ORIGINAL PAPER

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Prosthetic reconstruction of the femur for primary bone sarcoma

Accepted: 16 August 1999

Abstract The survival of patients and implants, complications and functional outcome were reviewed in 25 consecutive femoral endoprosthetic reconstructions for treatment of primary bone sarcoma. The diagnosis was chondrosarcoma in 11, osteosarcoma in 10, MFH in 3 and Ewing's tumour in 1. Median follow up was 64 months (34 to 219) and median age at operation was 29 years (10 to 70). Twelve remained disease free at review. One had amputation for local recurrence and another was alive with metastases. 11 patients died at a median of 13 months (5 to 128); 8 from metastatic disease and 3 from other causes. Four implants were revised, at a median of 95 months (53 to 136); two for fractures of the stem and two for aseptic loosening. Three implants had radiological evidence of loosening at a median of 43 months (34 to 49). Fourteen patients had significant complications. The median functional score using the Musculoskeletal Tumour Society system was 68%. In our experience, prosthetic reconstruction of the femur does not compromise survival, although there is a significant complication rate.

Résumé La survie des patients et des implants, les complications et le résultat fonctionnel ont été étudiés dans 25 reconstructions prothétiques fémorales consécutives au traitement de sarcomes primaires de l'os. Le diagnostic était : ostéosarcome dans 11 cas, chondrosarcome dans 10, MFH dans 3 et tumeur d'Ewing dans 1. La médiane de suivie était de 64 mois (34 à 219) et la valeur médiane de l'âge à l'opération était de 29 ans (10 à 70). 12 patients sont sans métastase ni récurrence à la revue. Un a eu une amputation pour récurrence locale et un autre est vivant avec métastases. 11 patients sont morts

avec une médiane de 13 mois (5 à 128): 8 de méastases et 3 d'autres causes. 4 implants ont été réopérés avec une médiane de 95 mois (53 à 136) : 2 pour rupture de la tige et 2 pour descellement aseptique. 3 implants montraient un descellement radiologique à une médiane de 43 mois (34 à 49). 14 patients avaient des complications notables. Le score fonctionnel moyen utilisant la cotation de la Musculoskeletal tumor Society était de 68%. La reconstruction prothétique du fémur ne compromet pas la survie bien qu'il y ait un taux élevé de complications.

Introduction

Improved imaging techniques, chemotherapy and implant design have allowed limb sparing surgery to become established in the treatment of primary bone sarcoma. If adequate margins are achieved the disease free interval and overall survival are similar to that following amputation [8, 11, 13]. Surgical options for reconstruction include endoprosthetic replacement, allografts, autografts including vascularised fibular grafts, arthrodesis, rotationplasty and bone transport [5, 11, 12, 15]. We reviewed our experience of endoprosthetic reconstruction of the femur to determine survival of patients and implants, complications and functional outcome.

Patients and methods

The Scottish Bone Tumour Registry and hospital records were used to identify patients with primary sarcoma of the femur treated by resection and endoprosthetic reconstruction between 1978 and 1997. Records and radiographs were reviewed. Radiographs were measured to calculate the proportion of the femur resected. Survivors were contacted and clinically examined where possible. Functional scores were calculated using the system of the Musculoskeletal Tumour Society [2].

Before surgery, the extent of disease and the presence of metastases were determined by clinical assessment, plain radiographs, and where appropriate, CT, MRI and isotope bone scan. Biopsy was performed to make a histological diagnosis. Limb-sparing surgery was planned if wide excision could be performed without sacrificing major nerves or vessels. Imaging studies were

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used to determine the level of resection and order a suitable implant. Chemotherapy and radiotherapy were given in accordance with the protocols in place at the time.

Results

Diagnosis and treatment

25 consecutive patients were identified; 16 males and 9 females of median age 29 years (10 to 70). The results are summarised in Table 1. The diagnosis was chondrosarcoma in 11, osteosarcoma in 10, malignant fibrous histiocytoma (MFH) in 3 and Ewing's tumour in 1. There were 9 proximal, 2 diaphyseal and 14 distal femoral resections. By the staging system of Enneking [3], 7 patients were stage 1A, 1 was 1B, 2 were 2A, 13 were 2B, and 2 were 3B. Five patients underwent biopsy at the referring hospital. Two patients could not be traced. The remainder were contacted and reviewed. During the same period, 11 patients underwent primary amputation for sarcoma arising in the femur.

Two patients had a staged resection with use of a temporary spacer. Another had a vascularised fibular graft which failed. The remainder had a single procedure. Nineteen cases were performed by the senior author, four by a second consultant, and one each by two other consultants. The proportion of the femur resected was a median 40% (range 23 to 60%). Proximal implants were Vidal, Charnley, Stanmore or Kotz designs. An example is shown in Figs. 1 to 4. Two diaphyseal implants were Stanmore, one of which was a Mark V telescopic prosthesis [14]. Distal implants were Stanmore with rotating hinge articulation or Johnson and Johnson with a Rotaflex or Insall-Burstein knee articulation. An example is shown in Figs. 5 to 7. All components apart from the Kotz stem were cemented. The patella was not routinely resurfaced.

13 patients (10 with osteosarcoma, 1 Ewing's tumour, 2 MFH) had adjuvant chemotherapy. One patient with Ewing's sarcoma had preoperative radiotherapy. Five had post operative radiotherapy, two for palliation. Ten patients with chondrosarcoma had no adjuvant treatment; one had radiotherapy for metastatic disease.

Survival of patients

There were 14 survivors, at a median of 64 months (34 to 219 months). There was one local recurrence, treated by amputation. This patient was alive and free from disease 44 months later but has since been lost to follow up. One patient is alive with metastatic disease. 11 patients died at a median of 13 months (5 to 128 months). 8 died as a result of their primary tumour. Six of these had features associated with a poor prognosis; two had metastases at presentation, histological examination of the resected specimen showed two had had a poor response to chemotherapy and in one case the margin was unexpected

ly narrow. Another had presented with a pathological fracture. Of the other three patients, 1 died from bronchopneumonia, 1 from myocardial infarction and 1 with Hereditary Multiple Exostoses (HME) had a second primary tumour in the pelvis.

Survival of implants

Four implants were revised. Two were revised after fracture of the stem of the implant at 4 and 11 years. Two were revised for aseptic loosening at 6 and 10 years. Three implants were radiologically loose at review; one diaphyseal endoprosthesis and two distal endoprostheses.

Complications

14 patients had significant complications. 12 required further surgery. Four proximal implants dislocated. Three stabilised after closed reduction and bracing. One required open reduction, but later stabilised. One Insall-Burstein knee dislocated but was successfully treated by closed reduction.

Two patients with distal resections had patellar fractures internally fixed. One periprosthetic fracture was treated by open reduction and plating. The implant remains well fixed. One osteoporotic fracture of the ipsilateral tibia united in plaster.

There was one wound infection with Methicillin Resistant *Staphylococcus aureus* (MRSA). There was one acute pulmonary embolism after dislocation of a proximal femoral implant. There was one episode of angioedema following cementing and one lateral popliteal nerve palsy.

Functional outcome

Functional scores were available for 10 survivors with implants that had not been revised. The median score was 66%. The highest score was for emotional acceptance, (mean 4.4), and the lowest for gait (mean 2.1). 6 out of ten survivors of working age are employed. Two survivors with revised implants scored 92% and 67%.

Discussion

Limb sparing surgery is now widely accepted as appropriate treatment for primary sarcoma of the femur in selected patients [5, 6, 8–12, 14, 16]. The selection of reconstructive technique depends upon the risk of complication, functional result, long term durability, curative intent of the procedure and patient preference. Endoprosthetic reconstruction allows early return of function, but has a high incidence of short and long term complications and in young patients who survive, a revision procedure is almost inevitable [10].

Table 1 Summary of results

Case	Age	Sex	Diagnosis	Site	Stage	Resected length	Implant	Survival	Follow up	MSTS score	Complications
1	65	F	Chondrosarcoma	Proximal	2B	NA	Vidal	Died, metastases	13		Dislocation
2	13	F	Ewing's	Proximal	2A	45%	Vidal	Died, metastases	11		
3	25	M	Chondrosarcoma (HME)	Proximal	1A	44%	Vidal	Alive	219	92%	Revised at 136 months for stem fracture
4	53	M	Chondrosarcoma	Proximal	1A	NA	Long stem Charnley	Died, bronchopneumonia	25		Dislocation, open reduction
5	43	M	MFH	Proximal	2A	42%	Vidal	Died, metastases	5		
6	21	M	Chondrosarcoma (HME)	Distal	1B	60%	Custom Rotaflex knee	Died, second primary	128		Revised at 53 months for stem fracture
7	25	M	Osteosarcoma	Distal	2B	48%	Custom Rotaflex knee	Alive	133	60%	Fracture at bone/implant junction and patellar fracture
8	70	F	Chondrosarcoma	Proximal	1A	30%	Vidal	Alive	121	77%	
9	35	F	Osteosarcoma	Distal	2B	29%	Custom IB knee	Alive	138	77%	Revised at 72 months for aseptic loosening
10	52	M	Chondrosarcoma	Proximal	1A	23%	Vidal	Died, MI	47		Dislocation
11	19	M	Osteosarcoma	Distal	2B	40%	Custom Rotaflex knee	Died, metastases	13		
12	35	F	MFH	Distal	2B	36%	Custom IB knee	Alive	119	63%	Patellar fracture. Revised at 119 months for aseptic loosening
13	13	M	Osteosarcoma	Distal	2B	38%	Custom IB knee	Alive	68		Amputation at 23 months for local recurrence
14	51	M	Chondrosarcoma	Distal	2B	60%	Custom IB knee	Alive	34		
15	20	M	Chondrosarcoma	Distal	1A	25%	Custom IB knee	Alive	88	90%	Quadriceps plasty. Dislocation, closed reduction.
16	44	M	Chondrosarcoma	Proximal	1A	33%	Kotz	Alive	61	53%	Radiologically loose acetabular component
17	20	M	Osteosarcoma	Distal	3B	31%	Custom IB knee	Died, metastases	8		
18	16	F	Osteosarcoma	Distal	2B	40%	Custom Rotaflex knee	Alive	49	73%	Radiologically loose femoral component
19	29	M	MFH	Distal	2B	33%	Stanmore rotating hinge	Alive	55	73%	
20	56	F	Osteosarcoma	Diaphysis	3B	55%	Stanmore	Died, metastases	12		
21	21	M	Osteosarcoma	Distal	2B	NA	Stanmore rotating hinge	Died, metastases	22		
22	65	F	Chondrosarcoma	Proximal	2B	36%	Stanmore	Died, metastases	19		Dislocation
23	10	F	Osteosarcoma	Diaphysis	2B	54%	Stanmore telescopic	Alive	37	47%	Fracture of tibia. Radiological loosening of proximal stem
24	36	M	Chondrosarcoma (HME)	Distal	1A	43%	Stanmore rotating hinge	Alive	37	53%	
25	15	M	Osteosarcoma	Distal	2B	52%	Stanmore rotating hinge	Alive with metastases	34	63%	Radiologically loose femoral component

Fig. 1 Case 16. Radiograph of proximal femur showing destruction of normal bony architecture

Fig. 2 MRI scan showing increased signal intensity in the proximal femur, but no evidence of soft tissue extension

Fig. 3 Post operative radiograph showing Kotz endoprosthesis

Fig. 4 Follow up radiograph at 5 years showing well-fixed components

Fig. 5 Case 15. Radiograph showing an expansile lesion in the lateral femoral cortex

Fig. 6 Postoperative radiograph showing custom IB knee endoprosthesis

Fig. 7 Follow-up radiograph at six years showing cortical resorption adjacent to the prosthesis which remains well fixed

The goal of tumour surgery is to cure the primary tumour. Published series show that limb sparing surgery can be performed without adverse impact on the disease-free interval and long term survival, but patients need to be carefully selected [8, 11, 13]. One local recurrence is in keeping with published rates of around 10% [12, 14, 17]. Although, in retrospect, we could identify unfavourable prognostic factors in most of the patients who died of their disease, the presence of one of these factors does not necessarily preclude limb-sparing surgery. The patient who was found to have an unexpectedly narrow surgical margin had a good response to chemotherapy and it was not felt appropriate to proceed to amputation.

In common with others, we had a high rate of significant complications, the most common of which was dislocation of a proximal femoral implant [1, 4, 6, 8]. Our dislocation rate was high compared with some published results [9] but is comparable to others [18]. All stabilised after reduction and bracing. Many factors contribute, including the resection of a large amount of bone and soft tissue. Bipolar hemiarthroplasty and the use of a post-operative hip spica may reduce the dislocation rate [9].

Dislocation of the Insall-Burstein posterior stabilised knee has been recognised and the geometry of the implant has been modified to make it more stable [7]. In our case, soft tissue resection performed at the primary procedure was followed by a quadricepsplasty for patellar subluxation which may have been contributory. Stem fracture may be related to the degree of soft tissue resection and stem diameter [1, 8]. Newer implants may be less likely to fracture. Aseptic loosening is more common in distal implants, and in younger patients [16]. Three of four patients with loosening were under 16 years of age at the time of their index procedure.

The functional outcome score of the Musculoskeletal Tumour Society has five scales, for pain, function, emotional acceptance, the use of walking supports, walking ability and gait. The lowest scores in our series were for gait, and all had at least a minor cosmetic alteration. However, all of our patients scored highly on the emotional acceptance scale, and most stated that despite the problems, limb-sparing was preferable to amputation.

Although endoprosthetic reconstruction of the femur is well accepted by patients, there are significant complications. The benefit of early return of function is offset by the prospect of revision. Despite this, endoprosthetic reconstruction remains the treatment of choice in many patients with primary bone sarcoma of the femur.

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