a firm, somewhat tender enlargement of the distal metaphysis of the radius. Hand function was not affected apart from the mild restriction of forearm rotations. No previous treatment had been performed. Radiographs (Fig. 1), computed tomography (CT) (Fig. 2), and magnetic resonance imaging (MRI) (Fig. 3) showed a purely osteolytic lesion involving the distal radial meta-epiphysis with well-defined margins and thinned and expanded cortex with no periosteal reaction.

The history and imaging were consistent with the diagnosis of GCTB. A biopsy was performed, and the histological diagnosis was undifferentiated pleomorphic sarcoma (UPS). No skip or metastatic lesions were detected during the initial assessment or the follow-up. Resection of the distal radius (Fig. 4a) and wrist arthrodesis with a fresh-frozen fibular allograft were performed. As a sufficiently long 3,5 mm plate was unavailable, the allograft was fixed with two plates (Fig. 4 and 5). The early postoperative period was uneventful. The plaster cast was removed at three weeks, and finger movements were encouraged. At a two-month follow-up, the patient presented with an edematous hand with stiff fingers. The radiographic appearance was that of complex regional pain syndrome (CRPS) (Fig. 5b). However, the patient was pain-free, content with the result, and highly protective of the extremity. He was reluctant to undergo any physical therapy and to try to re-initiate the use of the hand. Two years after the initial surgery, the allograft fractured (Fig. 5c), and the distal plate became loose; therefore, it was removed. The patient declined any other reconstruction. He was still barely using his hand. Over 10 years, the metaphyseal part of the allograft was completely resorbed with proxi-

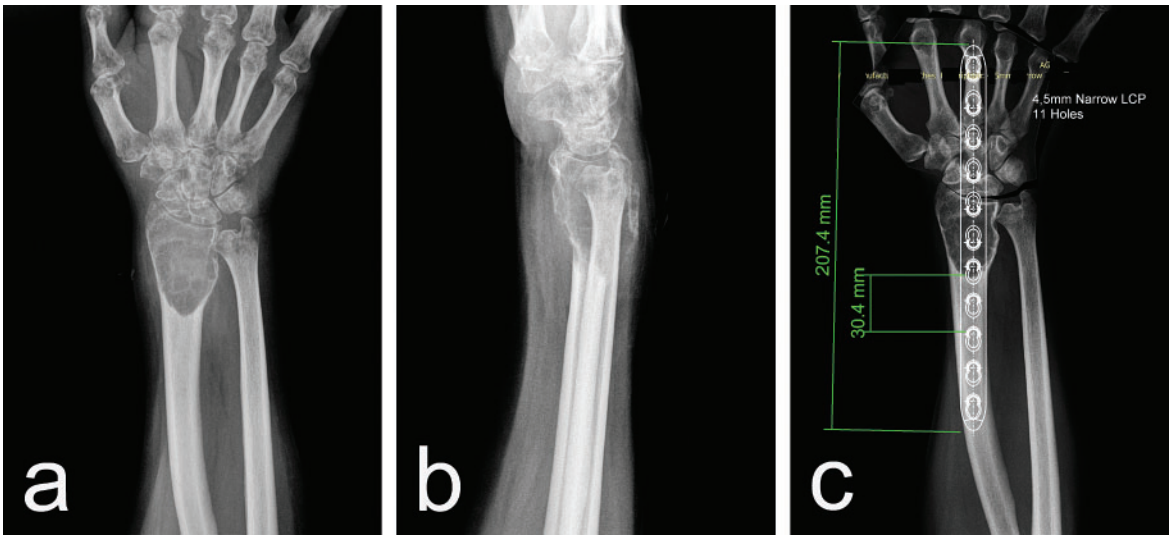

Fig. 1. a, b) AP and lateral radiographs at presentation; **c)** Preoperative planning option – narrow LCP with 11 holes was deemed to be too bulky for the dorsum of the hand and the metacarpal bone

Fig. 2. Preoperative CT

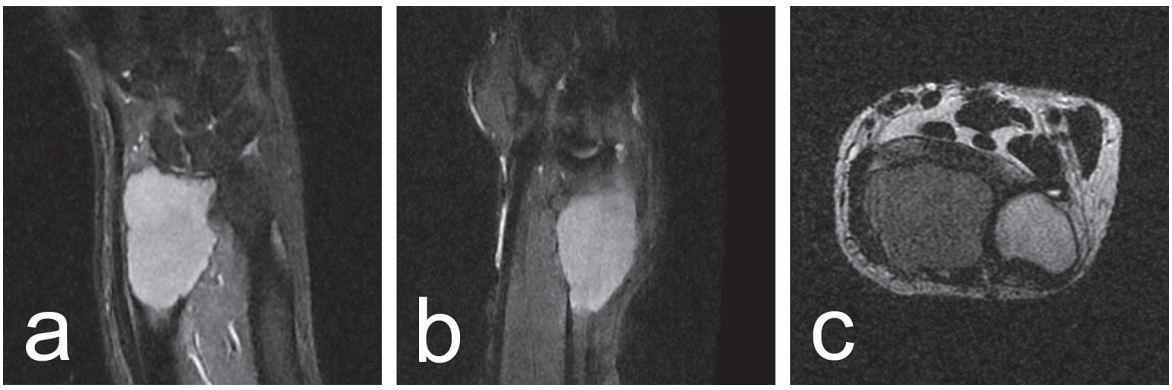

Fig. 3. Preoperative MRI

Fig. 4. Intraoperative view

Fig. 5. a) Radiograph after resection of the distal radius and wrist arthrodesis fixed with two plates. **b)** Radiograph at 8 weeks showing patchy osteoporosis, consistent with CRPS. **c)** Radiograph two years post-surgery reveals an oblique fracture line (arrow) in the metaphyseal part of the allograft. **d)** Radiograph ten years after the initial surgery shows complete resorption of the metaphyseal part of the allograft with good integration of the diaphyseal part

mal migration and radial deviation of the wrist (Figure 5d); minimal movements of the metacarpophalangeal joints were preserved; surprisingly, however, the patient was happy with the result because he “was able to shift the gears of his car” and declined any further treatment.

Case 2

A 39-year-old male presented with complaints of a painful mass in the distal radius with limited motion in the left wrist joint, which had been present for around two years. A year ago, curettage and filling the cavity with cancellous bone allograft were performed in another hospital with a histological diagnosis of “aneurysmal bone cyst”. Radiography showed a metaepiphyseal osteolytic lesion in the distal radius (Fig. 6). CT (Fig. 7) and MRI (Fig. 8) revealed a severely thinned and intermittently interrupted cortical layer. Histologically, a GCTB was diagnosed.

Wide resection was performed, followed by reconstruction using a fibular allograft, radiocarpal arthrodesis, and fixation with two plates (Fig. 9). Plaster cast immobilization was applied for two months. A follow-up examination 6 months post-surgery revealed a compromise of the osteosynthesis. Closed reduction was performed, and plaster cast immobilization was resumed for 3 months along with osteotropic therapy. However, failure of the osteosynthesis was established with further bone graft resorption and shortening; no signs of fusion between the fibular allograft and the carpal bones were evident (Fig. 10a). Reosteosynthesis was performed using tricalcium phosphate (TCP) synthetic bone graft as an adjuvant. After 2 years, there were clinical and radiological data on wrist fusion (Fig. 10b,c). Thirteen years after surgery, no clinical recurrence was detected.

Case 3

A 71-year-old female presented to our ward with an unrelated orthopedic condition. However, her history revealed that 35 years ago, she underwent surgery for a GCTB of the distal radius. Initially, she was treated with aggressive curettage and osteoplasty using a cancellous bone allograft. One year later, due to a recurrence, she had another procedure involving curettage and the application of polymethylmethacrylate bone cement. The subsequent recurrence was managed with a wide resection and reconstruction

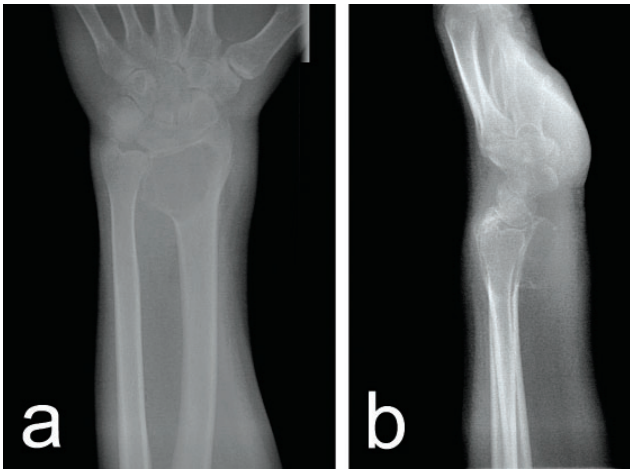

Fig. 6. a, b) AP and lateral radiographs at presentation

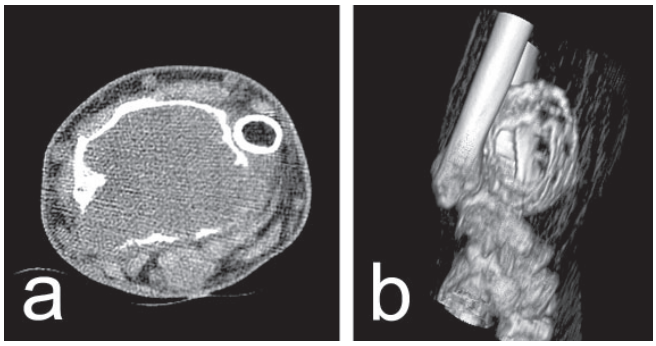

Fig. 7. Preoperative CT

Fig. 8. Preoperative MRI

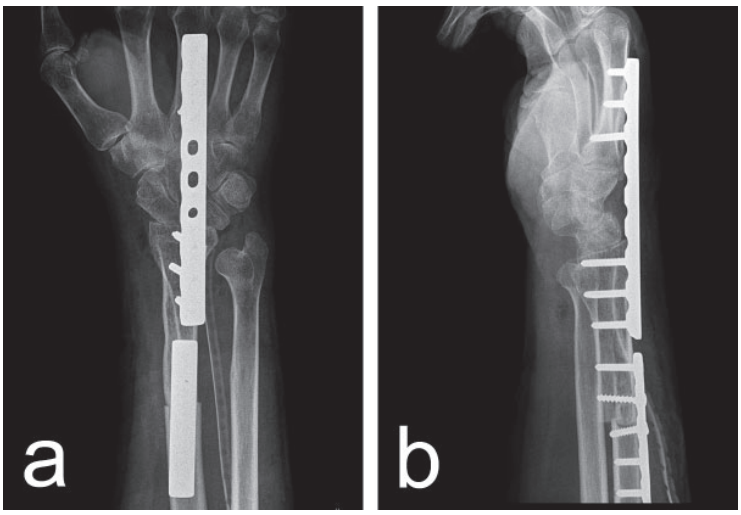

Fig. 9. Postoperative radiography

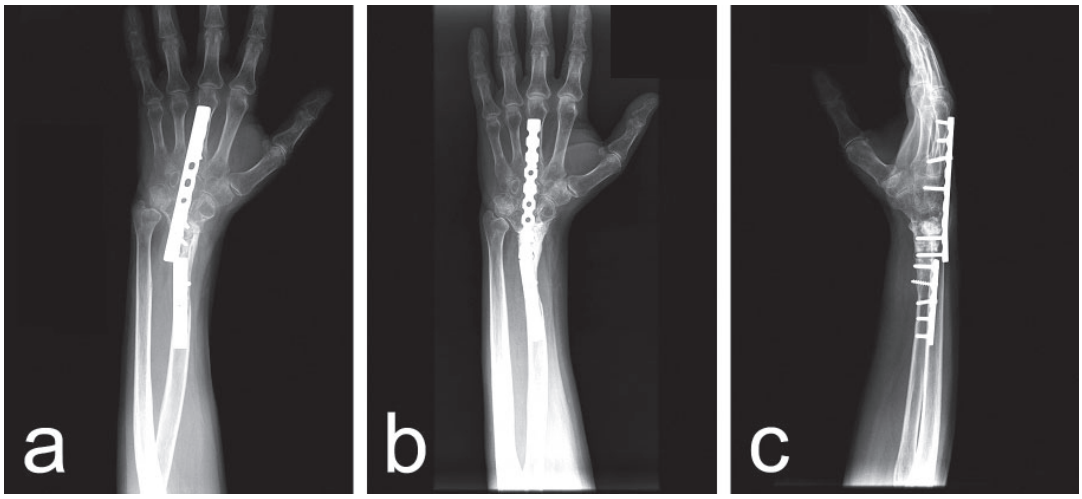

Fig. 10. Postoperative radiography

using a fibular autograft, with proximal plate fixation and 45 days of cast immobilization. The information provided is based only on medical documentation. From the preserved medical imaging, radiographs were available for 11 years (Fig. 11a), 14 years (Fig. 11b), and 32 years (Fig. 11c, d) after resection and autografting. On physical examination, a deformed wrist joint with subluxation of the head of the ulna was observed, along with intermittent moderate pain and limited pronation/supination; the patient refused further reconstructions in the area of the wrist.

Fig. 11. Radiographs after resection and fibular autograft reconstruction: **a)** after 11 years; **b)** after 14 years; **c, d)** after 32 years. Gradual separation of the distal radioulnar joint (DRUJ) is visible along with collapse of the proximal carpal row

DISCUSSION

The distal radius is a relatively rare location for the development of bone tumors, but it is one of the predilection sites for the appearance of GCTB [1, 2]. Most authors recommend en bloc resection in GCTB in cases of recurrence, cortical destruction with a significant defect and destroyed joint surfaces, the presence of a significant soft tissue component, or a severely displaced fracture (stage III according to Enneking; grade III according to Campanacci). Reconstruction is then required by replacement with an allograft or autograft, ulna translocation, or a custom-made prosthesis. Autografts (nonvascularized or vascularized fibula) are used with subsequent arthrodesis or arthroplasty of the affected joint [10-13]. In general, bone malignancies pose serious problems for treatment, especially when the tumor is located in the distal radius and hand [3, 4, 14, 15].

The reported disadvantages of allografts include a lack of blood supply and osteogenic cells, potential immunological reactions, difficulty in reconstructing the distal radioulnar joint, a high rate of nonunion, and allograft resorption [13].

In Case 1, the radiographic similarity between the histologically diagnosed pleomorphic sarcoma and GCTB raises suspicion for malignant transformation of the GCTB. Therefore, even when imaging findings correspond to GCTB, a histological diagnosis is essential before starting treatment.

In cases 1 and 2, the technique employed using two plates was mechanically unsound; still, time is of the essence in malignancies, so it was the best option available. Using two plates creates a locus minoris resistentiae and compromises the osteosynthesis; compromised fixation of the allograft with two plates does not provide the best opportunities for radiocarpal arthrodesis. This limitation may be overcome by using 3.5 mm DCP/LC-DCP with sufficient length – in our cases, plates with 13-15 holes would have been required – and by using an autologous bone graft, which would ensure better bone healing and prevent tissue incompatibility.

In Case 1, the lack of patient compliance led to the development of somewhat atypical CRPS, which resolved with no formal treatment. In cases of allograft reconstruction, the typical concern involves failure of allograft revascularization. In this case, the relatively avascular diaphysis fused well with the diaphyseal part of the allograft, while the cancellous portion of the allograft was subjected to aggressive osteolysis. We speculate that such massive activation of osteoclasts was mediated by an immune response to bone marrow elements in the fresh-frozen donor bone, which were scarce in its diaphysis. In terms of diagnosis, UPS is a diagnosis of exclusion, and this entity is known to be secondary in about 30% of cases. In this patient, it could have arisen from a preexisting GCTB, as suggested by the initial radiographic appearance of the lesion. Sometimes, UPS is histologically indistinguishable from primary malignant GCTB, and its differentiation requires genetic testing. However, it would not have changed the course of treatment. Finally, this case shows once again the huge discrepancy that can exist between radiographic appearance and physical function on the one hand, and patient satisfaction on the other.

In Case 2, the limitation again was compromised fixation of the metaphyseal part of the allograft, since the use of two plates does not provide the best opportunities for radiocarpal arthrodesis. Like Case 1, it is our supposition that allograft resorption was immune-mediated. However, the exact mechanism by which the addition of osteoconductive TCP reduced osteoclast activity and ensured bone fusion to an allograft remains unclear.

In Case 3, the instability of the reconstructed DRUJ was clinically significant, still it did not interfere with the patient's daily life to such an extent as to warrant another surgery. Stabilization of the DRUJ at the time of reconstruction could have provided better functional results and reduced complaints in the newly formed joints.

In all three cases, ulnocarpal fusion could have prevented proximal carpal migration or DRUJ separation at the expense of loss of forearm rotation. Such a decision should be thoroughly discussed with the patient. In our opinion, it should be used as a salvage procedure in selected cases.

CONCLUSION

Different methods have been performed for the wrist reconstruction following en bloc resection of the distal radius. Each approach has its advantages and disadvantages. The most important factor is preventing tumor recurrence, which is crucial in choosing surgical options. Orthopedic surgeons must be well-prepared for each procedure to select the most appropriate reconstruction method according to the individual patient's needs. We hope the presented critical analysis of reported complications will be helpful for future work on similar cases.

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