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Outcome of Limb Salvage Using Modular Resection Endoprosthesis for Primary Bone Tumors Around the Knee

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Introduction

Most common site for musculoskeletal tumors is knee, that is the distal femur and proximal tibia **(**1**)**. In the past the main line of treatment was amputation. As the medical knowledge expanded there was a gradual change in treatment guidelines, which advanced from amputations to resection arthrodesis, osteoarticular or massive allografts, allograft-prosthetic composites **(**APC**)**, rotation-plasty, re-implantation of tumor bearing bone and limb sparing surgeries which includes use of Endoprosthesis **(**2,3**)**.

The therapeutic approach is based on factors like type of tumor, tumor stage, age, gender, general condition, quality of life and life expectancy **(**4**)**. With advancements in chemotherapy, radiotherapy and microsurgical techniques, limb sparing salvage surgery provides improved physical, cosmetic and psychological acceptance and better compliance compared to amputation for patients with locally aggressive and malignant bone tumors **(**2, 5, 6, 7**)**.

Currently, 90–95% of patients with sarcomas and aggressive bones tumors undergo a limb salvage surgery with a successful result **(**8,9**)**. Advances in implant material and designs of endoprosthesis enables immediate rehabilitation, providing a durable, stable and functional limb. Also, compared to biological reconstructions like rotation-plasty and arthrodesis, endoprosthetic replacement offers advantages like shorter operating time, early stability, weight bearing mobilization and less hospital stay. It also allows the early introduction of postoperative adjuvant therapy in malignant tumors **(**10**)**.

The aim of our study is to assess whether limb salvage with modular resection prosthesis in periarticular tumors of knee gives an acceptable outcome at a short term follow up of 2 years.

Materials and Methods

Patients:

This is a prospective study of 64 patients who underwent limb salvage surgery of knee with endoprosthetic replacement in the Department of Orthopaedics, Vydehi institute of Medical sciences and research centre, Bangalore. The study was done between 2012-2019 with a minimum follow up of 5 years. Outcome data was analyzed at the end of 5 years. Mean age of the patients, gender and type and location of tumor is summarized in Table 1. Patients with Giant cell tumor **(**GCT**) (**aggressive and recurrent**)**, Osteosarcoma and Chondrosarcoma around knee joint are included in the study.

The type of tumor and staging was determined by using imaging modalities like radiographs, computerized tomography, Magnetic resonance Imaging, Bone scan and Positron Emission Tomography **(**depending on necessity**)**. All the tumors were histologically confirmed by a core needle biopsy. All patients were staged using Enneking System for staging Benign & Malignant Musculoskeletal Tumors **(**11**)**. Patients with tumors involving nerves, vessels & extensive soft tissue envelop are excluded from the study.

Treatment

Patients with GCT and Chondrosarcoma were managed with surgery alone. Patients with Osteosarcoma were managed with Neo-adjuvant therapy; 2 cycles of Methotrexate, Doxorubicin, Cisplatin **(**MAP**)**, followed by surgery and 4 cycles of MAP; or 3 cycles of Ifosfamide, Doxorubicin, Cisplatin **(**IAP**)**, followed by surgery and 3 cycles of IAP.

Surgical Technique

The level of resection of bone and soft tissues was determined preoperatively by detailed sectional imaging **(**MRI or CT**)**. The resection of the tumor was calculated with wide acceptable free margin. We used the standardized antero-medial approach for resection of distal femur and proximal tibia tumors **(**12,13**)**. After the tumor was resected with a wide margin, adequate reaming was done and the implant was fixed with cement in proper rotational alignment using anatomical landmarks. The ResTOR, modular resection prosthesis system was used in all the patients.

For distal femur reconstruction patient's post-operative rehabilitation was started from day 2. For the initial 2 weeks, patients were trained to walk with gradual weight bearing with the help of a walker and a knee immobilizer. Range-of-motion exercises were started from day 3 as tolerated. Quadriceps strengthening exercises were stared from week 3. The knee immobilizer was used while walking until adequate strength has returned.

For proximal tibia reconstruction patient's knee was strictly immobilized for 3 weeks. For the initial 3 weeks, patients were trained to walk without weight bearing, with the help of a walker and a knee immobilizer. Gradual weight bearing, range-of-motion and strengthening exercises were stared from week 3. The knee immobilizer was used while walking until adequate strength has returned

Postoperative complications like infection, skin necrosis, implant loosening were monitored closely.

Outcome Measurement

Musculoskeletal Tumour Society Rating Scale **(**MSTS**) (**14**))** was used to assess functional outcome of the surgery.

Results

Mean MSTS score of distal femur tumors was 76.47% and of proximal tibia was 71.11%. The overall MSTS score of all the patients was 73.96% corresponding to good outcome.

FIGURE 1: WIDE RESECTION OF TUMOR AND RECONSTRUCTION OF DISTAL FEMUR

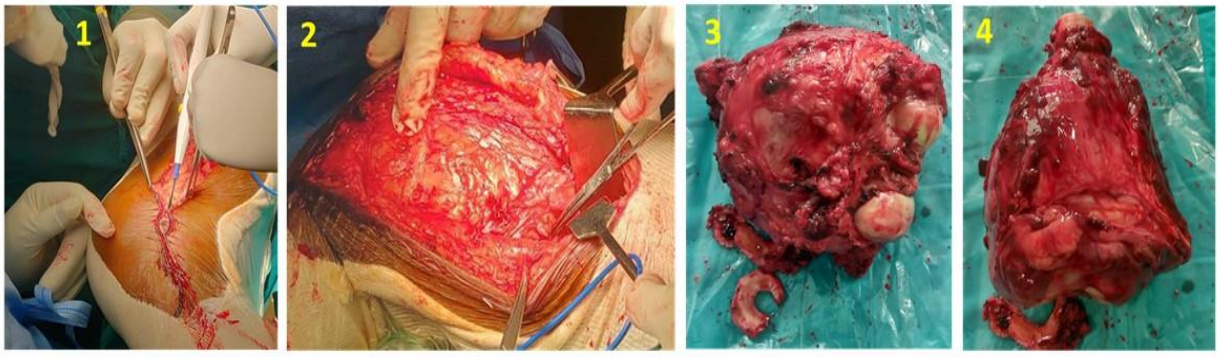


FIGURE 2: WIDE RESECTION OF TUMOR AND RECONSTRUCTION OF PROXIMAL TIBIA

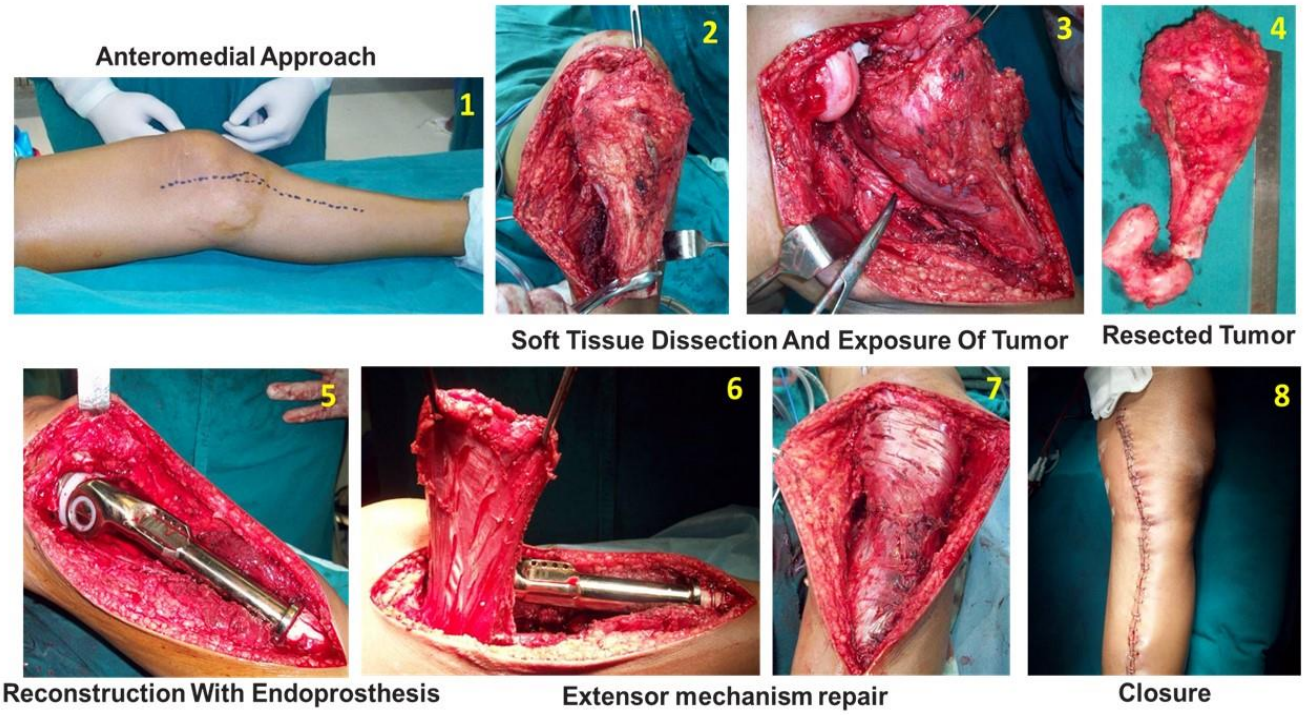


FIGURE 3: RECURRENT GCT OF DISTAL FEMUR

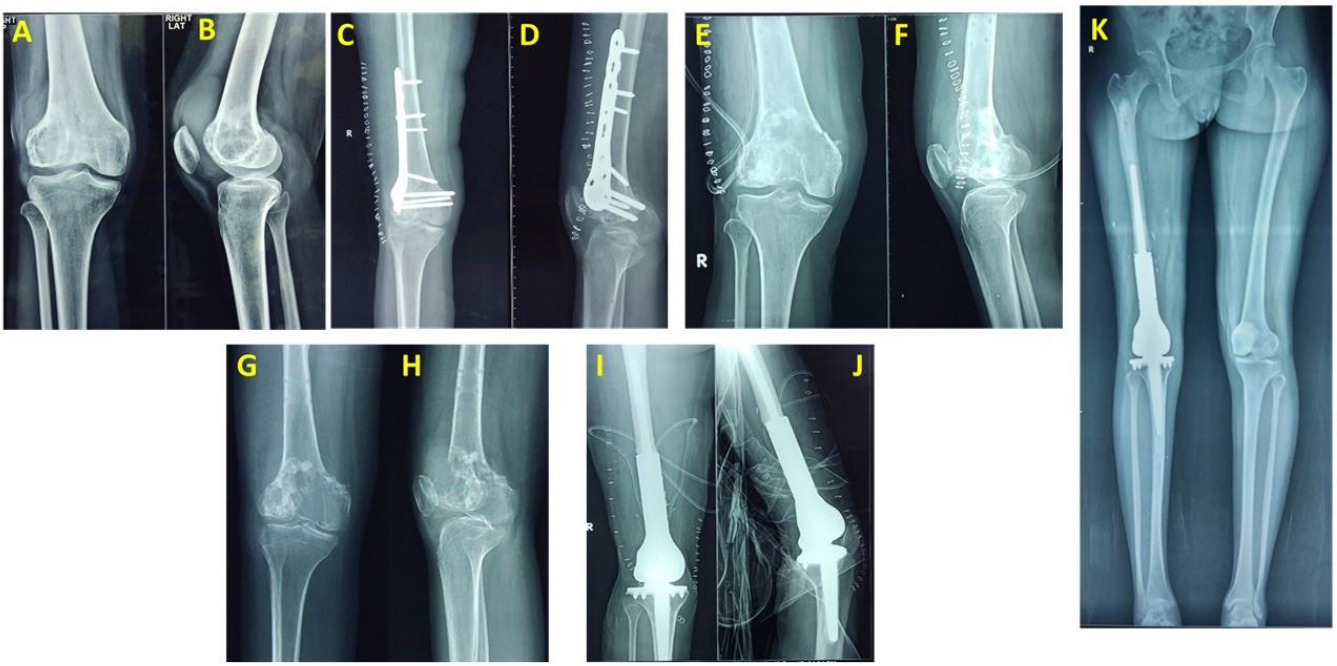


FIGURE 4: EXTRA COMPARTMENTAL GCT OF PROXIMAL TIBIA

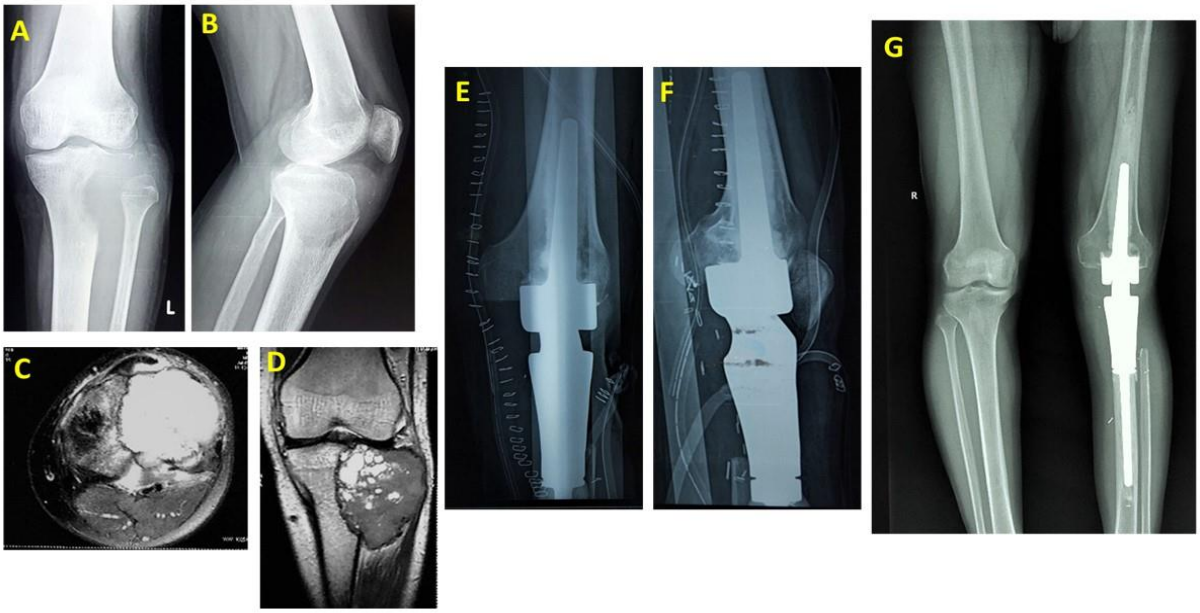


FIGURE 5: CHONDROSARCOMA OF DISTAL FEMUR

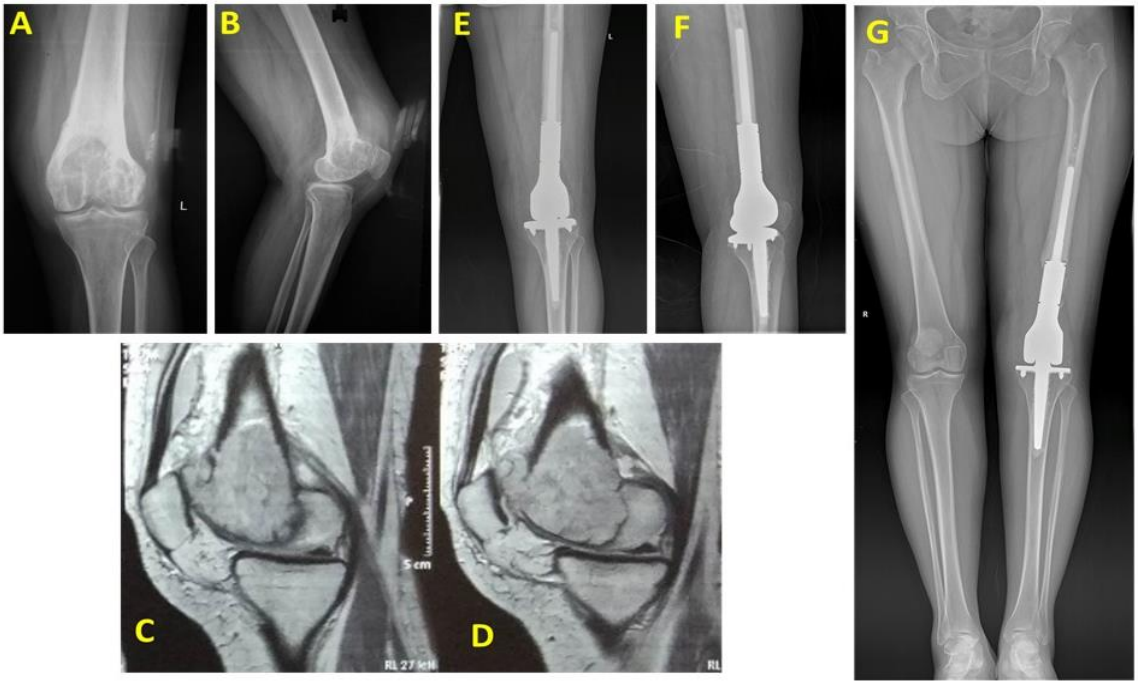
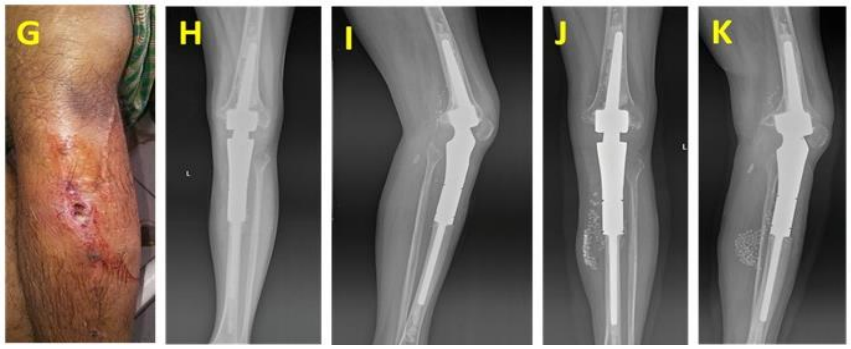


FIGURE 6: OSTEOSARCOMA OF DISTAL FEMUR

FIGURE 7: COMPLICATIONS

SKIN NECROSIS : TREATED WITH DEBRIDEMENT AND SSG

ASEPTIC LOOSENING



INFECTION: TREATED WITH DEBRIDEMENT AND ANTIBIOTIC BEADS

Figure 1 shows the surgical approach, resection and endoprosthetic reconstruction of distal femur tumors. Figure 2 shows the surgical approach, resection and endoprosthetic reconstruction of proximal tibia tumors.

Figure 3 shows radiographs of recurrent GCT of distal femur in a 26-year-old female. Initial GCT **(**3A,3B**)** was treated with extended curettage, bone graft and prophylactic fixation **(**3C,3D**)**. GCT recurred **(**3G,3H**)** six months after implant removal and wide resection with endoprosthetic reconstruction was done **(**3I, 3J**)**.

Figure 4 shows radiographs of extra compartmental GCT of distal femur **(**4A, 4B**)** in a 27-year-old male. MRI scans **(**4C, 4D**)** do not show any neurovascular involvement. Wide resection with endoprosthetic reconstruction was done **(**4E, 4F**)**.

Figure 5 shows radiographs of Chondrosarcoma of distal femur **(**5A, 5B**)** in a 45-year-old female. MRI scans **(**5C, 5D**)** do not show any neurovascular involvement. Wide resection with endoprosthetic reconstruction was done **(**5E, 5F**)**.

Figure 6 shows radiographs of Osteosarcoma of distal femur **(**6A, 6B**)** in a 14-year-old male. Wide resection with endoprosthetic reconstruction was done **(**6C, 6D**)**.

6 patients **(**9.3%**)** had postoperative skin necrosis **(**Figure 7A, 7B**)** who recovered with debridement and split thickness skin graft **(**SSG**) (**Figure 7C, 7D**)**.

4 patients had aseptic loosening **(**Figure 7E, 7F**)**. Revision surgery was done in 2 patients and 2 with mild pain are under regular follow up.

Out of 64 patients, 10 patients **(**15.6%**)** developed surgical site infections who were initially treated with intravenous antibiotics and regular dressing. 6 patients recovered by the same and 3 patient underwent local debridement and antibiotic beads. **(**Figure 7J, 7K**)**. 1 patient who didn't respond to debridement underwent implant removal and spacer application, followed by revision surgery.

1 patient had recurrence of GCT in Proximal tibia 4 years after surgery, involving Neurovascular bundle, and was treated with above knee amputation.

TABLE 1. PATIENT AND TUMOR DETAILS			
TOTAL NUMBER OF PATIENTS			64
GENDER		MALE	38
		FEMALE	26
AGE (YEARS)		RANGE	14 to 54
		AVERAGE	31.6
TUMOR			
SITE	DISTAL FEMUR		34
	PROXIMAL TIBIA		30
TYPE OF TUMOR	PRIMARY GIANT CELL TUMOR		28
	RECURRENT GIANT CELL TUMOR		12
	OSTEOSARCOMA	STAGE IIA	6
		STAGE IIB	8
	CHONDROSARCOMA		10

TABLE 2. MUSCULOSKELETAL TUMOR SOCIETY RATING SCALE		
DISTAL FEMUR	PROXIMAL TIBIA	OVERALL
76.47	71.11	73.96

Discussion

Distal femur and distal tibia are the most common sites for primary bone tumors. Osteosarcoma and GCT are the common tumors which require attention for local surgical intervention and further follow up. Limb salvage surgery is the most accepted treatment for tumors around the knee and amputations should be reserved for tumours with multi-compartment soft tissue and major neurovascular involvement. Wide excision and reconstruction with endoprosthesis gives optimal patient satisfaction with complete excision of tumor and retaining a functional limb **(**1**)**.

In a cross sectional study by Sharil, AR et.al., **(**2013**)**, 54 patients with tumours around the knee were treated with limb salvage and endoprosthesis fixation with a mean follow up of 36.8 months. Patients in the distal femur group had a mean MSTS score of 73.1% compared to the proximal tibia group with mean score of 66% **(**1**)**. In a retrospective study by Kamal, AF et.al., **(**2019**)**, Osteosarcomas around Knee, treated with megaprosthesis had an excellent MSTS score of score 78.7% **(**9**)** at 1 year follow up.

Wilson, PJ, et.al., **(**2019**)**, in a systemic review of outcomes in lower limb – limb salvage surgeries with endoprosthesis, have reported a MSTS score of 72.7% to 91% for distal femur and 66% to 86.7% for

proximal tibia. They observed that there will be impairment of the lower limb strength, flexibility and range of motion but it is not the priority when compared to retaining daily routine activities and also increasing the 5-year survival rate **(**15**)**.

Goryń, T.,et.al., **(**2019**),** conducted a study of a total 90 patients with osteosarcoma of extremities which included 61 patients of distal femur and 7 patients of proximal tibia. All patients underwent resection and reconstruction with megaprosthesis. The functional outcome was analyzed by MSTS scoring with results of 85% and 75% for distal femur and proximal tibia respectively **(**16**)**.

Our study included 64 patients of which the 30 were distal femur and 34 were proximal tibia. Distal femur tumors group had a mean MSTS score of 76.47% and proximal tibia group had a mean score of 71.11%. Overall MSTS score of all tumors around knee was 73.96% corresponding to good outcome. Most of the patients returned to work or school and were able to do most of the day to day activities without any assistance. The results of both distal femur and proximal tibia are in acceptance with the other studies mentioned above. We were not able to assess implant survival rates and long-term functional outcome as the follow up period was only 5 years.

Conclusion

Limb sparing surgery has become the gold standard for management of bone tumors. Our study and most of the recent literature supports that resection and endoprosthetic reconstruction as the best procedure for the tumors around the knee with good to excellent functional results in the majority of the patients.

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