



Original Article

Determination of the painful level in osteoporotic vertebral fractures—Retrospective comparison between plain film, bone scan, and magnetic resonance imaging

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Abstract

Background: Determining the actual painful vertebral level is difficult when evaluating osteoporotic vertebral fracture, especially when there are acute and chronic fractures simultaneously. In this study, we retrospectively evaluated and compared the findings between plain film, bone scan, and magnetic resonance imaging (MRI) in the diagnosis of new fracture in osteoporotic vertebral fractures.

Methods: This is a retrospective clinical study of patients who were diagnosed with osteoporotic vertebral fractures using plain film, bone scan, and MRI within a 1-month interval between February 2008 and December 2012. The findings in plain film, the extent of increased uptake in bone scan, and signal change in MRI were compared to evaluate the actual level of pain. All patients received percutaneous vertebroplasty according to MR finding. Pain scores (visual analog scale) of the study patients were compared prior to and after the procedure.

Results: A total of 52 patients with a mean age of 79.1 years (range 59–92 years) were enrolled in this study, and were treated by vertebroplasty confirmed by MRI. It was observed that patient pain score (visual analog scale) improved from 7.6 to 2.8. Plain film examination revealed 79 vertebrae that were suspected to be compression fractures. Among the suspected vertebrae, 62 showed increased uptake in bone scan, and MRI showed bony edema change in 58 vertebrae. The consistency between bone scan and MRI was 96.9% in patients with single-level suspected fracture on plain film. There was moderate agreement (kappa was 0.56) in patients where multiple levels were noted. Fifteen vertebrae with vacuum cleft sign on plain film showed total concordance in both bone scan and MRI.

Conclusion: For patients with single-level compression fracture, the painful level in osteoporotic vertebral fractures can be determined by plain film and bone scan testing. Vacuum cleft sign noted on plain film may be enough to localize the level of pain. However, MRI testing is further needed in multiple osteoporotic vertebral fracture patients.

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1. Introduction

As the mean age of the population continues to increase, the incidence and risk of vertebral compression fracture due to osteoporosis have recently manifested a rising trend. For such osteoporotic vertebral compression fracture patients, it is important to accurately determine the symptomatic vertebra prior to establishing treatment levels.

Conflicts of interest: The authors declare that there are no conflicts of interest related to the subject matter or materials discussed in this article.

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However, it is difficult to find the painful level using only plain X-rays in those patients whose time of fracture onset and site of pain are unclear. It is also not easy to perform a physical examination on elderly patients. Increased activity revealed by bone scan is highly predictive of positive clinical response after surgical treatment.¹ The diagnostic benefits of magnetic resonance imaging (MRI) include the capacity to identify the correct location of injury and also detect concomitant diseases.² In this study, we evaluated the findings of plain film examination and the efficacy of bone scan and MRI to diagnose a painful fracture, which is an acute fracture or chronic nonunion fracture, in elderly patients with osteoporotic vertebral compression fracture.

2. Methods

Between February 2008 and December 2012, 52 patients diagnosed with osteoporotic vertebral fracture who received vertebroplasty were retrospectively reviewed after institutional review board approval. All patients underwent a plain film, bone scan, and MRI testing within a 2-month period. The mean age of the patients was 79.1 years (range 59–92 years), and there were 20 male and 32 female patients. The presence of vertebral body compression fracture was assessed by plain X-ray and bone scan, and MRI was thereafter performed to decide the level of percutaneous vertebroplasty.

The decreased body height, wedge or biconcave shape, and vacuum defect in plain film were suspected to be involved with the painful level. The vacuum defect was considered to be associated with nonunion related to the formation of pseudoarthrosis in these vertebrae. The suspected lesions were divided into three groups: (1) single-vertebral-body group, (2) two-vertebral-body group, and (3) more-than-three-vertebral-body group. The intensity on the bone scan increased more than the hot uptake by the anterior superior iliac spine and the posterior superior iliac spine, leading to a diagnosis of increased uptake lesions.

MRI was then used to confirm the painful level by distinguishing between painful and painless fractures according to the appearance of bone marrow edema and hemorrhagic fluid. Levels with low intensity on the T1-weighted image and high intensity on the T2-weighted image were considered to be the painful levels. Malignant lesions and cemented vertebral bodies with or without a signal change were excluded. All patients underwent percutaneous vertebroplasty by the same surgeon, each with an MRI-confirmed level of signal change. Focusing on the pain relief, patients were asked to provide a value for pain intensity using a visual analog scale, ranging from 0 to 10, prior to and after the procedure.

Due to the postvertebroplasty appearance of cold defect on bone scan,³ cemented vertebral bodies were assumed not to rise to the painful level and were excluded even if similar signal changes were evident on MRI.⁴

The uptake levels on bone scan in the three groups were then compared and evaluated depending on the change of signal intensity on MRI. For the statistical analysis, paired Student *t* tests were performed for pain score, and $p < 0.05$

was considered to be significant. Agreement and kappa statistics were used for concordance between plain film, bone scan, and MRI.

3. Results

Among the 52 patients who underwent plain X-ray, bone scan, and MRI, 79 vertebrae showed characteristic findings of vertebral compression fractures on plain film, and vacuum defect was identified in 15 vertebrae. On bone scan, increased uptake was noted in 59 vertebrae, and 45 were confirmed to have a painful fracture by MRI and received vertebroplasty under local anesthesia.

A total of 32 patients had single-level suspected vertebral compression on plain film. Among the 32 vertebral bodies, 31 were determined by bone scan to have an increased uptake lesion and 30 vertebral bodies (96.7%) were determined to have a painful fracture by MRI. The agreement between the results of bone scan and MRI was 96.9% in patients with a single-level suspected vertebral fracture on plain film.

In patients with more than two levels of suspected fractures on plain film, increased uptake on bone scan was noted for 28 out of 47 vertebrae (59.5%). Additionally, 15 vertebrae were confirmed to have a painful fracture by MRI. One of the cases is presented in Fig. 1. The agreement between bone scan and MRI was 76.6%, and the kappa value was 0.56. In multiple-level patients, the concordance percentage of plain film and MRI was 31.9% and that of bone scan and MRI was 53.5% (Table 1).

Intravertebral air, known as vacuum cleft sign or pseudoarthrosis, and considered nonunion, was identified in 15 vertebral bodies. Altogether, all 15 vertebral bodies (100%) showed an increased uptake on bone scan. All of these 15 vertebral bodies were determined as painful level by MRI confirmed low intensity on T1-weighted image and high intensity on the T2-weighted image, suggesting fluid occupation of the cleft (Fig. 2).

The average pain score before vertebroplasty was 7.6. By MRI determination in this study, the pain score improved to 2.8 immediately after the procedure, with statistical significance (Table 2).

4. Discussion

Localizing the level of pain is difficult to achieve in treating patients with multiple osteoporotic fractures of uncertain age. Besides physical examination, preoperative evaluation including plain X-ray, computed tomography, and MRI may all be needed to achieve the therapeutic effect of percutaneous vertebroplasty.⁵ Bone scanning has been reported to be reliable in treatment planning and predicting pain relief after kyphoplasty.⁶ It is also valuable for detection and assessment of vertebral fracture age in patients with severe osteoporosis.⁷ However, bone scan imaging may reveal increased activity for up to 2 years after fracture. Furthermore, there is a lag period of ≥ 1 week following collapse in elderly patients.⁸ The overall positivity of the bone scan in detection of levels that

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