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Absent Bone Marrow Edema on MRI in a Patient with Acute Vertebral Compression Fractures: Implications for Vertebral Augmentation

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Background: Vertebral compression fractures (VCFs) are a common and debilitating consequence of multiple myeloma (MM). Acute VCFs often benefit from percutaneous vertebral augmentation (PVA), indicated by bone marrow edema (BME) on MRI. We present a rare case of a MM patient with several acute VCFs lacking BME on imaging who was successfully treated with PVA.

Case Report: A 49-year-old woman with a history of MM presented with acute mid-back pain. MRI revealed multiple compression fractures without BME, interpreted as chronic. Suspicion was increased based on the presentation and a review of prior imaging confirmed recent fractures. The patient then underwent PVA successfully with significant improvement.

Discussion: MRI is the gold standard method of determining the morphology of VCFs. However, this report demonstrates that MRI may not be accurate in detecting BME in MM patients. Clinicians should make a careful evaluation in determining the candidacy of these patients for PVA in case of contradictory MRI findings.

Key words: Chronic pain management, vertebral compression fractures, vertebral augmentation, multiple myeloma, case report

BACKGROUND

Vertebral compression fractures (VCFs) are a common occurrence associated with osteoporosis, trauma, and neoplastic conditions such as multiple myeloma (MM). Early minimally invasive interventions such as percutaneous vertebral augmentation (PVA) (percutaneous vertebroplasty or balloon kyphoplasty) in patients with VCFs have been shown to improve patients' pain levels, functional outcomes, and quality of life, and may confer mortality benefit (1). Loss of vertebral body height and bone marrow edema (BME) seen on megnetic resonance imaging (MRI) scans are important indicators to evaluate the acuity of VCFs. We present the rare case of a MM patient who presented with multiple VCFs without the presence of BME on MRI. The patient's BME was initially determined to be chronic. Previous imaging assisted in determining the acuity of the VCFs and amenability for PVA.

Informed consent was obtained from the patient described in this case report.

CASE REPORT

A 49-year-old woman with a past medical history of hypertension, MM, and chronic cancer-related pain presented to the clinic, complaining of acute onset mid-back pain ongoing for 4 weeks. The patient, who was diagnosed with MM one year ago, was undergoing chemotherapy treatment with Daratumumab-RVd

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at the time of her presentation. She had a history of chronic pain in the low back and lower extremities; however, she reported newly onset pain located in the mid-back without new radiation to the chest, abdomen, or lower extremities. The patient denied any recent falls or injuries. The pain was constant and worsened upon standing and walking. Pain was rated 10/10 despite the patient's chronic opioid regimen of Percocet 10 (325 mg Q4H) and required her to use a wheelchair for mobility.

Physical examination demonstrated percussion tenderness over the lower thoracic spine and 5/5 strength throughout. Thoracic MRI scans including T1, T2, and STIR sequences were obtained and demonstrated several compression fractures at multiple thoracic and lumbar vertebrae, including T5, T6, T9, T11, T12, and L1 (Fig. 1). Diffuse heterogeneous marrow signal, punctuated T1 hyperintensities, and diffuse heterogeneous enhancement throughout the vertebral bodies consistent with myeloma were noted. No BME was observed, and all fractures were determined to be chronic by the radiologist. However, the patient had undergone several imaging studies 5 to 6 weeks prior including a full-body positron emission tomography scan, to evaluate the progression of MM. She had also received lumbar and thoracic computed tomography scans during an emergency department visit and subsequent lumbar MRI in the management of chronic low back pain (Figs. 2,3). When the previous imaging was reviewed, it was discovered that many of these fractures were in fact new. The patient had attempted physical therapy but was unable to participate due to severe pain. It was determined that kyphoplasty would be beneficial to the patient. She underwent 2-level kyphoplasty at the areas of the most severe fractures, T11 and T12, one week later, without complication. The patient tolerated the procedure well and had significant, continued pain relief in the lower thoracic spine upon follow-up. Her mid-back pain was rated 2/10 on the 30-day follow-up, and she rarely required further wheelchair assistance. The patient continued her chronic opioid medication as needed, with adequate control of chronic pain.

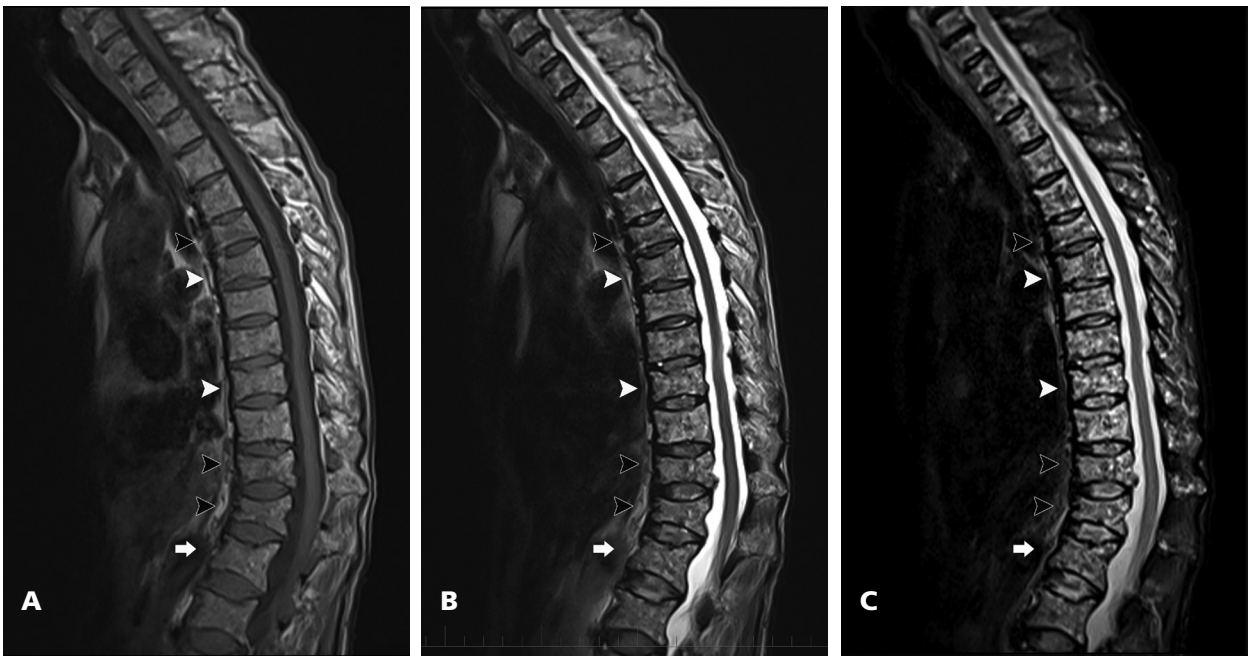

Fig. 1. Imaging of the patient's thoracic spine upon presentation, including (A) thoracic MRI T1, (B) thoracic MRI T2, and (C) thoracic MRI STIR sequences. L1 (light arrow) is visible, demonstrating a stable wedge fracture from previous lumbar MRI. The T6 and T9 vertebrae (light arrowheads) also appear to have stable compressions when compared to previous CT imaging. However, there are distinctly new vertebral body compression fractures at T5, T11, and T12 (dark arrowheads). Again, diffuse abnormal bone marrow signal changes and enhancement are present, which is consistent with MM, but there is no noticeable development of BME indicating acute fracture events. All fractures were read as chronic by the radiologist.

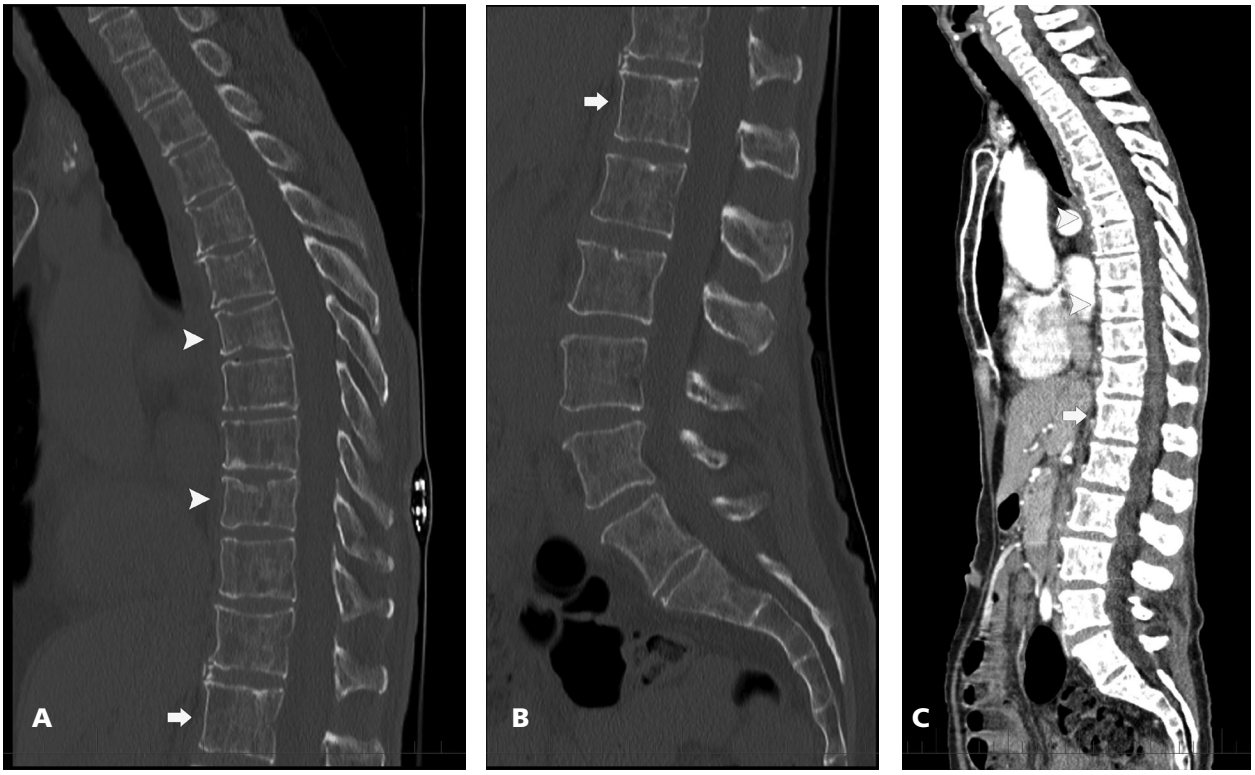

Fig. 2. Imaging of the patient's lumbar and thoracic spine 6 weeks prior to presentation, including (A) thoracic spine CT, (B) lumbar spine CT, and (C) PET-CT. The PET scan was performed initially during the process of the MM treatment. The thoracic and lumbar CT scans were performed during an ED visit concerning the exacerbation of chronic low back pain. The T12 level is present in all images (arrow). There is clear wedging of the vertebral bodies at T6 and T9 consistent among the CT and PET scan (arrowhead). However, the rest of the vertebrae are relatively preserved.

DISCUSSION

Back pain is the most common cause of pain and disability worldwide. The etiology of back pain is diverse and includes muscle strains, radiculopathy, spinal stenosis, facet degeneration, and VCF. Accurate diagnosis is therefore essential to provide appropriate treatment for patients. Diagnostic criteria of VCF include the acute onset of back pain, which may worsen with positional changes, a positive closed-fist percussion sign or supine sign on exam, and correlating imaging; MRI is the gold standard for the diagnosis of this condition (2). PVA is recommended for patients with confirmed, unhealed VCFs and severe pain at the fracture site. The procedure is not typically recommended for patients with VCFs beyond 12 weeks due to the natural healing process and associated decrease in pain symptoms (1). On MRI, acute VCFs (< 2 months) show low signal intensity on T1 and high signal intensity on T2, corresponding with BME and the fracture line. Chronic VCFs are isointense in all sequences compared with normal vertebrae (3-5). BME is thought to be caused by microfractures, edema, and hemorrhage in the medullar bone, and the evolution of the condition is directly correlated to histological changes in the vertebral body during the healing process (6,7). BME has also been found to be directly associated with patients' pain symptoms and quality of life (8). Although BME may be variable and even absent in distraction and separation fractures, it is consistently present in VCFs (9).

The patient in this case had a rare presentation in which she suffered multiple acute VCFs, none of which developed BME on MRI. Due to the complex nature of back pain and the extensive list of its etiologies, she would not have otherwise been a candidate for PVA with what were initially determined to be chronic VCFs. However, with the combination of acute pain onset, percussion tenderness on physical exam, and previous imaging that demonstrated an absence of fractures 6

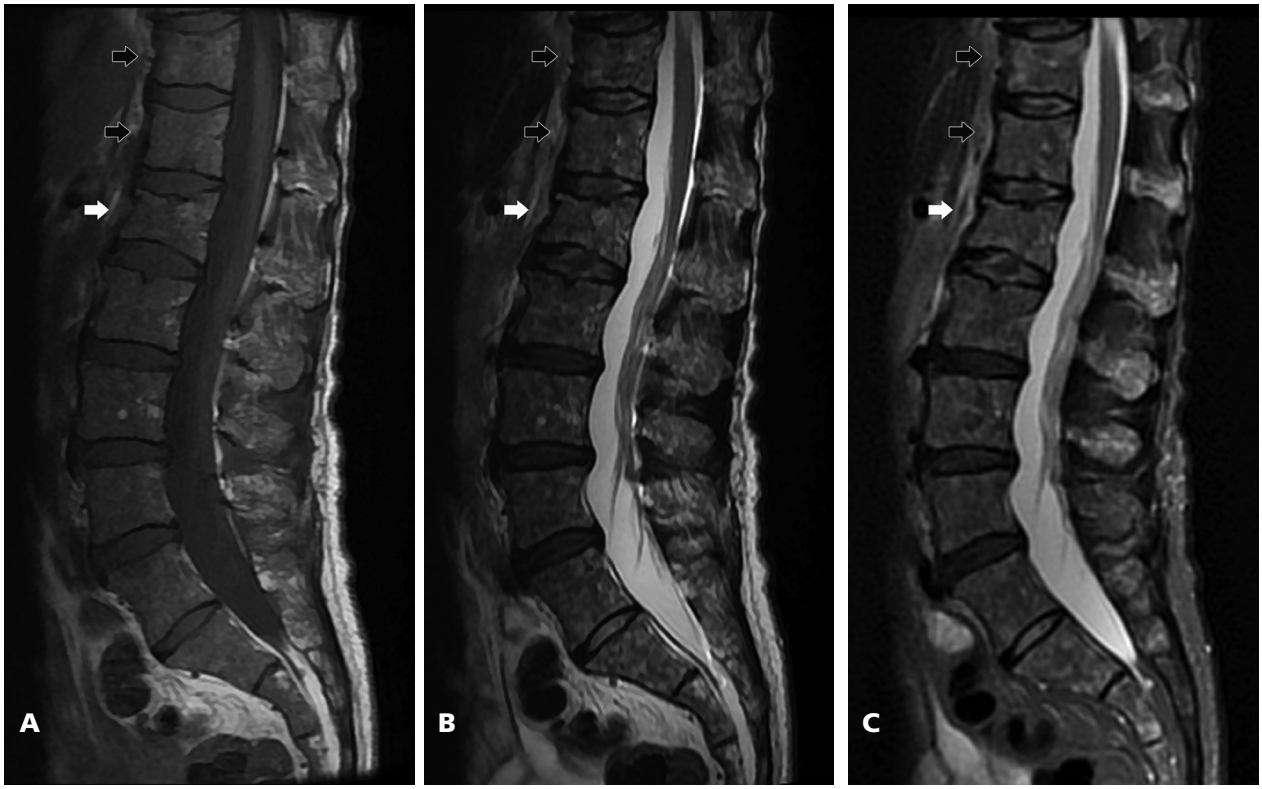

Fig. 3. Imaging of the patient's lumbar spine 5 weeks prior to presentation, including (A) lumbar MRI T1, (B) lumbar MRI T2, and (C) lumbar MRI STIR sequences. This MRI was performed during a follow-up to the ED visit approximately one week later. The L1 vertebra (light arrow) has a very clear new wedge fracture. However, there is no formation of BME indicating an acute event. This result was read as chronic by the radiologist, and no interventional treatment was performed. Diffuse abnormal bone marrow signal changes and enhancement are seen, a development consistent with MM. The T11 and T12 (dark arrows) vertebrae are visible in these sections and do not demonstrate vertebral body fractures at this time.

weeks earlier, PVA was performed to excellent benefit in this patient. In our literature review, we found one other case series in which 2 patients, also with a history of MM, did not develop BME on MRI and similarly benefited from PVA. It was hypothesized that the BME may be decreased or even absent in this patient population (10). MM is defined by plasma cell proliferation in the bone marrow, resulting in increased osteoclastic activity and limited bone healing. MRI may show several different patterns, including focal infiltration, diffuse infiltration, and the salt-and-pepper pattern (11). Both the pathophysiology of MM and the resulting MRI changes may explain the lack of BME development in these patients. An additional factor to consider is this patient's chemotherapy regimen. Daratumumab-RVd is a powerful immunosuppressant that depresses the inflammatory response and may inhibit subsequent BME formation. Furthermore, both MM and Dara-RvD predispose patients to a hypercoagulable state, which may limit the degree of microvascular hemorrhage in the bone marrow that regularly develops in VCFs and appears as BME on MRI scans (12).

CONCLUSION

Due to the small number of reports, it is difficult to appropriately determine BME patterns in MM patients with VCFs. Further higher-quality studies are needed to reach definitive conclusions. In the interim, we believe it is important to use clinical judgement focused on history and physical examinations when deciding to perform PCA in MM patients with VCFs, despite an absence of BME detected in MRI scans. Reviewing previous imaging, if available, may be indispensable in the decision-making process.

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