

A. Abudu · R.J Grimer · R.M. Tillman · S.R. Carter

Endoprosthetic replacement of the distal tibia and ankle joint for aggressive bone tumours

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Abstract Below knee amputation remains the treatment of choice for most patients with aggressive tumours of the distal tibia. We report the clinical and functional outcome of limb preserving surgery and endoprosthetic reconstruction of the distal tibia and ankle joint in five patients who declined amputation. The mean age was 32 years. Two had osteosarcoma, one Ewing's sarcoma, leiomyosarcoma and Giant cell tumour. Three patients developed significant complications including local recurrence, wound dehiscence and infection, and fibula impingement. Despite these complications the patients declined amputation even in the presence of significant discomfort. Early function was excellent in all patients but deteriorated with time. The patients still maintained an Enneking Score of more than 50%. Some patients are unwilling to undergo amputation for aggressive tumours of the distal tibia. For these, excision and reconstruction with endoprosthesis allow early functional recovery but there is significant medium term morbidity and functional deterioration.

Résumé L'amputation au dessous du genou reste le traitement de choix pour la plupart des patients présentant des tumeurs agressives au niveau de l'extrémité distale du tibia. Nous rapportons ici les résultats cliniques et fonctionnels de 5 patients qui, ayant refusé toute amputation à ce niveau, ont bénéficié d'une chirurgie conservatrice et d'une reconstruction prothétique de l'extrémité inférieure du tibia et de la cheville. L'âge moyen était de 32 ans. Deux patients présentaient un ostéosarcome; les autres présentaient un sarcome d'Ewing, un leiomyosarcome et une tumeur à cellules géantes. Trois patients ont présenté des complications sérieuses: récurrence locale, désunion et infection, conflit au niveau de la fibula. Malgré ces complications aux conséquences fonctionnelles lourdes, tous les patients ont refusé l'amputation. Le ré-

sultat fonctionnel précoce a été excellent pour tous les patients mais s'est détérioré avec le temps. Certains patients refusent de subir une amputation pour une tumeur agressive de l'extrémité inférieure du tibia. Pour ces patients, l'excision et la reconstruction à l'aide d'endo-prothèses permettent d'obtenir un bon résultat fonctionnel précoce cependant la morbidité ainsi que la détérioration fonctionnelle avec le temps reste importante.

Introduction

The subcutaneous location and proximity of the distal tibia to the neurovascular bundle and tendons make adequate excision of aggressive benign or malignant tumours of the distal tibia with wide margins difficult to achieve. Hence, below knee amputation has been the treatment of choice for treating the local tumour in these patients. However, there are limited indications for limb preserving surgery in patients with aggressive benign or malignant tumours of the distal tibia. These include patients with grade 3 benign tumours according to the criteria of Enneking, Spanier and Goodman [3], malignant primary bone tumours confined to the bone without soft tissue extension and patients with malignant tumours with extraosseous extension who refuse amputation. Limb preserving surgery is contraindicated when there is involvement of the neurovascular bundle, ankle joint or important tendons of the ankle and foot.

The option available for reconstruction of the defect following total excision of the distal tibia include free vascularised or non-vascularised fibula autograft and arthrodesis [1, 6], osteoarticular allograft [5] and endoprosthesis [7]. Endoprosthetic replacement of the distal tibia is still experimental and the long-term outcome is unknown. We report the clinical and functional outcome of excision of the distal tibia and endoprosthetic reconstruction of the distal tibia and ankle joints in five patients with aggressive benign and malignant tumours who refused below knee amputation as treatment of their primary bone tumour.

A. Abudu (✉) · R.J Grimer · R.M. Tillman · S.R. Carter
Oncology Service, Royal Orthopaedic Hospital,
Bristol Road South, Northfield, Birmingham B31 2AP, UK
Tel.: +44-121-685-4150, Fax: +44-121-685-4146

Table 1 Clinical, oncological and functional outcome

	Age	Sex	Diagnosis clinical stage	Margins	Follow-up (months)	Oncological stage	Complication	Function
1	43	Female	Leiomyosarcoma Stage IIA of bone	Wide	67	free of disease	Loose talar component Fibular impingement	50%
2	40	Male	Osteosarcoma Stage IIB	Marginal	84	free of disease	None	90%
3	25	Female	Osteosarcoma Rad.induced. Stage IIB	Marginal	44	died of disease	Deep sepsis. Wound necrosis Metastases	50%
4	27	Female	Recurrent Ewing's Sarcoma	Intralesional	33	died of disease	Local recurrence	67%
	46	Female	Chondromyxoid fibroma Stage 3	Wide	102	free of disease Lost to follow up	None	Not available

Patients and method

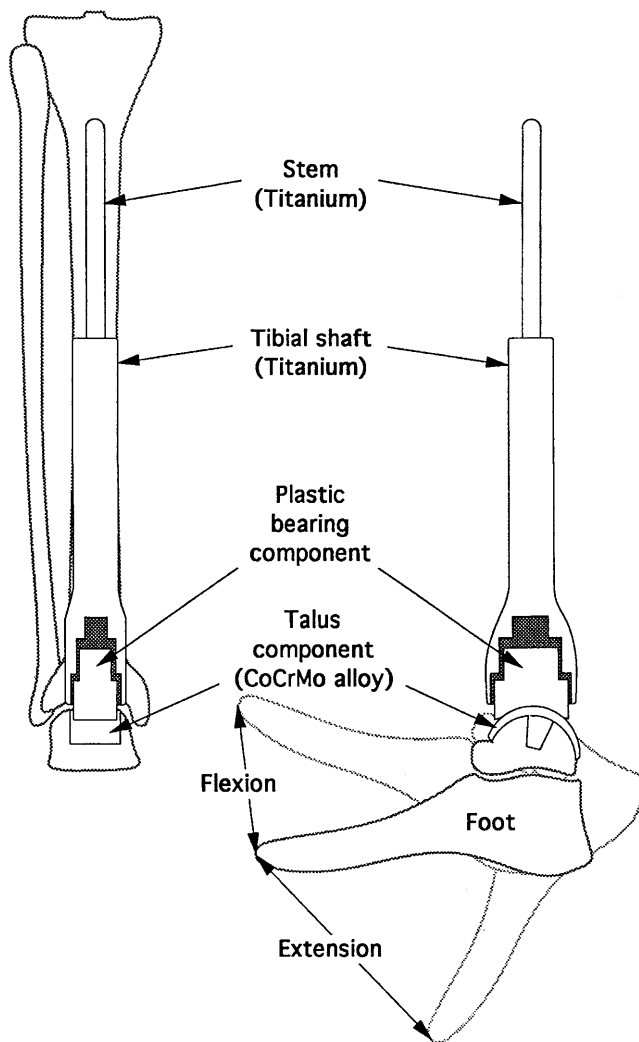
Five consecutive patients with aggressive primary bone tumours of the distal tibia treated by limb sparing tumour excision and endoprosthetic replacement of the distal tibia and ankle joint between 1977 and 1994 were studied. The histological diagnosis and clinical staging according to the criteria of Enneking, Spanier and Goodman [3] were stage IIB osteosarcoma in two patients, Stage IIA Leiomyosarcoma in one, Stage IIB recurrent Ewing's sarcoma in one and recurrent chondromyxoid fibroma in one (Table 1). Neoadjuvant chemotherapy (cisplatin and adriamycin) was given to the patients with osteosarcoma. The patient with recurrent Ewing's sarcoma had chemotherapy 6 years previously and was given adjuvant post-operative radiotherapy because she presented with a pathological fracture. All the patients were offered below knee amputation as the preferred treatment of the tumours but refused the advice insisting on preserving the limb.

Clinical and radiological records of the patients were reviewed retrospectively. Functional assessment were made according to the criteria of the Musculoskeletal Tumour Society Functional Assessment System (4).

Surgical technique

Staging and diagnostic studies consisting of haematological and biochemical tests, plain radiographs of the lesion and chest, MRI scan of the lesion, CT scan of the chest, whole body bone scan and biopsy were performed in all the patients. The prostheses (Fig. 1) were custom made based on the anticipated level of resection of the tibia. The tibial stem and shaft were made from titanium. The talar component was made from chrome cobalt alloy with an ultra high molecular weight polyethylene bearing component. The articulation was designed to be a semiconstrained rotating hinge.

Per-operative tourniquet without exsanguination of the limb was applied. A longitudinal incision lateral to the tibial crest was used. Skin flaps were raised on the medial and lateral sides deep to the deep fascia. The anterior tibial vessels, deep peroneal nerve and posterior tibial neurovascular bundle were retracted medially. Division of the tibia and interosseous membrane at a pre-determined level often about 5 cm proximal to the tumour was performed and this allowed retrograde mobilisation and dissection of the tumour. The aim was to completely excise the tumour and biopsy tract en bloc covered by a cuff of normal tissue with preservation of important tendons. The medullary canal of the tibia was prepared to accept the intramedullary portion of the tibial implant and the talus was sculptured to accept the talar component. Both tibial and talar implants were secured with methylmetacrylate (Fig. 2). Closure of the deep fascia and skin was performed over a single suction drain. Continuous intravenous antibiotics usually Cefuroxime were administered throughout surgery.

**Fig. 1** Design of a typical prosthesis

The patients were placed in a plaster of Paris back slab cast and had bed rest for 5 days before the drains were removed and new complete casts applied. The patients were mobilised non-weight bearing for six weeks and thereafter progressive weight bearing without any cast was allowed. Intensive physiotherapy

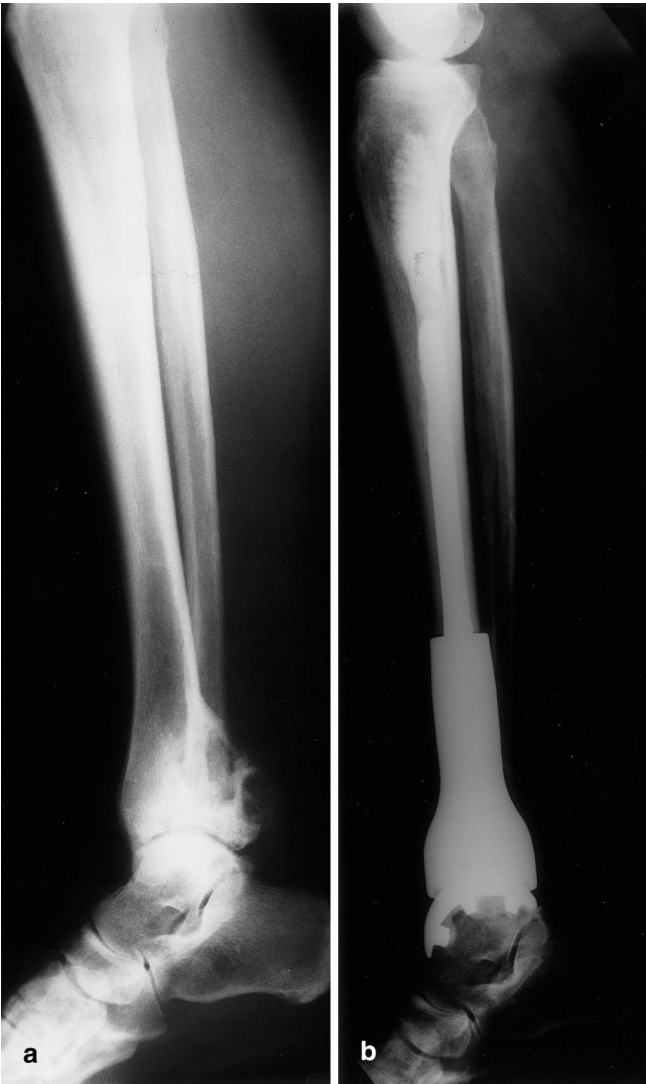


Fig. 2a,b Plain radiographs of Chondromyxoid fibroma of the distal tibia (a) treated by excision and endoprosthetic reconstruction (b) after two failed curettage procedures

was commenced at six weeks until maximum ankle and subtalar motion was achieved. All the patients achieved full unprotected weight bearing by 3 months.

Results

The mean age at the time of surgery was 36 years (25 to 46). There were four females and one male. Excision margins were wide in two patients, marginal in two and intralesional in one. One patient was lost to follow up 102 months following surgery. Two patients had died of metastatic disease at 33 and 44 months following surgery. Two patients were alive and continuously free of disease at 67 and 84 months following surgery.

Significant complications developed in three patients. The patient with a pathological fracture had intralesional margins and developed local recurrence at 33 months

following surgery despite having had adjuvant post-operative radiotherapy. Wound necrosis and deep infection developed in one patient who had received radiotherapy 15 years previously for Ewing's sarcoma but later developed radiation induced osteosarcoma. One patient had aseptic loosening of the talar component, impingement of the lower fibula and significant chronic pain.

Early function was good in all the patients with a functional score of between 67% and 90% (mean 81%) at one year following surgery but this deteriorated with time mainly due to occasional discomfort and limited ability to do sports. At the last follow-up functional scores varied from 50% to 90% (mean 65%) as shown in Table 1.

Discussion

The distal tibia is an uncommon site for primary malignant bone tumours. Of 190 patients with primary bone sarcoma of the tibia treated at our centre over 25 years, in only 21 (11%) was the distal tibia the location of the tumour. Most of the patients with primary malignant tumours of the distal tibia were treated by below knee amputation because we believe that this achieves the safest oncological margins, predictable outcome and best function in these patients. However, amputation is associated with significant psychological, physical, social and financial cost to patients [2] and some patients refuse amputation when recommended as treatment of their tumours. All the patients described in this report were offered amputations but refused.

Reconstruction of distal tibial defects by autogenous free vascularised or non vascularised fibula graft and arthrodesis of the ankle joint requires prolonged immobilisation, unpredictable outcome, need for multiple operations to achieve arthrodesis and loss of ankle motion [1, 6]. Allograft reconstruction is time consuming, associated with significant risk of graft infection, fractures, prolonged immobilisation and unpredictable outcome [5]. Endoprosthetic reconstruction offers the possibility of early functional recovery and preservation of ankle motion but the outcome of these prostheses is unknown in the medium and long term.

Adequate margins were obtained in only two patients, one with recurrent chondromyxoid fibroma and another with intracompartmental leiomyosarcoma. Two patients with extracompartmental osteosarcoma had marginal excision. The patient with a pathological fracture through a recurrent Ewing's sarcoma had an intralesional excision margins and received post-operative radiotherapy. Significant complications developed in three of the five patients but despite the complications the patients still declined amputation as salvage procedure even in the presence of significant discomfort.

Early function is good following endoprosthetic reconstruction of the distal tibia and ankle joint but this deteriorated with time due to development of discomfort and limited level of sports and leisure activities. However, the pa-

tients still achieved 65% of the pre-morbid functional capacity at the time of last follow-up and remained satisfied.

Some patients are extremely reluctant to undergo amputation for aggressive tumours of the distal tibia. For these, excision and endoprosthetic replacement of the defect and ankle joint allow early functional recovery but there is significant medium term morbidity and functional deterioration.

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