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Original Research Article

COMPARISON OF LIMB SALVAGE WITH MEGA PROSTHESIS VERSUS AUTO GRAFT RECONSTRUCTION AFTER CRYOTHERAPY IN LIMB SARCOMA PATIENTS

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Abstract: *Osteosarcoma is the most common primary malignant bone tumor, with children and adolescents being the most at-risk population. It accounts for 2% of all childhood tumors. The main goal of this study was to compare the use of limb salvage with mega prosthesis versus auto graft reconstruction after cryotherapy in patients with limb sarcoma. This retrospective study was conducted at Liaquat College of Medicine and Dentistry Darul Sehat Hospital Karachi from June 2023 to August 2023. The data was collected with the permission of the hospital's ethical committee. A standard uniform management protocol was adopted for each case. All patients were skeletally immature, with the predicted overall growth of less than 3 cm calculated using the Multiplier method. The data was collected from 45 patients with a mean age of 13.8±4.6 years. The predominant type of tumor was Osteosarcoma (77.14%) followed by Ewing Sarcoma and Chondrosarcoma. Five patients required a more extended hospital stay after mega prosthesis as compared to the other group. It is concluded that patients with limb sarcomas treated with Mega prosthesis had better functional outcomes than those treated with autograft reconstruction after cryotherapy.*

Keywords: Osteosarcoma, Limb salvage, Mega prosthesis, Auto graft reconstruction, Cryotherapy

Introduction

Osteosarcoma is the most common case of a primary malignant bone tumor, with the population most at risk being children and adolescents, accounting for 2% of all childhood tumors. Before 1970, osteosarcoma treatment predominantly relied on surgical resection, yielding a five-year survival rate below 20% (Araki et al., 2021). Advancements in radiological imaging and the increased utilization of effective adjuvant treatments, including chemotherapy and radiotherapy, have notably improved limb salvage surgery (LSS) outcomes. Consequently, the five-year survival rate for osteosarcoma has surged to 60% from its previous 20%, marking a significant increase in limb salvage rates (URIST and DAWSON, 1981).

In osteosarcoma, the lower extremity, particularly the femur (42% occurrence) and tibia (19% occurrence), constitutes the most common sites, with approximately 75% and 80% of tumors, respectively, occurring in the distal part of the femur and the proximal bone of the tibia (Sharil et al., 2013), making up nearly 60% of osteosarcomas in the knee region. Musculoskeletal sarcomas account for 12% of pediatric neoplasms, where 80% arise from soft tissues and the remaining 20% from bone (Lauritzen et al., 1991). Extensive tumor resection combined with biological reconstruction or mega prostheses has revolutionized limb salvage possibilities. The primary goal of limb salvage surgery is achieving wide resection with tumor-free margins, followed by stable reconstruction to ensure optimal functionality with minimal morbidity (Ehara et al., 2000).

Modern mega prosthesis designs facilitate early functional recovery and offer reasonable long-term survival. Although considered the gold standard in skeletally mature sarcoma patients, mega prostheses are viable for adolescents predicted to have less than a 3 cm leg length discrepancy at skeletal maturity, albeit with certain limitations (Whelan et al., 2015). Osteosarcoma, the most prevalent primary malignant bone tumor, mainly occurs in the metaphysis of long bones, particularly around the knee joint (distal femur and proximal tibia) (Higuchi et al., 2017). With neoadjuvant chemotherapy's widespread application and advancements in bone tumor surgery, limb salvage surgery has become the primary approach. Notably, some osteosarcoma cases present localized pathological changes above the diaphysis or metaphysis without invading the epiphysis at diagnosis (Brookes et al., 2021). Joint-preservation limb salvage (JPLS) treatment is increasingly relevant in clinical practice. Compared to joint-prosthesis replacement surgery (JPRS), JPLS better preserves ligaments and joint capsules, favoring joint function recovery and mitigating long-term complications like limb shortening, prosthesis loosening, and infections, thereby emphasizing biological reconstruction (Brookes et al., 2021). As survival and limb salvage rates for osteosarcoma have improved, prioritizing

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both limb function recovery and high-quality life outcomes becomes crucial. Quality of life (QoL) has become an index for Clinical Curative Effect Evaluation in the contemporary medical model. Thus, exploring patient QoL becomes imperative (Ozaki et al., 2003).

In earlier times, radical resections like amputation were joint for surgical management. However, recent decades have witnessed the ascendancy of limb salvage surgery owing to advancements in diagnostic radiology, neoadjuvant, and adjuvant treatments. The approach emphasizes tumor resection with negative margins followed by reconstruction to attain favorable functional outcomes (Cartiaux et al., 2013). While limb salvage surgery offers better functional outcomes, it also presents known complications such as surgical site infection, implant issues, and periprosthetic fractures.

(Krettek et al., 2004). Thus, the study's main objective is to compare limb salvage with mega prosthesis versus auto graft reconstruction after cryotherapy in limb sarcoma patients.

Methodology

This is a report on a retrospective study at Liaquat College of Medicine and Dentistry Darul Sehat Hospital Karachi from June 2023 to August 2023. The hospital's ethical committee granted permission for the collection of data.

The study included patients under the age of 18 years who had been diagnosed with limb sarcoma. Patients with recurrent tumor, metastasis, pathological fracture at presentation, or who had undergone initial surgery elsewhere were excluded from the study.

After obtaining permission from the hospital's ethical committee, the data was collected from 45 patients. A standardized management protocol was uniformly applied to every case, considering that all patients were skeletally immature and predicted to have less than 3 cm of overall remaining growth, calculated using the Multiplier method. After completing the diagnostic workup, each case underwent thorough discussion in a Multidisciplinary meeting. This involved a comprehensive review of X-rays and MRI scans of the affected extremity, the histological diagnosis, bone scan, and chest CT imaging. Specifically, patients diagnosed with Osteosarcoma underwent Neoadjuvant Chemotherapy comprising two cycles of the MAP protocol, while those with Ewing sarcoma received 6 cycles of VDC/IE. Preoperatively, patients underwent templating using their cross-sectional images to ensure suitable parameters such as diaphyseal canal adequacy, femoral Inter-epicondylar distance, posterior tibial slope, tibial size, and a predicted limb length discrepancy of less than 3 cm at skeletal maturity. Those meeting these criteria underwent mega-prosthesis reconstruction following tumor excision. In cases where adult mega prosthesis placement wasn't viable according to templating, yet the predicted limb length discrepancy remained less than 3 cm at skeletal maturity, patients received reconstruction using liquid nitrogen-treated autografts after tumor excision. Following wide local excision, frozen sections from the proximal and distal bone ends were analyzed through testing to ensure tumor-free margins. The tumor-bearing bone underwent a specific freezing process involving liquid nitrogen, which included freezing for 20 minutes, thawing in air at room temperature for 15 minutes, and subsequent thawing in distilled water for 10 minutes. Reconstruction post-resection aimed to address substantial bone and osteochondral defects through the use of frozen tumor-bearing autografts alongside hardware such as prostheses, intramedullary nails, and plates. The autograft reconstruction procedure utilized the free freezing method for bone treatment. This involved carefully dissecting the resected bone from the soft tissue envelope, reaming the bone to ensure the medullary canal was clear of any noticeable tumor, and then creating drill holes in preparation for the liquid nitrogen treatment.

The data was analyzed using SPSS version 20. All the values were expressed in mean and standard deviation.

Results

The data were collected from a cohort comprising 45 patients, with the mean age of the sample being 13.8 ± 4.6 years. Osteosarcoma was the predominant type of tumor, accounting for 77.14% of cases, followed by Ewing Sarcoma and Chondrosarcoma. Among the patients, 5 required extended hospital stays after receiving the mega prosthesis compared to the other group. Notably, no statistically significant difference was observed in the MSTS (Musculoskeletal Tumor Society) score concerning the distal femur and proximal tibia. Further details outlining the comparison of surgical outcomes and other pertinent variables between mega prosthesis and auto graft reconstruction are outlined in Table I.

Table 01: Characteristics of versus autograft reconstruction in selected patients

Outcome	Mega prosthesis group	Autograft reconstruction group	P-value
Chemotherapy delay >4 weeks	20 %	80%	0.002
Hospital stay (5-10days)	5 patients	18 patients	0.001
Limb length discrepancy (2-3cm)	10 patients	12 patients	0.001
Amputation Yes No	 02 10	 04 18	0.001
Re-surgery Yes No	 02 18	 09 06	0.001

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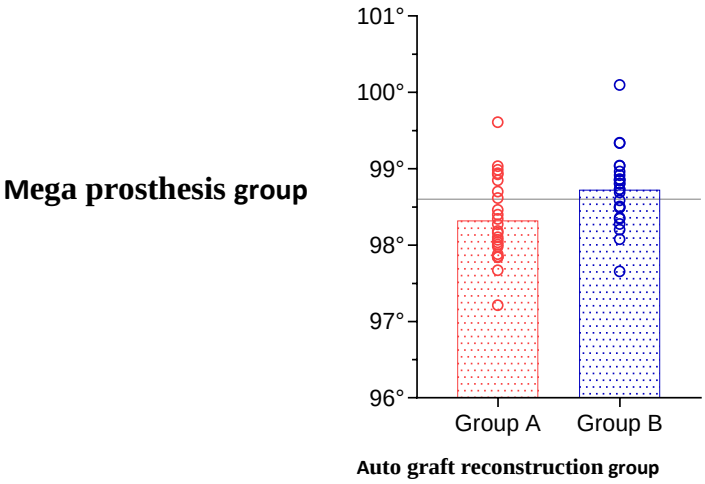

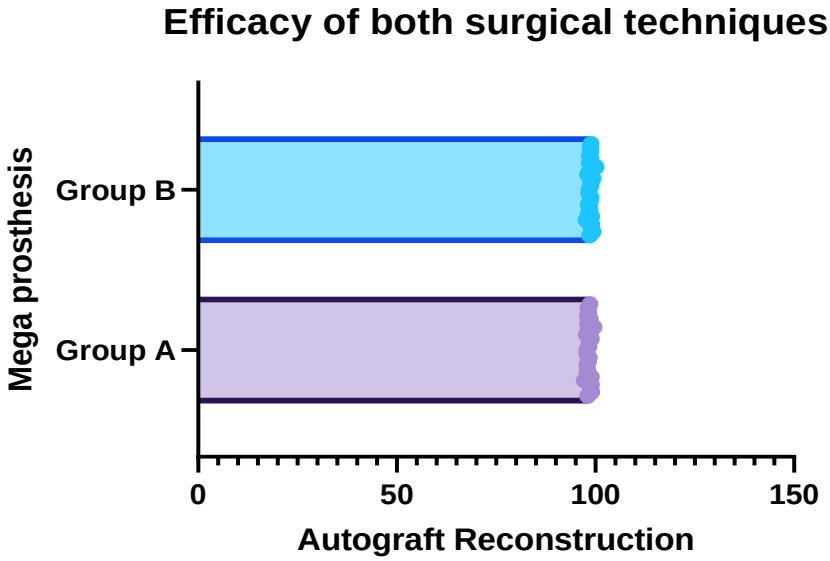

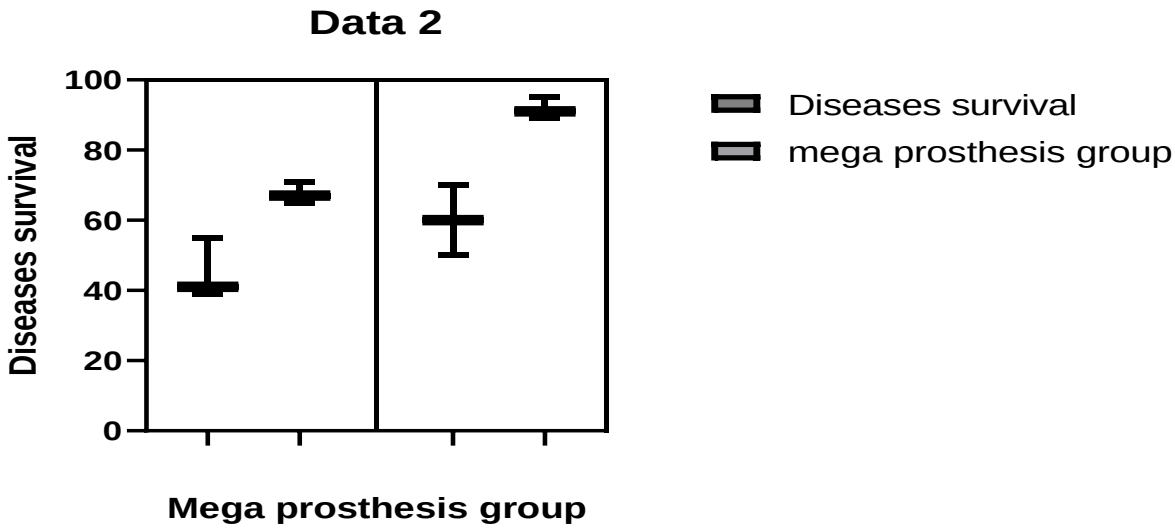

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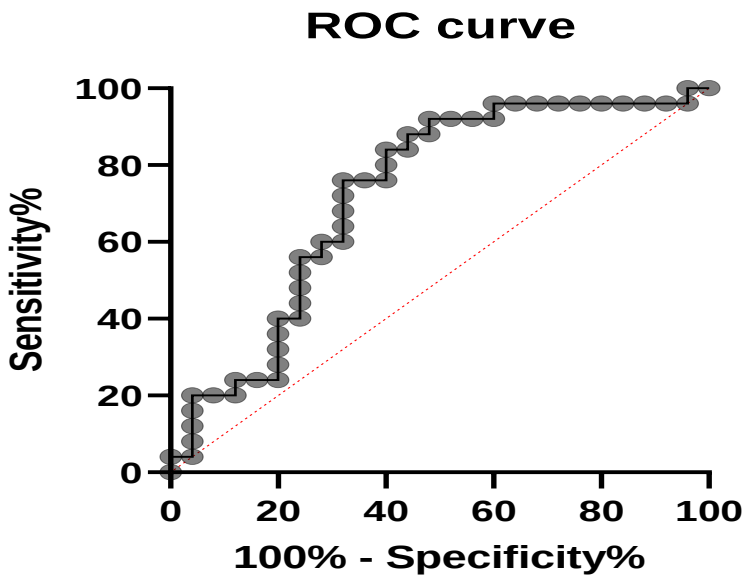

The area under the ROC curve	
Area	0.7248
Std. Error	0.07441
95% confidence interval	0.5790 to 0.8706
P value	0.0064

Discussion

In contemporary surgical practices, endoprosthesis serves as a prevalent choice for post-tumor resection reconstruction. Despite endoprosthesis design and materials advancements, limb salvage surgery remains a complex procedure that demands skilled surgical execution (Ni et al., 2019). Our study documented an increased overall complication rate in liquid nitrogen-treated auto grafts compared to mega prostheses (Mirabello et al., 2009). Among these cases, the primary issue in the liquid nitrogen-treated group was wound dehiscence, affecting 5 patients (33.33%), resulting in chemotherapy delays, impeding post-operative recovery, and prolonging hospital stay (Sadykova et al., 2020). Skin necrosis post-treatment with liquid nitrogen was comparable to findings in previous studies (Gede et al., 2017), although conflicting results regarding skin necrosis post-treatment have been reported.

Enhancing functional outcomes post-resection extends beyond the scope of limb salvage procedures alone. Despite meticulous surgical intervention, there remains a subset of patients for whom amputation remains the sole option (Manabe et al., 2004). In such instances, surgeons aim to optimize residual limb length, enhancing ultimate function (Bickels et al., 2009). Techniques aimed at augmenting the length of resected bone have been described to improve prosthetic fitting and post-amputation function. For instance, in cases where amputation just below the knee is necessary, the remaining proximal tibia may be insufficient for a below-knee prosthesis, even with a normal knee (Bilal et al., 2021). Surgical methods involving the distal tibia or foot in a long posterior flap to extend the length of a very short proximal tibial stump have been explored, preserving the knee and facilitating better use of the prosthesis. Such techniques apply when the distal leg maintains normalcy and adequate vascularity. Additionally, for cases of hip disarticulation, preserving a musculocutaneous flap and employing a modular endoprosthesis in the acetabulum can enhance functional outcomes (Garg et al., 2020; Puri, 2015). The consideration of autografts or allografts to augment residual limb length proves beneficial for patients in whom traditional amputation techniques might lead to poor function, prosthesis fitting issues, or excessive anatomical loss (Enneking and Shirley, 1977; Kinkel et al., 2010).

Conclusion

It is concluded that patients with limb sarcomas treated with Mega prosthesis yielded better functional outcomes when compared with autograft reconstruction after cryo-sterilization.

Declarations

Data Availability statement
All data generated or analyzed during the study are included in the manuscript.
Ethics approval and consent to participate
Approved by the department Concerned.
Consent for publication
Approved
Funding
Not applicable

Conflict of interest

The authors declared absence of conflict of interest.

Author Contribution

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Manuscript revisions, critical input.
Coordination of collaborative efforts.
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