

Aneurysmal Bone Cyst of Distal Tibia in an Adolescent Male a Successful Management with Extended Curettage and Autologous Bone Grafting: A Case Report

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ABSTRACT

Background: Aneurysmal bone cyst (ABC) is a benign but locally aggressive osteolytic lesion that predominantly affects pediatric and adolescent populations, typically involving the metaphysis of long bones. While the distal femur and proximal tibia are common sites, distal tibial involvement is rare, occurring in fewer than 9% of cases, and carries an inherent risk of pathological fracture and ankle joint morbidity.

Methods: A 14-year-old male presented with gradually progressive pain and swelling over the left distal leg for six months. Radiographs demonstrated an eccentric, expansile lytic lesion in the distal tibial metaphysis with cortical thinning and internal septations. Magnetic resonance imaging (MRI) showed a multiloculated cystic lesion with characteristic fluid-fluid levels. Core needle biopsy confirmed a primary ABC. The patient underwent extended intralesional curettage through an anteromedial approach with high-speed burr burring. The cavity was filled with an autologous cancellous bone graft harvested from the iliac crest combined with a hydroxyapatite/ β -tricalcium phosphate composite synthetic bone graft (G-Bone).

Results: At 12-month follow-up, the patient achieved full, painless ankle range of motion and complete weight-bearing functionality. Radiographs demonstrated excellent graft incorporation and cortical remodeling, with no evidence of local recurrence.

Conclusion: Early advanced imaging, extended curettage, and robust bone grafting provided satisfactory clinical and radiological outcomes in this rare distal tibial ABC. This approach may be an effective treatment strategy for ABCs occurring at uncommon anatomical locations.

Key-words: Aneurysmal bone cyst, Distal tibia, Extended curettage, Autologous bone graft, Adolescent, Benign bone tumor

INTRODUCTION

Aneurysmal bone cyst (ABC) is a benign, locally aggressive, and highly vascular osteolytic bone lesion that accounts for approximately 1% to 2% of all primary bone tumors ^[1]. First described by Jaffe and Lichtenstein in 1942, this entity is pathologically characterized by blood-filled anastomosing cavernous spaces separated by cellular fibrous septa containing fibroblasts, reactive woven bone, and multinucleated osteoclast-like giant cells ^[1,2]. The condition predominantly affects children

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and adolescents, with nearly 80% of clinical cases manifesting in individuals under the age of 20 years^[3]. The metaphysis of long tubular bones is the most vulnerable site, with the distal femur and proximal tibia representing the classic locations^[4]. However, involvement of the distal tibia is relatively uncommon, reported in only 8.93% of cases across large series^[5]. Managing an ABC in this region poses distinct structural challenges due to the subcutaneous nature of the distal tibia, minimal soft-tissue coverage, and the high mechanical stresses placed across the ankle joint, which increase the risk of a catastrophic pathological fracture^[5].

Surgical intervention remains the gold standard, though traditional simple curettage has a high recurrence rate ranging from 10% to 30%^[2,6]. Extended curettage—utilizing chemical or mechanical adjuvants like a high-speed burr—dramatically reduces recurrence^[5,6]. We present a case of a primary distal tibial ABC in a 14-year-old male successfully managed with extended curettage, an autologous iliac crest bone graft, and a synthetic bone substitute.

CASE REPORT

Patient Information- A 14-year-old male patient presented to the outpatient department with complaints of pain and progressive swelling over the left distal leg for a duration of six months. The pain was insidious in onset, gradually progressive, and aggravated by weight-bearing activities. The swelling was localized to the distal aspect of the left leg and had been progressively increasing in size. There was no history of antecedent trauma, fever, or constitutional symptoms such as weight loss or night sweats. The patient had no significant past medical or surgical history, and there was no family history of bone tumors or genetic disorders.

Clinical Examination- Physical examination revealed a distinct, firm, non-fluctuant swelling over the anteromedial aspect of the left distal tibia, measuring approximately 4×3 cm. The overlying skin appeared normal with no erythema, warmth, or prominent superficial veins (Fig. 1 a & 1b). Mild localized tenderness was elicited on deep palpation.

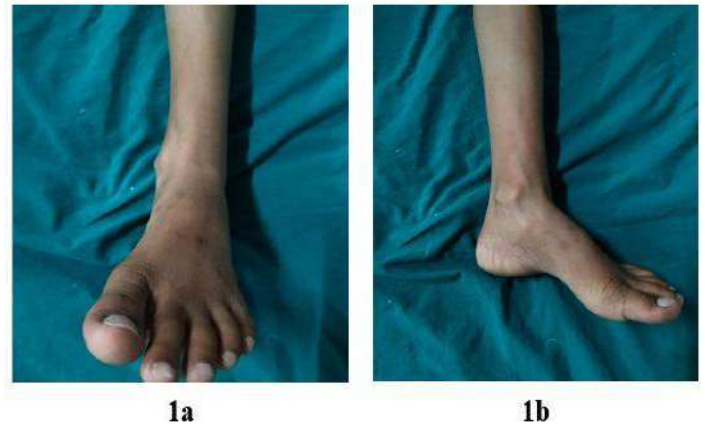


Fig. 1a, 1b: Clinical presentation showing swelling over the anteromedial aspect of the left distal tibia

The range of motion of the ankle joint was preserved, and the patient was able to bear weight with discomfort. Distal neurovascular examination revealed intact sensation, normal motor function, and palpable dorsalis pedis and posterior tibial pulses. No regional lymphadenopathy was present.

Radiological Evaluation- Plain radiography of the left leg, including anteroposterior and lateral views of the distal tibia, revealed an eccentric, expansile lytic lesion located in the distal tibial metaphysis. The lesion demonstrated cortical thinning with expansion and internal septations, producing a characteristic "blown-out" appearance. There was no evidence of cortical breach, periosteal reaction, or matrix mineralization (Fig. 2).



Fig. 2: Preoperative anteroposterior and lateral radiographs of the left distal tibia showing an eccentric, expansile lytic lesion with cortical thinning and internal septations

Computed Tomography (CT) [Fig. 3a- Axial CT slice showing internal septations (left)] and Magnetic Resonance Imaging (MRI) [Fig. 3b-Coronal T2-weighted MRI image displaying multiloculated cystic spaces with diagnostic fluid-fluid levels (right)] were performed to

assess structural margins and soft-tissue extension. The CT scan delineated a sharp zone of transition with an intact, paper-thin rim of reactive cortical bone (Fig. 3a). The MRI demonstrated a multiloculated cystic mass with intermediate signal intensity on T1-weighted images and high signal intensity on T2-weighted images (Fig. 3b). Notably, multiple internal fluid-fluid levels—representing the sedimentation of cellular blood elements within serum—were highly visible, a pathognomonic sign confirming an ABC. No intra-articular extension or extraosseous soft-tissue mass was observed.

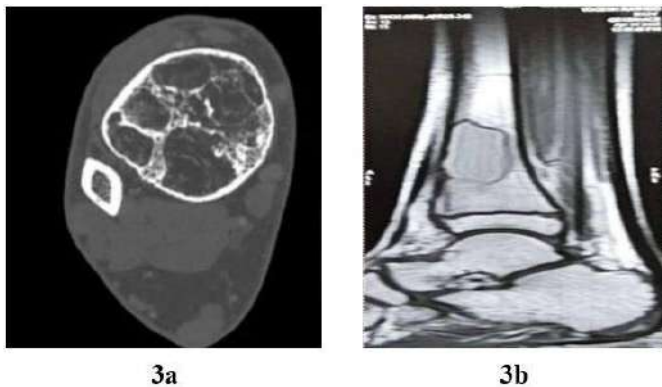


Fig. 3a, 3b: (a) Axial CT image showing internal septations within the lesion.

(b) Coronal T2-weighted MRI image showing a multiloculated cystic lesion with characteristic fluid-fluid levels.

Laboratory Investigations- Routine hematological and biochemical investigations (complete blood count, renal and hepatic profiles, and coagulation indices) were entirely normal. Serum calcium (9.4 mg/dL), phosphorus (3.8 mg/dL), and alkaline phosphatase (142 U/L) levels were within standard pediatric physiological ranges, ruling out metabolic or hyperparathyroid bone diseases.

Histopathological Examination- To definitively exclude telangiectatic osteosarcoma or a giant cell tumor, an ultrasound-guided core needle biopsy was performed. Histopathology demonstrated cavernous spaces filled with erythrocytes, bounded by fibrous septa containing proliferation of spindle-shaped fibroblasts, woven bone rimmed by osteoblasts, and scattered multinucleated giant cells. No cytological atypia, hyperchromatic nuclei, or atypical mitotic figures were observed, confirming a benign ABC (Fig. 4a & 4b).

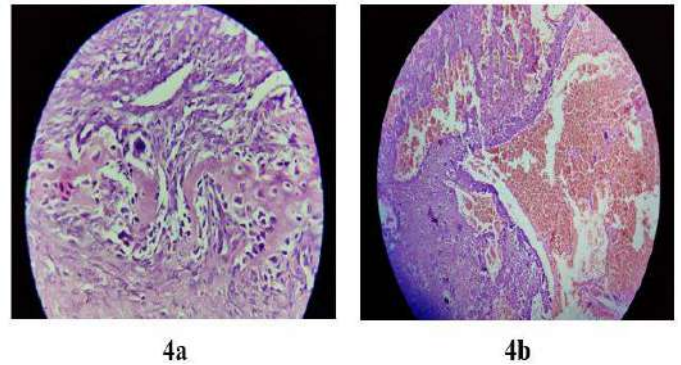


Fig. 4a, 4b: Histopathological images showing cavernous blood-filled spaces separated by fibrous septa containing spindle-shaped fibroblasts, woven bone, and multinucleated giant cells, consistent with aneurysmal bone cyst.

Surgical Management- The patient was taken up for definitive surgery under spinal anesthesia and pneumatic tourniquet control. An anteromedial approach to the distal tibia was chosen to directly expose the expanded cortex while preserving the surrounding soft-tissue envelope. A precise cortical window was constructed using a high-speed mechanical burr. Thorough intralesional curettage was executed to evacuate all hemorrhagic fluids, internal septal structures, and the vascularized tumor lining. Extended curettage was then performed by aggressively burring the inner walls of the cavity with a high-speed burr until healthy, bleeding bone margins were exposed, eliminating microscopic disease (Fig. 5a).



Fig. 5a, 5b: Intraoperative photographs showing extended curettage with high-speed burr and filling of the cavity with autologous cancellous iliac crest bone graft combined with hydroxyapatite/β-tricalcium phosphate synthetic bone graft (G-Bone).

The resulting structural void was tightly packed with a combination of autologous cancellous bone graft harvested from the ipsilateral anterior iliac crest and a

synthetic bone graft substitute consisting of a hydroxyapatite / beta-tricalcium phosphate ceramic composite (G-Bone) (Fig. 5b). Layered closure was performed over a negative-pressure drain, and the limb was immobilized in a below-knee posterior plaster slab.

Postoperative Management- The postoperative recovery period was completely uneventful. The surgical wound healed cleanly, and sutures were removed on the 14th postoperative day (Fig. 6a, 6b). The patient was kept non-weight bearing in a below-knee slab for six weeks to protect the structural integrity of the distal tibia and facilitate early graft consolidation. At six weeks, immobilization was discontinued, and progressive partial weight-bearing was initiated inside a protective functional brace.



Fig. 6a, 6b: Postoperative clinical and radiographic images following surgical management of the distal tibial aneurysmal bone cyst.

Postoperative histopathological examination of the curetted specimen confirmed the diagnosis of aneurysmal bone cyst and definitively excluded malignancy (Fig. 7a & 7b).

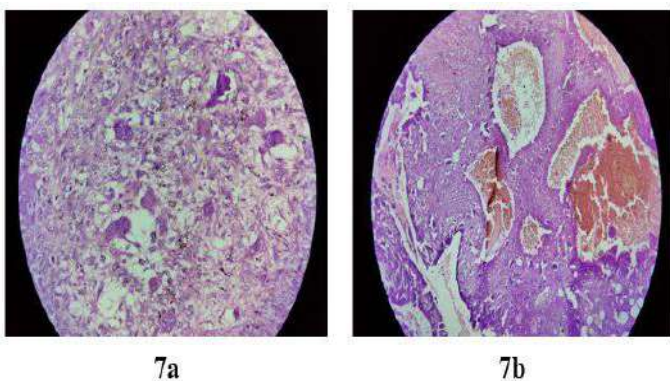


Fig. 7a, 7b: Postoperative histopathological images of the curetted specimen confirming aneurysmal bone cyst and excluding malignancy.

Follow-up and Outcome- At the 12-month follow-up, the patient exhibited an excellent functional outcome. He achieved full, pain-free ankle range of motion and could comfortably perform high-demand functional maneuvers, including single-leg heel raises (Fig. 8a, 8b).



Fig. 8a, 8b: Clinical photographs at 12-month follow-up demonstrating full, pain-free ankle range of motion and functional recovery, including single-leg heel raise.

Serial radiographs at one year post-surgery demonstrated complete bone remodeling, robust consolidation of the autograft/synthetic matrix mixture, progressive thickening of the neo-cortex, and zero signs of osteolytic radiolucency or local recurrence (Fig. 9a, 9b).



Fig. 9a, 9b: Follow-up radiographs at 12 months demonstrating bone remodeling, consolidation of the autograft/synthetic graft construct, progressive cortical thickening, and absence of local recurrence.

DISCUSSION

Aneurysmal bone cysts present a therapeutic challenge because of their aggressive osteolytic nature and high risk of local recurrence if undertreated. Although the molecular pathogenesis was long thought to be a purely reactive hemodynamic vascular phenomenon, the discovery of clonal neoplastic rearrangements of the *USP6* gene on chromosome 17p13 in a major subset of

primary ABCs has redefined the lesion as a true neoplastic process [2, 3].

While the epidemiological profile of our patient (a 14-year-old male) perfectly mirrors the typical age predilection of ABCs, the anatomical site was highly unique [3]. Distal tibial metaphysis lesions constitute fewer than 9% of all ABC cases [5]. The surgical management of a distal tibial ABC is technically demanding because the bone is subcutaneous, lacks an extensive muscular sleeve to bolster vascularity, and lies in close proximity to the distal tibial physis and the ankle joint plafond.

Advanced imaging is vital. Plain film radiography provides initial diagnostic clues ("blown-out" expansile appearance), but MRI remains the gold standard for non-invasive diagnosis by demonstrating pathognomonic fluid-fluid levels in up to 85% of cases [7]. This appearance results from separation of unclotted blood products, with denser, iron-rich erythrocytes sedimenting beneath lighter, clear serum layers.

The primary goal of surgical treatment is complete eradication while conserving local bone anatomy. Historically, simple intralesional curettage resulted in unacceptable recurrence rates up to 30% [2]. The implementation of extended curettage via mechanical tools (high-speed burr) or chemical adjuvants (such as phenol, alcohol, or liquid nitrogen) reduces recurrence rates to under 5–7% [5,6]. The high-speed burr mechanically disrupts the peripheral ridges and destroys microscopic tumor nests within the surrounding cancellous bone.

To reconstruct the large structural defect left behind, autologous cancellous bone grafting remains the ideal option due to its supreme osteoinductive, osteoconductive, and osteogenic properties. However, donor site morbidity from the iliac crest limits the volume of harvestable autograft [8-10]. To bypass this, we supplemented the construct with a biphasic ceramic substitute (hydroxyapatite and beta-tricalcium phosphate). The tricalcium phosphate component undergoes rapid cellular resorption to stimulate early osteogenesis, while the hydroxyapatite matrix degrades slowly, providing long-term scaffolding for complete mechanical remodeling of the distal tibia [11-13]. It is important to study the bone healing and remodelling in patients in detail and to take into consideration various

other complications and variations for better patient care [14,15].

CONCLUSIONS

Primary aneurysmal bone cysts of the distal tibia are rare but clinically significant lesions in the adolescent skeleton and require careful evaluation and appropriate surgical management. In the present case, advanced multiplanar imaging, particularly MRI, was valuable for early recognition and assessment of the lesion, including its characteristic fluid-fluid levels and structural extent. Histopathological examination confirmed the diagnosis and ruled out malignancy. Meticulous extended intralesional curettage using a high-speed mechanical burr was performed to remove the lesion and reduce the risk of residual disease. The resulting bone defect was reconstructed using an autologous cancellous iliac crest bone graft combined with a hydroxyapatite/ β -tricalcium phosphate synthetic bone graft substitute. At 12-month follow-up, the patient demonstrated full, painless ankle range of motion, complete weight-bearing functionality, satisfactory graft incorporation and cortical remodeling, with no evidence of local recurrence. This case supports extended curettage with combined bone grafting as an effective approach for distal tibial aneurysmal bone cysts.

PATIENT CONSENT

The patient and his legal guardians provided written informed consent for publication of this case report and any accompanying images. The patient and guardians were informed about the nature of the publication and provided consent after understanding the implications.

CONTRIBUTION OF AUTHORS

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