Ulnar translocation after excision of a Campanacci grade-3 giant-cell tumour of the distal radius

AN EFFECTIVE METHOD OF RECONSTRUCTION

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Between June 2005 and March 2008, 14 patients with a Campanacci grade-3 giant-cell tumour of the distal radius were treated by en bloc resection and reconstruction by ulnar translocation with arthrodesis of the wrist. The mean length of radius resected was 7.9 cm (5.5 to 15). All the patients were followed to bony union and 12 were available at a mean follow-up of 26 months (10 to 49).

The mean time to union was four months (3 to 7) at the ulnocarpal junction and five months (3 to 8) at the ulnoradial junction. All except one patient had an excellent range of pronation and supination. The remaining patient developed a radio-ulnar synostosis. The mean Musculoskeletal Tumor Society score was 26 (87%, range 20 to 28). Three patients had a soft-tissue recurrence, but with no bony involvement. They underwent a further excision and are currently well and free from disease.

Ulnar translocation provides a local vascularised bone graft to reconstruct the defect left after excision of the distal radius for giant cell tumour. It avoids the need for a microvascular procedure while retaining rotation of the forearm and good function of the hand.

The distal end of the radius is the third most common site for a giant-cell tumour (GCT) with approximately 10% occurring at this location.1 The aims of treatment are complete removal of the tumour while preserving maximum function of the limb. In most cases this can be achieved by curettage and by packing the cavity with bone graft or methylmethacrylate cement. In some cases, especially those in which the tumour has broken through the cortex (Campanacci grade 3),1 has grown rapidly, or when there is local recurrence with a large soft-tissue component, the distal end of the radius has to be resected and reconstructed.2-6 This can be achieved either by arthroplasty or arthrodesis using vascularised or non-vascularised autografts from the tibia, proximal fibula, iliac crest or distal ulna.7-11 Other procedures include the use of an osteoarticular allograft, transposition of the carpus on to the distal part of the ulna to create a one-bone forearm or a custom-made prosthesis.5,12,13

Although first described more than 25 years ago by Seradge,14 translocation of the ipsilateral ulna as a vascularised strut graft, has only been mentioned occasionally in the literature. To the best of our knowledge, only 11 cases have been reported.9,15-17

Our aim was to evaluate the results of translocation of the ulna with arthrodesis of the wrist after resection of a Campanacci grade-3 GCT of the distal radius. We examined the complications of the technique, the time taken to union and the functional outcome.

Patients and Methods

Between June 2005 and March 2008, 14 patients (Table I) with a Campanacci grade-3 GCT of the distal radius (Fig. 1) were treated by en bloc excision, translocation of the ipsilateral ulna and arthrodesis of the wrist. They were identified by retrospective review from a prospectively maintained database. Their medical records, imaging and functional status were reviewed. There were seven men and seven women with a mean age of 31.6 years (16.0 to 55.0). All were right-handed. The right radius was affected in nine patients and the left in five. Seven presented with recurrent disease. The mean duration of symptoms before presentation was 3.6 months (2.0 to 6.0).

A tissue diagnosis was obtained for all the primary tumours. Only those recurrent tumours in which the histological findings from the previous lesion were not available were subjected to a further biopsy. We used a core-needle biopsy technique and were satisfied with its yield and accuracy.18 Imaging
studies included plain radiography, MRI of the wrist and chest radiography. MRI was used to evaluate the extent of the lesion, its extraosseous component, its relation to the neurovascular bundle and to place the level of transection of the bone. The mean length of bone resected was 7.9 cm (5.5 to 15.0).

**Operative technique.** The radial lesion was excised *en bloc* with the surrounding soft tissue and pronator quadratus muscle in order to avoid contamination of the remaining tissue with tumour. After division of the adjacent ulna at the appropriate level, the distal ulna with its retained muscle attachment was transposed into the bony defect, denuded of cartilage and apposed to the cancellous surface of the similarly prepared scaphoid and lunate. Before transposing the ulna, care was taken to ensure that the periosteal sleeve had been completely divided around the ulna at the level of the proximal osteotomy. Without disrupting the retained muscle attachment, the transposed ulna was aligned with the radius and the second or third metacarpal so that the forearm retained full pronation and supination, and then internally fixed. In the first two patients we used an intramedullary nail passed proximally from the metacarpal, but changed to plate-and-screw fixation for the next 12 in order to obtain a more stable reconstruction. No patient had junctional bone grafting at their first operation.

Except for the first two patients who were immobilised in an above-elbow splint for eight weeks, all the others had a below-elbow splint for six weeks. Active shoulder, elbow and finger mobilisation was encouraged in the immediate post-operative period.

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**Table I. Details of the 14 patients and the results**

<table>
<thead>
<tr>
<th>Case</th>
<th>Age (yrs)</th>
<th>Gender</th>
<th>P/R*</th>
<th>Duration of symptoms (mths)</th>
<th>Resection length (cm)</th>
<th>Fixation</th>
<th>Complications</th>
<th>Mean time to union (mths)</th>
<th>Follow-up (mths)</th>
<th>MSTS† score (%)</th>
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<tr>
<td>1</td>
<td>22</td>
<td>F</td>
<td>R</td>
<td>4</td>
<td>6.0</td>
<td>IM² nail</td>
<td>Local recurrence</td>
<td>5</td>
<td>7</td>
<td>49 (87)</td>
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<tr>
<td>2</td>
<td>27</td>
<td>F</td>
<td>P</td>
<td>6</td>
<td>15.0</td>
<td>IM² nail</td>
<td>-</td>
<td>5</td>
<td>5</td>
<td>27 (90)</td>
</tr>
<tr>
<td>3</td>
<td>49</td>
<td>M</td>
<td>P</td>
<td>4</td>
<td>6.0</td>
<td>Plate</td>
<td>Local recurrence</td>
<td>4</td>
<td>4</td>
<td>42 (77)</td>
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<tr>
<td>4</td>
<td>35</td>
<td>F</td>
<td>P</td>
<td>5</td>
<td>10.0</td>
<td>Plate</td>
<td>-</td>
<td>6</td>
<td>4</td>
<td>38 (87)</td>
</tr>
<tr>
<td>5</td>
<td>55</td>
<td>M</td>
<td>P</td>
<td>2</td>
<td>7.5</td>
<td>Plate</td>
<td>-</td>
<td>5</td>
<td>5</td>
<td>34 (87)</td>
</tr>
<tr>
<td>6</td>
<td>38</td>
<td>M</td>
<td>R</td>
<td>6</td>
<td>7.5</td>
<td>Plate</td>
<td>-</td>
<td>4</td>
<td>4</td>
<td>27 (90)</td>
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<tr>
<td>7</td>
<td>24</td>
<td>F</td>
<td>P</td>
<td>5</td>
<td>8.0</td>
<td>Plate</td>
<td>Post-traumatic fracture</td>
<td>3</td>
<td>3</td>
<td>32 (87)</td>
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<tr>
<td>8</td>
<td>21</td>
<td>M</td>
<td>R</td>
<td>3</td>
<td>6.5</td>
<td>Plate</td>
<td>Radio-ulnar synostosis</td>
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<tr>
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<td>23</td>
<td>F</td>
<td>R</td>
<td>2</td>
<td>7.5</td>
<td>Plate</td>
<td>Superficial flap necrosis</td>
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<td>5</td>
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<tr>
<td>10</td>
<td>48</td>
<td>M</td>
<td>R</td>
<td>2</td>
<td>10.0</td>
<td>Plate</td>
<td>Superficial infection, 6 Local recurrence, pulmonary metastases</td>
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<td>22 (93)</td>
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<tr>
<td>11</td>
<td>16</td>
<td>F</td>
<td>R</td>
<td>4</td>
<td>7.0</td>
<td>Plate</td>
<td>-</td>
<td>6</td>
<td>3</td>
<td>21 (90)</td>
</tr>
<tr>
<td>12</td>
<td>29</td>
<td>M</td>
<td>R</td>
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<td>8.0</td>
<td>Plate</td>
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<tr>
<td>13</td>
<td>28</td>
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<td>4</td>
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<td>-</td>
<td>4</td>
<td>4</td>
<td>17 (93)</td>
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<td>27</td>
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<td>5.5</td>
<td>Plate</td>
<td>-</td>
<td>4</td>
<td>4</td>
<td>16 (90)</td>
</tr>
</tbody>
</table>

* P, primary; R, recurrent
† Musculoskeletal Tumor Society score
‡ intramedullary
§ LTFU, lost to follow-up

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*Fig. 1a* Pre-operative anteroposterior a) and lateral radiographs b) of a patient with a giant-cell tumour of the distal radius.
The patients were seen every three months for the first two years and every six months thereafter. Radiographs of the wrist were assessed at each visit. A chest radiograph was evaluated every six months for evidence of metastases. The functional status was determined at the final follow-up using the Musculoskeletal Tumor Society scoring system.19 This was based on the analysis of three factors of pain, functional activities and emotional acceptance, pertinent to the patient as a whole, and three specific to the upper limb namely positioning of the hand, manual dexterity and lifting ability. For each of the six factors, values of 0 to 5 were assigned based on established criteria. The result was expressed as a sum total with a maximum score of 30 and as a percentage of the expected normal function for the patient. The mean follow-up was for 26 months (10 to 49).

Results
Two patients developed superficial skin necrosis and one a superficial wound infection. All settled with conservative management. All 14 patients were followed to bony union. A total of 12 patients were available at the final review. The mean time to radiological union was 4.4 months (3.0 to 7.0) at the ulnocarpal junction and 4.9 months (3.0 to 8.0) at the ulnoradial junction (Fig. 2). No patient required an additional procedure to augment union. All except one patient had excellent pronation and supination. The remaining patient developed a radio-ulnar synostosis and had no rotation of the forearm. In these 12 patients the mean Musculoskeletal Tumor Society score was 26 (87%; 20 to 28).

Three patients had a local soft-tissue recurrence with no bony involvement. The recurrences were excised. One also had subsequent pulmonary metastases and underwent their excision. All three patients are currently well and free from disease. One patient had a fall one year after the procedure and sustained a fracture through the transposed ulna. He underwent further internal fixation with uneventful union.

Discussion
GCT of the distal radius is a condition which allows excision of the tumour while preserving excellent function of the wrist and hand. While excision may not be mandatory in every case it has been suggested that this rather than intralesional curettage may be preferred to reduce the incidence of local recurrence, particularly if the tumour has breached the cortex, violated the articular surface or destroyed more than half of the surrounding metaphysis.20

Reconstruction after excision of the distal radius for GCT is a challenge because of the high functional demands on the hand, the limited surrounding soft tissue, the proximity of adjacent nerves and tendons and the young age and relatively long life expectancy of this group of patients.5 Various factors need to be considered when evaluating a technique of reconstruction. These include the ease of the procedure, its morbidity, the complications and functional outcome and the durability of the reconstructed segment. The use of an avascular strut autograft is often limited by the long length of the resection gap and by donor-site morbidity. When the upper fibula is used there is a risk of persistent pain in the leg, laxity of the lateral ligament at the knee, palsy of the peroneal nerve and dysaesthesia in the back of the leg.10 Strut allografts, although a useful option, are limited by their availability and are associated with nonunion, fracture, infection and the fear of transmission of disease.5,21 The use of custom-made endoprostheses for tumours of the distal radius is limited.13,22 Whether vascularised or non-vascularised bone grafts are used, defects of the distal radius can be reconstructed either by arthroplasty or arthrodesis. Various authors have reported that for extraosseous GCTs in this region, the best clinical results are seen in patients who have been treated by radiocarpal arthrodesis.2,11,20,21,23

Ipsilateral ulnar transfer is an easy, inexpensive technique which does not require microvascular skills. It is also quicker to perform than free vascularised fibular grafting. The reduction in volume of the forearm from the radial displacement of the ulna facilitates skin closure after excision of the tumour, especially in cases in which a fungating lesion or extensive soft-tissue involvement has resulted in loss of soft tissue and skin. Since the surgical procedure is restricted to the same limb morbidity is reduced. The shorter surgical procedure and the fact that a graft which retains its blood supply has been used possibly help to reduce infection. Retaining the vascularity of the graft also improves the chances of union which is quicker than that of a non-vascularised graft.2,20,23,24
Ensuring that the periosteal sleeve has been completely divided at the level of the ulnar osteotomy may prevent post-operative radio-ulnar synostosis. Failure to divide the proximal periosteum circumferentially causes it to shear off from the end of the divided ulna as it is being transposed. This may not only impair the vascularity of the transposed bone, but may result in the formation of bone along the retained periosteal bridge thereby limiting rotation of the forearm.

Unlike Chalidis and Dimitriou we do not advocate routine tenodesis of the extensor or flexor carpi ulnaris since we have not found that there is any cosmetic or functional disturbance. An ancillary benefit of the resultant one-bone forearm is that the problems associated with ulnar variance which may occur after reconstruction with the fibula, iliac crest or allograft, can be avoided.

Despite creating a one-bone forearm, this technique retains forearm rotation (Fig. 3). This is not possible when the ulna is fused directly to the carpus which causes considerable functional difficulty.

The most common complication of this procedure in earlier descriptions was delayed union or nonunion of the proximal radio-ulnar junction. This required revision of the internal fixation and autogenous cancellous bone grafting. The use of a longitudinal pin to stabilise the radio-ulnar junction probably allowed micromovement at the site of the osteotomy resulting in a low rate of union. We now use plates and screws to stabilise the construct since this gives better fixation and provides a better biological and mechanical environment for bony union.

This is probably why no additional procedures were needed to promote union. The stable fixation also enabled us to use a below-elbow splint which allowed early active movement of the shoulder, elbow and fingers.

Although local recurrence of tumours is not a reflection of the technique of reconstruction which has been used we have mentioned it in our results. The incidence of local recurrence in our series of 25% is in keeping with that described in the literature for Campanacci grade-3 GCTs of the distal radius.

Ulnar translocation is an easy, inexpensive method of reconstructing the distal end of the radius after excision for a GCT. It avoids the need for a microvascular procedure and gives excellent rotation of the forearm and function of the hand.

No benefits in any form have been received or will be received from a commercial party related directly or indirectly to the subject of this article.

References
15. Chalidis BE, Dimitriou CG. Modified ulnar translocation technique for the reconstruction of giant cell tumour of the distal radius. Orthopedics 2008;31:808.