ORIGINAL ARTICLE

LOWER LIMB SALVAGE FOR TUMOURS AROUND THE KNEE USING ONCOLOGICAL RESECTIONS AND MEGAPROSTHETIC RECONSTRUCTIONS

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Background: This descriptive case series documented the clinical presentation of tumours around the knee in our population and explored the outcome of lower limb salvage with oncological resections and megaprosthetic reconstructions. The variables analysed included return of knee function, disease free survival and any complications observed over a follow up period of 5-years. **Methods:** The study spanned over a period of 13-years. It included adult patients of all genders who presented with tumours around the knee and underwent tumour resections followed by megaprosthetic reconstructions at our institute. **Results:** Out of 73 patients, there were 43 (58.90%) males and 30 (41.09%) females. Their ages ranged between 16–53 years with a mean of 32.97±10.68 years. The tumours included giant cell tumours (n=41), osteosarcomas (n=24), Spindle cell sarcoma (n=5), chondrosarcoma (n=2) and Ewing's sarcoma (n=1). The average postoperative musculoskeletal tumour society (MSTS) score was 84.65%. Various complications encountered included superficial infections/ delayed wound healing among 9 (12.32%) patients, local recurrence in 6 (8.21%), deep infections among 5 (6.84%) and transient palsy of peroneal nerve in 3 (4.10%) cases. There was aseptic loosening and traumatic disruption of extensor mechanism one each (1.36%). There were 7 (9.58%) mortalities in our series. **Conclusion:** Giant cell tumours and osteosarcomas were the most frequent tumours observed around the knee. The tumours affected relatively younger population. Safe oncological resections of the tumours followed by megaprosthetic reconstructions provided reasonable outcome in the majority of patients.

Keywords: Knee megaprosthetic reconstructions; Tumours around the knee; Giant cell tumour; Osteosarcoma; Modular megaprostheses

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INTRODUCTION

The knee constitutes a frequent site for primary bone tumours such as the giant cell tumour (GCT) and osteosarcomas. Limb salvage excision of tumours and prosthetic reconstruction has emerged as the standard of care to address these challenging tumours. This dream has become a reality owing to remarkable improvements in the imaging diagnostics, neo-adjuvant and adjuvant chemotherapy, surgical excisional techniques and ever enhancing designs of the endoprostheses increasingly available for reconstructing the excisional defects. The newer generation modular prosthetic systems provide several added advantages such as quicker learning curve, better reproducibility of technique, intra-operative flexibility, solid reattachment of the extensor mechanism to the device, stable reconstruction, and immediate postoperative rehabilitation of the joint.[1–4]

The goals of treatment in managing tumours around the knee is to achieve reasonable locoregional control of the tumour as well as restore adequately functioning knee joint. The advent of neoadjuvant chemotherapy for osteosarcomas in particular has played pivotal role in the limb salvage efforts. Resultantly up to 80% of these patients are considered potential candidates for limb salvage. The modular endoprostheses are currently the most widely employed reconstructive tools in this context.[3, 5–7] The present study was carried out to document the clinical presentation of tumours around the knee in our population and determine the outcome of oncological resections and reconstructions with rotating hinge modular megaprostheses in terms of knee function, disease free survival and any complications at 5-years follow up.

MATERIAL AND METHODS

This prospective case series was carried out over a period of thirteen years, spanning from Jan 01, 2009 to Dec 31, 2021. Informed consent was taken from the patients. The study was approved by the hospital ethics committee. It included all patients with tumours around the knee, such as those originating from distal femur, proximal tibia and proximal fibula, who underwent oncological resections and megaprosthetic reconstructions. Our exclusion criteria included children <16 years, age >70 years with associated comorbid,

metastatic disease, stage III b tumours that failed to respond to neo-adjuvant chemotherapy and patients with invasion of popliteal neurovascular structures.

Initial clinical evaluation of the tumour was performed with standard plain X-rays, magnetic resonance imaging (MRI) scan of knee followed by open biopsy to confirm the diagnosis. The biopsy was performed under spinal or general anaesthesia. Metastatic work-up included computed tomography (CT) scan of the chest and abdomen, and bone scan. Neo-adjuvant chemotherapy was instituted among all patients with osteosarcoma. Over the last five years we have started neo-adjuvant chemotherapy for giant cell tumours also. The patients were hospitalized for definitive excision and prosthetic reconstruction under spinal or general anaesthesia. We undertook en bloc extra-articular resection of tumours. We employed anteromedial or anterolateral parapatellar incisions. Medial and lateral skin flaps were elevated to expose the anterior surface of the knee. After dissecting soft tissues, femoral and tibial osteotomies were performed with 3–5 cm safety margins depending on the tumour histology. Frozen sections of the marrow components at the margins of bone resection were evaluated to ensure tumour free margins of resection. The rotating hinge modular prostheses were employed in all patients. Medial gastrocnemius muscle flap was employed in twenty-one patients to ensure complete coverage of the megaprostheses.[8]

All the patients had initiation of physical therapy on the day following surgery. The definitive chemotherapy was restarted four weeks postoperatively once the wounds had healed perfectly. Our follow up protocol for tumour surveillance was two monthly for the first six months, then 3-monthly for the first two years followed by 6-monthly follow up for lifelong. The follow up evaluation included clinical assessment and imaging investigations to detect any local or systemic recurrence and determine functional status of the reconstructed knee. The musculoskeletal tumour society (MSTS) scoring system was employed for determining the functional outcome of the patients. It consisted of allocation of a score of 0–5 for each of the following assessment criteria: 1) pain, 2) function, 3) emotional acceptance, 4) support, 5) walking and 6) gait.[9] The various outcome measures of the study were recorded at 5-year follow up. Figures-1 (a) through 2(e) show two representative cases among the included patients.

SPSS version 21 (SPSS Inc., Chicago, IL, USA) was used to analyse the data statistically. Descriptive statistics were employed to measure the outcomes.

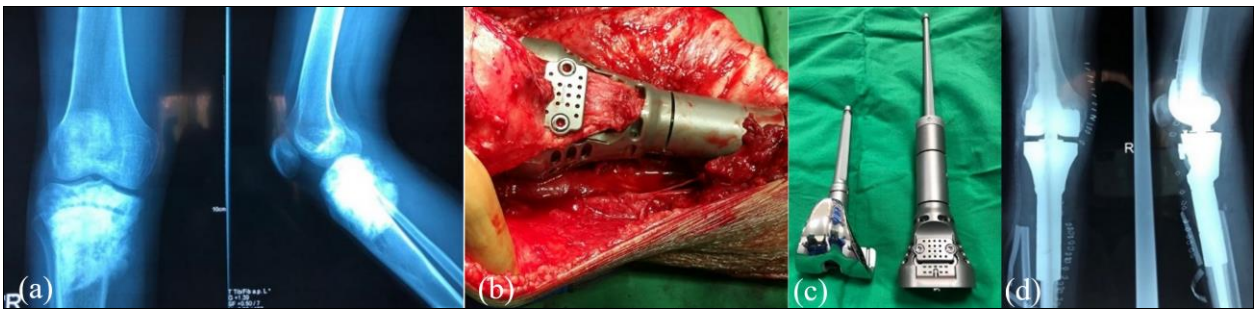

Figure-1 (a): Plain X-rays showing oteosarcoma of the proximal tibia in a 16 years old girl. Figure 1 (b): Intraoperative photograph following tumour excision and megaprosthetic reconstruction of the excisional defect. Figure 1 (c): Modular megaprosthetic device employed for reconstruction in the patient. Figure 1 (d): Immediate postop X-rays showing the reconstructed knee joint.

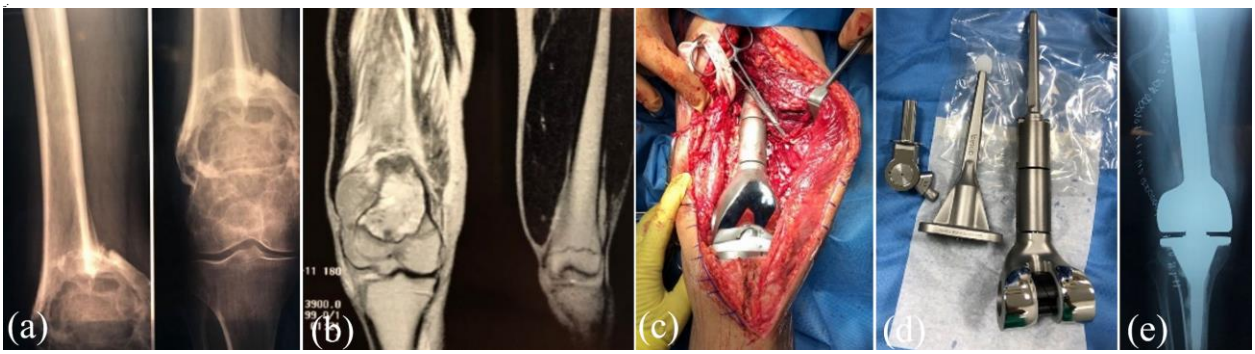

Figure-2 (a): Plain X-rays showing giant cell tumour of the distal femur in a 17 years old male. Figure 2 (b): MRI scan of the same patient. Figure 2 (c): Intraoperative photograph following tumour excision and megaprosthetic reconstruction of the distal femur and knee joint. Figure-2 (d): The modular megaprosthesis employed. Figure-2 (e): Immediate postop X-ray showing the reconstruction.

RESULTS

There were a total of 73 patients with 43 males and 30 females. The various entry variables are summarized in table-1. The average postoperative MSTS score was 84.65%. The commonest complication encountered was superficial infection/ delayed wound healing observed among 9 (12.32%) patients. Table-2 summarizes the various outcome measures observed among the patients.

Table-1: Clinical presentation data of the included patients. (n=73)

Characteristics	Number of patients (%)
Age:	Mean 32.97±10.68 (range 16-53) years
Gender:	
Male	43 (58.90%)
Female	30 (41.09%)
Histological types of the tumours:	
Giant cell tumour	41 (56.16%)
Osteosarcomas	24 (32.87%)
Spindle cell sarcoma	5 (6.84%)
Chondrosarcoma	2(2.73%)
Ewing's sarcoma	1 (1.36%)

Table-2: Outcome measures observed among the patients. (n=73)

Outcome measures:	Number of patients (Percentage)
Complications encountered: (n=25)	
Superficial infections/ delayed wound healing	9 (12.32%)
Local recurrence	6 (8.2%)
Deep infections	5 (6.84%)
Transient palsy of peroneal nerve	3 (4.10%)
Aseptic loosening	1 (1.36%)
Traumatic disruption of extensor mechanism	1 (1.36%)
Postoperative average MSTS scores:	84.65%
Mean hospital stay:	9.87±3.62 (range 7–25) days
Mortalities observed:	7(9.58%)

DISCUSSION

In our study, giant cell tumours (GCT) and osteosarcomas constituted the bulk of tumours (i.e., >90%) around the knee. The GCT is known to typically affect the epiphyses of long bones around the knee and may account for up to 20% of all primary bone tumours. It is usually graded into three grades by its histological appearances. In most cases these are benign, however notorious for local recurrence which may be as high as 45% if not excised adequately in the first instance. In view of the recently growing evidence in favour of denosumab, we are currently employing it as a neo-adjuvant therapy in our patients with GCT.[10–13]

Osteosarcoma was the second commonest tumour in our patients accounting for 33% of the tumours around the knee. We routinely employed neo-adjuvant chemotherapy followed by completion chemotherapy once the patient enjoyed uneventful postoperative recovery. For neo-adjuvant therapy, we used MAP regimen which included methotrexate, adriamycin, and cisplatin. Necrosis >90% achieved with neo-adjuvant chemotherapy was considered a good prognostic factor and the same regimen was continued postoperatively. If the resected surgical specimens didn't show favourable histological response (i.e., over 10% viable tumour), the patients received modified multi-agent regimen including ifosfamide/etoposide.[7,13,14]

In our study we employed rotating hinge modular endoprostheses for reconstructing the defects resulting from tumour excision. The modular endoprostheses are currently used by majority of the surgeons across the globe. Their beauty is that their standard sized component sets with varying lengths are readily available for use in reconstructing any given defects of the bones around knee. The various components are readily assembled in different combinations to reconstruct the large skeletal defect and achieve a functioning knee joint. Moreover, the published literature proves superiority of the modular megaprostheses in terms of limb survival, complication rate and functional outcome of the reconstructed knee.[15,16] With ever enhancing sophistications in implant design, additional advances in this field are desired in order to further improve the overall results of surgery and quality of life of the patients.

We employed the MSTS scoring system as an outcome assessment tool in our patients. For the lower limb, the MSTS score is a measure of function across six items. i.e., 1) pain, 2) function, 3) emotional acceptance, 4) support, 5) walking and 6)

gait. The descriptive grading for each of these items ranges from 0 to 5, with a maximum score of 30.[9,16–19]

In our study the average postoperative MSTS score was 87.49%. Our outcome results conform to most of the published studies which have reported the MSTS scores ranging between 60–88%.[2,11–14]

We encountered one case of aseptic loosening in our series. Depending on the length of follow up, the incidence of aseptic loosening has been variably reported in the published studies. In some of the published studies it has been reported to be as high as 20%. Since we had a target follow up of three years in our series, this complication rate may increase with a longer follow up as reported in some of the studies. Also, the new generation modular prostheses have considerably reduced this complication.[1,18]

We recorded seven cases of superficial wound infection and delayed wound healing, all of which responded to conservative measures. The rate of infection reported in the literature is up to 15%. Aggressive and prompt management of infectious complications is mandatory for a satisfactory outcome in terms of averting the need for implant removal or secondary amputation. Oncologic orthopaedic patients undergoing reconstruction with large implants are prone to infections owing to a host of factors. For instance, there is in an environment of immunosuppression caused the malignancy as well as induced by chemotherapy and/ or local irradiation. There may be associated malnutrition also. Prophylactic use of appropriate antibiotics as well as meticulous surgical technique are mandatory to reduce the risk of infections.[2,6,20, 21]

We had local tumour recurrence in five patients. In the published studies, the reported rate of local recurrence ranges from 0–18% with a mean local recurrence rate of 6.9%. Tumour recurrence almost invariably leads to amputation of the limb.[1,15,22]

In our study, we had limb survival rate of 91.22% at 3 years follow up. The published literature on use of megaprostheses among oncological patients reveals functioning limb in a satisfactory number of patients and for a satisfactory period of time. Gosheger *et al* reported 88% limb survival rate 5-year whereas Jeys *et al* reported 91% survival rate at 20 years postoperatively.[23,24]

We had one case of traumatic extensor mechanism disruption which was managed with operative repair of the extensor mechanism.

A variety of complications which are uncommon with the newer modular prostheses, have been reported in the old literature. For instance, fatigue fractures of the stems and failure of the attachment of the soft tissues to the prosthesis. The overall rate of these complications remained up to 48%. However, these complications have diminished considerably over time, owing the introduction of modern, robust modular designs. Additionally biocompatible materials have been introduced, which have improved attachment of the soft tissue envelope to the prosthesis. Technique modification such as the reconstruction of the capsule using local muscle transfer or composite materials such as the Dacron tape. Moreover, the rotating-hinge knee prostheses have shown remarkably lower risk for mechanical complications in comparison to the older fixed-hinge implants.[1,2,6,15,16,25,26]

CONCLUSION

Giant cell tumours and osteosarcomas were the most frequent tumours observed around the knee. The tumours affected relatively younger population. Safe oncological resection of tumours followed by megaprosthetic reconstruction provided reasonable outcome in the majority of patients.

AUTHORS' CONTRIBUTION

FKZ & MS: Designed the study and wrote the manuscript. MN & FQ: Performed data collection and analysed the results. FKZ & MS: Responsible for accuracy and integrity of the work. All authors approved the manuscript.

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