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Custom megaprosthesis replacement for proximal tibial tumours

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Abstract We analysed 133 patients treated with resection and endoprosthesis proximal tibial replacement from 1988 to 2000. Mean age was 22.3 years and osteosarcoma was the most common tumour. Average follow-up was 59.4 months. An excellent functional result was achieved in 63 patients and a good result in 36. The number of patients who had no evidence of disease was 102. Twenty-four patients died due to disease. Infection was the most common complication, followed by periprosthetic fracture and aseptic loosening. The 5-year limb survival rate was 85.5%.

Résumé Nous avons analysé 133 malades, traités par résection et remplacement endoprothétique du tibia proximal de 1988 à 2000. L'âge moyen était 22.3 ans et l'ostéosarcome était la tumeur la plus fréquente. Le délai moyen de suivi était 59.4 mois. Un excellent résultat fonctionnel a été obtenu pour 63 malades et un bon résultat pour 36. Le nombre de malades qui n'avaient pas de signe de maladie était 102. Vingt-quatre malades sont morts à cause de la maladie. L'infection était la complication la plus fréquente, suivi par les fractures périprothétiques et le descellement aseptique. La présence du membre à 5 ans était de 85.5%.

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Introduction

Limb salvage surgery has been established as an alternative to amputation in patients with both low-grade and high-grade malignant tumours and also aggressive benign tumours due to technical advances in diagnostic imaging, chemotherapy and radiotherapy, and improved surgical methods [25]. With the advent of effective adjuvant chemotherapy, cure rates in excess of 60% can be expected for osteosarcoma and Ewing's sarcoma [3, 21]. This improvement in patient survival has presented to the orthopaedic surgeon the challenge of maintaining the function and integrity of the involved limb for longer periods.

Management of proximal tibial tumours present the most challenging problems in limb salvage surgery due to various factors like lack of local musculature and the paucity of soft tissue available for covering the defects after tumour removal [25]. We have chosen to undertake endoprosthesis replacement, as it has been demonstrated to provide a good functional outcome in most cases.

Materials and methods

One hundred and thirty-three patients who underwent resection and endoprosthesis proximal tibial replacement between 1988 and 2000 and who had a minimum follow up of 24 months were analysed by us. Eighty-six patients were men and 47 were women. Five were lost to follow-up. Mean age was 22.3 (7–54) years. Osteosarcoma was the most common tumour and comprised 66% of the patients. Giant cell tumour was present in 35% of the patients. The other tumours encountered were chondrosarcoma, malignant fibrous histiocytoma and Ewing's sarcoma. Histopathological diagnoses are shown in Table 1. Patients were followed up at regular intervals—monthly during the first year, every 6 months in the second year and yearly thereafter. The mean follow-up period was 59 (24–152) months.

Staging evaluation consisted of plain radiography, CT scan, Technetium 99m bone scans and digital subtraction angiography when appropriate. In the later part of the series, MRI was preferred to CT scan in the evaluation. Closed needle biopsy was the preferred method of biopsy. However, a majority of patients were referred to us after an open biopsy performed elsewhere.

Table 1 Diagnoses and outcomes in patients followed up for a minimum of 2 years

Diagnosis	Number	Functional outcome				Oncological outcome			Lost to follow-up
		Excellent	Good	Fair	Poor	No disease	With disease	Died	
Giant Cell tumour	35	15	9	1	9	34	0	0	1
Chondrosarcoma	5	2	1	1	1	4	0	1	0
Osteosarcoma	88	42	25	6	11	60	2	22	4
Ewing's sarcoma	1	1	0	0	0	0	0	1	0
Malignant fibrous histiocytoma	4	3	1	0	0	4	0	0	0
Total	133	63	36	8	21	102	2	24	5

**Fig. 1** Osteosarcoma of the proximal tibia**Fig. 2** Eighteen months postoperatively—after resection and custom megaprosthesis replacement

Staging was done according to the Musculoskeletal Tumour Society (MSTS) system [8]. The majority of patients belonged to stage II; 39 had stage I and two had stage III tumours.

Pre-operative chemotherapy was administered to 81 patients according to the regimen in use at that particular time. Two patients with giant cell tumour presented to us after receiving radiotherapy. Fifty-six patients received post-operative chemotherapy.

Measurement radiography and, in some cases, CT scan and MRI, were used to estimate the size of the prosthesis to be used. All prostheses were indigenously manufactured, using stainless steel in 108 and titanium in 25. The total knee prosthesis was used most commonly and the intercalary prosthesis in the remaining patients. A more constrained type of prosthesis was used initially, which was later modified to a rotating hinge variety.

Surgically, an anterior midline incision encircling the biopsy scar was used. A wide margin of resection was achieved in 100 patients, while a marginal margin was accepted in 33. In 81 patients the tibial length resected was between 100–150 mm, and 38 had resection lengths between 151 and 200 mm.

A medial gastrocnemius rotation flap was used routinely in all patients. The extensor mechanism was repaired by direct suturing

of the patellar tendon to the transposed flap. Preoperative and postoperative radiographs are shown in Figs. 1 and 2.

Results

The functional outcome was analysed based on the modified rating system of the MSTS [9]. An excellent result was achieved in 63 patients, good in 36, fair in 8 and poor in 21 (Table 1).

At the latest follow-up, 102 patients had no evidence of disease, 24 had died due to disease and two were alive with disease (Table 1).

Survivorship analysis was done using the Kaplan–Meier estimator; and prosthesis, limb and patient survival was analysed. The 5-year prosthetic survival was 84.5%, the 5-year limb survival 85.5% and the 5-year patient survival was 79.1%.

Complications

Infection was the most common, present in 16 patients. It was controlled in three by antibiotics, ten underwent amputation and the prosthesis was removed in three. Flap necrosis occurred in five patients.

Periprosthetic fracture occurred in 12 patients, of whom revision was done in seven. Fracture incidence was high in the early part of the series, which declined over the years, probably due to advances in implant design and manufacture. Aseptic loosening was present in five patients, four of whom underwent revision and one had an excellent functional outcome despite evidence of loosening. Disassembly and bending of the prosthesis occurred in one patient each.

Ten patients with osteosarcoma developed pulmonary metastasis; eight of them died, one was lost to follow-up and one is alive. Local recurrence was encountered in four patients, all of whom had osteosarcoma. Amputation was done in three patients, of whom two died.

Discussion

The issue of limb salvage versus amputation has been raised by several authors during the past decade. The overall survival, quality of life, function and disability have been found to be the same for both procedures [11, 20], although there is an increased risk of local recurrence in patients with limb salvage [22]. Limb salvage, however, has a definite cosmetic advantage when compared to amputation [20].

There are various options available for reconstruction after proximal tibial tumour resection. Rotationplasty [10] gives excellent functional success in children [16] but has a very low patient acceptability [13]. Resection arthrodesis achieves excellent stability but has the major drawback of lack of knee motion [2]. Osteochondral allografts have been used for benign and low-grade malignant tumours but have several complications like a high rate of infection, allograft fracture, non-union and joint instability [5, 18, 25].

The advantages of endoprosthetic replacement are cost-effectiveness [11], early resumption of knee function and unassisted ambulation [1, 6, 13, 25] and lower energy expenditure than an above-knee amputation and fitting with a prosthesis [19]. Gait and stride length are, however, not significantly different between endoprosthetic replacement and above-knee amputation using an external prosthesis [26]. Endoprosthetic replacement is also associated with several possible complications like failure of primary wound healing, flap necrosis, secondary infection, aseptic loosening, fracture and breakage [1, 13, 15, 24, 25].

The proximal tibia is the most technically demanding site for limb salvage surgery. The medial gastrocnemius rotation flap has provided a very satisfactory method of overcoming the two major problems in managing proximal tibial tumours, namely, providing soft-tissue cover

for the metallic endoprosthesis and maintaining continuity of the extensor mechanism [6, 17]. The method described by Malawer and McHale [17] has been used by us, and we have achieved an excellent MSTTS functional outcome in 49.6% and good in 27% of patients. The issue of extensor lag still remains one of the major causes for a decreased functional outcome after proximal tibial endoprosthetic replacement [23]. The mean extensor lag in our series was 18 (10–35)°. The use of extramedullary porous coating materials in the endoprosthesis has been shown by several authors to overcome this mechanical disadvantage. This is because a pseudocapsule forms around the prosthesis and the soft tissues adhere to it by scar tissue and exert their pull through the pseudocapsule, moving the limb more effectively [7].

The 5-year prosthetic survival in our series was 84.5% and patient survival 79.1%. Horowitz et al. [14], in a series of 16 patients, used a constrained prosthetic design for the proximal tibia and reported a 5-year prosthetic survival of 54% and patient survival of 93%. The 5-year survival of patients with proximal tibial tumours is superior to other sites, as observed by several authors, and is probably due to the smaller lesion size at presentation due to earlier detection [14, 17].

The most common complication encountered by us was infection, which is consistent with other series [12, 24], occurring in 16 (12%) patients. Grimer et al. [12] reported a 33% infection rate in endoprosthetic proximal tibial replacement, which—with improved soft-tissue cover techniques like the medial gastrocnemius flap—decreased to 12% [13]. The various factors contributing to the high rate of infection are duration of surgery, extensive tissue exposure and immunocompromise due to chemotherapy and pre-operative radiotherapy [13]. Periprosthetic fracture occurred in 12 (9%) of our patients and is probably due to the increased demands posed by return to normal activity in young patients [13, 14].

Four patients with osteosarcoma had local recurrence, three of whom underwent amputation; two died within a year, indicating that local recurrence is a poor prognostic factor for survival [4]. Aseptic loosening was observed in five of our patients. Unwin et al. [24] have stated that the risk of aseptic loosening of proximal tibial endoprosthesis was higher in younger patients and in patients who had a greater percentage of tibial shaft resection. We used the rotating hinge prosthesis in the majority of patients, and this design has been proved to dramatically reduce the incidence of aseptic loosening [4].

The management of proximal tibial tumours still continues to be one of the most challenging areas in orthopaedic oncology. Achieving optimal results, by any method, proves to be a daunting task due to the various anatomical factors unique to this site. Though there are several methods of reconstruction available, all of them have several drawbacks that outweigh the potential benefits. Custom megaprosthesis replacement has emerged as the accepted modality of treatment for malignant proximal tumours, as it has been proved to produce a good functional result with an acceptable rate of complica-

tions. However, careful patient selection, a precise pre-operative work-up and a meticulous surgical technique are essential to achieve the desired outcome.

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