

Functional outcome of limb salvage surgery with mega-endoprosthetic reconstruction for bone tumors

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Abstract

Background The use of a mega-endoprosthesis has become the method of choice for reconstruction after bone tumors. In this study, we sought to determine the functional outcome and complications associated with mega-endoprosthesis.

Methods A retrospective review of the charts of 16 patients who had undergone resection of bone tumors followed by reconstruction with mega-endoprosthesis between 2006 and 2011 was performed. Functional evaluation was based on the Musculoskeletal Tumor Society (MSTS) scoring system. Complications of the procedures were also analyzed.

Results Eight men and eight women at an average age of 36.7 years were included in the study. The tumor involved lower limb in 14 patients and upper limb in 2 patients. The average MSTS functional score was 72.3 ± 15 . Excellent results were achieved in six patients, good in five, moderate and fair in two each and poor in one. Complications occurred in eight patients. Two patients had aseptic loosening of the femoral component of total knee replacement. Flap necrosis occurred in two patients, both of whom required latissimus dorsi free flap for coverage of total knee prosthesis. One patient underwent revision of femoral component subsequent to knee dissociation. Local recurrence of tumor, patellar tendon rupture and foot drop occurred in one patient each.

Conclusion Mega-endoprosthetic reconstruction in limb salvage provides good functional outcome in patients with bone tumors.

Keywords Mega-endoprosthesis · Limb salvage surgery · Bone tumors · Functional outcome · Musculoskeletal Tumor Society Score

Introduction

Definitive surgical management of extremity tumors has changed dramatically since total femur reconstruction was first described by Buchanan in 1950 [1]. Advances in diagnostic imaging, adjuvant and neoadjuvant chemotherapy, and surgical techniques have increased the overall 5-year survival rate after endoprosthetic replacement from 20 to 85 % in the past three decades [2–4]. These superior results along with minimal complications have established mega-endoprosthetic replacement as the primary modality in the management of bone tumors in patients of all age groups [5, 6].

Over the past three decades, the focus has now shifted from controversy over the various forms of limb salvage to methods of enhancing functional and oncological outcome after endoprosthetic replacement [5]. However, the issues are different from a developing nation's perspective, where the debate still moves around the most cost-effective method of treatment. In a health-care system where patients themselves are primary payers of medicare services, endoprosthesis are expensive and beyond the reach of most patients. Managing these bone tumors in a third world country poses a significant challenge. We present here our early experience with functional outcome after mega-endoprosthetic replacement for bone tumors over a

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5-year period. No similar work has previously been presented from Pakistan.

Patients and methods

Sixteen patients diagnosed with bone tumors, both primary and metastatic, underwent definitive wide local resection and mega-endoprosthetic reconstruction between 2006 and 2011. They were evaluated with regard to their functional outcome using the Musculoskeletal Tumour Society (MSTS) scoring system. This system assigns numerical values (0–5) for each of six categories: pain, and function and emotional acceptance in the upper and lower extremities; supports, and walking and gait in the lower extremity; and hand positioning, and dexterity and lifting ability in the upper extremity [7]. These values were added, and the functional score was presented as a percentage of the maximum possible score. The results were graded according to the following scale: excellent 75–100 %; good 70–74 %; moderate 60–69 %; fair 50–59 %; and poor <50 %.

Complications related to surgery such as infection, implant breakdown, aseptic loosening, dislocation, skin necrosis and fractures were evaluated. Local recurrences and metastases were also recorded. The management of complications, such as revision surgery (removal of endoprosthesis, arthrodesis, amputation), was also recorded.

Results

Eight men and eight women with an average age of 36.7 years (range 14–73 years) and a mean follow-up of 18.3 months (1–42 months) were included in the study. Histologic types of tumors included osteosarcoma in five patients, giant cell tumor in three patients, Ewing's sarcoma and chondrosarcoma in two patients each and multiple myeloma, metastatic renal cell carcinoma, metastatic breast cancer and leiomyosarcoma in one patient each. The tumor involved the lower limb in 14 patients. Of these, the distal femur was involved in ten patients, proximal femur in three patients and proximal tibia in one patient. Both cases in the upper limb involved the proximal humerus. Mega-endoprosthesis for distal femur with a rotating hinge knee was the most common procedure done in eight patients, followed by total hip replacement and total femur replacement in three patients each and proximal humerus replacement in two patients Fig. 1. Table 1 shows patient characteristics and outcomes.

The average MSTS functional score was 72.3 ± 15 . Excellent results were achieved in six patients, good in five, moderate and fair in two each and poor in one.

Statistical analysis was performed on the MSTS functional scores using the SPSS software *t* test. Lower limb procedures have a higher mean functional score compared with upper limb procedures (72.8 vs. 68.5). Using the independent *t* test, we found no statistically significant difference between the two groups ($P = 0.178$). This finding may be influenced by the small sample size and the uneven subgroup sizes (upper limb procedure no. = 2, lower limb procedure no. = 14). In addition, comparing hip and knee procedures using the *t* test, we found no significant statistical difference between the two groups ($P = 0.099$), even though hip procedures were found to have a higher mean functional score (88.7 vs. 69.5). In addition, we found no evidence of gender difference in terms of functional score ($P = 0.249$).

Complications occurred in eight patients. Two patients had aseptic loosening of the femoral component of total knee replacement within 6 weeks of primary surgery. Both were treated by re-cementing the femoral component. Flap necrosis occurred in two patients. Wound debridement and intravenous antibiotics were instituted, but both patients ultimately required latissimus dorsi free flap for coverage of total knee prosthesis Fig. 2. One of these patients required a second gastrocnemius flap due to wound dehiscence. One patient underwent revision of femoral component subsequent to knee dissociation. One patient had foot drop secondary to common peroneal nerve injury after a total femur replacement. One 73-year-old lady had pulmonary metastasis and local recurrence of the tumor after proximal humerus replacement and is currently on neoadjuvant chemotherapy. One patient had poor MSTS score due to patellar tendon rupture during a total knee reconstruction for bone metastasis from renal cell cancer. He subsequently died from pulmonary metastasis.

Discussion

Mega-endoprostheses have been used to replace the femur, the hip joint, part of the pelvis, the knee joint, the humerus and shoulder joint, and parts of the ulna and radius. These are the most common predilection sites of primary bone tumors [6].

Megaprosthesis reconstruction has many advantages. The load-bearing characteristics of prosthetic reconstruction surgery offer immediate postoperative stability and facilitate rapid rehabilitation. Most endoprostheses are modular, thus allowing incremental prosthetic replacement in response to the length of resected bone. In addition, improvement in implant materials has greatly increased the durability of modern endoprostheses. They are able to achieve their primary aim of providing long-term function

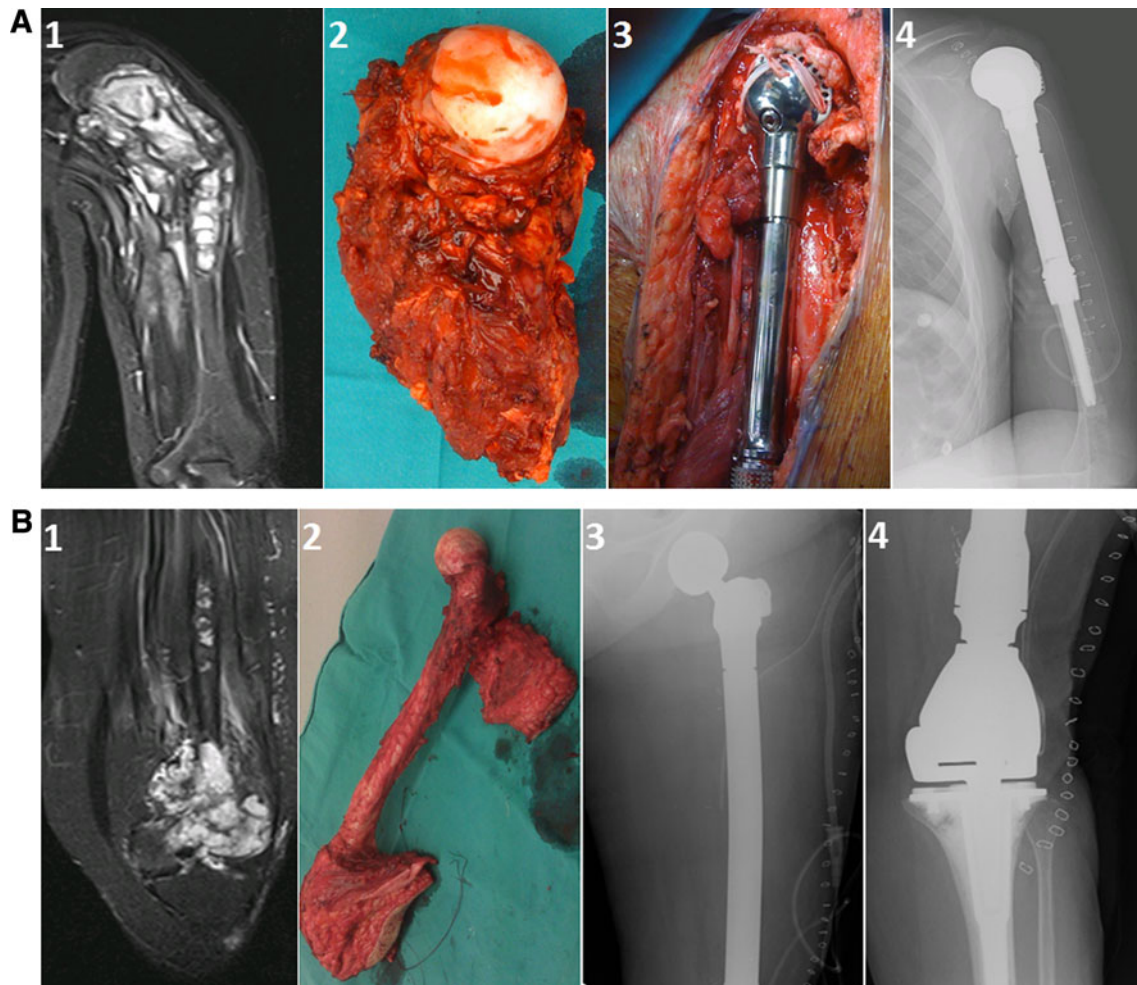


Fig. 1 a 14-year-old boy presented with pain, swelling and restricted range of motion of the left shoulder. 1 MRI showed pathological fracture of the humerus and a mass (later, biopsy-proven osteosarcoma); 2 resected humeral head; 3 proximal humerus prosthesis. 4 Post-operative X-ray showing left shoulder proximal humerus

prosthesis. **b** A 63-year-old lady presented with knee pain. 1 MRI showed mass in distal femur and a separate mass in the proximal femur. 2 Resected femur. 3 Post-operative X-ray showing proximal part of total femur prosthesis. 4 Distal half of the total femur prosthesis

for some patients with relatively low physical demands. For patients with limited life expectancy, an important factor in the selection method is a low rate of complication. These patients may be unable to undergo revision surgery due to poor general health with progressive disease. With fewer complications and failures, prosthetic reconstruction surgery for metastatic bone disease may be preferable [6, 8].

The effectiveness of megaprosthesis is judged in terms of improvement in functional status according to Musculoskeletal Tumor Society score and consequences of complications. However, the degree of improvement in MSTS score and rate of complications differ with the type of prosthesis used (such as total femur replacement vs. distal femur replacement). Table 2 shows the comparison

of results of this study with published literature on different types of prosthesis.

Oncological reconstruction may appear to have higher complication rates compared with standard total joint arthroplasty due to the extensive nature of the operation, extensive tissue loss and the compromising effects of associated radiotherapy and chemotherapy. The most common complications in prosthetic reconstruction surgery are postoperative infection, prosthetic loosening, peri-prosthetic fractures and dislocation [9].

In our study, the average MSTS functional score was 72.3 and complications occurred in 50 % of the patients. With regard to the different categories of the Musculoskeletal Tumor Society functional scoring system, pain received the highest score, which indicated that the patients

Table 1 Patient characteristics and outcomes

Patient no./sex/age (years)	Diagnosis	Side/location	Prosthesis	Neoadjuvant/Adjuvant	MSTS (%)	Survival	Complication	Follow-up (months)
1/M/25	Osteosarcoma	L/distal Femur	Total knee replacement	No	83	Alive	Loose femoral component	18
2/M/43	Multiple Myeloma	R/distal femur	Total knee replacement	No	73	Alive	Loose femoral component	42
3/M/19	Osteosarcoma	R/distal femur	Total knee replacement	Yes	93.3	Alive	No	28
4/F/63	Osteosarcoma	R/distal femur	Total knee replacement	Yes	40	Dead	Patellar tendon rupture	16
5/M/56	Metastatic renal cell carcinoma	R/proximal femur	Total hip replacement	Yes	90	Dead	No	27
6//F/14	Ewing's sarcoma	R/proximal femur	Total hip replacement	Yes	86.6	Alive	No	27
7/M/57	Metastatic breast cancer	R/proximal femur	Total hip replacement	Yes	90	Alive	No	42
8/F/14	Osteosarcoma	R/distal femur	Total femur replacement	Yes	70	Alive	No	24
9/F/55	Chondrosarcoma	L/total femur	Total femur replacement	No	53.3	Alive	No	19
10/F/24	Giant cell tumor	L/distal femur	Total knee replacement	No	73.3	Alive	Wound infection	12
11/F/19	Ewing's sarcoma	L/distal femur	Total knee replacement	Yes	50	Alive	Wound infection	12
12/M/45	Leiomyosarcoma	L/distal femur	Total femur replacement	Yes	73.3	Alive	Foot drop	4
13/F/28	Giant cell tumor	L/proximal tibia	Total knee replacement	No	66.7	Alive	No	1
14/M/17	Osteosarcoma	L/proximal humerus	Proximal humerus replacement	Yes	66.7	Alive	No	3
15/M/35	Giant cell tumor	R/distal femur	Total knee replacement	No	76.7	Alive	Dissociation of femoral component	8
16/F/73	Chondrosarcoma	R/proximal humerus	Proximal humerus replacement	Yes	70	Alive	Local recurrence	9



Fig. 2 Gastrocnemius flap in a 19-year-old girl who had necrosis of the latissimus dorsi flap after mega-endoprosthesis reconstruction of the distal femur due to Ewing's sarcoma distal femur

experienced little pain, whereas emotional acceptance and the ability to walk received the lowest scores. Upon further analysis of the results according to the type of prosthesis used, we found that in total knee replacement group (including 8 distal femurs and 1 proximal tibia), the average 69.5 % MSTS score was lower than that described in the study by Futani et al. [10] and Wilkins et al. [11], in which the mean MSTS functional scores were 74 and 73 %, respectively. With regard to complications in this group, wound infection and aseptic loosening were most common complication (25 % each). In the previous literature, the rate of deep infection in the femur ranged from 4 % (1 of 24 patients) in the study by Cool et al. [12] to two of five patients in the study by Schiller et al. [13]. Similarly, aseptic loosening has been reported as a major problem, accounting for a complication rate of 2–22 % in

Table 2 Comparison of functional outcome and complication rate of our study with that of other studies

Author	No. of cases	Type of prosthesis	MSTS (%)	Aseptic loosening (%)	Implant fracture (%)	Infection (%)
Schwartz et al. [23]	52	Proximal tibia	82	13.4	1.9	5.8
Cho et al. [24]	62	Proximal tibia	81	0	0	25.8
Futani et al. [10]	22	Distal femur	74	22.7	9.1	27.3
Ruggieri et al. [19]	21	Total femur	66	4.8	0	9.5
Ilyas et al. [15]	15	Proximal femur	70	6.7	0	13.3
Current series	16	Mix	72.3	12.5	0	12.5

the earlier studies, ranging in size from 13 to 133 patients [3, 4, 14].

Although megaprosthesis is an attractive option for proximal femur tumors, it has a tendency to predispose patients to aseptic loosening due to the loss of abductors, the short external rotators and, in many cases, the loss of knee extensors [15]. In the orthopedic literature, the rate of hip dislocation following reconstruction of proximal femoral tumors with megaprosthesis varies from 2–28 % [16]. In this study, we did not have any complications in the patients undergoing total hip replacement for proximal femoral tumors. The mean MSTS was 89 % in this group compared with 70 % reported by Ilyas et al. [15].

Previous studies demonstrate that recurrence (ranging between 9.5 and 30 %) [17, 18] and dislocation (ranging between 11 and 15 %) [17] are the two major complications following a total femur replacement. We did not have any complications in three patients undergoing total femoral replacement, and the 65.5 % MSTS score was comparable with 66 % score reported by Ruggieri et al. [19].

Published literature reports low rate of infection in patients undergoing proximal humerus replacement. Mayilvahanan [20], Fuhrmann [21], Malawer [22] reported infection rate of 3.5 %. However, we achieved an MSTS score of 68.5 % in our patients which was significantly lower than the 78 % score reported by Mayilvahanan et al. [20].

Our study is subject to a number of limitations. First, although we report our experience over a 5-year span, the number of patients is small owing to financial constraints of such a treatment modality and only a recent provision of mega-endoprosthetic reconstruction in Pakistan. Second, our series of tumors was heterogeneous for type, stage and adjuvant treatment. Third, endo-prosthesis of different companies from different countries were used, primarily to minimize the cost of treatment, as for most of the patients it was unaffordable and were funded through charity or donations. These variables certainly would affect rates of survival, but not whether we achieved adequate margins and restored function. Fourth, different procedures for soft tissue reconstructions were used, according to the case-specific situation. Fifth, follow-up is too short in some

patients to determine local recurrence rates or to draw long-term conclusions regarding function and survival of the reconstructions.

Conclusion

Mega-endoprosthetic reconstruction provides good functional outcome in patients after bone tumor resection in limb salvage surgery. However, the patients and their families must be carefully selected with an emphasis on motivation and acceptance, since rather frequent and substantial treatment during follow-up is inevitably required. In the future, improvements in the surgical techniques and equipment are needed to diminish the number of complications related to the initial limb salvage surgery.

Conflict of interest Authors declare that they have no competing interests.

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