International Journal of Research in Orthopaedics
Swamy GG et al. Int J Res Orthop. 2024 Mar;10(2):358-363
http://www.ijoro.org

Original Research Article

DOI: https://dx.doi.org/10.18203/issn.2455-4510.IntJResOrthop20240419

Limb salvage surgery for primary bone tumors: retrospective study in a tertiary care centre

Gopu Govindha Swamy, Senthil Kumar Krishnan*

Department of Surgical Oncology, Rajiv Gandhi Government General Hospital, Madras Medical College. Chennai, Tamil Nadu, India

Received: 07 January 2024
Revised: 13 February 2024
Accepted: 16 February 2024

***Correspondence:**
Dr. Senthil Kumar Krishnan,
E-mail: drksksurgeon@gmail.com

ABSTRACT

Background: Limb salvage surgery is the standard of care for patients with primary bone tumors. The study retrospectively analyses a single center experience of use of endo-prosthesis for limb conservation in cases of primary bone tumors over a five-year period (2015-2020).
Methods: Total of 34 histologically proven primary bone tumor were retrospectively studied which included 25 males and 9 females who received limb salvage surgery for bone tumors at department of surgical oncology, Rajiv Gandhi Government general hospital, Madras medical college, Chennai.
Results: Median age at diagnosis was 23 years. Tumor localized to lower limb in 23 patients, and upper limb in 9 patients, pelvic bones in 3 cases. Tumors were malignant in 24 patients (70.4%) and benign in 10 patients (29.4%). The most common diagnosis was osteosarcoma17 patients (50%). The median resection length was 10 cm. High grade tumors (grade 2a and 2b and grade 3) was found in 14 cases (41.1%). 6 patients had prosthesis related complications. The mean follow-up was 5 years (range: 3-7). 27 (79.4%) patients of 34 were alive with the endo-prosthesis at the last follow-up.
Conclusions: The custom mega prosthesis favored by us in most of the cases in limb sparing surgery for bone tumors results in satisfactory results in terms of local tumor control and limb function.

Keywords: Primary bone tumors, Limb salvage surgery, Custom mega prosthesis

INTRODUCTION

Limb salvage surgery (LSS) provides greater psychological benefits to patients and preserves limb function to a greater extent than amputation. Limb salvage surgery consists of: resecting the tumor with oncologically acceptable negative resection margins, performing skeletal reconstruction of the resultant defect with a metal endoprosthesis or a biological substitute to restore function and cosmesis and, performing soft tissue coverage for the used endoprosthesis, Rotation plasty; a reconstructive ,limb sparing option for management of lower limb tumors which involves resection of the involved segment followed by 180* rotation of the limb to allow the ankle to function as knee joint . A lack of feasibility for any of these steps indicate that the limb salvage is not possible and that amputation is more suitable. With the introduction of neoadjuvant chemotherapy, increased expertise in surgical oncology, and advanced skeletal imaging techniques limb salvage surgery is the standard care for patients with bone tumors which renders acceptable oncologic, functional and

cosmetic results. LSS has a similar complication profile local recurrence and survival rates, to that of amputation

Aim and objectives

Our aim was to assess the multiple outcomes of LSS in a total of 34 patients with primary bone tumors who were treated at department of surgical oncology, Madras medical college, Chennai. The custom mega prosthesis favored by us in most of the cases in limb sparing surgery for bone tumors results in satisfactory results in terms of local tumor control and limb function.

METHODS

Inclusion criteria

All patients with primary bone tumors who underwent limb salvage procedures utilizing custom mega prosthesis

Exclusion criteria

All patients with primary bone tumors in whom LSS not feasible (major neuro vascular bundle involvement, resection of the tumor not possible with adequate margin, adequate motor and soft tissue soft tissue reconstruction not feasible, all previous biopsy sites and all contaminated tissues cannot be removed enbloc and those patients who received primary amputation).

Procedure

Retrospective study of 34 patients who underwent LSS for primary bone tumors in a tertiary care centre (department of surgical oncology, Rajiv Gandhi Government general hospital, Madras Medical College, Chennai) for a period of 5 yr from 2015 to 2020. Standard Investigations done at our Centre for all the patients include: Plain X-ray of the part involved with adjacent joint, X-ray-chest, CT-scan of the local part, MRI-scan of the local part CT chest to rule out lung metastasis, angiography is done in few patients in whom the tumour is located close to the neurovascular structures Metastatic workup also includes Tc 99m bone scan, positron emission tomography-computed tomography (PET-CT). Core needle biopsies/J-Needle biopsies (under image guidance).

An open biopsy was performed in a few selected cases when core biopsies were inconclusive to achieve a definitive diagnosis. All bone biopsies were performed by a trained onco-surgeon and intervention radiologist and biopsy site is planned in such a way that it is included in definitive surgery incision. All Biopsy specimens were evaluated and reported by trained oncopathologist. Before consideration of limb salvage surgery, all the patients were appropriately staged and presented at a multidisciplinary tumor board and all patients with a proven histopathology of Osteosarcoma and Ewing's sarcoma were given neoadjuvant chemotherapy. At our institute, we prefer 3 cycles of IAP (Ifosfamide 1.3 gm/m2 Day 1-3, Adriamycin 25 mg/m2 Day 1-2, Cisplatin 100 mg/m2 D1-D2) as neoadjuvant for Osteosarcomas and 4 cycles of IE/VAC (alternating, Ifosfamide 2 gm/m2 Day 1-3, Etoposide 100 mg/m2 Day 1-3, Vincristine 1.4 mg/m2, Adriamycin 60 mg/m2, Cyclophosphamide 600 mg/m2) for Ewing's sarcoma. Response assessment to chemo therapy was done by Imaging modalities and compared with previous imaging findings. Results was analysed using SPSS software. The outcome of treatment in term of survival and failure were recorded. Functional outcome and major complication in the limb salvage group were documented. The actuarial survival of patients was estimated using Kaplan-Meier's non-parametric method

Limb salvage surgery and prosthesis for reconstruction

Wide excision of the affected bone with a normal muscle cuff three dimensionally in all directions is possible. All previous biopsy scar sites and all potentially contaminated tissues included in the resected specimen which is removed enbloc. The adjacent joint and joint capsule resected if necessary. The major neurovascular bundle is free of tumor. Adequate motor reconstruction can be accomplished by regional muscle transfers and soft tissue coverage to decrease the risk of skin flap necrosis and secondary infection.

Prosthesis used were custom mega prosthesis (CMP) for distal femur and proximal tibia and proximal humerus. Extra Cortical plate and screw fixation for arthrodesis done in few cases. All stems are cemented in place with bone cement.

Immeadiate post-op and post discharge follow-up

All patients were started with isometric exercise and ambulation started with crutches from POD 3, and patients who received neo adjuvant chemo therapy were given adjuvant chemotherapy depending upon response to NACT. After discharge all patients were followed up for every 3 monthly for first two years ,6 monthly for next next two years

and annually thereafter. On follow-up visits, a thorough clinical examination was carried along with digital X-ray of the part, digital X-ray of the chest and CT-scan of the chest done if X-ray is suspicious of metastatic lesion and PET-CT was reserved for suspected metastatic lesions.

RESULTS

Demographic

In our study total of 34 cases were studied which includes 72.73% (N=25) males and 27.27% (N=9) females as shown in (Figure 1). Median age at diagnosis of bone tumors is 23 years. Age group affected between 10-20 years 39.39%, 20-30 years is 30.30% ,30-40 years is 21.21% and 40-50 years is 9.09% as shown in (Figure 2).

Clinical presentation

Most commonly involved site are extremities. Upper limb involvement is noted in 9 cases (N=8 humerus, N=1 shoulder), Lower limb involvement 23 cases (N=13 femur, N=9 tibia; N=1 fibula), pelvic bones (N=3 ileum) cases. Benign giant call tumor of bone constituted about 29.4% (N=10) malignant tumors constituted about 70.4% (N=24). Most common malignant tumour was osteosarcoma 50% (N=17) followed by chondro-sarcoma 11.7% (N=4) and Ewing's sarcoma 8.8% (N=3) (Figure 3).

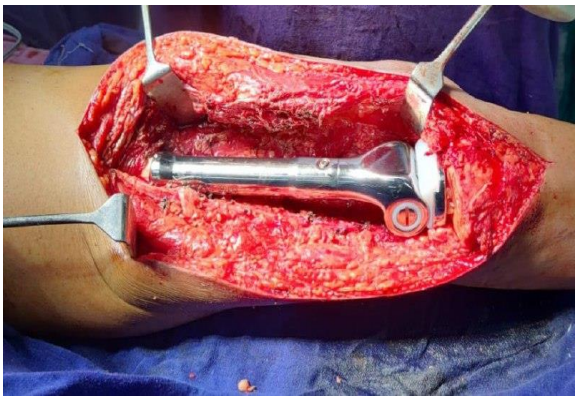

Figure 1: Limb salvage surgery showing prosthesis.

Figure 2: X-ray of left distal femur showing tumor.

Figure 3: CMP in situ.

Histopathological grading of tumor

High grade tumors malignant tumors grade 2a, 2b and grade 3 were found in 41.1% of cases (N=14). Histopathological grading of tumor types was in (Table 2).

Table 1: Demography.

Parameter	Median	Minimum	Maximum
Age	23	12	66

Table 2: Histopathological grading of tumor.

Parameters		Grades					
		1		2		3	
		N	%	N	%	N	%
Histo-pathology	Chondro-sarcoma	1	7.7	3	20.0	0	0.0
	Ewings sarcoma	1	7.7	2	13.3	0	0.0
	GCT	3	23.1	1	6.7	2	100
	OS	8	61.5	9	60.0	0	0.0

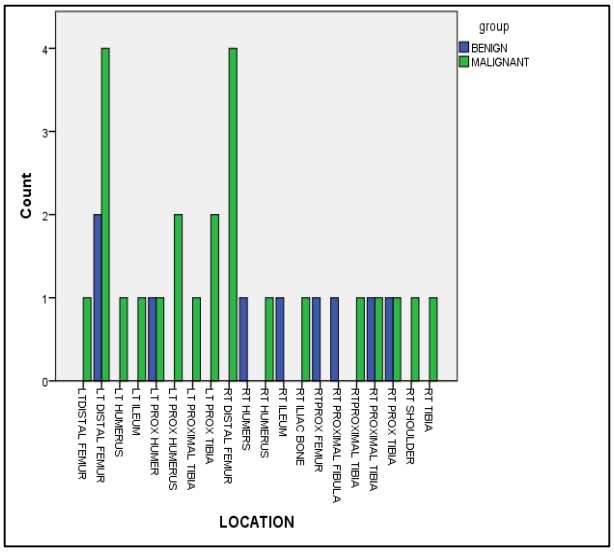

Figure 4: Location of bone tumors.

Complications in LSS

About 44.11% (N=15) encountered any one of the complications such as wound infection, loosening of prosthesis, peri prosthetic fracture, local recurrence and lung metastasis. Most of these complications were encountered in patients who received neo-adjuvant chemotherapy because of their altered immune power of the chemotherapeutic agents. Complications encountered and their management is given in (Figure 6).

Follow up

Mean follow up was 5 years (3-7 yrs). About 44% (N=15) had follow up for more than 5 years. Total number of patients who died during follow up period is 20.5% (N=7).

20.5% (N=7) of our patients during follow up developed lung metastasis among which one of the patients underwent VATS metastatectomy.

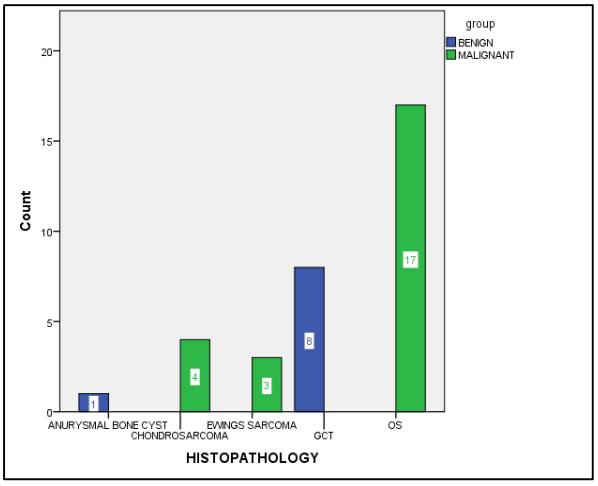

Figure 5: Histopathology.

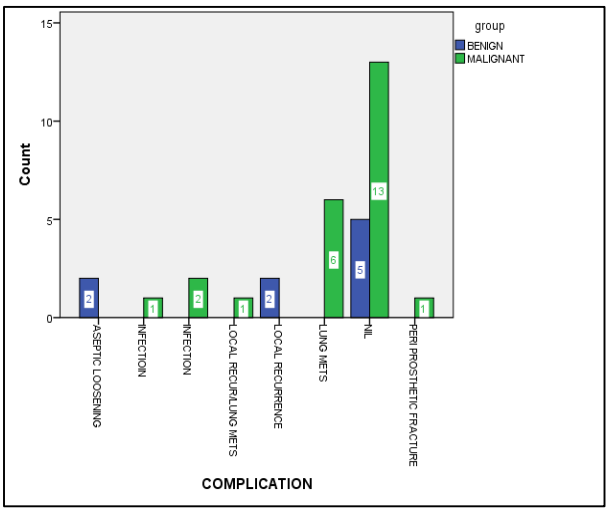

Figure 6: Complications.

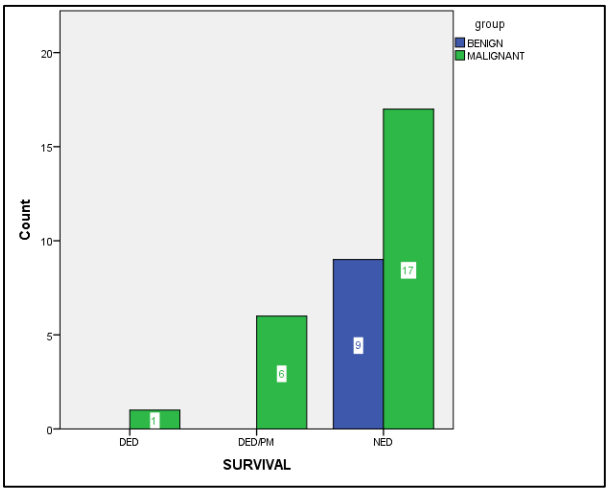

Figure 7: Survival rate.

Recurrence was encountered in giant cell tumor of bone (N=2) and one patient with chondrosarcoma developed local recurrence along with lung meatstasis. Patients who died due to tumor progression are as follows: 4 out of 17 patients with osteosarcoma (23.5%), 1 of 3 patients with Ewing sarcoma (33.3%), 2 of 4 (50%) patients with chondrosarcoma. 79.5% (N=27) patients were living with the prosthesis at our last follow up visit.

Table 3: Survival rate.

Parameters		Primary bone tumors	
		N	%
Survival	Dead	7	20.5
	Alive	27	79.5

DISCUSSION

Primary malignant bone tumors, though relatively rare, historically led to transbone amputations or disarticulations due to limited treatment options. Prior to the advent of neoadjuvant chemotherapy, survival rates lingered between 10% to 20%. However, advancements in chemotherapeutic agents and treatment protocols have notably elevated survival rates, permitting a shift in management focus toward limb preservation.[1-3] Osteosarcoma, the most prevalent malignant bone tumor, accounted for 42% of cases and 50% (N=17) according to our study and demonstrated a significant recurrence rate, often presenting as pulmonary metastases despite primary surgical resection 29.4% (N=5) according to our study.[4] This high recurrence suggests potential micro metastatic disease upon diagnosis. Neo adjuvant chemotherapy serves a dual purpose by shrinking tumors and addressing microscopic disease, optimizing subsequent surgical removal.[5,6] Additionally in few patients with pathological fracture in primary bone tumours which is a relative contra indication to LSS, use of neo adjuvant chemotherapy offers a better chance of limb salvage surgery.[7] Moreover, favorable responses to chemotherapy serve as prognostic indicators. Patients exhibiting robust histopathological responses (>95 % tumor cell kill or necrosis) to neoadjuvant chemotherapy typically exhibit better prognoses than non-responsive cases.[8] Consequently, neoadjuvant chemotherapy has become a standard in treating osteosarcoma and Ewing's sarcoma. In our study, among 24 cases of malignant tumors, 7 patients succumbed during follow-up, resulting in a cumulative 5-year survivorship of 38%. While comparable studies report survivorship between 28% to 76%, our series notably includes a relatively higher percentage of high-grade tumors and incorporates chondrosarcoma, which poses distinct challenges to effective chemotherapy regimens. Presently, 80% to 85% of patients with primary malignant bone tumors involving extremities (osteosarcoma, Ewing's sarcoma, and chondrosarcoma) can safely undergo wide resection and limb preservation, often with reconstruction.[9] Landmark studies, such as Simon et al.'s research, validate limb-salvage procedures' efficacy in high-grade osteosarcoma. Subsequent studies reinforce the

norm of limb preservation in bone tumor management.[10-14] Limb salvage procedures commonly divide into arthrodesis or arthroplasty, each presenting advantages and limitations.

Arthrodesis, achieved via bone allografts or vascularized autografts, provides stable reconstruction but compromises joint function and imposes mechanical stress on other joints.[14-16] Conversely, arthroplasty conserves the joint, utilizing allografts or metallic prostheses.[17-19] Contemporary modular prosthetic designs offer intraoperative flexibility, aiding precise reconstruction and facilitating early rehabilitation. However, prosthetic reconstructions carry inherent risks such as mechanical complications. Reported survival rates range from 60% to 80% at 5 years and 40-70% at 10 years. Longevity, complications of prosthesis vary based on prosthesis type, anatomic site, and fixation technique. However, prosthesis has low risk of transmission of infection. Complications like loosening and infection pose significant challenges post-prosthesis implantation, demanding additional surgical interventions. In our study we had an overall prosthesis related complications of about 26.4% (N=9) in the form of infections, prosthetic loosening, peri-prosthetic fracture. Many studies have been performed to investigate endoprosthetic survival rates after tumor resection, but the results cannot be summarized and systematic review cannot be performed, mostly because of a small number of patients, as well as different models and principles of endoprosthesis. Tumor endoprosthetic survival rates are mostly about 60% to 80% at 5 years, and 40-70% at 10 years.[21-23] For the current rotating-hinge knee design, reported follow-up is limited to approximately 10 years. Malawer et al in 1995 showed an 83% survival of prostheses at 5 years and 67% at 10 years.[24] They had a revision rate of 15%, infection rate of 13%, amputation rate of 11%, and local recurrence rate of 6%.[25] Horowitz et al reviewed their experience with 93 prosthetic reconstructions of lower extremity over 8 years with a minimum follow-up was 24 months (mean, 80 months).[25] The overall event-free prosthesis survival was 63% at 5 years and 36% at 10 years. Limb survival for the entire group was 87% at 5 years. In our series we noted 5.8% (N=2) patients with loosening of endoprosthesis, managed successfully with re application of endoprosthesis. Malawer et al noted aseptic loosening as cause for failure in approximately 20% at 5 years and 30% at 10 years.[24] Periprosthetic fracture occurred in 2.9% (N=1) patient during sport activity and was managed with endoprosthetic elongation. The incidence of infection was 8.8% (N=3) in our study. Curettage, debridement and irrigation and conservative management with appropriate antibiotics were the treatment given in these patients with satisfactory results. Notably bone tumors arising from the growing ends of bone mandates the removal of the affected growth plate and subsequent continued growth in the contra lateral extremity results in limb-length inequality which necessitates specialized expandable prostheses.[17] Expandable prosthesis were developed to solve this issue. Custom expandable prostheses system consists of a fixed stem with a screw or a multiple plate extension mechanism. The disadvantage in these systems is that a surgical procedure is required for the subsequent expansions. We donot have any experiences with such prosthesis. Modular segmental replacement system (MSRS) is one of the options for Limb conservation surgery in bone tumors .in our study we did not use MSRS for limb salvage surgery procedures. Innovative procedures like The Van Nes rotationplasty is the best available alternative option for bone tumors in skeletally immature individuals in adolescent age groups. When an above knee amputation is indicated, a “more functional” limb that will act as a below knee amputation can be obtained with this procedure. In a study by Lindner et al out of 136 patients with a high-grade osteosarcoma, 79 were treated by limb salvage, 21 by Van Nes rotationplasty and 33 by amputation.[26] The patients were then followed for a mean of 43 months. The authors demonstrated that the functional result of the Van Nes rotationplasty was superior to that of amputation or limb salvage. In our Center, we have treated one case with arthrodesis and one case with van nes rotation plasty too. It is pertinent to mention that limb salvage surgery requires state of the heart infrastructure which includes an experienced multidisciplinary team of surgical oncologists and orthopaedic surgeons, high-quality prostheses, a good tissue bank for allografts, good intensive care facilities and rehabilitation training programmes. The prosthesis itself entails a major cost burden. Thus, limb salvage surgery can be implemented only in limited, tertiary level centers.

Limitations

Limitations of this study are; it is a single institution study, study population is small, as said above it is vital to have a multidisciplinary team dedicated for such a technical operation, also a proper postoperative follow-up and rehabilitation programme is essential.

CONCLUSION

The surgical management of patients with primary tumors of bone is challenging which necessitates robust infrastructure and substantial financial resources, including skilled multidisciplinary teams, expertise in surgical and medical oncology, and advanced skeletal imaging techniques, sophisticated prostheses, a good tissue bank for allografts, and rehabilitation training modules. The custom mega prosthesis favored by us in most of the cases in limb sparing surgery for bone tumors results in satisfactory results in terms of local tumor control and limb function. Appropriate case selection needs to be done to obtain good long-term results in limb salvage surgery which is the current standard of care.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee

REFERENCES

1. Enneking WF. An abbreviated history of orthopaedic oncology in North America. Clin Orthop. 2000;374: 115-24
2. Eckardt JJ, Yang RS, Ward WG, Kelly C, Eilber FR. Endoprosthetic reconstruction for malignant bone tumors and nonmalignant tumorous conditions of bone. In: Stauffer RN, Erlich MG, Fu FH, Kostuik JP, Manske PR, Sim FH, eds. Advances in operative orthopaedics, 3rd ed. USA: Mosby; 1995:61-83.
3. Choong PF, Sim FH. Limb-sparing surgery for bone tumors: new developments. Semin Surg Oncol. 1997; 13:64-9.
4. Ries LAG, Smith MA, Gurney JG. Cancer incidence and survival among children and adolescents: United States SEER program 1975-1995. Available at: http://seer.cancer.gov/publications/childhood/. Accessed on 20 November 2023.
5. Link MP, Eilber F. Osteosarcoma. In: Pizzo PA, Poplack DG, eds. Principles and practice of pediatric oncology, 3rd ed. Philadelphia: Lippincott-Raven; 1997:889-920.
6. Weis LD. Common malignant bone tumors: Osteosarcoma. In: Simon MA, Springfield D, eds. Surgery for bone and soft tissue tumors. Philadelphia: Lippincott-Raven; 1998:265-74.
7. Ebeid W, Amin S, Abdelmegid A. Limb salvage management of pathologic fractures of primary malignant bone tumors. Cancer Control. 2005;12:57-61.
8. Kim SY, Helman LJ. Strategies to explore new approaches in the investigation and treatment of osteosarcoma. Cancer Treat Res. 2009;152:517-28.
9. Sluga M, Windhager R, Lang S, Heinzl H, Bielack S, Kotz R. Local and systemiccontrol after ablative and limb sparing surgery in patients with osteosarcoma. Clin Orthop. 1999;358:120-7.
10. Simon MA, Aschliman MA, Thomas N, Mankin HJ. Limbsalvage treatment versus amputation for osteosarcoma of the distal end of the femur. J Bone Joint Surg Am. 2005;87:2822.
11. Biermann JS, Adkins D, Benjamin R. Bone cancer. J Natl Compr Canc Netw. 2007;5:420-37.
12. Mankin HJ, Hornicek FJ, Rosenberg AE, Harmon DC, Gebhardt MC. Survival data for 648 patients with osteosarcoma treated at one institution. Clin Orthop Relat Res. 2004;429:286-91.
13. Bacci G, Ferrari S, Lari S. Osteosarcoma of the limb: amputation or limb salvage in patients treated by neoadjuvant chemotherapy. J Bone Joint Surg Br. 2002;84:88-92.
14. Enneking WF, Shirley PD. Resection-arthrodesis for malignant and potentially malignant lesions about the knee using an intramedullary rod and local bone grafts. J Bone Joint Surg Am. 1997;59:223-36.
15. Weinberg H, Kenan S, Lewis MM. The role of microvascular surgery in limb-sparing procedures for malignant tumors of the knee. Plast Reconstr Surg. 1993;92:692-8.
16. Marulanda GA, Henderson ER, Johnson DA, Letson GD, Cheong D. Orthopedic surgery options for the treatment of primary osteosarcoma. Cancer Control. 2008;15:13-20.
17. Gebhardt MC, Flugstad DI, Springfield DS. The use of bone allografts for limb salvage in high-grade extremity osteosarcoma. Clin Orthop Relat Res. 1991; 270:181-96.
18. Sim FH, Frassica FJ. Use of allografts following resection of tumors of the musculoskeletal system. Instr Course Lect. 1993;42:405-13.
19. Bradish CF, Kemp HB, Scales JT, Wilson JN. Distal femoral replacement by custom-made prostheses, Clinical follow-up and survivorship analysis. J Bone Joint Surg Br. 1987;69:276-84.
20. Neel MD, Letson GD. Modular endoprostheses for children with malignant bone tumors. Cancer Control. 2001;8:344-8.
21. Zehr RJ, Enneking WF, Scarborough MT. Allograft prosthesis composite versus megaprosthesis in proximal femoral reconstruction. Clin Orthop. 1996; 322:207-23.
22. Kabukcuoglu Y, Grimer RJ, Tillman RM, Carter SR. Endoprosthetic replacement for primary malignant tumors of the proximal femur. Clin Orthop. 1999; 358:8-14.
23. Farid Y, Lin PP, Lewis VO, Yasko AW. Endoprosthetic and allograft-prosthetic composite reconstruction of the proximal femur for bone neoplasms. Clin Orthop Relat Res. 2006;442:223-9.
24. Malawer MM, Chou LB. Prosthetic survival and clinical results with use of large-segment replacements in the treatment of high-grade bone sarcosarcomas. J Bone Joint Surg Am. 1995;77:1154-65.
25. Horowitz SM, Glasser DB, Lane JM, Healey JH. Prosthetic and extremity survivorship after limb salvage for sarcoma: how long do the reconstructions last? Clin Orthop. 1993;293:280-6.
26. Lindner NSJ, Ramm O, Hillmann A. The University of Muenster experience. Clin Orthop Relat Res. 1999; 358:83-9.

Cite this article as: Swamy GG, Krishnan SK. Limb salvage surgery for primary bone tumors: retrospective study in a tertiary care centre. Int J Res Orthop 2024;10:358-63.