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Fractured Aneurysmal Bone Cyst in Children – Is Conservative Treatment an Option?

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Abstract

Objective: To evaluate the outcomes of conservatively managed pathological fractures through aneurysmal bone cysts (ABCs) in children and to assess the potential for spontaneous cyst healing post-fracture.

Methods: A retrospective review was conducted of hospital records between January 2014 and October 2024. Children aged ≤ 14 years with fractured long bone ABCs and managed conservatively with at least six months of radiographic follow-up were included. Cases treated surgically or with recurrent/previously treated lesions were excluded. Radiographs were reviewed for lesion characteristics, Enneking staging, and radiographic features (loculation, cortical rim, tubulation, and bone scalloping). Outcomes were assessed using fracture union and cyst healing according to Rastogi's criteria.

Results: Eight patients (6 males, 2 females; mean age 7.3 ± 3.2 years) met the inclusion criteria. The proximal humerus ($n=5$) was the most frequently affected site, followed by the proximal femur ($n=2$) and distal radius ($n=1$). All lesions were metaphyseal and classified as Enneking stage II. At a mean follow-up of 7 ± 1.1 months, all fractures united radiologically. Partial cyst healing occurred in 3 patients (37.5%), while 5 patients (62.5%) showed no significant healing. No deformities or complications were reported.

Conclusions: Conservative management of pathological fractures through ABCs in children achieves fracture union and may induce partial cyst healing. Larger, multi-centre studies are required to better define the predictors of healing after a fracture through the cyst.

Keywords: Aneurysmal bone cyst, Pathological fracture, Benign bone tumour, Spontaneous healing, Paediatric

Introduction

Aneurysmal bone cysts (ABC) are benign but locally aggressive lesions that predominantly affect children and adolescents. They account for 1-6% of all primary bone tumours [1-5]. The overall incidence rate varies from 0.14-0.32 cases per 100,000 individuals annually. While there is no clear gender preference, some studies indicate a higher incidence in females [6, 7]. They are characterized by expansile, blood-filled cavities within the bone. ABC commonly present with pain and swelling. Sometimes, they present with pathologic fractures at initial presentation.

Although spontaneous regression or healing of ABC is rare, isolated reports have suggested that spontaneous healing of ABC may occur, potentially eliminating the need for surgical intervention in some cases [8-11]. However, the natural history of ABC post-fracture remains poorly defined, especially in children, where the bone remodelling potential is higher. Moreover, there is no consensus on the management of fractured ABC in children, as it is influenced by multiple factors. Proximity to the

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physis and whether the lesion is affecting a weight-bearing bone are important factors while managing these lesions [12, 13]. There is a lack of comprehensive studies assessing the frequency or predictors of spontaneous resolution in ABC following fractures in children. This study evaluates the characteristics and outcomes (in terms of spontaneous healing) of fractured ABC in the paediatric age group and the role of conservative management.

Patients and Methods

Patient data were obtained from electronic hospital records from January 2014 to October 2024 using ICD 10 codes M85.5 (aneurysmal bone cysts) and M84.4 (pathological fractures). Being a retrospective radiological chart review, Institutional Ethics Committee approval was not required. Additional search filters included skeletally immature children (considered age 14 years for this study), lesions of long bones and the presence of a representative magnetic resonance imaging (MRI) with characteristic fluid-fluid levels within the lesion. Only children offered conservative modality of fracture management and a minimum radiographic follow-up of six months post-fracture were included. Children who underwent surgical interventions for ABC such as sclerotherapy, curettage, bone grafting with or without internal fixation for fracture management, previously treated cases and those presenting with recurrent ABC were excluded.

Demographic information was recorded for all patients in the study. Radiographs were independently assessed by a paediatric orthopaedic surgeon with over ten years of experience. Each case was evaluated to identify the affected bone, anatomical location of the lesion (categorized as proximal or distal and further classified as metaphyseal, meta-diaphyseal, or diaphyseal), and its relation to the adjacent physis.

Cysts were staged according to the Enneking [14] staging system (Table 1). Additional radiographic parameters assessed on initial imaging included:

- Loculation [15]: Defined as the number of intra-cystic loculations with a continuous contour and graded as follows:

1. Grade 1: Unilocular
2. Grade 2: 2 to 4 loculations
3. Grade 3: 5 to 10 loculations
4. Grade 4: More than 10 loculations

- Cortical Rim [15]: Evaluated as a continuous rim around the cyst and graded based on the percentage of the cyst perimeter it encircled:

1. Grade 1: Absent
2. Grade 2: 1–24%

3. Grade 3: 25–49%

4. Grade 4: 50–74%

5. Grade 5: 75–99%

6. Grade 6: 100%

- Tubulation [15]: Defined as an abnormal widening of the affected bone beyond its normal diameter and documented as present or absent.

- Bone Scalloping [15]: Assessed as cortical thinning of the bone and recorded as either present or absent.

At the final follow-up (minimum six months), radiographs were reviewed for evidence of fracture healing. The status of cyst healing was classified based on the Rastogi et al criteria [16] (Table 2).

Statistical analysis

The data was entered in a spreadsheet, Microsoft Excel [Internet] 2.2018 (Microsoft Corporation). Available from: <https://office.microsoft.com/excel>. Statistical analysis was performed using DataTab (2026) Online Statistics Calculator, U. Graz, Austria. URL: <https://numiqo.com>. Quantitative data are presented as means and standard deviation whereas qualitative data are denoted as numbers and percentages.

Results

From the hospital register, 22 patients with fractured ABC were identified. Four patients did not undergo MR imaging, five patients were managed at initial presentation with curettage and bone grafting, and five patients lacked adequate follow-up. A total of eight paediatric patients (6 males, 2 females) with a mean age of 7.3 ± 3.2 years were included in the study.

The most commonly affected bone was the proximal humerus (5 cases), followed by the proximal femur (2 cases) and distal radius (1 case). All lesions were located in the metaphyseal

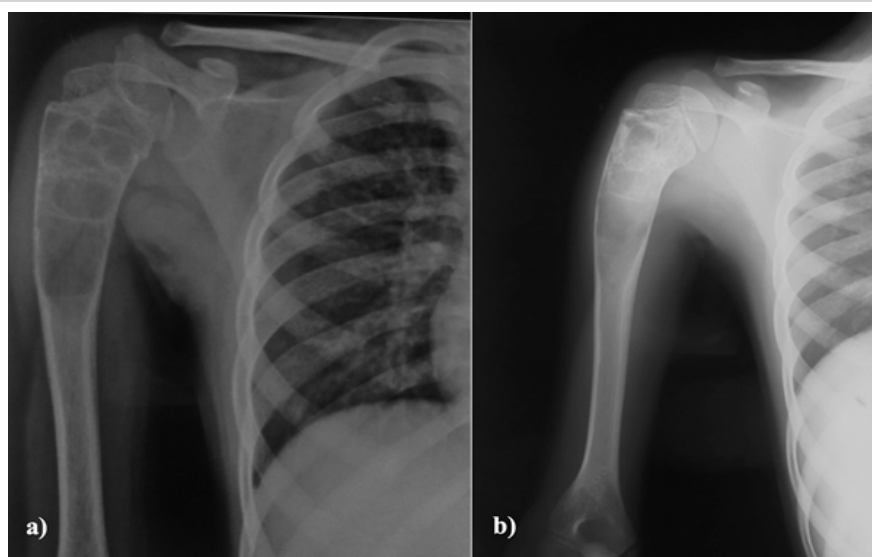


Figure 1: Radiograph of 12 year old female aneurysmal bone cyst of the proximal humerus a) showing pathological fracture b) showing partial healing of the cyst with fracture healing.

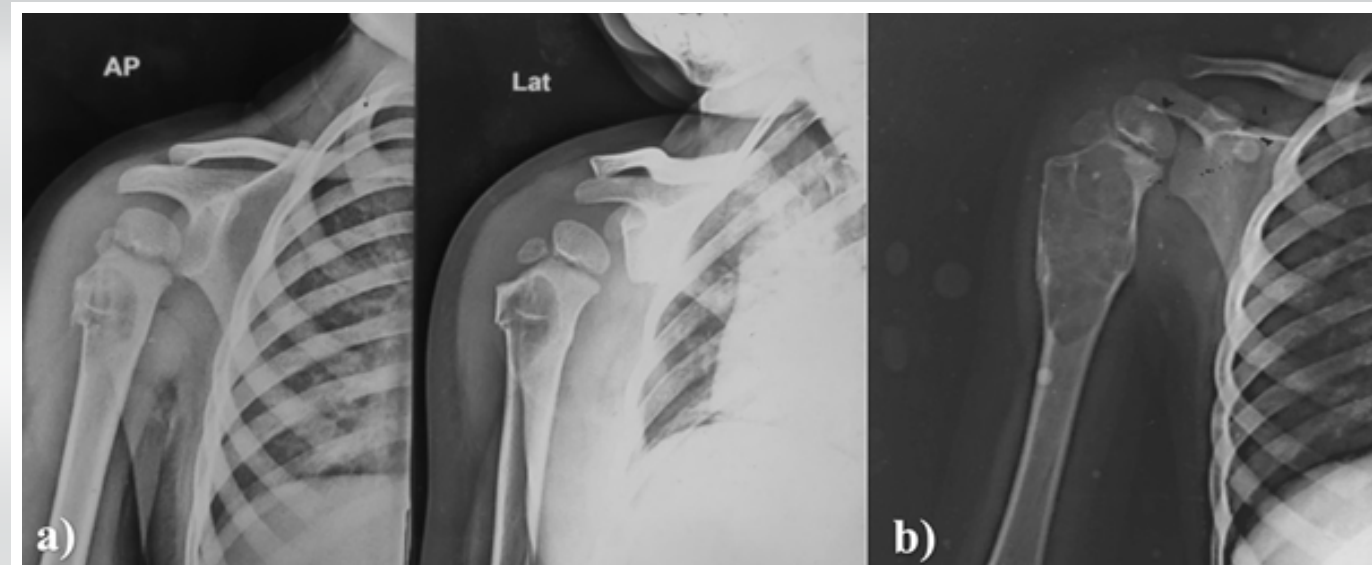


Figure 2: Radiograph of 2 year old male aneurysmal bone cyst of the proximal humerus a) showing pathological fracture b) showing no healing of the cyst with fracture healing.

region, and six of eight lesions were adjacent to the physis. All cases were classified as Enneking Stage II. Loculations varied across patients: Grade I (n=3), Grade II (n=2), Grade III (n=1), and Grade IV (n=2). Cortical rim was absent in 6 cases and present (25–50%) in 2 cases. Tubulation was observed in 5 patients, while bone scalloping was noted in 7 cases, with one case showing 50% scalloping and the remaining demonstrating 100% involvement.

The mean follow-up duration was approximately 7 ± 1.1 months (range: 6.2 – 7.9 months). All fractures achieved radiological union by final follow-up. In terms of cyst healing, 3 children (37.5%) showed partial healing (Fig. 1), while 5 (62.5%) demonstrated no significant healing (Fig. 2). According to the Rastogi classification, 3 lesions were categorized as Grade III and 5 as Grade IV.

Discussion

Principal findings

All eight patients in our cohort achieved fracture union with non-operative management, reaffirming that pathological fractures through ABC are amenable to conservative treatment. This is mainly due to limited displacement in the fracture fragments and robust healing potential in children. While ABC are traditionally treated with curettage, bone grafting, or sclerotherapy, the present findings highlight a potentially under-recognized phenomenon of partial cyst healing after fracture.

Review of literature

The management of fractured ABC remains controversial. Various treatment modalities are mentioned in the literature. Ahmad et al used polidocanol in eight patients with fractured ABC [17]. They showed complete healing of the cyst in all

patients at final follow-up. The authors concluded that sclerosant is safe in fractured cysts and there is no risk of extravasation into the soft tissues. They hypothesized that blood extravasation following fracture creates a pseudo-capsule, preventing sclerosant leakage. This is in contrast to Kraca et al where the authors used various treatment modalities such as curettage, extended curettage or grafting with or without internal fixation, for managing fractured ABCs in their series of 30 patients. The management depended upon the fracture morphology and their location. The presence of a lesion in the weight-bearing bones required internal fixation to prevent fracture displacement and allow early mobilization due to high mechanical load. Whereas, upper limb fractures were managed conservatively, and surgery was reserved for managing the cyst [18].

Similar management was reported in a recent systematic review by Di Costa et al., in which 140 patients with pathological fractures secondary to ABC across 37 studies were evaluated. All the patients underwent surgical treatment, which included curettage (124 patients) and en-bloc resection (15 patients). 70 patients underwent osteosynthesis with either a plate, screw, nail or external fixators. The authors concluded that the choice of treatment of fractured ABC should be individualized, taking into account patient's age, location of lesion, distance from physis and surgeon's expertise [12]. The fractured cysts in our series were managed conservatively with immobilization in a splint irrespective of their location in the upper or lower limb. The absence of significant displacement and the high healing potential of paediatric bone justified our initial conservative treatment. All fractures united without any significant deformity in our series.

Spontaneous healing of the cyst after pathological fracture of a simple bone cyst is a known phenomenon. It has been observed

in approximately 10-15% of cases in children, but the mechanism is not fully understood [5, 19]. After pathological fracture, the resulting hematoma is thought to initiate an inflammatory response which promotes bone healing and gradual resolution of the simple bone cyst. A fracture may also disrupt the cyst lining, improving the intraosseous circulation leading to resolution of cyst in some cases [20]. In contrast, ABC, even though benign, are considered to be more aggressive. The difference in healing potential between simple bone cysts and aneurysmal bone cysts post-fracture may be due to fundamental distinctions in their underlying pathologies and biological behaviour. Only a few documented cases have reported healing of ABCs after biopsy [8-11]. Biesecker et al. suggested that ABCs arise from an osseous arteriovenous malformation and that disruption of its haemodynamic balance by fracture or biopsy may induce regression [21]. Partial healing of the lesion was observed in 1/3 cases (3/8=38%) following fracture in our series, indicating that it is not that an uncommon occurrence in children. We feel that the literature may be underreporting spontaneous healing of the ABCs following pathological fractures, as most are dealt surgically, due to its perceived aggressive nature.

Clinical implications

The findings in our series suggest that pathological fractures through aneurysmal bone cysts in children can potentially heal conservatively. This approach allows for fracture union to occur without the added complexity of simultaneous surgical management of the cyst. Once the fracture has healed, subsequent interventions can be planned more effectively,

when indicated. Some cases may demonstrate spontaneous healing as well. Even in cases with partial cyst healing, a better mechanical stability of the cyst is available prior to intervention. However, this strategy necessitates regular clinical and radiological follow-up for signs of cyst progression or recurrence.

Strengths and Limitations

This study addressed a significant gap in the literature by specifically evaluating the healing of pathological fractures secondary to ABC in children. Previous reports focussed mainly on the surgical management and included adults in their series.

The primary limitation of this study is the small sample size. Additionally, the retrospective design and absence of a control arm limit the generalizability of our findings. Further, all cases were followed for a minimum of six months, a time span sufficient for ordinary fractures to heal. Longer-term outcomes, particularly regarding recurrence or late healing, remain unknown. Larger multicentric studies are necessary to determine the true prevalence and predictors of spontaneous ABC healing after fracture.

Conclusions

Conservative management of pathological fractures through aneurysmal bone cysts in children can achieve reliable fracture union and, in some cases, partial cyst healing. Larger prospective studies are needed to clarify the true potential for spontaneous cyst resolution post-fracture.

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Declaration of patient consent : The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient has given the consent for his/ her images and other clinical information to be reported in the journal. The patient understands that his/ her names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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