A Case study of Proximal Middle 3rd junction Humerus Unicameral Bone Cyst with Pathological Fracture

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Abstract

Unicameral bone cysts (UBC) are benign, fluid-filled cavitary lesions that predominantly affect the metaphyseal region of long bones in children and adolescents, with the proximal humerus being the most common site after the proximal femur. These cysts pose significant clinical challenges due to their propensity to cause pathological fractures, which can lead to functional impairment and growth disturbances if not managed appropriately. This case study presents a comprehensive analysis of a 12-year-old male patient who sustained a pathological fracture through a unicameral bone cyst located at the proximal-middle third junction of the right humerus following minor trauma during sports activity. The patient presented with acute onset of severe arm pain, swelling, and inability to move the affected limb after falling during a basketball game. Clinical examination revealed localized tenderness, deformity, and restricted range of motion at the shoulder and elbow joints. Radiological investigations including plain radiographs and magnetic resonance imaging confirmed the presence of a large unicameral bone cyst with associated pathological fracture and revealed characteristic features including a centrally located, well-defined, fluid-filled cavity with thin cortical walls and absence of internal septations. The patient underwent surgical management consisting of open reduction and internal fixation with a locking compression plate, followed by cyst curettage, bone grafting using autologous iliac crest bone graft, and injection of bone marrow aspirate concentrate to promote healing and prevent recurrence. Post-operative recovery was uneventful with progressive improvement in pain, range of motion, and functional outcomes over a 12-month follow-up period. Serial radiographs demonstrated excellent fracture healing, significant cyst resolution, and restoration of normal bone architecture without evidence of recurrence. This case highlights the importance of early recognition, appropriate imaging, and timely surgical intervention in managing unicameral bone cysts with pathological fractures, emphasizing the need for a multidisciplinary approach involving orthopedic surgeons, pediatric specialists, and rehabilitation teams to optimize patient outcomes and prevent long-term complications.

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Introduction

Unicameral bone cysts, also known as simple bone cysts, represent one of the most common benign bone lesions encountered in pediatric orthopedic practice, accounting for approximately 3% of all primary bone tumors and 75% of all cystic bone lesions

in children [1]. These lesions are characterized by single-chambered, fluid-filled cavities lined with a thin fibrous membrane and are predominantly found in the metaphyseal region of long bones, with the proximal humerus and proximal femur being the most frequently affected sites [2].

The etiology of unicameral bone cysts remains incompletely understood, although several theories have been proposed to explain their development. The most widely accepted hypothesis suggests that these cysts arise from disturbances in local bone metabolism and fluid dynamics, possibly related to venous obstruction or altered interstitial fluid pressure within the bone [3]. Other proposed mechanisms include local growth factor imbalances, inflammatory processes, and developmental anomalies affecting bone formation and remodeling [4].

The clinical presentation of unicameral bone cysts varies considerably depending on the size, location, and presence of complications such as pathological fracture. Many cases remain asymptomatic and are discovered incidentally on radiographs obtained for other reasons [5]. However, larger cysts, particularly those located in weight-bearing bones or areas subject to mechanical stress, may present with pain, swelling, or functional limitation. The most significant complication is pathological fracture, which occurs in approximately 60-70% of cases and often represents the initial presenting symptom [6].

Pathological fractures through unicameral bone cysts pose unique challenges in terms of diagnosis, management, and prognosis. These fractures typically result from minimal trauma due to the weakened bone structure caused by the cystic lesion, and they may be associated with delayed healing, malunion, or growth disturbances if not appropriately managed [7]. The proximal humerus location is particularly problematic due to its proximity to the growth plate and its importance in shoulder function and upper extremity biomechanics.

Diagnostic evaluation of suspected unicameral bone cysts relies primarily on radiological imaging, with plain radiographs providing the initial assessment and advanced imaging modalities such as magnetic resonance imaging (MRI) offering detailed characterization of the lesion and surrounding structures [8]. Radiographic features typically include a centrally located, well-defined, radiolucent lesion with thin cortical walls, absence of internal septations, and a characteristic "fallen leaf" sign when pathological fracture occurs [9].

Treatment options for unicameral bone cysts have evolved significantly over the past several decades, ranging from observation and activity modification for small, asymptomatic lesions to various surgical interventions for larger cysts or those complicated by pathological fracture [10]. Traditional treatment approaches included simple curettage and bone grafting, while more recent techniques have incorporated the use of bone marrow aspirate concentrate, synthetic bone substitutes, and minimally invasive injection therapies [11].

The management of pathological fractures through unicameral bone cysts requires careful consideration of multiple factors, including patient age, fracture pattern, cyst characteristics, and functional requirements. The goals of treatment include fracture healing, cyst resolution, prevention of recurrence, and restoration of normal bone architecture and function [12]. This often necessitates a combination of fracture stabilization techniques and cyst treatment modalities to achieve optimal outcomes.

Materials and Methods

Case Presentation

This case study was conducted at a tertiary care pediatric orthopedic center following institutional review board approval and informed consent from the patient's parents. A comprehensive retrospective analysis was performed of a 12-year-old male patient who presented with a pathological fracture through a unicameral bone cyst at the proximal-middle third junction of the right humerus.

Patient Demographics and History

The patient was a previously healthy 12-year-old male with no significant past medical history or family history of bone disorders. He was an active participant in recreational sports, particularly basketball and soccer, with no previous history of arm pain or functional limitations. The patient presented to the emergency department following an acute injury sustained during a basketball game, where he fell and landed on his outstretched right arm.

Clinical Assessment

A systematic clinical evaluation was performed including detailed history taking, physical examination, and assessment of neurovascular status. Pain assessment was conducted using age-appropriate pain scales, and functional evaluation included range of motion measurements at the shoulder, elbow, and wrist joints. Neurovascular examination included assessment of radial, ulnar, and median nerve function, as well as vascular supply to the upper extremity.

Imaging Studies

Comprehensive radiological evaluation was performed using standardized protocols. Initial assessment included anteroposterior and lateral radiographs of the right humerus, followed by comparison views of the contralateral extremity. Advanced imaging included magnetic resonance imaging (MRI) with T1-weighted, T2-weighted, and contrast-enhanced sequences to characterize the cystic lesion and assess for complications.

Surgical Technique

The surgical procedure was performed under general anesthesia with the patient in a supine position. A standard anterolateral approach to the proximal humerus was utilized, with careful dissection to preserve neurovascular structures. The surgical technique included open reduction and internal fixation of the pathological fracture using a locking compression plate, followed by comprehensive cyst management including curettage, bone grafting, and adjuvant therapies.

Post-operative Management

A standardized post-operative protocol was implemented including pain management, wound care, and progressive rehabilitation. Serial clinical and radiological assessments were performed at regular intervals to monitor healing progress, assess for complications, and evaluate functional outcomes.

Outcome Measures

Primary outcome measures included fracture healing, cyst resolution, and functional recovery. Secondary outcomes

included pain relief, range of motion restoration, and prevention of complications such as infection, nonunion, or recurrence. Functional assessment was performed using validated scoring systems appropriate for pediatric patients.

Statistical Analysis

Descriptive statistics were used to summarize patient characteristics and treatment outcomes. Clinical and radiological parameters were analyzed using appropriate statistical methods, with significance set at $p < 0.05$.

Results

Clinical Presentation

The 12-year-old male patient presented to the emergency department with acute onset of severe right arm pain following a fall during basketball. The injury occurred when the patient fell and landed on his outstretched right arm while attempting to catch a rebound. Clinical examination revealed significant pain, swelling, and deformity at the proximal-middle third junction of the right humerus, with marked limitation of shoulder and elbow motion.

Physical examination findings included localized tenderness over the lateral aspect of the proximal humerus, visible deformity with shortening of the arm, and protective muscle spasm. The patient demonstrated reluctance to move the affected extremity and required analgesic medication for pain control. Neurovascular examination was normal with intact radial, ulnar, and median nerve function, and adequate vascular supply as evidenced by normal pulses and capillary refill.

Radiological Findings

Initial plain radiographs revealed a large, well-defined, radiolucent lesion located at the proximal-middle third junction of the right humerus, consistent with a unicameral bone cyst. The cyst demonstrated characteristic features including central location, thin cortical walls, and absence of internal septations. A pathological fracture was evident through the cyst, with the classic "fallen leaf" sign representing a cortical fragment that had fallen into the dependent portion of the cyst cavity.

Magnetic resonance imaging provided detailed characterization of the lesion, demonstrating a fluid-filled cavity with low signal intensity on T1-weighted images and high signal intensity on T2-weighted images. The cyst measured approximately 6.5 cm in length and 3.2 cm in maximum diameter, occupying nearly 70% of the humeral diameter at its widest point. There was no evidence of solid components, septations, or surrounding soft tissue involvement.

Surgical Intervention and Technique

The patient underwent surgical treatment within 48 hours of presentation. The procedure was performed under general anesthesia using a standard anterolateral approach to the proximal humerus. Following exposure of the fracture site and cyst cavity, the pathological fracture was reduced and stabilized using a 7-hole locking compression plate with both locking and cortical screws for optimal fixation.

Comprehensive cyst management was then performed, including thorough curettage of the cyst lining and walls using curettes and high-speed burr to remove all fibrous tissue and ensure complete evacuation of cyst contents. The cavity was then irrigated with normal saline and prepared for bone grafting. Autologous iliac crest bone graft was harvested and packed into the cyst cavity to promote healing and prevent recurrence.

Table 1: Surgical Procedure Details

Parameter	Details
Anesthesia	General anesthesia with endotracheal intubation
Patient Position	Supine with arm table extension
Surgical Approach	Anterolateral approach to proximal humerus
Fracture Fixation	7-hole locking compression plate
Screw Configuration	4 locking screws, 3 cortical screws
Cyst Management	Complete curettage and irrigation
Bone Graft Source	Autologous iliac crest
Graft Volume	Approximately 15ml
Additional Therapy	Bone marrow aspirate concentrate injection
Operative Time	145 minutes
Blood Loss	Minimal (<50ml)

Post-operative Course and Complications

The immediate post-operative period was uneventful, with the patient experiencing good pain control and no evidence of neurovascular compromise. The surgical wound healed without complications, and there were no signs of infection or hardware-related problems. The patient was immobilized in a shoulder sling for the first two weeks, followed by progressive range of motion exercises under the guidance of a physical therapist.

Table 2: Post-operative Clinical Parameters

Time Point	Pain Score (0-10)	Shoulder Flexion (°)	Elbow Flexion (°)	Complications
24 hours	6/10	Limited (sling)	Limited (sling)	None
2 weeks	4/10	60°	120°	None
6 weeks	2/10	120°	140°	None
3 months	1/10	160°	145°	None
6 months	0/10	175°	150°	None
12 months	0/10	180°	150°	None

Radiological Outcomes

Serial radiological follow-up demonstrated progressive fracture healing and cyst resolution over the 12-month observation period. At 6 weeks post-operatively, early callus formation was evident at the fracture site, with maintained reduction and stable hardware position. By 3 months, solid union of the pathological fracture was achieved, with significant improvement in bone density within the previous cyst cavity.

Table 3: Radiological Healing Parameters

Time Point	Fracture Union	Cyst Resolution	Bone Density	Hardware Status
2 weeks	Early healing	Minimal change	Decreased	Stable
6 weeks	Callus formation	20% resolution	Improving	Stable
3 months	Solid union	60% resolution	Near normal	Stable
6 months	Complete union	85% resolution	Normal	Stable
12 months	Mature union	95% resolution	Normal	Stable

At the final 12-month follow-up, radiographs demonstrated complete fracture healing with restoration of normal bone architecture. The unicameral bone cyst had resolved by approximately 95%, with only minimal residual changes evident as increased bone density in the region of the former cyst cavity. There was no evidence of cyst recurrence, hardware failure, or other complications.

Functional Outcomes

Functional recovery was excellent, with the patient returning to full activities including sports participation by 6 months post-operatively. Range of motion measurements demonstrated complete restoration of shoulder and elbow function, with no residual limitations or functional deficits. Pain relief was complete, and the patient reported high satisfaction with the treatment outcome.

The patient was able to return to school activities within 4 weeks and gradually resumed sports participation over the following months. By 12 months post-operatively, he had returned to competitive basketball without restrictions and reported no residual symptoms or functional limitations.

Discussion

This case study provides valuable insights into the management of unicameral bone cysts complicated by pathological fracture, particularly in the challenging location of the proximal-middle third junction of the humerus. The successful outcome achieved in this patient demonstrates the effectiveness of a comprehensive treatment approach combining fracture stabilization with thorough cyst management [13].

Diagnostic Considerations

The diagnosis of unicameral bone cyst with pathological fracture in this case was straightforward based on the characteristic radiological findings and clinical presentation. The "fallen leaf" sign, representing a cortical fragment that has fallen into the dependent portion of the cyst, is pathognomonic for unicameral bone cyst and helps differentiate it from other cystic bone lesions [14]. The location at the proximal-middle third junction of the humerus, while less common than metaphyseal locations, is consistent with the known distribution of these lesions in growing children.

The use of MRI in this case provided valuable additional information regarding the extent of the cyst, the integrity of surrounding bone, and the absence of solid components that might suggest a more aggressive lesion. The fluid-filled nature of the cyst with homogeneous signal characteristics confirmed the diagnosis and ruled out other differential diagnoses such as aneurysmal bone cyst, giant cell tumor, or malignant lesions [15].

Treatment Rationale and Technique

The treatment approach employed in this case reflects current best practices for managing unicameral bone cysts with pathological fracture. The decision to proceed with open reduction and internal fixation was based on several factors, including the patient's age, the size and location of the cyst, the fracture pattern, and the need for definitive cyst treatment [16].

The use of a locking compression plate provided stable fixation while allowing for cyst management through the same surgical exposure. This approach has several advantages over alternative fixation methods, including superior biomechanical properties, reduced risk of hardware failure, and the ability to maintain reduction while promoting healing [17]. The combination of locking and cortical screws optimized fixation strength while accommodating the altered bone quality in the region of the cyst.

The comprehensive approach to cyst management, including thorough curettage, bone grafting, and the addition of bone marrow aspirate concentrate, was designed to maximize the likelihood of cyst resolution and prevent recurrence [18]. Autologous iliac crest bone graft remains the gold standard for filling bone defects, providing both osteoconductive and osteoinductive properties that promote healing and new bone formation.

Outcomes and Prognosis

The excellent functional and radiological outcomes achieved in this case are consistent with reported success rates for surgical management of unicameral bone cysts. The complete fracture healing, significant cyst resolution, and restoration of normal function demonstrate the effectiveness of the treatment approach [19].

The absence of complications, including infection, hardware failure, or growth disturbances, reflects careful surgical technique and appropriate post-operative management. The patient's young age and good bone healing potential likely contributed to the favorable outcome, as pediatric patients generally demonstrate superior healing responses compared to adults [20].

Implications for Clinical Practice

This case highlights several important principles in the management of unicameral bone cysts with pathological fracture. Early recognition and appropriate imaging are crucial for accurate diagnosis and treatment planning. The multidisciplinary approach involving orthopedic surgeons, radiologists, and rehabilitation specialists is essential for

optimizing outcomes.

The importance of patient and family education regarding activity modification and follow-up care cannot be overstated. In this case, the patient and parents were counseled regarding signs and symptoms of complications, the importance of compliance with restrictions, and the need for regular follow-up assessments [21].

Limitations and Future Directions

While this case demonstrates an excellent outcome, it represents a single patient experience and may not be generalizable to all similar cases. Larger case series and long-term follow-up studies are needed to better define optimal treatment protocols and identify factors predictive of success or failure.

Future research directions may include investigation of novel treatment modalities, such as minimally invasive techniques, biological augmentation strategies, and improved synthetic bone substitutes. The role of genetic factors in cyst development and healing response also warrants further investigation.

Conclusion

This case study demonstrates the successful management of a unicameral bone cyst with pathological fracture at the proximal-middle third junction of the humerus in a 12-year-old male patient. The comprehensive treatment approach, combining stable fracture fixation with thorough cyst management using curettage, bone grafting, and bone marrow aspirate concentrate, resulted in excellent functional and radiological outcomes.

The key factors contributing to success in this case included early recognition and appropriate diagnosis, prompt surgical intervention with stable fixation and comprehensive cyst treatment, and careful post-operative management with progressive rehabilitation. The absence of complications and the achievement of complete fracture healing with significant cyst resolution demonstrate the effectiveness of this treatment approach.

This case reinforces the importance of a multidisciplinary approach to managing unicameral bone cysts with pathological fracture, emphasizing the need for collaboration between orthopedic surgeons, pediatric specialists, radiologists, and rehabilitation teams. The excellent functional recovery and return to full activities, including sports participation, highlight the potential for complete restoration of normal function when appropriate treatment is provided.

The findings from this case contribute to the growing body of evidence supporting surgical management of unicameral bone cysts complicated by pathological fracture. The treatment principles demonstrated here, including stable fracture fixation, comprehensive cyst management, and appropriate biological augmentation, can serve as a guide for managing similar cases in clinical practice.

Future research should focus on long-term outcomes, optimal treatment protocols, and the development of minimally invasive techniques that can achieve similar results with reduced morbidity. Continued investigation into the etiology and pathophysiology of unicameral bone cysts may also lead to novel therapeutic approaches that can prevent the development of these lesions or reduce the risk of pathological fracture.

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