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Limb salvage in distal tibial osteosarcoma using a custom mega prosthesis

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Abstract We have assessed the oncological and functional results of limb salvage surgery using a custom-made endoprosthetic replacement in six patients (mean age 17 years) with distal tibial osteosarcoma (stage IIB). A wide margin excision was possible in three, marginal in two and contaminated in one. Skeletal reconstruction was performed using a locally designed and manufactured custom-made distal tibial and ankle replacement prosthesis. Two patients developed local recurrence and one necrosis of the flap and deep infection. In three in whom the prosthesis remained in place the mean functional score according to the rating system of the Musculoskeletal Tumour Society was 24.3/30. In carefully selected patients limb salvage with prosthetic replacement is possible for distal tibial osteosarcomas.

Résumé Nous avons évalué les résultats oncologiques et fonctionnels chez six patients atteints d'osteosarcome tibial distal (stade IIB). Une résection large a été faite dans trois cas, marginale dans deux et contaminée dans un. La reconstruction squelettique a été accomplie avec une prothèse massive tibia-cheville faite sur mesure. Un patient a développé une nécrose avec infection profonde et deux patients ont eu une récurrence locale. Chez les trois patients qui ont toujours la prothèse en place, le score moyen post-opératoire de la Musculoskeletal Tumour Society était 24.3/30. Avec une sélection prudente des patients, le sauvetage du membre par remplacement avec une endoprothèse doit être une alternative valable.

Introduction

Limb salvage surgery for malignant bone tumours has become an accepted practice due to the improvement in tumour control, which can be achieved with modern che-

motherapy [5, 11]. The distal tibia is an uncommon site for osteosarcoma and amputation has been the standard surgical treatment. This produces predictable and satisfactory functional results but necessitates the use of prosthesis. However, simultaneous advances in surgical technique and biomedical engineering now mean that limb salvage rather than amputation has become a practical option for many patients with bone tumours [12]. Various methods of reconstruction have been attempted to preserve limbs with distal tibial lesions, and these include autografts and prosthetic replacement. Because of the limited amount of soft tissue coverage and of complicated biomechanical factors, limb salvage presents unique difficulties in the distal tibia. We embarked upon limb salvage surgery for distal tibial osteosarcoma 6 years ago using a custom prosthetic replacement and there have been two other publications on the use of prosthetic replacement for bone tumours of the distal tibia [1, 10]. We report our experience with six patients suffering from osteosarcoma of the distal tibia who underwent custom prosthetic replacement after tumour resection.

Patients and methods

Between 1994 and 1998 six patients with an osteosarcoma of the distal tibia underwent resection of the tumour with prosthetic replacement. Four were men and two were women. Their ages ranged from 14 to 21 years with a mean of 17.7 years. All the patients had staging assessments with routine haematological and biochemical investigations, CT of the local tumour and more recently MRI. Five patients were referred to us after an open biopsy and one after a needle biopsy. All the patients had a stage IIB osteosarcoma according to the Musculoskeletal Tumour Society staging system (Enneking) [7].

All our patients received three cycles of pre-operative chemotherapy consisting of Ifosfamide (6 mg/m² in divided doses over 3 days) with Mesna, Adramycin (50 mg/m²) and Cisplatin (100 mg/m²) and with an interval of 3 weeks between each cycle. A wide margin of resection was achieved in three patients; a smaller margin in two and the margin was contaminated in one. Skeletal reconstruction was accomplished by a locally designed and manufactured custom distal tibial and ankle replacement prosthesis.

The tibial component was made of stainless steel and consisted of an intramedullary component, a shaft and an articular compo-

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Table 1 Details of six patients with distal tibial osteosarcoma (NED no evidence of disease)

Case	Age (years)	Sex	Margin of resection	Soleus-flap cover	Oncological result at last follow-up	Local recurrence	Flap necrosis	Functional score*	Follow-up (months)
1	20	M	Wide	+	NED	-	-	26	68
2	20	F	Wide	+	NED	-	-	23	57
3	16	M	Marginal	+	NED	+	-	-	36
4	14	M	Marginal	+	NED	-	-	24	28
5	21	F	Contaminated	-	NED	+	-	-	27
6	15	M	Wide	-	NED	-	+	-	24

*Modified Musculoskeletal Tumour Society Scoring System [6]

ment. The talar component was made of high-density polyethylene with a dome-shaped articulating surface and it had two pegs for fixation into the talus or calcaneum. In the first three patients intra-articular distal tibial resection was performed. In the next three patients an extra-articular resection had to be performed and this included excision of the talus. In the last three patients the polyethylene component was cemented to the calcaneum. The mean length of the tibial component used was 163 mm and that of the intramedullary extension was 85 mm. Soft tissue reconstruction was required in four patients and was achieved with soleus muscle pedicle flap cover. Post-operative partial weight bearing was allowed with a patellar tendon-bearing orthosis at 2 weeks and proceeded to full weight bearing at 12 weeks. All but one of the patients then received three cycles of post-operative chemotherapy consisting of the same three drugs in the same doses as they had had pre-operatively. The follow-up ranged from 24 months to 68 months, with a mean of 40 months. Clinical data, results, complications and period of follow-up are shown in Table 1.

Results

All six patients were alive at the time of the last follow-up examination and none had developed pulmonary metastases. Functional results were assessed using the modified Musculoskeletal Tumour Society rating system [6] in the three patients in whom the prostheses still remained in place. The mean score in these three patients was 24.3 (80%).

Two patients developed local recurrence of the tumour. One patient (case 5) had an inadvertent spillage of the tumour (contaminated margin) during surgery while the other (case 3) refused post-operative chemotherapy. Both these patients required above-knee amputation.

One patient (case 6) developed flap necrosis and deep infection. Attempts failed to control the infection and to provide soft tissue cover, and this patient also required amputation.

None of the three patients in whom the prosthesis remained in place had either any loosening or pain.

Discussion

In the past there were various reasons why limb salvage surgery for distal tibial bone tumours was rarely considered. It is difficult to obtain a wide clear margin of resection because of the difficulties of obtaining soft tissue cover around the distal tibia and ankle [10]. Lack of ade-

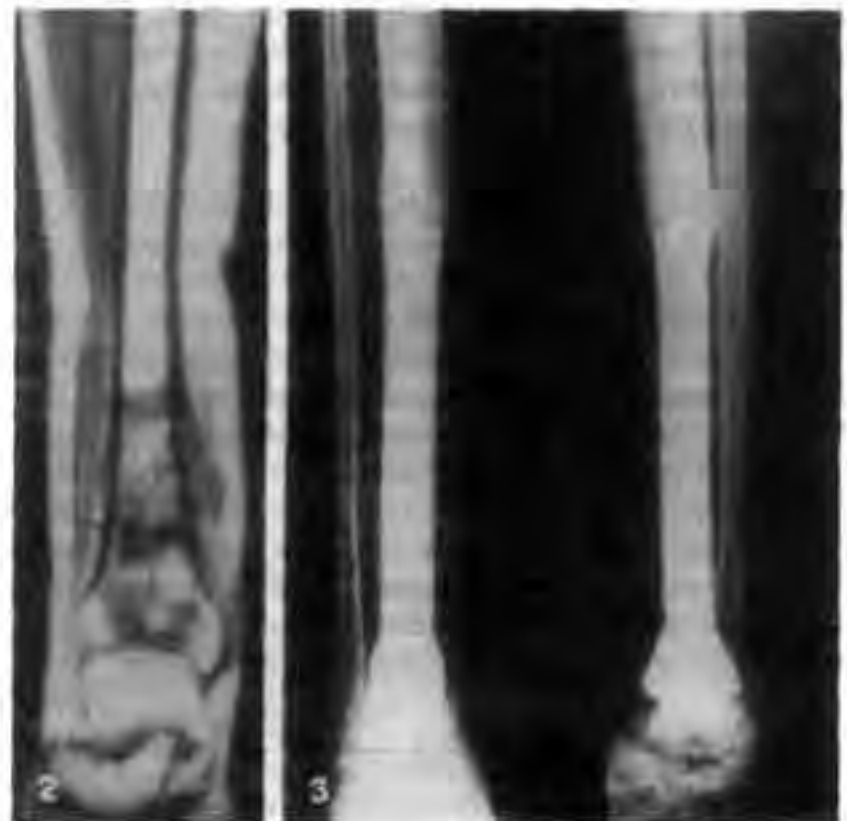


Fig. 1 Radiograph showing distal tibial osteosarcoma in a 20-year-old man

Fig. 2 MRI of the tumour showing the intramedullary and soft-tissue extension

Fig. 3 Five years follow-up radiograph. No evidence of loosening or talar collapse

quate muscle cover in this region also adds to the problems of soft tissue reconstruction after wide resection. Below-knee amputation used to be the standard surgical treatment as the function achieved with a below-knee prosthesis was very satisfactory. The results of ankle replacement arthroplasty, unlike the hip and the knee, have not been encouraging [3, 8, 9]. Bolton-Maggs et al. [3] recommended arthrodesis as the treatment of choice for the arthritic ankle in view of the high rate of compliance and generally poor long-term clinical results of ankle arthroplasty.

Arthrodesis has been regarded as one of the best options for skeletal reconstruction after bone tumour resection of the distal tibia and ankle. Casadei et al. [4] reported good functional and oncological results in 12 patients with malignant bone tumours of the distal tibia treated by resection and arthrodesis using an autogenous bone graft. Bishop et al. [2] reported satisfactory results using a free vascularised bone graft for reconstruction of segmental loss of bone secondary to osteomyelitis, tumour or trauma. The advantages of an arthrodesis are that it restores skeletal continuity, provides excellent stability and avoids problems related to prosthetic implantation. There will be loss of joint movement, however, and there is the possibility of non-union and a long period of recovery.

Prosthetic reconstruction of the distal tibia and ankle joint following tumour resection is a viable alternative to amputation or arthrodesis. Abudu et al. [1] in a review of five patients reported a good functional outcome with prosthetic replacement of the distal tibia and ankle joint. Lee et al. [10] reported satisfactory results in a medium-term analysis of six patients treated by limb salvage surgery using tumour prosthesis. In a period of 5 years we have performed prosthetic replacement of the distal tibia and ankle in six patients with an osteosarcoma. Four of our patients required soft tissue reconstruction with a muscle pedicle flap. Of the other two patients, one developed flap necrosis and deep infection and finally underwent amputation. Therefore we consider that it is most important to achieve adequate soft tissue cover of the prosthesis by using either local flaps or free microvascular flaps.

The functional results in the three patients who still have prosthesis have been very satisfactory, and there was no radiological evidence of aseptic loosening or of talar collapse. Below-knee amputation and the use of prosthesis produces satisfactory and predictable results

in distal tibial tumours, but many patients refuse amputation for psychosocial reasons. In this situation we prefer to attempt an excision with prosthetic replacement. The extent of soft tissue involvement is probably crucial in decision-making. Our three patients who had a large soft tissue involvement ended up with an amputation.

With careful patient selection limb salvage surgery by prosthetic replacement for distal tibial bone tumours can be a viable alternative to amputation or arthrodesis. However, more studies are still required with larger numbers of patients and with long-term follow-up in order to justify this method of treatment.

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