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ORIGINAL ARTICLE

## Management of Benign Bone Cyst by Bone Marrow and Bone Substitute Composite

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### ABSTRACT

**Background:** Bone cysts are tumor-like formations with varying fluid contents that resembled cavities. In flat bones, it is frequently asymptomatic until it is unintentionally found during imaging.

**Objective:** This study aimed to evaluate clinical and radiological results in management of benign bone cyst by using bone marrow and bone substitute composite. **Patients and methods:** This study included 30 patients with benign bone cystic lesion were discovered accidentally or come with pathological fracture who were admitted to Orthopedic department, Zagazig University Hospitals. Plain radiographs were reviewed to determine the anatomic location, presence of pathological fracture, cyst size (cyst index), postoperative osseous healing, and the presence of local recurrence. The follow up period was 2 years. **Results** Age was distributed as  $17.64 \pm 6.3$  and males represented 66.6%. Unicameral bone cyst was 50% then aneurysmal bone cyst. The majority site was tibia with (53%). All patients were without nail except one case only fixed with nail. Only 3 cases had complication with 10% (one case with delay healing, one case with infection and one case with nonunion). Regarding progress distribution; the majority of patients were good (96.7%). There was no significant association except between complication and bad progress there was significant association between them. **Conclusion:** Bone marrow and bone replacement composite management of bone cysts is a useful technique with numerous benefits as a reconstructive and reparative therapy.

**Keywords:** Benign Bone Cyst; Bone Marrow; Bone Substitute Composite

### INTRODUCTION

Bone cysts are tumor-like growths that resemble cavities and have a fluctuating fluid content [1]. A simple bone cyst is a single, benign, fluid-filled cyst that might have septations or be unicameral (single chamber). Any extremity bone may be affected, although the proximal humerus and proximal femur are the most frequently affected [2]. The ilium and calcaneus are common sites in adults. These lesions are known to heal on their own once the bone reaches maturity, and they are most active during growth spurts. A fracture is observed in two thirds of cases of bone cysts [3]

A benign cystic bone tumor that is rare, blood-filled, and locally damaging is called an aneurysmal bone cyst. In children and adolescents, it has to do with the metaphysis of long bones. The distal femur, proximal tibia, proximal humerus, and spine are the

most often affected bones, though they can affect any bone [4]. Most patients have mild to severe pain at first. The lesion's quick growth could be mistaken for cancer. Neurologic impairments or radicular discomfort may result from spinal lesions. They frequently affect the vertebral bodies' posterior components. In rare cases, ABC can also appear in soft tissue [5].

Mesenchymal and hematopoietic stem cells are found in bone marrow. Hematopoietic stem cells are found in the fragile, highly vascular fibrous tissue that makes up red bone marrow. Mesenchymal stem cells, also known as marrow stromal cells, are found in yellow bone marrow. Autologous bone marrow aspirates taken from the iliac crest using percutaneous means. Every three milliliters, the aspiration site was altered, either in depth or orientation. The amount of bone marrow aspirated

onto heparinized syringes is determined by the size assessed by the MRI. Bone marrow is subcutaneously injected into the cyst location until the cyst becomes resistant to the injection and is unable to hold any more aspirates [6].

Recently, material and tissue engineering specialists have become interested in the property of resorbable materials. These materials biodegrade and, through the process of bone remodeling, can eventually be replaced by new bone<sup>(7)</sup>. Dicalcium phosphate anhydrous (DCPA) and oxalic acid (OCP) are examples of acidic calcium phosphates that are soluble ceramics at neutral pH 4, 14.  $\alpha$ -TCP 4, 32 and amorphous calcium phosphate (ACP) 33, 34, 35 are acknowledged as highly soluble materials at neutral pH and have also been demonstrated to biodegrade [7].

Therefore, the purpose of this study was to assess the clinical and radiological outcomes of employing bone marrow and bone substitute composite in the management of benign bone cysts.

## METHODS

The included study population was patients with bone cystic lesion discovered accidentally or come with pathological fracture who were admitted to Orthopedic department in Zagazig University Hospitals. This study was carried out through a period of two year and half from the first of March 2021 to the end of November 2023.

### Criteria of inclusion:

Patients who have minimally traumatised pathological fractures. A high risk of pathological fracture exists for bone cyst diameters less than 80% and cortical thickening greater than 2 mm.

### Criteria of exclusion:

Patients without any symptoms or complaints that were unintentionally identified, with cysts appearing in a latent stage without growing, were followed up on. When a bone cyst has a diameter greater than 60% and a cortical thickness of less than 2 mm, there is little chance of a pathological fracture and no need for surgery.

### Ethical consideration:

Patients were enrolled in this study after obtaining written consent as there are no extra interventional measures was undertaken in the study apart from routine investigations & procedure done during treatment & follow up. An approval of the study was obtained from Zagazig University Academic and Ethical Committee (IRB #2908,2020). Written

informed consent of all the participants was obtained. This work has been carried out in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki) for studies involving humans.

### • Pre-Operative Clinical Evaluation

The patients in this study had a mean age of 15.0 (10-30) years. Among these thirty patients, ten (33.5%) were female and twenty (66.5%) were male. Anaemia and respiratory issues were the most prevalent medical conditions among the study's participants. All patients underwent regular laboratory investigations as part of their preoperative evaluation, including tests for the liver, kidneys, coagulation profile, random blood sugar, ESR, CRP, and viral indicators.

Preoperative assessments, including taking the patient's history, were performed on all patients. Preoperative and postoperative radiological and clinical evaluations were conducted based on the location of the cystic lesion. Every patient was exposed to the cystic lesion site both before and after surgery. Patients had orders for MRIs and X-rays. A biopsy might also be required to identify the type of cyst.

To determine the best course of action, the following two factors should be assessed: \* Bone cyst diameter and index; \* Enneking radiological criteria (latent stage, active stage, aggressive stage).

### Surgical Technique :

Patients with lower limb cystic lesions underwent spinal anaesthesia, while those with upper limb cystic lesions underwent general anaesthesia. Every patient in this trial was in the prone position.

### Surgical approach:

Based on the location of the cystic lesion: 10 cases proximal 1/3 of the tibia: two cases using anterolateral approach Four examples of proximal 1/3 fibula: direct lateral approach on bone Femur's distal 1/3: lateral approach, One instance Distal 1/3 radius: six scenarios using the modified Henry technique Tibia's distal third: medial approach, three cases Four case hand: dorsal approach, proximal 1/3 humerus: delto-pectoral approach. Once the cystic lesion is reached, curettage is performed to eliminate any fibrous or dead tissue before our composite is ready. Depending on the size of the cyst, a 5–10 gramme bone substitute made of calcium sulphate from Indonesia was used. Using a tiny needle, aspirate the iliac crest to get a sample of the liquid portion of the bone marrow, measuring between 2 and 3 cm. Next, fill

the deficiency by combining the bone substitute with the bone marrow sample.

**Postoperative Management:**

Both analgesics and antibiotics were continued for ten days. IV double antibiotics were administered for three days (Unasyn 1.5 gm vial/12h and Cefobid 1 gm vial/12h), followed by oral antibiotics (Hibiotic 1 gm tab/12h) for seven days. Radiographs were taken right away. After the procedure, the average length of hospital stay was three days (range: two to four days). For clinical and radiological evaluation, patients were asked to review every two weeks during the first month and subsequently once a month at the out-patient clinic. In the first two months following surgery, the functional result was assessed to make sure there was no infection and perfect union.

**Postoperative radiographic analysis:**

In order to assess the interaction between the bone substitute, bone marrow composite, and the benign cystic lesion and determine whether full callus development was reached, an X-ray was taken in two views (AP-Lateral) at the site of the lesion after surgery, anywhere from four weeks to one year.

**STATISTICAL ANALYSIS**

The collected data was computerized and statistically analyzed using SPSS program (Statistical Package for Social Science) version 16.0. Qualitative data were represented as frequencies and relative percentages. Quantitative data were expressed as mean ± SD (Standard deviation). Chi square test ( $\chi^2$ ) or Fisher's exact test was used to calculate difference between qualitative variables. Student t test was used to calculate difference between quantitative variables. The results considered significant when the Probability (P value) was less than 0.05, highly significant if it was less than 0.01 and very highly significant if it was less than 0.001.

**RESULTS**

The present study showed age was distributed as 17.64±6.3 with minimum 7 and maximum 30 years and regard sex distribution male were majority with 66.6% (Table 1).

Regard cyst type the majority were unicameral bone cyst with 50% then aneurysmal bone cyst type with 26.6%. Chondroblastoma with 13.4%. Regard site majority were tibia with 53%. All patients were without nail except one case only fixed with nail (Table 2).

Only 3 cases had complication with 10% (one case with delay healing, one case with infection and one case with nonunion) (Table 3). Regarding progress distribution; the majority of patients were good (96.7%) and only one case was with bad progress. Concerning Enneking Staging distribution; 53.3 % of the studied patients represented an active stage and 26.6% represented a latent stage (Table 4).

There was no significant association except between complication and bad progress there was significant association between them (Table 5).

A male case, 17 years old, with a history of pain in weight bearing from 2 weeks ago at Lt knee. X-ray AP and lateral view show large cystic lesion at proximal Lt tibia. MRI show cystic lesion extend to metaphyseal. CT show a defined lytic lesion suspect chondroblastoma and confirmed by biopsy. Patient was admitted and prepared for operation. He operated with bone marrow and bone substitute composite is used with no complication (Figure 1).

A female case, 7 years old, with a history of trauma from 3 days ago in Lt hand. X-ray AP and lateral view show cystic lesion in 3rd metacarpal bone in Lt hand. Biopsy analysis confirms the cystic lesion is simple bone cyst. Patient was admitted and prepared for operation. Routine operation and follow up period were done without complication (Figure 2).

**Table (1): Demographic distribution among studied group (N=30)**

		Age	
Mean± SD		17.64±6.3	
Median (Range)		15.0 (10-30)	
		N	%
Sex	Female	10	33.4
	Male	20	66.6
	Total	30	100.0

**Table (2): Cyst distribution and Type of fixation among studied group (N=30)**

		N	%
Type of cyst	Unicameral bone cyst	15	50
	Aneurysmal bone cyst	8	26.6
	Chondroblastoma	4	13.4
	Enchondroma	3	10
	Total	30	100.0
Site	Tibia	16	53.3
	Femur	4	13.3
	Hummers	3	10
	Hand	4	13.3
	Fibula	2	6.6
	Radius	1	3.3
	Total	30	100.0
Fixation	With nails	1	3.3
	Without	29	96.7
	Total	30	100.0

**Table (3): Complication distribution among studied group (N=30)**

		N	%
Complication	No	27	90
	Delay healing	1	3.3
	Infected	1	3.3
	Non union	1	3.3
Overall Complication	Non complicated	27	90
	Complicated	3	10
	Total	30	100.0

**Table (4): Progress and Enneking Staging distribution among studied group (N=30)**

		N	%
Progress	Bad	1	3.3
	Good	29	96.7
	Total	30	100.0
Enneking Staging	Latent stage	8	26.6
	Active stage	16	53.3
	Aggressive stage	6	20.1
	Total	30	100.0

**Table (5): Factors in relation to complication among the studied patients**

			No	Complicated	t/ X <sup>2</sup>	P
Age			16.72±6.25	21.0±7.02	0.89	0.38
Sex	Female	N	10	1		
		%	33.3%	33.3%		
	Male	N	20	2	0.009	0.92
		%	66.6%	66.7%		
Site	Femur	N	4	0		
		%	27.3%	0.0%		
	Fibula	N	2	0		
		%	18.2%	0.0%		
	Hummers	N	3	1	2.54	0.46
		%	9.1%	33.3%		
	Hand	N	4	0		
		%				

		%	13.3%	0.0%		
	<b>Tibia</b>	N	16	2		
		%	45.5%	66.7%		
Cyst	<b>Aneurysmal bone cyst</b>	N	8	2		
		%	27.3%	66.7%		
	<b>Enchondroma</b>	N	3	0		
		%	9.1%	0.0%		
	<b>Chondroblastoma</b>	N	4	0	1.78	0.61
		%	9.1%	0.0%		
<b>Unicameral bone cyst</b>	N	15	1			
	%	54.5%	33.3%			
Fixation	<b>With nails</b>	N	1	0		
		%	9.1%	0.0%		
	<b>Without</b>	N	29	3	0.29	0.58
		%	90.9%	100.0%		
Progress	<b>Bad</b>	N	1	1		
		%	0.0%	33.3%		
	<b>Good</b>	N	29	2	3.94	0.047*
		%	100.0%	66.7%		
Total	N	27	3			
	%	100.0%	100.0%			



**Figure (1):** A male case 17 years old showing (a) Ct scan show well defined Chondroblastoma about 40\*34 mm involve medial aspect of upper tibial epiphysis extend to metaphyseal ; (b) MRI show Chondroblastoma in upper left tibia without any soft-tissue extension ; (c) Plain X-ray of lt knee joint (2 months Post-operative); (d) Plain X-ray views of lt knee joint (7 months Post-operative).



**Figure (2):** A female case 7 years old showing (a) Plain X-ray AP views of lt hand show Simple bone cyst in 3<sup>rd</sup> metacarbale bone; (b) Plain X-ray Oblique views of lt hand show bone substitute fill the Simple bone cyst (2 months post-operative); (c) Plain X-ray AP views of lt hand (5 months Post-operative); (d) Plain X-ray AP views of lt hand (1 year post-operative).

### DISCUSSION

The treatment of benign bone cysts is a difficult issue to address, particularly when there is disagreement about the most effective course of action and a literature full of therapeutic alternatives. Benign bone cysts are benign lesions that typically go away on their own as the skeleton matures. However, when pathologic fractures occur and the cyst continues to show up on radiographs, these young children are not allowed to engage in full range of motion.

leisurely physical activity. Therapy may strengthen the bone cortex [8].

Treating benign bone cysts is a challenging problem, especially when there is conflicting evidence regarding the best course of action and a wealth of therapeutic options available. Benign bone cysts are benign lesions that usually disappear when the skeleton ages on its own. However, these young children are not permitted to participate in leisurely physical activity if pathologic fractures develop and the cyst still appears on radiographs. The bone cortex may get stronger with therapy [9].

Moreover, it is challenging to establish precise criteria because the literature reports on all treatment modalities with a broad range of healing rates. In order to treat bone cysts, we thus investigated whether, over the course of the two-year follow-up, a single injection of autologous BM combined with an allograft or substitute would result in healing rates that were comparable to those of multiple steroid injections, as well as whether the failure rate and healing rate at the last follow-up were correlated with the location and size of the cyst in relation to the epiphysis and the age of the patients [10].

So the purpose of this study was to evaluate the clinical and radiographic results of treatment of benign bone cysts by bone marrow injection and bone substitute composite and compare with results of benign bone cysts treatment by other methods.

According to type of cyst distribution among studied group; in our study mainly cystic lesion is simple bone cyst 50%. **Alisi et al. [11]** who discovered that 73.8% of cystic lesions are simple bone cysts and aneurysmal lesions. **Di Bella et al. [12]** who showed that mainly on simple bone cysts not on all benign cystic lesions as in our study.

As regarding to different methods of management and duration of follow up between our study and previous studies on bone cyst but lead us to the same aim.

**Cho et al. [13]** who included 30 patients receiving steroid injections and 28 patients receiving injections of natural bone marrow. In their study, the follow-up period averaged ten years.

**Sung et al. [14]** who revealed that 34 patients received treatment with a combination of demineralized bone matrix and native bone marrow in addition to 94 patients who received steroid injections. The remaining 39 patients had curettage alone. In their study, the follow-up period lasted for seven years.

**Di Bella et al. [12]** who showed that 41 patients received treatment with concentrated bone marrow and demineralized bone matrix out of the 143 patients who received steroid injections. In their study, the follow-up period lasted for 1.5 years.

In our study 30 patients treated by bone marrow injection and bone substitute composite. Duration of follow up (2 years). Some previous studies were not report the enneking staging and bone cyst index or diameter but our study proved the importance of it to reach the best results of study.

**Di Bella et al. [12]** who demonstrated that patients can be evaluated for treatment type and steroid injection against demineralized bone matrix by using enneking staging and bone index. With a bone index average of 60%, the common stage is active stage 72%.

In our study using enneking staging and bone index on patients to detect amount of bone marrow we aspirate and amount of bone substitute we need to fill the defect of bone cyst to reach a good prognosis. The common stage is active stage also 53%, and bone index >75%. According to complication distribution among studied group:

**Kanellopoulos et al. [15]** who revealed that of the approximately 20% of complications in their study, 12.5% were infection and 7.5% were non-union.

**Sung et al. [14]** who shown that around 35% of problems include infection (25%), refracture at the lesion location 7%), and fracture healing delay 3%.

In our study complication is about 10% include infection 3.3% and delay healing 3.3% and non-union 3.3%. Progression ratio of cases differs from study to another one according to number of patients and duration of follow up and method of intervention. In our study we have the highest progress ratio 96.6% comparing to other studies.

We agreed with other authors in that the intended clinical benefit means the negative findings should be interpreted cautiously. More data also needed to examine the utility and effectiveness of our composite in management of benign cystic lesion.

Our results with significant improvement in using the composite of bone marrow and bone substitute of calcium sulphate than others techniques reported in the previous studies including **Alisi et al. [11]** who used curettage and allograft in management of benign bone cysts; **Farber et al. [16]** used steroid injection; and **Wright et al. [17]** used bone marrow injection.

**Alisi et al. [11]** who achieved poor prognosis for curettage-only care of bone cysts led to the use of allograft in conjunction with curettage to improve outcomes over curettage alone; nevertheless, the graft resorbs without forming new bone.

**Farber et al. [16]** used The use of steroids in the treatment of bone cysts had the benefit of regressing the cyst from an active or regressive stage to a latent stage; however, the use of steroids inhibited the ability of osteoblast cells to form new bone, which resulted in a poor prognosis in 50% of cases.

**Wright et al. [17]** applied bone marrow injection inside the cyst in close proximity to our study's findings in comparison to other investigations.

Our study proved the best results of management of bone cyst by our nova composite of bone marrow and bone substitute.

There were limitations in our study that we were in need of a larger number of patients and a longer period of follow up.

### CONCLUSION

Bone marrow and bone replacement composite management of bone cysts is a useful technique with numerous benefits as a reconstructive and reparative therapy.

On the basis of this study, When treating this difficult patient population, the outcomes of bone marrow and bone substitute composite are encouraging and satisfactory.

So in the future we need more research to investigate the variance of techniques and duration of follow up in management of bone cyst to confirm our conclusion and results.

### REFERENCES

1. Doğanavşargil B, Ayhan E, Argin M, Pehlivanoğlu B, Keçeci B, Sezak M. et al. Cystic bone lesions: histopathological spectrum and diagnostic challenges. *Turk Patoloji Derg.* 2015;31(2):95-103.
2. Rosenblatt J, Koder A. Understanding Unicameral and Aneurysmal Bone Cysts. *Pediatr Rev.* 2019;40(2):51-59.
3. Brenner JS; American Academy of Pediatrics Council on Sports Medicine and Fitness. Overuse injuries, overtraining, and burnout in child and adolescent athletes. *Pediatrics.* 2007;119(6):1242-5.
4. Zishan US, Pressney I, Khoo M, Saifuddin A. The differentiation between aneurysmal bone cyst and telangiectatic osteosarcoma: a clinical, radiographic and MRI study. *Skeletal Radiol.* 2020;49(9):1375-1386.
5. Telera S, Raus L, Vietti V, Pace A, Villani V, Galié E, et al. Schwannomas of the sciatic nerve: A rare and neglected diagnosis. A review of the literature with two illustrative cases. *Clin Neurol Neurosurg.* 2020;195:105889.
6. Meirlaen S, Haoudou R, Thiteux Q, Bellanova L, Docquier PL. Treatment of bone cysts by percutaneous injection of demineralized bone matrix mixed with bone marrow. *Acta Orthop Belg.* 2022;88(3):559-567.
7. LeGeros RZ. Calcium phosphate-based osteoinductive materials. *Chem Rev.* 2008;108(11):4742-53.
8. Kaelin AJ, MacEwen GD. Unicameral bone cysts. Natural history and the risk of fracture. *Int Orthop.* 1989;13(4):275-82.
9. Thawrani D, Thai CC, Welch RD, Copley L, Johnston CE. Successful treatment of unicameral bone cyst by single percutaneous injection of alpha-BSM. *J Pediatr Orthop.* 2009;29(5):511-7.
10. Cevolani L, Campanacci L, Sambri A, Lucarelli E, De Paolis M, Donati DM. Is percutaneous injection of bone marrow concentrate, demineralized bone matrix and PRF an alternative to curettage and bone grafting for treating aneurysmal bone cyst? *J Tissue Eng Regen Med.* 2021;15(3):269-278. .
11. Alisi MS, Abu Hassan F, Hammad Y, Khanfar A, Samarah O. Percutaneous Curettage and Local Autologous Cancellous Bone Graft: A Simple and Efficient Method of Treatment for Benign Bone Cysts. *Arch Bone Jt Surg.* 2022;10(1):104-111.
12. Di Bella C, Dozza B, Frisoni T, Cevolani L, Donati D. Injection of demineralized bone matrix with bone marrow concentrate improves healing in unicameral bone cyst. *Clin Orthop Relat Res.* 2010;468(11):3047-55.
13. Cho HS, Oh JH, Kim HS, Kang HG, Lee SH. Unicameral bone cysts: a comparison of injection of steroid and grafting with autologous bone marrow. *J Bone Joint Surg Br.* 2007;89(2):222-6.
14. Sung AD, Anderson ME, Zurakowski D, Hornicek FJ, Gebhardt MC. Unicameral bone cyst: a retrospective study of three surgical treatments. *Clin Orthop Relat Res.* 2008;466(10):2519-26.
15. Kanellopoulos AD, Yiannakopoulos CK, Soucacos PN. Percutaneous reaming of simple bone cysts in children followed by injection of demineralized bone matrix and autologous bone marrow. *J Pediatr Orthop.* 2005;25(5):671-5.
16. Farber JM, Stanton RP. Treatment options in unicameral bone cysts. *Orthopedics.* 1990;13(1):25-32.
17. Wright JG, Yandow S, Donaldson S, Marley L; Simple Bone Cyst Trial Group. A randomized clinical trial comparing intralesional bone marrow and steroid injections for simple bone cysts. *J Bone Joint Surg Am.* 2008 ;90(4):722-30.



### ***Citation***

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