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Original article

Outcomes of giant cell tumors around the foot and ankle: A pilot study

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Abstract. *Objective:* The giant cell tumor (GCT) of bone is a benign primary bone tumor that frequently exhibits aggressive behavior and a propensity for local recurrence, which is influenced by the treatment modality and the tumor's local characteristics. This study aimed to assess the efficiency, safety, recurrence and functional outcome of using the technique of extended curettage and cementation for the surgical management of GCT around the foot and ankle. *Methods:* Nine male and three female patients who had GCT around their ankle or foot were included. The average age was 33 years, with an average follow-up period of 12 months. Three patients had lesions in the distal tibia, one patient had lesions in the lateral malleolus, four patients had lesions in the talus, three patients had lesions in the calcaneus, and the remaining patient had lesions in the 1st metatarsal bone. *Results:* All patients experienced outstanding functional and satisfying results. No recurrence or damage to adjacent tissues was noted, and no serious intraoperative or postoperative problems were reported. There is a highly significant improvement of the American Orthopaedic Foot and Ankle Society (AOFAS) score with an average of 27.92 ± 5.42, which increased from 69.17 ± 5.97 preoperatively to 97.08 ± 3.34 postoperatively. *Conclusion:* Based on our study results, the technique of extended curettage and cementation is a valid option for treating GCT because, in contrast to cement's mechanical and cytotoxic properties, it provides exceptional safety results, ease of handling, and positive post-operative outcomes with no functional problems or recurrences. (www.actabiomedica.it)

Keywords: ankle, cement, curettage, giant cell tumor, foot

Introduction

Approximately 4–10% of all primary bone tumors are giant cell tumors (GCTs) of the bone, which are among the most common benign primary bone tumors. The normal epiphyseal position is seen in 90% of GCTs. GCT frequently spreads to the articular subchondral bone or even borders the cartilage. GCTs can occur in individuals over 50; however, they most typically affect young adults between the ages of 20 and 50. Females are slightly more prevalent than males, according to several authors. Females are at a higher risk of developing malignant forms (3:1) (1-3). GCTs are known to manifest clinically with pain and swelling, either with or without a pathological fracture. With a propensity for local recurrence, it manifests as a benign lesion that is frequently aggressive. Recurrence rates vary from 0% to 65%, depending on the approach taken and the tumor's local appearance (1,2). On plain radiographs, it shows as an eccentric metaphyseal -epiphyseal lesion that extends to the subchondral bone and is strongly lytic with no matrix. The lesions have a narrow transition zone, which is clearly demarcated. The sclerotic edge is usually absent (80–85%), with a narrow transition zone, and the periosteal reaction is also absent (4). Computed tomography (CT scan)

provides a clearer picture of the shape, size, and boundaries of a GCT, with accurate visualization of thinning and breakthrough of the cortical layer, as well as assessment of bone mineralization, which aids in planning the surgical approach. Primary osteosarcoma is suggested by the presence of primary bone development within the tumor (5,6). Magnetic resonance imaging (MRI) displays a uniform signal intensity; the lesion is well-defined, and the T1 image clearly distinguishes between the tumor and fatty marrow. On T1, the signal strength is dark (low to moderate), while on T2, it is bright (mid to high). On both T1 and T2 scans, regions of low signal intensity are attributed to high levels of hemosiderin. It is helpful in assessing the condition of the surrounding soft tissues, locating blood vessels, nerves, and determining subchondral extension into neighboring joints. It also helps to elect the most suitable option for surgical intervention to plan the operation effectively (5,6). A biopsy is essential for an accurate diagnosis and, therefore, for appropriate treatment. It enables prognosis, staging, and identification of tumors. However, it should be the final stage in the diagnostic procedure, following thorough anamnesis, a clinical examination, and extensive imaging of the lesion under investigation. Classic radiography, CT scans, MRI, and bone scans should all be used to detect any potential metastases (7). The primary objectives of treatment are to halt the lesion's growth, alleviate pain, prevent or stabilize pathological fractures, and reduce the likelihood of recurrence. Surgery is used to treat GCTs. The preferred method of treatment is intralesional resection by extended curettage (8,9). The objective of this study was to investigate and show the outcomes of extended curettage and cementation for the surgical management of GCT around the foot and ankle.

Materials and Methods

General data

Twelve patients (9 males and 3 females) with foot and ankle swellings who were diagnosed with GCT participated in a pilot study at the hospitals of Al-Azhar University in Egypt from March 2022 to December 2024. Patients were managed by the technique of extended curettage and cementation.

The inclusion criteria encompassed adults aged 20 years or older, primary lesions involving the bone, and lesions located around the foot and ankle; patients not amenable to surgery were excluded.

Preoperative evaluation

Every patient had a thorough medical history and a general checkup before they were recruited. All patients underwent a local physical examination for tenderness, range of motion (ROM), ability to walk and neurovascular examination. The Musculoskeletal Tumor Society (MSTS) (10) score and American Orthopaedic Foot and Ankle Society (AOFAS) (11) score were utilized to evaluate patients' symptoms, pain, foot and ankle function, ROM and patients' satisfaction after operation. Tumors working up including laboratory investigations, radiological imaging including plain radiographs (Figure 1A and 1B) and CT (Figure 1C and 1D) for assessing lesion, cortex invasion and articular surface extension and perforation, also, MRI (Figure 1E and 1F) for soft tissue extension and incisional biopsy for histopathological examination were done preoperatively for confirmation of diagnosis. Patients were 33 years old (22–46) on average, they all had a symptomatic GCT around the foot and ankle confirmed by tumor work up, three patients had lesion in distal tibia, one patient had lesion in lateral malleolus, four patients had lesion in talus, three on calcaneus, and the remaining one was in 1st metatarsal bone (Table 1). Before surgery, all patients underwent a standard evaluation process, which included laboratory testing, consultation with cardiologists, chest physicians, and anesthesia specialists to determine their surgical suitability and obtain their consent.

Operative technique

Five crucial elements are involved in the surgical procedure:

1. Anesthesia and preparations: All patients were positioned in the supine position. The surgery was performed under fluoroscopic guidance and spinal anesthesia. Antibiotics were administered

Figure 1(A-F). Radiograph of foot and ankle anteroposterior (A) and lateral (B) views shows an osteolytic lesion at the talus, eccentric, expansile, no periosteal reaction, erosion of the cortex, geographic and well demarcated. Computed Tomography Ankle Sagittal (C) and Axial (D) Views Show osteolytic lesion at the talus. Magnetic Resonance Images of the ankle, Sagittal (E) and Axial (F) Views, show a lesion in the talus, well circumscribed, Dark on T1 (low to intermediate signal intensity) and bright on T2 (intermediate to high intensity).

intravenously as prophylaxis to all patients, and a pneumatic tourniquet was utilized.

2. Surgical exposure and isolation of the soft tissues: Complete exposure at the start of the procedure enables visualization of the entire tumor cavity, as well as access to the bone and the soft tissue mass (Figure 2A) outside the bone. The muscles are separated from the bone and retracted away from the soft tissue component of the tumor, allowing for complete visualization of the tumor cavity. The tissues surrounding the cavity are shielded by putting mops soaked in hydrogen peroxide around the tumor cavity to kill the giant cells upon touch. To avoid spilling into uninvolved tissues, the tumor's soft tissue mass (Figure 2B) is excised

Table 1. Demographic and clinical data of the patients studied

Data		No = 12
Age	Mean ± SD	33.00 ± 7.83
	Range	22 – 46
Sex	Females	3 (25.0%)
	Males	9 (75.0%)
Site	Talus	4 (33.3%)
	Calcaneus	3 (25.0%)
	Distal Tibia	3 (25.0%)
	1st metatarsal	1 (8.3%)
	Lat. Malleolus	1 (8.3%)
Side	Right	7 (58.3%)
	Left	5 (41.7%)
Nature	Primary	12 (100.0%)
Space filling	Cement	12 (100.0%)
Operative time (Min)	Mean ± SD	102.08 ± 16.71
	Range	75 – 120
Recurrence	No	12 (0%)
Malignant transformation	No	12 (0%)
Complications	No	10 (83.3%)
	Occasional pain	2 (16.7%)

en bloc with a covering of healthy tissue. To prevent tumor leakage, the first opening into the osseous tumor cavity is made as narrow as possible. To obtain a full view of the tumor cavity (Figure 2C), the hole is then increased.

3. Curettage and burring of tumor: After clear visualization, the walls are carefully curetted with the curet's sharp edges. Tumors are sometimes concealed by overhanging osseous ridges in tumor cavities. A high-speed burr is used to break these hard osseous ridges, aiding in extending the curettage a few millimeters past the visible tumor boundary, as a curet might not be effective in doing so.
4. Extended curettage by using adjuvants: After a thorough curettage a hydrogen peroxide chemical agent has been used as an adjuvant to control the microscopic ailments that remain in the walls to prevent tumor recurrence.
5. Cavity reconstruction: Bone cement (Figure 2D) is used to fill the defect, followed by wound closure in layers and splinting.

Postoperative follow-up

Radiographs taken immediately after surgery to assess the accuracy of the curettage and cement containment. Excisional tissue sent for histopathological examination (Figure 3). In the outpatient clinic, follow-up radiographs (Figure 4) were routinely collected to observe the cement corporation and lesion healing. Immobilization in a below-knee slab for 3 weeks. Wound care and stitch removal after 12-14 days at the outpatient clinic. According to the cement corporation, partial weight bearing began after two to three weeks, and full weight bearing was completed after eight to ten weeks. All patients were routinely monitored every three to four weeks until the lesion healed, every three months for a year, then every six months to observe any delayed complications, including recurrence, infection, ankle instability, ankle arthritis, physeal injury, tendon subluxation, synovitis and wound problems. Functional outcomes were assessed with the MSTS and AOFAS scoring systems.

Statistical analysis

SPSS version 27.0 was used to conduct statistical analysis (Armonk, NY). Whereas categorical (qualitative) variables are shown as percentages, continuous (quantitative) variables are presented as the mean ± SD. Additionally, the chi-square test (χ^2) was used to compare categorical variables, and the paired t-test was used to compare continuous variables.

Results

The current study reveals a mean age of 33.00 ± 7.83 years. Of the patients, 75% were males and 25% were females. Seven patients developed the lesion on the right side (58.3%), and 5 patients developed the lesion on the left side (41.7%). This study showed that Four cases had the lesion in talus (33.3%), 3 cases had

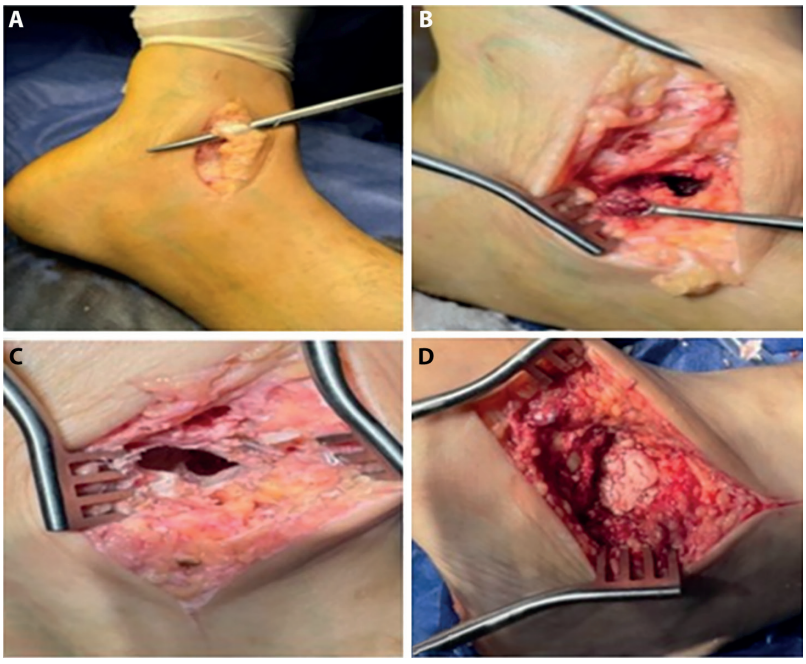

Figure 2(A-D). A. Dissection of Skin and Underlying Tissues. B. Tumor tissue removal. C. Empty cavity after evacuation of tumor tissue. D. Cavity cementation.

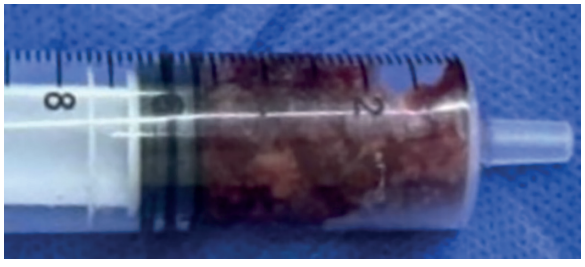

Figure 3. Tumor tissue excised from the lesions for histopathology.

the lesion in calcaneus (25%), 3 cases had the lesion in distal tibia (25%), 1 case had the lesion in 1st metatarsal bone (8.3%) and 1 case had the lesion in the lateral malleolus (8.3%). All the lesions were primary, not recurrent and treated with extended curettage and cement. The mean operation time was 102.08 ± 16.71 (75-120) minutes. There were no intraoperative problems. The average follow-up period was 12 months (6-24) (Table 1). At the follow-up outpatient clinic, no recurrence or malignant transformation was recorded. Two patients experienced occasional ankle pain, both improved after conservative treatment and physiotherapy without recurrence. The AOFAS revealed a highly significant average improvement in physical function, with a value of 27.92 ± 5, as it increased from an average of 69.17 ± 5.97 preoperatively to an average of 97.08 ± 3.34 postoperatively. Additionally, the MSTS score improved markedly from 17.92 ± 2.57 preoperatively to 27.92 ± 3.34 postoperatively (Table 2). Due to the lack of impairment, local irritation, and chronic pain, as well as the increase in physical activity without any serious problems or recurrence, all patients had satisfactory results.

Histopathology results

The gross picture of the lesions showed multiple soft, friable yellowish to orange, tan tissue pieces collectively admixed with multiple bony fragments. Microscopic picture of the lesions revealed pieces of tumour tissues formed of many osteoclastic multinucleated giant cells with surrounding vascularized stroma, with spindle-shaped mononuclear polyhedral cells with similar nuclei to those of giant cells. There is secondary haemorrhage and necrosis.

Figure 4(A-C). Follow-up radiographs of ankle joint anteroposterior and lateral views at 6 (A) ,12 (B) and 24 (C) months postoperative.

Discussion

Our study results did not report any recurrence of the lesions at the last follow-up; this result is superior to the result of Rajani et al. (12) who conducted a retrospective analysis of cases of GCT of the bone, particularly in the foot and ankle bones, from 1970 to 2010. Eighteen patients with a total of 19 disease locations were included. Ten of the 19 disease locations experienced recurrences. Patients require an average of 1.7 surgeries per illness site. Ten of the eighteen patients required at least two procedures, three required at least three, and one needed four. Two below-the-knee amputations were among the four total amputations carried out. Two of the ten individuals who experienced a recurrence also showed signs of metastatic illness. Additionally, Co et al. (2) reported seven cases in the foot and ankle, with the talus (57%) being the most commonly affected bone. Cuboid, calcaneus, and first metatarsal were also involved in one case each. Two patients had recurrent lesions involving the talus and metatarsal. Another study by Biscaglia et al. (13) found that 29 patients of GCT of the hand and foot had a 30% recurrence rate. While 79% of patients studied by Athanasian et al. (14) experienced recurrence, the primary lesion was treated with curettage. Our findings are comparable to those of Paul et al. (15) who employed an identical

Table 2. Preoperative and Postoperative functional scores.

Score	Pre	Pre	post	% change	Test value	P- value	Sig.
AOFAS	Mean ± SD	69.17 ± 5.97	97.08 ± 3.34	27.92 ± 5.42	17.849	<0.001	HS
	Range	55-75	90-100	20-35			
MSTS	Mean ± SD	17.92 ± 2.57	27.92 ± 3.34	10.0 ± 3.69	9.381	<0.001	HS
	Range	15-20	20-30	5-15			

P>0.05: Non-significant (NS); P<0.05: Significant (S); P<0.01: Highly significant (HS); Paired t-test. *Abbreviations:* AOFAS: American Orthopaedic Foot and Ankle Society, MSTS: Musculoskeletal Tumor Society.

technique (extended curettage), however, with bone cement or bone graft, in a retrospective study from January 2009 to December 2017 on 19 patients identified with a GCT and a minimum of 1-year follow-up. The surgeries performed were extended curettage and bone graft /cement in 8 patients, excision and bone graft in 8 patients and excision and mega prosthesis in 3 patients. None of these patients had local recurrence after surgery. Kamath et al. (16) reported 8 cases of GCT around the foot and ankle with a minimum 36-month follow-up period. Out of eight instances, seven underwent intralesional procedures, and the other one underwent primary amputation below the knee. The difficulties of obtaining complete curettage in tiny bone tumors are demonstrated by one instance, which required additional surgery due to a local recurrence affecting the tarsal bones within two years of the previous treatment. GCT is a benign, locally aggressive tumor that occurs in adults. It usually affects the epiphysis of long bones but can also occur, in rare cases, in the foot. The RANK pathway is frequently implicated in the pathophysiology of GCT, according to literature reports (1,2,5,6). The primary goal of treating these lesions is to prevent their progression. But conventional open surgery usually has more risk of complications, causing more damage to the surrounding soft tissue and structures, and may have long-term morbidity (17,18). Adding chemical cautery with phenol, utilizing liquid nitrogen for numerous freeze-thaw cycles, and employing a high-speed rotary burr to treat the cavity walls can all help reduce the high recurrence rate that occurs with curettage alone (17). It is estimated that 50% of patients will experience local recurrence following curettage alone. After extended curettage, recurrence rates are around 10%. Treatment options for local recurrence include repeated protracted curettage or, in case that local control is not achievable, the valid option is extensive excision and bone graft restoration (17-19). The heat generated during the polymerization of polymethylmethacrylate (PMMA) cement may aid in the destruction of any remaining tumor cells and reduce the likelihood of local recurrence. Depending on the surgeon's preference, either bone graft or PMMA cement may be used to fill the tumor cavity. Some people believe that because PMMA cement releases a significant amount of heat during hardening, it reduces the likelihood of a local recurrence. A second intralesional procedure is typically used to treat recurrences. In instances where bone grafting is used, it could be more challenging to identify the preliminary signs of local recurrence (5,18-20). The outcome depends on factors such as age, tumor size, location, and the treatment method. GCT can recur, so regular follow-up visits with radiographs and chest radiographs are essential for several years post-treatment. Monitoring ensures early detection and management of any recurrence (15). One of the study's advantages is that we assessed the patient's functional activity after surgery using the AOFAS and MSTS scoring systems, in contrast to the other institution, which focuses only on the recurrence of the lesion. The small sample size of our study poses a limitation, which is due to the rarity of the lesions, a phenomenon also noted in other studies, due to its single-center design and brief follow-up duration.

Recommendations

Longer follow-up periods and larger sample sizes are necessary required for additional comparison studies to validate our findings and pinpoint recurrence risk factors.

Conclusion

Based on our study results, the technique of extended curettage and cementation are a valid option for treating GCT because, in contrast to cement's mechanical and cytotoxic properties, it provides exceptional safety results, ease of handling, and positive post-operative outcomes with no functional problems or recurrences.

Ethical Approval: Our study adhered to the principles of the Helsinki Declaration, and the Institutional Review Board at Al-Azhar Ethics Council of Al-Azhar University Hospitals, approved this research project. The registration number: Pat.3Med-Research-000003 was issued on 1/3/2022.

Conflict of Interest: Each author declares that he or she has no commercial associations (e.g., consultancies, stock ownership, equity interests, patent/licensing, arrangement etc-) that might pose a conflict of interest in connection with the submitted article.

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Use of AI: The authors certify that neither the manuscript nor the photos were written or edited using AI technology.

Patients' Consent to Use their Data and Images: The authors certify that they obtained all required patient consent forms.

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