Imaging features of vertebral fractures in ankylosing spondylitis

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Authors: A. LEONE\textsuperscript{1}, F. Tamburrelli\textsuperscript{2}, P. Colelli\textsuperscript{2}, C. dell'atti\textsuperscript{3}; \textsuperscript{1}ROMA/IT, \textsuperscript{2}Rome/IT, \textsuperscript{3}rome/IT  
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Purpose

The primary purposes of this exhibit were to outline the factors that increase the incidence of vertebral fractures in patients with ankylosing spondylitis (AS), and review the radiological features and general treatment guidelines of these conditions.

AS is a chronic inflammatory disease of unknown cause that primarily affects the sacroiliac joints and vertebral column. The two central features of AS that promote the pathological remodeling of the spine are inflammation and new bone formation (1). The inflammation is characterized by enthesopathy that promotes ectopic bone formation resulting in ossification of the vertebral ligaments, intervertebral discs, endplates, and apophyseal structures. Although new bone formation is central to the pathogenesis of AS, this disease is also associated with osteoporosis that is attributed to an uncoupling of the bone formation and bone resorption processes (2). Therefore, bone resorption, through increased osteoclast activity, also occurs and promotes weakening of the spinal column as well as increased risk of vertebral fractures (3).

Methods and Materials

In order to discover the most commonly observed imaging findings and treatment options, a medline search was made for previously published cases reported in the literature. References were obtained from the search parameters 'ankylosing spondylitis', 'trauma', and their respective synonyms. Articles in languages other than English, French or German and articles without English language abstract were excluded. Inclusion criteria were: publication date between 1st January 1980 and 31st December 2011, the presence of AS and a spinal fracture, a sufficiently detailed description of fracture type, location, and mechanism of injury; an adequate description of neurological status, complications and duration of follow-up. Three authors performed the close reading of all articles and extracted data independently to minimize selection bias and errors. The data from the three readers were compared and where they differed, the pertaining article was reread until consensus was reached.

Results

After excluding 1,068 articles due to off topic abstract content, failure to meet the inclusion criteria, insufficient detail, overlap of same author/institution or uncertain history of trauma, 102 articles were included describing a total of 372 patients.
The mean patient age was 59.9 years (male/total ratio: 0.92). The mean duration of follow-up was 12.1 months. The percentage of patients with multiple trauma was 1.3%. 251 patients (69.6%) sustained low energy trauma causing their fracture. In most cases, the mechanism of injury consisted of a fall from standing/sitting position (Figs. 1-3). High energy impacts caused a fracture in 106 patients (28.7%). In 15 patients there was no recollection of trauma at all. 302 fractures (81.2%) were localized in the cervical spine, 41 (11%) in the thoracic spine, 28 (7.5%) in the lumbar spine, and one in the sacral spine. The hallmark fracture in an ankylosed spine is a fracture traversing both its anterior and posterior elements, either through osseous structures or through ossified ligaments (transverse fracture) (4-6). Illustrative cases are shown in figures 4-8. A delay in diagnosis occurred in 69 patients (18.5%) due to patient and doctor related factors. Of the 372 vertebral fractures, 253 (68%) demonstrated neurologic deficits and 175 (47%) were associated with neurological complications, varying from transient paresthesia to paraplegia. Surgical treatment was performed in 208 patients (56%) and consisted mainly of posterior fixation often combined with decompression of the spinal cord.

Images for this section:

![Fig. 1: Transverse fracture of C6 vertebra in a 80-year-old woman, after a fall from standing height, complicated by paralysis in both arms and paresis in both legs. (a) Axial CT scan passing through C6 vertebra, (b) midsagittal, and (c) sagittal to the right of the midline multiplanar reformatted CT images show the highly displaced nature of the fracture involving all three columns of C6 vertebra. Note the laminar fragment encroaching the spinal cord (small arrow in a, and b), the disruption of ossified anterior longitudinal ligament (double-head arrow in b), and the flaval ligament tear (arrow in c).]
Fig. 2: The same patient as in Fig. 1. (a) Sagittal T1-weighted, (b) corresponding T2-weighted, and (c) fat-suppressed T2-weighted images confirm the acute fracture of C6 vertebra with extensive vertebral body edema and retropulsion, and define the position of the laminar fragment relative to the spinal cord (yellow arrow in b, and c). The resultant cord contusion that spans five vertebral levels is seen on the T2-weighted images (small arrow in b, and c). Posterior longitudinal ligament stretching (white arrow in b, and c), and a heterogeneous prevertebral hematoma (* in a, b, and c) resulting from the anterior longitudinal ligament disruption are also evident.
Fig. 3: Lumbar transverse fracture in a 65-year-old woman after a fall from seating position. (a) Lateral radiograph of the thoracolumbar spine shows the fracture through L1 vertebral body (arrow). (b) Axial CT scan confirms the fracture extending to the middle column (arrows). (c) Sagittal reformatted, and (d) three-dimensional volume-rendered CT images better define the through-and-through fracture involving the ossified anterior longitudinal ligament and the body of L1 to its posterior cortex (arrows in c, and d). Note ankylosis of posterior spinal elements in d. Fracture treatment entailed posterior instrumentation with fusion at T11-L3 (not shown) and immobilization after surgery with a thoracolumbosacral orthosis brace, which led to successful healing of the injury.

Fig. 4: High dens fracture associated with a Jefferson bursting fracture in a 63-year-old man with AS after a fall down steps (dens fractures usually occur as an isolated injury, but frequently occur in conjunction with other injuries such as Jefferson fractures). (a) Axial CT scan shows the high dens fracture (white arrow) and the Jefferson bursting fracture with only a single fracture of the anterior arch (*), and bilateral fractures of the
posterior arch (yellow arrows). (b) Sagittal three-dimensional volume-rendered CT image shows the cranial displacement of the posterior arch fragment (arrows). (c) Axial CT scan passing through the foramen magnum and (d) sagittal multiplanar reformatted CT image demonstrate the displacement of the posterior arch fragment into the foramen magnum causing brainstem encroachment (yellow arrow in c, and d). The high dens fracture is well evident in d (white arrow). This injury was complicated by tetraplegia.

Fig. 5: The same patient as in Fig. 4. (a) Sagittal multiplanar reformatted CT image shows, in addition to the already-mentioned fractures, chronic C5 and C6 fracture with ankylosis of the vertebral bodies forming a single vertebral block, and mild retropulsion of posterior wall fragment (arrow). Increase in the C4-5 interlaminar and interspinous distance (double-head arrow) reflects a posterior ligament complex tear. This is an important sign of flexion injuries. (b) Sagittal T2-weighted MR image confirms the brainstem encroachment (yellow arrow) as well as the C5-6 vertebral body collapse (white arrow), with no evidence of signal changes in the cord. Due to the respiratory compromise, the patient had difficulty in remaining immobile during the examination. (c) Sagittal T2-weighted MR image of the thoracolumbar spine showing chronic compression fracture of T12 vertebral body (*). Note that the marrow signal is normal. The patient remained a complete tetraplegic until his death 9 days later for respiratory insufficiency.
Fig. 6: Transverse comminuted fracture of L5 vertebra with severe anterior displacement of the spine in a 56-year-old man after a simple fall. The patient was neurologically intact, with the sole complaint of lower back pain. (a) Sagittal T1-weighted and (b) corresponding fat-suppressed T2-weighted images show the fracture gap and the anterior subarachnoid space presenting with a low signal on T1-weighted image and a high signal on T2-weighted image (the signal of hematomas within the fracture gaps may vary with age). Note a heterogeneous dorsally located epidural collection extending from L1 to L5, which represents a spinal epidural hematoma (small arrows in b). This patient underwent emergent posterior lumbar decompression and instrumented fusion from L2 to S2. (c) Postoperative lateral radiograph and (d) sagittal three-dimensional volume-rendered CT image showing the instrumentation construct and the persistent fracture gap.
**Fig. 7:** Persistent mechanical back pain during 2-3 weeks in a 57-year-old man with AS. Lateral radiograph of the thoracolumbar spine shows ossification of the anterior longitudinal ligament except for L1-2 level (arrow) where the bony bridging is incomplete. This sign raised the suspicion of a fracture.

**Fig. 8:** The same patient as in Fig. 7. (a, b) Axial CT scans passing through L2 vertebra reveal bilateral nondisplaced fracture at L2 pedicle-articular pillar junction (arrows in a, and b). (c, d) Sagittal multiplanar reformatted CT images clearly define the transverse intradiscal fracture involving the anterior and posterior longitudinal ligaments (arrows in c) and extending to posterior elements (arrow in d). (e) Postoperative lateral radiograph of the thoracolumbar spine showing the T12-L4 instrumentation construct.
Conclusion

The diagnosis of vertebral fractures may be challenged by the following observations: a) even in the presence of symptomatic clinical vertebral fractures, they can be clinically overlooked in AS patients as acute and chronic back pain is common. The diagnosis can then be overruled by attributing the pain to disease activity; b) fractures of the thoracic neural arch and its pedicles are difficult to diagnose radiographically because of their location. Patients with AS presenting even with a trivial history of trauma should be critically evaluated for acute spinal fractures using radiography, CT and/or MR imaging. Furthermore, we should manage the vertebral fracture in AS very carefully; keeping in mind that it might actually be unstable transverse vertebral fracture. Neurologic involvement is common and outcomes largely depend on the early recognition and appropriate management.

References


Personal Information

Antonio Leone
Associate professor
Department of Bioimaging and Radiological Sciences