Spinous process fractures in osteoporotic thoracolumbar vertebral fractures

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Objectives: To evaluate the incidence and pattern of spinous process fractures (SPFs) in patients with osteoporotic compression fractures (OCFs) of the thoracolumbar spine.

Methods: Spinal MRI or CT of 398 female patients (age range 50–89 years, mean age 70 years) who had OCFs in the thoracolumbar spine were retrospectively reviewed. The incidence, location and imaging results for the SPFs were evaluated.

Results: Of the 398 patients who had thoracolumbar OCFs, 14 (3.5%) had SPF. In six patients with single compression fractures, the SPF occurred at the level just above the vertebral compression fracture. In six out of seven patients with multiple continuous compression fractures, the SPF occurred just one level above the uppermost level of the compression fracture. The remaining one patient who had thoracolumbar spinal fixation at T12–L2 with continuous compression fractures in T12–L5 had a SPF in L2. In one patient who had multiple compression fractures in discontinuous levels (fractures at T10 and L1, respectively), the SPF occurred at T12. The directions of the fractures were vertical or oblique vertical (perpendicular to the long axis of the spinous process) in all cases.

Conclusion: In the presence of an OCF in the thoracolumbar spine, a SPF was found in 3.5% of cases, and most of the fractures were located just one level above the compression fracture. Therefore, in patients who have OCF, the possibility of a SPF in the level just above the compression fracture should be considered.

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Osteoporosis is a common disease owing to an increase in the population of older people. Osteoporosis is a disease that induces bone fragility, caused by a decrease in trabecular bone, and the resulting fracture is called an insufficiency fracture. The most common osteoporotic compression fractures occur in the spine, sacrum, pubis, femoral neck and wrist [1].

Although the most common methods for imaging vertebral fractures are still spinal radiographs, benign spinal compression fractures are commonly detected by MRI or CT on osteoporotic patients with back pain. Sometimes, it is difficult to differentiate a benign spinal compression fracture from a malignant cause of the spinal compression fracture. However, in most cases, a benign spinal compression fracture shows some specific features: a low-signal-intensity band on T_1 and T_2 weighted images, spared normal bone marrow signal intensity of the vertebral body, retropulsion of a posterior bone fragment and multiple compression fractures [2]. A relationship between osteoporosis and benign spinal compression fractures, including insufficiency fractures, has been reported. A study examining the relationship between benign compression fractures of the spine and insufficiency fractures of the sacrum has also been reported [3]. However, there have been few reports of spinous process

fractures in the osteoporotic spine [4]. Moreover, there have been no studies examining the relationship between spinous process fractures and benign compression fractures of the spine.

We have noted index cases of spinous process fractures in certain patients with osteoporotic compression fractures. There has been no report of spinous process fractures in patients with osteoporotic compression fractures. The aim of this study was, therefore, to evaluate the relationship between osteoporotic compression fractures and spinous process fractures in patients with osteoporosis.

Materials and methods

Patients

From January 2007 to June 2008, 415 female patients over 50 years old with spinal compression fracture examined by MRI or CT of the thoracolumbar spine were evaluated.

Of the 415 patients, 398 patients were included and 17 were excluded owing to a clear traumatic history of crash or accident (3 cases), pathological fracture by primary or metastatic bone tumour (12 cases) or spinal destruction by infectious disease (2 cases).

The age of the patients ranged from 50 to 89 years (mean age 70): 42 patients were in the 50–59 year range, 135 were aged 60–69, 180 were aged 70–79 and 41 were in

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the 80–89 year range. The institutional review board of our hospital approved this study protocol.

Imaging techniques

Of the 398 patients, 275 were examined by MRI, 5 by CT and 118 using both techniques.

For MRI, sagittal and axial T_1 weighted images (repetition time (TR)/echo time (TE)=400–766/10–12) and T_2 weighted images (TR/TE=3000–3500/22–123) were examined with fast spin echo techniques using 1.5 T units (GE Medical Systems, Milwaukee, WI, and Siemens, Erlangen, Germany) and 3 T units (Achieva, Philips Medical System, the Netherlands). The sagittal images showed an echo train length of 20, a matrix number of 448×256 , a slice thickness of 4–4.5 mm and a slice gap of 0.1 mm. The axial images had an echo train length of 14, a matrix number of 384×256 , a slice thickness of 4.5 mm and a slice gap of 1–2 mm each.

For CT imaging, axial, sagittal and coronal images were reviewed using a 16-detector row helical CT (LightSpeed Pro; GE Medical Systems) or a 64-slice CT scanner (Brilliance; Philips, Eindhoven, the Netherlands). CT images were evaluated on a slice thickness of 2.5–3.0 mm with the bone setting (window level +500, window width +2000).

Image analysis

Each MRI and CT of the thoracolumbar spines was retrospectively analysed. The osteoporotic compression fractures of the vertebral body and the spinous process fractures were examined using the sagittal sequences. Osteoporotic compression fracture was diagnosed by a decrease in body height and changes in the internal signal intensity [2]. Spinous process fracture was diagnosed when a low-signal-intensity band connecting two parts of the cortex of the spinous process was seen on MRI and when there was a fracture line connecting two parts of the spinous process on CT [5].

In patients with osteoporotic compression fractures of the thoracolumbar spine by MRI or CT, the possible coexistence of a spinous process fracture was evaluated. The location and shape of the spinous process fracture were analysed. The locational relationship between the osteoporotic compression fracture and the spinous process fracture were analysed, depending on the type of spinal body fracture (single fracture, multiple continuous or multiple discontinuous fractures). Imaging analysis was performed by two experienced musculoskeletal radiologists, in consensus.

Results

In 398 patients, 14 (3.5%) had spinous process fractures. These 14 patients included 1 patient in the age range 50–59 years, 7 in the range 60–69 years, 5 aged 70–79 years and 1 aged 80–89 years. Osteoporotic compression fracture and spinous process fracture were diagnosed by MRI in 2 patients, by CT in 2 patients and using both techniques in 10 patients.

Of these 14 patients, 6 had single compression fractures and 8 had multiple compression fractures.

In the six patients with single compression fractures, the spinous process fracture occurred at the level just above the spinal compression fracture. The sites of spinous process fracture were at T10 in two patients, at T11 in two patients and at T12 in two patients (Figure 1).

In the eight patients who had multiple compression fractures, seven had continuous compression fractures and one had discontinuous compression fractures.

In six out of the seven patients with multiple continuous compression fractures, a spinous process fracture occurred at one level above the uppermost level of the compression fracture, with the sites of spinous process fracture being T9 (1), T10 (2), T11 (2) and T12 (1). The remaining patient showed a multiple compression fracture from T12 to L5 that was treated with posterior instrumentation at T12–L2. A spinous process fracture was noted on L2 (Figure 2).

One patient had discontinuous type multiple compression fractures. The patient showed compression fracture on T10 and L1, respectively. A spinous process fracture occurred on T12, the upper level of the L1 compression fracture.

As a result, the spinous process fractures of all 14 patients were observed just 1 level above the compression fracture.

On MRI and CT, we observed the shapes of the spinous process fractures. The directions of the fractures were vertical or oblique vertical (perpendicular to the long axis of the spinous process) in all cases (Figure 1).

The grade of vertebral fracture in patients with spinous process fracture was assessed using a semiquantitative method. The grades of the compression fractures at the level below the spinous process fractures were as follows: mild in three patients, moderate in four patients and severe in seven patients [6].

Discussion

Osteoporosis is a systemic skeletal disease, which can easily lead to fracture. Vertebrae affected by osteoporosis become delicate and are susceptible to fracture. Benign compression fractures of the thoracolumbar spine are common clinical occurrences for elderly people. Although these fractures can also be caused by trauma, infection or tumour, osteoporosis is the most common cause of fracture in the ageing population.

Insufficiency fractures, including vertebral compression fractures, and osteoporosis are closely connected. There has been a case of stress fracture of both pedicles of L4 in a patient with osteoporotic compression fracture of L5 [7]. This patient had postmenopausal osteoporosis and did not have a history of major trauma or surgery. In our study, it was supposed that abnormal muscular stress was applied to the osteoporotic spinous process with deficient resistance and mineral content. In a study by Kong et al [3], approximately 10.6% of patients who had an osteoporotic compression fracture also had a sacral insufficiency fracture. In the clinical setting, the diagnosis of sacral insufficiency fracture is easily overlooked, particularly when the symptoms are first reported [8]. Therefore, image findings are important in early

Figure 1. A 72-year-old woman who had osteoporotic compression fracture on the L1 vertebral body and a spinous process fracture on T12. (a) The T_1 weighted image shows a vertical band of low signal intensity (arrow) with surrounding bone marrow oedema at the T12 spinous process. (b) The T_2 weighted image demonstrates the hypointense fracture line (arrow) in the same area. (c) CT scan shows a fracture line (arrow) in the same area.

diagnosis. The authors emphasised the need to consider the possibility of pelvic sacral insufficiency fracture in cases of patients with osteoporotic compression fractures.

In our study, the prevalence of spinous process fractures in patients with osteoporotic compression fractures within a certain period was evaluated. In patients with osteoporotic compression fracture, 3.5% showed coexistence of a spinous process fracture. In osteoporosis, the decreased vertebral body height can generate abnormal muscular stress. In addition, spinous processes show decreased elastic resistance [7]. Abnormal muscular stress

on bones with decreased elastic resistance can result in fracture. In all cases, spinous process fracture occurred one level above the osteoporotic compression fracture. Osteoporotic compression fractures developed in the anterior translation of the upper spinal column and decreased anterior vertebral height owing to the wedged vertebral fracture. Spinous process fracture occurs just one level above an osteoporotic compression fracture because of flexion moment and shear force in that area [9, 10].

In the early stages of spinous process fracture, MRI findings show non-specific changes such as low signal on

Figure 2. A 72-year-old woman who had thoracolumbar spinal fixation on T12–L2 with multiple compression fractures in T12–L5. (a) The T_1 weighted image shows linear low signal intensity (arrow) at the spinous process of L2. (b) The T_2 weighted image demonstrates the hypointense fracture line (arrow) at the same area. (c) CT scan shows the fracture line (arrow) clearly.

T_1 weighted images and high signal on T_2 weighted images, which indicates bone marrow oedema at the fracture site. This could be hard to distinguish from transient bone marrow oedema, tumour or infection. In the later stages, fracture lines show low signal intensity on T_1 weighted images, which can easily be seen. CT is useful for diagnosis because the fracture line of a spinous process fracture can be clearly observed [5]. MRI diagnosed 2 of the 14 patients with possible spinous process fractures, but there was no difficulty in the differential diagnosis. Only two patients were diagnosed by CT alone. Occasionally, a non-united secondary ossification centre may appear similar to a spinous process fracture, or it may present as a sclerotic margin, absence of bone marrow oedema and absence soft tissue swelling [11, 12]. In addition, secondary ossification centres are usually located at the superior or inferior corner of a spinous process. In this study, spinous process fractures were not confused with non-united secondary ossification centres.

A limitation of this study was that bone mineral density was not performed on every patient, so it was hard to meet the requirements of clinical diagnostic standards for osteoporosis. The aim of the study was to prove the frequency of incidental spinous process fracture in patients with compression fracture diagnosed by CT or MRI. Although the exact frequency was not evaluated, the significance of this study was the ability to confirm the existence of a spinous process fracture on MRI and/or CT, with the capacity to determine the location of the fracture.

Conclusion

About 3.5% of patients who have a thoracolumbar osteoporotic compression fracture also experience a spinous process fracture. In addition, the spinous process fractures occurred just one level above the fractured vertebra. When radiologists diagnose thoracolumbar spine on MRI or CT, the possibility of a spinous process fracture in the level just above the compression

fracture should be considered, especially in patients who have an osteoporotic compression fracture.

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