**Analysis of Compression Fractures in Patients with Newly Diagnosed Multiple Myeloma on Comprehensive Therapy**

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**Materials & Methods**: From November 1996 to February 2001, 264 patients were enrolled in an MRI-sponsored phase III trial evaluating anti-angiogenesis with thalidomide and post-therapy consolidation chemotherapy at the Myeloma Institute, Arkansas Cancer Research Center. All patients enrolled for this study were newly diagnosed MM patients. As part of this trial, a spine magnetic resonance (MR) study of the axial skeleton and pelvis was performed to determine the extent of bone marrow involvement. Of those patients, 237 had follow-up MR examinations.

MR of the cervical, thoracic and lumbar spine consisted of sagittal T1-weighted (300/15/2), sagittal short-tau-inversion recovery (STIR) (2000/20/150), and axial T1-weighted imaging (550/15/2). In the initial evaluation of the newly diagnosed MM patient, sagittal post-gadolinium fat-suppressed T1-weighted (450/10/2) images of the thoracic and lumbar spine were also obtained. The follow-up MR studies were limited to sagittal T1 and STIR-weighted studies of the cervical, thoracic, and lumbar spine.

The studies were reviewed by neuroradiologists at the University of Arkansas for Medical Sciences for the following MR findings:

a) Extent of marrow involvement with evaluation of marrow signal overall marrow signal intensity and pattern on T1- and STIR-weighted images
b) Presence and number of focal lesions
i) Compression fractures (location and degree) on initial and follow-up MR studies

The extent of marrow involvement in MM was determined by assessment of overall marrow signal intensity and identification of focal lesions. Marrow involvement was shown on T1- and STIR-weighted images in comparison with adjacent normal structures. On T1-weighted images, the marrow signal was compared to the disc interphase and on STIR-weighted images, the marrow signal was compared to the adjacent paraspinal muscle. They were judged as hypo, iso, or hyperintense to these structures. In addition, marrow pattern was judged as homogeneous or inhomogeneous. A normal marrow pattern was judged as homogeneous or inhomogeneous. A normal marrow pattern was judged as homogeneous or inhomogeneous. A normal marrow pattern was judged as homogeneous or inhomogeneous. A normal marrow pattern was judged as homogeneous or inhomogeneous.

**Compressive lesions were graded as to the degree of loss of vertebral body height measured against a normal adjacent vertebral body. Included were mild fractures of less than 10% loss of vertebral body height and contour irregularities suggesting inflammatory disease.**

**Factors that indicated a "benign" appearance included:**

- The presence of focal lesions in the fractured vertebra
- Diffusely abnormal overall marrow signal on T1-weighted images (hypointense) and on STIR-weighted images (hypointense)
- Inhomogeneous overall marrow signal on T1 or STIR-weighted images (inhomogeneous)
- Presence of multiple focal lesions or focal enhancement on gadolinium-enhanced studies
- Associated soft tissue mass

**Factors that indicated a "malignant" appearance included:**

- Absence of any of the above criteria for "malignant" appearance
- Hard of abnormal signal intensity along the fractured vertebral end plate in an otherwise normal appearing vertebra

**Results:**

- **Overall MR study:**
  - Fractures in 177 out of 264 patients (44.3%)
  - Single fracture – 50 patients
  - 2-3 fractures – 38 patients
  - 4-6 fractures – 17 patients
  - 7+ fractures – 12 patients

- **Factors that indicate a “malignant” appearance:**
  - A majority of the compression fractures were located in the thoracolumbar spine between T7 and L2 (66% with single fractures and 80% with multiple fractures) (Charts 4 and 18).
  - The overall marrow appearance and the presence of focal lesions in the spine did not predict the incidence of compression fractures (Charts 2–4 and 9–11).
  - In the group of patients with single fractures, MR showed an abnormal marrow appearance, “malignant” fractures in 80% of cases (associated focal lesions or diffuse marrow involvement) (Chart 7).
  - In patients with multiple fractures, as the number of fractures increased, the incidence of “malignant” fractures decreased. (61% in patients with 2-3 fractures and 37-42% in patients with 4 or more fractures) (Chart 14).
  - Follow up MR studies following treatment reveal a low incidence of increasing, or new lesions (27 out of 237 patients who had follow up examinations) (Chart 18).
  - The decision to perform vertebroplasty at time of diagnosis should not be made for the purpose of preventing further compression fractures (80-90% stable fractures or no fractures on follow up studies) (Charts 8, 10, 17 and 18).
  - Vertebroplasty should be performed as a result of patient symptomatology and or the determination of future spine instability.

**Conclusions:**

1. In our study of 264 patients with newly diagnosed MM, 117 patients (44.3%) of patients had a spinal compression fracture on the initial MRI (Charts 1 and 2).
2. A majority of the compression fractures were located in the thoracolumbar spine between T7 and L2 (66% with single fractures and 80% with multiple fractures) (Charts 4 and 18).
3. The overall marrow appearance and the presence of focal lesions in the spine did not predict the incidence of compression fractures (Charts 2–4 and 9–11).
4. In the group of patients with single fracture, MR showed an abnormal marrow appearance, “malignant” fractures in 80% of cases (associated focal lesions or diffuse marrow involvement) (Chart 7).
5. In patients with multiple fractures, as the number of fractures increased, the incidence of “malignant” fractures decreased. (61% in patients with 2-3 fractures and 37-42% in patients with 4 or more fractures) (Chart 14).
6. Follow up MR studies following treatment reveal a low incidence of increasing, or new lesions (27 out of 237 patients who had follow up examinations) (Chart 18).
7. The decision to perform vertebroplasty at time of diagnosis should not be made for the purpose of preventing further compression fractures (80-90% stable fractures or no fractures on follow up studies) (Charts 8, 10, 17 and 18).
8. Vertebroplasty should be performed as a result of patient symptomatology and or the determination of future spine instability.