Image intensifier-guided percutaneous drilling for osteoid osteoma of the proximal femur

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Purpose
The aim of this study was to evaluate the efficacy of image intensifier-guided percutaneous drilling destruction of the nidus as a minimally invasive surgery for osteoid osteoma (OO) of the proximal femur.
Background
OO is a painful, benign, small osteogenic bone tumor. For a long time, surgery was the only treatment for these lesions. Different minimally invasive therapeutic techniques have been proposed.
Patients and methods
Between 2009 and 2011, 14 patients (nine male and five female) with OO were treated at Mansoura University Hospitals by percutaneous drilling destruction of the nidus under image intensifier.
Results
All procedures were technically successful. Clinical success was achieved in 94.5% of patients. Only one patient had incomplete removal of the nidus. There were no other complications.
Conclusion
Image intensifier-guided percutaneous drilling destruction of the nidus is a safe, simple, and effective minimally invasive technique for the treatment of OO of the proximal femur.

Keywords:
drilling, image intensifier, osteoid osteoma

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Introduction

Osteoid osteoma (OO) is a benign bone tumor with a nidus of less than 2 cm, surrounded by a zone of reactive bone. This lesion accounts for ~10% of all benign bone tumors. It occurs most frequently in the second decade and affects male twice as often as female [1].

The proximal femur is the most common location followed by the tibia, the posterior elements of the spine, and finally the humerus. OO is found more often in the proximal than in the distal metaphysis or diaphysis [1].

The distinct clinical picture, the classic radiological presentation, and the typical pathological findings make the diagnosis and even symptomatic control an easy problem. The main problem and matter of controversy is the control and eradication of the lesion itself [2].

OO causes an intense and chronic inflammatory response in the surrounding tissues with a periosteal reaction, sclerosis of bone, and synovitis because of the production of prostaglandins by the tumor, which regresses spontaneously after removal of the nidus [2–5].

OO can resolve without treatment in an average of 33 months, but if the patient does not wish to endure the pain and the prolonged use of nonsteroidal anti-inflammatory medication, surgical excision or percutaneous removal is indicated [6]. Surgical excision has been common place until recently. Many surgeons thought that for surgery to be successful, the tumor including the reactive zone was to be completely removed. Extensive surgery has a greater chance of success but carries a higher risk of complications and a longer recovery period. It is currently well accepted that removal of the nidus is sufficient [6].

Most of these tumors are situated in weight-bearing bones, so the recovery from surgery may require a long period of limited weight bearing, often with crutches [6].

Several methods have been proposed as an adjunct to surgery to reduce the risk of failed surgery and

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Figure 1

Sleeve and 4.5-mm cannulated drill bit over a guide wire.

Figure 2

C-arm picture of the sleeve and the drill.

minimize the amount of bone removed [7–10]. In recent years, several techniques of percutaneous treatment of OO under computed tomography (CT) control have been proposed: excision through bone trephination [11–13], a combination of partial percutaneous resection with subsequent intralesional ethanol injection [14,15], and destruction of the nidus using radiofrequency electrodes [9,16] or laser photocoagulation [17].

Patient and methods

In a period of 2 years between 2009 and 2011, 14 patients (nine male and five female) with OO were treated at Mansoura University Hospitals with percutaneous destruction. The mean age at operation was 19 years (range: 12–30 years). The average follow-up period was 20 months (range: 7–24 months). The duration of pain before treatment varied from 4 months to 1 year. The decision concerning treatment was made based on clinical and radiological criteria. Clinical criteria included pain, worse at night and at rest, and relieved by NSAIDs. Radiological criteria included four diagnostic features: (a) a sharp round or oval nidus that was (b) less than 2 cm in diameter, (c) had a homogeneous dense center, and (e) a 1–2 mm peripheral radiolucent zone [6]. CT was the preferred method of evaluation, especially if the lesion was obscured by reactive sclerosis. The mean size of the nidus was 8 mm (range: 6–12 mm). There were four OOs in the femoral neck, three in the lesser trochanter, and seven in the isthmus region.

Operative procedure

The operation was carried out on a standard operating table under a high-resolution image intensifier control. Magnification and adjustment of contrast are often required to see the nidus clearly in both anteroposterior and lateral planes.

Pneumatic drill was used to insert a guide wire (2 mm) under image intensifier into the center of the nidus, passing through its two margins. A skin incision (1–2 cm) was centered on the guide wire. A sleeve was placed over the guide wire. A cannulated drill bit (4.5-mm caliber) was inserted through the sleeve and over the guide wire; it was advanced into the bone with a pneumatic drill (Figs 1 and 2). Both margins of the nidus were drilled. Subsequently, a high-speed burr (4-mm caliber) was used to remove the remnants of the nidus. Bone samples obtained from drill bit and speed burr were examined pathologically to confirm the diagnosis. CT scan was performed postoperatively to assess the excision of the nidus. All patients were mobilized on the first postoperative day and left the hospital after 3–4 days. Oral analgesics were indicated if pain was present after discharge. During follow-up, patients were examined in the first 2 weeks after the procedure and then at 3, 6, and 12 months, evaluating the presence of pain or associated symptoms. After 1 year, follow-up data were obtained by telephone or postal interview. A good response was defined as the disappearance of symptoms.

Figure 3

A 14-year-old boy presented with knee pain at night. (a, b) Preoperative radiograph and computed tomography (CT). (c) Intraoperative C-arm picture showing the intralesional wire. (d) Postoperative CT showing removal of the nidus. (e, f) Radiograph (anterior–posterior and lateral views). (g, h) 3 months after operation.

Results

In 13 patients, the postoperative radiographs showed complete removal of the nidus. In these patients, histopathological examination confirmed the presence of an OO in the nidus. Rapid (24–48 h) relief of pain was observed in these patients. All returned to normal daily activities within 2 weeks. Complete sclerosis of the nidus was confirmed with plain radiographs 6 months after surgery.

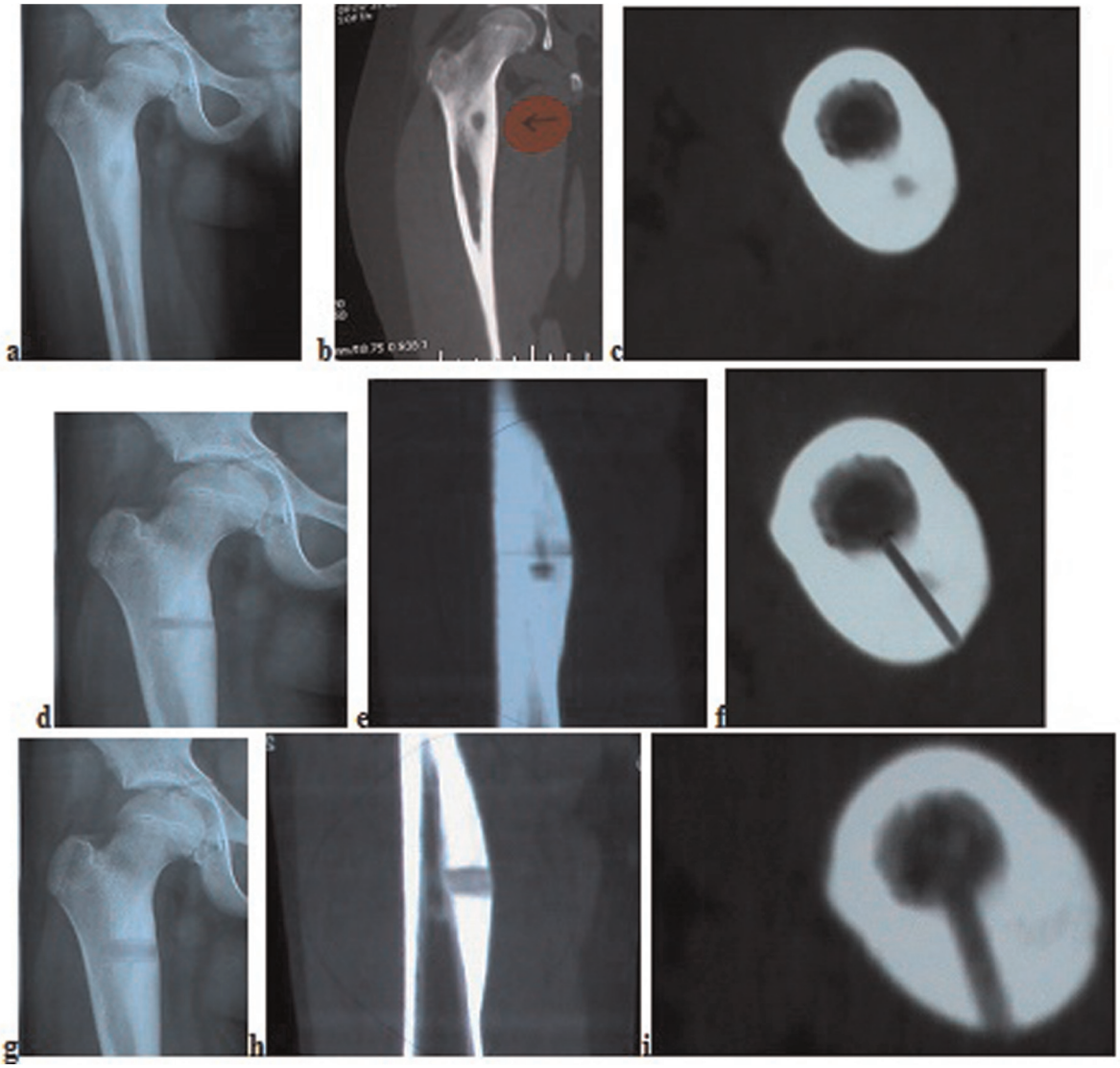
There was one failure of the primary procedure. In this patient, the nidus was not completely removed, and histopathological examination confirmed the presence of the reactive bone only. This patient had partial relief of pain for 3 months. Because of the return of pain a second procedure was performed. In this operation, complete excision of the nidus was confirmed radiologically and histopathologically, and pain relief was lasting.

Radiographs showed rapid healing of the operative defects. In the younger patients, the reactive changes in the proximal femur had resolved within 12–24 months. In older patients, with lesions at the calcar, reactive sclerosis persists. There were no infections, recurrences, or major complications (Figs 3 and 4).

Discussion

Surgery that consists of en-bloc resection of the nidus is successful in most cases [18]. However, because OO is a small lesion often surrounded by dense reactive bone sclerosis, preoperative localization of the nidus may be

Figure 4



A 16-year-old female patient presented with hip pain. (a) Preoperative radiograph. (b, c) Preoperative computed tomography (CT). (d) Postoperative radiograph showing incomplete removal of the nidus. (e, f) Postoperative CT showing incomplete removal of the nidus. (g) Radiographs after re-reaming by a larger burr. (h, i) CT after re-reaming by a larger burr, showing complete removal of the nidus.

difficult. In a small percentage of cases, the nidus may be missed during surgery resulting in failure and reoperation [18,19].

Some locations may be problematic. Surgical excision of a para-articular nidus may require arthrotomy [20], which has its own complications (reflex sympathetic dystrophy, infection, and secondary degenerative changes).

In recent years, several techniques of percutaneous treatment of OO under CT control have been proposed such as excision through bone trephination [11–13], a combination of partial percutaneous resection with subsequent intralesional ethanol injection [14,15], and destruction of the nidus using radiofrequency electrodes [16,21] or laser photocoagulation [17].

Percutaneous treatment of OO has several advantages over surgery; it allows precise localization and complete destruction of the nidus [11–13].

In a series of 38 patients treated by percutaneous resection with a trephine, the overall rate of complications was 24% [22]. These complications included two fractures and two skin burns. Parlier-Cuau *et al.* [23] reported that two of 32 patients had skin and soft tissue burns. To prevent secondary fractures, their patients were asked to avoid weight bearing and to use crutches for 6 weeks when the OO was located in the lower limb [23].

Percutaneous resection with a trephine requires relatively large-caliber instruments; therefore, subsequent structural weakness of the affected bone can lead to impaired

weight bearing for up to 6 weeks after surgery and even to fracture [23].

In our study, a 4.5-mm bone drill bit, followed by a 4-mm speed burr, through the same track, was sufficient for complete destruction of the nidus. Because only a small amount of bone was removed with percutaneous resection, the patients stay 3 or 4 days in the hospital and are quickly able to return to their normal activities [24]. This relatively small caliber of drill bit and burr avoided fractures, but the instruments provided enough material for histopathological examination. Moreover, a sufficiently large skin incision (2–3 cm) and the use of a sleeve protected the skin and the soft tissues against sepsis and burns.

The use of the fracture table and the C-arm for anteroposterior and lateral radiographs is familiar to all orthopedic surgeons and the equipment is widely available. We would stress, however, that the image intensifier must give a high-resolution image, have good contrast control, and be fitted, preferably, with magnification facilities.

Rosenthal *et al.* [25] described the technique of percutaneous radiofrequency thermocoagulation in 1992 and later reported their results in 18 patients [16]. A total of 16 patients had a successful outcome, whereas two had residual pain. Lindner *et al.* [26] described 58 cases treated with percutaneous radiofrequency ablation. The treatment was immediately successful in 95% of the patients and in 100% after a second ablation. De Berg *et al.* [21] reported 17 patients treated successfully by percutaneous radiofrequency thermocoagulation of the nidus; one patient needed two procedures. In 1997, Gangi *et al.* [17] discussed their experience with laser interstitial photocoagulation of OO. They had 13 successful results and one failure, owing to a technical problem. The main disadvantage of either percutaneous radiofrequency thermocoagulation or laser interstitial photocoagulation is the lack of histological verification [26].

Medical management of OO in surgically difficult sites has recently been advocated as an alternative to high-risk surgery [27], but our patients' symptoms were not controlled by nonsteroidal drugs, even when combined with other analgesics [27]. We suggest that, for many children, minimally invasive surgery is preferable to prolonged medication and incomplete control of symptoms. When a child's sleep is regularly disturbed by night pain, family life can be seriously disrupted.

Conclusion

Percutaneous treatment of OO is minimally invasive, safe, and simple. It allows an early return to normal activities. The procedure is particularly useful for a lesion located deep in the skeleton, which requires an extensive approach with conventional surgery. Surgical en-bloc excision should be restricted to cases impossible to treat with percutaneous methods. Percutaneous destruction of the nidus is more cost effective than the other percutaneous methods of destruction of the nidus (either by radiofrequency thermocoagulation or laser interstitial photocoagulation). Moreover, the destruction technique has fewer risks for the structural integrity of the skin and the subcutaneous tissues.

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Conflicts of interest

There are no conflicts of interest.

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