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Original Research Article

Outcome of modular megaprosthesis in management of Campanacci stage III giant cell tumor around the knee: a prospective study

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ABSTRACT

Background: Juxta articular giant cell tumors around the knee constitute 50-60% of the total cases reported. If the disease is detected at an advanced stage, reconstruction of the joint after tumor excision poses problems and has poor functional outcome. The aim of the study was to determine the functional outcome after resection of juxta-articular giant cell tumors around the knee and its reconstruction with mega prosthetic arthroplasty will be analyzed.
Methods: Between January 2017 and March 2021, 14 patients in the age group of 28-48 years (mean=42.85 years) with Campanacci stage three giant cell tumors around the knee were studied (12-distal femur patients, 2-proximal tibia). Patients underwent tumor excision and reconstruction with modular megaprosthesis. They were evaluated post-operatively using the Revised Musculoskeletal Tumor Society Score (MSTS) for lower limb.
Results: All the patients were followed up for 12-44 months (mean=29.5 months), the average knee flexion at 6 months being 116.4 degrees. The mean MSTS at 6, 12, 18 and 24 months are 19.45, 23.23, 26.61 and 28.77 respectively. Complications observed were infection and tumor recurrence.
Conclusions: In advanced cases where tumor excision leaves large bone segment loss, reconstruction with megaprosthesis can give desirable functional outcome.

Keywords: Giant cell tumor, Megaprosthesis, Campanacci, Limb salvage

INTRODUCTION

Giant cell tumor (GCT) is a benign but locally aggressive neoplasm that constitutes around five percent of all bone tumors.[1] Treatment of this tumor remains a challenging problem because of the lack of any definite clinical, radiological or histological parameters that can predict the progression of the disease.[2]

GCT usually involves the ends of long bones of a skeletally mature individual with seventy percent cases being juxta-articular around the knee.[3] Even though GCT follows mostly a benign course, it is notorious for local recurrence with a range of ten to fifty percent incidence in various studies. Malignant transformation is reported in only ten percent of total cases.[4] The primary aim in the management of locally aggressive giant cell tumor is to eradicate it while providing the patient with a stable and functional joint.[2] Enneking's and Campanacci's radiographic classifications are helpful in planning the initial surgical treatment. Those tumors with more active and aggressive lesions have a high rate of recurrence (20-50%) when treated with curettage with reconstruction of cavity with bone graft or cement.[5,6] To reduce recurrence rate, wide local excision is done for these tumors. The reconstructive procedure to bridge the bone gaps depends on- the durability of the procedure, the oncological prognosis, restoration of anatomy and functional needs of the patient.[7] Reconstruction methods include osteoarticular allografts, allograft prosthetic composites

and segmental endoprosthesis replacement.[8,9] Rotationplasty gives excellent functional results but it is not cosmetically acceptable to many.[10] Resection arthrodesis achieves excellent stability but renders the joint rigid and immobile. It hinders squatting and sitting cross legged, which is not acceptable in the Indian population.[11]

Custom megaprosthesis has proved to be an effective method of replacing lost segment of bone in benign aggressive lesions with or without pathological fractures. It is performed in cases where the disease has progressed to an extent which precludes skeletal reconstruction after intralesional curettage.[12] In this study, 14 patients- 12 with distal femur and 2 with proximal tibia Campanacci stage III GCT were treated with wide local excision and reconstruction with megaprosthesis. The aim of the study was to assess the functional outcome and complications encountered in these patients.

METHODS

The study was conducted in a tertiary care centre in eastern India. Prior to the conduct of study IRB approval was taken. The study population constituted of patients presenting to the out-patient department with swelling around the knee. Each patient was evaluated clinically, radiologically and those with final biopsy proven GCT were included in the study. The study period was from January 2017 to March 2021. All the patients included in the study were diagnosed with Campanacci stage III GCT around the knee. They were above 18 years of age and gave informed consent for the surgical procedure. The patients excluded were those unfit (American society of anaesthesiologists score>5) or not willing for surgery and patients with less than 6 months of follow up after surgery.

After clinical examination and radiological survey, patients were subjected to histopathological examination. The patient and family members were counselled regarding the surgical plan, the prognosis and the alternative options available based on their functional demand and socioeconomic status. After staging, biopsy was taken by the surgeons who would be conducting the definitive surgery. They were all competent in their field with more than seven years of experience. Patients' demographic details, socioeconomic status, side and site of the tumor and stage were documented. The patients underwent extensive pre-operative anaesthetic check-up.

The patients included in this study underwent surgery of giant cell tumor around the knee with modular fixed hinge cemented megaprosthesis. The Restor®- Resection of tumor and optimal reconstruction- manufactured in Pune, India was used in all the patients (Figure 1). Restor® is a modular system with components that can be selected either pre-operatively or intra-operatively. These implants consist of cast cobalt-chromium-molybdenum alloy (ISO 5832-4), wrought titanium-aluminium-vanadium alloy Ti6 Al4 V ELI (ISO 5832-3), stainless steel AISI 316L, Hi nitrogen stainless steel (ISO 5832-9) or Stainless Steel 316 LVM (ISO 5832-1). Polyethylene components are made of UHMWPE (ISO 5834-2). It consists of an intramedullary stem with hydroxyapatite coated collar that helps enhance extra cortical bone bridging. Separate left and right sided femoral components are there with anatomical valgus angulation that helps in recreating normal anatomy. Built-in hyperextension for femoro-tibial articulating components prevents buckling and allows passive locking during the gait cycle. It also has modular components which enhance intra-operative flexibility for size selection, polyethylene wedge on the tibial component for cushioning the impact on terminal extension and polyethylene bushings to prevent metal on metal articulation. This eventually reduces metallic debris decreasing the chances of aseptic loosening. It has options for cemented stem for both femoral and tibial components. After tumor resection the gap in the bone created is bridged by the added part of the prosthesis (range of femoral and tibial component is from 80 mm to 320 mm). The measurements obtained from radiological studies such as full-length X-rays (Ortho-scannogram), CT scans and full-length MRI were used to estimate the size of prosthesis required. All patients included in the present study were eligible for funding by the government.

The surgeries were conducted using standard operating technique. The patients were operated in supine position under general or combined spinal epidural anaesthesia. Pneumatic tourniquet was used at the discretion of the surgeon depending on the extent of the tumor and planned margin of resection. It was generally used in the initial stages of the surgery to aid dissection. The extended medial parapatellar approach with the incision encircling the biopsy scar was used in all cases. This approach was preferred as it aided in vascular dissection and separation of popliteal vessels (Figure 2A) during dissection of the tumor. The sleeve resection technique of quadriceps musculature was used for distal femur – to avoid damage of the rectus femoris muscle (Figure 2B). This provides sufficient soft tissue cover while retaining extension muscle power. Adequate tumor resection with a wide margin (>3 cm) of tumor free zone was done to decrease incidence of local recurrence as guided by pre-operative MRI. Before resection of the tumor specimen, anterior surface was marked so that during prosthesis implantation internal rotation of the limb can be avoided. The reciprocal bone of the joint i.e.; femur in case of tibial lesions and vice versa, was resected 3 cm beyond the MRI indicated tumor margin or till the smallest size of the component available, whichever is larger. The specimen was sent for HPE to evaluate the margins for microscopic evidence of the disease (Figure 2C). Femur and tibia were reamed up to the maximum possible size, trial was given to ensure knee joint would be at the same level as that of the other knee before final cemented prosthesis insertion (Figure 2D). For proximal tibia lesions, the medial gastrocnemius rotation flap was done. Before initiation of

closure, ROM was checked on table. Wound was closed in layers after obtaining meticulous haemostasis and 16 number suction drain was used. The pathologist documented the gross dimensions of the tumor lesion in the resected specimen.

Patients who had fixed flexion deformity pre-operatively were kept in knee flexion post operatively and gradually extended. Quadriceps strengthening exercises were started from the 2nd post-operative day. Patients were allowed to walk with the help of an assistance device and knee bending was allowed as tolerated one to two weeks after surgery. Patients were followed up every 15 days for the first six months for any complications and to assess compliance to physiotherapy. Serial radiographs were obtained every six months thereafter. At six months, patients range of motion of knee was measured with a goniometer. Functional assessment was done at every visit using Revised MSTS score for the lower limb (Figure 3). Statistical analysis was done using SPSS software (IBM version-20) and descriptive statistics was used.

RESULTS

During the study period, 30 patients presented with juxta-articular giant cell tumor around the knee, out of which 14 patients were included in the study group after applying exclusion criteria. The age of patients ranged from 28 to 48 with a mean age being 42.85 years (SD=5.37). There was a male preponderance in present study group with 12 patients being male and 2 being female. Two cases has proximal tibia tumor while the other twelve were cases of distal femur GCT. In five cases right side was affected, whereas the other seven had left sided lesions. ASA scoring was done to during the pre-anaesthetic check-up. The mean score was 2.57 (SD=0.93). Five patients had pathological fracture with intra-articular extension on presentation. The resected specimen was sent for HPE analysis and all patients were confirmed to have tumor free margins. The largest dimension of the tumors was found to be in a range of 8-17 cm, average being 12.07 cm with a standard deviation of 2.75. The patients were advised to initiate knee bending exercises as tolerated from the second post-operative day and assisted partial weight bearing after stitch removal in those without infection. The time from surgery to unassisted weight bearing varied between 4 to 8 weeks (mean=5.07 weeks, SD=1.439).

The average follow-up was for 29.5 months (12-44 months, SD=9.78). At six months, patients knee ROM was measured with goniometer with an average of 116.4 degrees (SD=11.67). Seven patients also had extension lag on examination, which was measured to be less than 10 degrees. Two patients who had undergone surgery due to a proximal tibia lesion had 15 and 20 degrees of extension lag. At 12 and 18 months after surgery patient's global functional status was assessed using revised MSTS Score for lower limb. It includes six criteria - pain, function, emotional aspect, supports, walking ability and gait. Each item was scored from 0-5 with a maximum possible score of 30. The revised MSTS score for lower limb was used to assess functional status biannually for 2 years and tabulated in Table 1. This was compared to the baseline pre-operative MSTS score of mean 8.07 (SD=2.2). The mean MSTS at 6, 12, 18 and 24 months are 19.45 (SD=1.34), 23.23 (SD=2.46), 26.61 (SD=2.32) and 28.77 (SD=1.09) respectively.

Three patients were found to have wound infection. They were managed with antibiotics as per the culture sensitivity and wound status. Acute phase reactants such as C-reactive peptide and ESR values were also monitored. Two of these three patients did not respond to antibiotics and required debridement and VAC therapy. In one case, the infection subsided and the wound was closed with split thickness skin grafting. The other case developed extensive flap necrosis (Figure 4), which warranted repeated interventions and prolonged hospital stay resulting in clinical depression. After diligent counselling of the patient and his family members, above knee amputation was performed at 13 months after the primary surgery. One case which had undergone the surgery for a proximal tibia lesion, complained of swelling and pain over the incision site at 2.5 years of follow up. She underwent radiographic and HPE evaluation and was found to have local recurrence. After counselling, she underwent revision surgery with wide excision and knee arthrodesis. No case of periprosthetic fracture, aseptic loosening, metastasis or death was reported.

Table 1: Functional assessment by MSTS score during the follow-up period.

Period of observation	No. of patients eligible	MSTS score					Mean	SD	Range	Increase from pre-op period	Percentage increase from 6 months post-surgery (%)
		<15	15-19	20-24	25-29	>29					
Pre-op	14	14	-	-	-	-	8.07	2.20	5-13	-	-
6 months	14	-	7	7	-	-	19.45	1.34	17-22	x2.41	-
12 months	14	-	1	7	6	-	23.23	2.46	19-27	x2.88	19.4
18 months	13	-	-	3	7	3	26.61	2.32	23-30	x3.30	36.81
24 months	9	-	-	-	4	5	28.77	1.09	27-30	x3.60	47.91

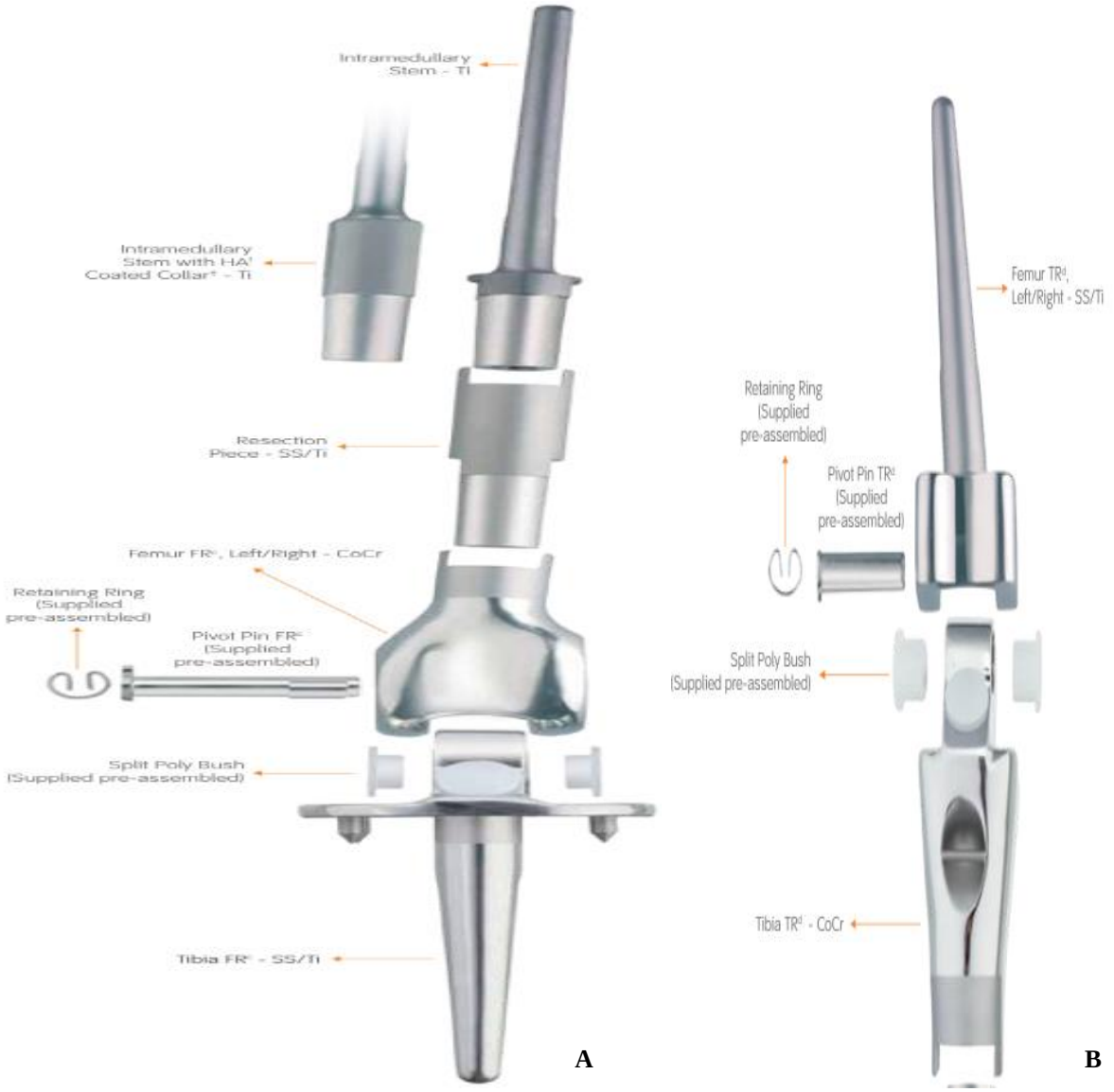

Figure 1: Prosthesis used for (A) distal femur; and (B) and tibia.

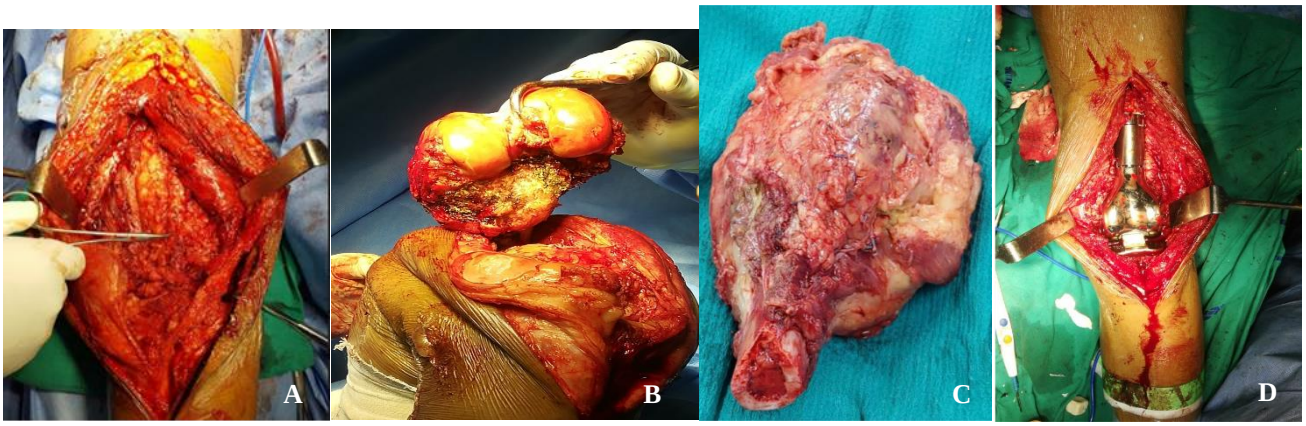

Figure 2: Intra-operative Images (A) popliteal vessels visualised after tumor dissection; (b) tumor with soft tissue envelope dissected out; (c) specimen with tumor free margin sent for pathological examination; and (d) trial of prosthesis given before final implanatation with cemented prosthesis.

Figure 3: Post-operative radiograph (A) range of motion; (B) assessed at each follow up.

Figure 4: Flap necrosis.

DISCUSSION

Management of GCT has always been a debate among those treating them despite its benign nature, due to its local invasiveness, which leads to detectable and often undetectable satellite lesions. If the joint cannot be retained, then the reconstruction will necessitate a total knee replacement.[13] GCT typically occurs in adults aged 20-40 years with a slight female preponderance, however the mean age in this study was found to be 42.8 years.[14] In the current study, more patients were male. Majority of the cases included in the study group were referred from elsewhere and in whom other treatment modalities could not be attempted. The delay in presentation lead to the older mean age in the study. Five of the patients had pathological fracture and eight had knee flexion contracture at presentation as they presented late in the disease process. Reconstruction of proximal tibia poses a surgical challenge, due to the close proximity of the tumour to major neurovascular bundles and inadequate soft tissue coverage. The medial gastrocnemius rotation flap technique provides soft tissue cover for the implant and maintains the continuity of the extensor mechanism.[9] Gkavardina et al concluded that proximal tibia replacements have poor outcomes as an effect of the attachment of the patellar tendon to the endoprosthesis.[15]

Endoprosthesis reconstruction enables immediate weight bearing, maintenance of joint mobility, shorter rehabilitation time and early return to activities of daily living. Functional outcomes were generally good to excellent with acceptable range of motion. In this study, the median knee flexion was 116.4 degrees at 6 months post-surgery and that reported by Choong et al was 110°.[16]

Amongst the treatment modalities available at an advanced stage of the tumor, limb salvage with endoprosthetic reconstruction gives a better functional status and quality of life after surgery than that which the patient would experience with an external prosthetic device after amputation or with joint arthrodesis. In this study the MSTS score in the follow up period was compared to the baseline pre-operative MSTS score. The study reported 2.41 and 3.6 times increase of the MSTS Score at one- and two-years post-surgery respectively. Wirganowicz et al classified complications faced after surgery as mechanical and non-mechanical. The mechanical complications have become less predominant in the current practice due to better techniques and implant designs. Prosthetic failures are reported when the amount of bone resected exceeds more than forty percent of the total length of the bone. There was no such incidence in the current study. The non-mechanical complaints continue to be a major detrimental factor in the final outcome.[17]

Infection occurred in 3 out of 14 patients in the present study (21.4%). The infection rate in the literature varies from 3.7% to 19.9% and usually occurs in the first two years after primary surgery.[18] The duration of surgery and the extensive exposure were considered to be the most important risk factors for surgical site infection.[19] In early cases without frank pus around the implant, Gundavda et al concluded that debridement and insertion of cement beads would lead to adequate infection control.[20] Surgical site infection often leads to secondary amputation in patients unwilling for multiple surgeries. Miwa et al evaluated the use of iodine coated prosthesis and concluded that though promising further studies are required to evaluate its efficacy.[21] Hardes et al reported that when silver coated prosthesis was used, there was an apparent reduction in the infection rate.[22] The limb survival rate in the present study was 92.87% and the implant survival rate was 85.7% at the end of the study period. The 5 years survival rate of implants reported in the literature ranges between 60%-84%, and 5 years limb survival ranging between 89%-92%.[17]

The limitations of the study were a small study group with a relatively short follow up period. The complications such as aseptic loosening, implant failure, periprosthetic

fractures, etc present after a longer duration and hence cannot be commented upon. There was also no control group to compare the efficacy of megaprosthesis with other treatment modalities in this group.

CONCLUSION

Juxta-articular GCT of the knee joint are treated with the aim to achieve a balance between adequate tumor resection and preserving knee function. In cases where the knee joint reconstruction was deemed impossible after removal of tumor, en bloc resection and reconstruction with modular megaprosthesis was used as an effective means for reconstruction with good oncological and functional outcome.

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REFERENCES

1. Donald DJ, Sim FH, McLeod RA, Dahlin DC. Giant-cell tumor of bone. J Bone Joint Surg Am. 1986;68(2):235-42.
2. Eckardt JJ, Grogan TJ. Giant cell tumor of bone. Clin Orthop Relat Res. 1986;(204):45-58.
3. Ghert MA, Rizzo M, Harrelson JM, Scully SP. Giant-cell tumor of the appendicular skeleton. Clin Orthop Relat Res. 2002;(400):201-10.
4. Grath PJ. Giant-cell tumour of bone: an analysis of fifty-two cases. J Bone Joint Surg Br. 1972;54(2):216-29.
5. Pawar ED, Mangukiya H, Mahajan NP, Singh AK, Ramteke U. A case report of resection arthroplasty for Giant cell tumor of distal femur with megaprosthesis. Int J Orthopaed Sci. 2016;2:463-7.
6. Campanacci M, Baldini N, Boriani S, Sudanese A. Giant-cell tumor of bone. J Bone Joint Surg Am. 1987;69(1):106-14.
7. Natarajan MV, Annamalai K, Williams S, Selvaraj R, Rajagopal TS. Limb salvage in distal tibial osteosarcoma using a custom mega prosthesis. Int Orthop. 2000;24(5):282-4.
8. Torbert JT, Fox EJ, Hosalkar HS, Ogilvie CM, Lackman RD. Endoprosthetic reconstructions: results of long-term followup of 139 patients. Clin Orthop Relat Res. 2005;438:51-9.
9. Sharil A, Nawaz A, Nor AM, Zulmi W, Faisham W. Early Functional Outcome of Resection and Endoprosthesis Replacement for Primary Tumor around the Knee. Malays Orthop J. 2013;7(1):30-5.
10. Wolf F, Kotz R, Knahr K, Kristen H, Ritschl P, Salzer M. Rotationplasty for limb salvage in the treatment of malignant tumors at the knee. A follow-up study of seventy patients. J Bone Joint Surg Am. 1991;73(9):1365-75.
11. Benevenia J, Makley JT, Locke M, Gentili A, Heiner J. Resection arthrodesis of the knee for tumor: large intercalary allograft and long intramedullary nail technique. Semin Arthroplasty. 1994;5(2):76-84.
12. Malo M, Davis AM, Wunder J, Masri BA, Bell RS, Isler MH, Turcotte RE. Functional evaluation in distal femoral endoprosthetic replacement for bone sarcoma. Clin Orthop Relat Res. 2001;389:173-80.
13. Biau D, Faure F, Katsahian S, Jeanrot C, Tomeno B, Anract P. Survival of total knee replacement with a megaprosthesis after bone tumor resection. J Bone Joint Surg Am. 2006;88(6):1285-93.
14. Azar F, Canale ST, Beaty J. Benign/Aggressive tumors of bone. Campbell's Operative Orthopaedics. 14th ed. Netherland: Elsevier; 2021: 986.
15. Gkavardina A, Tsagozis P. The use of megaprostheses for reconstruction of large skeletal defects in the extremities: a critical review. Open Orthop J. 2014;8:384-9.
16. Choong PF, Sim FH, Pritchard DJ, Rock MG, Chao EY. Megaprostheses after resection of distal femoral tumors. A rotating hinge design in 30 patients followed for 2-7 years. Acta Orthop Scand. 1996;67(4):345-51.
17. Wirganowicz PZ, Eckardt JJ, Dorey FJ, Eilber FR, Kabo JM. Etiology and results of tumor endoprosthesis revision surgery in 64 patients. Clin Orthop Relat Res. 1999;358:64-74.
18. Trovarelli G, Angelini A, Pala E, Cappellari A, Breda A, Ruggieri P. Infection in orthopaedic oncology: crucial problem in modern reconstructive techniques. Eur Rev Med Pharmacol Sci. 2019;23(2):271-8.
19. Grimer RJ, Carter SR, Sneath RS. Endoprosthetic replacements of the proximal tibia. In: Langlais F, Tomeno B, eds. Limb Salvage: Major reconstructions in oncologic and non-tumoral conditions. New York, NY: Springer; 1989: 285-292.
20. Gundavda MK, Katariya A, Reddy R, Agarwal MG. Fighting Megaprosthetic Infections: What are the Chances of Winning? Indian J Orthop. 2020;54(4):469-76.
21. Gundavda MK, Katariya A, Reddy R, Agarwal MG. Fighting Megaprosthetic Infections: What are the Chances of Winning? Indian J Orthop. 2020;54(4):469-76.
22. Hardes J, Henrichs MP, Hauschild G, Nottrott M, Guder W, Streitbuerger A. Silver-Coated Megaprosthesis of the Proximal Tibia in Patients With Sarcoma. J Arthroplasty. 2017;32(7):2208-13.

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