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Limb salvage for proximal tibial tumours using a modular prosthesis

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Abstract We report early results after the resection of proximal tibial tumours followed by reconstruction using a modular prosthesis. The indication for wide resection was a malignant tumour in 13 patients, and a neglected giant cell tumour in 2. There were no mechanical failures during an average follow-up of 3.5 years. However, there were 5 peroneal nerve palsies, 1 complete sciatic nerve palsy, 1 vascular injury leading to an above knee amputation, and 2 deep prosthetic infections. There were 2 superficial skin necroses and 1 fracture proximal to the femoral prosthetic component. The mean post-operative Musculo-Skeletal Tumour Society (MSTS) score in 12 patients who still had their prosthesis in situ was 18.3 out of a possible total of 30 (range: 10–28). Limb salvage surgery in the proximal tibia has a high early complication rate even with the use of modern implants and improved techniques.

Résumé Nous rapportons les résultats préliminaires de la résection de tumeurs tibiales proximales suivies d'une reconstruction avec une prothèse modulaire. 13 patients étaient porteurs de tumeurs malignes et 2 de tumeur a cellules géantes. Nous n'avons observé aucune complication mécanique au cours d'une période de suivie de 3.5 années. Les complications suivantes ont été rencontrées: paralysie du nerf pèronéal (5); paralysie complète du nerf sciatique (1); accident vasculaire exigeant une amputation au dessus du genou (1); infections prothétiques profondes (2); nécroses cutanées superficielles (2); enfin, fracture au dessus de la prothèse fémorale (1). Le score moyen post-opératoire de la Musculo-Skeletal Tumor Society chez 12 patients avec prothèse in situ était de 18.3 (écart de 10–28). La chirurgie du tibia proximal s'accompagne d'un taux de complications précoces élevées, même en présence d'implants modernes et d'améliorations techniques.

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Introduction

The proximal tibia is second only to the distal femur in frequency for malignant bone tumours, or for giant cell tumours of bone, and limb salvage surgery is now attempted in most patients [3, 7]. After resection of the tumour with a wide margin, reconstruction must include replacement of the knee joint and of much of the proximal tibia, and this may involve the use of a megaprosthesis, an allograft or an arthrodesis. A megaprosthesis combines a hinge type of knee joint with a variable length of metal to replace both joint and bone loss, and from the patient's point of view this is the most attractive option. These prostheses can either be custom-designed for each patient, or modular with a full range of sizes. We report our early results in 15 patients with one type of modular megaprosthesis (Modular Replacement System (MRS) Howmedica).

Materials and methods

Between 1993 and 1998 endoprosthetic reconstruction of the proximal tibia and knee with the MRS device was carried out in 15 patients after wide resection of a tibial tumour. All the tumours were malignant (Fig. 1a) except for 2 cases of large neglected giant cell tumours (Fig. 2a). These 15 constitute about one third of the 44 proximal tibial tumours treated in our Institution during the 5 year period. The specific diagnoses of these 15 patients are shown in Table 1. Those with chemo-sensitive tumours had appropriate courses of pre- and post-operative chemotherapy. There were 7 females and 8 males, and the mean age at the index procedure was 21 years (range: 12–35). All the patients had a complete tumour assessment after the clinical diagnosis and this included plain radiography of the limb and chest, bone scan, CT chest and MRI of the involved site, followed by an open biopsy. They also had a radiographic review and clinical assessment using the Musculo-Skeletal Tumour Society (MSTS) score [6].

Operative technique

An extensile medial or lateral (depending on the site of the biopsy) longitudinal incision was made and always incorporated the biopsy incision. A wide resection was carried out using standard

Fig. 1 *Case 8.* **a** Osteosarcoma of proximal tibia. **b** Radiographs 2 years postoperative

Fig. 2 *Case 2.* **a** Aggressive giant cell tumour of proximal tibia. **b,c** Radiographs 3 years postoperative

Table 1 Diagnoses and results of 15 patients who had prosthetic replacement of upper tibia

Pts	Age	Sex	Diagnosis	ROM	Extension Lag	Resection (cm)	Complications
1	16	F	GCT*	10–90	10	14	Sciatic palsy
2	27	F	GCT*	0–90	Nil	12	Nil
3	20	F	Ewings sarcoma	0–80	20	14	Nil
4	16	M	Osteosarcoma			12	Infection. Amputation
5	15	M	Osteosarcoma	20–100	20	12	Peroneal palsy
6	16	M	Osteosarcoma			14	Infection. Removal prosthesis
7	24	F	Osteosarcoma	20–120	20	13	Peroneal palsy
8	18	F	Osteosarcoma	0–90	Nil	14	Peroneal palsy
9	35	M	Fibrosarcoma	0–90	Nil	12	Nil
10	16	M	Osteosarcoma			16	Vascular injury. Amputation
11	35	F	Osteosarcoma	10–30	10	14	Fracture
12	18	M	Osteosarcoma	0–100	40	16	Peroneal palsy
13	29	F	Osteosarcoma	Nil	Nil	14	Stiff knee/skin necrosis
14	12	M	Osteosarcoma	0–90	90	18	Nil
15	14	F	Osteosarcoma	0–70	70	15	Peroneal palsy/skin necrosis

* Giant cell tumour.

techniques. A cementless MRS modular endoprosthesis was used in all 15 patients (Fig. 1b). The extensor mechanism was re-attached when possible by transposition of the fibula to the tibial tubercle site by using a proximal double fibular osteotomy (Fig. 2b,c). A medial gastrocnemius flap was routinely used during closure and was usually covered by skin grafting to avoid any undue skin tension.

Patients were encouraged to walk as soon as possible, usually after 48 h, and with a removable splint to keep the knee extended. They were allowed to bear weight as tolerated and the splint was used for a minimum of 4 weeks in order to allow the patellar tendon to re-attach. Gradual flexion of the knee was then started under the supervision of a physiotherapist.

Results

A wide margin of tumour excision was achieved in all our patients and there were no local recurrences. Six factors of MSTS functional scores were used for assessment, each having a maximum of 5 points, which indicates normality and no points, which indicates significant disability. The mean MSTS functional score was 18.3 out of 30 (range: 10–28) (Table 2).

The mean range of knee flexion was 79° (range: 0–120°). Eight patients had a mean extensor lag of 23° (range: 0–90°).

There were 2 deep infections and both resulted in failure. One of these was a 16-year-old male who developed infection 4 weeks following surgery. The causative bacteria was staphylococcus aureus and an above knee amputation was necessary. The second patient, also a 16-year-old male, developed infection 2 years after surgery, the causative organism being staphylococcus epidermidis. The prosthesis was removed and a gentamicin-impregnated cement spacer was inserted. When last seen

Table 2 Average post-operative MSTS score for each of the six factors and percentages of normal

MSTS categories	Mean score (of 5)	% Mean score
Pain	3.75	75
Function	2.83	56.6
Emotional acceptance	3.08	61.6
Support	2.83	56.6
Walking ability	3.08	61.6
Gait	2.75	55

Total mean score 18.3 or 61%.

the infection had not been controlled and amputation was advised but was refused by the patient.

Two patients required resection of peroneal nerves as part of the primary surgery. There were also 5 unexpected peroneal nerve palsies although all these nerves had been carefully identified and protected during the operation. These patients had an immediate post-operative foot drop, which did not recover. One patient had a complete sciatic nerve palsy, which also did not recover. The cause was never determined although the nerve was explored soon after the main procedure.

One patient developed ischemia immediately after surgery. At exploration all 3 vessels had extensive thrombosis which necessitated early amputation through the knee. Two patients had minor soft tissue loss, which required debridement and skin grafting. Both healed with no subsequent problems.

One patient, a 35-year-old male, fell 1 year after surgery and fractured his femur proximal to the tip of the stem of the femoral component. This was treated with open reduction and internal fixation using a compression plate and cerclage wires. The fracture united in 6 months.

There were no implant failures at a mean follow-up of 3.5 years.

Discussion

Limb salvage surgery has replaced amputation in most centres as the preferred treatment for tumours such as osteosarcoma and Ewing's sarcoma [10, 13]. Effective chemotherapy has reversed the figures for long-term survival for these tumours [1, 5]. The present long-term survival of nearly 70% is striking when compared to more than 80% mortality seen only 20 years ago. Chemotherapy, when combined with better imaging techniques such as CT and MRI, has made treatment by local resection of tumours and reconstruction much more attractive.

After wide resection of a tumour in the end of a long bone the options for reconstruction are arthrodesis with bone grafts or temporarily with cement, allograft replacement, or the use of a special tumour prosthesis designed to replace the adjacent joint and the resected bone. The major advantage of the use of an allograft is restoration of bone stock and better re-attachment of the patellar tendon although structural collapse and infection remain matters of concern [4]. Resection and arthrodesis gives a stiff knee, but patients can undertake strenuous activities which is useful as most of these patients are young [2, 3, 7]. Our indications for using a mega-prosthesis were almost the same as for resection-arthrodesis, and we did not have allografts available. Our patients when given a choice always selected a prosthesis in order to avoid a stiff knee. Arthrodesis was used for several patients when a prosthesis was not available because of fiscal restraints. This fusion was often done with cement so that it could be converted to a mega-prosthesis or a permanent arthrodesis if the patient lived long enough. In a few cases we did a palliative resection-arthrodesis when metastases were present or suspected. Amputation is still used for large unresectable tumours, local recurrences, or failure of limb salvage.

The contrast between the results of distal femur and proximal tibia limb salvage surgery is striking. Tumours of the distal femur can usually be removed with successful reconstruction [11, 12], but with tumours of the proximal tibia complications are much more frequent.

Other authors have also reported a much higher complication rate for proximal tibial tumour resections than for distal femoral tumour resections. Grimmer et al. [8] reported 151 patients with arthroplasty for proximal tibial tumours. Their initial results were poor as they had a wound breakdown and infection rate of 33%. However, this was reduced to 12% with the use of a gastrocnemius flap to cover the wound. Horowitz [9] reported on 16 patients, also with a high infection rate.

The problems peculiar to a proximal tibia resection are related to 3 areas – poor skin cover, patellar tendon re-attachment, and damage to neuro-vascular structures. The proximal tibia does not have nearly as good soft tissue cover as does the distal femur. Most musculoskeletal tumour surgeons now routinely favour using a gastrocnemius flap, some also add routine skin grafting over this in order to avoid any skin tension.

Re-attachment of the patellar tendon is another major problem, as it will not attach to metal. Solutions include suturing the tendon to the gastrocnemius flap or, even better, to the transposed fibula if this can be preserved. Petschnig et al. [11] studied 17 patients and compared 3 methods of extensor mechanism reconstruction. They found that suture of the patellar tendon either to the gastrocnemius flap or to the transposed fibula were the most successful in obtaining active extension. We do this whenever we can and it certainly gives the best results. The proximal fibula provides an excellent attachment but this bone cannot always be preserved when the tumour encroaches on or involves the proximal fibula, as in case 8 (Fig. 1a, b).

The presence of 3 small blood vessels rather than 1 large one, plus the frequent necessity of removing at least the anterior tibial, contributes to more frequent vascular complications with tibial tumour resection. The loss of the peroneal nerve whether part of a planned procedure or the result of an intra-operative event also reduces walking ability.

Despite using the new techniques for reconstruction of the proximal tibia as suggested by others [8, 11] we were not able to reproduce their results. Grimmer et al. [8] reported a mean functional score of 79% for pain, function 62%, emotional acceptance 84%, need for support 85%, walking ability 77% and gait 73%. Our figures are less satisfactory with 75% for pain, 61.6% emotional acceptance and 56.6% for support. Apart from this, nearly 50% of our patients had a significant walking disability imposed by the procedure and were worse off when compared to their pre-operative walking ability. Residual pain and diminished walking ability has a direct negative impact on the emotional acceptance by patients.

Joint replacements after tumour resection compare unfavourably to routine total knee arthroplasty for osteoarthritis. Their function is not nearly as good because this is a hinge device with no ligaments retained, and is often associated with a deficient patellar re-attachment.

Neurovascular complications are related to the difficulties of the tumour resection and not specifically to the prosthesis as we have seen them with the same frequency after resection-arthrodesis.

In summary, in spite of some excellent results, we have had a high complication rate with mega-prosthesis replacement for proximal tibial tumours, and this confirms the experience of other authors. We had a wound breakdown and infection rate of 13%. Patellar tendon re-attachment remains a problem with only a few patients regaining full active extension. Peroneal nerve paralysis is common even when this is not a specific part of the resection, and no patients with this complication returned to their pre-operative activities as none of the paralyses recovered. Any major wound breakdown or infection leads to total failure. We are only reporting early results, as our follow-up is short. When these early difficulties are added to the inevitable late mechanical failures this treatment option still has serious problems.

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