CASE SERIES

Outcome of Limb-sparing Surgery with Custom Mega Endoprosthesis Reconstruction for Bone Tumors in a Tertiary Care Center—10-year Study: Where Do We Stand?

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Abstract

Background and objectives: Limb-sparing surgery with custom mega endoprosthesis reconstruction for bone tumors has been the standard of care in our institution. The purpose of this study was to ascertain the complications and their management, the ability to retain the limb despite complications, and functional outcome of the retained limb.

Materials and methods: A retrospective analysis was conducted on 55 patients who, between 2013 and 2022, had undergone resection of extremity bone tumors followed by reconstruction with mega endoprosthesis. The complications were classified according to Henderson endoprosthesis failure modes. The management of these complications, rates of re-surgery, and associated limb-sparing rates were analyzed. Patients with retained limbs were rehabilitated by institutional protocol. Based on the Musculoskeletal Tumor Society (MSTS) scoring system, the functional outcome was determined.

Results: The study involved 55 patients. The mean follow-up was 28 months. A total of 22 patients (40%) experienced postoperative complications, with type I (soft tissue failure) and type II (aseptic loosening) being the most common. After re-surgery, either a second limb-sparing procedure or amputation, 49 patients (89.1%) retained their limb. The mean MSTS score for these 49 patients was 77.2%. The highest scores were encountered for patients with distal femur replacement (82.1%) and lowest for proximal humerus (72.4%).

Conclusion: Our study shows that despite the complications of custom mega endoprosthesis reconstruction, we have managed it with a good limb-sparing rate. The functional outcome, though reasonable, seems to have scope for improvement.

Keywords: Bone reconstruction, Bone tumors, Custom mega endoprosthesis, Endoprosthesis, Limb-sparing surgery.

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Introduction

The use of endoprosthesis has radically changed the management of patients with malignant bone tumors. As the rates of overall survival, recurrence, and metastasis are not significantly different from those of amputation, limb-sparing surgery has been performed on 90–95% of these patients over the past 3 decades.[1–3] These days, the emphasis is on ways to improve functional outcomes following endoprosthetic reconstruction. In our institution, limb-sparing surgery with a customized giant endoprosthesis has become the norm for care. The purpose of this study was to ascertain the complications and how they were managed, as well as the functional outcome for patients who were able to retain their limb. Outcomes were analyzed to explore and incorporate options for further improvement.

Materials and Methods

A retrospective analysis was conducted on 55 patients who, between 2013 and 2022, had undergone resection of extremity bone tumors followed by reconstruction with mega endoprosthesis. The complications were classified according to Henderson endoprosthesis failure modes.[4] The management of these complications, rates of re-surgery, and associated limb-sparing rates were analyzed. Patients were rehabilitated by institutional protocol. The Musculoskeletal Tumor Society (MSTS) scoring system was used to analyze the functional outcomes of individuals with endoprosthetic reconstruction.[5] The functional score was calculated by adding these values, and the result was shown as a percentage of the highest achievable score.

Results

A total of 55 patients were included in the study. The mean follow-up was 28 months.

Histology

A total of 29 patients had osteosarcoma, 16 patients had giant cell tumors, and six patients had chondrosarcoma. Ewing's sarcoma,

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Table 1: Histology

Histology	*Number*
Osteosarcoma	29
Giant cell tumor	16
Chondrosarcoma	6
Ewing's sarcoma	1
Oligometastatic cancer	1
Aneurysmal bone cyst	1
Fibrous dysplasia	1

Table 2: Tumor location and prosthesis

Custom mega endoprosthesis	*Number*
Proximal humerus	7
Total humerus	1
Proximal ulna	1
Pelvic saddle prosthesis	1
Proximal femur	4
Intercalary femur	1
Distal femur	19
Total femur	4
Proximal tibia	16
Distal tibia	1

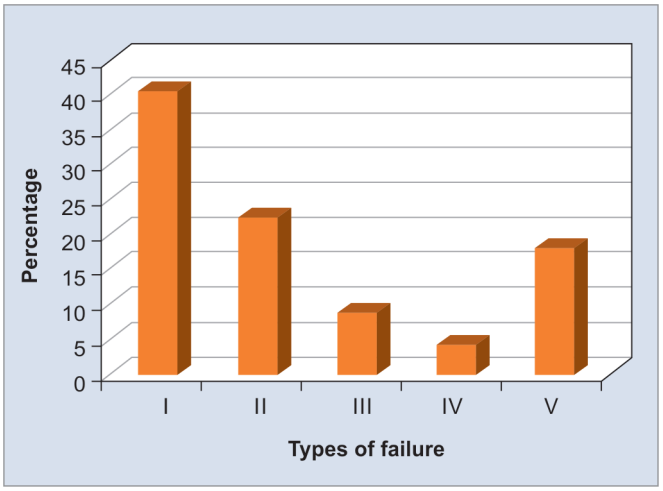

Fig. 1: Complications according to Henderson failure types

oligometastatic cancer, aneurysmal bone cyst, and fibrous dysplasia were present in one patient each (Table 1).

Tumor Location and Prosthesis

Nineteen patients underwent mega endoprosthesis reconstruction for the distal femur which was the most prevalent operation. This was followed by proximal tibia (16 patients) and proximal humerus (seven patients). The prostheses used are listed in Table 2.

Complications and Management

Complications occurred in 22 (40%) patients, most common being type I followed by type II (Table 3 and Fig. 1). Among the 22 patients, nine patients were managed nonsurgically, second limb-sparing surgery was done in eight patients and five patients underwent

Table 3: Complications

Henderson classification		*Number*
Type 1	Soft tissue failure (skin necrosis, flap insufficiency and stiffness/contracture of the reconstructed joint)	9
Type 2	Aseptic loosening failure	5
Type 3	Structural failure (fractures of bone or prosthetic components)	2
Type 4	Infection not amenable to retention of prosthesis	1
Type 5	Tumor recurrence or progression	4

Table 4: Functional outcome

Custom mega endoprosthesis	*MSTS score%*	*Custom mega endoprosthesis*	*MSTS score%*
Proximal femur—4	76	Proximal humerus—7	72.4
Distal femur—17	82.1	Total humerus—1	72.6
Total femur—4	75	Proximal ulna—1	73
Proximal tibia—14	78.7	Intercalary femur—1	81.5
Distal tibia—1	77	Saddle prosthesis—1	Not assessed

amputation due to recurrence or infection. After re-surgery (23.6%), either a second limb-sparing procedure or amputation, 49 patients (89.1%) retained their limb.

Functional Outcome

The mean MSTS score for these 49 patients was 77.2%. The highest scores were observed for patients with distal femur (82.1%) and lowest for proximal humerus (72.4%) (Table 4). About 15 patients who had interruption of >6 weeks in their rehabilitation had a mean score of 71.5%.

Discussion

The goal of limb-sparing surgery for bone tumors is to preserve a functional limb while achieving satisfactory oncological clearance. Either a modular prosthesis or a customized mega endoprosthesis can be used. The immediate postoperative stability and expedited rehabilitation are facilitated by the load-bearing properties of endoprosthetic reconstruction. Modular prosthesis is used according to the length of resected bone and can be modified accordingly to allow for incremental prosthetic replacement. Furthermore, the endurance of contemporary endoprostheses has significantly enhanced due to advancements in implant materials.

Complications from prostheses are of major concern as they are associated with a lower quality of life, a poorer functional outcome, and a lower survival rate. Lower extremity soft tissue and structural failures are more common, most likely because of weight bearing. Joint instability is attributed by Henderson et al. and Malawer et al.[6] to soft-tissue resection and extensive removal of normal surrounding muscle and bone. The substantial lengths of endoprostheses provide high bending stress at the prosthesis-bone interface, which can lead to component or periprosthetic fracture as well as loosening. Significant tension is also applied between the endoprosthesis and the cement or bone in restricted

joint designs, which raises the risk of loosening. Patients are more likely to become infected following extensive dissections, lengthy surgeries, big prosthesis volumes, and exposure to chemotherapy.[7]

In our study, complications occurred in 22 (40%) patients, most common being type I followed by type II. Type II and III were managed by revision surgery with prosthetic replacement. Four patients with recurrent/progressive disease and one patient with persistent infection underwent amputation. Our results were similar to Wirganowicz et al.[8] who analyzed the etiology and results of tumor endoprosthesis revision surgery. According to Berger et al.,[9] the rate of re-surgery after mega prosthesis reconstruction is 56% and despite a high re-surgery rate, 83% of the patients still had a functioning prosthesis. In the present study, the rate of re-surgery is 23.6%, and 89.1% of patients retained their limb after a limb-sparing procedure with cemented metal prosthesis (CMP).

The MSTS score is used to determine the functional status. The institutional protocol was used to rehabilitate the patients. We start physiotherapy (isometric exercises) early and weight bearing for lower limb will be started as early as 5–7 days depending upon the type of resection/prosthetic replacement. For upper limb, the extremity is kept in splint for 6 weeks and then changed to elbow brace for another 6–8 weeks. We advise avoid lifting weights >4–5 kg. The mean MSTS score in our study is 77.2% which is reasonable and comparable to that of orthopedic literature.[10–14] Upon further analysis of the results, we found that the degree of improvement in MSTS score differed with the location of tumor/type of prosthesis used and adherence to rehabilitation protocol. In Upper limb-sparing surgery, motor dexterity of the hand and the range of motion of the elbow and wrist were generally well preserved and the outcomes were mostly influenced by emotional parameter of MSTS score. In lower limb, distal femur replacement had better outcomes probably due to preservation of quadriceps insertion mechanism. Adherence to rehabilitation influenced outcomes. About 15 patients who had interruption of >6 weeks in their rehabilitation had a mean score of 71.5%.

Limitations of our study are that the tumors are heterogeneous for type, stage, and neoadjuvant treatment, and the subjectivity of our analysis of functional outcome using native version of MSTS questionnaire. Even though modular prosthesis has become the standard of care nowadays, in a resource-limited setting like ours, custom mega endoprosthesis provides an excellent economical option for limb-sparing surgery with reasonable functional outcome.

Conclusion

Our study shows that despite the complications of custom mega endoprosthesis reconstruction, we have managed it with a good limb-sparing rate. The functional outcome, though reasonable, seems to have scope for improvement. Development of a revised rehabilitation protocol adapting to patient's individual needs, emphasis on regular follow-up and strict adherence, and use of modular prosthesis in future might yield better outcome.

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