# Outcome of curettage of peritrochanteric benign lesions in skeletally immature patients without internal fixation

Bahaa Z. Hasan[a], Khaled S. Abd El Saleh[b]

[a]Department of Orthopedic Surgery, Menoufia University, Menoufia, [b]Department of Orthopedic Surgery, Fayoum General Hospital, Fayoum, Egypt

Correspondence to Bahaa Z. Hasan, MD, Department of Orthopedic Surgery, Faculty of Medicine, Shibin El-Koom, Menoufia 32511, Egypt. Tel: +20 100 305 8195; fax: +20 482 325 116; e-mail: bahaa.hassan@med.menofia.edu.eg

**Received** 11 December 2018
**Accepted** 27 December 2018

**The Egyptian Orthopaedic Journal** 2018, 53:219–229

**Background**
Peritrochanteric benign lesions are common in skeletally immature patients, which might cause limping and bone destruction up to pathological fracture. Many techniques have been described for the treatment of such lesions; curettage is one of them, which may be combined with bone graft and internal fixation. Curettage without internal fixation is the principal technique used in this study.
**Patients and methods**
This study included 20 patients, with 12 males and eight females, and their mean age was 10.6 years (range, 4–15 years). The diagnosis was 12 cases of simple bone, three cases of aneurysmal bone cyst, two cases of fibrous dysplasia, two cases of nonossifying fibroma, and one case of osteoid osteoma. Treatment included curettage, either simple or extended by high-speed burr and phenol adjuvant, and only cast as external immobilization. Patients were placed in hip spica or antirotational cast for 6–8 weeks. The visual analog scale (VAS) and Harris hip score (HHS) were used for preoperative and postoperative clinical and functional assessments.
**Results**
The mean follow-up period was 30.5 months. Clinically, 17 patients had full recovery 3–6 months postoperatively with excellent results according to HHS for hip function and VAS for pain assessment. The VAS score decreased highly significantly, which denoted pain improvement after treatment. HHS increased highly significantly, which denoted improvement of functional activity after treatment. Three patients developed complications.
**Conclusion**
Curettage without internal fixation and its replacement by external immobilization by cast is effective, less morbid, and technically simple procedure for the treatment of peritrochanteric benign lesions in skeletally immature patients. Good satisfactory results in local tumor control and excellent long-term functional and radiological results with less emotional negative effects on the patient or his family have been recorded.

**Keywords:**
Benign bone tumor, bone cyst, curettage, proximal femur, pathological fracture, peritrochanteric, skeletally immature

Egypt Orthop J 53:219–229

1110-1148

## Introduction

The management of a bone lesion in a child can be a source of great anxiety for the patient's family and the treating physician. Most bone tumors in children are benign, which cause few clinical problems, are detected incidentally, and have radiographic criteria denoting the diagnosis [1]. In many cases, these silent lesions only require observation, not surgery, and frequently are 'leave-me-alone' lesions [2]. However, lesions present in weight-bearing location such as proximal femur raise a higher concern in their mode of management owing to the nature of that anatomic site and stresses normally passing through it [3,4]. Simple bone cysts (SBCs), aneurysmal bone cysts, fibrous dysplasia, and nonossifying fibromas (NOFs) often are seen in this region [5].

Peritrochanteric benign lesions may lead to some clinical problems starting with pain and limping owing to impending fracture up to displaced pathological fracture [6]. Surgical intervention is required frequently to manage these lesions aiming to restore bone integrity and prevent a pathological fracture or deformity [5,7].

Treatment strategies for peritrochanteric benign lesions in children are limited [5,8]. Currently, treatment of such lesions includes curettage, decompression, and combined surgical techniques [9–12]. Although no single standard method has

emerged, treating physicians must consider and select the appropriate option for each patient [13]. So, the aim of clinical studies is the less invasive surgeries, less postoperative complications, and early recovery [14]. Achieving these objectives is not an easy job owing to lack of equipment of the pediatric orthopedic services and associated therapeutically challenges, including growth arrest owing to curettage near open physis, avascular necrosis of the femoral head, local recurrence of the treated lesion, and technical difficulties in fixation of peritrochanteric pathological fractures in pediatric patient [8–12,15].

This study hypothesized that curettage with only external immobilization without internal fixation is enough for treatment of such lesions. This study analyzed long-term clinical, functional, and radiological results of 20 skeletally immature patients with peritrochanteric benign lesions treated surgically by curettage without internal fixation but only external immobilization with only cast.

## Patients and methods

After approval of our ethical committee for research, all patients were consented; data were prospectively collected and retrospectively reviewed for all patients who underwent curettage without internal fixation but only external immobilization with cast for treatment of peritrochanteric benign lesions between April 2011 and December 2017.

A total of 20 patients were included in the study, with 14 male patients and six female patients. The mean age was 10.6 years (range, 4–15 years) at the time of presentation. The mean BMI was 21.2 kg/m$^2$ (range, 15–24 kg/m$^2$). The mean follow-up period was 30.5 months (range 18–63 months). Eighteen patients had de novo lesions, whereas the other two patients had recurrent lesions after a previous procedure of Kirschner wires pinning for fixation of nondisplaced peritrochanteric pathological fracture (Table 1). Most of these patients were complaining of limping and knee pain, which was referred from the hip. Examination of the affected hip revealed limited range of motion of the hip.

The location of these lesions was in the femoral neck extending to the intertrochanteric region in five (25%) patients, intertrochanteric extending to subtrochanteric region in five (25%) patients, intertrochanteric in seven (35%) patients, subtrochanteric in two (10%) patients, and basal neck in one (5%) patient (Fig. 1). The size of these lesions was defined as the ratio of length of cyst to width of the femoral physis. This method avoided errors, which may result from radiological magnification [16].

**Table 1 Distribution of patients regarding their personal data (*N*=20)**

| | *n* (%) |
|---|---|
| Sex | |
| Male | 12 (60) |
| Female | 8 (40) |
| Age (years) | |
| 4–7 | 2 (10) |
| 8–11 | 11 (55) |
| 12–15 | 7 (35) |
| Mean age=10.6 | |
| BMI | |
| 15–18 | 3 (15) |
| 19–22 | 10 (50) |
| 23–26 | 7 (35) |
| Previous procedure | |
| Pinning for pathological fracture | 2 (10) |
| No | 18 (90) |

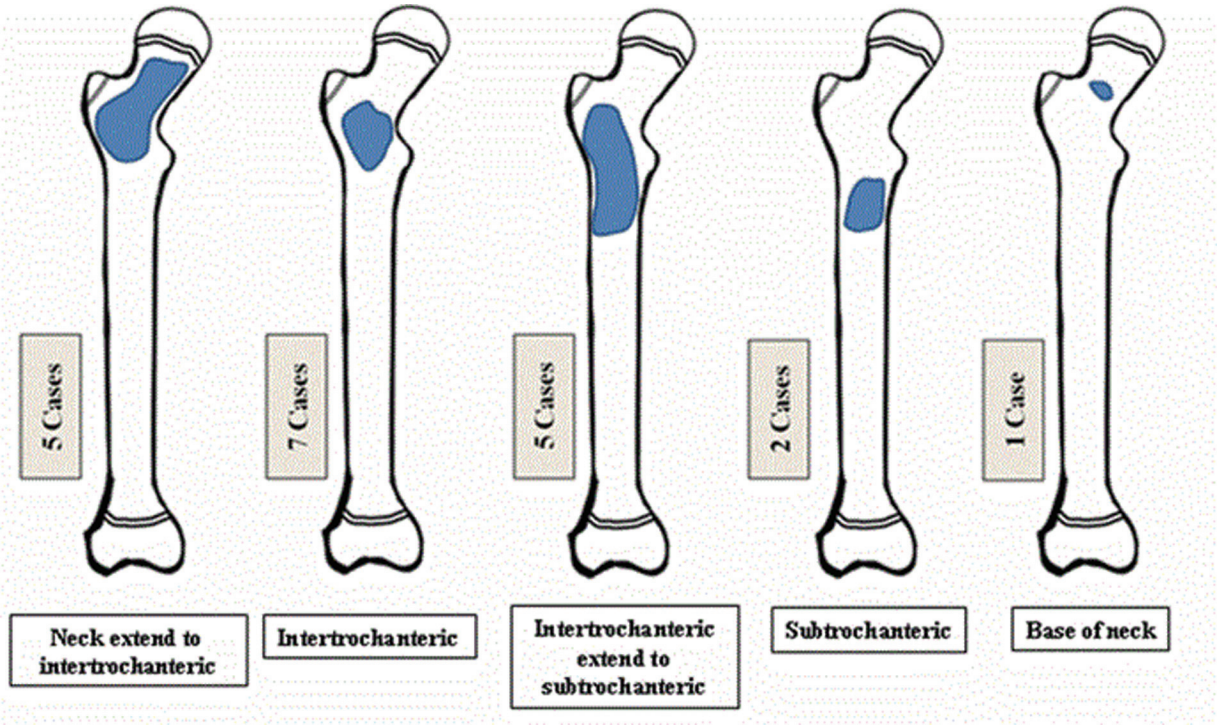
All patients were assessed preoperatively using anteroposterior and lateral plain radiography (Fig. 2). Computed tomographic scan (Fig. 3), MRI, and bone scan were applied in some cases in which diagnosis could not be fairly confirmed by radiographs. Open incisional biopsy was performed in two cases in which the diagnosis could not be fairly confirmed by radiographs. Preoperative pain assessment for all patients was measured by visual analog scale (VAS) [17]. Assessment of functional activity and symptoms of affected hip was analyzed by Harris hip score (HHS) [18]. The definitive histological diagnosis was confirmed later from tissue obtained during biopsy or definitive procedure. All of the lesions were symptomatic, and the indications for surgical treatment were impending pathological fracture and/or persistent pain.

### Surgical technique

The operation was performed under general anesthesia with the patient either in the lateral or supine positions on a radiolucent table. The hip joint and upper femur were screened under the image intensifier when needed.

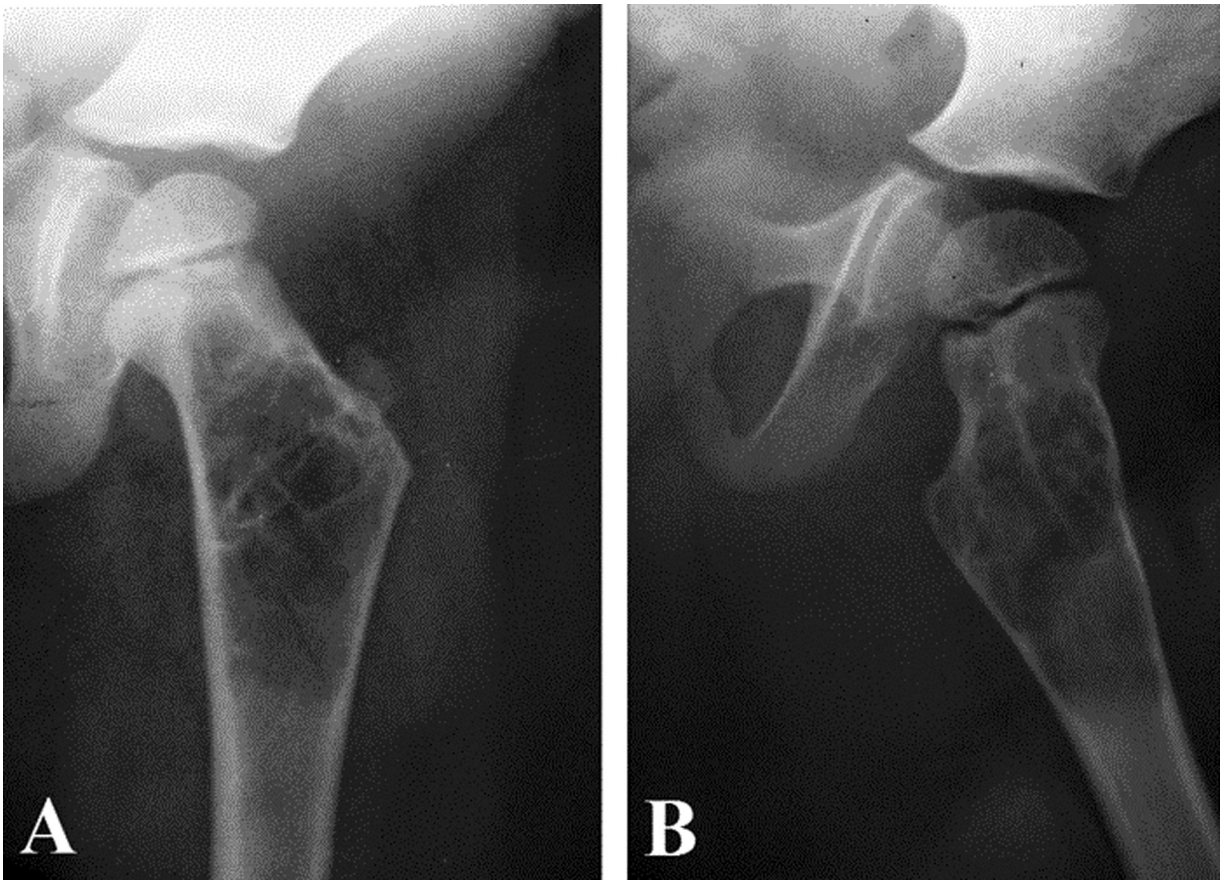
A lateral or medial skin incision was made according to lesion site and the suitable access to it. The lateral incision in 18 cases started from the greater trochanter and extended distally as necessary. Splitting of vastus lateralis was done to expose the proximal femur. The medial incision in two cases started 3 cm below pubic tubercle and extended distally as necessary. A plane was developed between gracilis muscle posteriorly and

**Figure 1**




Cases distribution according to peritrochanteric location.

**Figure 2**




Preoperative radiograph showing right large intertrochanteric cystic lesion expanding to subtrochanteric region. (a) Anteroposterior view. (b) Lateral view.

**Figure 3**

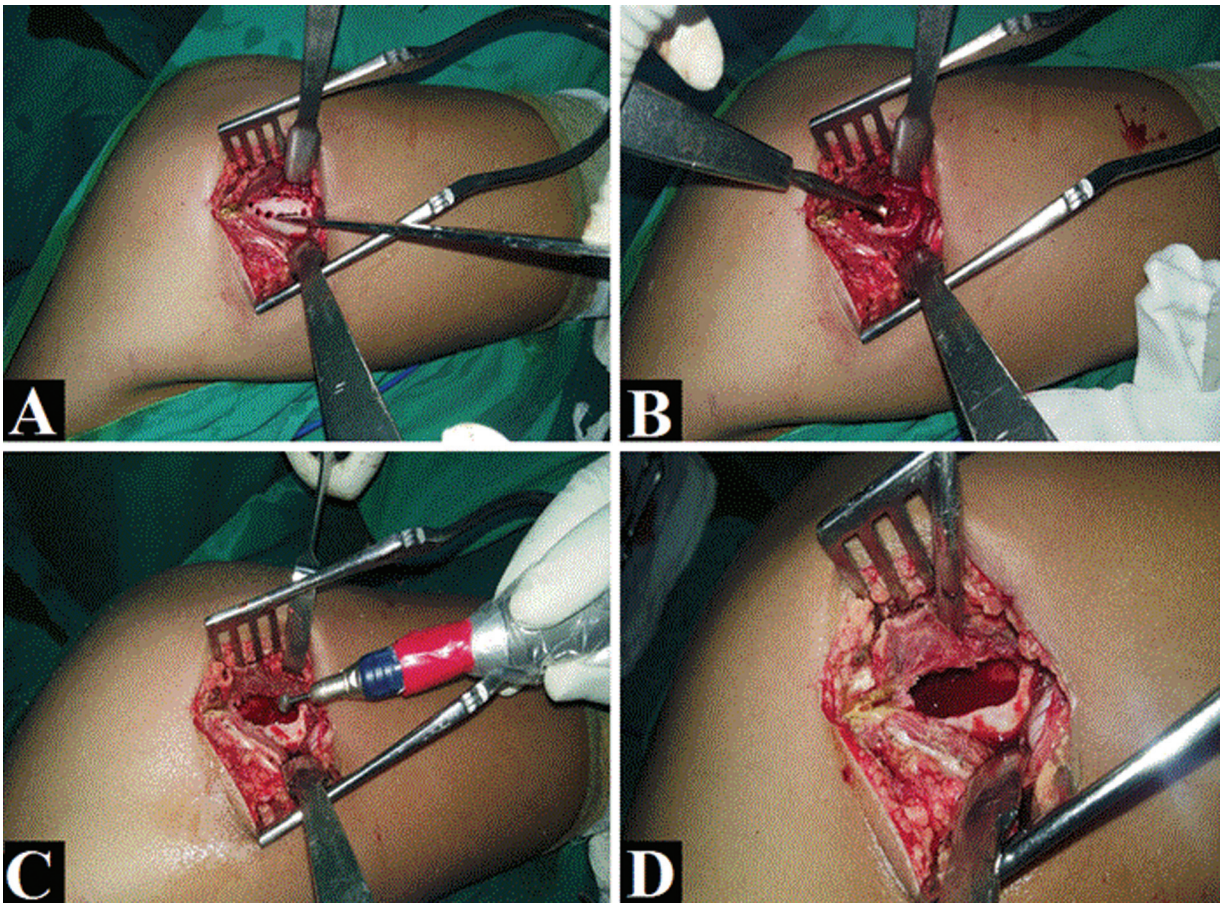

Preoperative computed tomographic scan showing cortical thinning and expanding lesion. (a) Axial view and (b) coronal view.

adductor longus anteriorly, and then another plane was developed deeply between adductor magnus anteriorly and adductor brevis posteriorly to expose lesser trochanter and base of the femoral neck. Care was taken not to injure the anterior and posterior branches of the obturator nerve.

A cortical window was made through the femoral cortex over the femoral lesion under fluoroscopic guidance. Adequate curettage of the lesion was performed by a curette, and tissues from it were sent for histological examination. Simple curettage was done in three patients. Extended curettage with phenol adjuvant was done in three patients. Extended curettage with use of high-speed burr only as a mechanical adjuvant was done in nine patients. Extended curettage by high-speed burr and phenol adjuvants was done in five patients. The high-speed burr was used until underlying normal bone is exposed (Fig. 4). Hydrogen peroxide (20%) was used routinely in all cases.

In the two cases of fibrous dysplasia, fibular strut graft was harvested and was used to fill the defect after curettage. The required length of the fibula was estimated preoperatively. A lateral incision over the mid-shaft of the ipsilateral fibula was done, and then the mid-section of the fibula was exposed and the bone dissected subperiosteally. The estimated length of fibula was excised subperiosteally. Care was taken that more than 5 cm of the proximal and distal fibula was preserved to ensure stability of the knee and ankle joints. The periosteum was closed to facilitate fibular reconstitution, and the wound was closed in layers and dressed. The fibular strut graft was impacted gently into the defect through the

**Figure 4**




Surgical steps. (a) Removal of the cortical window bone cap by an osteotome after outlining by a 2.5-mm drill bit. (b) A curette was used for simple curettage. (c) A high-speed burr was used to extend the curettage. (d) The bone defect after extended curettage.

cortical window to be fit securely under fluoroscopic guidance. The wound was then closed and dressed without insertion of suction drain.

No bone graft or bone substitutes were used in the remaining 18 cases. No internal fixation was used in all cases, but only external support was used in the form of hip spica for 17 cases and antirotational cast for three cases.

### Clinical and radiological follow-up

Patients were followed up monthly for the first 3 months, every 3 months in the first year, and every 6 months for patients who continued follow-up for either reassurance or symptomatic patients who complained after the first year. The external immobilization was applied for 4–8 weeks with a mean of 7.3 weeks. After cast removal, patients were allowed for partial weight bearing and progressed to full weight bearing in 4–6 weeks from removal of the cast.

Postoperative parameters, which included pain, emotional acceptance, and function of the affected lower limb with full unprotected weight bearing, were evaluated for each patient at 6-month intervals till last follow-up. HHS [18] results were calculated for postoperative functional assessment, and VAS scores [17] were calculated for postoperative pain assessment. Preoperative and postoperative VAS and HHS scores till last follow-up were separately analyzed statistically. Radiological appearance at last follow-up was recorded to determine cyst healing process as a response for treatment. Postoperative complications and the need for further treatment owing to early or late complications were recorded.

### Statistical analysis

Descriptive data were calculated by standard formulas (number, percent, mean, median, and range). Student's *t* test was used for comparison between preoperative and postoperative patient results of VAS and HHS.

## Results

The histological diagnosis was SBC in 12 (60%) patients, aneurysmal bone cyst in three (15%) patients, NOF in two (10%) patients, fibrous dysplasia in two (10%)

patients, and osteoid osteoma in one (5%) patient (Table 2). Lesion size ratio ranged from 0.5 to 2, with a mean of 1.6.

**Table 2 Distribution of the presented lesions regarding their criteria**

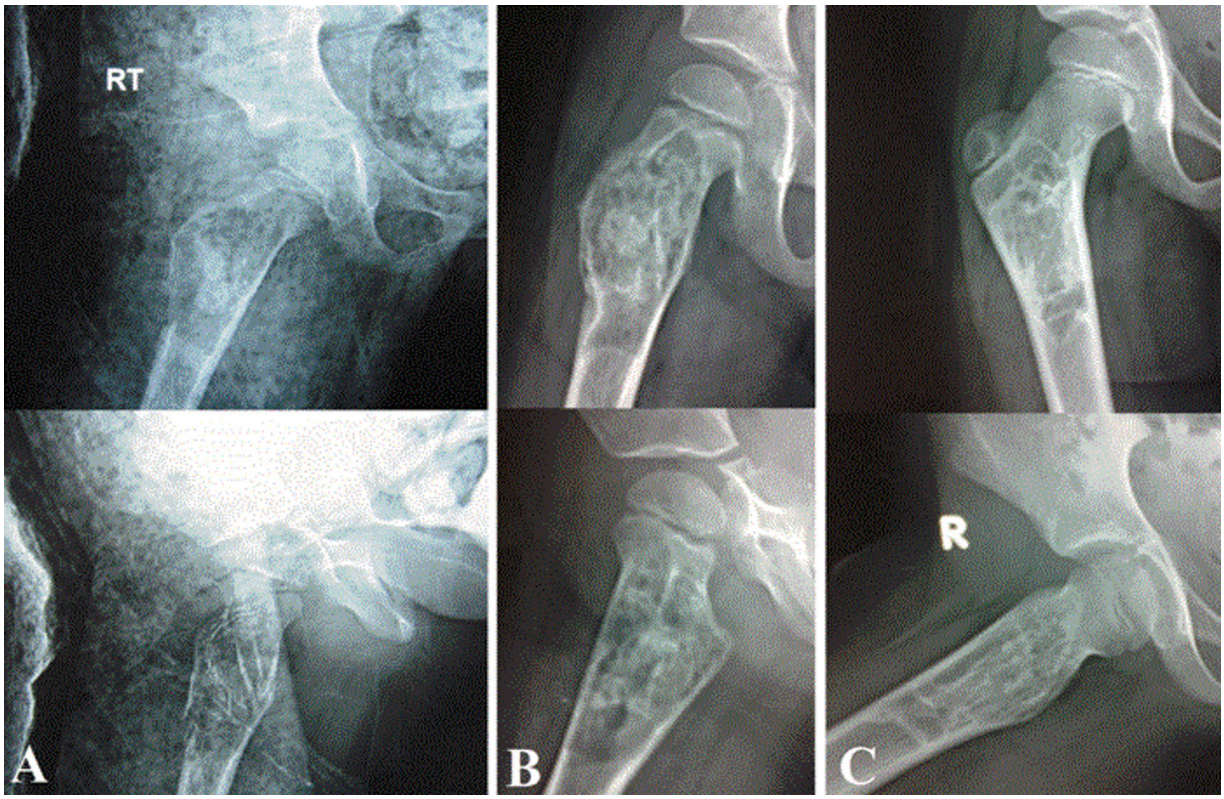
| | *n* (%) |
|---|---|
| Histopathological diagnosis | |
| Simple bone cyst | 12 (60) |
| Aneurysmal bone cyst | 3 (15) |
| Fibrous dysplasia | 2 (10) |
| Nonossifying fibroma | 2 (10) |
| Osteoid osteoma | 1 (5) |
| Peritrochanteric location | |
| Neck extends to intertrochanteric | 5 (25) |
| Intertrochanteric extend to subtrochanteric | 5 (25) |
| Intertrochanteric | 7 (35) |
| Subtrochanteric | 2 (10) |
| Base of neck | 1 (5) |
| Lesion size ratio | |
| Not specific[a] | 1 (5) |
| 1 | 2 (10) |
| 1.25 | 2 (10) |
| 1.5 | 3 (15) |
| 1.75 | 4 (20) |
| 2 | 4 (20) |
| 2.25 | 2 (10) |
| 2.5 | 1 (5) |

[a]Not specific, for osteoid osteoma because of its small size.

Complete clinical recovery without complications was achieved in 17 (85%) patients. Postoperatively, mobilization and full weight bearing without pain or limping were possible after 3–5 months postoperatively with radiological signs of healing (Fig. 5). In the other three patients, one patient (Table 3; No. 5) with SBC developed nondisplaced pathological fracture after 3 weeks postoperatively and was treated conservatively till healing of the fracture. After removal of the spica, local recurrence was observed. Internal fixation was done, and full recovery was achieved by 12 weeks from the second operation (Fig. 6). Another patient with NOF (Table 3; No. 7) had subtrochanteric fracture 3 months postoperatively after fall from height and was treated by internal fixation with flexible intramedullary nails, and full recovery was achieved by 12 weeks. Another patient with SBC (Table 3; No. 3) developed late recurrence 30 months postoperatively and underwent second operative intervention by extended curettage using high-speed burr and phenol adjuvant with hip spica as an external immobilization. Full recovery was achieved 12 weeks after the second operation (Figs 7 and 8).

After the classification of radiological appearance at the last follow-up, it was noted that almost full

**Figure 5**




Postoperative and follow-up anteroposterior and lateral radiographs. (a) Immediate postoperative radiographs. (b) Three-month postoperative radiographs. (c) One-and-half-year postoperative radiographs showing almost full consolidation of the peritrochanteric lesion.

**Table 3 Details of patients**

| Age/sex/ diagnosis[a] | Indication for surgery | Technique[b] | Complication | FWB/ HHS[c] | Radiological appearance | Follow-up period |
|---|---|---|---|---|---|---|
| 4/F/SBC | Impending fracture | Curettage +phenol +$H_2O_2$+hip spica | Nil | 10 weeks/ 96 (excellent) | Partial to full consolidation (10 months) | 9 years |
| 11/M/SBC | Previous pathological fracture+pain | Curettage +phenol +$H_2O_2$+burr+hip spica | Nil | 12 weeks/ 96 (excellent) | Partial to full consolidation (8 months) | 2 years |
| 10/M/SBC | Impending fracture+pain | Curettage +phenol +$H_2O_2$+hip spica | Recurrence after30 months ttt extended curettage using high-speed burr and adjuvant | 12 weeks/ 96 (excellent) | Almost full consolidation (60 months) | 5 years from recurrence |
| 13/M/ABC | Persistent pain | Curettage +phenol +$H_2O_2$+burr+hip spica | Nil | 11 weeks/ 96 (excellent) | Partial to full consolidation (10 months) | 1 year |
| 11/M/SBC | Impending fracture | Curettage +$H_2O_2$+hip spica | Subtrochanteric fracture at 3rd week ttt conservatively, recurrence after 3 months ttt by plate fixation | 12 weeks/ 89 (good) | Partial consolidation (12 months) | 1 year |
| 14/F/SBC | Impending fracture+pain | Curettage +$H_2O_2$+burr+AR cast | Nil | 10 weeks/ 96 (excellent) | Partial to full consolidation (8 months) | 1.5 years |
| 7/M/NOF | Impending fracture | Curettage +$H_2O_2$+hip spica | Subtrochanteric fracture after 3 months ttt ORIF plate and screw | 12 weeks/ 92 (excellent) | Partial to full consolidation (9 months) | 2 years |
| 15/M/OO | Persistent pain | Curettage +$H_2O_2$+AR cast | Nil | 8 weeks/ 96 (excellent) | Almost full consolidation (2 months) | 1 year |
| 11/M/ABC | Persistent pain +impending fracture | Curettage +$H_2O_2$+burr+hip spica | Nil | 12 weeks/ 92 (excellent) | Partial consolidation (12 months) | 2.5 years |
| 12/F/SBC | Impending fracture | Curettage +$H_2O_2$+burr+hip spica | Nil | 11 weeks/ 92 (excellent) | Partial consolidation (12 months) | 2 years |
| 9/F/SBC | Previous pathological fracture+pain | Curettage +phenol +$H_2O_2$+burr+hip spica | Nil | 12 weeks/ 96 (excellent) | Partial to full consolidation (7 months) | 2 years |
| 8/M/SBC | Impending fracture+pain | Curettage +phenol +$H_2O_2$+burr+hip spica | Nil | 12 weeks/ 96 (excellent) | Almost full consolidation (24 months) | 3 years from recurrence |
| 12/M/ABC | Persistent pain | Curettage +phenol +$H_2O_2$+burr+hip spica | Nil | 11 weeks/ 96 (excellent) | Partial to full consolidation (10 months) | 1 year |
| 10/F/SBC | Impending fracture+pain | Curettage +$H_2O_2$+burr+hip spica | Nil | 11 weeks/ 87 (good) | Partial consolidation (11 months) | 1 year |
| 13/F/SBC | Impending fracture | Curettage +$H_2O_2$+burr+AR cast | Nil | 10 weeks/ 96 (excellent) | Partial to full consolidation (12 months) | 1.5 years |
| 9/M/NOF | Impending fracture | Curettage +$H_2O_2$+burr+hip spica | Nil | 12 weeks/ 96 (excellent) | Partial to full consolidation (10 months) | 2 years |
| 13/M/FD | Impending fracture | Curettage +$H_2O_2$+burr +FSG+hip spica | Nil | 12 weeks/ 92 (excellent) | Partial consolidation (7 months) | 2 years |
| 10/M/FD | Impending fracture | Curettage +$H_2O_2$+burr +FSG+hip spica | Nil | 12 weeks/ 92 (excellent) | Partial consolidation (7 months) | 1.5 years |
| 11/F/SBC | Impending fracture+pain | Curettage +$H_2O_2$+burr+hip spica | Nil | 12 weeks/ 92 (excellent) | Partial consolidation (8 months) | 2.5 years |
| 9/F/SBC | | | Nil | | | 3 years |

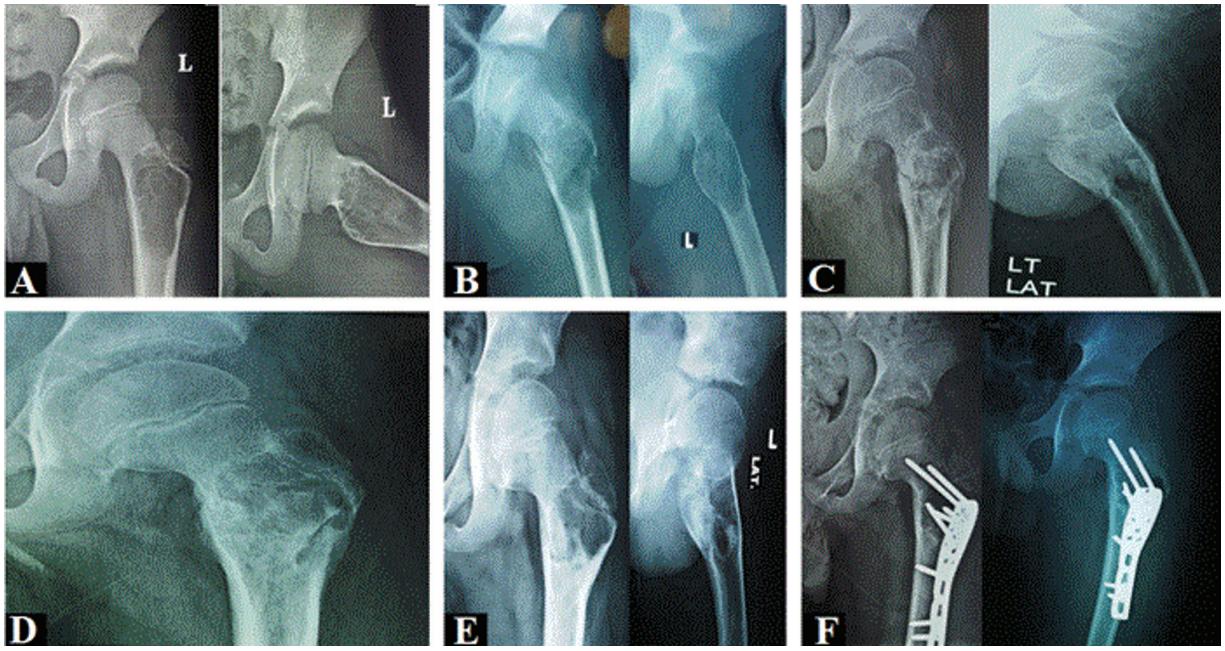
(*Continued*)

**Table3 (*Continued*)**

| Age/sex/ diagnosis[a] | Indication for surgery | Technique[b] | Complication | FWB/ HHS[c] | Radiological appearance | Follow-up period |
|---|---|---|---|---|---|---|
| | Impending fracture | Curettage +phenol +$H_2O_2$+hip spica | | 12 weeks/ 96 (excellent) | Partial to full consolidation (10 months) | |

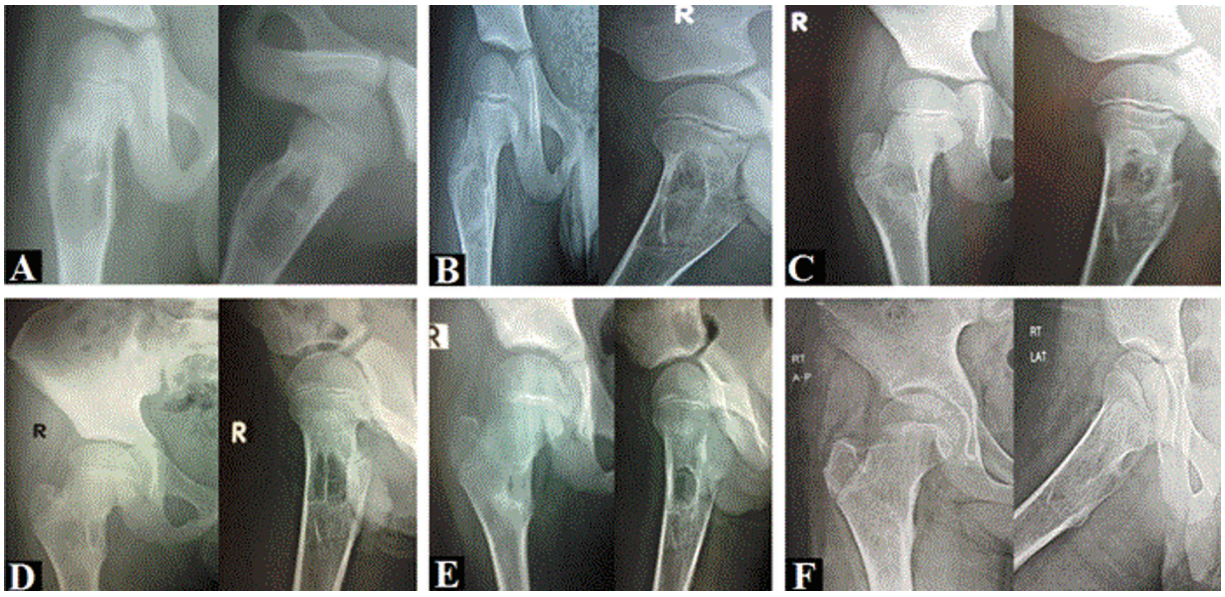
ABC, aneurysmal bone cyst; AR, anti rotational cast; F, female; FSG, fibular strut graft; FWB, full weight bearing; HHS, Harris hip score; M, male; NOF, nonossifying fibroma; OO, Osteoid osteoma; SBC, simple bone cyst; ttt, treatment.

**Figure 6**



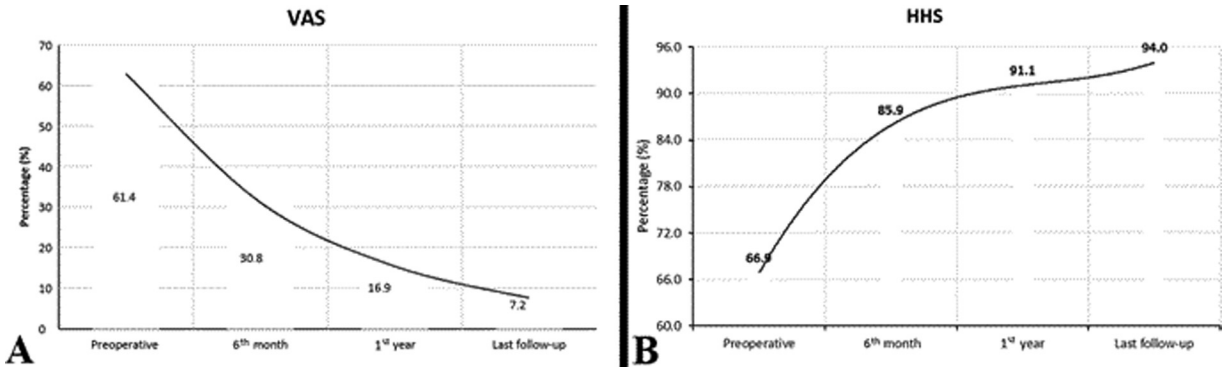

A case example for a male child 11 years old at presentation. (a) Radiographs showing left large intertrochanteric cystic lesion expanding to subtrochanteric region. (b) Three-week postoperative radiographs showing intertrochanteric fracture. (c) Six-week postoperative radiographs showing pathological fracture healing. (d) Radiographs showing healed fracture after 9 weeks. (e) Radiographs showing persistent defect denoting recurrence after 3 months. (f) Postoperative radiographs showing internal fixation by locked proximal humoral plate as a treatment for recurrence.

**Figure 7**




A case example for a male child 10 years old at presentation. (a) Radiographs showing right large peritrochanteric cystic lesion. (b) Six-month postoperative follow-up radiographs. (c) One-year postoperative radiographs showing partial to full consolidation of defect. (d) Thirty-month postoperative radiographs showing recurrence. (e) Radiographs showing postoperative follow-up after 1 year of treatment of recurrence. (f) Radiographs showing almost full consolidation of the defect 5 years after treatment for recurrence.

**Figure 8**




(a) Visual analog scale scores preoperatively and at sixth months, first year, and last follow-up. (b) Harris hip scores preoperatively and at sixth months, first year, and last follow-up.

**Table 4 Comparative study of the visual analog scale and Harris hip score preoperatively and at sixth months, first year, and last postoperative follow-up (*N*=20)**

| Items | Preoperative | Sixth months | First year | Last follow-up | *t* test | |
|---|---|---|---|---|---|---|
| | | | | | *t* | *P* value |
| VAS | | | | | | |
| Range | 45–88 | 19–40 | 7–28 | 0.0–25 | –19.37 | <0.001 |
| Mean±SD | 61.40±8.53 | 30.8±5.83 | 16.9±5.49 | 7.20±8.88 | | |
| HHS | | | | | | |
| Range | 61–72 | 78.7–90 | 85–96 | 87–96 | 13.24 | <0.001 |
| Mean±SD | 66.85±2.91 | 85.90±3.32 | 91.0±2.13 | 94.0±2.77 | | |

HHS, Harris hip score; VAS, visual analog scale.

consolidation, represented by presence of more than 75% of radiopaque area, was achieved in three (15%) patients; partial to full consolidation, represented by the presence of 50–75% radiopaque area, was achieved in 10 (50%) patients; and partial consolidation, represented by the presence of approximately 50% radiopaque area, was achieved in seven (35%) patients (Table 3).

Postoperative pain assessment (VAS) and functional scores (HHS) were statistically analyzed (Table 4) and the mean was measured at preoperatively and sixth months, first year, and at last follow-up. The average VAS scores were 61.40% (range, 45–88%), 30.8% (range, 19–40%), 16.9% (range, 7–28%), and 7.20% (range, 0–25%), respectively. The VAS score decreased highly significantly ($P<0.001$) in the postoperative period, which denoted pain improvement after treatment (Fig. 7a). On the contrary, HHSs [18] were measured as 66.85% (range, 61–72%), 85.90% (range, 78.7–90%), 91% (range, 85–96%), and 94% (range, 87–96%), respectively. HHS [18] increased highly significantly ($P<0.001$) in the postoperative period, which denoted improvement of functional activity after treatment (Fig. 7b).

## Discussion

Management of peritrochanteric benign lesions is a challenging and not an easy job. Several issues in the management of any peritrochanteric lesion in skeletally immature patients should be considered [13]. First, there is the presence of growth plates of femoral head and greater trochanter, which are responsible for ~30% of the overall longitudinal growth of the femur. Therefore, surgical intervention around that location may lead to further limb-length discrepancy [13,14]. Moreover, other deformities may occur owing to damage to the capital femoral or trochanteric physes [15].

Other issues include emotional disturbances of patients and their families and need for early recovery without any residual problems. Less invasive methods allow early recovery and no need for other operation for either treatment of complication or removal of implant [16].

Several methods of treatment of peritrochanteric benign lesions, including observation for asymptomatic incidentally discovered lesion, as shown by Shin *et al.* [6]; minimally invasive methods like injection of steroids only, or combined with bone marrow aspirate, demineralized bone matrix or bone substitutes; and decompression by cannulated screws or elastic stable

nails, which give stability for such area, have been described [12]. Curettage is considered the most common option for the treatment of most benign tumors and tumor-like lesions [19].

In this study, curettage with or without bone graft with no internal fixation yielded an accepted functional and radiological outcome, compared with Neer *et al.* [20], who treated 175 cases by curettage and reported healing in 50% of patients, which was significantly low, compared with this study, in which 85% of patients had excellent results.

Yanagwa *et al.* [21] demonstrated that curettage without filling of resultant bone defect is considered to be a standard treatment for benign bone tumors, which is comparable to the results of this study, in which curettage without bone graft in 18 cases yielded excellent results.

Erol *et al.* [12], after retrospective study of 62 patients who complained of peritrochanteric benign lesion, demonstrated a strategy of treatment methods modified from methods of Dormans and Pill [22] and De Mattos *et al.* [23] to guide treatment of proximal femur benign lesions. In the current study, which consisted of relatively the same percentage of patients' demographic criteria, peritrochanteric location of benign lesions, and relatively long follow-up period, it was found that in patients treated with curettage and only cast, full recovery achieved in all patients 3–5 months after last intervention. Only 15% of cases needed second operation for either treatment of early recurrence (5%), early pathological fracture (5%), or late recurrence (5%), compared with results of Erol *et al.* [12], who treated 85.5% of immature patients by curettage with combined internal fixation and found that full recovery was achieved in 90.3% of patients between 4 and 8 months, and in 9.7% of patients persistent limping presented and resolved by 1 year after physiotherapy and only 1.6% of patients needed second operation. These comparable results show less significant differences other than the internal fixation used by Erol *et al.* [12], which was replaced by external immobilization by spica or antirotational cast in this study. The results of Erol *et al.* [12] may reflect the efficacy of internal fixation in such lesion, whereas in this study, it had no significant benefits compared with its further expected complications, such as infection, growth plate injury and deformity in addition to increased morbidity owing to increased surgery time with associated blood loss and need for second operation to remove the implant used in surgical fixation.In this study, only 10% of patients developed local recurrence which was better than Campanacci *et al.* [24], who reported recurrence in 33% of cases after treatment by curettage and bone graft, and Gibbs *et al.* [25], who reported a 12% recurrence rate after curettage and high-speed burring.

In this study, only 10% of patients had pathological fractures that were managed with internal fixation, whereas 90% of patients were saved from hazards of internal fixation. No local recurrence was developed in the groups in which high-speed burr had been used throughout the follow-up period. These results denote the efficacy of curettage combined with high-speed burr.

We believe our study has several strengths. First, data were collected prospectively. Second, we have followed up patients for a relatively long period especially patients with complications. On the contrary, our study has some limitations, such as the relatively small number of patients, a heterogeneous group of patients with different histopathological diagnosis, and the absence of true comparison group.

## Conclusion

Curettage of peritrochanteric benign lesions in skeletally immature patients without internal fixation with only external immobilization is an effective, simple, less harmful, and more applicable procedure. This technique permitted early recovery with less postoperative complications in our series, which was a group of small, young low-weight patients who benefitted from immobilization with spica cast, and we recommend this type of treatment to them. However, for active, larger, and stronger teenagers who are more likely to develop a postoperative pathological fracture, we think that internal fixation is mandatory.

#### Financial support and sponsorship

Nil.

#### Conflicts of interest

There are no conflicts of interest.

## References

1 Dumitriu DI, Menten R, Clapuyt P. Pitfalls in the diagnosis of common benign bone tumours in children. Insights Imaging 2014; 5:645–655.

2 Hakim DN, Pelly T, Kulendran M, Caris JA. Benign tumours of the bone: a review. J Bone Oncol 2015; 4:37–41.

3 George B, Abudu A, Grimer RJ, Carter SR, Tillman RM. The treatment of benign lesions of the proximal femur with nonvascularised autologous fibular strut grafts. J Bone Joint Surg Br 2008; 90:648–651.

**4** Nakamura T, Matsumine A, Asanuma K, Matsubara T, Sudo A. Treatment of the benign bone tumors including femoral neck lesion using compression hip screw and synthetic bone graft. SICOT J 2015; 1:15.

**5** Franchi A. Epidemiology and classification of bone tumors. Clin Cases Miner Bone Metab 2012; 9:92–95.

**6** Shin SH, Yeo I, Seo SW. Can certain benign lesions of the proximal femur be treated without surgery?. Clin Orthop Relat Res 2013; 471:3319–3325.

**7** Erol B, Pill SG, Guttenberg ME, Meyer JS, Dormans JP. Pathologic hip fracture in a 4-year-old boy. Clin Orthop Relat Res 2002; 403:264–273.

**8** Vigler M, Weigl D, Schwarz M, Ben-Itzhak I, Salai M. Subtrochanteric femoral fractures due to simple bone cysts in children. J Pediatr Orthop B 2006; 15:439–942.

**9** Erol B, Onay T, Çalışkan E, Aydemir AN, Topkar OM. Treatment of pathological fractures due to simple bone cysts by extended curettage grafting and intramedullary decompression. Acta Orthop Traumatol Turc 2015; 49:288–296.

**10** Mascard E, Gomez-Brouchet A, Lambot K. Bone cysts: unicameral and aneurysmal bone cyst. Orthop Traumatol Surg Res 2015; 101(Suppl): S119–S127.

**11** Ulici A, Nahoi C, Carp M, Fodor I, Dinu C. Surgical treatment of an aneurysmal bone cyst with avascular bone graft. Chirurgia (Bucur) 2017; 112:172–177.

**12** Erol B, Topkar MO, Aydemir AN, Okay E, Caliskan E, Sofulu O. A treatment strategy for proximal femoral benign bone lesions in children and recommended surgical procedures: retrospective analysis of 62 patients. Arch Orthop Trauma Surg 2016; 136:1051–1061.

**13** Mazzini JP, Murphy RF, Kushare I, Dormans JP. Unicameral bone cysts: general characteristics and management controversies. J Am Acad Orthop Surg 2014; 22:295–303.

**14** Miu A. Pathological fractures of the proximal femur due to solitary bone cyst: classification, methods of treatment. J Med Life 2015; 8:536–543.

**15** Havránek P, Pesl T, Bartonícek J. Pathologic proximal femoral fractures in children in an unicameral bone cyst. Acta Chir Orthop Traumatol Cech 2005; 72:282–286.

**16** Gentile JV, Weinert CR, Schlechter JA. Treatment of unicameral bone cysts in pediatric patients with an injectable regenerative graft: a preliminary report. J Pediatr Orthop 2013; 33:254–261.

**17** Melzack R. The McGill Pain Questionnaire: major properties and scoring methods. Pain 1975; 1:277–299.

**18** Harris WH. Traumatic arthritis of the hip after dislocation and acetabular fractures: treatment by mold arthroplasty. An end-result study using a new method of result evaluation. J Bone Joint Surg Am 1969; 51:737–755.

**19** Malek F, Krueger P, Hatmi ZN, Malayeri AA, Faezipour H, O'Donnell RJ. Local control of long bone giant cell tumor using curettage, burring and bone grafting without adjuvant therapy. Int Orthop 2006; 30:495–498.

**20** Neer CS, 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 Am 1966; 48:731–745.

**21** Yanagwa T, Watanabe H, Shinozaki T, Takagishi K. Curettage of benign bone tumors without grafts gives sufficient bone strength. Acta Orthop 2009; 80:9–13.

**22** Dormans JP, Pill SG. Fractures through bone cysts: unicameral bone cysts, aneurysmal bone cysts, fibrous cortical defects, and nonossifying fibromas. Instr Course Lect 2002; 51:457–467.

**23** De Mattos CBR, Binitie O, Dormans JP. Pathological fractures in children. Bone Joint Res 2012; 1:272–280.

**24** Campanacci M, Capanna R, Picci P. Unicameral and aneurysmal bone cysts. Clin Orthop Relat Res 1986; 204:25–36.

**25** Gibbs CP Jr, Hefele MC, Peabody TD, Montag AG, Aithal V, Simon MA. Aneurysmal bone cyst of the extremities: factors related to local recurrence after curettage with a high speed burr. J Bone Joint Surg Am 1999; 81:1671–1678.