Bone marrow injection for the treatment of aneurysmal bone cyst

Mahmoud I. Abdel-Ghany

Department of Orthopedic and Trauma Surgery, Faculty of Medicine for Girls, Cairo, Egypt

Correspondence to Mahmoud I. Abdel-Ghany, MD, Department of Orthopedic and Trauma Surgery, Ibn-Al-Hakam Sqaure, EL-Ezz Bulding B, Helmiet Al-Zaytoun, Cairo, Egypt;
Tel: 01005196727;
e-mail: mhghany@hotmail.com

Received 15 July 2015
Accepted 27 June 2016

The Egyptian Orthopaedic Journal
2017, 51:209–214

Study design
Patients with aneurysmal bone cyst (ABC) lesion were treated by an injection of autologous bone marrow aspirates (ABM) and follow-up was performed to obtain the final results.
Patients and methods
Sixteen patients had an ABC that was treated by ABM injections. This study included 16 patients, 11 (68.75%) females and five (31.25%) males. Their age ranged from 3 to 14 years, with an average age of 7.5 years. The number of injections for every patient ranged from 2 to 6, with an average of 4.4. This study included five (31.25%) patients with a proximal femoral cyst, nine (56.25%) patients with a tibial cyst (two distal and seven proximal tibiae), and two (12.5%) patients with a proximal humeral cyst.

All patients were treated by an injection of ABM obtained from the iliac crest. The bone marrow (BM) aspirates were obtained percutaneously using a BM aspiration needle. On the basis of radiographic follow-up during injections, we decided to continue with the administration of injections. The average size of the defect was 2.3 cm and the average amount BM/injection was 10.2 cm^3.
Results
The pain score according to Visual Analogue Score ranged from 3 to 9, with an average of 5.7, which improved to an average of 1.5 at the final follow-up. Duration of healing time ranged from 21 to 90 days, with an average of 42.2 days. Motion of the arm, as patients could move their arm without pain, was allowed. Weight bearing for the lower limbs was also allowed as patients reported that pain subsided even when no complete healing was achieved according to radiological investigations.
Conclusion
The presence of an ABC leads to the risk of fractures and recurrences after various modalities of treatment. The BM has the advantage of percutaneous treatment (minimal invasive) and no recurrence was reported in the current study.

Keywords:
aneurysmal bone cyst, bone marrow injection, percutaneous injection of ABC

Egypt Orthop J 51:209–214

1110-1148

Introduction

An aneurysmal bone cyst (ABC) is a benign, tumor-like, highly vascular, locally aggressive, and relatively rare osteolytic lesion of unknown etiology [1]. Treatment options for ABCs are simple curettage with or without bone grafting, complete excision, embolization, radiation therapy, or a combination of these modalities [2,3]. Radical surgical excision should be the goal of surgery to decrease the recurrence rate. The recurrence rate is significantly lower in case of total excision [4].

Autologous mesenchymal stem cells have been harvested, processed, and readministered according to protocols specifically for target application. It ranges from simple single-step approaches by an injection of unprocessed or concentrated blood or bone marrow (BM) aspirates to fabrication of engineered constructs by natural or synthetic scaffolds with cells [5]. Percutaneous injection of autologous bone marrow (ABM) [6,7], allogenic demineralized bone matrix, and percutaneous curettage and bone grafting have been used, with widely variable success rates [8].

Patients and methods

Sixteen patients had an ABC that was treated by ABM injections. This study included 16 patients, 11 (68.75%) females and five (31.25%) males. Their age

 DOI: 10.4103/1110-1148.208910

ranged from 3 to 14 years, with an average age of 7.5 years. The number of injections for every patient ranged from 2 to 6, with an average of 3.0. The interval between injections was 2–3 weeks according to the size of the defect. This study included five (31.25%) patients with a proximal femoral cyst, nine (56.25%) patients with a tibial cyst (two distal and seven proximal tibiae), and two (12.5%) patients with a proximal humeral cyst. Three (18.75%) cases were discovered after fractures and were treated conservatively by slab, cast, or traction with persistence of parts of the cyst. Repeated fractures at the same site of the cyst were recorded in three cases with more conservative treatment.

Measurements of the cyst sizes were performed by MRI views, ranging from 3 to 21 cm, with an average size of 14.8 cm.

All patients were treated by an injection of ABMs that were obtained percutaneously from the iliac crest. The site of aspiration was changed every 3 ml either in depth or in direction. According to the size estimated by the MRI, the amount of BM in aspirate was obtained in heparinized syringes (Fig. 1).

A percutaneous injection of BM was administered into the site of the cyst until resistance to injection and until the cyst could not contain more aspirates. In many cases, the blood contents of the cyst had to be aspirated before injections, especially those who had no previous fractures. The aspirated marrow reduced each time as the part of space was ossefied and the last injection of bone marrow necessitating not more than 5–7.5 cm^3 of aspirated BM.

The average numbers of injections were 4.4, ranging from 3 to 6, with time intervals between injections of 2–3 weeks. Clinical evaluations at every visit and routine radiography before injections were performed to follow the progression of healing. The average size of the defect was 2.3 cm and the average amount of BM/injection was 10.2 cm^3.

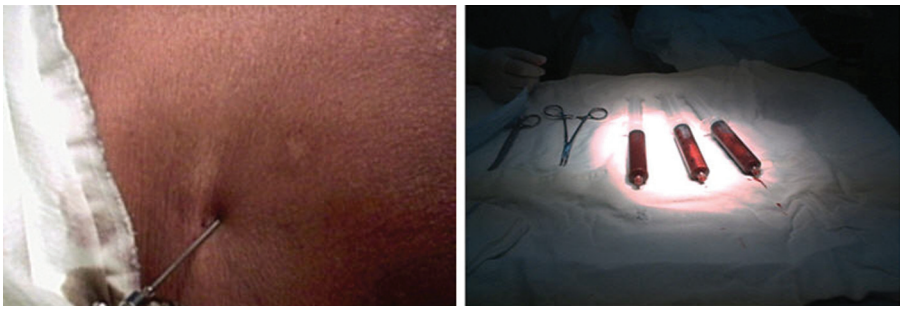
Results

Follow-up duration ranged from 18 months to 4 years for all patients. Close follow-up was performed until clinical improvement and radiological consolidation of the cyst. The pain score according to Visual Analogue Score ranged from 3 to 9, with an average of 5.7, which improved to an average of 1.5 at the final follow-up. Healing time ranged from 21 to 90 days, with an average of 42.2 days. Motion of the arm was allowed as patients could move their arm without pain. Weight bearing for the lower limbs was also allowed as patients reported that pain had subsided even when no complete healing was noted in radiological investigations. Painless nonsupported gait was observed and normal full activity for all patients, with return to usual activities. Sports activities such as football and running returned to normal in seven children; five out of these patients with a proximal femoral cyst and the other two patients with a tibial cyst were resumed their normal sport activities. At the final radiological evaluation, we found that all cases showed consolidated felling of cysts by bony tissue in an radiographic film and continuity of the cortical osseous structures. No cases of recurrence were observed at the last follow-up of all patients (Table 1 and Figs. 2–7). Special precautions are necessary when dealing with ABCs near open physes. The reported incidence of physeal injury is significant, and patients and their families must be made aware.

Discussion

The prevalence of an ABC is 1.4 cases per 100 000 individuals, and they constitute ~1% of all bone tumors [1,9]. It is known to be a benign, highly

Figure 1



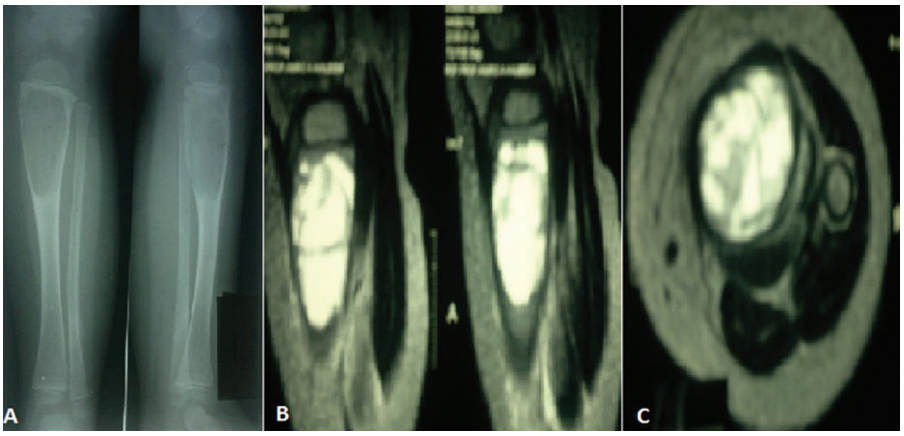
(a) Percutaneous aspiration from the posterior iliac crest and (b) bone marrow aspirates in heparinized syringes.

Table 1 Patients' preoperative and postoperative data

	Age (years)	Time for healing	Number of injections	Size of defect (l)	Circumference	Size (cm)	Average of BMA/ injection	VAS pre	VAS post
1	3	21	4	7	3.5	24.3	11.75	9	1
2	6	35	4	9	2.5	22.5	12.5	10	1
3	5	42	2	5	1	5	4.5	8	3
4	11	28	3	8	1.5	12	9	9	0
5	9	49	4	9	3	27	15	10	4
6	4	63	6	4	3.5	15	10	10	2
7	12	42	3	4	2	8	6	9	1
8	5	28	4	7	2	14	15	8	3
9	7	70	2	8	3	24	30	10	3
10	14	90	2	6	2.5	15	12	10	2
11	4	28	2	8	2	16	20	10	2
12	6	35	2	9	2	18	15	10	1
13	3	49	4	4	2	8	10	8	0
14	9	21	3	7	2	14	10	9	0
15	12	35	2	8	1.5	12.5	10	9	0
16	11	42	2	3	1	3	15	10	2
Average	7.6	42.3	3.0	6.6	2.1	14.8	12.8	9.3	1.5

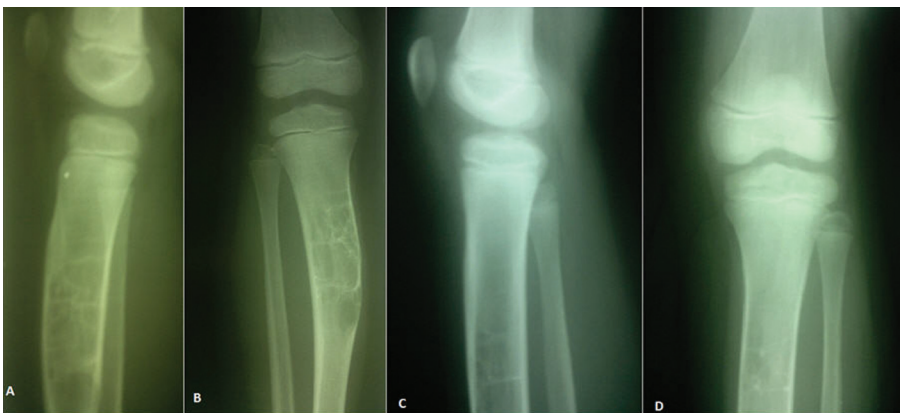
BMA, bone mineral accretion; VAS, Visual Analogue Score.

Figure 2



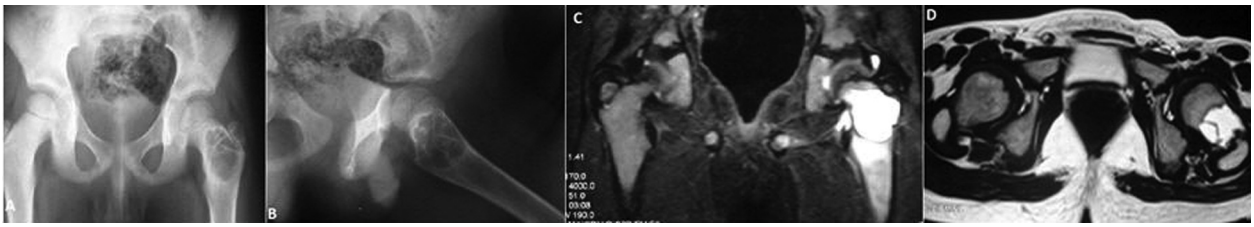
Juxta-articular tibial aneurismal bone cyst close to the proximal physes in a 3-year-old girl: (a) plain radiograph, anterioposterior and lateral; (b, c) MRI of the same case; sagittal and axial cuts shows the septum and how close the cyst is to the physes.

Figure 3



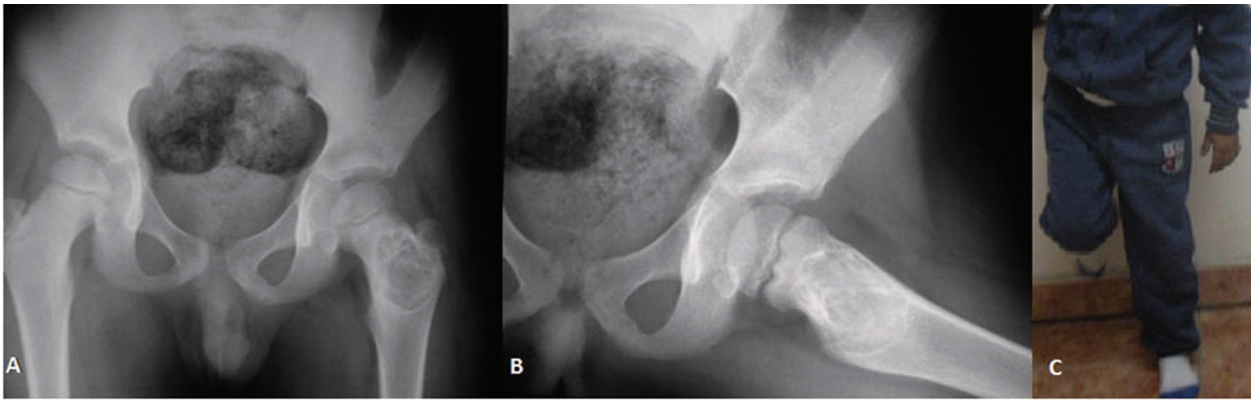
Follow-up radiography for the girl: (a, b) 2 years of follow-up with formed tibia (c, d) 3 years of follow-up of the patients with remodeling of the tibia and normal consolidated bone.

Figure 4



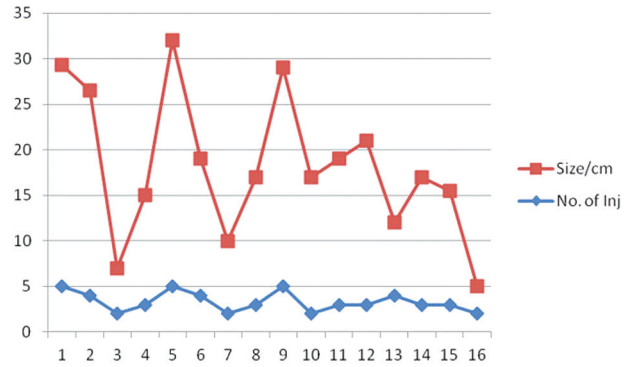
(a, b) Plain radiograph with a proximal femoral aneurysmal bone cyst: anterioposterior and lateral. (c, d) MRI pelvis with a huge cyst close to the physes.

Figure 5



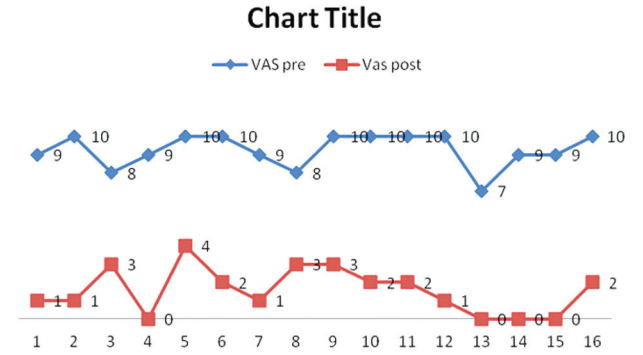
Follow-up 3-month plain radiograph with consolidated bone; the patient could stand on his affected limb.

Figure 6



Relation between the size of the defect and the number of injections.

Figure 7



Preoperative Visual Analogue Score (VAS) in correlation to the postoperative scores.

vascular, locally aggressive tumor, and its recurrence rates after curettage have been reported to be equal to or less than 50% [10].

Treatment of ABC is also controversial. The options for treatment are curettage with or without bone grafting, complete excision, arterial embolization, intralesional drug injections (steroid and calcitonin), and radiation [2]. En bloc resection is preferred when the ABC is growing superficially and eccentrically and more than half of the bone width is intact. Careful curettage and bone grafting still remains the surgical method of choice in the majority of cases, when the ABC is more destructive and affects the subchondral bone of the joints [11]. Despite this osteogenic characteristic, the clinical use of the marrow as an osteogenic source has remained limited [12].

In this study all patients were treated by repeated injections of Autogenous Bone Marrow Aspirates. Bhargava *et al.* [12] reported the advantage of the use of BM without the need for an operation of either the donor or recipient site.

Bone allografts are used mainly for reconstruction of cases with bone defects. Disadvantages include the risk of transmission of infectious agents and the risk of fracture because of bone fragility.

Selective arterial embolization has been available since the 1980s and has shown considerable potential for the treatment of ABCs in small studies. Few cases have been treated with this therapy and variable results have been reported in several studies [13].

Another method of treatment involves intralesonal injections for difficult cases such as juxta-articular cysts, which are difficult to treat by a surgical approach, or when there is a risk in surgery [14]. Depending on the size and nature of the lesion, the patient's fluid volume and blood loss may have to be monitored closely. Special precautions are necessary when dealing with aneurysmal cysts that are near open physes [15].

In this study, five (31.25%) patients (two patients with a proximal tibial cyst and three patients with a proximal femoral cyst) had a juxta-articular aneurysmal huge cyst and there was no need for adjuvant material during an intralesional injection of bone mineral accretion with complete consolidation. Special precautions are necessary when dealing with ABCs that are near open physes. ABC near the physes have the risk of physeal injury, as any intervention could harm the physeal plate and affecting the growth. The reported incidence of physeal injury is significant, and patients and their families must be aware of this possibility. Furthermore, it has been shown that attempts to spare the adjacent physes by performing less than aggressive curettage of ABCs have resulted in an increased risk of local recurrence in patients with open growth plates [15,16].

Patients with an ABC require a long follow-up because of the possibility of late recurrence of a timorous-like condition [15]. Some studies have reported recurrence rates as high as 59% with intralesional excision [17] and as low as 0% with resection [18].

In the literature, another type of injection has been reported for ABC; some authors used calcitonin injections with methylprednisolone and concluded that it may promote regression of the ABC.

Hammadi and Cole treated four children with ABC by saucerization of the cyst and injection of BM after open excision of all new bone formation under the periosteum. They concluded that BM injections are likely to augment the healing of aneurysmal cysts of long bones treated with saucerization in addition to reducing the morbidity and costs of alternative bone-grafting methods [19].

Relatively little has been reported on the occurrence of ABCs near growth plates. In one study from the Rizzoli Institute, a juxtaepiphyseal location was associated with an increased risk of subsequent growth arrest and skeletal deformities [20].

Cummings *et al.* [21] used an Argon beam in a group of patients with ABC and injected intralesional phenol; they did not find any differences between the group treated by an Argon beam with or without phenol injection. Shiel *et al.* [22] reported 20 cases of ABC treated by a percutaneous injection of doxycycline; they considered build-up of normal bone cortex as a sign of healing, with a low recurrence rate (5%).

Brosjö and Tsagozis [23] reported on patients with aggressive aneurysmal bone at the proximal humerus in Sweden; women were treated successfully using sequential percutaneous injections of polidocanol after the exclusion of malignancy.

In this study, over 3 years of follow-up, no complications or recurrence were observed for any patient.

Conclusion

An ABC leads to the risk for fracture and recurrence after various modalities of treatment. BM has the advantage of percutaneous treatment (minimal invasive) and no recurrence was reported for the current study. The risks and precautions should be considered in cysts close to physes; these can be treated easily using this simple technique. However, there were no cases of recurrence, but we suggest this method of treatment for recurrent cases that were treated before by any other surgical procedure.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

References

1 Ruiter DJ, Van Rijssel TG, Van Der Velde EA. Aneurysmal bone cysts: a clinicopathological study of 105 cases. Cancer 1977; 39:2231–2239.

2 Tsai JC, Dalinka MK, Fallon MD, Zlatkin MB, Kressel HY. Fluid-fluid level: a nonspecific finding in tumors of bone and soft tissue. Radiology 1991; 175:779–782.

3 Weinstein JN. Differential diagnosis and surgical treatment of primary benign and malignant neoplasm. Frymoyer JW, editor. The adult spine: principles and practice. New York, NY: Raven Press; 1991. pp. 830–850.

4 Zileli M, Isik SH, Ogut EF, Is M, Cagli S, Calli C. Aneurysmal bone cysts of the spine. Eur Spine J 2013; 22:593–601.

5 Steinert FA, Rackwitz L, Gilbert F, Noth U, Tunab SR. Concise review: the clinical application of mesenchymal stem cells for musculoskeletal regeneration: current status and perspectives. Stem Cells Transl Med 2012; 1:237–247.

6 Lokiec F, Ezra E, Khermosh O, Wientroub S. Simple bone cysts treated by percutaneous autologous marrow grafting. A preliminary report. J Bone Joint Surg Br 1996; 78-B:934–937.

7 Yandow SM, Lundeen GA, Scott SM, Coffin C. Autogenic bone marrow injections as a treatment for simple bone cyst. J Ped Orthop 1998; 18:616–620.

8 Killian JT, Wilkinson L, White S, Brassard M. Treatment of unicameral bone cyst with demineralized bone matrix. J Ped Orthop 1998; 18-5:621–624.

9 Leithner A, Windhager R, Lang S, Haas O, Kainberger F, Kotz R. Aneurysmal bone cyst. A population based epidemiologic study and literature review. Clin Orthop Relat Res 1999; 363:176–179.

10 Vergel de Dios AM, Bond JR, Shives TC, McLeod RA, Unni KK. Aneurysmal bone cyst. A clinicopathologic study of 238 cases. Cancer 1992; 69:2921–2931.

11 Szendröi M, Cser I, Kónya A, Rényi-Vámos A. Aneurysmal bone cyst. Orthop Trauma Surg 1992; 111:318–322.

12 Bhargava R, Sankhla SS, Gupta A, Changani RL, Gagal KC. Percutaneous autologous bone marrow injection in the treatment of delayed or nonunion. Indian J Orthop 2007; 41:67–71.

13 Rossi G, Rimondi E, Bartalena T, Gerardi A, Alberghini M, Staals EL *et al.* Selective arterial embolization of 36 aneurysmal bone cysts of the skeleton with N-2 -butyl cyanoacrylate. Skeletal Radiol 2010; 39:161–167.

14 Bush CH, Adler Z, Drane WE, Tamurian R, Scarborough MT, Gibbs CP. Percutaneous radionuclide ablation of axial aneurismal bone cysts. Am J Roentgenol 2010; 194:W84–W90.

15 Otsuka T, Kobayashi M, Sekiya I, Yonezawa M, Kamiyama F, Matsushita Y, Matsui N. A new treatment of aneurysmal bone cyst by endoscopic curettage without bone grafting. Arthroscopy 2001; 17:E28.

16 Lin PP, Brown C, Raymond AK, Deavers MT, Yasko AW. Aneurysmal bone cysts recur at juxtaphyseal locations in skeletally immature patients. Aneurysmal bone cysts recur at juxtaphyseal locations in skeletally immature patients. Clin Orthop Relat Res 2008; 466:722–728.

17 Schreuder HW, Veth RP, Pruszczynski M, Lemmens JA, Koops HS, Molenaar WM. Aneurysmal bone cysts treated by curettage, cryotherapy and bone grafting. J Bone Joint Surg 1997; 79-B:20–25.

18 Marcove RC, Sheth DS, Takemoto S, Healey JH. The treatment of aneurysmal bone cyst, Clin Orthop Relat Res 1995; 311:157–163.

19 Hemmadi SS, Cole WG. Treatment of aneurysmal bone cysts with saucerization and bone marrow injection in children. J Pediatr Orthop 1999; 19:540–542.

20 Capanna R, Springfield DS, Biagini R, Ruggieri P, Giunti A. Juxtaepiphyseal aneurysmal bone cyst. Skeletal Radiol 1985; 13:21–22.

21 Cummings EJ, Smith AR, Heck KR. Argon beam coagulation as adjuvant treatment after curettage of aneurysmal bone cysts: a preliminary study. Clin Orthop Relat Res 2010; 468:231–237.

22 Shiels EW II, Mayerson LD. Percutaneous doxycycline treatment of aneurysmal bone cysts with low recurrence rate: a preliminary report. Clin Orthop Relat Res 2013; 471:2675–2683.

23 Brosjö O, Tsagozis P. Treatment of an aggressive aneurysmal bone cyst with percutaneous injection of polidocanol: a case report. J Med Case Rep 2014; 8:450.