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Single center experience: midterm functional outcome of knee megaprosthesis after sarcoma resection

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ABSTRACT

Background: Endoprosthetic reconstruction following bone tumor resection is a well-known and popular method for preserving limbs. Endoprosthetic functional outcomes following reconstructions have been the topic of numerous studies the majority of which used subjective parameters like the Musculoskeletal tumor society (MSTS) score.
Methods: A retrospective consecutive sampling strategy was used, and all eligible patients with knee tumours treated at Nariman hospital between 2020 and 2023 were identified from medical records and included. Due to the rarity of knee tumours and the limited annual case volume of approximately 8-10 cases, no formal a priori sample size calculation was performed. The final cohort consisted of all available eligible cases during the study period (n=40). Patients were followed for functional outcomes at 6 months, 1 year, and 2 years, with an average follow-up duration of 38 months (range: 30-71 months). Cases with failure, infection, local recurrence, death, or unavailable functional follow-up were reported separately in the attrition/outcome flow.
Results: The functional outcome of knee tumor prosthesis was excellent with mean functional score for all patients were 68.71%. The mean functional score for distal femur patients was 71.94% while the mean functional score for proximal tibia cases was 63.85%. Younger patients with distal femur lesions showed better functional score, also patients with early management and early post-operative mobilization showed better results. The prosthesis survival was 90%.
Conclusions: Limb salvage surgeries are complex surgeries which need multidisciplinary teamwork. Tumor endoprosthesis is the best option for limb reconstruction following tumor excision around the knee joint allowing early mobilization with low rate of infection and local recurrence.

Keywords: Endoprosthetic, Sarcoma resection, Limb salvage

INTRODUCTION

In the early experience with limb salvage, functional outcomes were not of main interest because patients with malignant illness had extremely low survival rates.[1,2] Nowadays, the durability and functional outcomes of reconstructions are increasingly significant factors to take into account as a result of advancements in medical therapy that have boosted long-term patient survival.[3] Endoprosthetic reconstruction following bone tumor resection is very challenging as it has unique biomechanics so the rotating hinge prosthesis is important as it allows for three degrees of freedom.[4] This system produces a fairly stable knee by imitating the restraints offered by the cruciate and collateral ligaments.[5,6] Our objectives are to evaluate the midterm functional results of tumor endoprosthetic replacement around knee after primary bone tumor resection.[7,8] Is there a functional difference between distal femur and proximal tibia sarcoma

prosthetic reconstruction? What are the factors that were associated with better results?.[9]

METHODS

A retrospective consecutive sampling strategy was used, and all eligible patients with knee tumors treated at Nariman hospital between 2020 and 2023 were identified from medical records and included.

Due to the rarity of knee tumors and the limited annual case volume of approximately 8-10 cases, no formal a priori sample size calculation was performed. The final cohort consisted of all available eligible cases during the study period (n=40). Patients were followed for functional outcomes at 6 months, 1 year, and 2 years, with an average follow-up duration of 38 months (range: 30-71 months). Cases with failure, infection, local recurrence, death, or unavailable functional follow-up were reported separately in the attrition/outcome flow.

This is a retrospective study included 40 patients who had primary bone tumor (distal femur or proximal tibia) and previously treated by wide local excision and replacement by knee tumor prosthesis. A retrospective evaluation of 40 patients diagnosed with primary bone tumor around the knee that underwent wide local excision and reconstruction using tumor prosthesis in El hadara university hospital Alexandria Egypt since January 2021 to November 2024. Functional outcomes were assessed using MSTS (Musculoskeletal tumor society) at follow up period 6 months, one and 2 years.

Inclusion and exclusion criteria

Patients diagnosed with proximal tibia and distal femur osteosarcoma who underwent a single surgical procedure involving tumor resection and tumor prosthesis implantation were included in the study. Cases with a history of previous tumor resection or spacer placement were excluded from the study.

Statistical analysis of the data

Data were fed to the computer and analyzed using IBM SPSS software package version 20.0. (Armonk, NY: IBM Corp). Qualitative data were described using number and percent. The Shapiro-Wilk test was used to verify the normality of distribution.[10] Quantitative data were described using range (minimum and maximum), mean, standard deviation, median and interquartile range (IQR). Significance of the obtained results was judged at the 5% level.

The used tests were

Chi-square test

For categorical variables, to compare between different groups.

Fisher's exact or Monte Carlo correction

Correction for Chi-square when more than 20% of the cells have expected count less than 5.

Student t-test

For normally distributed quantitative variables, to compare between two studied groups.

Mann Whitney test

For abnormally distributed quantitative variables, to compare between two studied groups.

ANOVA with repeated measures (periods)

For normally distributed quantitative variables, to compare between more than two periods, and Post HOC test (Bonferroni adjusted) for pairwise comparisons.

F-test (ANOVA) (groups)

For normally distributed quantitative variables, to compare between more than two groups, and Post HOC test (Tukey) for pairwise comparisons.

Multidisciplinary team work

Results of pre-op imaging and biopsy had been discussed in a multidisciplinary team approach before surgery to select cases to take pre-op chemotherapy and to select cases to be operated with limb salvage surgery.

Operative management

Anesthesia

All patients given epidural anathesia combined with general anathesia.

Positioning

Supine position used in all cases.

Incision

Anteromedial incision for distal femur patients and for proximal tibia patients, the biopsy site was resected in all cases and taken in the incision line to be totally removed.

Resection of the tumor

Distal femur cases

Dissection done medially till deep fascia till identification of Sartorius muscle and pesanserenus and transected at the level of tibial insertion then medial head gastrocnemius cut to identify the neurovascular bundle then ligation of small

branches from bundle to the distal femur done (Figure 1 A and B).

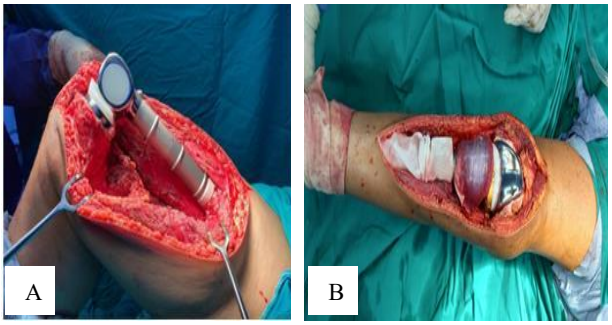


Figure 1 (A and B): Tumor prosthesis reconstruction following wide local excision of primary tumor: (A) cemented distal femur tumor prosthesis and (B) medial head gastrocnemius flap to cover the proximal tibia tumor prosthesis.

Level of bone osteotomy and safety margins decided from pre operative MRI done. Tumor Prosthesis used for skeletal reconstruction which was rotating hinge knee system after preparation of proximal tibia and proximal femur end and then the prosthesis was fixed to the femur and tibia either using cement OR cementless or hybrid.

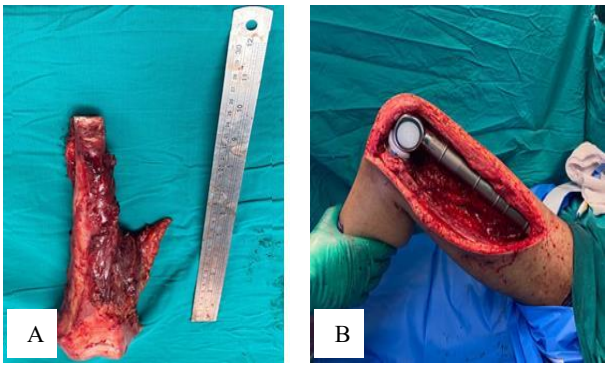


Figure 2 (A and B): Intra-operative photos for distal femur sarcoma patient: (A) distal femur resected segment and (B) mega prosthesis reconstruction.

Proximal tibia cases

Through anteromedial approach medial head gastrocnemius and pes-anserinus identification and reflection and exposure of popliteal and posterior tibial vessels. Dissection through solieus fascia for dissection of the vessels distally then lateral dissection done and reflection of the patella laterally after cutting patellar tendon. Tumor segment osteotomy done after measurement and medial head gastrocnemius released to be free for preparation for flap coverage. Insertion of proximal tibia prosthesis either using bone cement OR cementless. Rotation of medial gastrocnemius flap to cover the prosthesis and repair for extensor mechanism. Closure on a redivac drain after good homeostasis.

Post operative protocol

All patients given IV antibiotics for 3 days then oral antibiotics for 1 week. Early exercise and range of motion started as early as possible partial weight bearing encouraged and physiotherapy for 6 to 8 weeks patients' age ranged from a minimum of 17 years old to a maximum of 58 years old with a mean age of 33.20±13.76 years old, 24 of the cases were located distal femur and 16 patients were located in proximal tibia (Table 1). The data collected from the patient's archived data and functional evaluation according to the revised musculoskeletal tumor society (MSTS).[10] The functional score calculated as the average of total score of every patient in 4 visits in periods of immediate post-op, 6 months, 1 year and 2 years.

RESULTS

In our study, the mean MSTS functional score for all patients was 68.71%, table 2 the mean functional score for distal femur patients was 71.94% while the mean functional score for proximal tibia cases was 63.85% the maximum functional score was 81.67% while the minimum was 55.0% (Figures 2, 3 and 4). The average post-operative follow up was 38 months±14.52 months (range, 30 to 71 months).

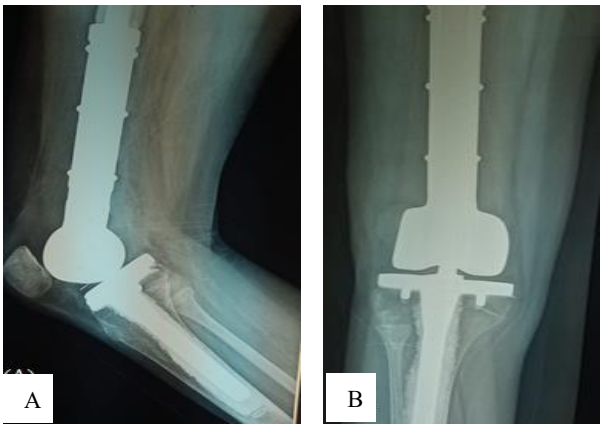


Figure 3 (A and B): Post-op X-rays (A) lateral view and (B) AP view.



Figure 4 (A and B): Range of motion at follow up 1 year: (A) flexion and (B) extension.

The prosthesis survival in this study was 90%, 4 cases of failure (10%), and three cases developed infection.

Table 1: Distribution of the studied group regarding demographic data (n=40).

Patient data	N	%	P
Age (years)			
<30	20	50	0.160
>30	20	50	
Sex			
Male	22	55	0.593
Female	18	45	
Site			
Distal femur	24	60	0.015*
Proximal tibia	16	40	
Pathological subtype			
Osteosarcoma	34	85	0.832
Chondrosarcoma	4	20	
GCT	2	5	
Time between discovery and surgery (days)			
<75	20	50	0.867
>75	20	50	
Receiving chemotherapy			
Yes	26	65	0.003*
No	14	35	
Response to chemotherapy			
No	14	35	0.001*
Good	16	40	
Unsatisfactory	10	25	
Time of post-operative mobilization (days)			
≤14	24	60	0.306
>14	16	40	

t:Student t test, p:p value for comparing between site and functional score, IQR:Inter quartile range, SD:Standard deviation
*Statistically significant at p≤0.05.

Table 2: Distribution of the studied cases according to functional score (n=40).

	N	%
Total score (degree)		
Unsatisfactory (<20)	14	35.0
Satisfactory (≥20)	26	65.0
Min-max	16.50-24.50	
Mean±SD	20.61±2.24	
Median (IQR)	20.75 (19.38-22.13)	
Functional score (%)		
Min-max	55.0-81.67	
Mean±SD	68.71±7.46	
Median (IQR)	69.17 (64.58-73.75)	

IQR: Inter quartile range, SD: Standard deviation.

Two of them was superficial skin infection which managed by debridement and implant retaining but the other managed by implant removal and spacer after recurrence of infection after two sessions of debridement at the end of the period of the study with overall 7.5 % infection rate, in our study one patient 2.5% showed local recurrence which needed amputation later on, and one patient died due to lung metastasis.

Factors associated with better functional results were found to be; younger patients, distal femoral lesions, males with short history before presentation and early post-operative mobilization had showed better results. The early diagnosis and management may give a better chance for good wide local excision and better results this explains better results in patients with shorter time interval between diagnosis and surgery.

DISCUSSION

As regards functional outcome

Do Kim et al reviewed 48 osteosarcoma patients who underwent tumor prosthetic reconstruction, MSTS functional score was 74.1% in post operation.[4] While in our study the mean functional score was 68.71%. Our patients in distal femur group had a mean functional score of 71.94% while patients in proximal tibia group had a mean functional score of 63.85 %.[11]

Sharil et al studied a group of 34 cases of distal femur and 20 cases of proximal tibia endoprosthesis replacement.[11] Functional outcomes, as measured by MSTS score were good to excellent in a majority of study patients (mean, 21.1 (70.43%); range, (6-28). Patients in the distal femur group had a mean MSTS score of 21.9 (73.1%) compared to the proximal tibia group with a mean of 19.8 (65.8%). This difference between groups was not significant (p=0.274).[12,13]

Regarding time lapse between diagnosis and management

The early diagnosis and management may give a better chance for good wide local excision and better results. This explains better results in patients with shorter time interval between diagnosis and surgery and this finding match that found by Grimer et al.[6]

Regarding site of the tumor

Li et al retrospectively analysed the results of wide resection of primary bone tumor around the knee with reconstruction by knee tumor prosthesis, the mean MSTS core was 25.0 (19.0-29.0) in the distal femur group, 24.4 (17.0-28.0) in the proximal tibia group with better results for distal femur group which matches with this finding in our study.[13] Zhang et al initiated a retrospective study on the long-term survival of cemented endoprostheses around the knee; the average MSTS score in follow up was 22.9 while the mean score in this study was 20.61±2.24 with better results for distal femur patients in both results.[14] Distal femur is the most common site for osteosarcoma.[14] This is evident in our study with 24 patients (60%). The mean functional score for these patients was satisfactory. Pang et al, 2021 retrospectively reviewed the survival of

patients who underwent knee reconstruction following tumor resection around the knee. The 1- and 5-year prosthetic survival rates were 94.0 and 90.8 respectively.[14] In a study which reviewed 63 patients treated with prosthetic limb salvage surgery around the knee the 5-year prosthesis survival was 72.8%. The prosthesis survival in this study was 90%, 4 cases of failure (10%) three of them are due to infection and the other was due to local recurrence and done amputation.

Limitations

Larger sample size is recommended for more valuable results. Longer period of follow up is better for more accurate information about prosthesis survival. Limbs salvage surgeries especially tumor endoprosthesis became of great value for reconstruction after resection of tumor. Bone tumors around the knee are so challenging and the functional evaluation of those patients became of great interest due to the advances in chemotherapy treatment that improved patients' survival.

CONCLUSION

Limb salvage surgeries are complex surgeries which need multidisciplinary team work. Tumour endoprosthesis is the best option for limb reconstruction following tumour excision around the knee joint allowing early mobilization with low rate of infection and local recurrence. Early diagnosis and management offer better results. Distal femur tumour prosthesis shows better functional outcome than proximal tibia tumour prosthesis, this is mainly related to the requirement of patellar tendon repair and the need for good soft tissue coverage in the proximal tibia patients.

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Ethical approval: The study was approved by the Institutional Ethics Committee

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