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Aneurysmal Bone Cyst of the Distal Tibia Treated by Intralesional Curettage and Cementation: A Case Report

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Abstract **Case Report**

Introduction: Aneurysmal bone cyst (ABC) is a benign but locally aggressive osteolytic bone neoplasm characterised by blood-filled, multi-septated cavities. It predominantly affects the metaphyseal regions of long bones in children and young adults. Distal tibial involvement is uncommon and presents specific surgical challenges due to the proximity of the ankle joint and physis. We report a case of a large ABC of the distal tibia treated successfully with intralesional curettage and polymethylmethacrylate (PMMA) cementation. ***Case Presentation:*** A 30-year-old patient presented with progressive pain and swelling of the right ankle. Plain radiographs and computed tomography (CT) revealed a large, expansile, multi-lobulated metaphyso-epiphyseal osteolytic lesion of the distal tibia measuring 40 × 26 mm in cross-section with a 38 mm craniocaudal extent, cortical thinning, and no soft tissue invasion. Magnetic resonance imaging (MRI) demonstrated pathognomonic fluid-fluid levels on T2-weighted sequences with moderate peripheral gadolinium enhancement, consistent with ABC. Intralesional curettage and PMMA cementation were performed. Histopathological examination confirmed the diagnosis. At final follow-up, the patient achieved complete resolution of pain and full, pain-free ankle range of motion with no recurrence. ***Conclusion:*** ABC of the distal tibia is a rare but treatable periarticular lesion. MRI with fluid-fluid levels is the cornerstone of preoperative characterisation. Intralesional curettage combined with PMMA cementation offers immediate mechanical stability, facilitates recurrence surveillance, and yields excellent functional outcomes.

Keywords: Aneurysmal bone cyst; distal tibia; curettage; PMMA; bone cement; ankle; benign bone tumour.

INTRODUCTION

Aneurysmal bone cyst (ABC) is a benign but locally destructive osseous neoplasm first formally described by Jaffe and Lichtenstein in 1942. It is composed of multi-loculated blood-filled or serum-filled cavities separated by fibrous septa containing osteoclast-like giant cells, reactive woven bone, and spindle-shaped stromal cells [1]. ABCs are rare tumours, accounting for approximately 1% of all primary bone tumours, with an estimated incidence of 0.14 cases per 100,000 population per year. They predominantly affect the first and second decades of life with no significant sex predilection [2, 3].

The pathogenesis of primary ABC has been significantly clarified by molecular studies. Approximately 70% of primary ABCs harbour rearrangements of the ubiquitin-specific protease 6 (USP6) gene, establishing their neoplastic nature, while secondary ABCs — accounting for roughly 30% of cases — arise in association with other bone lesions such as giant cell tumour, fibrous dysplasia, or chondroblastoma and do not carry USP6 rearrangements [4, 5].

The metaphyseal regions of long bones are the most common sites of occurrence, particularly the proximal humerus, distal femur, and proximal tibia. Involvement of the distal tibia in its metaphyso-epiphyseal region is uncommon and poses specific diagnostic and therapeutic challenges related to proximity to the ankle joint, the tibial articular surface, and — in skeletally immature patients — the distal tibial physis [6, 7].

Clinically, patients present with progressive pain, localised swelling, and occasional pathological fracture. Imaging is central to the work-up: plain radiographs reveal an expansile, osteolytic lesion with a characteristic 'soap-bubble' appearance and cortical thinning; CT defines the three-dimensional extent of bone destruction and cortical integrity; and MRI — the gold standard modality — demonstrates the

pathognomonic fluid-fluid levels produced by the sedimentation of blood products of varying ages within the cystic compartments [2, 8].

We report a case of a large, primary ABC of the distal right tibia in a young patient who presented with ankle pain, confirmed by characteristic CT and MRI findings, and treated with intralesional curettage and PMMA cementation, with an excellent functional outcome. Written informed consent was obtained from the patient for the publication of this case report and associated imaging.

CASE PRESENTATION

A 30-year-old male patient, with no significant past medical or surgical history, presented to our orthopaedic and trauma surgery department with a 4-month history of progressive, worsening pain localised to the right ankle. The pain was associated with mild diffuse swelling. There was no history of antecedent trauma, fever, weight loss, or constitutional symptoms. The pain was mechanical in nature, worsened by weight-bearing and physical activity, and had become increasingly limiting to the patient's daily activities and gait.

Physical examination revealed diffuse swelling of the distal right leg and ankle region. There were no cutaneous changes, local warmth, or erythema. Deep palpation over the distal tibia elicited tenderness. Ankle range of motion was globally restricted by pain, with no palpable mass and preserved neurovascular status distally. The contralateral ankle was clinically normal.

Anteroposterior and lateral plain radiographs of the right ankle demonstrated a large, well-defined, expansile osteolytic lesion centred in the posterior metaphyso-epiphyseal region of the distal tibia, with thinning and lobulation of the cortex. No periosteal reaction, pathological fracture, calcification, or matrix mineralisation was identified. The tibiotalar joint space and articular surfaces appeared intact.

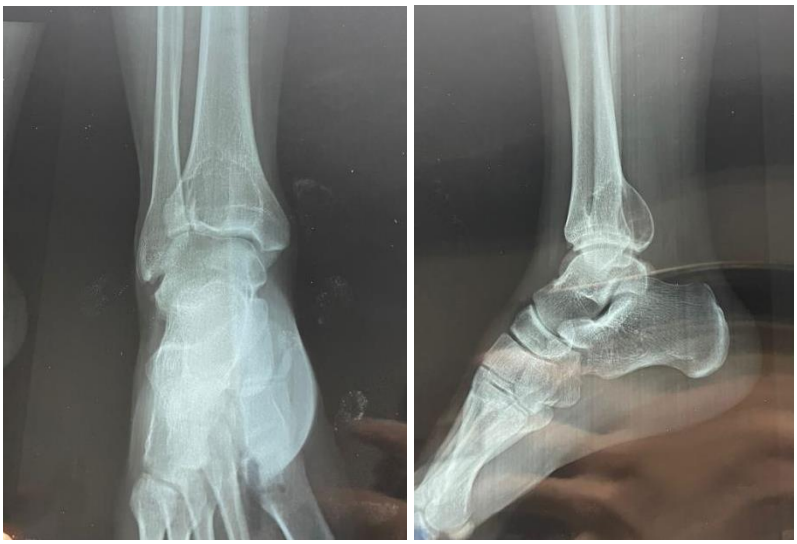

Figure 1: Anteroposterior and lateral plain radiographs of the right ankle demonstrated a large, well-defined, expansile osteolytic lesion

Computed tomography (CT) of the right ankle was performed at the Radiology Department of CHU Ibn Rochd, Casablanca (03/06/2023), using helical acquisition without contrast injection. CT confirmed a multi-lobulated, expansile, metaphyso-epiphyseal lesion of the distal tibia situated in the posterior compartment, measuring 40 × 26 mm in axial cross-section and extending 38 mm in the craniocaudal direction. The lesion demonstrated variable density internally with spontaneously hyperdense foci consistent with haemorrhagic content. Cortical thinning was present without cortical rupture, periosteal reaction, or soft tissue extension. The subtalar joint surfaces and surrounding tarsal bones appeared normal. Three-dimensional CT reconstruction elegantly depicted the lobulated bony expansion from multiple projections.

Magnetic resonance imaging (MRI) of the right ankle was subsequently performed at our department (12/06/2023), using a 1.5 Tesla GE Healthcare system. Axial T1, T2, fat-saturated proton-density (DP fat Sat), gradient-echo (echo de gradient), and post-gadolinium T1 sequences were acquired in all three planes. MRI demonstrated a posterior metaphyso-epiphyseal cortico-medullary lesion of the distal tibia, distending the osseous cortex, and containing multiple well-defined loculated compartments. Pathognomonic fluid-fluid levels were clearly visible on T2-weighted sequences, reflecting the sedimentation of blood products of varying ages. The lesion was isointense on T1 and markedly hyperintense on T2, with moderate peripheral and septal enhancement following gadolinium administration. A peripheral hypointense rim on gradient-echo sequences corresponded to haemosiderin deposition. No vascular

pedicle, periosteal reaction, or soft tissue invasion was detected. The posterior tibial tendon, flexor hallucis longus, and extensor tendons were morphologically intact and not invaded. The capsulo-synovial joint envelope was preserved. The MRI conclusion read: 'Aspect consistent with an aneurysmal bone cyst (ABC), metaphyso-epiphyseal, posterior, of the distal right tibia; histological correlation recommended.'

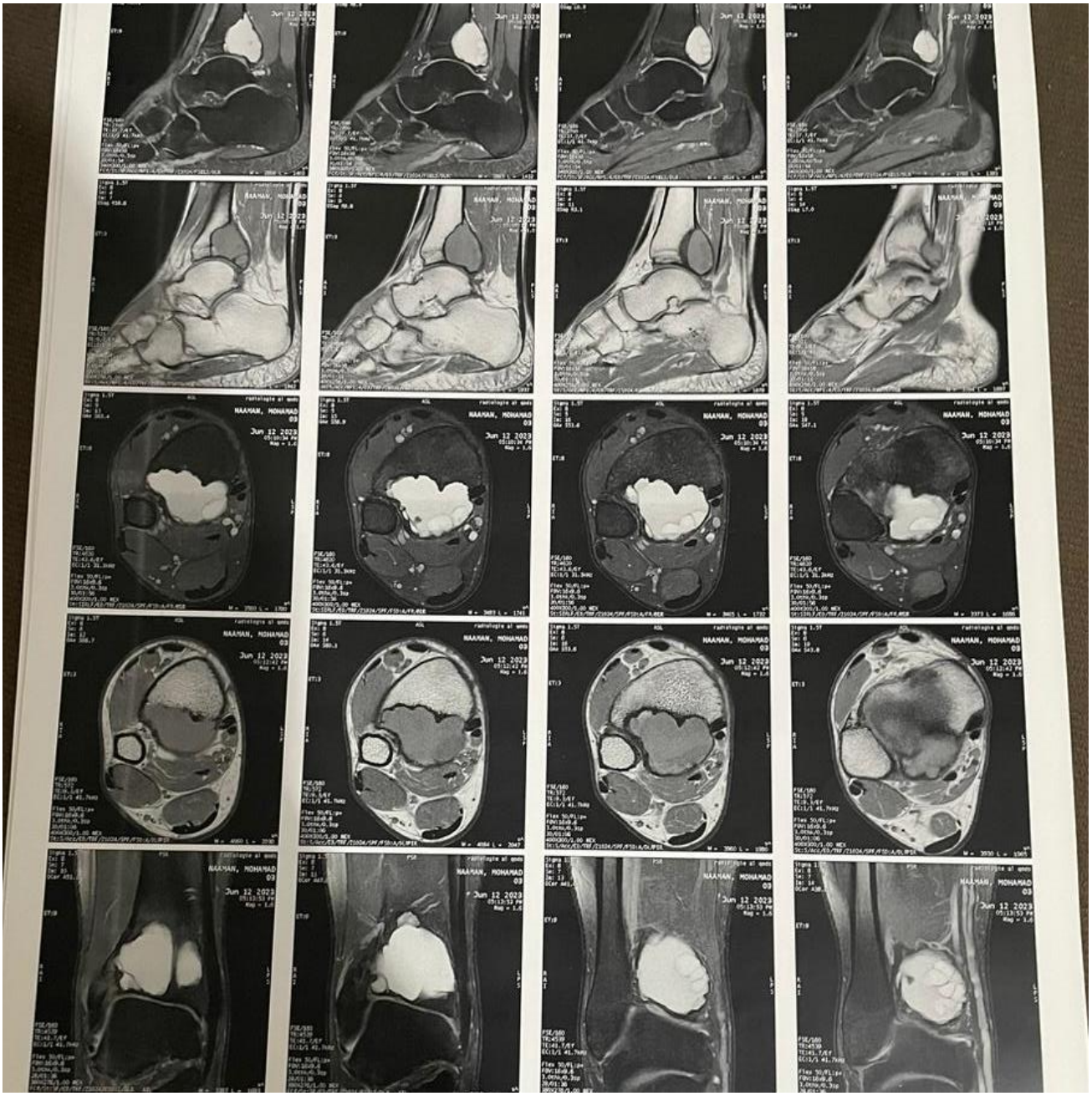

Figure 2: Preoperative IRM of the aneurysmal bone cyst of the distal tibia

Routine blood tests including full blood count, erythrocyte sedimentation rate, C-reactive protein, lactate dehydrogenase, alkaline phosphatase, and serum electrolytes were all within normal limits. Chest radiograph revealed no pulmonary lesion.

Following multidisciplinary discussion and review of all imaging, the decision was made to proceed with surgical management. Under general anaesthesia with tourniquet applied to the thigh, a medial longitudinal approach to the distal tibia was performed. A cortical window was fashioned over the lesion under fluoroscopic guidance. Thorough intralesional curettage was performed using curettes of varying sizes, removing all cystic contents, haemorrhagic material, fibrous septa, and the entire cyst wall lining. The cavity was then treated with a high-speed burr to extend the resection margin by approximately 1–2 mm in all directions, followed by cauterisation of the cavity walls as thermal adjuvants. The resulting bone defect was then packed with polymethylmethacrylate (PMMA) bone cement, which was allowed to polymerise and set in situ.

Intraoperative fluoroscopy confirmed complete filling of the cavity and preservation of the articular surface and joint space. The cortical window was replaced and wound closure performed in anatomical layers with a drain.

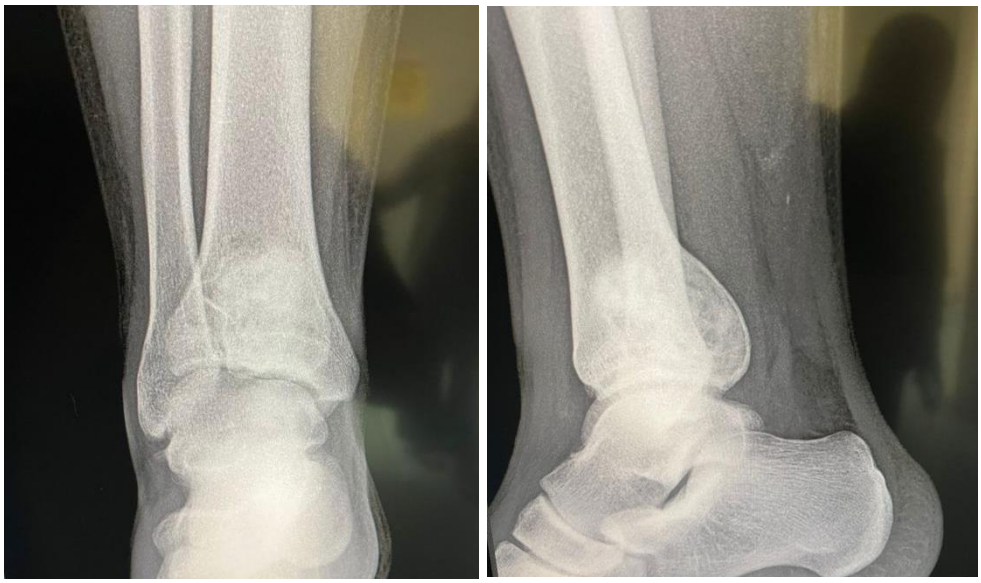

Figure 3: Post operative Radiographs showing complete filling of the cavity and preservation of the articular surface and joint space

Histopathological examination of the curetted material was consistent with primary aneurysmal bone cyst, showing blood-filled spaces lined by fibroblastic stroma, multinucleated osteoclast-type giant cells, and reactive woven bone formation, without nuclear atypia, mitotic figures, necrosis, or features of malignancy. No secondary underlying lesion was identified.

The postoperative course was uneventful. The patient was kept non-weight-bearing for 6 weeks, followed by progressive protected weight-bearing and structured physiotherapy. At 6-month clinical and radiological follow-up, the patient reported complete resolution of pain and demonstrated full, pain-free range of motion of the right ankle with no functional deficit. Radiographs showed a stable, well-integrated cement construct with no signs of local recurrence, cortical disruption, or joint involvement.

DISCUSSION

ABC is a benign but locally destructive bone neoplasm whose pathogenesis has been substantially redefined by molecular advances over the past two decades. The identification of USP6 gene rearrangements in primary ABCs — confirmed in approximately 70% of cases — has established their neoplastic nature, challenging the earlier hypothesis of a purely reactive vascular process [4, 5]. The WHO Classification of Bone Tumours now formally recognises primary ABC as a true neoplasm. Secondary ABCs, representing the remaining 30%, arise in the context of other bone lesions and do not harbour USP6 alterations [1].

Distal tibial involvement is uncommon among reported ABC series, which historically privilege the distal femur, proximal tibia, and proximal humerus as preferred sites [2]. When the distal tibia is affected — particularly in the metaphyso-epiphyseal region as in our case — the surgical strategy must carefully account for the proximity of the tibial plafond and the ankle joint, the risk of iatrogenic articular damage, and, in younger patients, potential physeal injury [6, 7]. The large size of the lesion in our case (40 × 26 × 38 mm), combined with its posterior metaphyso-epiphyseal location, required precise preoperative planning to ensure adequate surgical access and complete curettage without compromising joint integrity.

Imaging remains the cornerstone of preoperative evaluation. A comprehensive 2022 review on ABC pathophysiology and imaging confirmed that MRI with T2 fluid-fluid levels is the most specific finding for ABC, present in the majority of cases, and reflects sedimentation of blood products within multiloculated cystic chambers [8]. However, the presence of fluid-fluid levels is not entirely pathognomonic, as they may be seen in other conditions including telangiectatic osteosarcoma, fibrous dysplasia with haemorrhagic change, and giant cell tumour. The distinction from telangiectatic osteosarcoma is of paramount clinical importance, as both lesions may share overlapping imaging features; it has been established that the presence of a solid nodular component, cortical disruption, and periosteal reaction favour telangiectatic osteosarcoma and mandate tissue biopsy for definitive diagnosis [9]. In our case, the absence of any solid component, cortical rupture, or periosteal reaction on both CT and MRI, together with the clinical and

laboratory profile, strongly supported ABC; histopathological examination confirmed this.

The optimal treatment strategy for ABC remains debated. A 2023 current opinion review summarised the available modalities, including intralesional curettage with or without adjuvants, bone grafting, PMMA cementation, selective arterial embolisation (SAE), percutaneous sclerotherapy, and systemic agents such as denosumab [10]. Curettage with adjuvants remains the most widely employed approach, with reported recurrence rates of 25–31% without adjuvants, which are substantially reduced by the addition of high-speed burring, phenol, or argon beam coagulation [11, 12].

PMMA bone cement as a cavity filler after curettage offers several advantages at the distal tibia. First, it provides immediate structural support to the subchondral bone, preventing articular collapse or pathological fracture during the perioperative period — a risk that is particularly relevant at this weight-bearing periarticular site. Second, the exothermic polymerisation reaction of PMMA serves as an additional local thermal adjuvant, potentially destroying residual tumour cells at the cavity margins and contributing to local disease control [13]. Third, the radiopacity of the cement mass allows precise radiographic surveillance: any new lucent zone adjacent to the cement at follow-up is immediately detectable, facilitating early identification of recurrence [14]. A 2022 systematic review and meta-analysis on management of bone cysts confirmed that curettage with or without PMMA yielded satisfactory healing rates with acceptable recurrence, supporting its continued use in periarticular locations [15].

SAE has emerged as an increasingly utilised technique, both as a preoperative adjunct to reduce intraoperative haemorrhage and as a primary treatment for ABCs in surgically challenging locations. A 2023 comparative study by Cevolani *et al.,* demonstrated comparable healing rates between SAE and curettage with bone grafting, though SAE frequently required multiple sessions [12]. In our case, SAE was not employed, as the lesion was surgically accessible and the patient presented no contraindication to operative intervention.

Minimally invasive curettage with allogenic bone impaction grafting — another emerging technique — has been reported to yield complete resolution in a paediatric series with a mean follow-up of 6.4 years and no recurrence [16]. Denosumab, a monoclonal anti-RANKL antibody, has been used as a neoadjuvant or salvage treatment in recurrent or surgically difficult ABCs, particularly in the paediatric population, with favourable outcomes in selected cases [17].

Recurrence after surgical treatment remains the main concern. A large retrospective series reported an overall recurrence rate of 31% following curettage, with most recurrences occurring within 18 months of the index procedure [10, 11]. Risk factors for recurrence include young age, open physis, large lesion size, and incomplete curettage. The use of combined adjuvants — high-speed burring plus cauterisation, as employed in our case — has been shown to reduce recurrence risk compared to curettage alone [12]. Our patient showed no signs of recurrence at last follow-up, which is consistent with the reported outcomes following thorough curettage with adjuvants and PMMA cementation [13, 14]. Although a follow-up period of six months falls short of the reported 18-month window within which most recurrences are observed, the current clinical and radiological findings are reassuring; continued surveillance is nonetheless planned.

Finally, from a differential diagnostic perspective, the clinical and imaging evaluation of an expansile osteolytic ankle lesion in a young patient must consider not only ABC but also unicameral bone cyst, giant cell tumour of bone, fibrous dysplasia, chondroblastoma, and — critically — telangiectatic osteosarcoma. Histopathological confirmation is mandatory before definitive treatment in all cases [2, 8, 9].

CONCLUSION

Aneurysmal bone cyst of the distal tibia is a rare but important cause of ankle pain in young patients. CT and MRI — with the characteristic T2 fluid-fluid levels and peripheral gadolinium enhancement — are essential for establishing the preoperative diagnosis and guiding surgical planning. Histopathological confirmation remains mandatory to exclude telangiectatic osteosarcoma. Intralesional curettage combined with high-speed burring, cauterisation, and PMMA cementation is an effective treatment strategy offering immediate structural stability at this weight-bearing periarticular location, facilitating radiological recurrence surveillance, and providing excellent functional outcomes. Close long-term follow-up is warranted given the risk of recurrence.

PATIENT CONSENT

Written informed consent was obtained from the patient for publication of this case report and the accompanying imaging. A copy of the written consent is available for review by the Editor-in-Chief of this journal.

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AUTHOR CONTRIBUTIONS

A.A. and R.B. contributed to the conception and design of the study, data acquisition, and drafting of the manuscript. O.A., M.R.F., J.M., M.B., R.A.B., M.K., and

M.O.L. contributed to critical revision of the manuscript for important intellectual content. All authors reviewed and approved the final version submitted for publication.

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