The Spine Journal 15 (2015) 2503–2508

Clinical Study

Pathologic sternal involvement is a potential risk factor for severe sagittal plane deformity in multiple myeloma with concomitant thoracic fractures

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Received 23 May 2015; revised 19 August 2015; accepted 3 September 2015

Abstract

BACKGROUNDCONTEXT: Skeletal involvement is observed in almost 80% of patients presenting with symptomatic multiple myeloma (MM). The vertebral column is the most frequently affected site by myeloma-induced osteoporosis, osteolysis, and compression fractures. Multiple pathologic compression fractures can lead to significant spinal deformity, which is often considered for complex reconstruction because of the poor quality of life for the affected patients.

PURPOSE: This study aimed to compare the clinical and radiological outcomes of two groups of MM patients; the first group had thoracic spine fractures and a concomitant pathologic sternal fracture (SF), and the second group had thoracic fractures but no sternal fracture (NSF).

STUDY DESIGN: This was a cross-sectional study.

PATIENT SAMPLE: The sample comprised 98 consecutive patients (n=98) with symptomatic MM and concomitant pathologic thoracic spine fractures over a 3-year period at a national tertiary referral center for the management of MM with spinal involvement.

OUTCOME MEASURES: Clinical outcome measures used included European Quality of Life-5 Dimensions (EQ-5D), Oswestry Disability Index (ODI), and visual analogue scale (VAS) pain score.

METHODS: All consecutive patients with MM were enrolled. The cohort was split into two patient groups: patients with SFs (SF group) and patients without sternal fractures (NSF group). Clinical, serologic, and pathologic variables, radiological findings, treatment strategies, and outcome measures were collected.

RESULTS: The SF group was younger (58±13 years vs. 66±11 years [p=.008]) when compared with the NSF group. The SF group presented with a greater thoracic kyphosis (73°±18° vs. 53°±17.5° [p=.005]), similar VAS pain scores (50.6±22.1 vs. 54.4±22.5 [p>.05]), but poorer EQ-5D (0.24±0.13 vs. 0.48±0.23 [p<.001]) score and ODI (60.6±10.3 vs. 48.2±17.8 [p=.013]) when compared with the NSF group.

CONCLUSIONS: Pathologic SF in an MM patient with thoracic compression fractures is a potential risk factor for the development of a severe thoracic kyphotic deformity and sagittal malalignment. This has been demonstrated in this study to be associated with a very poor health-related quality of life. A greater awareness of sternal myeloma disease is needed at presentation (the time of the primary survey) so that SFs can be potentially avoided, thereby preventing progression to a severe kyphotic deformity.

Keywords: Kyphosis; Multiple myeloma; Sagittal plane; Spinal deformity; Sternum; Thoracic fractures

FDA device/drug status: Not applicable.

Author disclosures: ***JSB:*** Nothing to disclose. ***KM:*** Nothing to disclose. ***AP:*** Nothing to disclose. ***MDS:*** Nothing to disclose. ***AB:*** Nothing to disclose. ***CK:*** Nothing to disclose. ***SM:*** Nothing to disclose.

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http://dx.doi.org/10.1016/j.spinee.2015.09.031
1529-9430/

Introduction

Multiple myeloma (MM) is a neoplastic plasma-cell disorder that is characterized by clonal proliferation of malignant plasma cells in the bone marrow microenvironment, with high levels of monoclonal (M) protein in the blood or urine and associated organ dysfunction [1]. It accounts for approximately 1% of neoplastic diseases and 13% of hematologic cancers. In Western countries, the annual age adjusted incidence is 5.6 cases per 100,000 persons [2]. The median age at diagnosis is approximately 70 years; 37% of patients are younger than 65 years, 26% are between the ages of 65 and 74 years, and 37% are 75 years of age or older [2,3]. In recent years, the introduction of autologous stem-cell transplantation and the availability of agents such as thalidomide, lenalidomide, and bortezomib have dramatically changed the management of MM and extended overall survival [3–5]. In patients presenting at an age under 60 years, 10-year survival is now approximately 30% [4]. Clinical manifestations of MM include bone disease, hypercalcemia, cytopenia, renal dysfunction, hyperviscosity, and peripheral neuropathy [1].

It is estimated that over 60% of bone lesions occurring in MM patients involve the spine, as compared with 90% in metastatic prostate cancer, 75% in breast cancer, and 45% in lung cancer [6]. This could be attributed to the fact that vertebral bodies contain a high amount of hematopoietic bone marrow, so that a large surface of the hematopoietic niche is adjacent to osteoblasts, osteoclasts, or other stromal cells involved in bone remodeling. The principal underlying pathologic mechanism causing bone disease and pathologic vertebral collapse in MM is a shift in the balance of bone formation and bone resorption toward bone resorption, and eventually total dissociation between the two processes occurs in latter stages of the disease.

Over 80% of the vertebral fractures in patients with MM occur between T6 and L4 and 50% of them can be found between T11 and L1 [7]. This is similar to what is observed in patients with benign osteoporosis, and it is probably caused by the contribution of biomechanical factors acting at the thoracolumbar junction. The type of pathologic fracture caused by MM can vary depending on the site of spinal involvement; vertebral body collapses are found mainly in the thoracic region, wedge compression fractures in the thoracolumbar region, and superior end plate fractures in the lumbar region [7]. The spine is also the site where bone solitary plasmacytomas are more frequently observed; the average incidence is 50% as compared with 12% for the pelvis and 9% for the ribs [8]. In myeloma spinal disease, the thoracic and lumbar spines are more frequently involved than the cervical region [9].

Positive sagittal malalignment has been shown to be detrimental to health-related quality of life (HRQoL), with the severity of symptoms increasing in a linear fashion with progressive sagittal imbalance [10]. Vertebral compression fractures in the osteoporotic population, in addition to the resultant thoracic hyperkyphosis and sagittal malalignment, have been shown to result in significant functional disability and a reduction in HRQoL [11–13].

EVIDENCE & METHODS

Context

The authors present results among a series of patients with multiple myeloma and thoracic compression injuries. This study involved 98 patients in total.

Contribution

The study included 15 patients with pathologic sternal involvement. The authors report that pathologic sternal fracture in patients with thoracic compression fractures due to myeloma is a risk factor for the development of a severe thoracic kyphotic deformity and sagittal malalignment. This has deleterious effects on quality of life and function as measured using the EQ5D and ODI.

Implications

These findings echo determinations made for traumatic injuries to the thoracic spine and the impact of sternal involvement on stability as the proverbial "fourth column." It should be recognized that the study's findings hinge on the experiences of only 15 patients with sternal involvement. This may impair generalization to other populations. The authors appropriately recognize that this study presents Level IV evidence.

—The Editors

The sternal-rib complex has been previously referred to as the fourth column of the spine and has been demonstrated to confer mechanical stability to the thoracic spine when there is a thoracic fracture related to trauma [14–20]. However, with sternal involvement being relatively common in MM (Fig. 1), we hypothesized that a pathologic sternal fracture (SF) with concomitant thoracic compression fractures may be a risk factor for the development of a severe thoracic hyperkyphotic deformity and sagittal malalignment.

The aim of this study was to compare the clinical and radiological outcomes of two groups of MM patients; the first group had thoracic spine fractures and a concomitant pathologic SF and the second group had thoracic fractures but no sternal fracture (NSF).

Methods

This was a cross-sectional study of 98 consecutive patients over a 3-year period that was referred to our national tertiary referral center for the management of their thoracic fractures related to MM. The cohort was split into two patient groups: SF group (n=15) and NSF group (n=83). Exclusion criteria included monoclonal gammopathy of unknown significance, asymptomatic MM, plasma cell leukemia, and amyloid light-chain (AL) amyloidosis.