Rotationplasty as a limb salvage procedure for malignant bone tumours

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Summary. *Sixteen patients with malignant bone tumours, 15 osteosarcoma and one Ewing's sarcoma, were treated by rotationplasty at Tata Memorial Hospital between 1989 and 1994. The functional results are better than after amputation.*

Résumé. *Les auteurs rapportent 16 cas de tumeur osseuse maligne traités par plastie de rotation à l'Hôpital Tata Memorial entre 1989 et 1994. Il s'agit de 15 ostéosarcomes et d'une sarcome d'Ewing. Avec une bonne rééducation prothétique les résultats donnent une meilleure qualité de vie que ceux apportés par une amputation.*

Introduction

Rotationplasty as a limb salvage procedure was first described in 1930 for treating shortening after tuberculous ankylosis of the knee joint [2], and was later popularised by Van Nes [7] for congenital defects of the femur. The procedure has been used as an alternative to high above-knee amputation in malignant bone tumours [5] and good long term results were reported for survival, function and cosmetic and social acceptance [4].

In this paper we present our experience of rotationplasty in sixteen patients and discuss its ad-

vantages compared to amputation and other methods of reconstruction.

Patients and methods

From December 1989 to June 1995, 16 patients underwent rotationplasty at our hospital; 15 for osteosarcoma, and one for an Ewing's sarcoma which recurred after irradiation. The patient characteristics are given in Table 1. The mean age was 16.4 years; 7 were under 15 years of age and 9 were older. All complained of pain and swelling at the lower end of the thigh close to the knee joint for between 2 and 8 months, and difficulty in walking. One presented with a pathological fracture of the lower third of the femur.

All those selected were in good general health and had no clinical evidence of distant metastases or neurovascular deficits. A J-needle biopsy (Jamshedji) was carried out in every patient and the diagnosis confirmed by microscopy.

Available radiological investigations included conventional radiography, computerised axial tomography, MRI, bone scanning and angiography.

Preoperative chemotherapy was given only to patients who paid for it and special investigations were carried out to evaluate previs chemotherapy, and the cardiac and renal status. Seven received two cycles of preoperative chemotherapy with adriamycin and cisplatinum with a good clinical response. Operation was carried out approximately 3–4 weeks after the last dose.

The procedure was explained to the relatives and to adult patients. Consent for amputation was needed as the operative findings may necessitate an ablative procedure. Patients were shown others who had undergone similar procedures when possible, or else photographs with video recording of rehabilitation.

The operation demands meticulous planning. In children, the rate of epiphyseal growth of the normal side can be obtained from Anderson and Green's charts [1]. To compensate for the growth of the sound limb, the new ankle is placed at approximately 6 cm and 4 cm lower than the sound knee in children of 6 and 10 years of age respectively.

The operative technique described by Kotz and Salzer [4] was used (Figs. 1–4). Osteosynthesis is achieved by either a broad dynamic compression plate (DCP) or a femoral nail

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Table 1. Patient characteristics

No	Age/sex	Chemotherapy		Complications	Local Recurrence/ Lung metastases	Status
		Before	After			
1	14/M	2	4	Adriamycin induced cardiotoxicity	–	NED 66mo
2	24/F	2	4	Osteomyelitis	–	NED 38mo
3	18/M	–	–	–	LR+LM 6mo	Dead
4	16/M	–	–	–	LR+LM 10mo	Dead
5	14/M	–	–	–	–	NED 20mo
6	22/F	2	4	–	–	NED 26mo
7	8/F	2	4	–	–	NED 24mo
8	20/M	2	4	–	–	NED 16mo
9	15/M	–	–	–	–	NED 15mo
10	20/M	–	–	–	LR+LM 8mo	Dead
11	20/M	–	–	–	LM 12mo	Dead
12	10/F	–	6	–	–	NED 8mo
13	10/M	–	6	–	–	NED 8mo
14	12/M	2	1	Chemotherapy toxicity	–	Dead
15	14/M	–	–	Implant failure (plate breakage), infection, vascular comp. Amputation 8mo.	–	NED 18mo
16	15/F	12	RT	Pulmonary embolism	–	Dead on 1st postop. day

Table 2. Options after tumour resection around the knee

1.	Knee arthrodesis
2.	Endoprosthesis
3.	Resection-reimplantation, osteochondral allografts
4.	Amputoresection
5.	Reimplantation after extracorporeal removal of the specimen
6.	Expandable prosthesis
7.	Rotationplasty
8.	Bone lengthening to fill resection gap by Ilizarov methods
9.	Physal distraction

(Figs. 4, 5). Vascular anastomosis was performed in 2 patients. The average blood loss was around 500 cc and the operating time was 4 h.

The patient was started on immediate mobilisation of the ankle and discharged after the sutures were removed on the 10th day. A special prosthesis is provided 6 weeks after operation (Fig. 6) and physiotherapy is given to strengthen the ankle. Postoperative chemotherapy was started 3 weeks after operation, once the wound had healed entirely.

Results

Of the 16 patients, 10 were free of disease at intervals of from 3 to 66 months after operation (mean 23 months). All were able to walk with the prosthesis and without any external aid. One developed osteomyelitis but was disease-free at 33 months. She is unable to run, but can walk with moderate pain. All the others are able to run and perform outdoor activities such as cycling. Two of these patients reported occasional pain. Three developed concurrent local recurrence and lung metastasis 6 to 10 months after operation. All had been able to walk without external aid until local recurrence developed. One other patient died of lung metastases 12 months after operation. The patient with Ewing's Sarcoma died of a post-operative pulmonary embolism. One patient died of adriamycin toxicity after 4 months; his local disease was controlled and he had no distant metastasis. Implant failure with breakage of the plate was seen in one patient who subsequently developed vascular complications and had to undergo a disarticulation at the hip. He is at present free of

Table 3. Functional evaluation by Enneking's method

No	Pain	Function	Emotional acceptance	Supports	Walking	Gait	Score (%)
1	5	3	3	3	3	1	18/30 (60)
2	1	3	3	3	3	1	14/30 (46.7)
3	Dead, not scored						
4	Dead, not scored						
5	5	3	3	3	3	1	18/30 (60)
6	4	3	3	3	3	1	17/30 (56.7)
7	5	3	3	3	3	1	18/30 (60)
8	4	3	2	3	3	1	16/30 (53.3)
9	5	3	3	3	3	1	18/30 (60)
10	Dead, not scored						
11	Dead, not scored						
12	5	3	3	3	3	1	18/30 (60)
13	4	3	3	3	3	1	17/30 (56.7)
14	Dead, not scored						
15	Amputation, therefore not scored						
16	Dead, not scored

Fig. 1. Radiographs showing an osteosarcoma of the distal femur with extensive soft tissue involvement

Fig. 2. Specimen after removal of the tumour and rotationplasty

Fig. 3. Operative photograph after external rotation of 180° and osteosynthesis

Fig. 4. Radiograph showing osteosynthesis with a plate

Fig. 5. Radiograph showing osteosynthesis with a femoral nail

Fig. 6. Photograph showing a patient standing with the prosthesis 6 weeks after operation

disease. Of the 9 patients who are alive, the average function score was 57%, as evaluated by Enneking's method [3] (Table 3).

Discussion

In our institution, nearly 80% of primary bone tumours are situated around the knee. Large defects resulting from en bloc excision in the lower limb continue to be a problem. The different procedures described to bridge such gaps (Table 2) are extensive, time consuming and require an expensive custom-made prosthesis and sophisticated equipment; complications frequently result. Developing countries depend on procedures which are simple, adequate and financially within the reach of the patients, many of whom are poor.

In very young growing children, methods of reconstruction such as arthrodesis, total knee replacement, allograft joints, resection and extra-corporeal radiation are not applicable due to the resulting major leg-length discrepancy. In patients with extensive soft-tissue involvement, conservative surgery would be followed by local recurrence. A possible solution is to resect the tumour following oncological principles, and then perform a rotationplasty with conversion of the

ankle to function as a knee joint. The results in our patients were remarkably good.

Rotationplasty is an excellent alternative to other forms of reconstruction for primary bone tumours around the knee joint and provides an active, flexible knee joint with less risk of loosening or infection than is seen with artificial devices. Revisions are not necessary as they may be after customised prostheses.

The rehabilitation period with a prosthesis is short and active flexion of the new knee joint is possible up to 90°. Because of active control of the joint, patients have a nearly normal life style, and can participate in outdoor activities. The walking speed, gait, oxygen consumption and general efficiency were significantly better than with other procedures such as arthrodesis, an endoprosthesis and amputation [6].

Any discussion on rotationplasty must include the possibility of psychological problems. Initially, the procedure appears strange to the parents and the patients, but eventually they are grateful for the remaining limb and consider their children to be less abnormal than they would have been with an amputation.

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