ORIGINAL RESEARCH PAPER

A Study on Outcomes of Extended Curettage and Reconstruction by the Sandwich Technique for Giant Cell Tumours

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ABSTRACT

Background: In the management of GCTs, traditional methods like curettage, while effective at removing the primary tumour mass, often leave microscopic residual tumour cells that can lead to recurrence. To mitigate this, extended curettage combined with adjuvant therapies such as phenol, liquid nitrogen, or PMMA (Polymethylmethacrylate) is frequently employed. This study aims to evaluate the outcomes of extended curettage and reconstruction using the Sandwich Technique in patients with GCTs.

Methods: This was a retrospective and prospective observational study carried out over a period of one year involving 30 patients aged between 15 and 50 years. Follow-up visits were scheduled at 6 months, 12 months, 18 months, and periodically thereafter. The MSTS (Musculoskeletal Tumour Society) score based on pain, function, and emotional acceptance was employed to assess the functional outcomes of patients.

Results: The paired analysis of pre-operative MSTS scores with those at 6 months post-surgery ($t = 19.1$, $p < 0.001$), 12 months ($t = 19.7$, $P < 0.001$, 18 months ($t = 21.5$, $p < 0.001$), indicated a significant improvement. The paired analysis comparing MSTS scores at 6 months with those at 12 months post-surgery ($t = 14.0$, $p < 0.001$) and at 18 months post-surgery ($t = 18.3$, $p < 0.001$), as well as 12 months with those at 18 months ($t = 29.0$, $p < 0.001$) indicated a significant improvement. Only 1 patient (3.33%) had a recurrence. Complications were reported in 2 patients (6.67%).

Conclusion: Intralesional curettage combined with the Sandwich Technique using a combination of bone grafts and PMMA to leverage the benefits of both materials, protecting the underlying articular cartilage and enhancing structural support, achieves a low recurrence rate with very low complications as well as good functional outcomes.

Keywords: Extended Curettage, Reconstruction, Sandwich Technique, Giant Cell Tumours.

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INTRODUCTION

Giant cell tumours of bone are relatively rare, comprising about 5% of all primary bone tumours and 20% of benign bone tumours worldwide.[1] GCTs typically arise at the end of long bones, such as the distal femur, proximal tibia, and distal radius, often involving the epiphyseal region. The incidence of GCTs is estimated to be about 1.7 cases per million people annually.[2] Despite their benign classification, GCTs are known for their locally aggressive behavior, characterized by extensive bone resorption and potential for causing significant skeletal morbidity. They also have a notable propensity for recurrence following surgical

intervention, with recurrence rates ranging from 10% to 50% depending on the treatment method used. In rare instances, GCTs can metastasize to the lungs, though these metastatic lesions are typically benign. The aggressive nature of GCTs necessitates careful management to minimize recurrence and preserve function. Treatments often involve a combination of surgical curettage and adjuvant therapies, such as phenol, cryotherapy, or PMMA (Polymethylmethacrylate), to ensure thorough removal of tumour cells and to support structural integrity. The management of GCTs remains a significant challenge in orthopedic oncology due to the delicate balance between eradicating the tumour and preserving bone function.[3]

The focus on early diagnosis, appropriate surgical intervention, and regular follow-up is critical in mitigating the impact of GCTs on patients' lives. This approach not only aims to reduce recurrence rates but also strives to maintain and restore function, thereby improving overall patient outcomes and quality of life.[4] Traditional methods like curettage, while effective at removing the primary tumour mass, often leave microscopic residual tumour cells that can lead to recurrence. To mitigate this, extended curettage combined with adjuvant therapies such as phenol, liquid nitrogen, or PMMA is frequently employed. These adjuvants help to destroy residual tumour cells and reduce the likelihood of recurrence. However, the challenge remains in effectively reconstructing the bone defect left after curettage, which is critical for restoring structural integrity and function.[5]

The "Sandwich Technique" has emerged as a promising approach to address this challenge. This technique involves layering bone grafts or bone substitutes with PMMA to fill the defect and provide structural support. The combination of these materials not only supports immediate load-bearing but also promotes long-term bone healing and integration. Preliminary studies have shown that the Sandwich Technique can significantly reduce recurrence rates and improve functional outcomes for patients. By evaluating the efficacy of this technique in a systematic and comprehensive manner, this study aims to provide evidence-based recommendations for its use in clinical practice, potentially leading to better patient outcomes and a reduction in the morbidity associated with GCTs.[6] This study aims to evaluate the outcomes of extended curettage and reconstruction using the Sandwich Technique in patients with GCTs. By analyzing the functional and radiological outcomes over a specified follow-up period, this study seeks to provide evidence-based recommendations for the management of GCTs, thereby improving patient outcomes and reducing recurrence rates.[7] This research is crucial as it offers a new perspective on GCT management, particularly in India, where there is a significant need for effective and reliable treatment options.

MATERIALS AND METHODS

This was a retrospective and prospective observational study carried out over a period of one year involving 30 patients aged between 15 and 50 years. Patients were selected through purposive sampling based on their diagnosis of GCT and availability for follow-up visits. Patients with recurrent GCTs, lesions that were inaccessible to curettage, patients younger than 15 years and older than 50 years were excluded from the study. Patients who met the inclusion criteria underwent extended curettage and reconstruction using the Sandwich Technique. The study protocol was reviewed and approved by the Institutional Ethics Committee (EC/NEW/INST/1527/2022/08/031). Informed consent was obtained from all participants. Confidentiality and anonymity of patient data were maintained throughout the study. The procedure involved thorough curettage of the tumour cavity, followed by the application of a combination of bone grafts or bone substitutes layered with PMMA. This technique aimed to provide structural support and reduce the risk of recurrence.

Data were collected through a combination of clinical assessments, radiological evaluations, and follow-up visits. Pre-operative and post-operative radiographs were taken to assess the extent of bone involvement and the success of the surgical intervention. Follow-up visits were scheduled at 6 months, 12 months, 18 months, and periodically thereafter. The MSTS score based on pain, function, and emotional acceptance was employed to assess the functional outcomes of patients. Each of these components is scored on a scale from 0 to 5, with higher scores indicating better outcomes. The total possible score ranges from 0 to 30, with higher total scores reflecting better functional status and quality of life post-surgery. In this study, the MSTS scores were recorded pre-operatively and during follow-up visits at 6 months, 12 months, 18 months, and periodically thereafter.

Data for this study were entered and analyzed using Microsoft Excel and SPSS software. Descriptive statistics were used to summarize the patient demographics, clinical characteristics, and outcomes. Continuous variables were expressed as means and standard deviations, while categorical variables were presented as frequencies and percentages. The paired t-test was used to compare pre-operative and post-operative MSTS scores. A p-value of less than 0.05 was considered statistically significant.

RESULTS

The largest age group was patients up to 30 years old, comprising 11 individuals and representing 36.67% of the total sample. This is followed by the 31-40 years age group, which included 10 patients, accounting for 33.33% of the sample. The 41-50 years age group consisted of 9 patients, making up 30.0% of the total sample. Out of the total sample, 13 patients were female, representing 43.33% of the participants. The remaining 17 patients were male, accounting for 56.67% of the sample.

The most common tumour location was the proximal tibia, with 12 patients representing 40.0% of the sample. This was followed by the distal femur, where 11 patients have tumours, accounting for 36.67% of the sample. The distal radius was the least common site, with 7 patients representing 23.33% of the total sample.

Figure 1 provides the results of the paired analysis comparing pre-operative MSTS scores with those recorded at 6 months post-surgery. The mean pre-operative MSTS score was 15.1 with a standard deviation of 3.15. At 6 months post-surgery, the mean MSTS score increased to 23.97 with a standard deviation of 1.82. The mean difference between the pre-operative and 6-month scores was 8.87, with a t-value of 19.1 and a p-value of less than 0.001, indicating a statistically significant improvement in MSTS scores after surgery.

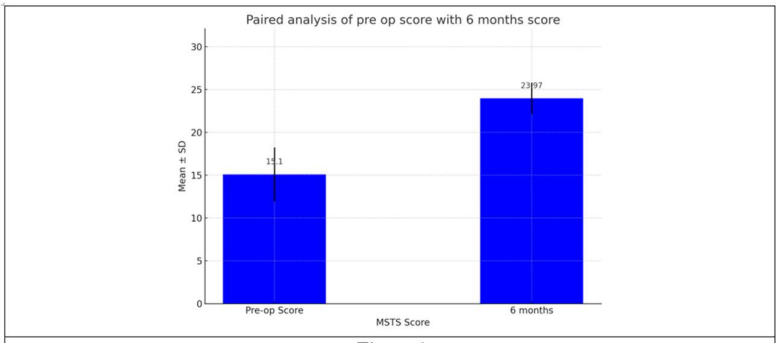

Figure 1

Figure 2 presents the results of the paired analysis comparing pre-operative MSTS scores with those recorded at 12 months post-surgery. The mean pre-operative MSTS score was 15.1 with a standard deviation of 3.15. At 12 months post-surgery, the mean MSTS score increased to 26.67 with a standard deviation of 1.50. The mean difference between the pre-operative and 12-month scores was 11.57, with a t-value of 19.7 and a p-value of less than 0.001, indicating a statistically significant improvement in MSTS scores one year after surgery.

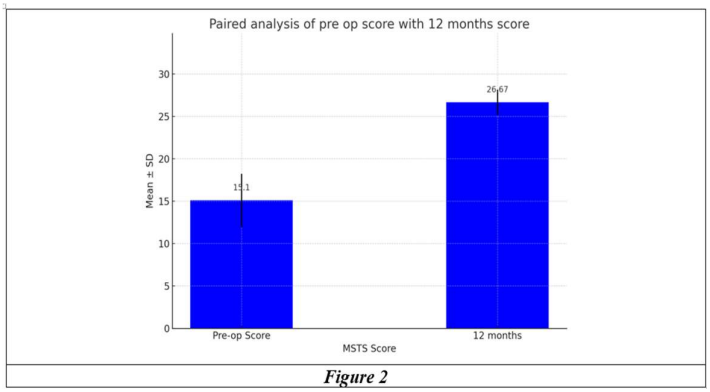

Figure 2

Figure 3 shows the results of the paired analysis comparing pre-operative MSTS scores with those recorded at 18 months post-surgery. The mean pre-operative MSTS score was 15.1 with a standard deviation of 3.15. At 18 months post-surgery, the mean MSTS score increased to 27.63 with a standard deviation of 1.52. The mean difference between the pre-operative and 18-month scores was 12.53, with a t-value of 21.5 and a p-value of less than 0.001, indicating a statistically significant improvement in MSTS scores a year and a half after surgery.

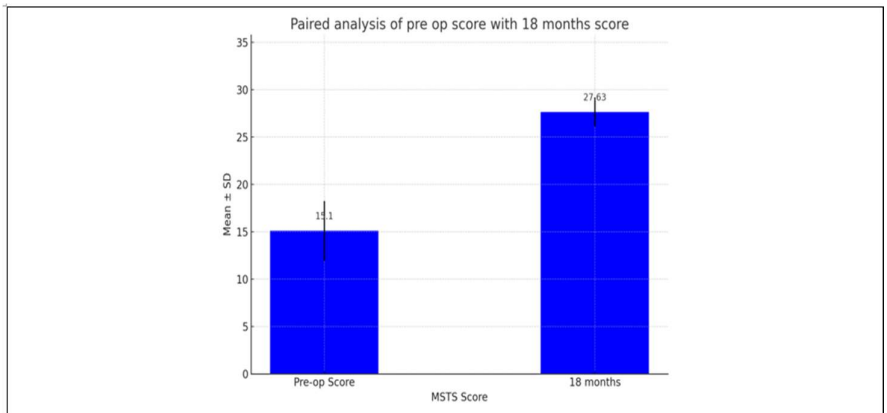

Figure 3

Figure 4 presents the results of the paired analysis comparing MSTS scores at 6 months with those recorded at 12 months post-surgery. At 6 months post-surgery, the mean MSTS score was 23.97 with a standard deviation of 1.82. By 12 months post-surgery, the mean MSTS score increased to 26.67 with a standard deviation of 1.50. The mean difference between the 6-month and 12-month scores was 2.7, with a t-value of 14.0 and a p-value of less than 0.001, indicating a statistically significant improvement in MSTS scores between the 6-month and 12-month post surgery periods.

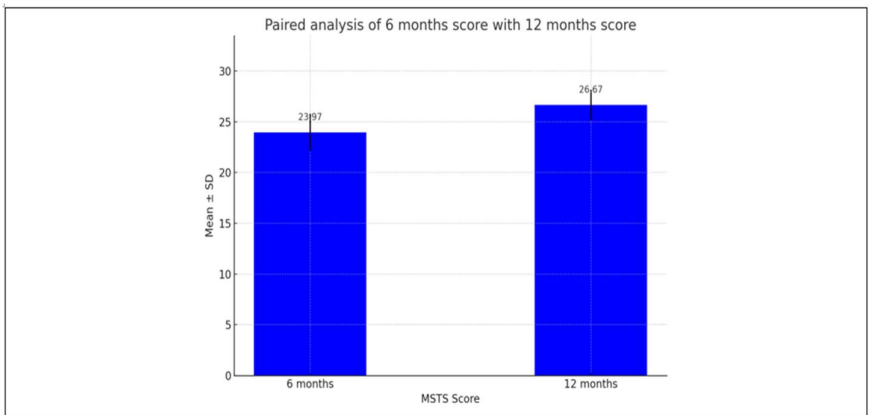

Figure 4

Figure 5 provides the results of the paired analysis comparing MSTS scores at 6 months with those recorded at 18 months post-surgery. At 6 months post-surgery, the mean MSTS score was 23.97 with a standard deviation of 1.82. By 18 months post-surgery, the mean MSTS score increased to 27.63 with a standard deviation of 1.52. The mean difference between the 6-month and 18-month scores was 3.67, with a t-value of 18.3 and a p-value of less than 0.001, indicating a statistically significant improvement in MSTS scores between the 6-month and 18-month post surgery periods.

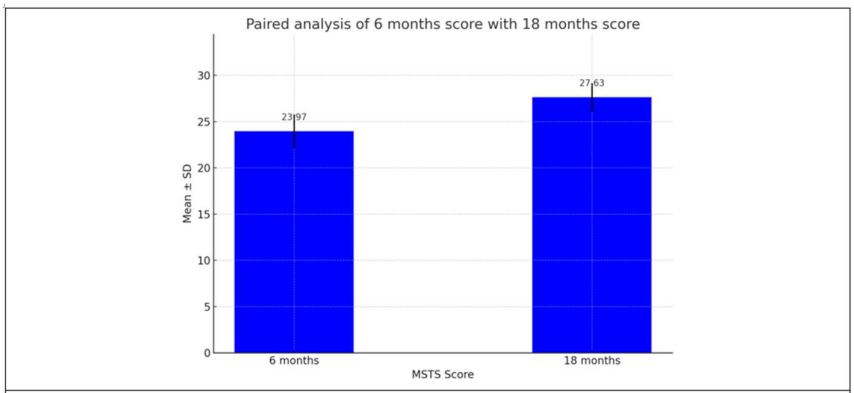

Figure 5

Figure 6 presents the results of the paired analysis comparing MSTS scores at 12 months with those recorded at 18 months post-surgery. At 12 months post-surgery, the mean MSTS score was 26.67 with a standard deviation of 1.50. By 18 months post-surgery, the mean MSTS score increased to 27.63 with a standard deviation of 1.52. The mean difference between the 12-month and 18-month scores was 0.97, with a t-value of 29.0 and a p-value of less than 0.001, indicating a statistically significant improvement in MSTS scores between the 12-month and 18-month post surgery periods.

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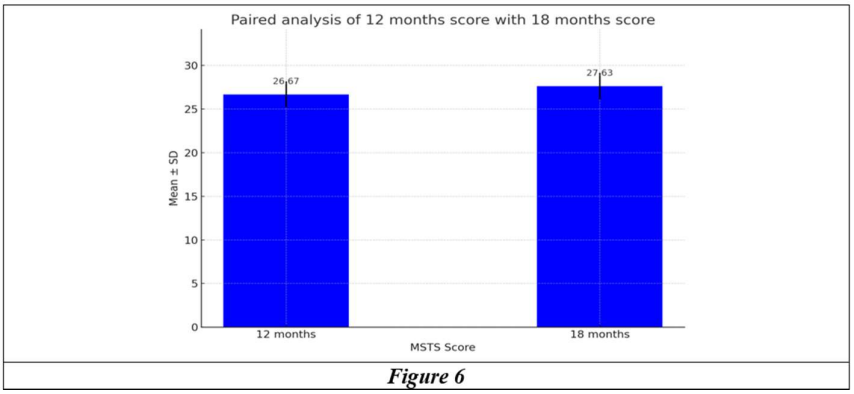

Figure 6

Table 1 illustrates the progression of MSTS scores over time, showing significant improvement from the preoperative phase to 18 months post-operation. Initially, the majority of patients were categorized as fair (83.33%), but by 18 months, all patients reached an excellent score (100%), indicating substantial recovery and improvement in functional outcomes.

Table 1. Change in MSTS Score with Time

Score	Preoperative	6 months	12 months	18 months
Excellent	1 (3.33%)	18 (60.00%)	29 (96.67%)	30 (100.00%)
Good	3 (10.00%)	12 (40.00%)	1 (3.33%)	
Fair	25 (83.33%)			
Poor	1 (3.33%)			

Out of the total sample, 29 patients (96.67%) did not experience a recurrence of the tumour post-treatment. Only 1 patient (3.33%) had a recurrence, indicating a low recurrence rate following the surgical intervention. 28 individuals (93.33%), did not experience any complications. However, 2 patients (6.67%) did encounter complications post-treatment.

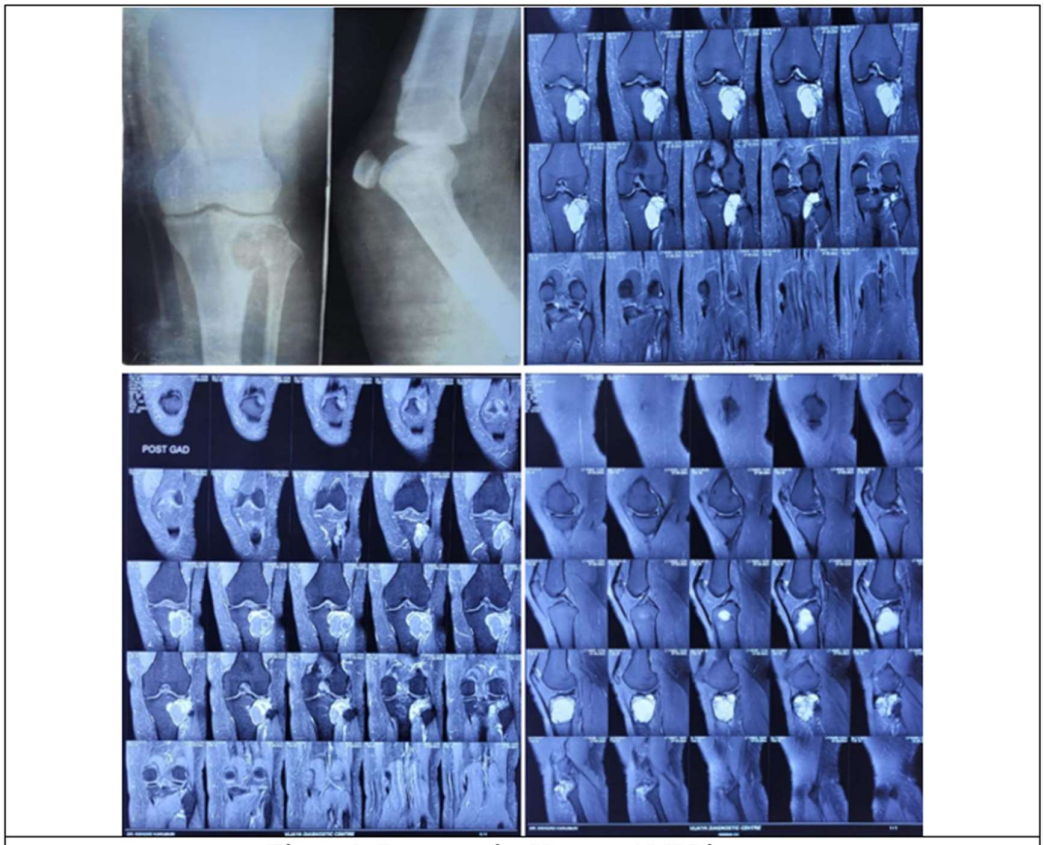

Figure 1: Pre-operative X-ray and MRI images

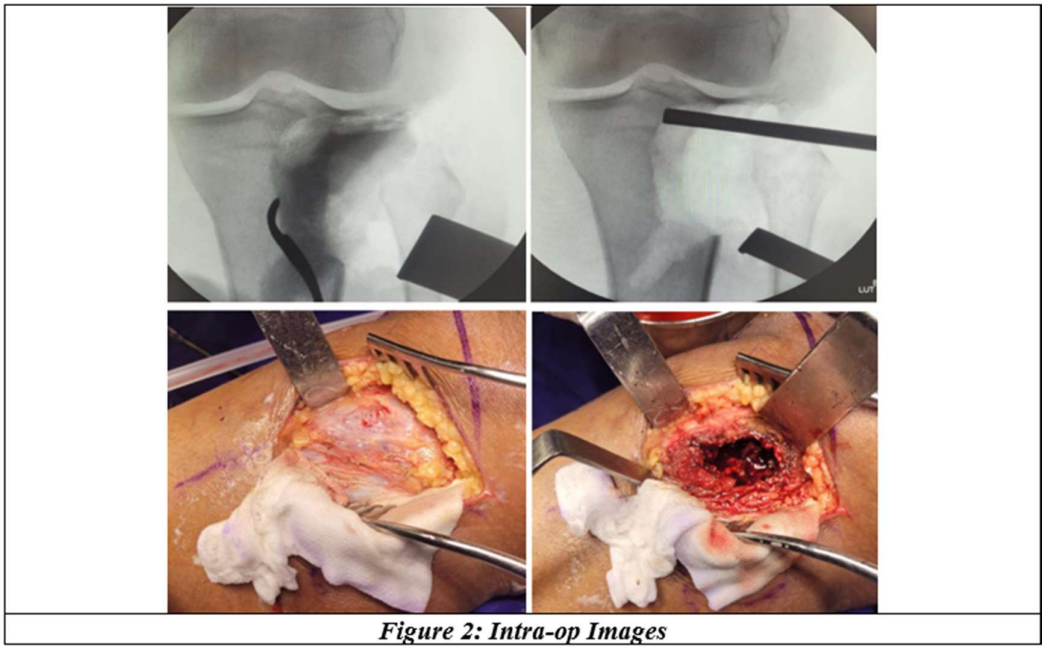

Figure 2: Intra-op Images

Figure 3: Post-operative X-ray

Figure 4: Figure no.15: Surgical technique for extended curettage of GCT of the distal femur showing (a) preoperative X-ray (b) preoperative MRI (c) creation of cortical bone window and curettage of contents (d) after burring and washing with hydrogen peroxide and saline (e) filling the cavity with bone allograft, bone cement, and fixing with LCP (f) postoperative X-ray

DISCUSSION

The study was designed as a retrospective and prospective observational study carried out over a period of one year with the aim to evaluate the outcomes of extended curettage and reconstruction using the Sandwich Technique in patients with GCTs (Giant Cell Tumours) of bone. The age distribution of patients with giant cell tumours (GCTs) shows that the largest group is patients up to 30 years old, comprising 11 individuals (36.67%). This is followed by the 31-40 years age group with 10 patients (33.33%) and the 41-50 years age group with 9 patients (30.0%). The gender distribution among patients with GCTs includes 13 female patients (43.33%) and 17 male patients (56.67%). The tumour was observed most commonly in the proximal tibia with 12 patients (40.0%), followed by the distal femur with 11 patients (36.67%), and the distal radius with 7 patients (23.33%).

These findings were similar to the incidence documented in the literature, with the tumour predominantly affecting adults between the ages of 20 and 40 years, with a slight female predominance. GCTs typically arise at the end of long bones, such as the distal femur, proximal tibia, and distal radius, often involving the epiphyseal region. The incidence of GCTs is estimated to be about 1.7 cases per million people annually.[2] In India, the prevalence and incidence of GCTs are not well documented due to the absence of a centralized cancer registry. However, hospital-based studies indicate that the prevalence pattern of GCTs in India is similar to global data. Most patients present with GCTs in their third and fourth decades of life, with a slight female predominance.[4] This demographic trend aligns with the international experience, highlighting a consistent age and gender distribution of GCT cases worldwide. Despite the lack of comprehensive national data, these hospital-based insights are crucial for understanding the local burden of GCTs and guiding clinical practices.

Our study shows a significant improvement in functional outcomes when comparing pre-operative MSTS scores with those at 6 months post-surgery. The mean pre-operative MSTS score of 15.1 (SD = 3.15) increased to 23.97 (SD = 1.82) at 6 months post-surgery. This increase of 8.87, with a t-value of 19.1 and a p-value of less than 0.001, highlights the efficacy of the extended curettage and Sandwich Technique in facilitating patient recovery in the short term. This result is consistent with previous research, which has demonstrated the advantages of adjuvant therapies like phenol in reducing local recurrence and enhancing functional outcomes.[8]

Further supporting the benefits of the Sandwich Technique, the analysis comparing pre-operative MSTS scores with those at 12 months post-surgery showed a positive trend. The mean pre-operative MSTS score of 15.1 (SD = 3.15) rose to 26.67 (SD = 1.50) at 12 months post-surgery, resulting in a mean difference of 11.57. The t-value of 19.7 and a p-value of less than 0.001 indicating a significant improvement. This sustained functional enhancement over a year emphasizes the lasting impact of the surgical intervention. These findings are in line with studies emphasizing the importance of combining curettage with effective reconstruction methods for optimal long-term results.[9,10]

The paired analysis of pre-operative MSTS scores with those at 18 months post-surgery continues to show significant improvement. The mean pre-operative MSTS score of 15.1 (SD = 3.15) increased to 27.63 (SD = 1.52) at 18 months post-surgery, with a mean difference of 12.53. The t-value of 21.5 and a p-value of less than 0.001 confirm the statistical significance of this improvement. These results demonstrate that the benefits of the Sandwich Technique extend beyond the initial post-operative period, providing sustained functional recovery and stability. Comparing MSTS scores at 6 months with those at 12 months post-surgery, the mean score increased from 23.97 (SD = 1.82) to 26.67 (SD = 1.50), with a mean difference of 2.7. The t-value of 14.0 and a p-value of less than 0.001 indicate a significant improvement over this period. This incremental improvement suggests that the structural integrity and functional benefits of the Sandwich Technique continue to enhance patient recovery beyond the early post-operative months. The analysis of MSTS scores at 6 months compared to those at 18 months post-surgery also demonstrates significant improvement. The mean score increased from 23.97 (SD = 1.82) at 6 months to 27.63 (SD = 1.52) at 18 months, with a mean difference of 3.67. The t-value of 18.3 and a p-value of less than 0.001 support the statistical significance of this improvement. This consistent upward trend in MSTS scores highlights the long-term benefits of the Sandwich Technique, ensuring that patients experience continued functional recovery and stability well into the later stages of post-surgical care.

The paired analysis comparing MSTS scores at 12 months with those at 18 months post-surgery shows a mean score increase from 26.67 (SD = 1.50) to 27.63 (SD = 1.52), with a mean difference of 0.97. The t-value of 29.0 and a p-value of less than 0.001 indicate a significant improvement. This final comparison underscores the continued effectiveness of the Sandwich Technique in providing incremental improvements in patient outcomes even beyond the first year post-surgery.

Regarding recurrence, 29 patients (96.67%) did not experience a recurrence of the tumour post-treatment, while only 1 patient (3.33%) had a recurrence. This low recurrence rate is significant, given that intralesional curettage alone is associated with a high recurrence rate of up to 65% (54). The use of adjuvant therapies such as phenol and the structural support provided by the Sandwich Technique likely contribute to this reduced recurrence rate. Additionally, incorporating bisphosphonates in some treatment protocols has been found to reduce local recurrence by inducing apoptosis in tumour cells, further supporting the effectiveness of the treatment strategy used in this study. The low recurrence rate observed, along with the consistent improvement in MSTS scores, highlights the effectiveness of this technique in managing GCTs. The use of PMMA and bone grafts not only supports immediate weight-bearing but also minimizes the risk of recurrence through cytotoxic and thermal effects.[9]

Complications were reported in 2 patients (6.67%), while the remaining 28 patients (93.33%) did not experience any complications post-treatment. The low complication rate demonstrates the safety and feasibility of the Sandwich Technique combined with extended curettage. Common complications associated with bone tumour surgeries include infection, fracture, and implant failure.[11] However, the meticulous surgical technique and careful post-operative management in this study likely contributed to the low incidence of such complications. The use of PMMA not only provides immediate weight-bearing capacity but also has a thermal effect that minimizes the risk of local recurrence, without significantly increasing the risk of complications.[12] The posterior periosteum is crucial for the reconstitution of the posterior cortex, especially after bone grafting, and its preservation is vital for preventing post-operative complications and ensuring successful outcomes.[13]

Our findings align with those of Poudel et al., who reported significant improvements in functional outcomes and a low recurrence rate using the sandwich technique.[14] The average MSTS score in their study improved from 15.5 pre-operatively to 27.2 post-operatively, closely aligning with our observed improvements. Additionally, Sahito et al., demonstrated the benefits of bone allografts in combination with extended curettage, showing significantly lower recurrence rates and better functional outcomes.[15] Similarly, El Desouqi and Ahmed's study highlighted the effectiveness of the sandwich technique in providing structural support and reducing local recurrence rates.[16] Their reported MSTS score improvement from 14.3 to 28.5 aligns with our findings, reinforcing the value of this technique. Panchwagh et al.'s comparison of bone graft alone versus the sandwich technique also supports our results, with the sandwich technique group showing superior outcomes in terms of recurrence rates and MSTS scores.[17]

Meena et al.'s retrospective study on the sandwich technique with internal fixation reported significant improvements in MSTS scores, which is consistent with our findings.[18] Their observed reduction in recurrence rate to 7.4% underscores the efficacy of combining these techniques for better outcomes. Singh et al.'s exploration of joint preservation surgery using the sandwich technique also demonstrated high success rates and improved functional outcomes, further supporting our results.[19] Gundavda et al.'s study on extended curettage for GCTs of bone found favourable functional outcomes and a low recurrence rate, similar to our findings.[20] Their reported mean MSTS score increase from 16.2 to 26.7 is in line with our observed improvements. Do Brito et al.'s systematic review concluded that curettage-based techniques with adjuvants provided acceptable oncological control and superior functional outcomes compared to wide resections, which supports the use of less invasive techniques like the sandwich technique.[21]

The sandwich technique showed excellent functional outcomes and no recurrence, highlighting the effectiveness of this approach in several other studies.[22-25] This has been further cemented by many researchers.[25-29] The AAOS (American Academy of Orthopaedic Surgeons) also highlighted curettage with PMMA as a commonly used and effective procedure for GCTs, which aligns with our use of the sandwich technique.[30]

The use of adjuvant therapies such as phenol and PMMA in our study aligns with the approaches taken in other successful studies, but there remains variability in the choice and application of adjuvants across different institutions. Standardizing these protocols could help optimize outcomes and reduce variability in recurrence rates and functional recovery. Our study also highlights the importance of post-operative care and rehabilitation in achieving optimal functional outcomes. The consistent improvement in MSTS scores over time suggests that ongoing physical therapy and monitoring play crucial roles in patient recovery. Developing standardized post-operative care protocols could further enhance recovery and functional outcomes for GCT patients.

Some of the major limitations of the study were relatively small sample size, limited number of participants, lack of longer follow-up periods and single-center design.

CONCLUSION

Intralesional curettage combined with the Sandwich Technique using a combination of bone grafts and PMMA to leverage the benefits of both materials, protecting the underlying articular cartilage and enhancing structural support, achieves a low recurrence rate with very low complications as well as good functional outcomesas evidenced by the substantial improvement in MSTS scores at 6, 12, and 18 months post-surgery compared to pre-operative scores. This underscores the effectiveness of combining curettage with the Sandwich Technique in preserving joint function and reducing recurrence. Future studies with larger sample sizes and longer follow-up periods could further validate these results and provide additional insights into optimizing treatment protocols for GCTs.

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