Peri-acetabular resection and endoprosthetic reconstruction for tumours of the acetabulum

We treated 98 patients with peri-acetabular tumours by resection and reconstruction with a custom-made pelvic endoprosthesis. The overall survival of the patients was 67% at five years, 54% at ten years and 51% at 30 years. One or more complications occurred in 58.1% of patients (54), of which infection was the most common, affecting 30% (28 patients). The rate of local recurrence was 31% (29 patients) after a mean follow-up of 71 months (11 to 147). Dislocation occurred in 20% of patients (19). Before 1996 the rate was 40.5% (17 patients) but this was reduced to 3.9% (two patients) with the introduction of a larger femoral head. There were six cases of palsy of the femoral nerve with recovery in only two. Revision or excision arthroplasty was performed in 23.7% of patients (22), principally for uncontrolled infection or aseptic loosening. Higher rates of death, infection and revision occurred in men.

This method of treatment is still associated with high morbidity. Patients should be carefully selected and informed of this pre-operatively.
fibrous dysplasia in two, malignant fibrous histiocytoma in two, malignant peripheral nerve-sheath tumour in two, angiosarcoma in one and chondroblastoma in one.

We reviewed the clinical data from the hospital databases, case notes and imaging studies. The patients completed the Toronto Extremity Salvage Score (TESS), a well-validated measure of functional outcome.

Five patients were lost to follow-up, of whom four had moved abroad and could not be traced, and the records were incomplete in a further five.

The mean age of the patients was 43.6 years (10 to 76), with a bimodal pattern peaking in the second and sixth decades. The mean follow-up was 65 months (2 months to 33.5 years), and 49 of 93 patients were male (52.7%). The nature of the staging studies, chemotherapy regimes and the surgical technique have previously been described.

The surgical technique varied depending upon the anatomical location of the tumour and the operating surgeon. Some procedures used an extended Ollier approach with a trochanteric osteotomy, while others were carried out using an anterior ilioinguinal incision or a combined anterior and posterior approach. After resection of the tumour, the prosthesis was fitted to the cut surface of the ilium and fixed in place with cement if necessary or without if the prosthesis fitted well. In each case some form of hip replacement was used. After 1996 a larger femoral head was used to reduce the risk of dislocation.

Of the 93 patients, 23 had a two-stage procedure in which the tumour was first excised and a temporary implant inserted, after which a prosthesis was constructed and implanted at a second operation. Since 1994, almost all the procedures have been carried out in one stage using a prosthesis which has been designed in advance from CT images.

Statistical analysis. This was performed using SPSS version 14.0 (SPSS Inc., Chicago, Illinois). We performed Kaplan-Meier survivorship analysis from the date of the operation to the endpoints of local recurrence, revision and death. The log-rank test was used to compare two or more survivorship curves when factors such as gender, diagnosis, excisional margins and the site and size of the tumour were taken into account. The chi-squared test was used to compare two variables with discrete outcomes. A p-value ≤ 0.05 was considered to be significant.

Results

At the time of review, 62 of 93 patients (66.7%) were alive with a mean follow-up of 91 months (3 months to 33.5
Of the 93 patients 29 (31%) had a local recurrence after a mean of 22.2 months (6 to 111), 11 of whom (37.9%) required amputation. The overall rates for local recurrence were 36% at five years and 39% at 20 years (Fig. 2a). The rate of local recurrence at five years was 49% for patients with Ewing’s sarcoma, 43% for those with chondrosarcoma, 40% for those with an osteosarcoma and under 20% for all others.

Of the 93 patients 29 (31%) had a local recurrence after a mean of 22.2 months (6 to 111), 11 of whom (37.9%) required amputation. The overall rates for local recurrence were 36% at five years and 39% at 20 years (Fig. 2a). The rate of local recurrence at five years was 49% for patients with Ewing’s sarcoma, 43% for those with chondrosarcoma, 40% for those with an osteosarcoma and under 20% for all others.

The greatest risk factor for local recurrence was the margin of excision. The risk of local recurrence at five years for intralesional excision was 67% compared with 25% for a marginal or wide margin (Fig. 2b). The higher the grade of the tumour, the greater the incidence of local recurrence (p = 0.043). The anatomical location of the tumour (p = 0.669), gender (p = 0.208) and diagnosis (p = 0.297) did not influence local recurrence.

Table II. Details of the number of dislocations before and after 1996 in 93 patients

<table>
<thead>
<tr>
<th></th>
<th>Number (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before 1996 (n = 42)</td>
<td>17 (40.5)</td>
</tr>
<tr>
<td>After 1996 (n = 51)</td>
<td>2 (3.9)</td>
</tr>
<tr>
<td>Total</td>
<td>19</td>
</tr>
</tbody>
</table>

Kaplan-Meier survival curves showing the probability of a) avoiding local recurrence and b) avoiding local recurrence related to the adequacy of tumour excision.

Kaplan-Meier survival curve showing survivorship without either infection, local recurrence or revision.
The median survival after local recurrence was 21 months (interquartile range 10 to 32), but 21% of patients were still alive five years after local recurrence, all of whom had undergone a secondary hindquarter amputation.

Dislocation. Recurrent dislocation occurred in 19 patients (20%). The first dislocation always occurred within one year of surgery. Patients had a mean of 2.9 (2 to 6) episodes of dislocation. Closed reduction was successful in 16. The remaining three patients needed an open reduction. Subsequently, they had intensive physiotherapy, hydrotherapy and an abduction brace if necessary. One patient needed revision of the hemipelvis and femoral components and one prosthetic realignment involving replacement of the acetabular component. Operations performed before 1996 (in 42 patients) were associated with a dislocation rate of 40.5% (17 patients). After 1996, when larger femoral heads were used (in 51 patients), the rate decreased to 3.9% (two patients) (chi-squared test, \( p < 0.001 \); Table II).

The femoral nerve was injured in six patients (6.5%) (complete in four and incomplete in two) and in one this was combined with injury to the sciatic nerve. Only two of the femoral palsies resolved.

**Revision.** Revision of the hemipelvis and femoral component was needed in 22 patients (23.7%) at a mean of 49 months (0.5 to 221). The indications for revision were infection in 18, aseptic loosening in three and medial migration of the acetabular component in one. The five-, ten- and 20-year revision rates were 24%, 35% and 49%, respectively. Men had a significantly higher rate of revision than women (\( p = 0.021 \)). The probability of a male patient needing a revision at ten years was 52% compared with 15% for a female patient.

Figure 3 shows the survivorship of the prostheses without either infection, local recurrence or revision.

**Amputation.** A hindquarter amputation was needed in 12 patients (12.9%); in 11 for local recurrence and in one for infection. The mean time to amputation from the initial surgery was 27.3 months (0.8 to 134).

**Functional outcome.** A TESS was calculated for 44 of the surviving patients. The mean TESS was 59.4% (16.7% to 100%). In the 17 patients with a major complication (infection and dislocation), the TESS was 37.1% (16.7% to 63%). If no major complication occurred, the TESS was 70.3% (41% to 100%) (chi-squared test, \( p < 0.001 \)).

**Survival.** The overall survival of the patient as determined by the Kaplan-Meier method was 67% (95% confidence interval (CI) 56.4 to 77.6) at five, 54% (95% CI 41.5 to 66.5) at ten and 51% (95% CI 37.9 to 64.1) at 30 years (Fig. 4). The five- to 15-year survival rates for the six most common diagnoses is shown in Table III. Only one patient died within a month of surgery.

The adequacy of the excision of the tumour significantly affected rates of survival. The one- and five-year survival rates of patients with a wide excision were 97% (95% CI 90.9 to 103.7) and 78% (95% CI 66 to 90) and for patients with an intralesion excision 92% and 0%, respectively (\( p = 0.011 \), Fig. 5). There was also a difference in the survival rates between men and women with survival being signifi-

---

**Table III. Survival rates (%) at five, ten and 15 years with respect to diagnosis**

<table>
<thead>
<tr>
<th>Diagnosis</th>
<th>Years</th>
<th>5</th>
<th>10</th>
<th>15</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chondrosarcoma</td>
<td>65</td>
<td>57</td>
<td>57</td>
<td></td>
</tr>
<tr>
<td>Ewing’s sarcoma</td>
<td>45</td>
<td>45</td>
<td>45</td>
<td></td>
</tr>
<tr>
<td>Osteosarcoma</td>
<td>65</td>
<td>65</td>
<td>65</td>
<td></td>
</tr>
<tr>
<td>Metastasis</td>
<td>68</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Spindle-cell sarcoma</td>
<td>78</td>
<td>78</td>
<td>39</td>
<td></td>
</tr>
<tr>
<td>Plasmacytoma myeloma</td>
<td>100</td>
<td>75</td>
<td>75  (max 13 yrs)</td>
<td></td>
</tr>
</tbody>
</table>

---

**Fig. 4**
Kaplan-Meier survival curve showing the overall survival of the patients.

**Fig. 5**
Kaplan-Meier survival curve showing the adequacy of tumour excision related to survival.
cantly worse for men (p = 0.035). The most frequent cause of death was from metastases (46.9%, 15 of 32 patients). Other causes included local invasion of the tumour, cardiac arrest and liver failure. Patients who developed local recurrence were at high risk of having synchronous or subsequent metastases. They had a mean survival of 20 months (3 to 87) from the time of local recurrence and only 34% (10 of 29 patients) lived for two years after the recurrence had been identified. There was a 70% survival in those treated by amputation for local recurrence beyond five years from the date of local recurrence. None of those who did not have an amputation survived longer than three years.

**One- or two-stage procedures.** We investigated whether there was evidence of any improvement in these figures if the patient underwent a two-stage (pre-1994) rather than a one-stage procedure (1994 onwards). We found that the rates of local recurrence, infection and overall survival were identical in the two periods. The only difference was in the rate of dislocation.

**Discussion**

Excision of a peri-acetabular tumour and reconstruction is one of the most demanding procedures in orthopaedic oncology, both for the patient and the surgeon. Some authors have considered the rate of complications of this procedure to be so great that they recommend excision arthroplasty.17

The overall rate of complications in our series was 58.1%, and 32.2% of patients required a further operation. The series previously reported from our institutions6 showed a similar complication rate of 60% and a re-operation rate of 40%. Hoffmann et al17 previously reported complications in six of 20 patients who had undergone transposition of the hip after resection of the tumour and complications in eight of ten patients who had reconstruction with a prosthesis. Other studies report similar rates ranging between 28.6% and 80% when performing reconstruction with a prosthesis after excision of an acetabular tumour.11,18-21

Infection is the most common reported complication.2,6,11,17,19,22,23 This was borne out in our series. The median time to the diagnosis of infection was six months which suggested that many of these patients developed the infection at the time of surgery or shortly after, although clearly some developed it much later. Every superficial infection (39%, 11 of 28 total infections) was controlled with antibiotics alone. Just over half (53%, 9 of 17) of the deep infections were treated effectively with debridement, washout and suppressive antibiotics whilst the rest needed a more radical salvage procedure. This highlights the potentially devastating consequences of deep infection in this group of patients.

The location of the tumour and therefore the type of resection had no significant effect on the infection rate. In accordance with Ozaki et al,24 the site of the tumour and the type of excision had no statistically significant relationship with the infection rate in our series. However, there was a slight trend towards infection occurring in tumours of the ilium or pubis. This trend would support the view that high rates of infection and wound problems are the result of wide approaches, high tumour load with a large amount of dead space after resection, and long operations.14

Local recurrence was seen in 31% of patients and is similar to figures found in other studies.5,11,17,20,24 We found that the surgical margin influenced the rate of recurrence; this has been also noted elsewhere.20,22,24,26

High-grade tumours were associated with a higher rate of local recurrence (p = 0.043), but not with a correspondingly higher death rate. As can be seen from Figure 2a, the rate of local recurrence was related to the tissue diagnosis, of which chondrosarcoma, Ewing’s sarcoma and osteosarcoma had the highest local rates of recurrence. Chondrosarcoma was the only tumour in which local recurrence was seen after five years, with the latest recurrence being seen after more than nine years. Identification of local recurrence was notoriously difficult in these cases and all cross-sectional imaging (MRI and CT) was distorted by scatter from the large amount of metal **in situ**. The best method of assessing patients for local recurrence has yet to be established, but the risk is greatest in the first two years and, with the exception of chondrosarcoma, is least after five years.

The overall rate of dislocation was 20%. All dislocations were recurrent and occurred in the first year. In 1996 we began to use larger sizes of femoral head, initially between 32 mm and 40 mm and, more recently, large (≥ 50 mm) metal-on-metal articulations. We also began to use retentive bore acetabular components and it is likely that both of these steps have led to a decrease in the rate of dislocation. Similar experiences have been reported in total hip replacement.27

The rate of major nerve palsy was 6.5%. The femoral nerve was most at risk as would be expected from the nature of the surgery. Recovery occurred in only one-third of cases.

Male patients were more likely to need a revision procedure (p = 0.021). The probability of needing a revision at ten years for men was 52% compared with 15% for women. The most common cause was septic loosening, although aseptic loosening accounted for nearly 13.7% of the cases. This may have been due to a higher demand being placed on the reconstruction by the male population.

Most hindquarter amputations (11 of 13) were for local recurrence; 37.9% of patients with a local recurrence were managed by amputation. Most of the others underwent either a local excision or palliative treatment as many had concomitant metastases. The only long-term survivors after local recurrence were those who had an amputation.

Functional outcome was measured using the TESS and we have shown that function is satisfactory if a major complication is avoided. The scores were low for those patients in whom a complication arose.

Notwithstanding, the scores in this group of patients were significantly better than those reported by Hillmann et al26 for pelvic replacement and similar to those reported by Falkinstein et al.23
The overall survival was influenced mainly by the adequacy of excision of the tumour and the gender of the patient. Grimer et al\textsuperscript{25} reported that the survival rate at five years in patients with osteosarcoma of the pelvis and with wide or marginal surgical excision was 61.4\%, while it was 0\% for patients with an intrallesional excision. The importance of wide local excision is supported in this current series which had a five-year survival rate for wide and marginal surgical excision of 78\%, and 0\% for an intrallesional excision. This showed that complete excision at the initial procedure was one of the most important prognostic factors for survival and that every effort should be made to avoid an intrallesional excision. It remains uncertain, however, whether an improved margin and an improved outcome could be obtained in these cases by primary hindquarter amputation. In many cases the margin would have been no better than with this procedure.

Grimer et al\textsuperscript{25} reported a five-year survival rate for osteosarcoma of 41\% compared with 65\% in our series. Furthermore, Ozaki et al\textsuperscript{24} reported a five-year survival rate for chondrosarcoma of 54\% compared with 65\% in this series. Our findings are therefore comparable but we accept that patients who are suitable for limb-salvage surgery may have smaller or more localised tumours which may explain the small differences in survival. We have no evidence that attempts at limb salvage prejudiced the survival of our patients, but this is clearly a matter which must be discussed with the individual patient at the time of informed consent.

Our study is the first to demonstrate a poorer prognosis in men following endoprosthetic replacement after resection of a pelvic tumour (p = 0.035). This is likely to be associated with their higher rate of local recurrence (p = 0.043). Other studies have actively searched for a difference in survival between men and women, but concluded that there was no statistically significant difference.\textsuperscript{22,24,26}

We conclude that limb salvage with hemipelvic replacement for a peri-acetabular tumour is a major undertaking. It has a high rate of complications and post-operative morbidity, particularly if infection or dislocation occurs. The importance of complete excision of the tumour cannot be over emphasised and has a bearing on the long-term survival. Patients need to be informed pre-operatively about the major complications, expected rates of local recurrence and the long-term survival.

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