

Clinical and Radiographic Outcomes of Pediatric Benign Bone Tumors

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INTRODUCTION:

Pediatric benign bone lesions are frequently located in the long bones of skeletally immature individuals and can predispose children to pathologic fracture. Treatment aims to minimize risk of pathologic fracture, enhance lesion healing, and improve patient symptoms. Many of these tumors are amenable to conservative treatment and may spontaneously improve with increased skeletal maturity or following pathologic fracture. Tumors that are at high risk for pathologic fracture or cause persistent symptoms can be treated surgically.

The indications for surgical treatment of pediatric benign bone lesions are not standardized and the best treatment options remain controversial. Understanding clinical and radiographic outcomes of various benign bone tumors in this population is important for informing future treatment recommendations. However, outcome data is limited and often specific to a particular lesion type and location or surgical intervention. The aim of this retrospective study is to assess the clinical and radiographic outcomes of children 18 years of age and younger with benign tumors of the long bones.

METHODS: ICD-10 codes were used to identify patients who presented to a tertiary children's hospital for treatment of a benign bone lesion between January 2011 and December 2021. Retrospective chart review was performed. Patients with a long bone lesion appreciable on x-ray and at least one follow-up visit were included. Osteochondromas and patients with multiple lesions were excluded. X-rays at the final follow up were used to determine radiographic outcome using Capanna criteria.

RESULTS:

A total of 294 patients were included for analysis (Table 1). The average length of follow up was 22 months. Eleven (6.2%) patients treated conservatively had repeat fractures. The average distance between the physis and lesion was significantly shorter in patients who experienced tumor recurrence (10.8mm) versus those who did not have recurrence (25.8mm, $p=0.025$).

In total, 109 lesions were treated surgically (Table 2). Patients who underwent surgery were significantly younger than those who were treated conservatively ($p=0.04$). The area of lesions treated surgically (12.4cm²) were significantly larger than lesions treated conservatively (6.8 cm², $p<0.0001$). The average age of patients who required additional surgery (7.9 years) was significantly younger than that of patients who only required one surgery (10.4 years, $p=0.004$).

Over 60% of the lesions treated conservatively showed radiographic improvement by the time of final follow up (10.5% Capanna grade 1, 50.9% Capanna grade 2). In total, 66.7% of conservatively treated lesions that showed no radiographic change at last follow up were non-ossifying fibromas and fibrous dysplasia. Lesions that were treated surgically showed improvement in 94.2% of cases (20.2% Capanna grade 1, 74.0% Capanna grade 2). Surgically treated lesions had better radiographic outcomes than those treated conservatively as defined by Capanna criteria ($p<0.0001$).

All except 18 patients had no activity restrictions at the time of last follow up. There was no significant difference in the activity outcome between the surgical and conservative treatment ($p=0.23$).

DISCUSSION AND CONCLUSION: The majority of our patients healed successfully with conservative treatment. Even following a pathologic fracture, our patients had good potential for healing with no long-term complications following conservative treatment. Nearly all our patients had no outstanding activity restrictions at the time of final follow up indicating good functional outcomes following conservative and surgical treatment. Among patients who underwent surgical intervention, our results confirm low perioperative morbidity in the treatment of pediatric benign bone lesions. Our results suggest that younger patients treated surgically are more likely to need subsequent surgery. When appropriate, delaying surgical intervention until a child is closer to skeletal maturity may improve outcomes. These results may help guide future practice when deciding on treatment plans for patients and counseling families on anticipated outcomes.

Table 1: Patient Demographics and Lesion Characteristics

Characteristics	No Pathologic Fracture at Presentation		Pathologic Fracture at Presentation	
	Value	Number of Patients N, (%)	Value	Number of Patients N, (%)
Age (Years)				
Median (Range)	12.0	(1.0-17.0)	9.0	(2.0-17.0)
Gender				
Male	85	(51%)	95	(75%)
Female	82	(49%)	32	(25%)
Race				
Caucasian	115	(69%)	93	(74%)
African American	26	(16%)	15	(12%)
Asian / Pacific Islander	3	(2%)	1	(1%)
Native American / Alaska	2	(1%)	2	(2%)
Native	20	(12%)	15	(12%)
Histological Diagnosis				
Non-Ossifying Fibroma	95	(58%)	18	(14%)
Unicameral Bone Cyst	18	(11%)	88	(70%)
Aneurysmal bone Cyst	15	(9%)	8	(6%)
Fibrous Dysplasia	11	(7%)	11	(9%)
Enchondroma	2	(1%)	0	(0%)
Giant Cell Tumor	1	(1%)	0	(0%)
Other	22	(13%)	1	(1%)
Bone Location				
<i>Upper Extremity:</i>				
Humerus	15	(9%)	78	(62%)
Radius	2	(1%)	5	(4%)
Ulna	2	(1%)	0	(0%)
<i>Lower Extremity:</i>				
Femur	71	(43%)	15	(12%)
Tibia	61	(37%)	20	(16%)
Fibula	14	(8%)	8	(6%)
Treatment Type				
Conservative	112	(70%)	63	(51%)
Operative	41	(26%)	32	(26%)
Conservative & Operative	7	(4%)	29	(23%)

Table 2: Characteristics of Lesions Treated Surgically

Characteristics	Number of Patients N, (%)
Histological Diagnosis	
Non-Ossifying Fibroma	17 (15.6%)
Unicameral Bone Cyst	60 (55%)
Aneurysmal bone Cyst	18 (16.5%)
Fibrous Dysplasia	9 (8.3%)
Enchondroma	1 (0.9%)
Giant Cell Tumor	1 (0.9%)
Other	3 (2.8%)
Initial Surgery Type	
Curettage alone	2 (1.8%)
Curettage with bone graft substitute	72 (66.1%)
Curettage with osteosynthesis	9 (8.3%)
Other (excision, IMN, aspiration)	26 (23.9%)
Complications	
Infection	5 (4.6%)
Refracture	9 (8.3%)
Symptomatic Hardware	9 (8.3%)
Need for Repeat Surgery	27 (24.8%)
Lesion Recurrence	17 (15.6%)
Graft Leakage Requiring Seroma I&D	1 (0.9%)