The use of osteo-articular allografts for reconstruction after resection of the distal radius for tumour

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Several techniques have been described to reconstruct a mobile wrist joint after resection of the distal radius for tumour. We reviewed our experience of using an osteo-articular allograft to do this in 17 patients with a mean follow-up of 58.9 months (28 to 119).

The mean range of movement at the wrist was 56° flexion, 58° extension, 84° supination and 80° pronation. The mean ISOLS-MSTS score was 86% (63% to 97%) and the mean patient-rated wrist evaluation score was 16.5 (3 to 34). There was no local recurrence or distant metastases. The procedure failed in one patient with a fracture of the graft and an arthrodesis was finally required. Union was achieved at the host-graft interface in all except two cases. No patient reported more than modest non-disabling pain and six reported no pain at all. Radiographs showed early degenerative changes at the radiocarpal joint in every patient.

A functional pain-free wrist can be restored with an osteo-articular allograft after resection of the distal radius for bone tumour, thereby avoiding the donor site morbidity associated with an autograft. These results may deteriorate with time.

The distal radius is an unusual site for primary bone tumour. Different methods have been proposed to reconstruct the defect left by their resection. There is agreement that arthrodesis is the technique of choice in patients who are manual workers and who need a strong, stable wrist.1-13 In less complex or demanding cases arthroplasty may be considered to allow some movement. Several techniques of arthroplasty of the wrist using a variety of autologous grafts have been described.13-32 An osteo-articular allograft of the distal radius has the advantages of offering the best anatomical match with the first carpal row, as well as avoiding the donor site morbidity and increased operating time associated with the harvesting of an autogenous graft. A small number of patients treated in this way have been reported to date.13,21,24,29-31 The aim of this study was to evaluate the medium-term outcome of this procedure.

Patients and Methods

Between 1999 and 2007 we resected the distal radius with a tumour and reconstructed the defect with an osteo-articular allograft in 18 patients. One patient was excluded as he had undergone a primary excision and graft arthrodesis elsewhere, which had subsequently failed.

The mean age of the remaining 17 patients was 36.6 years (13 to 56). There were 15 patients with a giant-cell tumour and one each with an Ewing’s sarcoma and osteosarcoma. These two patients received pre- and post-operative chemotherapy. The mean length of the resected radius was 7.3 cm (5 to 13). The dominant hand was involved in eight of the 17 patients.

A volar approach to the radius was used. After identifying and preserving the radial artery, the brachioradialis tendon was detached from its insertion and the distal radius isolated from all tendinous and neurovascular structures except the pronator quadratus muscle, which was resected with the radius. A capsulotomy was performed, leaving as much capsule as possible on the carpal side for the subsequent reconstruction. Proximally, a transverse osteotomy was performed in all cases but one, where a step-cut osteotomy was used. A capsulotomy was performed, leaving as much capsule as possible on the carpal side for the subsequent reconstruction. Proximally, a transverse osteotomy was performed in all cases but one, where a step-cut osteotomy was used. A specimen from the medullary canal was sent for frozen-section.

The graft was fixed to the proximal radius with a compression plate. The step-cut osteotomy was stabilised with two supplementary interfragmentary screws. In order to re-establish the stability of the joint, an accurate host-graft capsulorrhaphy was performed. An adjunctive distal radioulnar stabilisation
procedure was not used in any case. In eight cases, intra-medullary cement was injected to enhance the strength of the graft. Prophylactic antibiotics were given using a regimen for surgical procedures with a high risk of infection. This involved vancomycin plus tobramycin, or teicoplanin plus tobramycin at surgery and for five days thereafter, followed by oral broad-spectrum antibiotics, amoxicillin plus clavulanic acid, for 15 further days. An above-elbow cast was applied for 30 days with the forearm in neutral. Afterwards, a below-elbow wrist splint was used for 30 days, and graduated rehabilitation of the wrist with active and passive exercises was started.

At follow-up, patients were evaluated clinically and radiologically. Functional evaluation was performed using the upper-limb International Society of Limb Salvage-Musculoskeletal Tumor Society (ISOLS-MSTS) functional scoring system and the wrist-specific patient-rated wrist evaluation score. Range of movement was measured with a manual goniometer.

**Results**

Details of the patients are shown in Table I. The mean follow-up was 58.9 months (28 to 119). Excluding a patient whose graft failed twice and required revision to an arthrodesis (no. 2), all except one were available for clinical follow-up. This patient (no. 9) was interviewed by phone and sent radiographs.

There was no local recurrence or distant metastases. The surgical margins had been wide in 16 cases and marginal in one.
Nonunion of the allograft occurred in two patients (nos 14 and 16). In one (16), autologous cancellous bone grafting from the iliac crest was carried out 19 months after the original surgery; bony union was radiologically sound six months later. The second patient (14) was asymptomatic and declined further surgery. Union was achieved in all 15 remaining patients primarily: radiological signs of union were present after four to nine months. No wound or graft became infected.

One patient (2), with a giant-cell tumour of the distal radius of his dominant hand, fractured the allograft 11 months after surgery. A revision procedure was carried out using a fresh allograft, but the second graft failed after 37 months. There had been no infection or further trauma. An arthrodesis was undertaken using an autologous vascularised fibular graft. This was the only failure in our series.

A further patient (6) had an incomplete fracture of the graft involving the epiphysis 23 months after the operation. This was treated with a cast and united unremarkably.

The range of movement at the wrist was measured in 15 patients at follow-up. The patient who underwent revision arthrodesis and the patient who was only interviewed by phone were excluded. The mean range of flexion was 56° (20° to 80°), extension 58° (30° to 80°), supination 84° (45° to 90°) and pronation 80° (50° to 90°) (Table I). In 16 patients including the patient interviewed by phone, the mean ISOLS-MSTS score was 86% (63% to 97%) and the mean patient-rated wrist evaluation score 16.5 (3 to 34) (Table I). An illustrative case is shown in Figure 1.

No patient reported more than modest non-disabling pain and six reported no pain at all. No patient had limitation in activities of daily living, but some had limitations in
recreational or occupational activity. The ability to lift weights was restricted, usually as a result of instruction from the treating surgeon rather than an inability to perform such tasks.

Radiographs showed early degenerative change at the radiocarpal joints in every patient. At follow-up there was no correlation between these changes and the patient’s symptoms: most patients remained pain-free. Widening of the distal radioulnar joint occurred in every patient, but only four noted mild instability of this joint. This was clinically and functionally irrelevant.

Discussion

After resection of the distal part of the radius for tumour, the wrist may be reconstructed in different ways. It may be arthrodesed using different types of autologous graft: a vascularised autologous fibula,1,2 non-vascularised autologous fibula,3,4 distal autologous ulnar,3,8 autologous iliac crest,3,4,9-11 or autologous tibial corticocancellous graft.4,11-13 An arthrodesis-transposition of the carpus to the ulna has also been described.3 We have performed a distal resection-arthrodesis of the radius in several cases, preferring a vascularised autologous fibular graft because of its capacity for early union and subsequent hypertrophy.

Arthrodesis of the wrist can give good results as the loss of movement at the wrist can be adequately replaced by the other joints of the arm for most activities of daily living. In order to preserve some wrist mobility, a partial arthrodesis can be performed, with fixing the graft only to the scaphoid and lunate. This can be accomplished using different techniques, such as distal ulnar translocation35,36 and vascularised or non-vascularised autologous free fibular transfer.3,37-39

Nevertheless, most patients with a tumour of the distal radius want their surgeon to provide them with a functional mobile wrist. Several different procedures have been used to accomplish this. Replacement of the distal radius with a prosthesis has been attempted with varying degrees of success.14-17 If the aim is to restore a mobile radiocarpal joint, the resected distal radius can be replaced by an autologous non-vascularised proximal fibula,13,18-24 an autologous vascularised proximal fibula,1,2,25,28-31 a distal radius allograft13,21,24,29,31 or an autologous vascularised graft from the iliac crest.32

Good restoration of wrist function has been reported by most authors with all of these techniques. The mean ranges of movement at follow-up have been reported as 21° to 51° for flexion, 36° to 52° for extension, 58° to 70° for supination and 50° to 80° for pronation/supination after allograft reconstruction.24,29,31 Following reconstruction with autologous fibula the following mean values have been achieved: from 16° to 38° for flexion, 22° to 43° for extension, 42° to 66° for pronation and 10° to 80° for supination.18,19,22,24 Some authors reported only combined values of flexion and extension (from 15° to 105°) and of pronation and supination (from 37° to 60°).13,39 Better results have been reported in children using a vascularised proximal fibular epiphysial transfer to reconstruct the distal radius,28 but these results are difficult to compare with those in adults. In our series, the mean range of movement was 55° flexion, 59° extension, 84° supination and 80° pronation. The excellent range achieved may well be due to our decision not to use adjunctive fixation of the distal radioulnar joint. Several authors have recommended temporary fixation, usually with Kirschner wires, to reduce the risk of late radioulnar instability, and some routinely perform a Darrach procedure at the time of allograft reconstruction.31 In our series, distal radioulnar instability was not a problem. An accurate suture of the capsule of the graft to the host bone appears to afford good stability of the reconstructed joint.

Another complication of allograft reconstruction of the distal radius is resorption and/or fracture of the graft. We saw this in two patients. The cause may be immunological, or possibly as a result of fatigue fracture.

In one of these cases a partial fracture of the epiphyseal region of the graft occurred after 23 months. This healed after immobilisation in a cast. Spontaneous healing of a fracture through an allograft is rare. Such a fracture is usually followed by failure of the graft. Szabo et al31 reported spontaneous healing of a fracture of the allograft in one of their patients. It may be postulated that after reconstruction in the upper limb, particularly in the forearm where there are two bones, a non-weight-bearing allograft can have a better chance of healing after partial collapse than might be the case in the lower limb.

The functional results of an osteo-articular allograft of the distal radius can be excellent, as the functional evaluation of our patients shows, but knowledge of the long-term results is generally lacking and degenerative joint changes are usually detectable early. Early narrowing of the joint and other radiological signs of degenerative change are more evident in osteo-articular allografts,21,29,31 but can also be seen in most series after reconstruction with autologous fibula.19,21,39 Even though these early changes are usually asymptomatic, our feeling is that an osteo-articular reconstruction of the distal radius must be considered a time-limited solution for young patients, as progressive degenerative changes should be expected either with massive osteo-articular allografts (anatomically matched but not vital) or with osteo-articular autografts whether vascularised or not (anatomically mismatched, as a proximal fibula or ulna is used to replace the distal radius).

On this basis, osteo-articular allograft reconstruction may be the best option, as it is the least invasive of the proposed techniques and does not include the sacrifice of the fibula. This additional procedure not only risks local morbidity but more importantly, may reduce the options available for subsequent revision. An intermediate option between arthroplasty and arthrodesis is partial arthrodesis of the wrist, which can be achieved by fibulocapholunate fusion, after replacing the distal radius with autologous proximal fibula, which may be vascularised.2,38,39 or not.37 This gives a reported range of flexion/extension of between
60° and 80°,2,3,18,39 and 115° to 150° for combined pronation/supination.2,39 Larger series and longer follow-up are needed to verify the long-term efficacy of this promising technique.

Our study has some significant limitations: the number of patients is small and follow-up is not yet sufficient to report on the long-term results. It is also retrospective, but at least studies a consecutive series of patients. Even with these limitations, in our opinion the results show that a functional pain-free wrist can be restored by using an osteoarticular allograft after resection of the distal radius for bone tumour. These results may deteriorate with time, so further follow-up is needed.

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References