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Limb salvage surgery in bone tumour with modular endoprosthesis

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Abstract Thirty-three patients with bone tumours were treated by resection of the growth and reconstruction with a Kotz modular endoprosthesis. The average follow-up was for 50 months, ranging from 14 to 79 months. At the last review, 12 patients (36%) had died due to the tumour and 9 others (27%) had metastases. All 4 patients with proximal tibial reconstruction had poor functional results, due to an extension lag or to knee stiffness. Four of the six tumours of the proximal femur were complicated by local recurrence or dislocation of the hip, and had poor or fair functional results. Of the patients with distal femoral reconstruction, 17 out of 22 had excellent or good functional results. Reconstruction with a modular prosthesis after resection of a tumour gives excellent or good functional results in more than three-fourths of the cases of distal femur reconstruction, but it should be used with caution in the proximal tibia and proximal femur.

Resumé 33 patients avec une tumeur(s) osseuse(s) ont été traités par résection chirurgicale suivie d'une reconstruction avec endoprothèse modulaire de Kotz. Les patients étaient suivis pour une période allant de 14 à 79 mois (50 mois). Au dernier bilan 12 malades (36%) avaient une mort liée à la tumeur. Le résultat fonctionnel a été insatisfaisant chez tous les patients ayant subi une reconstruction tibiale proximale: soit un déficit de l'extension du genou ou la raideur. Dans les deux-tiers des cas (4 sur 6) avec reconstruction femorale proximale, des complications ont été observées: récurrence locale, luxation de la tête femorale et mauvais voire médiocre résultat

fonctionnel. Plus des trois quarts des patients avec reconstruction femorale distale (17/22) ont eu un bon voire excellent résultat fonctionnel. Le type de reconstruction avec prothèse modulaire après résection tumorale paraît bien indiquée chez des patients avec grosse tumeur osseuse et souhaitant préserver une mobilité adéquate. Cette chirurgie peut donner un bon ou excellent résultat fonctionnel dans plus de 3/4 des cas de reconstruction distale du fémur, mais elle doit être utilisée avec précaution dans la reconstruction tibiale et femorale proximales vu le risque de complications à type de luxation de la tête femorale et de déficit de l'extension.

Introduction

Limb salvage has become an accepted treatment for bone tumours [1, 2, 4–7, 9–11, 13–15], but reconstruction of the residual defect after wide resection in the leg is still a difficult problem in developing countries. Most of the patients seek medical advice when the tumour is already large and they reject the fusion of the joints, particularly the knee, for social and cultural reasons.

Movement can be restored by using an allograft [6, 8, 11] or an endoprosthesis [2, 7, 9, 13, 15]. Our hospital does not have access to allografts due to social and technical reasons. They also have a higher incidence of complications including fracture, infection, and loss of fixation [8, 11, 14].

We have therefore employed the Kotz modular endoprosthesis for managing large tumours.

Patients and methods

We studied retrospectively 33 patients with bone tumours treated by resection and reconstruction with a Kotz modular endoprosthesis from July 1991 to December 1994 (Table 1). The clinical and radiological information was collected by reviewing the charts, X-rays, and other imaging studies, and by interviewing all patients in the clinic.

There were 17 males and 16 females with an average age of 27 years (range 16 to 69 years). Histologically, 24 patients had an os-

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Table 1. Clinical data

Serial no.	Age	Sex	Diagnosis	Bone involved	Stage	Date of surgery	Surgical margins	Tumour size (in cm)	Skeletal reconstruction (in cm)	Date and length of follow-up (months)	Recurrence up	Complications (early & late)	Recent patient status	Radiographic observations			Functional Result
														Remodelling	Inter-face	Anchorage	
1	35	M	Fibro-sarcoma	Right distal femur	II B	7/91	Wide	12×10×10	12+8	12/97 (77)	No		AWNED	G	E	E	E
2	25	M	Osteo-sarcoma	Left distal femur	II B	7/91	Wide	15×9×8	12+6	12/97 (77)	No	Skin breakdown; broken screw	AWD	G	G	F	F
3*	31	F	GCT	Right distal femur	NA	10/91	NA	NA	12+0	5/98 (79)	No	Broken screw	AWNED	G	E	P	E
4	17	M	Osteo-sarcoma	Right distal femur	II B	10/91	Wide	18×5×7	12+8	8/94 (34)	No		TRD	E	E	E	G
5	36	F	Osteo-sarcoma	Left distal femur	IIB	12/91	Marginal	7×5×5	14+0	11/93 (23)	(?) Yes	Peroneal nerve palsy	TRD	P	P	E	F
6	29	F	Osteo-sarcoma	Left distal femur	II B	2/92	Wide	15×7×9	12+8	7/97 (65)	No		AWNED	G	E	E	E
7	16	F	Osteo-sarcoma	Left distal femur	II B	3/92	Wide	11×8×6	14+0	7/97 /64)	No		AWNED	G	E	E	E
8	16	F	Osteo-sarcoma	Left distal femur	II B	3/92	Wide	18×10×9	16+8	5/93 (14)	Yes	Skin breakdown	TRD	G	G	E	G
9	17	M	Osteo-sarcoma	Right proximal femur	II B	4/92	Contaminated	27×6×7	14+10	10/92 (6)	No	Dislocation of hip	TRD	G	E	E	P
10	20	M	Osteo-sarcoma	Right distal femur	II B	6/92	Wide	16×7×8	14+6	4/95 (34)	No		TRD	G	G	E	E
11	17	W	Osteo-sarcoma	Left distal femur	II B	6/92	Wide	14×5×6	14+6	8/97 (62)	No	Loosening of anchor 5/96	AWD	G	G	p	G
12*	16	M	Osteo-sarcoma	Left distal femur	NA	10/92	Wide	11×5×6	12+6	11/97 (61)	No	12 cm shortening due to first surgery	AWD	G	G	E	P
13	16	M	Osteo-sarcoma	Left distal femur	II B	11/92	Wide	14×10×10	14+6	7/95 (32)	No		TRD	G	E	E	E
14*	30	F	Osteo-sarcoma tibia	Left proximal tibia	NA	4/93	NA	NA	16+0	3/96 (35)	No	Stiffness of knee	AWD	G	E	E	P
15	63	M	Osteo-sarcoma	Right proximal femur	II B	9/93	Wide	15×8×6	14+6	4/98 (55)	No	Dislocation of hip 40 deg.	AWD	E	E	E	P
16	16	F	Osteo-sarcoma	Left distal femur													
16	16	F	Osteo-sarcoma	Left distal femur	II B	11/93		20×12×8	16+8	4/94 (5)	No	extensor lag	TRD	E	E	E	P
17	58	F	Chondro-sarcoma	Left proximal femur	II B	1/94	Contaminated	24×7×8	16+10	7/95 (18)	Yes		AWD	E	E	E	F

Table 1. Continued

Serial no.	Age	Sex	Diagnosis	Bone involved	Stage	Date of surgery	Surgical margins	Tumor size (in cm)	Skeletal reconstruction (in cm)	Date and length of follow-up (months)	Recurrence up	Complications (early & late)	Recent patient status	Radiographic observations			Functional Result
														Metaphyseal	Remo-delling	Inter-face	An-chorage
18	23	M	Chondro-sarcoma	Left proximal femur	I B	12/93	Marginal	20×10×8	14+10	8/94 (8)	Yes		TRD	G	E	E	F
19	59	F	Osteo-sarcoma	Right proximal femur	II B	1/94	Wide	11×9×10	12+0	2/95 (13)	No		TRD	E	E	E	E
20	31	M	Recurrent GCT	Recurrent femur	3 B	2/94	Wide	8×5×5	12+0	3/98 (49)	No		AWNED	E	E	E	E
21	19	M	Osteo-sarcoma	Right distal femur	II B	2/94	Wide	18×9×8	16+6	3/98 (49)	No		AWNED	G	E	E	E
22	22	M	Osteo-sarcoma	Left proximal femur	II B	4/94	Wide	12.5×10.5×8	16+8	3/98 (48)	No		AWNED	E	E	E	E
23	24	F	Parosteal Osteo-sarcoma	Left distal femur	II B	5/94	Wide	10×6×5	12+10	4/98 (48)	No		AWNED	G	E	E	E
24	16	M	Osteo-sarcoma	Right distal femur	II B	5/94	Wide	9×7×5	14+6	4/98 (48)	No		AWD	G	G	E	E
25	18	F	GCT	Left distal femur	3 B	7/94	Wide	9×7×5	14+6	1/98 (42)	No		AWNED	G	E	E	E
26	19	M	Osteo-sarcoma	Left proximal tibia	II B	7/94	Wide	10×6×4	16+6	2/98 (44)	No	50 deg. extensor lag	AWNED	E	E	E	P
27	18	M	Recurrent Ewing's sarcoma	Left total femur	II B	9/94	Wide	25×10×10	16+6+16	10/95 (13)	No		TRD	E	E	E	E
28	25	F	Osteo-sarcoma	Left distal femur	II B	9/94	Wide	15×8×4	12+8	7/96 (22)	No		TRD	E	E	E	E
29	20	F	Parosteal osteo-sarcoma	Right proximal tibia	I B	9/94	Wide	15×7×5	12+8	10/97 (37)	No	20 deg. extensor lag; Foot drop	AWNED	G	E	E	P
30	25	F	GCT	Right distal femur	3 B	11/94	Wide	8×5×3	14+0	2/98 (39)	No	10 deg. extensor lag	AWNED	E	E	E	G
31	16	F	Osteo-sarcoma	Right proximal tibia	II B	11/94	Marginal	15×8×6	12+6	1/96 (14)	No	40 deg. extensor lag	AWD	F	F	E	P
32	17	M	Osteo-sarcoma	Right distal femur	II B	11/94	Wide	12×8×6	12+6	5/98 (30)	No		AWD	E	E	E	E
33	69	M	Malignant fibrous histiocytoma	Right distal femur	II B	11/94	Wide	14×8×8	14+6	4/98 (43)	No	Stiffness of knee	TRD	E	E	E	P

AWNED=alive with no evidence of disease; AWD=alive with disease; TRD=tumour-related death; E=Excellent; G=Good; F=Fair; P=Poor; *=Failed previous reconstruction

teosarcoma, 4 a giant cell tumour, 2 a chondrosarcoma, and 1 each had a Ewing's sarcoma, fibrosarcoma, and malignant fibrous histiocytoma. All tumours were staged according to the Enneking system [5]. Patients with osteosarcoma had preoperative and post-operative chemotherapy with cis-platinum or cis-platinum and adriamycin. The distal femur was involved in 22 patients, the proximal part in 6 and the whole femur in 1. The proximal tibia was the size of the tumour in 4 patients.

Radiological assessment was carried out according to the International Symposium on Limb Salvage (ISOLS) grading system for radiological assessment of endoprostheses. Results are rated as excellent, good, fair, and poor [9]. The functional results were based on motion, pain, stability/deformity, muscle strength, emotional acceptance, functional activities, and complications. The results are rated as excellent, good, fair, and poor [3].

Operative technique

The lesion was approached through a straight longitudinal incision, where possible. The previous biopsy scar was removed with the tumour, with a margin of at least 1.5 cm on each side. The growth was removed en bloc with a wide margin as far as possible. We were able to save the rectus femoris muscle for lesions of the distal femur. Around the knee resection was with a wide margin except at the anterior part of the supracondylar region, where the tumour was usually covered with thin synovium. The menisci and the cruciate ligaments were removed from the tibial attachment when the tumour involved the distal femur and from the femoral attachment when it was in the proximal tibia. The medial head of gastrocnemius was severed to expose the neurovascular bundle before posterior dissection around the knee. En bloc resection was carried out for lesions of the proximal femur. The capsule and ligamentum teres were cut at the acetabular attachment. The site of resection was assessed after studying the preoperative CT, MRI, and the bone scans. After removal of the tumour, the medullary canal of the residual bone was curetted out for frozen section to rule out the presence of tumour. All patients had intra-articular en bloc resection of the neoplasm.

Prostheses were used in 30 patients for primary reconstruction and in 3 for secondary procedures following failure of the initial operation. In primary reconstruction, the surgical margins were wide in 25 cases, marginal in 3, and contaminated in 2. The resected length of the tumour ranged from 12 to 26 cm. Total femoral resection averaged 38 cm. In proximal femoral reconstruction a prosthesis with a 32-mm head and bipolar cup of appropriate size was used. The prosthesis was never cemented.

All proximal tibial lesions had gastrocnemius plasty, usually of the medial head. After encountering arterial spasm during one case [12], we monitored the distal circulation by continuous pulse oxymetry. No further such complication was seen. The patients were mobilised 2 days after surgery using walking aids.

Results

When last reviewed, 12 patients were alive with no evidence of the disease, 9 had metastases, and 12 had died from tumour-related causes. The average follow-up was for 50 months, ranging from 14 to 79 months (Table 1). The size of the tumours ranged from 7×5×5 cm to 27×6×7 cm. The average length of skeletal reconstruction was 20 cm, ranging from 12 to 26 cm (Fig. 1). The average length of the femoral reconstruction was 38 cm. The metaphyseal remodelling was graded as good in 18 patients (Fig. 2), the interface as excellent in 25, and anchorage as excellent in 30. At the last follow-up, 16 patients had excellent functional results, 4 patients were good, 4 fair, and 9 poor.

All 4 patients with proximal tibial reconstruction had poor functional results due to either an extension lag or to stiffness of the knee. Four out of the 6 patients with lesions of the proximal femur had poor or fair functional results due to either local recurrence or dislocation of the hip. Seventeen out of 22 patients with distal femoral reconstruction had excellent (14) or good (3) functional results.

Two out of 3 patients who had a salvage procedure with a prosthesis following failure of a previous reconstruction using cement and an intramedullary nail showed poor results.

Complications

Local recurrence was seen in 3 patients (9%), who also developed lung metastases; two died due to the tumour, and one was still alive. These tumours were large, the maximum size being 20 cm×10 cm×8 cm. The proximal femur was the site of the tumour in 2 patients, and distal femur in 1. Recurrence developed less than 12 months after surgery. The review of the literature showed a recurrence rate from 5 to 15% [2, 6, 13].

All 4 patients with proximal tibial reconstruction had complications due to either an extension lag (3) or stiffness (1). Four out of 6 patients with proximal femoral reconstruction had complications due to either local recurrence (2) or dislocation of the hip (2 patients). Only 9 out of the 22 patients with distal femoral reconstruction had one or more complications. Two out of these had a prosthesis inserted after failure.

An extension lag ranging from 10–50 degrees was seen in 5 patients, 3 with proximal tibial resection, and 2 with lesions of the distal femur. Skin breakdown, stiffness of the knee, and broken screws were seen in 2 patients each. Loosening of diaphyseal anchor and a peroneal nerve palsy were seen in 1 patient each. The patients with broken screws and a loose diaphyseal anchor had no symptoms. None of the patients had a fracture of the implant.

Discussion

Joint movement can be restored after resection of a large tumour by using an allograft or an endoprosthesis. Osteoarticular allograft reconstruction of the knee showed early promise [8], but recent reviews have shown a failure rate exceeding 40–50% [6, 8, 11].

The advantages of using an endoprosthesis are considerable [2, 7, 9, 10, 13, 15] with a success rate exceeding 90% in most series. A disadvantage to its use is that the implant will ultimately fail due to the demands of the young patients into whom it is usually introduced. However, 30–40% of patients with grade II osteosarcoma die within the first 2 years due to lung metastases [2, 6]. In our study, none of the prostheses were revised for loosening or a fracture. However, 36% of the patients died

Fig. 1a, b Giant cell tumour of distal femur with a pathological fracture and destruction of both condyles; **c, d** X-rays 1 year after surgery

Fig. 2a, b, c Radiograph at 3 years and 4 months after surgery, showing an intact implant, no loosening, and no recurrence. Note sclerosis around the tip of stem

from the tumour within an average of 21 months after operation, and another 27% had already developed lung metastases.

All 4 of our patients with proximal tibial reconstruction had poor or fair functional results, due to either extension lag or the stiffness of the knee, and these are the common problems after this procedure [2]. Resection arthrodesis is probably a better option after proximal tibial resection [3, 5, 12] because although movement is lost the knee retains stability.

Four of the 6 patients with reconstruction of the proximal femur had complications with poor or fair functional results. Those with dislocated hips had undergone extensive soft tissue resection due to the large size of the tumour. These patients experienced shortening and a limited range of movement following dislocation, but no local recurrence. In the other 2, an attempt was made to save part of the greater trochanter to maintain the abductor mechanism and improve gait control. Both patients had excellent hip function but suffered local recurrence and lung metastases.

Two of the 3 patients who had implantation of a prosthesis following a failed attempt at arthrodesis showed poor results. One of them regained only 45 degrees of flexion of the knee, while the other had no movement.

Reconstruction with a Kotz modular endoprosthesis after resection can be successful in patients who present with a large tumour and need to maintain movement of the involved joint for social and cultural reasons. It gives excellent or good functional results in distal femur reconstruction but should be used with caution in lesions involving the proximal femur and proximal tibia.

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