Ivory Vertebra Sign

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The radiographic finding of a solitary dense sclerotic vertebral body retaining normal size and contour without alteration in adjacent intervertebral disc spaces is the ivory vertebra sign. First described by Souques[1] in 1925, the ivory vertebra is a rare finding that provides a diagnostic challenge for the clinician and the radiologist.

Radiographically, the ivory vertebra is a dense, sclerotic vertebral body with possible involvement of the posterior elements (Figure 1). Adjacent intervertebral disc spaces are preserved. Computed tomography (CT) shows the sclerotic change involving most if not all of the affected vertebral body (Figure 2). Magnetic resonance imaging (MRI) shows decreased marrow signal intensity on T_1-weighted sequences with mildly increased signal on fluid-sensitive sequences (Figure 3). Bone scan may show increased radionuclide uptake. Positron emission tomography using fluorodeoxyglucose (^{18}F-FDG PET), a study that detects metabolically active cells by intracellular accumulation of an injected tagged glucose analogue, is usually positive. Standard uptake value (SUV) is a measure of cellular uptake of the radiopharmaceutical. The most metabolically active cells accumulate more of the glucose analogue and thereby demonstrate higher SUVs. PET-CT fuses the functional information of PET with the anatomical information of CT, acquired almost simultaneously, and provides precise localization of abnormal FDG activity (Figure 4). Elevated SUVs are seen with neoplasm, fracture, and other metabolically active processes, such as infection.

"...the ivory vertebra is a rare finding that provides a diagnostic challenge...Numerous conditions may be responsible..."

Numerous conditions may be responsible for ivory vertebra.[2,3] In adults, the most common include metastatic carcinoma (particularly of the breast and the prostate), lymphoma, postradiation necrosis, infection (eg, Pott disease), and Paget disease. Less common are chordoma, primary sarcomas (osteosarcoma in particular), SAPHO (synovitis, acne, pustulosis, hyperostosis, osteitis) syndrome, and diffuse condensing osteoses (eg, renal osteodystrophy, mastocytosis, osteopetrosis,

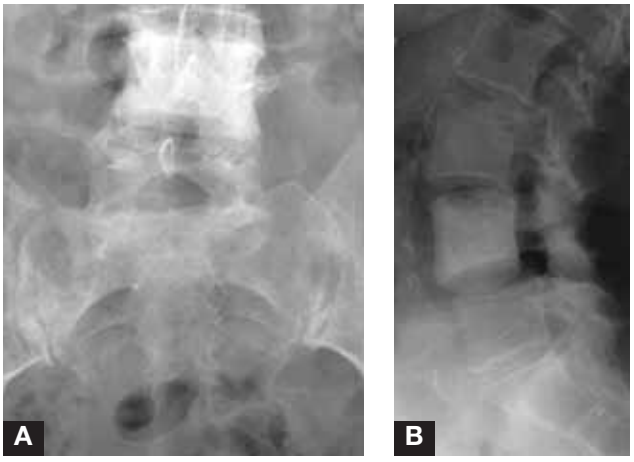

Figure 1. Anteroposterior (A) and lateral (B) radiographs show L4 vertebral body with uniformly increased opacity—the ivory vertebra sign. There is sclerosis of posterior elements. Vertebra remains normal in size and contour, and adjacent intervertebral discs are preserved in this patient with prostate cancer.

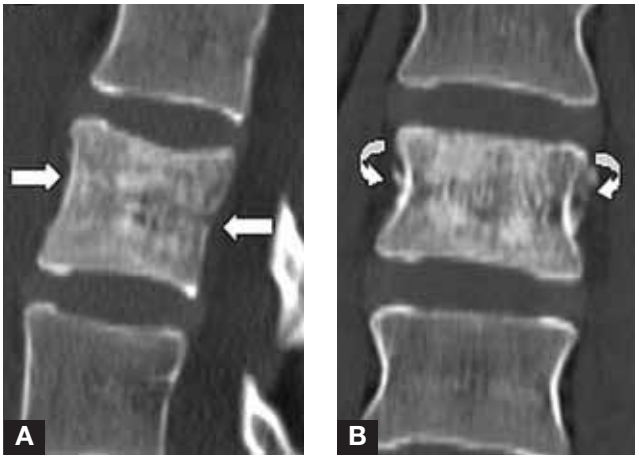

Figure 2. Sagittal (A) and coronal (B) computed tomography reconstructions of lumbar spine show increased opacity involving nearly entire vertebral body (arrows), with normal size and contour of adjacent intervertebral discs. Aggressive-appearing blastic cortical changes surround vertebral bodies (curved arrows) in this patient with breast cancer.

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Figure 3. Sagittal magnetic resonance imaging of lumbar spine shows ivory vertebra (arrows). There is diffusely decreased T_1 marrow signal reflecting marrow replacement (A), with mildly increased signal on T_2-weighted (B) and short tau inversion recovery (C) sequences. Adjacent intervertebral discs (curved arrows) are of relatively normal size and signal intensity. There is no paravertebral mass in this patient with Hodgkin lymphoma.

pycnodysostosis, myelofibrosis, fluorosis).[3] Many of these entities may manifest at multiple osseous sites or with systemic signs and symptoms that may be used to narrow the differential diagnosis. Clinical history, physical examination, and laboratory studies may suggest the underlying etiology, as in patients with vertebral osteonecrosis after radiation therapy, with dermatographism and cutaneous lesions characteristic of mastocytosis or with the pancytopenia characteristic of myelofibrosis. A paravertebral soft-tissue mass associated with cortical anterior or lateral erosions is considered characteristic of lymphoma. Single-level osteomyelitis may show erosive changes at the interface with the vertebral disc.[2] Paget disease may often be distinguished from other entities in that it tends to expand the vertebral body and may exhibit a thickened cortex and coarsened trabecular pattern. Vertebral involvement in Paget disease more commonly presents as a "picture frame" vertebra with sclerosis being most marked at the periphery of the vertebra with a lucent vertebral center secondary to atrophy of the spongiosa. SAPHO syndrome should be suspected in patients with an ivory vertebra in the thoracic spine and palmar pustulosis.[4] Renal osteodystrophy associated with chronic kidney failure is usually historically evident. There may be associated characteristic subperiosteal, endosteal, trabecular, subtendinous, and ligamentous bone resorption at multiple sites. Chondrocalcinosis, soft-tissue calcification, brown tumors, and osteosclerosis at other sites may be detected. Patients with skeletal fluorosis have characteristic radiodense bones in the axial skeleton and sparing of the skull and tubular bones, while associated vertebral osteophytosis and bony enthesopathic changes develop at sites of ligamentous attachment. In children, ivory vertebra is particularly rare, with the leading culprits being neuroblastoma, medulloblastoma, and occasional primary osteosarcoma.[5]

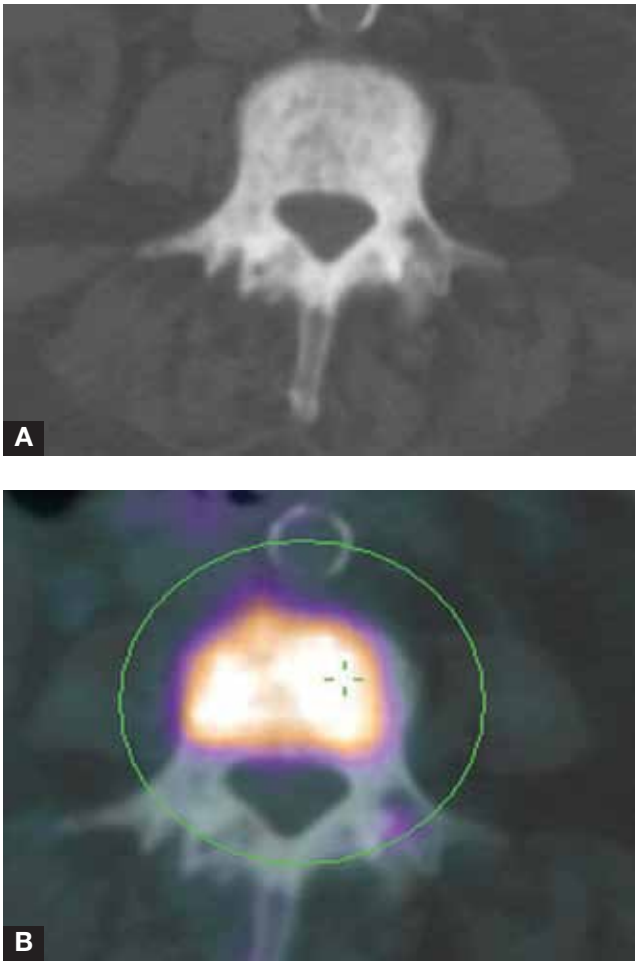

Figure 4. (A) Axial computed tomography (CT) shows diffuse sclerosis of vertebral body extending into pedicles and posterior elements. (B) Axial positron emission tomography–CT (PET-CT) fuses functional information of PET with anatomical information of CT. Sclerotic vertebral body shows abnormal accumulation of radiopharmaceutical, indicated by color and numerically represented by elevated standard uptake value. PET-CT findings confirm increased metabolic activity within vertebral body in this patient with metastatic prostate cancer.

The term asymptomatic idiopathic ivory vertebra has been used when no underlying causative agent or process is discovered and the vertebra remains unchanged over time. An asymptomatic idiopathic ivory vertebra is a diagnosis of exclusion.

Carpineta and Gagne[3] proposed an algorithm for management of ivory vertebra. The initial careful history and physical examination are followed by a set of baseline screening tests directed toward identifying common causes of the ivory vertebra sign. Screening laboratory tests include complete blood cell count, erythrocyte sedimentation rate, metabolic bone workup (calcium, phosphate, aspartate aminotransferase, alkaline phosphatase), prostate-specific antigen (males), and 24-hour urine measurement of hydroxyproline and calcium. Screening radiographic baseline studies include chest radiographs, bone scans, and mammograms. Treatment should be initiated for any pathology detected. If all results are negative and the patient is asymptomatic, observation and periodic clinical and radiographic reassessment are recommended. When all tests are negative and the patient is symptomatic, further imaging with CT and MRI followed by biopsy and culture should be performed. An asymptomatic patient under observation who becomes symptomatic or who demonstrates radiographic progression should undergo repetition of baseline screening examinations followed by further imaging with CT and MRI. Biopsy and culture may also be required.

Authors' Disclosure Statement

The authors report no actual or potential conflict of interest in relation to this article.

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