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Clinical Study

Morphology of the injured posterior wall causing spinal canal encroachment in osteoporotic vertebral fractures

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Abstract

BACKGROUND CONTEXT: The relationship between fractured posterior vertebral wall patterns and the protrusion of bony fragments into the spinal canal is not clear.

PURPOSE: We sought to elucidate the effects of fracture patterns of the injured posterior wall on posterior wall instability and spinal canal encroachment using computed tomography myelography (CTM) in two different positions.

STUDY DESIGN/SETTING: This is a prospective analysis of CTM in both supine and semi-sitting positions.

PATIENT SAMPLE: The sample includes 36 consecutive elderly patients with delayed neurologic disorders due to insufficient bone union at the posterior vertebral wall after vertebral fracture.

OUTCOME MEASURES: Radiological parameters, including the rates of dural compression and of occupation by bony fragments (OBFr) and the posterior vertebral body height ratio (PVBHr), were used.

METHODS: All patients were examined using CTM in both supine and semi-sitting positions. According to fracture patterns of the posterior vertebral wall, we classified injured posterior walls with one fragment as the simple type and those with two or more fragments as the comminuted type.

RESULTS: The simple type was found in 19 of 36 cases, whereas the comminuted type was found in 17 of 36 cases. A significant correlation was identified between changes in OBFr and PVBHr in both the simple and comminuted types. The mean change of PVBHr between the two positions in the comminuted type was significantly larger (9.2%) than that in the simple type (4.8%). Likewise, the mean change in OBFr in the comminuted type (14.0%) was significantly larger than that in the simple type (8.2%), indicating that the injured posterior vertebral wall with the comminuted type would be more likely to collapse and protrude into the spinal canal.

CONCLUSIONS: Both simple and comminuted fracture types could cause protrusion of vertebral fragments into the spinal canal because of a collapsing non-united posterior vertebral wall; however, the comminuted type showed more severe spinal canal encroachment, with axial loading. The morphology of the injured posterior wall is thus important for estimating instability.

Keywords: Comminuted fractures; Computed tomography myelography; Dural compression; Fracture patterns; Osteoporotic vertebral fractures; Posterior vertebral body height ratio; Spinal canal encroachment

Introduction

Osteoporotic vertebral fractures are common in elderly patients, with an estimated 1.4 million new fractures occurring every year worldwide [1]. They usually heal without neurologic complications; however, some patients experience chronic

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back pain or delayed-onset neurologic deficits after vertebral collapse.

In elderly patients with delayed neurologic deficits following osteoporotic vertebral collapse, optimal methods of treatment remain controversial due to the fragility of the bone [2,3]. In terms of the mechanism for palsy, the influence of loading would be involved in spinal canal encroachment (SCE) [4]; however, the details are still not well understood.

We hypothesized that the comminuted posterior wall would cause the most severe instability of the spinal canal in patients with vertebral fractures involving the posterior vertebral wall. The objective of this study was to elucidate the effects of the fracture pattern of the injured posterior wall on the instability of the posterior wall and SCE, using computed tomography myelography (CTM) in both supine and semi-sitting positions.

Materials and methods

Patients

A total of 36 consecutive elderly patients (6 men and 30 women) with a mean age of 76.5±7.9 years (range: 61–91) were prospectively examined using CTM in two different positions from July 2009 to October 2014. They showed varying degrees of delayed neurologic disorders due to insufficient bone union at both the vertebral body and the posterior vertebral wall after vertebral fracture, and underwent surgery. Inclusion criteria were as follows: (1) age more than 60 years; (2) insufficient bone union of both the vertebral body and the posterior vertebral wall; and (3) vertebral fractures that occurred without trauma or with minor trauma. Patients with severe trauma, paralysis immediately after trauma, metabolic bone disease except primary osteoporosis, malignancies, or infections were excluded. All patients were diagnosed as having primary osteoporosis according to the diagnostic criteria published by the Japanese Society for Bone and Mineral Metabolism [5]. Insufficient union of the vertebral body was diagnosed on the basis of an intravertebral vacuum cleft on plain radiographs or computed tomographic (CT) scans, or fluid collection on T2-weighted magnetic resonance images within the vertebral body. Similarly, insufficient union of the posterior wall was detected on sagittal or axial CT scans.

Neurologic status on admission was assessed using the Frankel grading system [6], with grade C in 26 patients and grade D in 10 patients. The institutional review board at our institute approved this study, and all subjects provided written informed consent before participating in the study.

Classification of simple and comminuted fracture types

Vertebral fractures with a fractured posterior wall were classified into two groups according to the morphology of the fracture of the posterior wall, as evaluated using CT. Injured posterior walls with one fragment, which had bilateral side fractures of the spinal canal, were defined as the simple type. Those with two or more fragments, having three or more fracture lines, were defined as the comminuted type (Fig. 1). Intra- and interobserver reliabilities for this classification were evaluated.

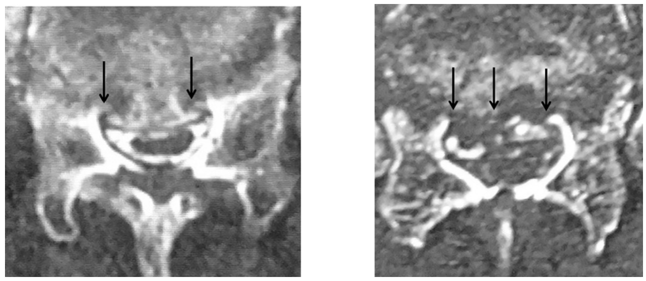

Fig. 1. The posterior walls with bilateral side spinal canal fractures, which had two fracture lines, were defined as the simple type (Left) on computed tomography myelography. Those with three or more fracture lines were defined as the comminuted type (Right).

Radiological measurement

All patients underwent CTM in both a completely supine position and a semi-sitting position. In the semi-sitting position, pillows were inserted under the thoracic and cervical vertebrae. Then, the position was adjusted as high as possible within 70 cm of the diameter of the opening of the CT scanner [4].

The posterior vertebral body height ratio (PVBHr) was measured as the percentage of the posterior vertebral height of the collapsed vertebra compared with the mean heights of the two adjacent vertebrae on midsagittal CT scans [7,8]. The PVBHr was calculated using the following equation: $H/\{(F+G)/2\}\times100$ (Fig. 2). The change in PVBHr was calculated as the difference between PVBHr in the supine position and that in the semi-sitting position.

The ratio of occupation by bony fragments (OBFr) of the spinal canal was calculated as the ratio of the sagittal diameter of bony fragments to the sagittal diameter of the spinal canal on midsagittal CT. The OBFr was calculated using the following equation: $D/E\times100$. The change in OBFr was calculated as the difference between OBFr in a semi-sitting position and that in a supine position.

The dural compression ratio provides a ratio of compressed to supposedly normal dura at the level of injury, which was calculated using the following equation: $[1-C/\{(A+B)/2\}]\times100$ [9].

All radiological measurements and classification were performed by two investigators blinded to the name, clinical findings, and other imaging data of the patient.

Statistical analysis

Differences between fracture types were assessed using the Mann-Whitney *U* and chi-square tests. Correlations between change in OBFr and change in PVBHr were assessed using the Pearson product moment correlation