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Investigating Factors Influencing the Risk of Recurrence of Simple Bone Cysts: Retrospective Analyses of 41 Cases

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ABSTRACT

Introduction: Recurrence is a major challenge in the treatment of solitary bone cysts (SBC). In this study, we aimed to analyze the factors that influence the risk of recurrence in patients with simple bone cysts.

Methods: The study included patients who underwent curettage and bone grafting for SBC between 2010 and 2021 at a single center. Data collected included age, sex, side, bone location, pathological fracture history, cyst activity, internal fixation, graft type, radiological features of the cyst (cyst index, cyst diameter ratio, cyst area and cyst length), follow-up time, and presence of recurrence. The Cox algorithm was applied to identify factors independently associated with SBC recurrence.

Results: A total of 41 patients with a mean age of 10.8±3.19 years (range 4-15 years) were included in this study. The average follow-up period was 51±21.3 months. Recurrence was observed in 13 of 41 patients during follow-up. There were no significant differences in sex, bone location, pathological fracture history, and the type of graft used between patients with and without recurrence. The age at surgery was found to be significantly lower in the recurrence group (p=0.02). The radiological features of the cyst: cyst index, cyst diameter ratio, cyst area, and cyst length, were found to be higher in the recurrence group, although there was no significant difference.

Conclusion: It is important to inform families that the risk of recurrence is high at a young age and in patients with large solitary bone cysts.

Keywords: Bone cyst, diameter, recurrence, radiological features

Introduction

Solitary bone cysts (SBC) (also known as basic bone cysts, SBC) are benign non-tumoral lesions that usually present in the metaphyseal region of long bones in children and adolescents. This tumor-like lesion of unknown origin accounts for 3% of bone tumors, with 70% of them occurring in the proximal humerus and femur (1). The exact cause and pathogenesis of SBC remain unknown; venous obstruction, synovial tissue in the metaphysis, and delayed metaphyseal ossification have been hypothesized (2,3). The diagnostic radiological characteristic is a radiolucent, well-defined, geographic osteolytic lesion with a thin sclerotic margin that causes bone expansion and cortical thinning, seen on a direct X-ray. In magnetic resonance imaging (MRI), which is requested for differential diagnosis, a homogenous fluid-equivalent signal intensity is generally observed, although it varies depending on the amount of blood present (4).

Although they are usually asymptomatic, they can lead to pathological fractures and impairment of the normal growth and development of affected bones. There is no consensus on the best treatment option. There are many different treatment alternatives, including observation, minimally invasive surgery (percutaneous or endoscopic curettage, aspiration and steroid injection), and open curettage and grafting (5). Recurrence is a major issue in these alternative treatment approaches. Previous studies have reported active SBC and younger age as risk factors (6-8). In this study, we investigated and analyzed factors influencing the risk of recurrence in patients with simple bone cysts.

Methods

IRB and İstanbul University, İstanbul Faculty of Medicine Local Ethics Committee approval was obtained before the study initiation (approval number: 2024/611, date: 13.03.2024). The study included patients who underwent curettage and bone grafting (including the patients who received nail or plate fixation according to the fracture risk) for SBC between 2010 and 2021 at a single center. The inclusion criteria were a diagnosis of humerus and femur SBC, open physis at the operating bone, and a minimum follow-up of 2 years after surgery. The exclusion criteria were recurrent cases, pathologically unverified, and incomplete imaging

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(MRI, X-Ray) SBC patients (Figure 1). The informed consent of the parents and the consent of the child to participate was obtained.

Patients' management and operation procedure: In patients admitted to our outpatient clinic with a complaint of a pain at shoulder and hip joint, physical examination and radiological examinations were performed thoroughly. We generally perform magnetic resonance imaging evaluations in the differential diagnosis of aneurysmal bone cysts in aggressive lesions. Patients with pathological fractures of the proximal humerus were followed conservatively because they had the possibility of spontaneous healing. Lower extremity surgery was preferred. Intralesional resection based on the Musculoskeletal Tumor Society as defined by Enneking et al. (9) was used for SBC treatment.

After this, the surgeon decided to perform extended curettage and bone grafting with an allograft or bioactive glass graft (Bone-G, Meta Bioengineering). All surgeries were performed under general anesthesia by two surgeons (A.S. and S.B.) with expertise in orthopedic oncology while preparing the patients and placing them in the supine position and beach chair position. After administration (50 mg/kg, max, 1.5 gr) cefuroxime for prophylaxis, a deltopectoral incision was used for the humeral lesion and a modified anterolateral longitudinal incision (Watson Jones) for the femoral lesion. The bone window was opened using a burr or blade. After extended curettage, the medullary cavity was reammed to open vascular channels between the cysts and the intramedullary venous system. Pulsatile lavage was performed on the exposed bone using an isotonic solution, and the allograft or glass graft was impacted into the curing area of the bone. Plate fixation was performed in patients at risk of fracture (Figure 2).

Postoperative management: Postoperative pain management was provided with non-steroidal anti-inflammatory, tramadol, and

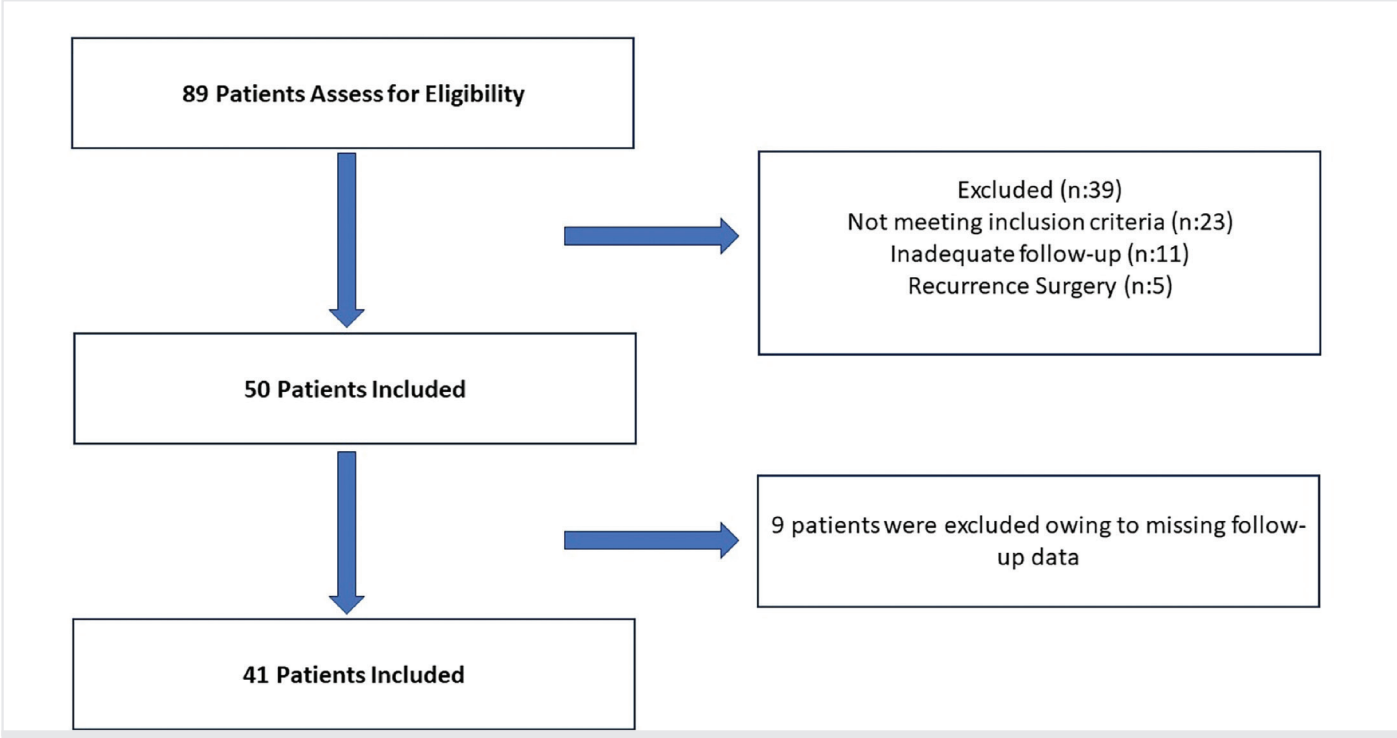

Figure 1. Flow chart

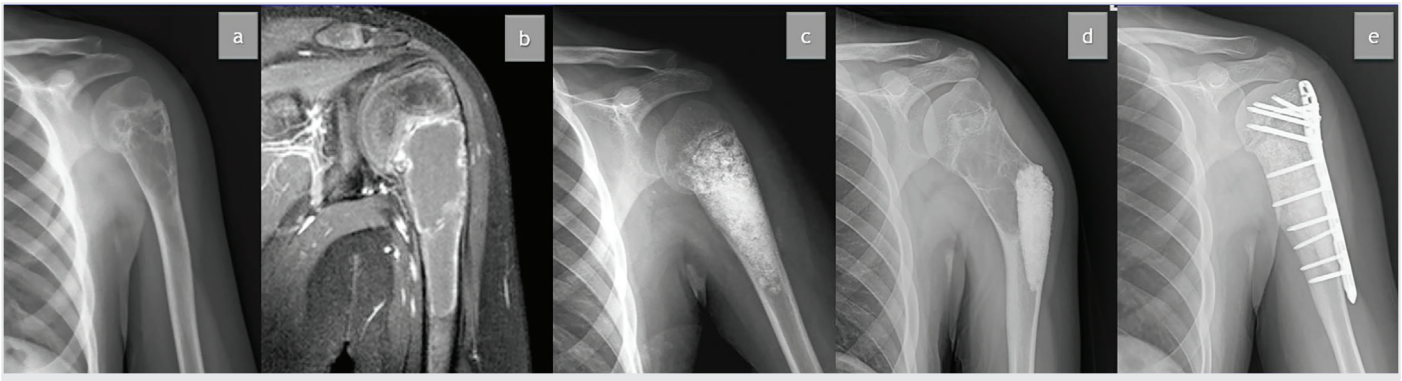

Figure 2. (a, b) A 10-year-old male patient was diagnosed with humerus SBC. (c) The patient was treated with curettage and grafting with bone glass graft (d) Recurrence and deformity are observed in the third postoperative year. (e) Follow-up radiograph of the patient after re-operation.
SBC: Solitary bone cysts

paracetamol as standard. Patients who underwent surgery for humeral SBC were followed up with arm sling for 2 weeks. First, active and passive ROM exercises were performed during follow-up. After the sixth week, no restrictions were applied. Femur SBC patients were mobilized with double crutches with non-weight bearing for six weeks. Active ROM exercises were performed starting from the postoperative period. After the sixth week, crutches were discontinued, and gradual loading was allowed. After the 12th week of surgery, patients were allowed to return to activities and sports.

Radiological evaluation: Standard anterior-posterior and lateral femur and anterior-posterior, oblique, and axillary humerus radiographs were obtained at the sixth week, third month, sixth month, and final visit. A Picture Archiving and Communication System (PACS) was used for radiological evaluation at our center. We used a Neers Modified Basic Bone Cyst classification system to standardize recurrence evaluation (10). Grades III and IV were considered as recurrence:

Grade I-Healed: Cyst formed with new bone, with or without a small radiolucent area(s) <1 cm in size.

Grade II-Healed with defects: Radiolucent area on X-ray <50% of the bone diameter with cortical thickness that does not pose a fracture risk.

Grade III persistent cyst: Radiolucent area >50% bone diameter, thin cortical margin; no enlargement of cyst size.

Grade IV recurrent cyst: Recurrence of a cyst in a previously excised area or an increase in the size of a radiolucent cyst.

SBCs were classified as active when they were less than 0.5 cm from the physis and as latent when they were not (10). The cyst mean area was calculated using the following formula: 0.5×D×d2. This was calculated considering that the SBC is ellipsoid and regular in form. The cyst index was calculated by dividing the cyst area by the cortical diameter, as described by Kaelin and MacEwen (11). The cyst diameter ratio was calculated by dividing the cyst longitudinal length by the bone diameter (12). All radiologic measurements were performed by a single experienced orthopedic surgeon using the hospital's (PACS™, Centricity Universal Viewer, GE Healthcare, Milwaukee). The magnification error was corrected by placing a metal ruler on the X-rays.

Statistical Analysis

SPSS 26 software was used for statistical analyses. Descriptive statistical methods (mean, standard deviation, percentage) were used to evaluate the study data. The conformity of quantitative data to normal distribution was tested using Shapiro-Wilk test and graphical analyses. The significance of quantitative variables with normal distribution between the two groups was compared using Student's t-test. Mann-Whitney U test was used for comparisons of quantitative variables that did not show normal distribution between the two groups. Pearson's chi-square test and Fisher's exact test were used to compare qualitative data. Statistical significance was set as $p<0.05$. Recurrence factors were identified in the univariate analysis. Elements with p-values (two-sided) of 0.05 or less were included in the multivariate Cox model to identify independent variables in a stepwise manner.

Results

A total of 41 patients were included in the study. In correlation with the male predominance of SBC, 36 patients (87%) were male. The mean patient age at operation was 10.8±3.19 years (range, 4-15 years). Twenty-five patients presented with SBC in the humerus and 16 in the femur. SBC was latent in 53% of patients. More than half of the patients had a history of pathological fracture.

The mean SBC area was 8.25±4.62 cm^2 (range, 1.1-26.2 cm^2). The mean SBC longitudinal length was 6.67±3.83 cm (range, 2.1-24.4 cm). The average SBC index was 4.58±2.61 ratio (range, 0.9-13.5). The mean SBC diameter ratio was 4.97±2.66 ratio (range, 1.85-12.96). The average follow-up period was 51±21.3 months (range, 25-112 months). Allografts were used in 27 patients and synthetic glass grafts in 14 patients. In four femur and two humerus SBC patients, plate fixation was used because of the risk of fracture. The demographic data of patients were also showed in Table 1.

Recurrence was observed in 13 of 41 patients during follow-up. The recurrence rate was 31%. Eight of these patients underwent re-operation, three underwent observation, and three were lost to follow-up. Deformity after recurrence was observed in only one patient in the study groups. This patient recovered after recurettage + grafting and plate fixation (Figure 2). There were no significant differences in sex, bone location, pathological fracture history, and the type of graft used between patients with and without recurrence. The age at surgery was found to be significantly lower in patients with recurrence (recurrence patients: 8.75±2.96 years, no recurrence: 11.07±2.82 years, p=0.02). The radiological features of the cyst: cyst index, cyst diameter ratio, cyst area, and cyst length, were found to be higher in the recurrence group, although there was no significant difference. The data comparing the radiological features of both groups are shown in Table 2.

Table 1. Demographic and baseline data

		Group		Test value
		Recurrence group, (n=13)	No recurrence group, (n=28)	p
Age	Mean ± SD	8.75±2.96	11.07±2.82	[a]**0.002***
Sex	Male	13 (100)	23 (82)	[b]**0.104**
	Female	0	5 (18)	
Bone	Humerus	8 (61)	17 (60)	[b]**0.960**
	Femur	5 (39)	11 (40)	
Localization	Metaphysis	12 (92)	23 (85)	[b]**0.641**
	Diaphysis	1 (8)	4 (15)	
Fracture history	Yes	7 (53)	16 (57)	[b]**0.843**
	No	6 (47)	12 (43)	
Follow-up time (month)	Mean ± SD	43.83±14.16	54.73±22.82	[a]**0.120**

[a]Data analyses were performed with Independent samples t-test,
[b]Data analyses were performed using Pearson's chi-square test, *p<0.05,
SD: Standard deviation

Table 2. Radiological findings of SBC and surgery type

		Group		Test value
		Group 1 (n=13)	Group 2 (n=21)	p
Graft type	Allograft	10 (76)	17 (60)	**0.308**[a]
	Bone-glass	3 (24)	11 (40)	
Internal fixation	Yes	1 (8)	5 (18)	**0.391**[a]
	No	12 (92)	23 (82)	
Cyst activity	Active	8 (61)	11 (39)	**0.184**[a]
	Latent	5 (39)	17 (61)	
Cyst volume (cm^2)	Mean ± SD	9,288±5,821	7,768±3,982	**0.750**[b]
Cyst longtidunal size (cm)	Mean ± SD	7.43±0.89	6.32±0.46	**0.814**[b]
Cyst index	Mean ± SD	5.69±3.24	4.07±2.14	**0.121**[b]
Cyst diameter ratio	Mean ± SD	5.63±3.54	4.65±2.14	**0.515**[b]

[a]Data analyses were performed using Fisher's exact test. [b]Data analyses were performed using the Mann-Whitney U test, *p<0.05, SD: Standard deviation, SBC: Solitary bone cysts

Discussion

Younger age was the only significant factor associated with increased risk of recurrence. No significant relationship was found between the other factors determining the risk of recurrence. In another study assessing the predictive factors for recurrence of proximal humerus SBC, Teoh et al. (13) defined refracture and re-expansion of the cyst as recurrence. In this study, 31 of 32 patients presented with pathological fracture, and curettage was performed in only nine patients. Active cysts were not significantly associated with recurrence. They stated that a high cyst index, young age, and non-impacted pathological fracture significantly increased the risk of recurrence. It was mentioned that decreasing the cyst volume due to impaction may have a favorable effect on healing. In the present series, younger age at surgery was clinically significant in the recurrence group (p=0.02). Although mean SBC size, area, index, and diameter ratio were higher in the recurrence group, no clinically significant difference was detected.

In a systematic review of different treatment modalities for SBC, the healing rates of 3,217 patients were evaluated (8). Approximately 85% of these cases involved humerus and femur SBC. The M:F ratio was set to 2. Among the treatment modalities, the lowest healing rate was observed in observation (healing rate 64%), whereas the highest healing rates were observed in long bone SBC with open curettage and grafting (healing rate 90%) and elastic nailing without curettage (healing rate 100%). In this study, it was emphasized that the recovery rates of the most unsuccessful surgical treatments were higher than the observed rates. In addition, the success of allograft, autograft, and synthetic grafts as graft types was evaluated in cases with surgical curettage, and similar healing rates were observed. The higher recurrence rate (30%) in our series may be due to the longer follow-up period and smaller sample size. In addition, allograft and bioactive synthetic bone grafts were used. Because synthetic grafts are cheaper and more accessible, large-volume SBCs were used more frequently. Although there was a bias in the study, the graft types used did not have a clinically significant effect in recurrence (p=0.308).

There are several conflicting studies in the literature on the effects of pathological fracture development on the risk of recurrence. Flont et al. (6) retrospectively investigated the risk factors for recurrence in 24 patients with SBC. It was determined that patients with humeral SBC who had pathological fractures upon diagnosis were more likely to have recurrence. Radiological parameters such as cyst area, cyst index, and cyst diameter ratio were significantly lower in patients without recurrence. No significant difference was found in terms of age, gender, or type of bone graft. Researchers explained the negative effect of presentation with pathological fracture on prognosis as difficulty in surgical technique due to the irregularity in the cystic cavity after fracture. Nearly half of the patients in our study group had a history of pathological fracture. The pathological fracture history had no significant effect on recurrence. In contrast to this study, another retrospective study was conducted by Cha et al. (7) to determine the effect of pathological fracture on recurrence. A total of 54 patients (25 patients admitted pathological fractures) who underwent only retrograde elastic nailing (no curettage and grafting) due to femoral SBC were included in the study. The researcher found no significant difference in the average healing time between the two groups. The healing and recurrence rates were similar, suggesting that the presence of a pathologic fracture did not affect the outcome of intramedullary nailing treatment. Although pathological fracture history was present in nearly half of the patients in the present study group, it had no significant effect on recurrence (p=0.843).

Study Limitations

Regarding methodology, the study's primary limitation is the small sample size. Another limitation is the retrospective nature of the study. The SBC series usually has a medium sample size, similar to our study. The results obtained during the mid-term follow-up will contribute to the literature. An important limitation of this study is that the treatment methods were not randomized.

Conclusion

Since recurrence is one of the most challenging issues in the treatment of SBC and is frequently observed, this should be shared with the family, and it should be explained in detail that repeat surgical interventions may be required. It is important to inform the family that the risk of recurrence will be high at a young age and when the SBC is large. The treatment of SBC should be patient-specific. In patients with asymptomatic SBC detected at an early age, observation in the primary treatment plan instead of surgical treatment at a young age is more appropriate.

Ethics Committee Approval: IRB and İstanbul University, İstanbul Faculty of Medicine Local Ethics Committee approval was obtained before the study initiation (approval number: 2024/611, date: 13.03.2024).

Informed Consent: The informed consent of the parents and the consent of the child to participate was obtained.

Authorship Contributions: Surgical and Medical Practices - S.B., A.S.; Concept - A.M.Y.; Design - S.B.; Data Collection or Processing - F.O.; Analysis or Interpretation - A.M.Y.; Literature Search - S.B., A.S.; Writing - S.B., A.M.Y.

Conflict of Interest: No conflict of interest was declared by the authors.

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References

1. Wilkins RM. Unicameral bone cysts. J Am Acad Orthop Surg. 2000; 8: 217-24.
2. Mascard E, Gomez-Brouchet A, Lambot K. Bone cysts: Unicameral and aneurysmal bone cyst. Orthop Traumatol Surg Res. 2015; 101(Suppl 1): S119-27.
3. Jaffe HL, Lichtenstein L. Solitary Unicameralbone Bone Cyst with Emphasis on the Roentgen Picture, the Pathologic Appearance and the Pathogenesis. Arch Surg. 1942; 44: 1004-25.
4. Kang HS, Ahn JM, Kang Y. Oncologic Imaging: Bone Tumors. Springer; 2017.
5. Baghdadi S, Arkader A. Unicameral Bone Cysts: Treatment Rationale and Approach. J Pediatr Orthop Soc North Am. 2021; 3: 267.
6. Flont P, Malecki K, Niewola A, Lipczyk Z, Niedzielski K. Predictive characteristic of simple bone cyst treated with curettage and bone grafting. BMC Musculoskelet Disord. 2015; 16: 350.
7. Cha SM, Shin HD, Kim KC, Park JW. Does fracture affect the healing time or frequency of recurrence in a simple bone cyst of the proximal femur? Clin Orthop Relat Res. 2014; 472: 3166-76.
8. Kadhim M, Thacker M, Kadhim A, Holmes L Jr. Treatment of unicameral bone cyst: systematic review and meta analysis. J Child Orthop. 2014; 8: 171-91.
9. Enneking W, Dunham W, Gebhardt M, Malawar M, Pritchard D. A system for the classification of skeletal resections. Chir Organi Mov. 1990; 75(1 Suppl): 217-40.
10. Neer CS 2nd, Francis KC, Marcove RC, Terz J, Carbonara PN. Treatment of unicameral bone cyst. A follow-up study of one hundred seventy-five cases. J Bone Joint Surg Am. 1966; 48: 731-45.
11. Kaelin AJ, MacEwen GD. Unicameral bone cysts. Natural history and the risk of fracture. Int Orthop. 1989; 13: 275-82.
12. Kanellopoulos AD, Mavrogenis AF, Papagelopoulos PJ, Soucacos PN. Elastic intramedullary nailing and DBM-bone marrow injection for the treatment of simple bone cysts. World J Surg Oncol. 2007; 5: 111.
13. Teoh KH, Watts AC, Chee YH, Reid R, Porter DE. Predictive factors for recurrence of simple bone cyst of the proximal humerus. J Orthop Surg (Hong Kong). 2010; 18: 215-9.