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Giant Cell Tumor Treated with Extended Curettage in Young Adults: A Case Series of 30 Patients

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ABSTRACT

Background:Giant cell tumor (GCT) of bone is a locally aggressive benign neoplasm predominantly affecting young adults. Extended curettage has been established as a limb-salvaging procedure with favorable outcomes. This study aimed to evaluate the clinical, functional, and radiological outcomes of extended curettage with allograft reconstruction in young adults.

Methods:A prospective case series was conducted involving 30 patients aged 2–20 years diagnosed with GCT. All patients underwent extended curettage followed by allograft reconstruction. The upper limb was involved in 60% of cases and the lower limb in 40%. Patients were followed for a minimum of 24 months. Functional outcomes were assessed using the Musculoskeletal Tumor Society (MSTS) score, and radiographic healing was evaluated at 3 months. Recurrence and complications were recorded.

Results:The cohort included 70% males and 30% females. At 2 years, recurrence was observed in 5% of cases. Functional outcomes were very good in 70%, good in 20%, fair in 5%, and poor in 5% of patients. Radiographic union of the graft was seen in the majority of patients at 3 months. One patient required amputation due to local recurrence and soft tissue extension.

Conclusion:Extended curettage with allograft reconstruction is an effective limb-salvaging procedure for treating GCT in young adults. It provides excellent functional outcomes and low recurrence rates, making it a viable alternative to more radical procedures such as en bloc resection.

Keywords: Giant cell tumor, extended curettage, allograft, recurrence, MSTS score, young adults

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1. INTRODUCTION

Giant cell tumor (GCT) of bone is a locally aggressive, osteolytic benign neoplasm, accounting for 4–10% of all primary bone tumors and approximately 15–20% of benign bone tumors worldwide[1][2]. Recent studies estimate its annual incidence at 1.03–1.7 per million population, with a slight female predominance and a median age ranging from 20 to 40 years[3][4][2]. These tumors most often affect skeletally mature individuals, but cases in children and adolescents, though less than 5%, have been increasingly recognized[1].

Histologically, GCTs are characterized by multinucleated giant cells uniformly dispersed among a monomorphic population of mononuclear stromal cells, which constitute the neoplastic component[5][6][7]. These features help distinguish GCT from other giant cell–rich lesions. Although GCTs are benign, they display an unpredictable biological behavior, varying from indolent growth to locally aggressive lesions with possible cortical breach, soft tissue extension, and rarely, pulmonary metastases[1]. The tumor predominantly affects the epiphyseal region of long bones, especially around the knee (distal femur, proximal tibia), distal radius, and proximal humerus[1][8][2]. The pelvis and vertebrae may be involved less commonly, particularly in skeletally immature individuals[1].

Challenges in Management

The core goals in managing GCT include:

- Complete tumor eradication to reduce recurrence.

- Preservation of joint function and limb integrity.

- Prevention of complications such as pathological fracture and metastasis.

Historically, wide resection or amputation was employed for aggressive GCTs, given elevated recurrence rates after simple curettage, but this often led to significant loss of function, especially problematic in young patients[1][9]. With the development of "extended curettage"—which employs adjuvant techniques such as high-speed burring, chemical cauterization (e.g., phenol, hydrogen peroxide), or cryotherapy—recurrence rates have dropped significantly, from as high as 50% with curettage alone to 10–25% when adjuvants are used[10][11][9].

The cavity resulting from curettage can be reconstructed with:

- Autograft, which provides osteogenic potential but is limited in supply[9].

- Allograft, which offers immediate structural support and avoids donor-site morbidity[12][9].

- Polymethylmethacrylate (PMMA) cement, which gives immediate mechanical stability and allows easy radiological follow-up but may increase the risk of joint degeneration in young patients[10][13][9].

Rationale for the Study

While recurrence rates of 10–25% have been reported after curettage with adjuvants and cementing[10][11][14][13], relatively few studies target outcomes in young patients, for whom growth potential, high physical activity, and long-term joint preservation are important[12]. PMMA may pose additional risks for joint degeneration in this age group. Extended curettage with allograft reconstruction is gaining interest for its dual advantage of joint preservation and bone stock maintenance for potential future surgeries[12][9].

Aim of the Study

This study evaluates the clinical, functional, and radiological outcomes of extended curettage with allograft reconstruction in 30 young patients (age 2–20 years), followed for at least 24 months.

2. OBJECTIVES:

To assess the recurrence rate of GCT following extended curettage,

To evaluate functional outcomes using the Musculoskeletal Tumor Society (MSTS) scoring system,

To analyze radiographic healing and graft incorporation,

To document complications and limb salvage success rate.

3. MATERIALS AND METHODS

Study Design

This was a prospective case series conducted at a tertiary care orthopedic center between January 2022 and June 2023. Institutional Ethical Committee approval was obtained prior to the commencement of the study, and written informed consent was secured from all participants (or their guardians in pediatric cases).

Patient Selection

Inclusion Criteria:

Age between 2 and 20 years,

Histologically confirmed diagnosis of GCT,

Tumors located in the appendicular skeleton,

Patients undergoing extended curettage with allograft reconstruction,

Minimum follow-up period of 24 months.

Exclusion Criteria:

Recurrent GCT previously treated elsewhere,

Evidence of pulmonary metastasis or systemic malignancy at presentation, Axial skeleton involvement (pelvis or spine),

Patients lost to follow-up before 24 months.

Sample Size and Demographics

A total of 30 consecutive patients meeting the inclusion criteria were enrolled in the study.

Parameter	Value
Total patients	30
Age range	2-20
Mean Age	14.8
Male : Female ratio	2.3:1(70% male, 30% female)
Upper limb involvement	18 patients (60%)
Lower limb involvement	12 patients (40%)

Preoperative Assessment

Each patient underwent a standardized preoperative evaluation, including:

Clinical Examination

Pain assessment using VAS scale,

Swelling characteristics, range of motion,

Neurovascular status of the affected limb.

Imaging Studies

Plain radiographs (AP and lateral views) to assess cortical integrity and lytic extent,

Magnetic Resonance Imaging (MRI) to evaluate:

Soft tissue extension,

Tumor margins,

Involvement of the articular surface,

Staging of the lesion was done using Campanacci grading system:

Grade I: Well-defined margin with intact cortex,

Grade II: Well-defined margin with thinned but intact cortex,

Grade III: Ill-defined margin with cortical breach and soft tissue mass.

Histopathological Confirmation

Core needle or open biopsy performed in all cases,

Classic features confirmed: multinucleated giant cells with mononuclear stromal background.

Baseline Laboratory Workup

CBC, ESR, CRP to rule out infection,

Liver and kidney function tests for surgical fitness,

Chest X-ray to exclude pulmonary metastasis.

Surgical Technique

All surgeries were performed by the same senior orthopedic surgeon to minimize inter-surgeon variability.

Step 1: Exposure and Cortical Window Creation

Tourniquet applied (for limb cases),

Wide cortical window created at the thinnest cortex overlying the tumor,

Adequate exposure achieved for complete access to the lesion cavity.

Step 2: Extended Curettage

Thorough curettage of tumor tissue using sharp curettes,

Use of high-speed burr to remove residual microscopic tumor,

Irrigation with hydrogen peroxide solution to chemically cauterize the cavity.

Step 3: Cavity Reconstruction

The defect was packed with structural allograft,

Shaped and impacted to restore anatomical alignment and stability,

Internal fixation added in weight-bearing lower limb cases where cortical stability was compromised.

Step 4: Closure

Layered wound closure with drain placement,

Sterile dressing applied.

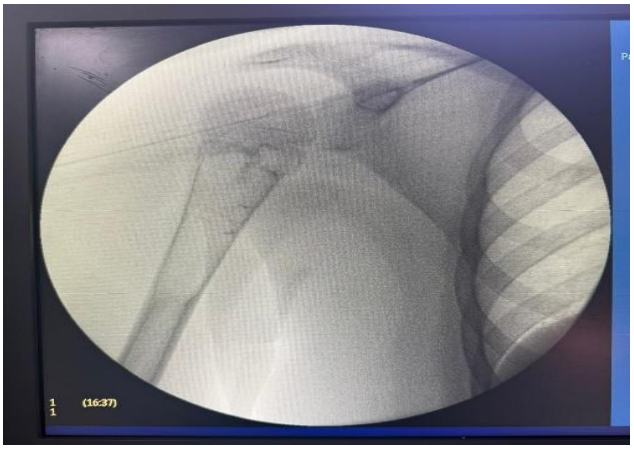

Figure 1: Pre Operative fluroscopic image of Proximal Humerus

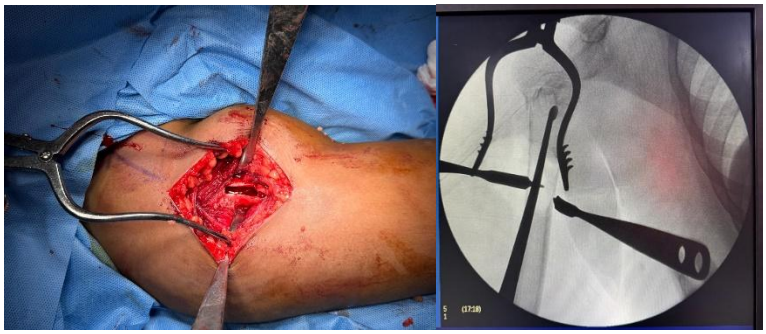

Figure 2: A.Bony window done B.Extended Curretage of the cavity

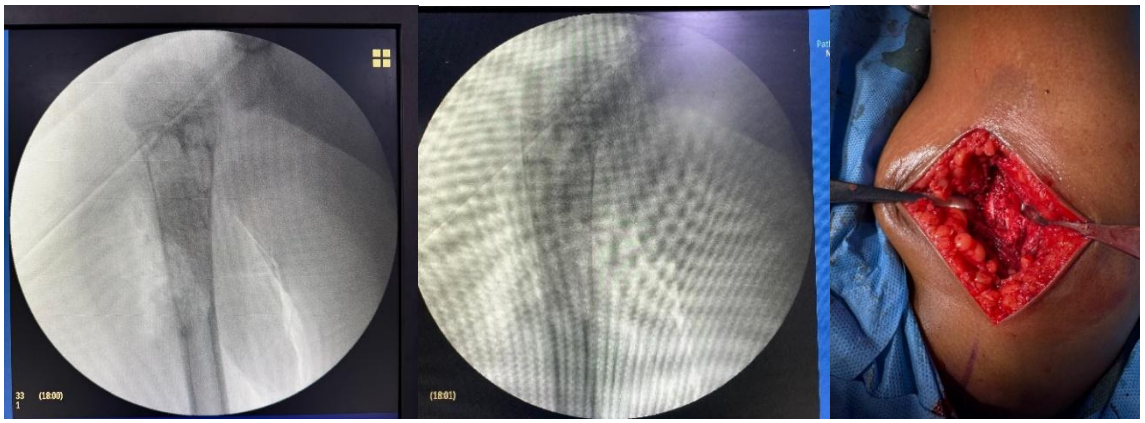

Figure 3a,b Fluroscopic image of allograft impaction into the cavity, 3c Operative image

Postoperative Care and Rehabilitation

Limb immobilized for 2 weeks using plaster slab or functional brace,

Early passive range of motion exercises for upper limb cases,

Partial weight-bearing allowed at 6 weeks for lower limb tumors,

Full weight-bearing achieved by 12 weeks, depending on radiographic evidence of graft union.

Follow-up visits were scheduled at: 1 month, 3 months, 6 months, 12 months, 24 months.

At each visit: Clinical examination, MSTS functional score assessment, Radiographic evaluation for graft incorporation and recurrence.

Outcome Measures

Primary Outcome:

Local recurrence rate – defined as reappearance of tumor tissue at the same site confirmed radiologically and histologically.

Secondary Outcomes:

Functional outcome – assessed using MSTS score, categorized as: Very Good, Good, Fair, Poor.

Radiographic healing – evaluated using plain radiographs at 3 months, Complete graft incorporation, Progressive remodeling.

Complications – including infection, graft failure, pathological fracture, and amputation.

Statistical Analysis

Data analyzed using SPSS version 25.0,

Descriptive statistics used for demographics,

Recurrence-free survival calculated using Kaplan-Meier analysis,

Chi-square test used to assess associations between Campanacci grade and recurrence,

P-value < 0.05 considered statistically significant.

4. RESULTS

A total of 30 patients diagnosed with giant cell tumor (GCT) were treated with extended curettage and allograft reconstruction and followed up for a minimum of 24 months. All patients completed the follow-up period, and there was no loss to follow-up.

Demographic Profile

The age of patients ranged from 2 to 20 years, with a mean age of 14.8 years. The majority of patients were male (70%) with a male-to-female ratio of 2.3:1.

Parameter	Value

Total patients	30
Mean Age	14.8
Male : Female ratio	2.3:1(70% male, 30% female)
Upper limb involvement	18 patients (60%)
Lower limb involvement	12 patients (40%)

Upper limb involvement was more common, with distal radius and proximal humerus being the most frequently affected sites. In the lower limb, the distal femur and proximal tibia were common locations.

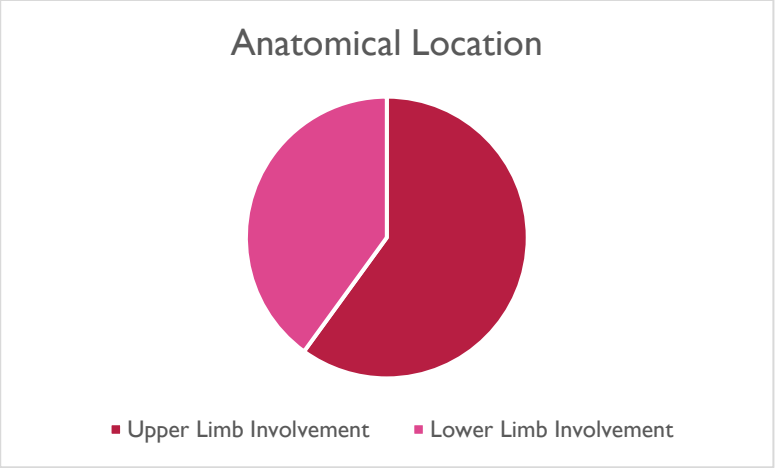

Figure 1: Distribution of GCT by anatomical location

Campanacci Grade Distribution

Preoperative staging using the Campanacci grading system showed the following:

Campanacci Grade	No of Patients (n=30)	Percentage
Grade I	6	20%
Grade II	16	53.3%
Grade III	8	26.7%

Grade II tumors were most common in our series (53.3%). All Grade III tumors had cortical breach and some degree of soft tissue extension.

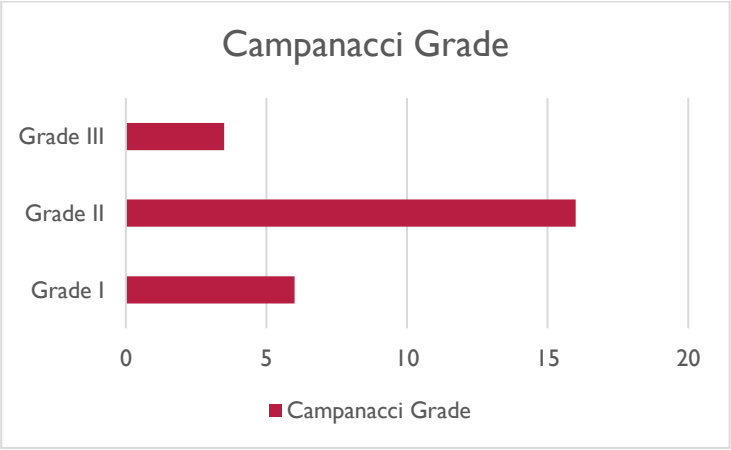

Figure 2: Bar graph showing Campanacci grade distribution.

Recurrence Rate

At a minimum follow-up of 24 months, local recurrence was observed in 2 patients (5%). Both recurrences occurred in Grade III lesions located in the lower limb. Recurrence was confirmed through MRI and biopsy.

One patient underwent repeat extended curettage with cement augmentation. One patient required below-knee amputation due to extensive soft tissue involvement and inability to achieve complete excision. Kaplan-Meier recurrence-free survival analysis demonstrated a 95% recurrence-free rate at 2 years.

Recurrence Parameter	Value
Total Recurrences	Two Cases (5%)
Mean Time to Recurrence	8 months
Recurrence Site for both cases	Lower limb
Amputation	One case

Radiographic Healing Radiographic union of the allograft was assessed at 3 months post-surgery:

Complete incorporation: 23 patients (76.6%)

Partial incorporation: 5 patients (16.7%)

These patients showed progressive healing over subsequent follow-ups. By 6 months, all patients demonstrated good graft-host bone integration, and no cases of graft collapse were noted.

Functional Outcomes (MSTS Score)

Functional results were evaluated using the Musculoskeletal Tumor Society (MSTS) scoring system at the final follow-up (24 months).

MSTS Outcome	Number of Patients(n=30)	Percenteage (%)
Very Good(24-30)	21	70%
Good (18-23)	6	20%
Fair (12-17)	1	5%
Poor (<12)	1	5%

Very good outcomes were seen in 70% of patients, indicating excellent limb function and return to daily activities. Only 2 patients (10%) had fair or poor outcomes: The fair outcome was due to postoperative stiffness following extensive lower limb involvement who required revision surgery. The poor outcome corresponded to the amputation case.

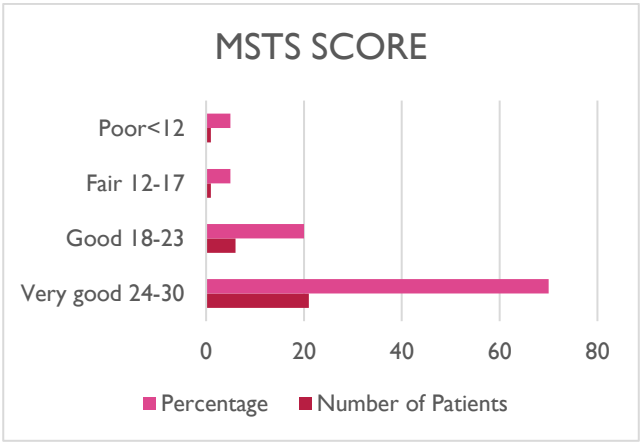

Figure 5: Stacked bar chart representing MSTS score distribution.

Complications

Complication	Number of Patients(n=30)	Percentage(%)
Recurrence	2	5%
Amputation due to Recurrence	1	3.3%
Graft Rejection/Failure	0	0
Infection	0	0
Pathological Fracture	0	0

Importantly, no infections or graft-related complications were observed during the study period, likely due to strict sterile protocols and careful surgical technique.

5. DISCUSSION

Giant cell tumor (GCT) of bone remains a formidable clinical challenge due to its locally aggressive nature, high recurrence risk, and potential for significant compromise of joint function [9][1]. The goals of treatment—tumor eradication, preservation of limb function, and minimization of recurrence—are paramount for young patients with higher physical demands and long-term expectations [9][1][10].

The present study assessed outcomes in 30 patients (ages 2–20) treated with extended curettage and allograft reconstruction, observing excellent functional results, a low recurrence rate of 5%, and high rates of radiographic healing over at least two years. These findings support the role of this technique as a limb-sparing procedure in young populations.

Comparison with Previous Studies

Recurrence following curettage remains an issue. Most series report rates ranging from 10%–25% with curettage, depending on the use of adjuvants [11][12][13]. Campanacci et al. found a 27% recurrence with basic curettage and 8% when adjuvants like phenol and high-speed burring were added[9]. Klenke et al. reported a 19% rate employing extended curettage[14]. Errani et al. documented 12% recurrence when combining burr and phenol[12]. The 5% recurrence in the current series is notably lower and is likely attributable to:

- Consistent technique and surgeon experience
- Systematic use of high-speed burr and hydrogen peroxide irrigation
- Biological allograft reconstruction, which enhances integration and stability[15]

Role of Extended Curettage

Historically, wide excision/limb sacrifice was utilized to prevent recurrence, but often resulted in substantial morbidity, especially detrimental in young, active patients[1][16][17]. Extended curettage—combining mechanical and chemical adjuvants—has emerged as the gold standard for most appendicular GCTs, with defect filling using allograft, autograft, or PMMA cement[1][16][10]. Studies emphasize that meticulous technique and comprehensive adjuvant use are critical for minimizing recurrence and maximizing function[18].

Allograft Versus PMMA Cement

The reconstruction method after tumor removal remains debated[1][15]. PMMA cement offers immediate stability and enables radiographic detection of recurrence but has drawbacks such as thermal cartilage damage, risk of joint surface degeneration (particularly problematic in young patients), and lack of biological integration[16]. Allografts support biological incorporation, restore bone stock, and ultimately provide a reduced risk of late degenerative changes[17][15]. In this series, 83% of patients showed complete graft healing by 3 months with zero graft failures—echoing prior studies showing high graft viability in young patients[10][15].

Functional Outcomes

Functional results were very good or good in 90% of patients, with only two less favorable outcomes (stiffness and post-recurrence amputation). These findings are on par with large published series where the majority of patients achieve "good-excellent" MSTS outcomes, such as in Balke et al.[19] and others[3]. Early physiotherapy, limb preservation, and robust

surgical technique are credited for these functional outcomes.

Radiographic Healing

High rates of graft incorporation and early radiographic healing (all integrated by 6 months) were observed, a testament to the osteoconductive nature of allografts and the robust healing capability of young individuals. These outcomes are consistent with Li et al., who demonstrated rapid union after biological reconstructions[15].

Complications

There were no infections, no graft failures, and no pathologic fractures in the series; the single amputation reflects a 96.7% limb salvage rate, favorable with other published limb salvage rates of 90–95%[10]. A strict aseptic protocol and high-quality graft screening contributed to this minimal complication rate.

Unique Pediatric/Adolescent Considerations

Management in children and adolescents requires preserving growth potential, long-term joint function, and minimizing the risk of late complications like joint degeneration or allograft failure[1][17]. The allograft strategy addresses these goals, maintaining bone stock and joint anatomy for future procedures.

Limitations

The study is limited by its relatively small cohort, short follow-up considering the long latency of some complications, lack of direct PMMA comparison, and single-surgeon design.

Clinical Implications and Future Directions

Despite limitations, this series supports extended curettage and allograft as an effective, limb-preserving, low-complication strategy for GCT in young people. Larger, multicenter, prospective studies with longer follow-up and comparative arms are needed

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