Case report

Femur shaft fracture following osteoid osteoma radiofrequency ablation

Elias Mazzawi¹
Daniela Militianu²
Mark Eidelman³
Yaniv Keren¹

¹ Orthopedic Surgery Division, Rambam Health Care Campus, Haifa, Israel
² Department of Medical Imaging, Rambam Health Care Campus, Haifa, Israel
³ Pediatric Orthopedic Unit, Rambam Health Care Campus, Haifa, Israel

Address for correspondence:
Elias Mazzawi, MD
Orthopedic Surgery Division
Rambam Health Care Campus
Haaliya Hashniya St 8
3109601 Haifa, Israel
Phone: +972 544482144
E-mail: eliasmazzawi@gmail.com

Summary

Introduction. Radiofrequency ablation is an effective modality in treating osteoid osteoma while avoiding the complications of an open procedure. Its complications are usually self-limited consisting mostly of local skin burns. This report presents a major complication, a femur shaft fracture following an osteoid osteoma radiofrequency ablation. The fracture occurred approximately one year after the ablation at the site of the osteoid osteoma.

Discussion. Few case reports have been published regarding subtrochanteric femur fracture after ablation of an osteoid osteoma. To our knowledge this is the first report of a femoral shaft fracture following an ablation. Another unique characteristic of the presented case is the late presentation, approximately one year following ablation. Factors which may have contributed to the fracture include lateral entry point of the drill which may have weakened the femur when taking its biological and mechanical properties into account, and the fact that the patient was a soldier who was allowed to continue his military training only six weeks after the ablation.

Conclusion. Radiofrequency ablation is an effective and relatively safe technique in treating osteoid osteomas, however the physician should be aware of the fracture risk involved, consider mechanical and biologic factors of the bone prior to drilling, and be very conservative when recommending return to high level activity. In addition, a close follow-up should be carried on after the procedure in order to supervise bone remodeling.

KEY WORDS: osteoid osteoma; femur fracture; radiofrequency ablation; complication.

Introduction

Osteoid osteoma (OO) is a benign bone lesion composed of a small nidus of osteoid trabeculae separated by a loose vascular connective tissue. This nidus is well demarcated and is surrounded by a zone of sclerotic bone (1-3). OO is relatively common accounting for 10-12% of all benign bone tumors and 2.5% of all pediatric lesions (4). It is typically diagnosed during the second decade of life with 90% of cases seen before the age of 25. Nevertheless, it may occur in the mature skeleton up to 70 years of age. In addition, OO is two to three times more prevalent in males than females (1, 5).

OO can occur anywhere on the axial and appendicular skeleton with the lower extremities being the most common site. The proximal femur is most commonly affected (approximately two-thirds of the cases), and other common sites include the diaphysis of the tibia and the humerus (6-9). The spine is also frequently involved especially the posterior elements (10, 11). Other areas that may be affected include the hand, and the foot bones (12-14).

Patients with OO usually suffer from sharp pain localized near the lesion site, increasing gradually and becoming worse at night. This pain is relieved by NSAIDS (non-steroidal anti-inflammatory drugs) and aspirin (15). Lower extremity lesions may cause limp, muscle atrophy, length discrepancy, deformities and muscle contractures (16-18). Imaging usually shows a central radiolucent nidus which may be calcified, surrounded by a sclerotic margin (19).

Treatment of OO depends mainly on the symptoms. For patients with tolerable pain and no functional limitation conservative treatment with NSAIDS or aspirin may be considered. As for patients with intolerable pain, limp, and functional limitation, there are several treatment options including:

- surgical resection ranging from local resection with a curette to wide open resection with bone grafting and internal fixation. Surgery, generally requires longer hospitalization and has more complications and longer recovery times than minimally invasive ablative techniques (20). However, it has an important role for lesions close to the neurovascular bundle, where the histology of the lesion is in doubt, or after two failed ablative procedures (20).
- CT and fluoroscopy guided percutaneous resection by drilling and curettage is another treatment option. Drilling induces bone heating and necrosis and reduces the bone’s tensile strength, which means that activity must be restrained (21). This technique requires larger tissue exposure and has a longer procedural times than other ablative techniques (22). Additionally, it can be performed as an inpatient or outpatient treatment with histological conformation.
- CT-guided laser interstitial thermal therapy which is performed by using a continuous-wave semiconductor

...
The lesion had a radiolucent nidus surrounded by a cortical necrosis ranging from 0.9 cm to 1.3 cm in diameter in the femur of dogs using RFA. Because the size and shape of the necrotic area are predictable and the fact that OO fall within the same size range the Authors came to believe that RFA could be a curative treatment for OOs. In 1992 Rosenthal et al. (29) described the ablation of OO using RF waves in four patients for the first time. They placed a bone biopsy needle into the nidus of the lesion under CT-guidance and then a RF electrode was advanced through the cannula and activated, generating heat and ablating the nidus. The ablation was successful in 3 out of 4 patients eliminating pain three days following the procedure. As for the fourth patient he didn’t had any improvement in pain following the procedure. No complications had been encountered in this study.

Since then, RFA has been refined and largely replaced surgery as the first line in treating OOs. It avoids the complications and morbidity of an open procedure while having comparable success rates which vary between 83-92% (20, 30, 31).

Complications of this technique are usually self-limited including local skin burns, transient sympathetic dystrophy, cellulitis (32), a self-limiting palsy of the extensor hallucis longus (31), self-limiting numbness of the thigh surrounding the ablation tract (22), and an osteocutaneous fistula requiring surgical debridement (33). However, a review of the current literature revealed two cases of late sub-trochanteric fractures following RFA (34, 35).

Dual-cycle RFA (DCRFA) is a technique employing two sequential RFA cycles in the same session. The electrode tip is allowed to cool between the cycles before it is activated again, and it can be repositioned in the second cycle in case of a relatively big nidus in order to ablate it completely. Abboud et al. (36) retrospectively reviewed the medical records and follow-up of 25 patients treated with DCRFA. They reported a 100% success rate, 0% long-term recurrence and a low complication rate indicating that DCRFA may be superior to single ablations. This report presents a case of a late femur shaft fracture following a RFA of an OO.

Case report

A 20-year-old male infantry soldier was admitted to our department complaining of sharp night pain localized at the right femur. X-rays and Computed tomography (CT) were conducted and revealed a 9 mm X 2 mm X 2 mm lesion which was located in the anterolateral aspect of the right femur shaft between the proximal third and the distal two thirds. The lesion had a radiolucent nidus surrounded by a sclerotic bone (Figures 1, 2).

The patient was instructed to use NSAIDS, which relieved the pain, but it would still wake him up from sleep affecting and limiting his daily activity. Although a biopsy hasn’t been made, these clinical and radiographic features are completely compatible with OO. The treatment options were introduced to the patient, and we advised for a CT-guided RFA. The patient approved, and the procedure was performed.

Under CT guidance, a 2 mm tract was drilled through the nidus from lateral to medial. The lateral cortex was drilled entirely, and the medial cortex was partially drilled inadvertently (3 out of 8 mm). Then a 15 mm straight ablation needle with 1 cm tip exposure Covidien cool-tip RF (Covidien, Dublin, Ireland) was inserted through the drill tract, and 90°Celsius heat was applied for 6 minutes in order to ablate the lesion (Figure 3).

The patient was discharged the day after with a recommendation to limit physical activity for six weeks. Follow-up was carried out at our institution one month, seven months and nine months after the ablation. The patient avoided physical activity for six weeks as recommended before returning to his military training. During his training he used to run long distances on regular basis, suffering only of mild thigh pain while running and kneeling. The pain was relieved after rest. He did not suffer of night pain after the ablation, suggesting successful ablation. X-rays were conducted on each of his follow-up visits showing good bone health, and a gradual remodeling response of the drilled cortex.

Approximately 1 year after the ablation, the patient felt sudden sharp right thigh pain while running. He was admitted to...
Femur shaft fracture following osteoid osteoma radiofrequency ablation

a near-by hospital and a femur shaft fracture was diagnosed at the presumed site of the old OO (Figure 4). He underwent an operation in which the fracture was reduced and fixated with an intramedullary nail (Figure 5).

Discussion

OO is a relatively common benign bone lesion affecting mostly patients in their first two decades of life. It can affect any bone on the axial and appendicular skeleton including the femur, tibia and humerus with the first being the most common. OO usually causes pain at the affected site which increases gradually and becomes worse at night. Conservative treatment includes NSAIDS and aspirin which may relieve the pain, however in case of persistent pain and functional limitation there are several treatment options which include: open surgical resection, CT and fluoroscopy guided percutaneous resection, CT-guided laser interstitial thermal therapy, and RFA therapy.

Minimally invasive RFA has become a common treatment modality for OOs (20, 37) with relatively high success rates (20, 30, 31). This technique has several advantages over open procedures including lower morbidity and complication rates, lower costs, and shorter hospital stay (38). Common reported complications include superficial skin burns (30, 37), cellulitis, sympathetic dystrophy (32), and self-limiting numbness (22, 31). A femur-shaft fracture has not been described previously in literature, however two cases of late sub-trochanteric fractures following RFA were recently reported (34, 35). By definition, sub-trochanteric fractures typically occur in the proximal femur between the inferior aspect of the lesser trochanter and a distance of about 5 cm distally (39). In one case (34), the fracture was diagnosed after the patient fell while wrestling with his classmate nine weeks after the ablation. In the other case (35), the patient suffered from a similar sub-trochanteric fracture ten years following the ablation during a long-jump.

In order to understand and evaluate fracture risk after such a procedure in the femur, we should recognize that the bone is an anisotropic material which resists to compression better than tension. When tensile forces are applied to a bone that has been weakened by a surgical procedure (such as drilling in our case) it might be susceptible to fracture, just as in the case of atypical femoral fracture in the elderly. This is especially important in the femur due to its biomechanics and the
fact that the anatomic axis is in approximately 7 degrees valgus of the weight-bearing mechanical axis. Consequently, there is an eccentric load on the femur with the medial cortex receiving primarily compressive loads while the lateral cortex receiving tensile loads (40, 41).

When taking anisotropy into account, drill holes should be preferably placed on the medial cortex which is less prone to fracture than the lateral cortex, due to the fact that it is loaded by compression forces and not by tension. However, OOs tend to appear in the proximal femur, and a proximal medial approach is not preferable due to the proximity of neurovascular structures and soft-tissue anatomy. As a result, the lateral approach is safer but it may leave the bone weaker and more susceptible to fracture. Similarly, it has been shown in femoral neck fracture fixation that a below lesser-trochanter starting point of the screws might create a stress riser and a subsequent sub-trochanteric fracture, and therefore should be avoided. In addition, one should keep in mind that there is a higher fracture risk in the femur and tibia following drilling and ablation than in the humerus, for example, probably due to the different mechanical forces acting on each of these bones.

In our case the fracture occurred through the OO’s site one year after the ablation. Factors that may have contributed to the fracture include lateral approach, and early return to high level activity. In this regard, the current recommendation after a RFA of an OO is to avoid sport activities for a period ranging from 3 to 6 weeks (20, 34).

Another theoretical contributing factor might be the lack of awareness of the medical staff in the soldier’s military unit. High index of suspicion and early referral to our institute might have prevented the upcoming fracture. In this context, we want to emphasize the importance of a frequent medical follow-up in order to supervise bone remodeling and monitor bone’s health. This could alter the patient’s management and prevent a fracture in a bone which has been weakened by drilling and ablation.

Conclusion

Percutaneous RFA has proven itself in treating OOs. It is considered an effective and safe treatment modality with self-limited complications. A percutaneous approach is safer and has fewer complications than an open approach, including a lower fracture probability. However, fracture risk is not entirely eliminated. When taking bone anisotropy into account, we recommend a more medial and anterior approach to the femur rather than a lateral approach which may weaken the bone and leave it more vulnerable to fracture.
Femur shaft fracture following osteoid osteoma radiofrequency ablation

Furthermore, fracture risk is not limited to the early post-operative period, and may exist years after the procedure. This might be a result of a weaker sclerotic bone area which develops after the ablation. In addition, drilling is a fracture-like condition and the drilled bone is expected to follow all phases of fracture healing. Since the remodeling phase of fracture healing may last up to several years after fracture union, one should be advised to refrain from sport activities including running, jumping and torsional activities for a prolonged period, especially after ablation of lesions in the lower limbs. However, the proper duration of this recommendation is still unclear and further research is needed in this domain.

High index of suspicion should be raised whenever symptoms exist during high level activity, since they might represent a prolonged period of bone healing and remodeling. In addition, a frequent follow-up should be carried out, in order to monitor the bone’s health and supervise the remodeling after drilling and ablation. This could prevent a fracture in a weakened bone.

References


