CLINICAL ARTICLE

Value of Bone Scan Imaging in Determining Painful Vertebrae of Osteoporotic Vertebral Compression Fractures Patients With Contraindications to MRI

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Objective: To assess the value of bone scan imaging in determining painful vertebrae of osteoporotic vertebral compression fractures (OVCFs) patients with contraindications to MRI.

Methods: Twenty-three OVCFs patients with contraindications to MRI, diagnosed and treated in our hospital between December 2007 and November 2010, were enrolled in this retrospective study. There were 18 females and five males, aged from 57 to 87 years, with a mean age of 69.5 years. All patients underwent X-ray, CT scans examinations and bone scan to determine painful vertebrae. After the painful vertebra was defined, percutaneous kyphoplasty (PKP) was performed. Efficacy of PKP was assessed with visual analog (VAS) pain scale and the Oswestry Disability Index (ODI) preoperatively, postoperatively and during final follow-up assessments.

Results: The painful vertebrae shown on radiological films did not accord with those found based on bone scan imaging, with a high rate of incongruent findings (27.3%, 9/33). Radiological films showed 33 vertebrae with fractures, but only 26 vertebrae (22 patients) were selected as painful vertebrae for PKP based on bone scan imaging. There were statistically significant differences in mean VAS and ODI between the preoperative and the postoperative assessments; no significant differences were observed between postoperative and final follow-up assessments.

Conclusions: For the OVCFs patients with contraindications to MRI, bone scan imaging could be used to determine painful vertebrae, which is an effective method.

Key words: Bone cements; Osteoporosis; Radionuclide imaging; Spinal fractures

Introduction

The incidence trends and risk of osteoporotic vertebral compression fractures (OVCFs) have recently risen due to the increased number of elderly people. Such fractures often result in severe back pain, progressive vertebral collapse, limited mobility, and significantly impact the quality of life¹. Conservative management for OVCFs usually consists of bed rest, analgesic use, brace, and physical therapy. However, pain sometimes relieves slowly or persists for a long time^{2,3}. Open surgery is generally not considered because of the danger of

hardware failure or “pullout” in osteoporotic bone. Percutaneous kyphoplasty (PKP) is a minimally invasive surgical treatment for OVCFs^{4,5}. It is designed to address the fracture-related pain and the associated spinal deformity. But it is a prerequisite to accurately diagnose the painful vertebra prior to deciding the treatment protocols.

Indeed, it may be difficult for the clinician to determine the exact painful vertebrae by physical examination alone. Plain X-rays and CT scans will detect the sites of fractures but perform poorly for determining their age. MRI of the spine is

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Disclosure: The authors declare no conflict of interest. No benefits in any form have been, or will be, received from a commercial party related directly or indirectly to the subject of this manuscript.

Received 11 March 2012; accepted 26 June 2012

Both Zhi-bing Tang and Lei Zhang are equal contributors to this work.

the most useful means in defining the cause of spinal pain, determining painful vertebrae of OVCFs, and selecting the appropriate treatment⁶⁻¹⁰. But in the clinical setting, there are some special patients, who have internal implants in their body because of previous surgeries, such as cardiac pacemaker, coronary and peripheral artery stents, metallic internal fixation, artificial joint, permanent contraceptive devices. For these patients, MRI is not suitable, because MRI entails a strong static magnetic field and changing magnetic and radiofrequency fields, in which problems can arise from any metal objects present in the body^{11,12}.

Bone scan could provide useful information about bone turnover and, thereby, identify any vertebral fracture that has an ongoing healing process. So in this retrospective study, we want to assess the value of bone scan imaging in determining painful vertebrae of OVCFs patients with contraindications to MRI, and explore the efficacy of performing PKP based on bone scan imaging.

Materials and Methods

The study was approved by the Institutional Ethics Committee of Soochow University, and all patients provided written informed consent for participation. Twenty-three OVCFs patients with contraindications to MRI, diagnosed and treated in our hospital between December 2007 and November 2010, were enrolled in this retrospective study. There were 18 females and five males, aged from 57 to 87 years, with a mean age of 69.5 years. The mean bone mineral density was -3.3 (range, -1.2 to -5.2). All patients suffered from severe back pain without leg pain and had a history of gentle spinal trauma (defined as not causing vertebrae fracture in a person without osteoporosis) or no previous trauma history. All patients underwent X-ray, CT scan of the spine before operation, and the vertebrae with fracture could be found.

Moreover, all patients underwent bone scan in the department of nuclear medicine of our hospital. The mean interval time from the beginning of symptoms to performing bone scan was 7.8 days (range, 1 to 14 days). Whole-body regional images were performed 2–3 h following the intravenous administration of 20 mCi (740 MBq) of Tc-99 m methylene diphosphonate. Each bone scan image was evaluated by two experienced nuclear physicians. And the cases whose hot uptake in vertebrae was more than that in the sacroiliac joint were considered as painful vertebrae. Then, PKP was performed based on the painful vertebrae defined by bone scan imaging.

With general anaesthesia, C-arm X-ray fluoroscopy was used throughout to guide the procedure. After incision of the skin, a gauge needle was placed percutaneously into the posterior vertebral body through a transpedicular approach. Biopsy needles were exchanged over a guide wire for a working cannula. Inflatable bone tamps (IBTs) were placed bilaterally into the vertebral body through a working cannula. They were then inflated under-fluoroscopic guidance and manometric parameters. Inflation continued until the vertebral body height was restored, the IBT touched a vertebral body cortical wall,

the IBT reached 689.5–1930.5 kPa, or the maximal balloon volume was reached. The IBT was then withdrawn and polymethyl-methacrylate (PMMA) cement was placed into the cavity within the fractured vertebral body.

Efficacy of PKP was assessed by the mean change in anterior/middle vertebral body height, Cobb's angle, visual analog pain scale (1, no pain; 10, worst possible pain) and the Oswestry Disability Index at preoperative, immediate postoperative and final follow-up assessments.

Statistical analysis

Paired simple *t*-tests were performed using the SPSS 16.0 statistical software system (SPSS Inc., Chicago, IL, USA), and a *P*-value less than 0.05 was considered to be significant.

Results

The painful vertebrae shown on radiological films did not accord with those found based on bone scan imaging, with a high rate of incongruent findings (27.3%, 9/33). Radiological films showed 33 vertebrae with fractures, but only 26 vertebrae (22 patients) were selected as painful vertebrae for PKP based on bone scan imaging. Nine vertebrae that were defined as painful vertebrae by X-ray or CT scans were not the painful vertebrae detected by bone scan imaging (Table 1). All of these nine vertebrae (nine patients) were found to be old fractures. Two vertebrae with obvious deformities on X-rays were not the painful vertebrae by detecting with bone scan imaging in two patients (patient 14 and 15 in Table 1). One of them was shown in Fig. 1.

Percutaneous kyphoplasty was successfully performed on the involved painful vertebral bodies of the patients, whose symptoms had different improvement. The mean follow-up period was 28.5 months (range, 12–47 months). Statistically significant improvements in the mean postoperative anterior and middle vertebral body heights were observed compared with preoperative values. There was also statistically significant improvement in the mean values for Cobb's angle, visual analog pain (VAS) scale and the Oswestry Disability Index (ODI) at the immediate postoperative assessment compared with the preoperative assessment. There were no statistically significant differences between the postoperative and final follow-up assessment in any of the evaluated efficacy measures (Table 2).

There was no injury of nerve, infection, and pulmonary embolism. Bone cement leakage occurred during operation in two cases, but this did not cause any related clinical or neurological symptoms. One patient had an adjacent vertebral body fracture 6 months after the operation, which needed conservative treatment.

Discussion

Not every vertebral fracture is a source of pain or necessitates surgery. Pain is caused by subtle mobility of a vertebral fracture¹³. Being able to determine which vertebral fractures are associated with mobility might be key to the success of treatment. MRI can play a major role in judging the

TABLE 1 Patients' data and painful vertebrae defined by X-rays, CT scans and bone scan imaging

Patients	Sex	Age	Metallic implants causing contraindication to MRI	Painful vertebrae defined by X-rays or CT scans	Painful vertebrae defined by bone scan imaging and performed PKP
1	F	67	Artificial joint	L1	L1
2	F	72	Internal fixation	L2,4	L2,4
3	M	70	Coronary artery stent	T11, L1	T11, L1
4	M	68	Cardiac pacemaker	T12	T12
5	F	58	Contraceptive device	L1,2	L1
6	F	66	Contraceptive device	T12, L2	L2
7	F	62	Internal fixation	T7,10	T7,10
8	F	63	Cardiac pacemaker	L1	L1
9	F	77	Artificial joint	T11,12	T12
10	M	87	Internal fixation	L1	None
11	F	73	Contraceptive device	T11	T11
12	F	84	Artificial joint	T10,11	T11
13	F	57	Cardiac pacemaker	L2	L2
14	F	65	Peripheral artery stent	T11	L1
15	F	75	Internal fixation	L1	T12
16	F	79	Internal fixation	T12, L1	L1
17	F	78	Artificial joint	L2	L2
18	F	67	Cardiac pacemaker	L1	L1
19	F	63	Coronary artery stent	T12	T12
20	M	66	Internal fixation	T11, L3	T11
21	F	81	Artificial joint	T12, L2	T12, L2
22	M	59	Coronary artery stent	T10	T10
23	F	62	Peripheral artery stent	L1	L1

extent of vertebral fracture healing and whether or not to select vertebrae for surgery. And our previous study showed that MRI and especially the short tau inversion recovery (STIR) sequence of MRI is the most useful test for detecting painful vertebrae of multiple-level VCFs¹⁰. But clinically, there are some special patients with contraindications to MRI. Bone scan could provide useful information about bone turnover and, thereby, identify any vertebral fracture that has an

ongoing healing process. Therefore, we used bone scans to detect painful vertebrae of patients with OVCFs.

Bone scan reflects the bone metabolism. It may play an important role in the differentiation of old fractures and to detect metabolic diseases or fracture that is undetected by simple X-rays and CT scans. Cook *et al.* reported that for osteoporotic patients with back pain, the bone scan could distinguish the cause of back pain among fracture, facet joint

TABLE 2 Comparison of vertebral body height, Cobb's angle, visual analog scale (VAS) score and Oswestry Disability Index (ODI) score between preoperative, postoperative and final follow-up

Items	Preoperative	Postoperative	Final follow-up
Vertebral body height (%)			
Anterior	54.0 ± 14.4	80.1 ± 10.0*	77.9 ± 9.8
Middle	67.1 ± 11.5	85.4 ± 7.2*	83.1 ± 7.4
Cobb's angle (°)	17.1 ± 4.8	8.8 ± 2.3*	9.0 ± 2.2
VAS score	8.1 ± 1.6	2.3 ± 1.4*	2.2 ± 1.1
ODI score	36.5 ± 8.2	9.4 ± 4.9*	8.7 ± 3.7

*P < 0.01 versus the preoperative assessment.

Fig. 1 A 75-year-old woman who suffered from severe back pain caused by a gentle spinal trauma. The preoperative X-rays showed vertebral deformity of L1 (A,B). However, the preoperative bone scan imaging showed more hot uptake in vertebral body of T12 (C). So, T12 was defined as the painful vertebra and percutaneous kyphoplasty (PKP) was performed. The postoperative X-ray showed the vertebra of T12 was full of bone cement (D). The patient got complete pain relief after operation.

arthritis and disc degenerative lesions so that it is of great help to administer appropriate treatments¹⁴. However, Cook *et al.* didn't suggest clear objective standards that distinguish individual diseases. Maynard *et al.* reported that increased radio-nuclide uptake on a bone scan is associated with recent fracture and has been shown to be predictive of pain relief after vertebroplasty¹⁵. Jordan *et al.* reported that the bone scan was useful to confirm an acute fracture, to determine the most active fracture for vertebroplasty in cases with multiple fractures of indeterminate age and to determine other causes of back pain¹⁶.

In this study, bone scan was used to determine painful vertebrae of OVCFs patients with contraindications to MRI. The cases whose hot uptake in vertebrae was more than that in the sacroiliac joint were considered as painful vertebrae. According to this principle, 26 vertebrae (22 patients) were selected as being painful vertebrae for PKP. All the patients had a good clinical outcome after the surgery. There were statistically significant differences in mean VAS and ODI between the preoperative and the postoperative assessments, but no significant differences between postoperative and final follow-up

assessments. It showed that bone scan was very sensitive to detect painful vertebrae of these patients.

Simple X-ray and CT scans are important diagnostic tests for making the initial diagnosis of OVCFs. Nonetheless, making the differential diagnosis of old fracture and new fracture cannot be clearly done in many cases, such as the presence of multiple and/or insufficiency fractures. The high rate of incongruent findings (27.3%) was shown between radiological films and bone scan imaging in this study. Therefore, for the OVCFs patients with contraindications to MRI, besides X-ray, CT scan, and clinical examinations, bone scan is effective in determining the real painful vertebrae.

For the OVCFs patients with contraindications to MRI, preoperative bone scan image can be used to determine painful vertebrae on which PKP can get a good outcome. We recommend routinely performing bone scan for exclusion of underlying pathological fractures.

Acknowledgments

The authors thank Professor Li-xin Huang, Dr Cheng Ji and Dr Ding-hua Jiang for their help and guidance.

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