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Clinical Study

# Radiographic progression of vertebral fractures in patients with multiple myeloma

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**Abstract**

**BACKGROUND CONTEXT:** Nearly 70% of patients with multiple myeloma (MM) experience vertebral fracture. As a consequence, these patients suffer significantly poorer quality of life. However, no studies have characterized the natural progression of these fractures.

**PURPOSE:** The purpose of this study was to characterize the progression of MM-associated vertebral fractures.

**STUDY DESIGN/SETTING:** A consecutive retrospective chart review at a single tertiary-care center was carried out.

**PATIENT SAMPLE:** Patients with MM and pathologic vertebral fracture with at least one follow-up between January 2007 and December 2013 were included. Radiographic measurements were recorded until last follow-up (LFU) or until surgical intervention or patient death. Patients with a history of vertebral fracture not associated with MM were excluded.

**OUTCOME MEASURES:** The primary outcome measure was change in height of the fractured vertebrae. Fractures were characterized by Genant grade and morphology.

**METHODS:** At baseline and each follow-up, anterior, middle, and posterior vertebral body heights were measured from midline sagittal T1-weighted magnetic resonance imaging. Student *t* tests and Fisher exact tests were performed to identify variables associated with fracture progression.

**RESULTS:** Among 33 patients, 67 fractures were followed. Sixty-four percent of patients were female, with a mean age of 66. Baseline mean anterior, middle, and posterior vertebral body height losses were 30%, 36%, and 15%, respectively. Forty-three percent of fractures were Genant grade 3, and 57% were biconcave. Mean time to LFU was 40 months. At LFU, mean anterior, middle, and posterior vertebral body height losses increased to 47% ($p<.01$), 49% ($p<.01$), and 28%

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IRB approval (IRB #13-1351) was obtained before initiation of the study.

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(p<.01), respectively. More fractures became Genant grade 3 (75%, p<.01) and wedge (54%, p=.03). On average, patients lost 0.83% in vertebral body height per month, with initial Genant grade 1 fractures progressing most rapidly (1.69%/month, p<.01). Patients treated with bisphosphonates suffered less additional height loss compared with untreated patients (14% vs. 24%, p=.07).

**CONCLUSIONS:** We observed significant fracture progression despite high utilization of bisphosphonates. Patients lost nearly 1% of additional vertebral body height per month, with the least severe presenting fractures progressing most rapidly, highlighting the necessity for early referral to spine specialists and evidence-based guidelines for surveillance and treatment in the myeloma population. 

*Keywords:* Multiple myeloma; Vertebral fracture; Genant grading; Height loss

## Introduction

There are more than 26,000 newly diagnosed cases of multiple myeloma (MM) in the United States annually, with 11,000 deaths attributable to MM [1]. The 10-year survival of patients with this disease is approximately 30% [2]. Myeloma patients suffer a significantly diminished quality of life (QOL) secondary to end-organ damage, with the greatest burden of morbidity stemming from bony disease.

Owing to excessive bone resorption, patients with MM most often present with bone pain in the back or ribs [2,3]. Initial imaging workup reveals osteolytic bony lesions in nearly 80% of patients [2]. As a consequence of this resorption, 55%–70% of patients with MM suffer from vertebral fractures [3–5]. These fractures occur in patients of all disease stages, treatment regimens, and even in those with biopsy-confirmed remission [3]. The detrimental impact of fractures upon QOL is well-documented in MM [6–12]. These fractures may result in permanent radicular or myelopathic symptoms that may severely limit mobility and everyday activities [13]. To combat this, kyphoplasty and vertebroplasty are two procedures commonly used to alleviate symptoms and prevent fracture progression. Several studies have demonstrated improvements in SF-36, Oswestry Disability Index, pain visual analog scale (VAS), and Roland Disability Questionnaire scores following kyphoplasty [6–12].

Despite the burden of these fractures upon patient QOL, no studies have characterized the progression of these fractures over clinical follow-up. Detailing this progression may aid in developing evidence-based guidelines for spine surveillance among patients with MM, and establish earlier referral to spine specialists for prophylactic treatment of these fractures. In the present study, we sought to radiographically characterize the natural history of these vertebral fractures over time. We hypothesized that vertebral fractures in patients with MM would suffer significant vertebral body height loss over time, with the greatest change in height occurring immediately following fracture diagnosis which often corresponds with initial diagnosis of MM.

## Methods

### *Patient selection*

A consecutive retrospective chart review of all patients at a single tertiary-care institution diagnosed with both MM and pathologic vertebral fracture between January 2007 and December 2013 was conducted. Patients were excluded if they had no imaging follow-up or a prior vertebral fracture not associated with MM.

### *Data collection*

Demographic, medical history, symptomatology, and radiographic data were retrospectively collected at baseline from electronic medical records. Radiographic measurements of fractured vertebrae were obtained from midline sagittal T1-weighted magnetic resonance imaging (MRI) at baseline and each follow-up until last follow-up (LFU) [14]. Two reviewers (JAM, RX) performed all measurements; differences in measurements greater than 1 mm were resolved by consensus. Measurements were recorded using a caliper tool in the Epic electronic medical records system (Epic Systems Corporation, Verona, WI, USA). Anterior, middle, and posterior heights of the fractured and adjacent vertebral bodies were measured in a quantitative fashion (Fig. 1) [13,15–18]. Height loss was defined as the difference between the fractured vertebral body height and the expected height, calculated as the mean of the immediately superior and inferior unfractured vertebral body heights. Greatest vertebral body height loss was defined as the maximum height loss observed among the anterior, middle, and posterior aspects. Each vertebral body measurement was then given a semi-quantitative Genant grade ("mild" grade 1, 20%–25% height loss; "moderate" grade 2, 25%–40%; "severe" grade 3, >40%; Fig. 1) [15,19]. Finally, fractures were morphologically classified as wedge, biconcave, or crush (Fig. 1) [16–18]. Patients were followed for radiographic measurements until last imaging follow-up or until the time of surgical intervention or patient death.