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Complications and outcomes of curettage, chemical cauterization and bone graft in giant cell tumor of bone

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ABSTRACT

Background: Giant cell tumor of bone (GCTB) is a locally aggressive benign bone neoplasm with a high potential for recurrence. While intralesional curettage remains the standard treatment, combining chemical cauterization and bone grafting may enhance therapeutic outcomes. This study aimed to evaluate the complications and outcomes of this combined approach in managing GCTB.
Methods: A prospective observational study was conducted at the national institute of traumatology and orthopedic Rehabilitation (NITOR), Dhaka, Bangladesh, from September 2021 to March 2024. A total of 32 patients diagnosed with GCTB were treated using curettage, chemical cauterization and bone grafting. Functional outcomes were assessed using the Musculoskeletal Tumor Society (MSTS) scoring system, while complications and recurrence rates were recorded. Statistical analysis was performed using Student's t-test and Chi-square test, with significance set at $p<0.05$.
Results: The mean MSTS score significantly improved from 58.8%±15.4% preoperatively to 85.2%±15.9% at the last follow-up ($p<0.01$). A low recurrence rate of 6.25% was observed. Pain levels, assessed by the visual analogue scale (VAS), significantly decreased from 4.3±1.2 to 2.1±1.5 ($p=0.00002$). Complications included joint stiffness (25%), superficial infections (9.38%) and early osteoarthritis (6.25%).
Conclusions: The combination of curettage, chemical cauterization and bone grafting proved to be an effective treatment strategy for GCTB, resulting in low recurrence, significant pain reduction and favorable functional outcomes. This approach should be considered a reliable management option, particularly in resource-limited settings.

Keywords: Bone grafting, Curettage, Chemical cauterization, Functional outcome, Giant cell tumor of bone, MSTS score, Orthopedic oncology, Pain reduction, Recurrence

INTRODUCTION

Giant cell tumor of bone (GCTB) is a locally aggressive, intermediate-grade benign bone neoplasm that predominantly affects young adults aged between 20 and 40 years.[1] It accounts for approximately 4-10% of all primary bone tumors and is characterized by a high tendency for local recurrence, despite its benign classification Nagarajan et al. GCTB most frequently involves the epiphyseal region of long bones, particularly the distal femur (25–30%), proximal tibia (20-25%) and distal radius (10-15%), making it a critical concern in orthopedic oncology due to its impact on joint function and mobility.[2,3] Notably, epidemiological studies indicate that GCTB has a higher prevalence in Asian populations, where it comprises 15-20% of all benign bone tumors, compared to Western populations where the incidence is lower.[4] The absence of comprehensive epidemiological data from Bangladesh necessitates further research to determine regional variations in prevalence, recurrence rates and treatment outcomes. Histopathologically, GCTB is composed of multinucleated giant cells, mononuclear stromal cells and osteoclast-like cells, which contribute to its aggressive osteolytic activity.[5] The tumor exhibits high

levels of matrix metalloproteinase-9 (MMP-9), which facilitates bone resorption and tumor invasion, explaining its propensity for local recurrence and cortical bone destruction.[6] Clinically, patients present with progressive bone pain, swelling, limited joint movement and pathological fractures, symptoms that may mimic other aggressive bone lesions, necessitating accurate diagnosis through radiography, MRI and biopsy.[1,7] Although rare, lung metastases occur in approximately 1-5% of cases, emphasizing the need for early intervention and long-term surveillance.[8,9] The current standard of care for GCTB is intralesional curettage, a bone-preserving surgical approach aimed at removing the tumor while maintaining joint integrity.[10]

However, simple curettage has an unacceptably high recurrence rate of 40–50%, making the use of adjuvant therapies essential in minimizing residual tumor cells.[11] Various adjuvants have been investigated, including chemical cauterization with phenol, ethanol or liquid nitrogen, as well as physical adjuvants like cryotherapy and high-speed burring.[12,13] While phenol application was previously believed to reduce recurrence, recent meta-analyses suggest that thorough curettage with high-speed burring and PMMA cementation is more effective in lowering recurrence rates. A systematic review of 2,579 patients demonstrated that phenol and hydrogen peroxide had no significant effect on recurrence rates compared to PMMA alone, challenging the routine use of these chemical adjuvants.[14]

Reconstructive options following curettage include autografts, allografts and polymethylmethacrylate (PMMA) bone cement.[15] Bone grafting facilitates biological integration and bone remodeling, but it is associated with donor-site morbidity, slower incorporation and a higher recurrence rate compared to PMMA cementation. A meta-analysis of 1,293 patients reported that bone grafting had a recurrence risk 2.09 times higher than PMMA cementation ($P<0.001$), reinforcing the preference for PMMA as the reconstructive material of choice.[16] However, concerns regarding thermal necrosis and subchondral bone damage with PMMA use highlight the need for further evaluation of long-term functional outcomes.[17] Despite advancements in treatment, GCTB remains a highly recurrent tumor, with recurrence rates ranging from 20-50%, depending on the surgical approach and adjuvant use.[18]

The debate between curettage with adjuvants vs. wide resection remains unresolved, as wide resection significantly reduces recurrence risk but comes at the cost of increased operative complications, functional impairment and higher morbidity.[18] Moreover, complications such as pathological fractures, joint stiffness and donor-site morbidity from bone graft harvesting further complicate treatment decisions.[19] The introduction of denosumab, a RANKL inhibitor, has shown promise in reducing tumor size and recurrence, but concerns regarding osteonecrosis, malignant transformation and high recurrence upon discontinuation have raised significant concerns regarding its long-term safety.[20] One of the major gaps in the literature is the lack of long-term functional outcome studies, particularly in developing countries where treatment protocols vary significantly.[21] Existing studies focus primarily on short-term recurrence rates, but few have assessed functional impairment, post-treatment quality of life or long-term survival outcomes.[22]

Additionally, regional disparities in treatment availability and follow-up care in countries like Bangladesh warrant localized studies to evaluate patient outcomes, recurrence patterns and complication rates. Given these challenges, the present study aims to evaluate the complications and outcomes of curettage, chemical cauterization and bone grafting in GCTB patients, focusing on recurrence rates, functional recovery and long-term complications. By bridging existing knowledge gaps, this study will provide evidence-based insights to optimize treatment strategies for GCTB in the Bangladeshi population and similar resource-limited settings.

METHODS

Study place

This prospective observational study was conducted at the National Institute of Traumatology and Orthopedic Rehabilitation (NITOR), Dhaka, Bangladesh.

Study duration

The study was carried over a period of two and a half years, from September 2021 to March 2024.

A total of 32 patients diagnosed with histopathologically confirmed GCTB were included in the study. The sampling technique followed purposive sampling (non-randomized), where patients were recruited based on availability while strictly adhering to the inclusion and exclusion criteria.

Inclusion criteria

Patients included in the study were those with a confirmed histopathological diagnosis of GCTB across all age groups. Additionally, selected cases of Campanacci Grade III GCTB, where computed tomography (CT) imaging demonstrated a cortical breach confined to a single surface and affecting less than one-third of the circumference, were considered eligible.

Exclusion criteria

Patients with recurrent or malignant GCTB, those with tumors located in inoperable anatomical sites and those with extensive Campanacci Grade III lesions with significant joint destruction were excluded.

Furthermore, subjects with pre-existing arthritic joint changes, extensive lesions affecting more than two-thirds of the cortical bone or subchondral bone stock measuring less than 5 mm post-extended curettage were not included. The clinical outcomes of the 32 patients who underwent curettage, chemical cauterization and bone grafting were evaluated using the musculoskeletal tumor society (MSTS) scoring system (Italian Modification), categorizing functional results as excellent, good, fair or failure.[23]

Further classification of MSTS scores was done based on Pandey's grading system, where an MSTS percentage score of 75% to 100% was considered excellent, 70% to<75% as good, 60% to<70% as moderate, 50% to <60% as fair and less than 50% as poor.[24] Data were processed and analyzed using Microsoft Office 365 (Excel and Word). Categorical variables were expressed as frequency and percentage (%), while quantitative data were presented using mean, standard deviation (SD) and range.

Statistical analysis

Statistical analysis was performed using the student's t-test for comparing continuous variables and the Chi-square (χ^2) test for categorical data. A p value<0.05 was considered statistically significant and results were presented with a 95% confidence interval (CI) for statistical reliability. Ethical approval for the study was obtained from the Institutional Review Board (IRB) of NITOR, Dhaka, Bangladesh. Informed consent was taken from all participants before enrollment and strict confidentiality of patient data was maintained throughout the study.

RESULTS

The baseline characteristics of the study participants (n=32) are presented in Table 1. The mean age of the participants was 28.5 years with a standard deviation of 10.1 years, ranging from 17 to 60 years. The majority of patients were in the 18-30 years age group, accounting for 50% of the sample, followed by 37.5% in the 31-40 years category. A smaller proportion of patients were aged 41-50 years (9.38%) and only one participant (3.13%) fell within the 51-60 years range. In terms of gender distribution, there was a slight female predominance, with 53.13% of the participants being female (n=17) and 46.88% being male (n=15).

The most commonly affected anatomical site was the distal femur, involved in 43.75% of cases (n=14), followed by the proximal tibia (25%, n=8). Other affected sites included the proximal femur (12.5%, n=4), distal tibia and distal radius (each accounting for 6.25%, n=2), while the proximal humerus and calcaneum were the least commonly involved, with only one case each (3.13% each). The occurrence of pathological fractures was relatively low, observed in 9.38% of patients (n=3), whereas the majority of the participants (90.63%, n=29) did not present with fractures at the time of diagnosis.

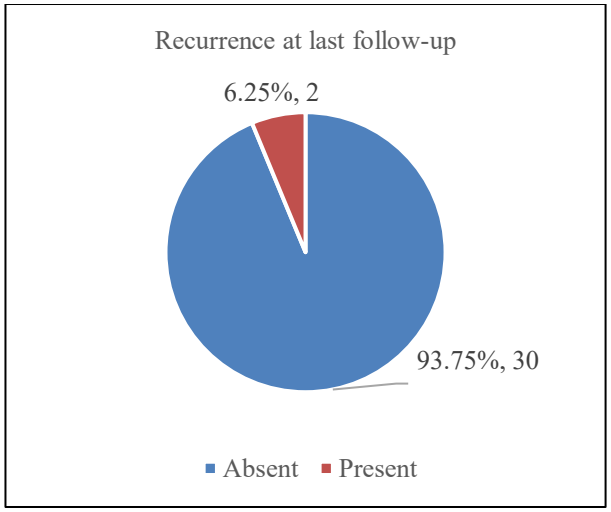

Figure 1: Recurrence of GCT of the study patients after last follow up (n=32).

The preoperative clinical features of the participants are summarized in Table 2. All patients (100%, n=32) presented with pain, making it the most prevalent symptom among the study population.

Other frequently observed symptoms included swelling of the knee, reported by 62.5% of participants (n=20) and knee stiffness, which was experienced by 50% of the patients (n=16). Muscle wasting was the least common clinical feature, affecting only 9.38% of participants (n=3). The duration of symptoms ranged from 2 to 9 months, with an average duration of 5.8 months and a standard deviation of 1.7 months.

The majority of patients (46.88%, n=15) experienced symptoms for 6-7 months, followed by 25% (n=8) who reported symptoms for 4-5 months. A smaller proportion of patients experienced symptoms for 2-3 months (12.5%, n=4) and 8-9 months (15.63%, n=5).

Regarding the Campanacci grading, most patients were classified as Grade II, accounting for 84.38% of the study population (n=27), indicating moderate bone destruction and cortical thinning without significant soft tissue involvement. The remaining 15.63% (n=5) were classified as Grade III, characterized by more extensive bone destruction and potential cortical breach.

Figure 1 illustrates the recurrence status of GCTB among the study participants at the last follow-up. Out of 32 patients, the vast majority (93.75%, n=30) did not experience any recurrence of the tumor during the follow-up period. In contrast, 6.25% of the participants (n=2) exhibited signs of tumor recurrence. The comparison of visual analogue scale (VAS) scores between the preoperative period and the last follow-up after 12 months is presented in Table 3. The mean preoperative VAS score was 4.3±1.2, indicating a moderate level of pain experienced by the patients before treatment. At the last

follow-up, there was a significant reduction in pain, with the mean VAS score decreasing to 2.1±1.5. This reduction was statistically significant, with a p value of 0.00002, indicating a highly significant improvement in pain levels following treatment. The distribution of complications among the study participants is presented in Table 4. Out of the 32 patients, the most frequently observed complication was stiffness of the adjacent joint at the last follow-up, affecting 25% of the participants (n=8). Superficial infections were reported in 9.38% of cases (n=3), which were managed with appropriate medical interventions. Additionally, early osteoarthritis was observed in 6.25% of patients (n=2), indicating the potential long-term degenerative effects of the tumor or its treatment on joint structures. The final outcomes of the study participants, assessed using the musculoskeletal tumor society (MSTS) scoring system at the last follow-up, are detailed in Table 5. The majority of patients (75%, n=24) achieved an excellent outcome, indicating a high level of functional recovery following treatment. A good outcome was observed in 12.5% of participants (n=4), while moderate and fair outcomes were recorded in 3.13% of patients each (n=1 for both categories). However, 6.25% of participants (n=2) experienced a poor outcome, reflecting limited functional recovery. The comparison of Musculoskeletal Tumor Society (MSTS) scores between the preoperative period and the last follow-up after 12 months is presented in Table 6. The mean preoperative MSTS score was 58.8%±15.4%, indicating a moderate level of functional ability prior to treatment. At the last follow-up, there was a significant improvement, with the mean MSTS score increasing to 85.2%±15.9%. This improvement was statistically significant, with a P value of<0.01, highlighting the effectiveness of the treatment in enhancing functional outcomes.

Table 1: Distribution of baseline characteristics among the participants (n=32).

Baseline characteristics	N	%
Age (in years)		
18-30	16	50.00
31-40	12	37.50
41-50	3	9.38
51-60	1	3.13
Mean±SD	28.5±10.1	
Range	17-60	
Gender		
Male	15	46.88
Female	17	53.13
Anatomic locations		
Distal femur	14	43.75
Proximal tibia	8	25.00
Proximal femur	4	12.50
Distal tibia	2	6.25
Distal radius	2	6.25
Proximal humerus	1	3.13
Calcaneum	1	3.13
Pathological fractures		
Present	3	9.38
Absent	29	90.63

Table 2: Preoperative clinical feature distribution among the participants (n=32).

Variables	N	%
Clinical symptoms		
Pain	32	100.00
Swelling of knee	20	62.50
Stiffness of knee	16	50.00
Muscle wasting	3	9.38
Duration of symptoms (in months)		
2-3	4	12.50
4-5	8	25.00
6-7	15	46.88
8-9	5	15.63
Mean±SD	5.8±1.7	

Continued.

Variables	N	%
Campanacci grading		
Grade II	27	84.38
Grade III	5	15.63

Table 3: Difference between preoperative and last follow up after 12 months (n=32).

Period	VAS (Mean±SD)	P value
Preoperative	4.3±1.2	0.00002
At the last follow up	2.1±1.5	

Table 4: Complications of the study patients (n=32).

Complication	N	%
Superficial infection	3	9.38
Early osteoarthritis	2	6.25
Stiffness of adjacent joint at last follow up	8	25.00

Table 5: Final outcome according to MSTS score at last follow up (n=32).

Final outcome	N	%
Excellent	24	75.00
Good	4	12.50
Moderate	1	3.13
Fair	1	3.13
Poor	2	6.25

Table 6: Difference of MSTS score between preoperative and last follow up (n=32).

Period	MSTS (Mean±SD)	P value
Preoperative	58.8%±15.4%	<0.01
At the last follow up	85.2%±15.9%	

DISCUSSION

The present study evaluated the outcomes of a combined treatment protocol involving curettage, chemical cauterization and bone grafting for GCTB, with a focus on recurrence rates, pain reduction, functional improvement and postoperative complications.

The findings revealed a low recurrence rate of 6.25%, a significant reduction in pain levels (p=0.00002), substantial functional recovery as evidenced by the increase in MSTS scores from 58.8%±15.4% preoperatively to 85.2%±15.9% at the last follow-up (p<0.01) and a relatively low complication rate. These outcomes highlight the effectiveness of this treatment strategy, with results comparable to or surpassing those documented in existing literature. The recurrence rate observed in this study is notably lower than rates reported in earlier research. For instance, Machak et al demonstrated that using combined adjuvant therapies reduced recurrence rates to a median of 11% across 6441 patients.[11] Our study's lower recurrence rate could be attributed to the stringent inclusion criteria and the meticulous execution of surgical techniques, including high-speed burring and thorough chemical cauterization, which have been previously associated with improved local control outcomes.[11] Similarly, Şirin et al, reported a recurrence rate of 5.1% following extended curettage, electrocauterization and cementation, which closely aligns with the 6.25% recurrence rate found in our study.[25] The significant reduction in pain levels observed in our cohort also reflects the effectiveness of the treatment strategy employed. The mean visual analog scale (VAS) score dropped from 4.3±1.2 preoperatively to 2.1±1.5 postoperatively, which is comparable to the findings of Jamshidi et al, who reported significant postoperative pain reduction in patients treated with total synovectomy, curettage and bone grafting/cementation for diffuse-type tenosynovial GCTB.[26] This aligns with the outcomes reported by Carolino et al, who documented excellent pain relief and functional outcomes following extended curettage and limb salvage surgery for GCTB in the lower extremities.[27] Functional improvement was another crucial aspect of the study, with MSTS scores showing significant postoperative improvement. The increase from a preoperative mean of 58.8%±15.4% to 85.2%±15.9% at the last follow-up is consistent with the findings of Şirin et al, where patients experienced an improvement from 46.1% preoperatively to 91.7% postoperatively.[25] Additionally, the study by Pandey reported a mean MSTS

score of 84.27% following surgery, which is in close agreement with the results of our study, highlighting the efficacy of surgical intervention combined with adjuvant therapies in restoring function in GCTB patients.[24] Similarly, Machak et al emphasized that combined curettage techniques yielded significantly better oncological and functional outcomes compared to simple curettage.[11] The relatively low complication rate observed in this study further underscores the effectiveness of the treatment protocol.

Joint stiffness was the most common complication, affecting 25% of patients, followed by superficial infections (9.38%) and early osteoarthritis (6.25%). These findings are consistent with those of Yenigül et al, who reported a 4.6% complication rate among patients treated with extended curettage and Şirin et al, who found a 7.6% complication rate, including instances of local recurrence and superficial wound infection.[25,28] The occurrence of early osteoarthritis in 6.25% of patients in our study aligns with findings from Algarf et al, who noted similar outcomes following extended curettage in patients with GCTB around the knee.[29]

Moreover, our observed infection rate is comparable to that reported by Kundu et al, who also identified superficial infections as a common complication following curettage procedures.[30] The low recurrence and complication rates observed in this study highlight the importance of combining curettage with chemical cauterization and bone grafting. The inclusion of chemical adjuvants, as emphasized by Machak et al, appears to contribute significantly to reducing recurrence rates and enhancing local control of the tumor.[11] Furthermore, our results underscore the importance of meticulous surgical technique and careful postoperative monitoring, particularly in high-risk anatomical locations, such as the distal femur and proximal tibia, which were the most commonly affected sites in this cohort. In conclusion, the findings of this study are consistent with previous research demonstrating the efficacy of combining curettage, chemical cauterization and bone grafting for treating GCTB.

This treatment strategy offers significant benefits in terms of reducing recurrence rates, alleviating pain, enhancing functional outcomes and minimizing complications. However, despite the promising outcomes, joint stiffness remains a notable complication that warrants further investigation. Future studies with larger sample sizes and longer follow-up periods are recommended to validate these findings and refine treatment protocols to further reduce recurrence rates and improve functional recovery.

The study was conducted in a single hospital with a small sample size. So, the results may not represent the whole community.

CONCLUSION

The findings of this study underscore the efficacy of combining curettage, chemical cauterization and bone grafting in the management of GCTB. This treatment approach demonstrated a low recurrence rate of 6.25%, alongside significant pain reduction and functional improvement, as evidenced by the substantial increase in MSTS scores from 58.8% to 85.2% ($p<0.01$). Additionally, complications such as joint stiffness, superficial infections and early osteoarthritis were relatively infrequent and manageable, highlighting the overall safety and effectiveness of this intervention.

These outcomes are consistent with and, in some cases, surpass those reported in previous studies, emphasizing the importance of meticulous surgical technique combined with appropriate adjuvant therapy for optimal patient outcomes. Given the favorable results observed in this cohort, this treatment strategy presents a viable option for managing GCTB, particularly in resource-constrained settings. However, further studies with larger sample sizes and longer follow-up periods are necessary to validate these findings and refine management protocols, particularly concerning long-term functional outcomes and complication rates.

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