Case Report
Volume 10:2, 2021

Journal of Spine

ISSN: 2165-7939 Open Access

Microwave Ablation as a Minimally Invasive Surgical Option for the Posterior Spinal Elements Osteoid Osteoma: A Case Report

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Abstract

We report a 24-year-old male who was presented with constant intensive low back pain on the right side for 3 years. Large doses of NSAIDs were ineffective and resulted in gastric ulcer. Magnetic resonance tomography and computed tomography imaging revealed osteoid osteoma of L3 pars interarticularis and a needle biopsy confirmed it. An innovative approach for spinal osteoid osteoma was chosen after many considerations. The patient underwent microwave ablation of the lesion in the spine.

Keywords: Osteoid osteoma• Spine• Microwave ablation• Minimally invasive spinal surgery

Introduction

Osteoid osteoma is a benign bone-forming neoplasm which was initially depicted by Berg-strand in 1930 and portrayed by Jaffe as distinct entity in 1935 [1,2]. Osteoid osteoma com-pose about 5% of all bone tumors and 11% of benign bone tumors [3]. The proximal femur is the most often affected area, trailed by the tibia, posterior elements of the spine, and the humerus. Around 7% of osteoid osteomas are detected in the spine, most often in the lumbar region nearly solely within-side the posterior vertebral elements [4]. The etiology and pathogenesis of osteoid osteomas are still unknown, although some authors anticipate that it might appear due to previous trauma to the affected area [5]. Morphologically it is a sclerotic band of reactive bone formation that surrounds a small nidus of active bone formation [6]. The nidus is composed of variably mineralized woven bone trabeculae that are covered by osteoclasts and a single layer of osteoblasts. Usually, the cells of the tumor do not have nuclear pleomorphism nor an increased mitotic activity. The osteoblasts have eccentric nuclei with small nucleoli and open chromatin and are uniform in size and shape. Osteoid osteomas share common genetic pathways with normal skeletal development. The tumor occurs most frequently in the second decade of life and affects males twice as often as females [7]. It is found that high levels of prostacyclin and prostaglandin E2 are within the nidus; increased levels of cyclooxygenase-2 (COX-2) expression in nidus osteoblasts have also been reported. All these active substances contribute to local inflammation, vasodilatation and sclerosis around the nidus triggering the pain. The fact that increased COX-2 expression can be found explains why NSAI drugs help to relief the pain [3]. Nerve fibers have been also identified within the nidus causing pain, because they are constantly stimulated by prostaglandins, prostacyclins and other inflammatory agents [5]. Typically, osteoid osteoma causes night-time torment, which can be alleviated by NSAIDs [8]. Patients will in general describe it as a dull pain. Local symptoms may include an increase in skin temperature, sweating and tenderness [8]. Usually the physician has to consider three options of treatment: 1) conservative treatment with NSAIDs 2) surgical enbloc excision of the nidus which is considered to be the gold standard and 3) the minimally invasive CT-guided percutaneous procedure: percutaneous thermocoagulation including radio frequency ablation and microwave ablation, percutaneous laser photocoagulation [9].

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Received 04 February 2021; **Accepted** 17 February 2021; **Published** 24 February 2021

Case Report

A 24-year-old male patient with no relevant medical history presented with a 3-year history of constant low back pain at the level of L3/L4 spinal segment on the right side. The patient denied traumatic event of the affected lumbar area. Large doses of NSAIDs were implemented but the pain could only be partially alleviated and for very short period. Usage of NSAIDs resulted in abdominal pain and gastric ulcer. The patient was referred to a rheumatologist and a radiological investigation was performed on the lumbar spine. The radiological investigation revealed an osteoid osteoma in pars interarticularis of right inferior articular process of L3 vertebra (Figures 1 and 2). The patient was referred to a spinal neurosurgeon. Open surgical excision of the lesion was considered of high risk for segmental instability and the requirement for the spinal fusion while percutaneous thermo-coagulation technique despite being minimally invasive carried a risk of injury to neurovascular elements due to proximity to the lesion. After discussing the treatment options and benefit/risk ratio with the patient, the minimally invasive CT-guided percutaneous microwave ablation was selected. The procedure was performed under general anesthesia with a patient lying in prone position. Lesion biopsy was taken with spiral Spirotome BONE (BIONCISE NV, Belgium) biopsy needle leaving coaxial needle as a route for ablation probe. Lesion ablation was per-formed with TATO 2 (Biomedical Srl, Italy) using 18G needle with 15W of

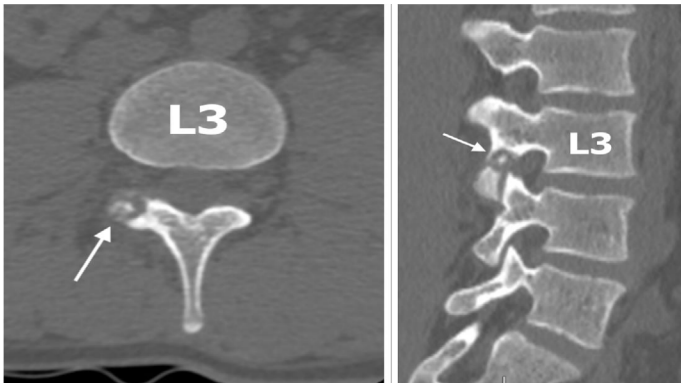

Figure 1. CT scan demonstrating an osteoid osteoma in pars interarticularis of right inferior articular process of L3 vertebra.

energy for 7 minutes (Figure 3).

The pathological investigation of the biopsy specimen contained bone tumor consist-ing of vascularized fibrous tissue with active osteoblasts and single small osteoclasts sur-rounded by osteoid of various width and immature bone trabeculae. SATB2 reaction had 100% osteoblast positive nuclear response and as for Ki-67 reaction up to 10% of osteoblasts had positive nuclear response. The day after procedure the pain on the right side of L3/L4 area resolved. There were no treatment related complications regardless to the proximity of right L3 nerve root to the targeted area. A follow-up examination on the patient was performed one and two months after the procedure. The pain was minimal and inconsistent and the occasional need of NSAIDs decreased to minimum. The patient regarded the applied treatment as highly successful. The follow-up radiological investigation revealed on going sclerosis of the lesion and diminished bone and soft tissue reaction (Figures 4 and 5).

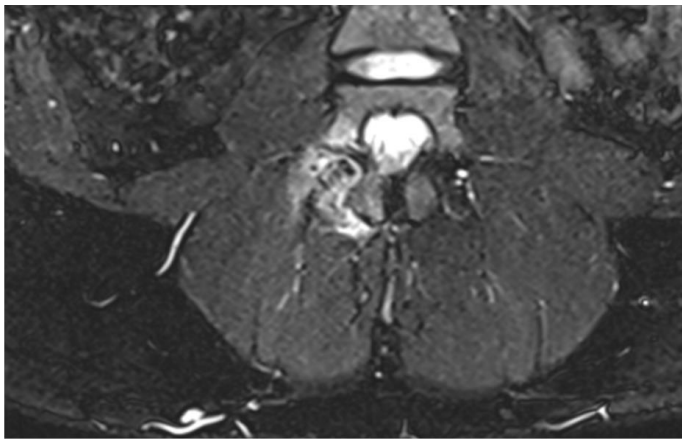

Figure 2. MRI Flair image of affected area shows increased signal representing focal edema and inflammation related to osteoid osteoma.

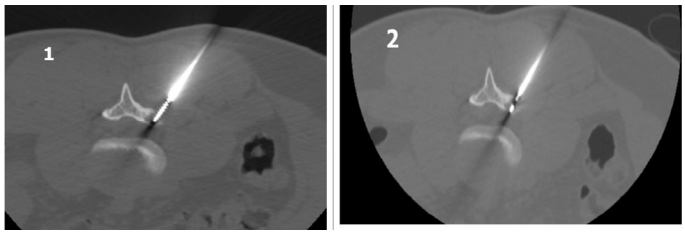

Figure 3. 1-Lesion biopsy through coaxial needle using spiral biopsy needle. 2- Lesion ablation CT image showing microwave antenna positioned through coaxial needle.

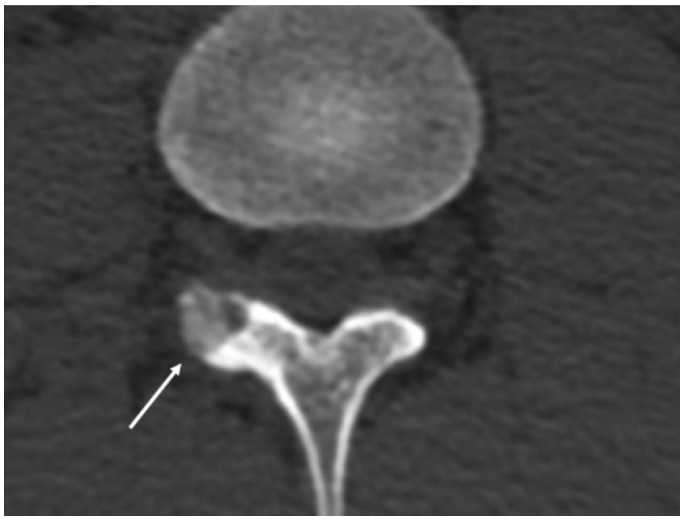

Figure 4. CT imaging 2 months after the procedure revealed ongoing sclerosis of L3 osteoid osteoma.

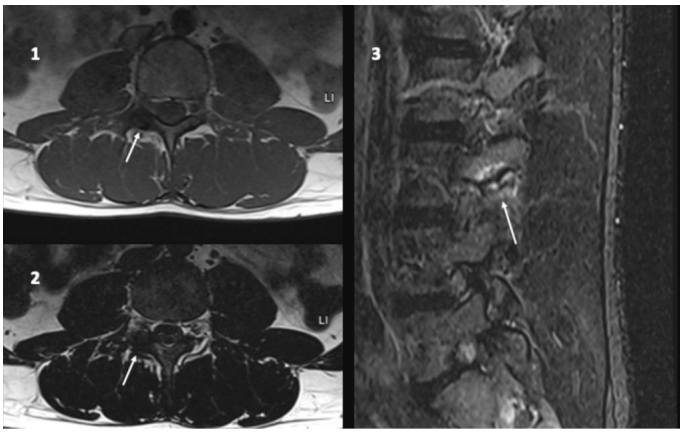

Figure 5. MRI images 2 months after the treatment shows lower signal intensity on T1 and T2 (Figures 1 and 2). FLAIR images (Figure 3) shows high signal intensity representing perifocal edema in the targeted area.

Discussion

Osteoid osteoma is generally diagnosed with a CT scan as it is the preferred method of evaluation suggested by many authors [7]. Nevertheless, in some cases the active nidus may be missed requiring the need of differential diagnosis between chronic osteomyelitis, stress fracture and osteoid osteoma. SPECT/CT is considered as a highly sensitive method when suspecting an osteoid osteoma [10]. According to a clinical trial conducted by a group of radiologists, the sensitivity, specificity, and accuracy of SPECT/CT for osteoid osteomas are all about 100% using 99mTc-methylene diphosphonate (bone scan), while those of CT are around 77%, 92% and 83% respectively [11]. Other study discerns that osteoid osteomas with or without conclusive appearance on plain radiography, were correctly identified on bone scintigraphy which suggests the implementation of radionuclide imaging more often for the detection of osteoid osteomas [12]. The young age and unidentified local pain should at least signal the doctor about the possibility of osteoid osteoma [13]. Painful scoliosis in young age is highly suspicious of osteoid osteoma and warrant for further investigation [14-16]. Following the excision of the tumor the pain is to be relieved and the scoliosis tend to regress [16]. Treating osteoid osteomas conservatively by managing it with NSAIDs is a well-accepted option. Clinical improvement applying conservative management occurs after about 33 months [17]. However, prolonged NSAIDs use increase the risk of acute renal failure, gastric ulcer, stroke or myocardial infarction even in young adults [18,19]. This fact emphasizes the importance of diagnosing the osteoid osteoma and implementation of the optimal treatment plan, as far as misdiagnosis and inadequate therapy can result in other systematic health problems. If NSAIDs are little effective to relieve the symptoms or the use of NSAIDs results in serious adverse events-other treatment options should be considered. For many years the golden standard of osteoid osteomas' treatment was enbloc surgical excision of the nidus and the surrounding sclerosis [13].

The main concern of open surgery is that the tumor border morphologically looks similarly to normal bone tissue. That is why a surgeon must perform a wide resection to ensure a radical removal of a tumor. In spine, this may result in iatrogenic spinal instability and a need of spinal fusion [20]. Thus, in some cases the more conservative approach should be considered [21]. There is a variety of CT-guided percutaneous techniques such as radiofrequency and microwave ablation, trephine excision, cryoablation, and laser thermos-coagulation that are used for the treatment of osteoid osteomas. Enbloc excision was compared with CT-guided mini-incision surgery and radio frequent ablation. The results revealed that the pros of using minimally invasive surgery are smaller bone defects, shorter surgical time and shorter hospital stay. Moreover, the rate of recurrence or incomplete excision was 23% for conventional surgery and as for mini-incision surgery the recurrence rate was 0% [22]. Some authors suggest treating osteoid osteomas using radiofrequency ablation due to the cost effectiveness and good results in a long-term follow-up, as in their study al-most all patients were cured using this method [23]. However, the study also suggests that despite of reduced operating time, blood loss, in-hospital stay and number of complications while using radiofrequency ablation technique, open surgery is recommended in cases of spinal cord or nerve root compression. As presented earlier, our patient did not have any signs of compression, so a minimally invasive surgery

may be implemented [24]. The treatment plan was selected considering young age, the localization of osteoid osteoma and possible long-term complications of open surgery in addition to slightly lower recurrence rates after treating osteoid osteoma with microwave ablation [25]. A Computed Tomography (CT) scan revealed osteoid osteoma in pars interarticularis of inferior articular process of L3 vertebra. In this case, radical surgery would require spinal fusion. Nevertheless, microwave ablation used for intraspinal lesions near the neural arch can potentially damage the neural structures [21-25]. In our case, after carefully calculations of microwave ablation parameters a satisfying result was achieved, the pain was relieved. Compared with enbloc surgical method, this innovative spinal approach resulted in a good clinical outcome, prevented the need of spinal fusion, resulted in short hospital stay and provided scope for consideration of applying a new, more conservative, innovative and less traumatizing treatment in selected cases.

Conclusion

Treatment resistant low back pain as well as painful scoliosis in young age should always signal the physician to consider an osteoid osteoma. Osteoid osteoma is often diagnosed by using a CT and/or SPECT/CT. Enbloc surgical excision of the nidus is not always the best and only option for the treatment of the osteoid osteomas. Microwave ablation is also an efficient method for the treatment of osteoid osteomas even in relatively problematic areas as in our case. The tumor was situated near the neural elements but careful calculations of the ablation parameters and planning the procedure resulted in a successful treatment without no adverse events. The case presented by the authors demonstrates that percutaneous techniques are attempting to become the new golden standard for the treatment of spinal osteoid osteomas.

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How to cite this article: Kastytis Budrevicius, Donatas Jocius, Ona Lapteva, and Dmitrij Seinin. "Microwave Ablation as a Minimally Invasive Surgical Option for the Posterior Spinal Elements Osteoid Osteoma: A Case Report." J Spine 10 (2021): 464.