Use of metal proximal radial endoprostheses for treatment of non-traumatic disorders

A CASE SERIES


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We have reviewed five adult patients treated with endoprosthetic reconstruction of the proximal radius following resection of non-traumatic lesions. The patients had a mean age of 33.4 years (20 to 60) at the time of surgery and the mean follow-up was 7.6 years (0.8 to 16).

Following surgery, all elbows were clinically stable and there was 100% survivorship of the prosthesis. Evaluation of function was assessed clinically and by the Mayo Elbow Performance Score, achieving a mean of 86% (70 to 100).

Results at medium-term follow-up are encouraging with regards to elbow stability, implant survivorship and functional outcome.

Significant fractures of the proximal radius in adults may be treated with resection of the radial head, which can result in instability of the elbow and shortening of the radius. This causes alterations in the biomechanics of the elbow and wrist and impaired function. Reconstruction of the head of the radius using an endoprosthetic implant has been used in cases involving complex, unstable fractures. Implants manufactured from acrylic, silicone, vitallium, cobalt-chromium and titanium have provided varying levels of success in the restoration of function and stability.1-12

Neoplastic disorders of the proximal radius are uncommon. Options for treatment for benign lesions include curettage or resection, with or without bone grafting to reconstruct the resulting defect.13-17 Traditional surgical options for the management of malignant tumour of bone include amputation, resection alone, resection with arthrodesis, resection with bone grafting and excision arthroplasty. Little evidence is available on the use of endoprosthetic reconstruction of the proximal radius following resection of non-traumatic lesions.

In 2002, Ward18 described the use of a custom-made endoprosthesis in a 43-year-old male to reconstruct the proximal radius following resection of a metastasis from a renal cell carcinoma.

In one patient the lesion was a metastasis from a primary renal carcinoma. This patient had undergone a nephrectomy for treatment of the primary lesion one month prior to operation on the proximal radius and was undergoing chemotherapy. The diagnosis in the other patients included chondroblastoma and recurrent benign fibrous histiocytoma. The latter patient had developed a recurrence following treatment by curettage and a fibular...
A further patient with a Ewing’s sarcoma of the proximal radius (Fig. 1) with metastasis to the contralateral iliac crest had pre-operative chemotherapy and additional radiotherapy to the secondary lesion. The patient with synostosis of the proximal radioulnar joint had a previous endoprosthetic reconstruction of the ipsilateral proximal humerus for a malignant chondrosarcoma, but had no signs of local recurrence. The patient developed a painful elbow which was seen to be secondary to infection. This was successfully treated but it was felt that synostosis subsequently developed.

Radiographs, MRI and CT of the individual lesions and radiographs of the contralateral elbow and forearm were used to manufacture a custom-made implant for each patient. All of the endoprostheses were monobloc and constructed primarily from titanium. They had a concave CoCr-coated articulating surface to allow normal movement about the capitellum and a distal intramedullary stem for fixation (Fig. 3). They had a bow of varying extent to replicate that present in the contralateral radius. The three implants which were manufactured after 2001 incorporated a distal hydroxyapatite-(HA) coated collar to enhance osseo-integration. The prosthesis for the patient with a recurrent benign fibrous histiocytoma included a long distal extracortical plate since, following her previous operation, the existing metalwork would have to be removed leaving decreased bone stock.

After application of a tourniquet to the upper arm the operation was undertaken through an anterior approach. Neurovascular structures, including the superficial and posterior intra-osseous branches of the radial nerve, were identified and protected when possible. The appropriate length of the proximal radius was excised (Table I), allowing adequate margins. In the case of the bone tumours a minimum 5 mm margin was achieved. A distal imprint was taken and sent for histological examination along with the resected tissue. The implants were inserted with press-fit uncemented techniques in three, with the remaining two stems being cemented using narrow diameter catheters to aid the introduction of cement into the intramedullary canal. For the patient with a recurrent benign fibrous histiocytoma, three titanium bicortical screws were used to secure the extracortical plate distal to the tip of the short uncemented intramedullary stem (Fig. 4).

The soft tissues which were released during resection of the radius were not reattached after insertion of the implant. These included the biceps brachialis and supinator muscles and the anterior, radial collateral and annular ligaments. Detachment of the musculotendinous structures removed any direct pull on the proximal radius which might allow
subluxation of the radial head in the absence of any stabilising ligamentous support around the radio-capitellar joint. Preservation of the medial collateral ligament of the elbow and an accurate fit of the endoprosthesis ensured that there was no valgus instability of the elbow joint.

All the patients received physiotherapy after satisfactory wound healing. They were clinically and radiologically reviewed regularly (Fig. 5). Clinical examination included assessment of movement and of pain at both the elbow and the wrist which was assessed using a visual analogue scale (VAS) (0, no pain; 10, intolerable pain). Anteroposterior and lateral radiographs were analysed for signs of loosening, and recurrence if the primary diagnosis was neoplastic. At the latest follow-up, all patients were assessed using the Mayo Elbow Performance Score which includes assessment of pain, movement, stability of the elbow and function of the forearm. Assessment of function included five specific activities: combing the hair, feeding, performing tasks of personal hygiene, putting on a shirt and putting on shoes.

**Results**

Those with neoplastic disease had clear margins and biopsies. The mean follow-up was 7.6 years (0.8 to 16). Patients had good function.

Four patients had a full range of movement at the wrist and elbow (Table II). The patient with a synostosis had a full range of movement of the wrist before operation but a restricted range of flexion at the elbow (45° to 90°) and pronation and supination were reduced to 60°. At 176 months (14.7 years) follow-up the range of flexion at the elbow was 25° to 140° with a full range of pronation and supination. No patient had pain at the wrist, but three had occasional mild pain at the elbow joint on extension, scoring no greater than three of ten on the VAS. All the elbows were stable clinically and radiologically (Table III) with no evidence of local recurrence of the neoplastic lesions.

The mean Mayo elbow performance score was 86% (70 to 100), with two patients attaining the maximum score. The remaining three had occasional difficulty in putting on shoes due to mild pain at the extremes of movement, particularly extension. The patient with a synostosis also had occasional difficulty in putting on a shirt but still attained a satisfactory score. However, all five tasks could be completed by all the patients and none scored less than satisfactory.
There were no signs of infection. One patient had a palsy of the posterior interosseous nerve resulting in impaired extension of the thumb and wrist but this had recovered when reviewed at ten months. There were no other complications.

**Discussion**

There is limited information available concerning the use of proximal radial endoprostheses. The only published report is by Ward who treated a metastatic lesion of the proximal radius with such an implant. The patient was reported to have a range of movement in the elbow from 10° to 140° of flexion with 90° of both supination and pronation after ten months.

The five patients in our series all had a satisfactory outcome. As seen in previous studies, the HA-coating promoted osseo-integration at the bone-prosthesis interface, enhancing stability despite a short intramedullary stem. HA-coating has not previously been used with proximal radial endoprostheses. We found that an additional extra-cortical plate may be used in the presence of recurrent disease or decreased bone stock. We thought it important to replicate the radial bowing with the prosthesis in order to mimic normal anatomy.

While proximal radial endoprostheses have not commonly been used in the treatment of non-traumatic disorders, their use in the management of radial head fractures has been widely reported. Morrey reported a success rate of about 80%, when using these prostheses in the treatment of radial head fractures.

Thus satisfactory stability of the elbow has been reported following the use of metal proximal radial endoprostheses despite associated soft-tissue injury. Reconstruction in this way also prevents proximal migration of the radius and dysfunction of the distal radioulnar joint. In our study, the absence of wrist pain suggests that proximal migration of the radius did not occur.

Non-traumatic disorders of the proximal radius are rare and the literature documenting forms of treatment including curettage with or without bone graft, excision alone, above-elbow amputation and reconstruction either by autograft, allograft or allograft-prosthesis composite, is limited. Curettage of benign lesions is associated with a significant incidence of recurrence. Resection without reconstruction has been described by Goldenberg et al. Reconstruction with free vascularised fibular bone grafting and allograft-prosthesis composites have shown acceptable results in individual cases with regards to range of movement and function without recurrence. Replicating the size of the native radial head and the radial diaphyseal bowing has allowed our prostheses to sustain relatively normal biomechanical forces through the elbow and forearm, providing good medium-term outcomes.

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**Table II.** Pre- and post-operative ranges of movement of the elbow and wrist

<table>
<thead>
<tr>
<th>Number</th>
<th>Flexion (°)</th>
<th>Supination (°)</th>
<th>Pronation (°)</th>
<th>Flexion (°)</th>
<th>Supination (°)</th>
<th>Pronation (°)</th>
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<tbody>
<tr>
<td>1</td>
<td>-10 to 140</td>
<td>85</td>
<td>85</td>
<td>90</td>
<td>70</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>0 to 135</td>
<td>80</td>
<td>80</td>
<td>80</td>
<td>60</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>-5 to 140</td>
<td>85</td>
<td>80</td>
<td>90</td>
<td>70</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>45 to 90</td>
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<td>60</td>
<td>85</td>
<td>65</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>0 to 140</td>
<td>80</td>
<td>80</td>
<td>90</td>
<td>70</td>
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**Table III.** Results including elbow stability, pain scores, functional scores and complications

<table>
<thead>
<tr>
<th>Number</th>
<th>Follow-up (mths)</th>
<th>Stable elbow (clinically &amp; radiologically)</th>
<th>Elbow VAS</th>
<th>Wrist VAS</th>
<th>MEPS†</th>
<th>Complications</th>
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<tbody>
<tr>
<td>1</td>
<td>69</td>
<td>Y</td>
<td>0</td>
<td>0</td>
<td>100</td>
<td>-</td>
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<tr>
<td>2</td>
<td>10</td>
<td>Y</td>
<td>0</td>
<td>0</td>
<td>100</td>
<td>Posterior interosseous nerve injury (recovered)</td>
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<tr>
<td>3</td>
<td>10</td>
<td>Y</td>
<td>2</td>
<td>0</td>
<td>80</td>
<td>-</td>
</tr>
<tr>
<td>4</td>
<td>176</td>
<td>Y</td>
<td>3</td>
<td>0</td>
<td>70</td>
<td>25° fixed flexion deformity (improved from pre-operative)</td>
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<tr>
<td>5</td>
<td>192</td>
<td>Y</td>
<td>1</td>
<td>0</td>
<td>80</td>
<td>-</td>
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<tr>
<td>Mean</td>
<td>91.4</td>
<td>1.2</td>
<td>0</td>
<td>0</td>
<td>86</td>
<td>-</td>
</tr>
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</table>

* Y, yes
† VAS, visual analogue scale
‡ MEPS, Mayo elbow performance score

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References


