ORIGINAL ARTICLE

Surgical Treatment for Osteoid Osteoma — Experience in Both Conventional Open Excision and CT-guided Mini-incision Surgery

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Background: Conventional open excision, or *en bloc* excision, was the standard treatment for osteoid osteoma until the development of percutaneous treatment for this tumor in the early 1990s. Most percutaneous treatments were performed under the guidance of computed tomography (CT), which could clearly demonstrate the exact location of the tumor and minimize bone destruction or resection. In order to minimize bone resection without adding to the costs of these new percutaneous instruments, we modified the percutaneous technique into a CT-guided mini-incision surgery. The patients treated with this technique were compared with those treated by conventional open excision.
Methods: We retrospectively reviewed the medical charts of patients with osteoid osteoma treated between 1990 and 2004. The patients diagnosed before 2000 were all treated with conventional open excision. After 2000, some of them were treated with CT-guided mini-incision surgery. Follow-up was done either by phone or on an outpatient basis.
Results: There were 23 patients with osteoid osteoma who were treated surgically between 1990 and 2004, of whom 20 were treated with conventional open excision. Six patients were treated with CT-guided mini-incision surgery, including 3 primary cases and 3 patients who had previously been treated with conventional open excision (2 recurrent cases and 1 with incomplete excision). The patients treated with CT-guided mini-incision surgery had smaller bone defects, shorter surgical time, and shorter hospital stay. The rate of recurrence or incomplete excision was 23% for conventional surgery and 0% for mini-incision surgery.
Conclusion: CT-guided mini-incision surgery is effective in treating primary as well as recurrent osteoid osteoma. [*J Chin Med Assoc* 2007;70(12):545–550]

Key Words: CT-guided mini-incision, open excision, osteoid osteoma

Introduction

Osteoid osteoma is a benign osteogenic tumor. Clinically, the tumor has little or no growth potential and the size is usually less than 1 cm in diameter.[1,2] It commonly occurs in the long bones (especially in the lower extremities) of children, adolescents or young adults. Nocturnal pain, dramatically relieved by aspirin or nonsteroidal anti-inflammatory agents, is a typical sign of this disease.

Complete removal or destruction of the nidus is curative for this disease. Surgical treatments consist of open excision of the nidus with a bone block or percutaneous computed tomography (CT)-guided removal or destruction of the nidus.[3–7]

The purpose of this study was to compare the clinical outcome and complications associated with conventional open excision and CT-guided mini-incision surgery in the treatment of osteoid osteoma.

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Table 1. Details of 20 patients with osteoid osteoma treated with conventional open excision

Case	Age (yr)	Sex	Symptoms	Duration of symptoms (mo)	Location	Size of specimen (bone defect, mL)	Operation time (min)	Hospital stay (d)	Follow-up (mo)
1	11	F	Limping	6	R femoral neck	0.4 cm in diameter (0.064)	105	3	142
2	23	M	Thigh pain	24	L femoral shaft, middle 1/3	6 × 3 × 1 cm (18)	90	4	60
3	13	M	Lower leg pain	2	L tibia shaft, middle 1/3	0.6 × 0.4 × 0.2 cm (0.048)	70	1	37
4	6	M	Thigh and knee pain	12	R lesser trochanter	1 × 3 × 1 cm (3)	140	4	58
5	9	M	Hip pain	24	L lesser trochanter	2.5 × 1.5 × 1 cm (3.75)	105	5	70
6	10	F	Knee pain, limping, quadriceps atrophy	7	L lesser trochanter	0.3 cm in diameter (0.027)	120	3	49
7	14	F	Nocturnal hip pain	24	L femoral neck	1 cm in diameter (1)	110	5	18
8	9	M	Nocturnal thigh pain, limping	1	L femoral shaft, upper 1/3	1 × 1 × 0.8 cm (0.8)	125	2	6
9	6	M	Nocturnal knee and hip pain	6	R lesser trochanter	1.5 cm in diameter (3.375)	80	4	10
10	8	M	Nocturnal knee pain	12	R femur supracondylar area	1 × 0.6 × 0.6 cm (0.36)	90	7	6
11	26	M	Wrist pain	36	L capitate	0.4 cm in diameter (0.064)	150	7	15
12	15	M	Painful ankle swelling	12	R talar neck	1.5 × 1 × 1 cm (1.5)	85	4	63
13	8	F	Ankle pain	24	L distal tibia	1 × 1 × 1 cm (1)	80	4	88
14	16	F	Shoulder pain	2	L proximal humerus	2 × 1 × 0.3 cm (0.6)	80	3	18
15	39	F	Hip pain	1	R femoral neck	1.5 cm in diameter (3.375)	90	8	39
16	11	F	Knee pain	3	R proximal tibia	2 × 2 × 1 cm (4)	70	3	115
17	13	M	Nocturnal hip pain, limping	12	L femoral neck	0.6 cm in diameter (0.216)	105	4	48*
18	11	M	Nocturnal knee pain, limping	2	L lesser trochanter	2 × 1.5 × 0.5 cm (1.5)	65	1	7†
19	6	F	Nocturnal hip pain, limping	12	R proximal femur	Not measured	60	3	5†
20	23	F	Thigh pain	60	R proximal femur	1.5 × 1 × 0.6 cm (0.9)	40	1	3 wk‡

Recurrence that was subsequently treated with another conventional open excision; †recurrence that was subsequently treated with CT-guided mini-incision surgery; ‡incomplete excision that was subsequently treated with CT-guided mini-incision surgery. R = right; L = left.

Methods

Twenty-three surgically treated cases of osteoid osteoma between 1990 and 2004 were reviewed (Tables 1 and 2). There were 20 patients who were treated with conventional open excision and 3 who were treated with CT-guided mini-incision surgery. The CT-guided mini-incision group also included 2 recurrent cases and 1 patient who had previously been treated with conventional open excision and had incomplete excision.

Thirteen patients were male and 10 were female. The clinical diagnoses were made based on history, technetium-99m methylene diphosphonate radionuclide scans, and radiographic examinations including plain X-ray, conventional tomography, and CT scans or magnetic resonance imaging (MRI). All procedures were performed with spinal or general anesthesia on an inpatient basis.

Conventional open excision was achieved by localizing the nidus with a fluoroscope and subsequent *en bloc* excision or curettage.

Mini-incision surgery consisted of the following procedures: first, a smooth K-wire, 1.6 mm in diameter, was inserted into the nidus under CT guidance, and a 2–3-cm longitudinal incision was made centered at the K-wire. The wound was then deepened to the bone along the K-wire with special attention paid to prevent neurovascular injuries. The guide wire was then removed and a drill-bid or a high-speed burr was used to break through the cortex overlying the nidus. The nidus was removed with curettes, and the tumor bed was cleaned with a high-speed burr.

All specimens acquired by either conventional open excision or CT-guided mini-incision were sent for histologic examination. The size of the bone defect was estimated by multiplying the length of the specimen on the three dimensions.

Patients were followed up every 4 weeks to evaluate bone healing, residual symptoms, and potential complications. After complete bone union, follow-up was at 3-month intervals. Complete relief of pain and union of the original tumor site at 1-year follow-up were considered as curative, and then the patient was followed-up annually. Three patients (cases 8, 9, 10) were lost to follow-up.

Statistical analysis

The Mann–Whitney U test was used to compare the differences between the 2 groups with regard to bone defect, surgical time, and hospital stay; p values of less than 0.05 were considered to be statistically significant. Patients with less than 1 year of follow-up were excluded from analysis.

Table 2. Details of 6 patients with osteoid osteoma treated with CT-guided mini-incision surgery

Case	Age (yr)	Sex	Symptoms	Duration of symptoms (mo)	Location	Size of specimen (bone defect, mL)	Operation time (min)	Hospital stay (d)	Follow-up (mo)
18	11	M	Recurrence	–	L lesser trochanter	0.5 cm in diameter (0.125)	45	2	30
19	6	F	Recurrence	–	R proximal femur	0.5 cm in diameter (0.125)	55	2	72
20	23	F	Persistent pain	–	R proximal femur	0.4 × 0.3 × 0.2 cm (0.024)	25	2	62
21	10	F	Knee pain	10	L femoral shaft, middle 1/3	0.2 cm in diameter (0.008)	55	4	66
22	24	M	Nocturnal wrist pain	3	L distal radius	0.3 cm in diameter (0.027)	30	1	43
23	34	M	Knee pain	12	L femoral shaft, lower 1/3	0.2 cm in diameter (0.008)	40	2	49

L = left; R = right.

Results

Of the 23 cases of osteoid osteoma, 20 patients had the tumor located in the lower extremities, which included 11 cases with the tumor in the proximal femur, 3 in the femoral diaphysis, 1 in the distal femur, 2 in the proximal tibia, 1 in the tibial diaphysis, 1 in the distal tibia, and 1 in the talar neck. Three patients had the tumor located in the upper extremities: 1 in the proximal humerus, 1 in the distal radius and 1 in the capitate. The size of the excised specimens ranged from $0.3 \times 0.3 \times 0.3$ cm to $6 \times 3 \times 1$ cm in the conventional surgery group, and from 0.2 cm to 0.5 cm in diameter for the mini-incision group. Mean operation time was 92 minutes (range, 40–150 minutes) for the conventional surgery group, and 42 minutes (range, 25–55 minutes) for the minimally invasive surgery group. Mean hospital stay was 3.7 days (range, 1–8 days) for the conventional surgery group, and 2.2 days (range, 1–4 days) for the mini-incision surgery group. Compared with conventional open excision, CT-guided mini-incision surgery resulted in smaller bone defect (0.052 mL *vs.* 2.44 mL; $p = 0.004$) and a shorter surgical time (41.7 minutes *vs.* 92.1 minutes; $p = 0.001$). The slightly shorter hospital stay for the CT-guided mini-incision surgery group was found to be statistically insignificant ($p = 0.054$).

The rate of recurrence or incomplete excision was 23% for conventional surgery and 0% for CT-guided mini-incision surgery. Only 1 patient subjectively complained of persistent pain 48 hours postoperatively. This was a 23-year-old female patient (case 20) with osteoid osteoma in her right proximal femur. Follow-up CT scan showed retained osteoid osteoma. CT-guided mini-incision surgery was carried out 3 weeks later and her symptoms were relieved soon after the operation. Tumor recurrence occurred in 3 patients treated with conventional open excision. Case 17 had a recurrent osteoid osteoma after a symptom-free period of 4 years, and was treated with conventional surgery again. Cases 18 and 19 had tumor recurrence 5 and 7 months later, respectively, and both were treated with CT-guided mini-incision surgery. All of the recurrent tumors were successfully removed with pathological confirmation. As for the patients treated with CT-guided mini-incision surgery, they were all symptom-free at a mean follow-up of 54 months (range, 30–72 months). No pathological fracture or deep wound infection occurred.

Discussion

Although spontaneous regression of osteoid osteoma after long-term administration of nonsteroidal anti-inflammatory agents has been reported, the side effects of prolonged medication and the lack of histologic diagnosis are still a major concern in conservative treatment.[3,8] Therefore, surgery is often favored in treating this disease.[2] In addition to conventional open excision (removing the nidus with a surrounding bone block), percutaneous excision with large-bore hollow needles and drills, radiofrequency ablation, cryotreatment, ethanol injection, or laser photocoagulation have been used to treat osteoid osteoma.[6–10] No matter what modality is chosen, complete removal or destruction of the nidus is necessary to obtain a successful outcome.[1,2] However, finding the exact location of the nidus is a challenge during operation. In conventional open excision or *en bloc* excision, precise localization of the nidus using a fluoroscope is often difficult because of the extensive sclerosis around the nidus. Excessive bone blocks together with the tumor have to be removed to ensure total excision. This may jeopardize bone strength and cause fractures. Several methods, including nuclear scanning, tetracycline fluorescence, tomography, MRI or CT, have been used to improve the accuracy of localization.[5,11,12] Because CT provides a more precise location of the nidus,[11] treating osteoid osteoma with CT guidance gained popularity in the 1990s.[4–8,10,13–15]

We have been treating patients with osteoid osteoma using CT-guided mini-incision surgery since April 2000. The location of the nidus is clearly demonstrated by CT scan, even in recurrent cases (Figure 1). Therefore, nidus removal is possible without sacrificing too much cortical bone. Cortical defects greatly weaken the bone, especially in torsional stress. It has been shown that small cortical defects with length less than the diameter of the bone can decrease bone strength up to 60%.[16] For a larger cortical defect with length exceeding the bone diameter, the bone strength is decreased by as much as 90%.[16] In the current study, patients treated with CT-guided mini-incision surgery had a smaller bone defect than those treated with conventional open excision. Although there was no pathological fracture in either group, postoperative protection (such as crutches, casting, or even hip spica immobilization) were usually administrated for those treated with conventional open excision. Figure 2 is of a 6-year-old boy with an osteoid osteoma near the lesser trochanter. Excision with conventional surgery was performed, which resulted in a bone defect measuring $3 \times 1 \times 1$ cm in the proximal femur. A hip spica was administrated for 1 month to prevent pathological fracture.

The surgical time was shorter for CT-guided mini-incision surgery. This is probably due to clear demonstration of the three-dimensional position of the nidus

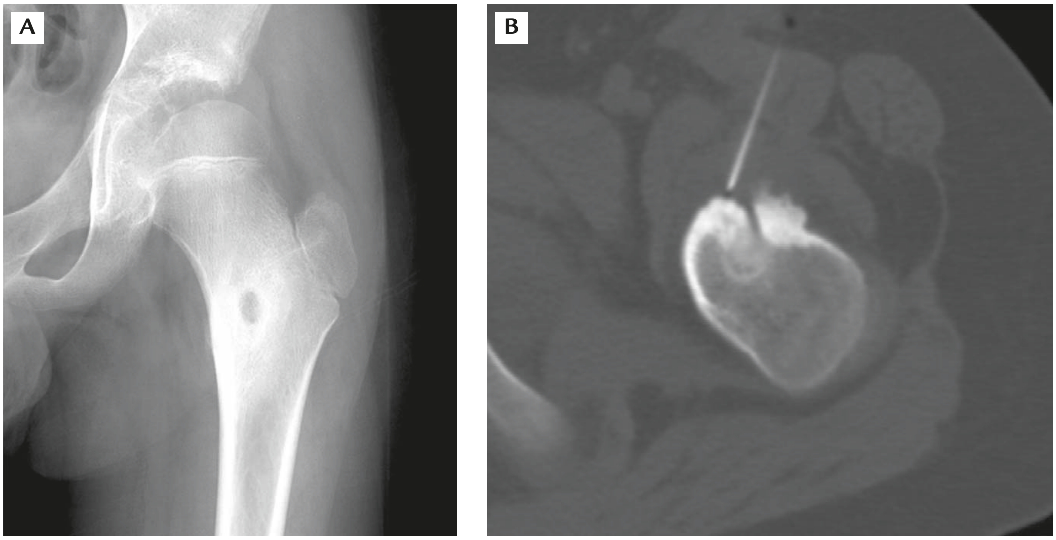

Figure 1. An 11-year-old boy with recurrent osteoid osteoma involving the proximal femur: (A) radiograph; (B) computed tomography (CT) scan. It is difficult to distinguish the nidus from the old drilling hole by plain radiography, but the CT scan clearly demonstrates these 2 entities.

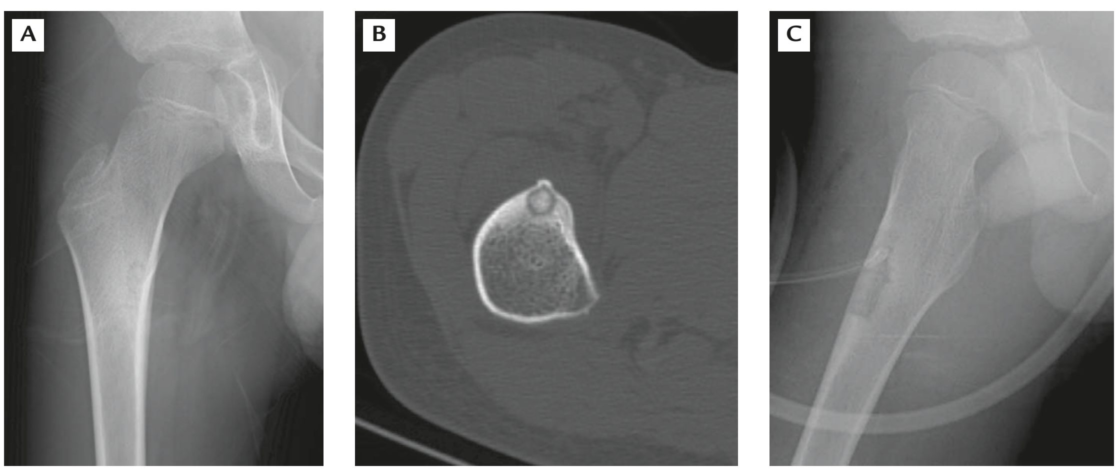

Figure 2. A 6-year-old boy with osteoid osteoma near the lesser trochanter: (A) radiograph; (B) computed tomography scan. (C) Radiograph soon after conventional open excision shows a bone defect measuring $3 \times 1 \times 1$ cm in the proximal femur.

by CT scan, which lessens the intraoperative time needed to look for the lesion.

The rate of recurrence of osteoid osteoma is reported to range from 0% to 25%.[13] In our study, the recurrence rate, including incomplete excision, was 23% for patients who were treated with conventional open excision. No recurrence occurred in the patients treated with CT-guided mini-incision surgery. The recurrence rate seems lower for the CT-guided group, but more cases are needed to validate this finding.

Thermal injury to the skin has been reported as a complication associated with percutaneous treatments.[10,14,17] This complication is probably caused by close contact of the skin with the trocar which is commonly used in percutaneous core resection. The metallic trocar may conduct the heat that is generated while drilling the cortex or while performing radiofrequency ablation. In the current study, after inserting the guide wire under CT, we used 2 Army-Navy retractors to protect the soft tissue during the excision procedures. The heat produced during drilling or burring was removed by irrigation and suction. With this method, no skin burns occurred in the CT-guided mini-incision group.

Without using radiofrequency or photocoagulation, CT-guided mini-incision surgery is more cost-effective than percutaneous procedures using this equipment. Like all types of percutaneous destruction (either by radiofrequency coagulation or laser coagulation), the major drawback of the mini-incision surgery in this study is the difficulty in confirming total excision during the operation.

CT-guided mini-incision surgery allows precise access to the osteoid osteoma with less sacrifice of surrounding bone compared to conventional open excision. Shorter operation time and hospital stay are also advantages of this technique. Although the results of the current study favor the use of CT-guided mini-incision surgery in treating osteoid osteoma, more cases are needed to achieve a solid conclusion.

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