Case Report

Insufficiency Fracture of the Sternum Simulating Myocardial Infarction: Case Report and Review of the Literature

AKIRA HORIKAWA,1 NAOHISA MIYAKOSHI,2 HIROYUKI KODAMA1 and YOICHI SHIMADA2

1South Akita Orthopedic Clinic, Katagami, Japan
2Department of Orthopedic Surgery, Akita University School of Medicine, Akita, Japan

HORIKAWA, A., MIYAKOSHI, N., KODAMA, H. and SHIMADA, Y. Insufficiency Fracture of the Sternum Simulating Myocardial Infarction: Case Report and Review of the Literature. Tohoku J. Exp. Med., 2007, 211 (1), 89-93 — Insufficiency fracture is a type of stress fracture that occurs when stress is applied to the bone with less than the normal elastic resistance, as in osteoporosis. Insufficiency fracture of the sternum is rare among all kinds of fractures. We describe two cases with insufficiency fractures of the sternum secondary to osteoporosis and thoracic kyphotic deformity. Both of the present cases, a 76-year-old woman and a 65-year-old woman, presented with severe anterior chest pain simulating myocardial infarction. However, cardiopulmonary examinations including chest radiographs, electrocardiograms, and laboratory tests were normal. Lateral radiographs of the sternum in both patients showed insufficiency fractures of the sternum. Conservative treatment with rib bandaging/bracing and analgesics relieved their symptoms. Clinical behavior, type of sternal insufficiency fractures, and mechanism of the fracture are reviewed from perusal of the literature. We emphasize that sternal insufficiency fracture should be considered in the differential diagnosis of acute chest pain in the elderly along with myocardial infarction or pulmonary embolism.

© 2007 Tohoku University Medical Press

Insufficiency fractures are stress fractures that occur in bones with decreased mineralization and elastic resistance, as in osteoporosis (Pentecost et al. 1964). There was no reported case with any history of trauma. The spine, pelvis, and lower extremities are commonly affected by these fractures, whereas insufficiency fracture of the sternum is rare. Approximately 40 cases with sternal insufficiency fractures have been reported in the literature (Itani et al. 1982; Cooper 1988; Chen et al. 1990; Sapherson and Mitchell 1990; Schapia et al. 1995; Benbouazza et al. 2003; Min and Sung 2003; Soubrier et al. 2003; Ragucci and Vainrib 2005; Lin and Ponampalam 2006) and the fracture was classified as either the buckling type or nonbuckling type as suggested by Chen et al. (1990). A buckling sternal fracture was defined as a sternal deformity in which the upper portion of the sternum was located posterior to the lower portion, and in which there was no...
cortical disruption, focal bone resorption, or cal-lus formation (Chen et al. 1990). All the other sternal fractures excluding the buckling type were classified as the nonbuckling type.

Clinically, sternal insufficiency fractures can be silent (Cooper 1988; Chen et al. 1990; Soubrier et al. 1994). However, the fracture can cause spontaneous and severe anterior chest pain and is sometimes misdiagnosed as myocardial infarction (Rutledge 1962; Shapira et al. 1995) or pulmonary embolism (Vassallo 1969). In this article, we describe two cases of sternal insufficiency fracture mimicking myocardial infarction and subsequent anginal pain, and present a review of previously reported cases.

**CASE REPORTS**

**Case 1**

A 76-year-old woman, who had no history of trauma, presented at a physician with intermittent anterior chest pain for two days, which became severe and continuous for hours before presenta-

![Fig. 1. Lateral radiograph of thoracic spine in case 1. Note a severe kyphotic deformity with multiple osteoporotic vertebral fractures (arrows).](image1)

![Fig. 2. Lateral radiograph of the sternum in case 1. Note a sternal fracture with buckling deformity (arrow).](image2)
increased, which were consistent with a recent fracture and/or high turnover osteoporosis. Bone mineral density of the distal radius, as assessed by dual-energy x-ray absorptiometry (DTX-200; Toyo Medic, Tokyo) showed significant bone loss (0.171 g/cm² or 36% of young adult mean). We therefore diagnosed a sternal insufficiency fracture secondary to severe osteoporosis and thoracic kyphotic deformity. The patient’s chest pain subsided with a rib band and the administration of calcitonin and analgesics.

Case 2
A 65-year-old woman with diagnosed rheumatoid arthritis, for which she had been given prednisolone in dosages ranging from 5 to 10 mg/day for 8 years, visited a physician, reporting severe anterior chest pain without any specific trauma. The patient suddenly complained of anterior chest pain and perceived no change in the quality of pain with position or on inspiration. The pain seemed to be cardiac, caused by myocardi-
A. Horikawa et al.

Insufficiency Fracture of the Sternum

Insufficiency fractures of the sternum may have been secondary to bending and compressing stresses from the thoracic kyphotic deformity with multiple osteoporotic vertebral fractures. The mechanism of this type of sternal fracture can be explained by Fowler’s flexion-compression theory (Fowler 1957). Namely, the stresses of acute forward bending of the thoracic spine in violent flexion are transmitted to the sternum by the ribs and clavicles. Similar forces but with more gradual application can also be transmitted to the sternum in cases with progressive thoracic kyphotic deformity. Biomechanical evidence with cadavers also supports this view because the sternum provides 11.2% of compressive stiffness (inverse of the flexibility) of the thoracic spine in axial compression (Watkins et al. 2005). Therefore, if the skeleton is already weakened by osteoporosis, insufficiency sternal and spinal fractures can occur simultaneously.

Most of the reported cases with sternal insufficiency fractures occurred in the sternal body (lower part of sternum), while manubrium (upper part of sternum) fracture is rare. Incidences of buckling and nonbuckling type fractures accounted for approximately 50% each. Relations between the fracture type and symptoms are still

**DISCUSSION**

Fractures of the sternum have been mainly reported as resulting from trauma (Athanassiadi et al. 2002), secondary malignancy (Urovitz et al. 1977), myeloma (Gompels et al. 1972), and rarely secondary to osteoporosis compounded by thoracic kyphotic deformity without any specific trauma (Cooper 1988). The latter fracture was defined as an insufficiency fracture of the sternum. In a retrospective survey by Soubrier et al. (2003) on all of the insufficiency fractures except spinal fractures, only one sternal fracture (1.1%) was identified among 91 insufficiency fractures. To the best of our knowledge, only 41 cases including the present two cases, with insufficiency fractures of the sternum secondary to osteoporosis have been reported in the past several decades (Table 1).

Because there was no reported trauma in any of the reported cases, the sternal insufficiency fractures may have been secondary to bending and compressing stresses from the thoracic kyphotic deformity with multiple osteoporotic vertebral fractures. The mechanism of this type of sternal fracture can be explained by Fowler’s flexion-compression theory (Fowler 1957). Namely, the stresses of acute forward bending of the thoracic spine in violent flexion are transmitted to the sternum by the ribs and clavicles. Similar forces but with more gradual application can also be transmitted to the sternum in cases with progressive thoracic kyphotic deformity. Biomechanical evidence with cadavers also supports this view because the sternum provides 11.2% of compressive stiffness (inverse of the flexibility) of the thoracic spine in axial compression (Watkins et al. 2005). Therefore, if the skeleton is already weakened by osteoporosis, insufficiency sternal and spinal fractures can occur simultaneously.

Most of the reported cases with sternal insufficiency fractures occurred in the sternal body (lower part of sternum), while manubrium (upper part of sternum) fracture is rare. Incidences of buckling and nonbuckling type fractures accounted for approximately 50% each. Relations between the fracture type and symptoms are still

---

**Table 1. Location and type of insufficiency fractures of the sternum reported in the literature.**

<table>
<thead>
<tr>
<th>Source</th>
<th>Body-buckling</th>
<th>Body-nonn buckling</th>
<th>Manubrium-buckling</th>
<th>Manubrium-nonn buckling</th>
<th>Unknown</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Itani et al. (1982)</td>
<td>2</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>Cooper (1988)</td>
<td></td>
<td></td>
<td>7</td>
<td></td>
<td></td>
<td>7</td>
</tr>
<tr>
<td>Chen et al. (1990)</td>
<td>2</td>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td>7</td>
</tr>
<tr>
<td>Sapherson and Mitchell (1990)</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>Schapira et al. (1995)</td>
<td></td>
<td></td>
<td>1’</td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Benbouazza et al. (2003)</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Min and Sung (2003)</td>
<td>7</td>
<td>7</td>
<td>1</td>
<td></td>
<td>1</td>
<td>15</td>
</tr>
<tr>
<td>Soubrier et al. (2003)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Ragucci and Vainrib (2005)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Lin and Ponampalam (2006)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Present cases</td>
<td>2’</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>Total</td>
<td>15</td>
<td>14</td>
<td>2</td>
<td>10</td>
<td></td>
<td>41</td>
</tr>
</tbody>
</table>

*Body, sternal body.

*Pain simulating myocardial infarction.*
controversial. Chen et al. (1990) reported that in their 7 patient series with sternal insufficiency fracture, patients with nonbuckling sternal fractures (5 patients) reported pain, while buckling fractures (2 patients) were asymptomatic. On the other hand, Min and Sung (2003) reported that 5 of the 7 patients in their series with the buckling type of fracture had chest pain. The discrepancy might be attributed to the small number of cases. Both of the present cases were the buckling type of fracture with severe spontaneous chest pain.

The spontaneous pain may be so intense that it may simulate myocardial infarction (Rutledge 1962; Schapira et al. 1995) or pulmonary embolism (Vassallo 1969). Initial diagnoses of the present cases were also suspected myocardial infarction because the intensity and frequency of the anterior chest pain simulated cardiopulmonary pathology. Therefore, it has been emphasized, from the present cases and previously reported cases (Rutledge 1962; Vassallo 1969; Schapira et al. 1995), that sternal insufficiency fracture should be considered in the differential diagnosis of acute chest pain in the elderly along with myocardial infarction or pulmonary embolism.

In summary, we presented two cases with the buckling type of insufficiency fractures of the sternum secondary to osteoporosis and thoracic kyphotic deformity. Both cases reported severe anterior chest pain simulating myocardial infarction and subsequent angina pectoris. Sternal insufficiency fracture should be considered in the differential diagnosis of acute chest pain in the elderly.

References


