Functional Outcome of Custom-Built Fixed Hinged Prosthesis for Tumors around the Knee.

Hizbullah Riaz Ansari[1], Araib Ghega[2], Majid Zaheer[3], Ashfaq Ahmed[4], Rizwan Akram[5], Atiq uz Zaman[6], Amer Aziz[7]

[1,2,3]Resident, Department of Orthopedic and Spine Ghurki Trust Teaching Hospital Lahore
[4]Senior Registrar Department of Orthopedic and Spine, Ghurki Trust Teaching Hospital Lahore
[5,6]Professor Department of Orthopedic and Spine Ghurki Trust Teaching Hospital Lahore
[7]Professor and Head of Department of Orthopedic and spine Ghurki Trust Teaching Hospital Lahore.

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Corresponding author:
Ashfaq Ahmed
E-mail: ashfaqjadoon40@yahoo.com

ABSTRACT

Objective: The determine the functional outcome of custom-built fixed hinged prosthesis for tumors around the knee.

Methods: This descriptive study was conducted in Department of Orthopedics & Spine Surgery Ghurki Trust Teaching Hospital Lahore from 3rd January 2015 to 3rd January 2021.All adults patients of either gender and age with tumours of distal femur,proximal tibia or both fulfilling the inclusion criteria were operated for custom-built fixed hinged prosthesis.Post operative functional outcome was determined using Musculoskeletal Tumor Society(MSTS) system and results were graded as excellent(75-100%), moderate (70-74%), Good (60-69%), Fair(50-59%) and Poor (<50%) outcome.Functional outcome was compared for type of tumor,gender and site of tumour and *P* value calculated with simple Pearson Chi-Square test.*P* value<0.05 was considered significant.

Results: A total of 34 patients were included in our study.The mean age was 30.65±14.23 years.Male patients were 23(67.6%) and female 11(32.4%). Osteosarcoma was present in 25(73.5%) patients,Giant cell tumour in 5(14.7%) and Ewing Sarcoma in 4(11.8%). Tumor involvement of the distal femur was present in 25(73.5%), proximal tibia in 7(20.6%) and both femur and tibia in 2(5.9%) patients. The mean Musculoskeletal Tumor Society(MSTS) score at 2.5 years was 73%(range 34% to 95%).Excellent functional outcome was noted in 22(64.7%), moderate in 2(5.9%),good in 7(20.6%), fair in 1(2.9%) and poor in 1(2.5%). No significant difference was noted when functional outcome was compared for gender,type of tumour,stage of tumor,location of tumor, side of tumor and type of stem fixation (*P*>0.05).

Conclusion: Custom-built fixed hinge prosthesis for tumors around the knee yielded excellent functional results in majority of our patients. We found custom build fixed hinged endoprosthetic reconstruction safe and effective technique for limb salvage in cases of distal femur and proximal tibia tumors.

Keywords: Ewing's sarcoma, Fixed hinged, Giant cell tumor,Mega Endoprosthesis, Musculoskeletal Tumor Society (MSTS) Score, Osteosarcoma.

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INTRODUCTION

Osteosarcoma is the commonest bone tumor and occurs around the knee joint in 70% cases while 30% of all other malignant tumours arise from distal femur and proximal tibia.[1]Historically these tumours were treated with amputations[2] but advancements in imaging,chemotheraphy,radiotherapy and prosthetic designs now enabled limb salvage surgery successful in majority of such cases.[3] After resection of the distal femur and proximal tibia the bone defect can be reconstructed with autograft,[4] allograft [5,6], custom

made megaprosthesis[7] and modular endoprosthesis.[8] Allograft reconstruction is associated with fracture, non union and infection [5,6] while custom made endoprosthesis are costly.[8,3] Modular knee prosthesis although widely used has been associated with higher complication rate and failure because of extensive bone and soft tissue resection causing longer operative time in patients of impaired general health due to chemotheraphy.[9,10] Studies have reported survival rate of 66% for fixed hinged prosthesis and 77% to 100% survival rate of rotating hinged prosthesis using different megaprostgesis designs.[11,12] Although rotating hinge designs have been shown to decrease mechanical stress at the bone prosthesis interface,hinged prosthesis are still indicated for elderly low demand patients and in patients with extensive extensor mechanism resection.[13] The first fixed hinged knee megaprosthesis(Kotz Modular Femur-Tibia Reconstruction systm-KMFTR®,Stryker,UK)[14] was introduced in 1982 but one can only find retrospective studies relating to the survival of megaprosthesis [8,14-16] and no summary results or systematic review is avaialable due to small number of study patients and different designs of megaprosthesis.[13] Custom built locally made low price hinged prosthesis have been used in India with good results.[17]

The objective of our study was to assess the functional outcome of custom-built fixed hinged implant for tumors around the knee.

METHODS

This descriptive study was conducted in Department of Orthopedics & Spine Surgery Ghurki Trust Teaching Hospital Lahore from 3rd January 2015 to 3rd January 2021.All adults patients of either gender and age with primary bone tumours (Osteosarcoma, Ewing Sarcoma and Giant cell tumour) of distal femur and proximal tibia or both were included in our study. Patients with popliteal or femoral vessel involvement and those treated in other centres were excluded from our study.The study was approved by the Ethical Committee of our hospital and informed written consent was taken from every patient.In the included subjects complete history,physical examination and investigations(radiographs,MRI,CT scan,bone scan,CT chest) were obtained.The tumour was histologically confirmed and graded after incision biopsy.Giant cell tumour was staged according to Enneking system[18] on radiographs as latent(boarders of the tumor well demarcated), active (boarders indistinct) and aggressive (boraders indistinct). Malignant tumors were staged as per Enneking system[18,19] and included grade (G,G1,G2), extent of the tumour locally (T1,T2,T3) and whether metastasis or not (M0,M1). Adminstration of adjuvants were done by oncologist and radiotherapist according to the tumor type as per international protocols. The resection was done as per standard protocol and principles of oncological resection[19] to ensure tumour free margins. Pre operative radiographs and CT scans were used for determining the length of resection.A locally made single design custom build metallic cemented or cementless hinged megaprosthesis (®AAA) was used in all cases.Medial or lateral parapatellar incision was used depending upon the tumor location and incorporating the biopsy incision.Proximal tibial tumours were resected alongwith extensor mechanism insertion.The extensor mechanism was reconstructed as per Malawer and Sugarbaker trchnique.[20] The patella was not resurfaced. Intravenious Cefuroxime 1.5 gram was given as prophylaxis and continued forv seven days after surgery. After excising the tumour the quadriceps defects were classified according to Capanna et al[21,22] classication into type A(Vastus Intermedius excision), type B (Vastus Intermedius,Vastus Medialis or Vastus Lateralis excision), type C (only Rectus Femoris was spared) and type D (whole Quadriceps muscle excision). Type C and type D defects were not reconstructed.

Patients with distal femoral resection were advised post operative knee flexion and extension exercises on first poat operative day and patients were mobilized with crutches or zimmer frame.Patients with proximal tibia resection and extensor mechanism reconstruction were immobilized in long limb slab for three weeks followed by range of motion exercises.Follow up visits were scheduld monthly for first three months then every three months for two years, every six months for the next two years and then yearly.

Functional assessment was done with the help of Musculoskeletal Tumor Society(MSTS) system[23] and included 6 variables of assessment namely pain,limitation of function, walking distance,use of a cane, crutches or zimmer frame while walking,emotional acceptance and gait analysis.Each variable can have 5 points (Excellent), 4 points (Moderate), 3 points (Good), 2 points (Fair) 0r 1 point (Poor). All the points were added and the final MSTS functional score was represented as percentage and rated as excellent (75-100%), moderate (70-74%), Good (60-69%), Fair (50-59%) and Poor (<50%). Post operative complications were

documented as per Henderson *et al* classification[24] as type 1 (Soft Tissues), type 2 (Asceptic Loosening), type 3 (Prosthesis Failure), type 4 (Infection) and type 5 (Tumor recurrence or progression)

All the data were entered and analyzed with the help of SPSS software version 22. Frequency and percentages were calculated for categorical variables like gender while mean and standard deviation was calculated for quantative variables like age.Functional results were compared for type of tumor,gender and site and *P* value was calculated with simple Pearson Chi-Square test.*P* value<0.05 was considered significant.

RESULTS

We included 34 patients in our study.The mean age was 30.65±14.23 years.Male patients were 23(67.6%) and female 11(32.4%). Osteosarcoma was present in 25(73.5%) patients,Giant cell tumour in 5(14.7%) and Ewing Sarcoma in 4(11.8%). Tumor involvement of the distal femur was present in 25(73.5%), proximal tibia in 7(20.6%) and both femur and tibia in 2(5.9%) patients.Right side was involved in 21(61.7%) patients and left in 13(38.2%). As per Eneking classification the type of tumor was IAG1 in 3(8.8%) patients,IBG1 in 1(2.9%),IIAG2 in 16(47%) and IIBG2 in 9(26.4%) patients. The mean length of resection bone was 11.4cm(range 6.3cm to 15.5cm).Cements were used for stems in 19(55.8%) patients while 15(44.1%) patients had cemented stem fixations. Majority(73.5%,n=25) of our patients had received neo adjuvant chemotherapy while 9(26.4%) patients had not received chemotherapy. Quadricps defects were of type A in 2(5.8%) patients,type B in 4(11.7%) and type C in in 3(8.8%) patients. The mean follow up duration was 2.5 years(range 2 to 5 years). The mean Musculoskeletal Tumor Society(MSTS) score at 2.5 years was 73%(range 34% to 95%)..Excellent functional outcome was noted in 22(64.7%), moderate in 2(5.9%),good in 7(20.6%), fair in 1(2.9%) and poor in 1(2.5%). No significant difference was noted when functional outcome was compared for gender,type of tumour,location of tumor,stage of tumor, side of tumor and type of stem fixation (P>0.05).The overall complication rate was 23.5%(n=8).Type 1 complication was noted in 1(2.9%),type 2 in 3(8.8%%),type 4 in 2(5.8%) and type 5 in 2(5.8%).Type 3(prosthesis failure) was noted documented in our study. All patients of Type 2 complication had cementless stems.One patient of type type 4 complication had cemented stem while the other had cementless stem.All patients of type 5 complication were Osteosarcoma of distal femur and had cementless stem fixation. Revision surgery was done in 7(20.6%) patients.No mortality was noted in our series.

DISCUSSION

In our study we treated 34 patients with custom-built fixed hinged prosthesis for tumors around the knee.(Fig.I & II) The mean post operative Musculoskeletal Tumor Society(MSTS) score at 2.5 years was 73%%(range 34% to 95%).Excellent functional outcome was noted in 22(64.7%), moderate in 2(5.9%),good in 7(20.6%), fair in 1(2.9%) and poor in 1(2.5%).In literature the mean MSTS score of patients with prosthesis for distal femur malignancy ranges from 78% to 86% while in patients with prosthesis for proximal tibia malignancy the MSTS was 65% to 90%.[25-28] Ahlmann[8] treated 211 patients of tumour around the knee with endoprosthesis.The mean age was 50 and mean follow up duration was 37.3 months.The mean MSTS score was 22.25%(range 14% to 30%) in jis series.No significant difference was noted in MSTS for distal femur or proximal tibial resection and reconstruction.(P>0.05).Implant survival was 78% at 5 years.

Ruggieri[13] treated 126 patients with fixed hinge prosthesis KMFTR® design and 543 with HMRS® design.The overall mean MSTS score at 10 year follow up was 76%(Range 26% to 100%).For KMFTR®design the MSTS was 76% and for HMRS® design the MSTS score was 78%.These authors concluded that fixed hinged megaprosthesis provided stability in elderly patients with weak musculature,extensive resection and large quadriceps defects.The fixed hinged knee prosthesis must not be abandoned in favour of rotating hinged prosthesis because long term follow up studies on the latter were yet to be conducted. Pala and Trovaelli[29] compared 491 fixed hinged knee prosthesis with 196 rotating hinged prosthesis in their retrospective study.Although functional results were better in rotating hinged prosthesis no significant difference in the implant survival was noted at 20 years follow up. Mavrogenis[27] treated 30 patients with fixed hinged(KMFTR1),135 with modular(HMRS1) and 60 patients with rotating hinged(GMRS1).The overall mean MSTS score was 77% while for KMFTR1 the MSTS score wass 75%, for HMRS1 77% and for GMRS1 88%.Rotating hinge prosthesis had significantly better functional outcome than others in Mavrogenis series.Al-Zaben[30] treated 28 patients with

tumors around the knee with custom made endoprosthesis and documented MSTS score of 60% at 30 month follow up. Al-Zaben recommended custom built endoprosthesis as the implant of choice for malignant tumours around the knee. Mattei *et al*[31] Treated 136 patients with mean age 41.2 years with cemented fixed hinged endoprosthesis and at mean follow up period of 81 months the mean MSTS was 82%(range 55% to 100%) and five year implant survival was 78%.

The overall complication rate in our study was 23.5%(n=8).Type 1 complication was noted in 1(2.9%),type 2 in 3(8.8%%), type 4 in 2(5.8%) and type 5 in 2(5.8%). Endoprosthesis failure rate in the literature varies from 25% to 92%.[10,11,32-35] This variation is due to different classifications and definitions of implant failure.We used Henderson *et al*[24] classification for documenting complications in our series. The most common mode of prosthesis filure is infection and reported in 5% to 40% in literature [26,34-36] while in our study the infection rate was 5.8%.

Our study had few limitations.Our sample size was small and follow up was short.We recommend comparative trials of larger sample size and longer duration to confirm our results.

Fig. I: Locally made custom-built fixed hinged knee prosthesis

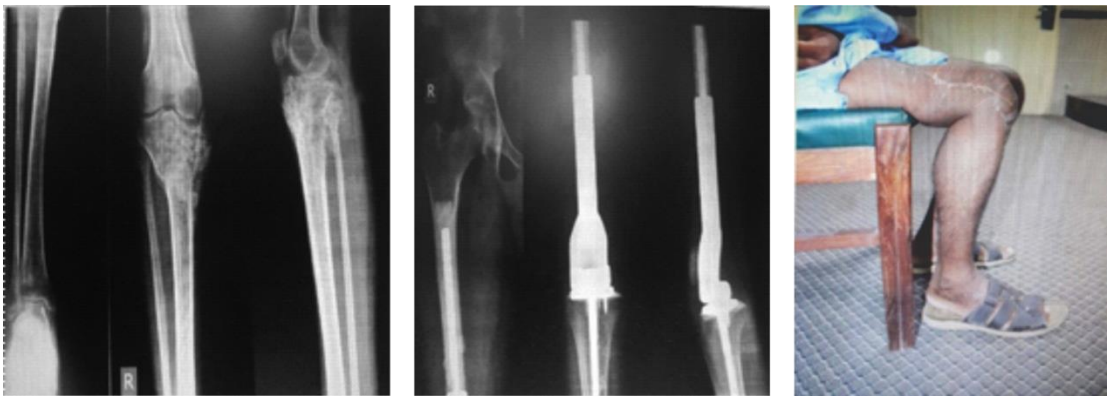

Fig. II: Pre operative xrays,post operative xray and clinical picture of right Osteosarcoma tibia treated with Locally made custom-built fixed hinged knee prosthesis.

CONCLUSION

Custom-built fixed hinge prosthesis for tumors around the knee yielded excellent functional results in majority of our patients. We found custom build fixed hinged endoprosthetic reconstruction safe and effective method for limb salvage in cases of distal femur and proximal tibia tumors.

Conflict of Interest: None
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