TECHNICAL NOTE

Distal radius reconstruction using a split vascularized fibula. Two cases following giant cell tumor resection

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Summary We propose a distal radius reconstruction technique that provides a strong stable wrist while preserving mediocarpal range of motion. Two cases of giant cell tumor of the distal end of the radius were treated. The technique included en bloc resection of the lesion followed by wrist reconstruction with partial arthrodesis. A vascularized fibular graft was used. With 4 years of follow-up for patient 1 and 1 year for patient 2, range of movement in flexion was, respectively, 20° and 20°; in extension, 20 and 30°; in pronation, 80 and 30°; and in supination, 20 and 15°. Strength reached 68 and 57% of the strength of the opposite side. The time to union of the radial graft and the carpal graft was 2 months in both cases. This technique provided cosmetic and functional results matching the results reported in the literature. It increases the reliability of the procedure and the recovery process.

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Introduction

Giant cell tumors are the leading cause of extended bone loss of the distal radius [1–6]. This is a surgical challenge in that a painless, stable, and mobile wrist with no risk of recurrence must be obtained. Many reconstruction techniques have been proposed after tumor resection. Their choice depends on local and functional factors as well as the resources and preferences of the surgical team.

This article presents two cases of vascularized fibular graft wrist reconstruction with partial arthrodesis, i.e., preserving the mediocarpal joint.

Patients and methods

Study material

One male (patient 1) and one female (patient 2) were operated on in 2005 and 2008, each of them for a voluminous giant cell tumor invading the distal epiphysis of the radius (Figs. 1 and 2). The age at diagnosis was 43 years for the man and 27 years for the woman. The dominant side was involved in patient 1. There were no preoperative functional limitations or neurovascular complications. A preoperative
CT and MRI, both with contrast product injection were used to evaluate the local tumor situation. A bone scintigraphy and a thoracic CT scan ruled out metastasis. The biopsy performed through a posterior approach in both cases confirmed the diagnosis of giant cell tumor.

Surgical technique

Under locoregional anesthesia completed by general anesthesia, two teams worked together: one harvested at the donor site and the other prepared the receiver site.

Only the specificities of the technique are described here, i.e., the preparation of the flap and its arrangement on the receiver site. The harvesting and excision phases were performed classically via the posterior approach, along the biopsy trajectory. The lower end of the ulna was resected as reported by Darrach in the surgical phase in patient no. 2 and secondarily for patient no. 1.

The objective of the assembly was radioscapulonare arthrodesis with a fibular barrette extending from the radius to the cancellous tissue of the scaphoid and the other barrette extending from the medial cortex of the first barrette to the cancellous tissue of the lunate bone.

Preparation

After periosteal stripping of the fibula, while preserving vascular continuity to half of the flap measuring approximately 3 cm in width, a subtraction osteotomy was performed to obtain two independent barrettes that could be easily mobilized. The barrettes were cut with a chamfered edge so they could be attached together proximally and at the first row of the carpal bones distally. A skin paddle was preserved for vascular monitoring.

At the receiver site, after resection, the radius was cut in a V shape so that it could be easily assembled with the fibula. The first row of carpal bones was cut diagonally to produce a chamfer edge. The first barrette was placed between the radius and the scaphoid. Proximal osteosynthesis was achieved with a nonlocking dynamic compression plate (DCP) (Synthes® Étupes-France). The distal osteosynthesis was performed with screw fixation for patient 2 and screw and inverted T-plate fixation for the other patient. The second barrette was osteosynthesized on the lunate. The proximal fixation was made at the other barrette.

Evaluation method

The patients were seen at the 1st, 2nd, 3rd, and 6th months postoperative and then once a year. The last follow-up was at 4 years for patient 1 and 1 year for patient 2. At each consultation, the patient underwent an x-ray of the wrist, measurement of the joint range of movement using the goniometer, and comparative measurement of wrist strength using the Jamar® grip test.

Results

The resection was performed in healthy tissue in both cases, with no recurrence at the last follow-up.

Range of movement and strength are reported in Table 1. Elbow and digital chain range of movement were complete in both cases. Both patients presented no pain or discomfort in their daily activities and resumed their previous occupation. Patient 2 had a lower strength result than patient 1, but was affected on her nondominant side.

The time to bone union of the graft was 2 months on the proximal and distal sides. There was no sign of bone resorption at the latest follow-up. Patient 2 presented a bony bridge between the distal end of the resected ulna and a barrette of the flap. This distal radioulnar synostosis explains the deficit in pronosupination. Given the absence of discomfort in daily activities, it was decided not to attempt a new intervention (Figs. 3 and 4).

<table>
<thead>
<tr>
<th>Patient</th>
<th>Side</th>
<th>Flex</th>
<th>Ext</th>
<th>Pro</th>
<th>Sup</th>
<th>Strength</th>
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<tr>
<td>Patient 1</td>
<td>D</td>
<td>20</td>
<td>20</td>
<td>80</td>
<td>20</td>
<td>68</td>
</tr>
<tr>
<td>Patient 2</td>
<td>G</td>
<td>20</td>
<td>30</td>
<td>30</td>
<td>15</td>
<td>57</td>
</tr>
<tr>
<td>Mean</td>
<td></td>
<td>20</td>
<td>25</td>
<td>55</td>
<td>17.5</td>
<td>62.5</td>
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</tbody>
</table>

Flex: flexion; Ext: extension; Pro: pronation; Sup: supination; strength expressed in percentage of strength on healthy side; range of motion expressed in degrees.
Discussion

The extension of the resection of giant cell tumors depends on the diagnosis and the histological grade of these bone tumors. In cases where the tumor is benign or grade I or II, treatment consists of curettage and filling of the cavity. Grade III and recurrent grade II tumors are treated with resection of the distal radius and the adjacent soft tissues. The frequent recurrences that we have encountered have led us to opt for immediate resection of the distal radius [1,2].

Several grafting techniques have been used to reconstruct the distal radius [3,7–10], some anecdotal. Reconstruction using a split vascularized fibula has been described a number of times since the 1980s [2,4].

Use of the nonvascularized fibula is widespread [2,11]. The functional results are good; the time to bone union, however, is multiplied by three compared to vascularized grafts [2,4,12,13]. Infectious complications and secondary fractures are not rare. We prefer using vascularized grafts, which have a better osteogenic potential. We believe that reducing the time to bone union improves functional recuperation after surgery.

Arthroplastic reconstruction of the distal radius via the proximal end of the fibula is frequently used [11,13,14]. Its value in children is incontestable. However, we remain skeptical given the joint congruence obtained in adults despite several publications pointing in this direction [12,13,15]. The esthetic and functional results are satisfactory over the short term [15]. At the medium term, the appearance of palmar subluxation of the carpal bones associated with diffuse carpal osteoarthritis is frequent [11,16]. The range of movement obtained with this technique is good [15], but wrist strength and function are not improved [16]. Capsuloligamentous preservation and ligament reconstruction [11,14], which provide a stable wrist, are not systematically possible. Several authors contraindicate this surgery in laborers [11]. We believe it is important to indicate that the patients undergoing this surgery are often young and occupationally active. Given the risk of obtaining a degenerative wrist over the more or less long-term, we prefer not to use this technique. Finally, the anatomic variations of the vascularization of this portion of the fibula increase the difficulty of graft harvesting [13,17].

Complete arthrodesis of the wrist [4,5] is the only method that can be used in cases of carpal extension of the disease, requiring bipolar resection. It provides a strong and painless wrist at the cost of range of movement. This technique is also valuable in secondary surgery after arthroplasty failure.

Partial arthrodesis (radius, scaphoid-lunate) of the wrist [6,16] makes it possible to obtain a stable wrist while preserving range of movement in the mediocarpal joint. The range of movement obtained is limited [16], but is sufficient to accomplish the majority of daily activities without discomfort.

Using a split fibula allows one to perform an arthrodesis between the first barrette and the scaphoid and between the second barrette and the lunate. Screw fixation osteosynthesis alone at the carpal bones seems sufficient to obtain the desired stability.

Allograft reconstruction of the radius provides good functional results [7,10], obviates the need for graft harvesting and provides the best anatomical result. However, the complications in terms of infection, bone union and secondary fracture are identical to a nonvascularized fibula. Distal radioulnar instability is frequent [18]. The long-term outcome of the graft is unknown [10]. Moreover, the allograft supply is sometimes limited in France.

Conclusion

The main objective of tumoral surgery of the distal radius is healing of the patient’s cancer. The diagnosis must be based on biopsy and tumor staging, which will determine the resection and reconstruction to accomplish. The vascularized fibular graft is a first-choice substitute for reconstruction.
Partial arthrodesis seems to be the best method for the young and active patients that we have treated. The technical modifications that we have made have facilitated the surgery and made it more reliable.

The functional and cosmetic results obtained are in line with others reported in the literature.

Disclosure of interest

The authors declare that they have no conflicts of interest concerning this article.

References