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Clinical Study

Radiologic and clinical characteristics of vertebral fractures in multiple myeloma

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Abstract

BACKGROUND CONTEXT: Nearly 80% of patients with newly diagnosed multiple myeloma (MM) have bony lesions on magnetic resonance imaging (MRI). These lesions may progress to debilitating vertebral fractures. No studies have quantitatively characterized these fractures or identified predictors of fracture burden and severity.

PURPOSE: The purpose of this study was to characterize the clinical and radiologic features of these fractures and to identify independent predictors of fracture burden and severity.

STUDY DESIGN/SETTING: : A consecutive retrospective chart review was conducted from January 2007 to December 2013 at a single tertiary-care institution.

PATIENT SAMPLE: Patients with diagnoses of both MM and vertebral fracture were included in this study. Those with a history of non-MM vertebral fracture were excluded.

OUTCOME MEASURES: The primary outcome measure was height loss of the fractured vertebral body, whereas secondary outcome measures included number of fractures and morphology.

METHODS: Data were collected at fracture presentation. Radiologic data were obtained from T1-weighted MRI. Anterior, middle, and posterior vertebral body height losses were recorded, and a Genant grading was made. Multivariable Poisson and logistic regression were performed to identify predictors of fracture burden and severity.

RESULTS: Among 50 patients presenting with vertebral fracture, 124 fractures were observed. The majority (76%) of these patients did not have a previous MM diagnosis. The most common presenting symptom was back pain (84%), followed by neurologic (54%) and constitutional (50%) symptoms. The mean anterior, middle, and posterior height losses of the fractured vertebral body were 30%, 37%, and 16%, respectively. Twenty percent of fractures were Genant Grade 1 (mild), whereas 32% and 48% were grades 2 (moderate) and 3 (severe). Fifty-five percent of fractures were biconcave, whereas 32% and 13% were wedge and crush fractures. Lower body mass index and albumin and increased myeloma protein, light chains, and creatinine predicted an increased number of fractures at presentation. Increased β2-microglobulin and creatinine predicted more severe vertebral fractures.

FDA device/drug status: Not applicable.

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Institutional review board (#13-1351) approval was obtained before initiation of the study.

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CONCLUSIONS: In the present study, 124 fractures were observed among 50 patients. These fractures were generally severe, biconcave, and in the thoracic spine. Laboratory signs of advanced MM predict greater fracture burden and severity. In the future, monitoring of these predictors may raise suspicion for an MM-associated vertebral fracture.

Keywords: Multiple myeloma; Vertebral fractures; Genant grading; Imaging; Height loss; Plasmacytoma

Introduction

Multiple myeloma (MM) is a neoplasm of terminally differentiated plasma cells that occurs in 6 per 100,000 patients annually [1,2]. It is relatively uncommon, accounting for 1% of all malignancies and 13% of hematologic malignancies. As a systemic disease, patients with MM may present with signs and symptoms of renal failure, hypercalcemia, anemia, or infection. However, these patients most commonly present with bone pain in the back or ribs [1,2].

Eighty percent of patients with newly diagnosed MM have osteolytic bony lesions on imaging [1,2]. As a consequence of osteolysis, hypercalcemia and anemia may be observed with or without fracture in the affected bone. Bone loss in MM may not always be clinically observable, as approximately 50% of bone must be resorbed to result in radiologic changes [3]. As a result of bone loss, vertebral fractures are common (55%–70%) in MM and are generally classified as benign or malignant based on the presence of a focal mass on magnetic resonance imaging (MRI) [1,3,4]. These vertebral fractures may occur in patients with active treated and untreated diseases and in patients with biopsy-confirmed remission [1]. Patients with initial MRI evidence of diffuse marrow disease suffer a shorter fracture-free interval after MM diagnosis than patients with a solitary plasmacytoma [1,4]. Steroid use and hypercalcemia have been identified as risk factors for these fractures. Unfortunately, little data are available regarding specific radiologic characteristics of these fractures.

Patients with MM-associated vertebral fractures suffer from poorer quality of life than patients without fracture [5–11]. These fractures may be accompanied by radicular or myelopathic symptoms, limiting mobility and everyday activities [12]. Numerous studies have investigated the beneficial role of kyphoplasty in these patients. Preoperatively, patients report poor Short-Form 36, Oswestry disability index, pain Visual Analog Scale, and Roland Disability Questionnaire scores, all of which improve with surgical intervention [5–11]. Despite the burden of these fractures on patient quality of life, radiologic characteristics have been poorly characterized in the literature. In addition, although steroid use and hypercalcemia have been identified as predictors of fracture risk in MM, no studies have confirmed whether serum levels of myeloma-specific laboratory markers (myeloma protein [M-protein] and light chains) are predictive of fracture burden or severity.

Investigating the frequency, location, characteristics, and predictors of these fractures may contribute to standardized screening, surveillance, and referral regimens for spine health in this population. In the present study, we sought to characterize these vertebral fractures radiologically and identify predictors of greater fracture burden and severity at presentation.

Methods

Patient selection

A consecutive retrospective chart review of all patients with a diagnosis of MM and identified vertebral fracture between January 2007 and December 2013 at a single tertiary-care institution was conducted. Patients were excluded if they had a history of vertebral fracture or vertebral-deforming pathologies (including developmental deformities, Scheuermann disease, osteomalacia, and Paget disease).

Data collection

Demographic, medical history, surgical history, presenting symptoms, laboratory, and radiologic data were collected in a retrospective fashion from electronic medical records. For those patients with vertebral fracture as the presenting sign of myeloma, data were collected from the primary MM workup. For those patients with a previous diagnosis of MM, data were collected from outpatient visits closest to the time of the first vertebral fracture.

C-reactive protein (CRP), erythrocyte sedimentation rate, β2-microglobulin (β2-MG), kappa/lambda light chains, M-protein, albumin, calcium, creatinine, and hemoglobin were recorded from blood samples at initial presentation with myeloma or fracture. Surgical pathology reports of bone marrow aspirate were used to assess plasma cell burden as a percentage of total cellularity. Patients were staged according to both the International Staging System (ISS) and the Durie-Salmon Staging System (DSS) [13,14]. The DSS was developed in the 1970s and uses hemoglobin, calcium, M-protein, and the presence of bony lesions on imaging to stage patients. This system has been used as an acceptable surrogate for plasma cell mass in the bone marrow. In contrast, the ISS, a newer system based on indicators of survival, uses β2-MG and albumin to stage patients, with median survival for stages 1, 2, and 3 of 62, 44, and 29 months, respectively [15].