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Original Article

Violet Fox: A Clinical View of Vertebral Fractures

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Abstract

Had Violet's abdominal MR not been performed, or its findings not appreciated, the cause of her clinical event might never have been known because our current concept of osteoporotic vertebral fracture (VF) is substantially predicated on a change in either vertebral height or shape on lateral or sagittal spine imaging. The intention of this commentary is to stimulate a multidisciplinary conversation of osteoporotic VFs from an integrated clinical, physiological, and imaging perspective. For research and epidemiological purposes, osteoporotic VFs have been defined as a reduction in anterior, middle, or posterior vertebral height although the required minimum height reduction (e.g., 15% or 20%) varies among definition schemes. We further classify osteoporotic VFs to be ''clinical'' when they are accompanied by back pain and ''morphometric'' when they are not, and we have generally accepted the assertion that most of the osteoporotic VFs are painless, that is, morphometric. This dichotomous VF definition scheme has been the foundation of osteoporosis epidemiology and the primary endpoint in most pivotal osteoporosis pharmaceutical trials. Although, having served the osteoporosis community well, our clinical experience, refined by recent insights into vertebral anatomy and spinal biomechanics, advances in vertebral imaging, and 2 decades of vertebral augmentation suggest that the spectrum of osteoporotic VFs is more complicated than this scheme suggests.

Key Words: Vertebral fractures; clinical; morphometric; dynamic mobility.

Violet, a petite 85-year-old Violet, a petite 85-year-old woman room complaining of excruciating back and hip pain that began after moving a potted plant 1 week earlier. Other than a previous hip fracture, good health had allowed her to live independently in her own home where she cared for her frailer husband of 60 years. In the emergency room, radiographs of her hips, pelvis, and lumbar spine showed no acute injury although she refused to lie down for imaging. She was discharged to home on oral narcotics and muscle relaxants with a diagnosis of nonspecific back pain. Violet spent much of the following 2 weeks in a recliner but increasing abdominal pain and mild delirium eventually resulted in her hospitalization. Social services recommended placement for her husband who had begun to wander. Extensive imaging revealed only age-related cerebral atrophy and severe obstipation. With time Violet improved so that she was able to join her husband in a nursing home for rehabilitation. Three weeks later, feeling back to normal, she and her husband returned home.

In preparing for Violet's 4-week post-hospitalization visit, her osteoporosis care provider noted that diffuse low T1 and high T2 signals within the body of L1 had been overlooked on the abdominal MR scan. Lumbar radiography taken at the follow-up visit, including a standing lateral view of L1, showed no evidence of vertebral fracture (VF).

Introduction

Had Violet's abdominal MR not been performed, or its findings not appreciated, the cause of her clinical event might never have been known because our current concept of osteoporotic VF is substantially predicated on a change in either vertebral height or shape on lateral or sagittal spine imaging. The intention of this commentary is to stimulate a multidisciplinary conversation of osteoporotic VFs from an integrated clinical, physiological, and imaging perspective.

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For research and epidemiological purposes, osteoporotic VFs have been defined as a reduction in anterior, middle, or posterior vertebral height although the required minimum height reduction (e.g., 15% or 20%) varies among definition schemes (1). We further classify osteoporotic VFs to be ''clinical'' when they are accompanied by back pain and ''morphometric'' when they are not, and we have generally accepted the assertion that most of the osteoporotic VFs are painless, that is, morphometric (2). This dichotomous VF definition scheme has been the foundation of osteoporosis epidemiology and the primary endpoint in most pivotal osteoporosis pharmaceutical trials. Although having served the osteoporosis community well, our clinical experience, refined by recent insights into vertebral anatomy and spinal biomechanics, advances in vertebral imaging and 2 decades of vertebral augmentation suggest that the spectrum of osteoporotic VFs is more complicated than this scheme suggests.

Occult VF

Before meeting any definitional threshold of height loss, a fracturing osteoporotic vertebra is still fracturing. The temporal lag between the onset of VF pain and the ability to detect changes in radiographic vertebral configuration is the reason why nuclear scintigraphy and MR are used to detect early symptomatic VFs. This lag also may explain much of the ''delay'' in the diagnosis of Kümmel's disease (3), to be discussed later. Nevertheless, as in Violet's case, there is good evidence that some painful osteoporotic VF remain radiographically ''occult'' forever. Healed trabecular microfracture and fracture repair are expected histologic findings in sections of overtly fractured osteoporotic vertebrae but similar findings are only slightly less common in contiguous, osteoporotic vertebrae that are radiographically unfractured (4). Pham et al (5) described 16 osteoporotic subjects with acute, severe back pain characteristic of new VF but in whom no fracture could be appreciated on lateral spine radiograph. Acute fracturing was corroborated by bone marrow edema (BME) on MR and/or characteristic linear radionuclide accumulation on bone scintigraphy in an anatomic distribution consistent with the clinical pain presentation. Subjects were prospectively followed until their VF pain resolved (3−18 months) and at the conclusion of the study, changes in lateral vertebral radiographs consistent with an incident VF developed in only 80% of the fracturing vertebrae. In the remaining 20%, VF pain completely resolved but left no radiographic record of the event; that is, the fracture event remained radiographically ''occult'' forever. Even in retrospect, the final radiographic outcome could not be predicted as both the early and late clinical courses of the 2 groups were identical. Yang et al (6) performed an early vertebroplasty intervention in a small group of osteoporotic patients with occult VFs. Characteristic fracture pain and clinically concordant vertebral BME on MR supported the intervention in spite of normal radiographs. These authors reported rapid pain relief and improved physical function identical to those outcomes usually reported after augmentation of classically defined osteoporotic VFs. Therefore, painful but radiographically occult osteoporotic VFs do indeed occur and can behave symptomatically such as classically defined VFs.

Morphometric VF

Painless fracturing is counter-intuitive to most patients and should give clinicians reason to reconsider the assertion that most of the osteoporotic VFs are painless (i.e., morphometric). Vertebral fracturing is an incremental process so that an initially occult VF, subsequently detected radiographically, might be erroneously deemed ''morphometric'' long after any fracture pain had resolved or had been forgotten. Additionally, some variations in vertebral shape (e.g., Schmorl nodules and Cupid's bow deformity) and errors in image acquisition can result in a misdiagnosis of a morphometric VF when none is actually present. Finally, disagreements in imaging interpretation exist even among expert readers. For instance, the systematic misclassification of a nonosteoporotic vertebral deformity designated short anterior vertebral height (SVH) may have contributed to an overestimation of the prevalence of osteoporotic VFs (7). In a reanalysis of the MrOS trial, a large prospective study of osteoporosis in men, the prevalence of morphometric VF was reduced 25% when SVH was excluded from the analysis yet the association between (non-SVH) morphometric VF and low bone mineral density was actually strengthened (8). Therefore, at least some proportion of morphometric VFs may be over-diagnosed.

In spite of the foregoing, good evidence exists that osteoporotic vertebrae can fracture painlessly. Voormolen et al (9) prospectively studied the incidence of new VF after vertebroplasty in 66 severely osteoporotic subjects (mean lumbar T-score −2.9, mean 3 prevalent VFs) by following them for incident back pain clinically and for incident VF radiographically. Supine anterior-posterior and lateral decubitus radiographs and MR (T1, short tau inversion recovery (STIR) and transverse T2-turbo spin echo sequences) of the entire spine were obtained at baseline, 3, 6, and 12 months. An incident VF required both vertebral height reduction (>15%) and BME on MR. One year after vertebroplasty, the per-person incident VF rate was 24% yet half of these reported no VF pain. This carefully executed, rigorously defined, prospective study demonstrates that osteoporotic vertebrae can fracture, change their radiographic shape yet remain clinically silent. Distinguishing these ''truly'' morphometric VFs from other changes of vertebral shape may be challenging but the bone mineral density−independent relationship between these VFs and future fracture risk should only be strengthened.

Silent VF

If painful vertebral fracturing can occur in the absence of radiographic changes and osteoporotic vertebrae can fracture and change shape painlessly, can osteoporotic vertebrae both fracture painlessly and remain radiographically occult? In the prospective, observational study previously cited (9)