Radiofrequency ablation of a difficult accessible osteoblastoma of the first sacral vertebrae: Fluoroscopic-guided electrode placement using a challenging posterior transpedicular approach

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Background: Osteoblastoma is a benign primary bone tumour >1.5 cm in size, histologically related to osteoid osteoma, and the potential for progressive growth. Between 7-17% of osteoblastomas involve the sacrum with clinically presentation of localized pain and neurological deficits. Resection is often impeded by close localization to vulnerable structures with a high risk of procedural complications. Purpose: To present a patient with a sacral osteoblastoma located at the difficult accessible anterior aspect of the S1 vertebral body using a technical demanding transpedicular approach for radiofrequency ablation (RFA). Study design: Case report. Methods: A 16 years old male patient presented with an eighteen months history of severe sacral back pain pretreated with nonsteroidal anti-inflammatory drugs. Native computed tomography revealed an osteoblastoma, 2 x 2 cm in diameter, of the S1 vertebral body, that was histologically confirmed. A challenging surgical anterior approach by laparotomy was precluded because of the increased risk of injury to vascular and intestinal structures. RFA and subsequent alcohol injection was performed by a transpedicular approach of the S1 vertebral body under fluoroscopic guidance combined with flat panel CT for probe position. Results: A significant pain reduction could be achieved when the patient leaved the hospital after 6 hours. At follow-up examination 3 months after RFA full daily activity was resumed and pain completely disappeared. Conclusions: The use of a biplane x-ray system with flatpanel-CT for RFA allows spatial orientation for the anatomically very complex transpedicular access to the anterior aspect of the S1 vertebral body that can surgically only be reached with an increased risk of procedural morbidity.

Keywords: Osteoblastoma; S1 vertebral body; radiofrequency ablation; transpedicular access; biplane x-ray system with flatpanel-CT; alcohol injection


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Introduction

Osteoblastoma is a benign primary bone tumour, histopathologically similar to osteoid osteomas but differentiated from those according to size (>1.5 cm) and the potential for progressive growth [1, 2].

Osteoblastomas are observed in any area of the skeleton, accounting for approximately 3% of benign tumours [3, 4] and for less than 1% of primary osseous tumours². Between 30% and 46% of osteoblastomas involve the spine [5, 6, 7, 8] with a rare appearance in the sacrum in 7%-17% [5, 9]. The predominant presentation is in adolescents and young adults in the second decade of life. It clinically presents with localized pain and neurological deficits in the affected region [10]. Surgical curettage is one treatment option. In some cases, however, intraoperative resection of the tumour may be impeded by close localization to intraabdominal, vascular or neural structures with a high risk of procedural complications. In these cases image-guided thermal radiofrequency ablation may act as a minimal invasive single modality or as an adjunct to surgical therapy [11, 12]. We present a patient with a sacral osteoblastoma located at the difficult accessible anterior aspect of the S1 vertebral body. Using a technical demanding transpedicular approach under fluoroscopic guidance combined with flat panel CT, radiofrequency ablation could be successfully performed.

Case report

A 16 years old male patient presented with an eighteen months history of sacral back pain (8 of 10 points at visual analogue scale (VAS)). Symptoms were controlled with nonsteroidal anti-inflammatory drugs. Native computed tomography (CT) showed a well defined central markedly mineralized round lesion (2 x 2 cm in diameter) of the S1 vertebral body with anterior cortical erosion, and slightly presacral protrusion. The lesion was surrounded by a semi-circular sclerotic zone. Histopathologic assessment revealed an osteoblastoma. A challenging surgical anterior approach by laparotomy was precluded because of the increased risk of injury to vascular and intestinal structures (Fig.1). After multi-disciplinary consent tumour treatment by thermal radiofrequency ablation (RFA) with general anaesthesia was considered. With the patient in prone position on chest rolls, via posterior access, a 10F vertebroplasty needle (10 cm) with mandrin was inserted and advanced through the soft tissues to the bone surface in 40° cranial-caudal angulation and 40° LAO projection monitoring its progress on fluoroscopic guidance with a biplane angiography system (Allura Xper FD20/20, Philips company Eindhoven) (Fig.2). By carefully hammering the outer cortex of the left pedicle of the S1 vertebral body was penetrated in short steps and the needle placed 1 cm dorsally the lesion to avoid unintended heating of the adjacent tissue by propagation from the RFA-electrode along the metal cannula. An 8F (15cm) mandrin was coaxially inserted to create a channel to the bone lesion (Fig.3). Following, the RFA-electrode (LeVeen Needle Electrode System, 2 cm, Boston Scientific) was inserted and the umbrella-shaped array completely deployed (Fig.4a).

Flat panel CT images (Xper-CT) were obtained to verify the correct position of the cannula out of the tumour, and to check the electrode position within the centre of the lesion. (Fig.4 b and c). The lesion size required three further ablation cycles in different positions by electrode placement in a more anterior and posterior position from initial position to create overlapping treatment zones. RFA was performed for a total of 11.5 minutes with a targeted temperature of 90°C. Manual adjustment of output controls maintained a stable lesion temperature. After removal of the RFA-electrode, 1.5 ml 95% alcohol labelled with iodine contrast media was injected through a coaxial inserted spinal needle to perform complete chemical ablation of the nidus (Fig.5). After removal of the vertebroplasty needle, post-procedural CT scan showed a minimal contrast media leakage into the entry channel without any clinical consequences. The routine discharge criteria were met and the patient could leave the hospital after 6 hours. At follow-up examination 3 months after RFA full daily activity was resumed and pain completely disappeared.

Discussion

Osteoblastoma is a rare and benign osteoid-producing primary bone tumour composed of well-vascularized connective tissue, and primitive woven bone that is histologically related to the more common osteoid osteoma [10, 13, 14].

The typical presentation is in a young adult, at a peak age between 10 and 20 years, with males being more frequently affected (2:1) [15, 16]. Presentation tends to be with pain and neurological deficits. Diagnosis especially of osteoblastoma in the sacrum is often delayed of several months between the onset and treatment because of the wide differential for low back pain [17, 18]. Unlike most primary benign bone tumours that usually affect only the long tubular bones, osteoblastomas also have a predilection for the spine, most often affecting the posterior elements [19].

Compared to osteoid osteoma, osteoblastomas tend to be locally aggressive, of larger size, with a higher recurrence rate. The optimal treatment of osteoblastoma of the sacrum

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cannot be conclusively assessed due to its rarity [1, 4] and failing randomized trials comparing various treatment modalities including surgical, interventional and radiation therapies [10, 20].

En-bloc resection with wide margins is suggested to be sufficient as leading treatment for osteoblastoma of the sacrum but includes the increased risk of postoperative morbidity with neurological dysfunction, e.g. loss of bowel and bladder function [21]. Intra-lesional excision in form of curettage is a further surgical technique that provides a good local control for sacral osteoblastoma [10]. Recurrence rates after surgical treatment from 7.7% to 40% were reported in the literature [22], whereby spinal osteoblastoma have the highest recurrence rates of all locations [23]. Complete resection is often impeded by extensive intra-operative bleeding [24].

RFA is a less invasive alternative to surgical excision or curettage [22].

Radiofrequency ablation was initially described by Rosenthal et al. in 1989 and can be used as a treatment in a variety of benign tumours including osteoid osteoma, osteoblastoma (<3 cm in diameter), chondroblastoma, aneurysmal bone cyst and eosinophilic granuloma [12,20,25]. Most frequently RFA has been successfully used in minimally invasive treatment of osteoid osteoma, with fewer complications compared to surgical treatment [1] and constitutes a first-line therapy for this benign tumour [11,12].

Potential complications are rare and include iatrogenic damage to the surrounding nerve root or tissues due to the access for the electrode when large gauge instruments are
used, heat effect and size of the bone necrosis \cite{12, 26}. For large volumes of ablation in lesions involving weight-bearing bones, additional consolidation with cementoplasty may be considered to prevent the risk of secondary fracture \cite{20}. RF ablation can be performed with the use of CT-guidance or by fluoroscopy combined with CT \cite{27}.

General or spinal anaesthesia is preferred in most cases, because local anaesthesia alone usually results in insufficient pain control, particular during entry into the nidus of the lesion \cite{11, 28}.

RFA of osteoblastomas is performed in the same way as in osteoid osteoma, using electrodes with a long active tip \cite{22}.

CT scan provides specific information about the lesion; it precisely defines the tumour location, size and degree of sclerosis and extent of bony involvement. Magnetic resonance imaging may pre-interventional used for evaluating the extent of soft tissue involvement, defining the relationship to the surrounding neurovascular structures, and extra-spinal extension \cite{19}.

Fluoroscopy-guided percutaneous access to the sacrum is technically demanding due to the complex radiological anatomy and close proximity to sacral nerve elements.

Existing reports have used CT, fluoroscopy, or both for guidance of needle placement. Advantages of using biplanar fluoroscopy include better visualization of the needle trajectory in 3D. Among the reported advantages of using CT for guidance is visualization of the tip of the needle in relation to the anterior sacral cortex \cite{29}.

The CT scan does offer the advantage for axial imaging of the sacrum to visualize the central spinal canal and thereby
help avoiding placing the cannula within the spinal canal.

The trans-sacroiliac approach involves placing the cannula under CT guidance from a near horizontal trajectory through the iliac bone and traversing the iliac joint to enter the S1 vertebral body. We avoided this approach due to the risk of infection of the sacroiliac joint and greater distance. In general the shortest way through the bones should be selected for access [11].

The central problem of CT-guidance for accessing the S1 vertebral body is the limited gantry tilt, which restricts the available trajectories for the cannula for a transpedicular approach, due to the presence of the iliac crest, the posterior iliac spine and the neuroforamen that eclipses the pedical from a dorsal percutaneous trajectory.

The dorsal transpedicular approach under fluoroscopy allows accessing the ventro-medial part of the S1 body [30]. Typically the sacral foramen are well visualized in an ap view where they align with the L5 and S1 vertebral pedicles extending in a line following the caudal direction.

We combined the advantages from CT and fluoroscopic imaging for transpedicular access of the S1 vertebral body. To overcome the difficulty of imaging the central spinal canal in relation to the needle trajectory and to reliable verify placement of the electrode tip within the lesion, we used Xper-CT.

The transpedicular access provides an anatomically safe entry point, but cannula trajectory is largely predetermined by the pedicle. Although, cannula trajectory can be directed by alignment of the needle cut. To access the caudal aspect of the vertebral S1 body the needle cut was pointed downward.

In large lesion dimension (>1.5 cm), further electrode positions with overlapping ablation zones are necessary, to cover the whole lesion. The transpedicular access limits cannula repositioning within the nidus. To overcome this problem we used an umbrella-shaped array with an ablation zone of 2 cm in diameter (LeVeen Needle Electrodes System, 2 cm, Boston Scientific) instead of a single needle electrode to cover the tumour periphery and performed ablation in central, anterior and posterior positions within the nidus.

To ablate probably remaining remnants of the nidus subsequent injection of 95% ethanol into the biopsy channel followed. Radiofrequency ablation with combination of alcohol injection is mostly reported in the treatment of osteoid osteoma with success rates of up to 100% [31,32]. The size and shape of the necrosis induced with ethanol is not always reproducible and depends on the degree of vascularization and tissue consistency. The advantage of fluoroscopy is monitoring distribution of iodine- marked ethanol in real time imaging to prevent necrosis of the soft tissue.

Conclusions

In cases of osteoblastomas, located on the median anterior aspect of the S1 vertebral body, probe position for RFA is very challenging. The use of a biplane x-ray system with flatpanel-CT allows spatial orientation for the anatomically very complex transpedicular access that can surgically only be reached with an increased risk of procedural morbidity.

Conflicting interests

The authors have declared that no conflict of interests exist.

References