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Analysis of the Functional Outcome of Limb Salvage Procedure Using Custom Made Endoprosthesis for Bone Tumours - A Case Series

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Abstract: ***Limb reconstruction following tumour resection in orthopaedic oncology is a challenging task needing surgical expertise and multimodal approach. Various reconstruction options have evolved over the past few decades and has helped the surgeons to provide a better quality of life to their patients. We discuss our experience in treating bone tumour patients using custom made endoprosthesis. Materials and Methods: A prospective and retrospective study was conducted in Rajiv Gandhi Government General Hospital, Chennai between 2016-2019 and 20 patients with bone tumours, treated by wide excision and custom made endoprosthesis were followed up. Functional outcome was assessed by Musculoskeletal tumour society score. Result: The mean MSTS score in our study was 66.65% showing good functional outcome. No statistically significant association (p>.05) was found between age, gender of the study participants, location and histological diagnosis of the tumours with treatment outcome. Conclusion: Custom made endoprosthesis provides a valuable reconstruction option for the treating surgeon in limb salvage surgeries. The results are better when done by experienced hands and in a tertiary care setup.***

1. Introduction

Amputation was the primary modality of treatment for bone tumours especially osteosarcomas until the concept of limb salvage was established. The advances in radiological imaging and chemotherapy and surgical techniques has helped immensely in the salvage and reconstruction of the limbs. Various reconstruction options include allograft, allograft-prosthesis composite, rotationplasty, metallic endoprosthesis[1]. It was around the 1970s, the use of megaprostheses was quoted in literature and by the 90s they were becoming increasingly popular[2]. Prosthesis design had also evolved from the monoblock and fixed hinge models to modular endoprostheses and rotating platforms, with improved geometry to enhance fixation and stability[3]. Malignant and even locally aggressive benign tumors of the bone (for example giant cell tumors) necessitate the use of a megaprosthesis almost around all major joints in the body[4].

In this article, we discuss our experience in salvaging the limbs in malignant and locally aggressive tumours using Custom made endoprosthesis.

2. Materials and Methods

Our study is an observational prospective and retrospective study done in Rajiv Gandhi Government General Hospital, Chennai between 2016 to 2019. Patients who were previously operated with custom made endoprosthesis and on regular follow up, patients who presented to our centre with bone tumour and had surgical indication for wide excision and endoprosthesis for malignant bone tumours and those with tumours extending into articular surfaces including aggressive giant cell tumours were included in the study. Patients who had undergone procedures like resection and arthrodesis for bone tumours, those with psychiatric illness and those patients lost to followup were excluded. Our study included 20 patients.

In addition to xrays, MRI and 3D multislice CT scan, CT angiography was done in all our cases. Open biopsy was done as first stage procedure and after confirmation of the histopathology, excision of the tumour and reconstruction was the second stage procedure. Chemotherapy was given in cases when indicated after medical oncologist opinion. Surgical excision was done following all the oncological principles by seniormost orthopaedic surgeon with 10 years experience in orthopaedic oncology. In distal femur tumours, sleeve resection of the quadriceps musculature was done and in proximal tibia tumours, once tumour resection is done, the patellar tendon was sutured to the apertures in the prosthesis. Gastrocnemius flap was done following proximal tibia tumour resection to provide adequate soft tissue cover to the metallic prosthesis. Similarly in proximal femur tumours, abductor musculature was anchored through the apertures in the prosthesis. Disease free margin was obtained in all our cases. All patients were treated with a custom made endoprosthesis, a specially designed endoprosthesis based on the exact anatomical model of each patient. PMMA bone cement was used to fix the stem of the prosthesis. Adherence to a strict postoperative protocol depending on the tumour location was carefully followed. Functional outcome was analysed using Musuloskeletal Tumour Society score at 6 months followup.

3. Results

In our study of 20 patients, 14 patients were male and 6 were female. The most common tumour were osteosarcoma (9 cases) (Enneking stage 2B) and aggressive giant cell tumour (9 cases), chondrosarcoma and solitary plasmacytoma (1 each). 10 patients were in the third decade, 5 in their second decade, 3 patients in fifth decade. One each in fourth and sixth decades. The most common tumour location was around the knee (12 patients in the distal femur/6 patients in proximal Tibia) and 2 patients in proximal femur. Neoadjuvant chemotherapy of 2 cycles and adjuvant chemotherapy of 4 cycles was given to patients with

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Osteosarcoma. The drugs used were Methotrexate, Adriyamycin and Cyclophosphamide. The minimum follow up was 6 months and maximum was 5 years. The mean follow up was 2.6 years. Musculoskeletal Tumour Society score for the lowerlimb was used to analyse the outcome of surgery and the results were graded according to the following scale: excellent -70% to 100%; good -60% to 69 %; fair -50% to 59% and poor - <50 %. 6 patients reported excellent results (MSTS >70%). In 12 patients good results were obtained (MSTS 60% TO 69%). The mean MSTS score was 66.55%. All the 20 patients were able to walk without support at 6 months. In most patients, emotional acceptance was the parameter with minimum score as the patients felt that the stainless steel implant was heavy during their activities. 3 patients with proximal tibia tumours had a common peroneal nerve palsy which was a neuropraxia and subsequently recovered. 1 patient had a wound deheiscence for which secondary suturing was done. 1 patient had a recurrence of proximal Tibia osteosarcoma at 6 months and hence an above knee amputation was performed. one patient had a broken stem of the prosthesis 1 year post op which was revised by a longer stem prosthesis. One patient with chondrosarcoma developed pulmonary metastasis 1 year post surgery and died. One patient with aggressive GCT developed a pulmonary metastasis for which he was referred for lobectomy. Thus, out of 9 patients with GCT, 3 had postoperative complications and out of 9 patients with Osteosarcoma 1 patient had complication (recurrence).

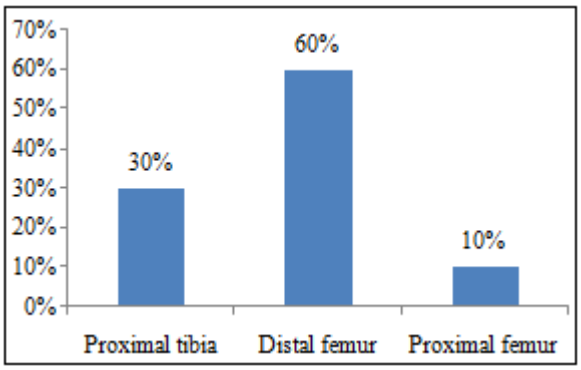
Picture 1: Stainless steel proximal Tibia prosthesis

Table 1: Age wise distribution of study participants (n=20)

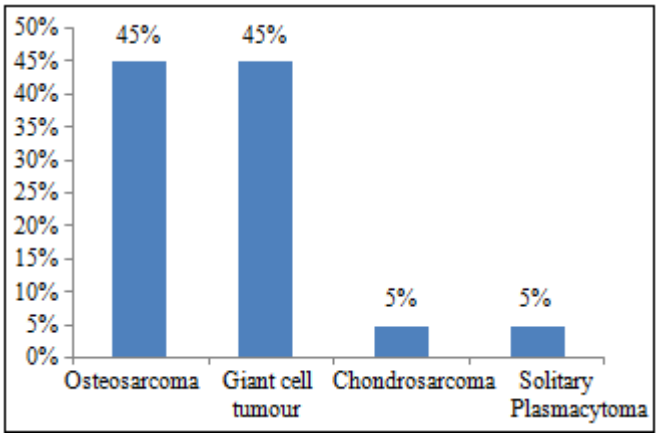
Age (years)	Numbers	Percentage (%)
11-20	5	25
21-30	10	50
31-40	1	5
41-50	3	15
>50	1	5
Total	20	100

Table 2: Distribution of study participants according to gender (n=20)

Gender	Number	Percentage (%)
Male	14	70
Female	6	30
Total	20	100



Graph 1: Distribution of study participants according to the location the tumour (n=20)



Graph 2: Distribution of study participants according to histologicaldiagnosis (n=20)

Picture 2: Case example– 52 years old patient with Right proximal femur chondrosarcoma

a) Preoperative Xays

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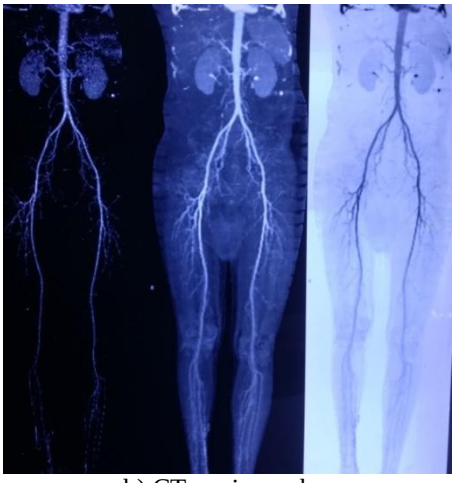

b) CT angiography

c) Postoperative xrays

d) Postoperative functional outcome

Table 3: Distribution of study participants according to the outcome (n=20)

Outcome	Number	Percentage (%)
Excellent (>70%)	6	30
Good (60 - 69%)	12	60
Fair (50 – 59%)	2	10
Poor (<50%)	NIL	-
Total	20	100

Table 4: Association between outcome and other parameters (n=20)

Parameters	Excellent (%)	Good (%)	Poor (%)	Total (%)	p – value
Age groups					
11 – 20	2 (40)	3 (60)	0 (0)	5 (100)	0.452
21 – 30	4 (40)	5 (50)	1 (10)	10 (100)	
31 – 40	0 (0)	1 (100)	0 (0)	1 (100)	
41 – 50	0 (0)	3 (100)	0 (0)	3 (100)	
>50	0 (0)	0 (0)	1 (100)	1 (100)	
Gender					
Male	4 (28.57)	8 (57.14)	2 (14.29)	14 (100)	1.000
Female	2 (33.33)	4 (66.67)	0 (0)	6 (100)	
Location					
Proximal tibia	1 (16.67)	5 (83.33)	0 (0)	6 (100)	0.431
Distal femur	5 (41.67)	5 (41.67)	2 (16.66)	12 (100)	
Proximal femur	0 (0)	2 (0)	0 (0)	2 (100)	
Histology Diagnosis					
Osteosarcoma	2 (22.22)	6 (66.67)	1 (11.11)	9 (100)	0.928
Giant cell tumor	4 (44.44)	4 (44.44)	1 (11.11)	9 (100)	
Chondrosarcoma	0 (0)	1 (100)	0 (0)	1 (100)	
Solitary Plasmacytoma	0 (0)	1 (100)	0 (0)	1 (100)	

Note: Fisher Exact test was applied

In our study, the treatment outcome showed no statistically significant association with age and gender of the study participants, location and histological diagnosis of the tumours.

4. Discussion

Advances in several fields have brought about a huge impact in the lives of survivors with bone tumours. Tumour biology and natural history are better understood and there exists an effective chemotherapy regimen with which even borderline cases can be salvaged. Prosthesis has been developed for virtually every site in the extremity which has been affected by bony tumours. Endoprosthesis allows reconstruction of the limb with immediate full weight bearing and stability helping in early mobilisation of the patients[5]. In our study, there was a good functional outcome (mean MSTS score >60 %) which was comparable with other studies.

Table 5: Functional outcome of our study in comparison to other studies analysed by MSTS score

Study	Number Of Patients	MSTS Score (%)
Hiroyuki et al[6]	40	74
Schindler et al[7]	12	77
Wilkins et al[8]	26	73
Khee Tan et al[9]	19	78
Our study *	20	66.55

Reconstructive procedures in the treatment of malignant bone tumours have significantly higher complication rates compared to the standard total joint arthroplasties. Mainly in tumour reconstructive procedures, bone resections are usually broad and affect a good portion of healthy tissue, reducing the substrate for adequate fixation and followed by compromising effects of chemo and radiotherapy. Hence there are more chances of slow wound healing and postoperative infections.

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Biau et al.[10] reported 91 patients with bone tumours in the region of the knee treated with endoprosthesis (not custom made implants) and in 36 patients, endoprosthesis had to be removed. Infection rates' following megaprosthesis has been reported often to be between 3% and 31%[11]. In our study, one patient (5%) had a superficial surgical site infection postoperatively. Staphylococcus aureus organism was isolated in cultures and was successfully treated with parenteral vancomycin therapy. Shortcomings of our study include limited sample size, short duration of study period and no inclusion of upperlimb tumours. A longterm followup is needed to better understand the longevity of the implant in various tumours.

5. Conclusion

Custom made endoprosthesis as a very useful option for limb reconstruction. Though tumours of long bones pose specific problems with reconstruction like soft tissue coverage, adequate vascularity, successful outcome depends on careful patient selection, proper preoperative workup and a combined team effort of pathologist, medical and radiation oncologist, orthopaedic surgeon and rehabilitation specialist.

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