Spinal ankylosis in low impact trauma, a pitfall for the unweary.

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Learning objectives

- Review the pathophysiology, anatomy and biomechanics of the ankylosed spine (AS)
- Review the key imaging findings
- Review cases from our institution demonstrating delayed or missed spinal injury in AS
- Propose a diagnostic pathway that aims to overcome the dangers associated with AS
Background

Ankylosing spondylitis (AS) is a well recognised clinical entity. It was previously thought of as a variant of rheumatoid arthritis (RA) until around 1960 and termed 'rheumatoid spondylitis'. In 1973, the association with human leukocyte antigen (HLA)-B27 gene was discovered, thus establishing the genetic background of AS, and in 1976 a unifying concept for the 'seronegative spondylarthritides' was proposed. The prevalence today is 0.5 - 1.9%.

Bone formation is typical for AS and distinguishes AS from RA in which bone destruction prevails. The radiographic findings may take 10 years or more to develop (although early inflammatory changes on MRI can be appreciated as Romanus and Andersson lesions). The process of enthesitis, spondylitis and sacroilitis may lead to eventual ankylosis. This is characterised by intra and extra-osseous bone formation (sclerosis, syndesmophytes) ossification of ligamentous structures, intervertebral discs and fusion of the sacroiliac joints.

In AS there is altered spinal biomechanics. Due to multilevel bony fusion, long lever arms develop in the spinal column on which forces can act during even minor trauma. Fractures are characterised by their unusual location (e.g. at the cervical spine and dens). These are usually trans-discal extension injuries through syndesmophytes involving the posterior elements resulting in three-column unstable spinal injuries.

Falls are the most frequent cause of trauma in AS patients and around 65% of fractures result from minor trauma. Cooper et al present a population based study of fractures in AS. 39% result from a fall from ground level and there is a high incidence of spinal cord injury (58-70%). The clinical outcome was worse compared with general spine trauma population with 13.9% (vs 0.08%) having secondary neurological deterioration following admission. There is a 17.7% mortality following injury (>3 months) (vs 0.4%) in AS.

Westerveld et al looked at 345 AS patients with spinal fractures. Low energy trauma was responsible for 65.8% of these. There was a delay in diagnosis > 24hrs in 17.1%. 52.7% of the time this was due 'doctors delay', for example, failure to obtain imaging, dismissal of 'minor trauma' and back pain, or incorrect interpretation of plain radiography. The remaining 47.3% was the result of a patient delay in presentation. They found that neurological impairment was present at presentation in 68.2% but there was secondary neurological deterioration in 13.9%.

Thumbikat et al looked at all spinal cord injury patients with AS over 10 years at a spinal cord unit in Sheffield, UK. The majority sustained injuries as the result of a fall from
standing. They found that 12 out of 18 patients were able to walk following injury but subsequently underwent secondary neurological deterioration. This was the result of the correction of pre-existing kyphosis (most common) and poor transfers and positioning e.g. in scanner gantry. On the basis of their findings they made recommendations for transferring and stabilising these patients in neutral flexion and having a low threshold for use of CT and MRI.
Diagnosis of spinal fractures in AS can be challenging. Two thirds of patients present in an atypical fashion or are unaware of their AS. The diagnosis is often overruled by attributing symptoms to chronic back pain even in the presence of acute symptoms. Fractures are often overlooked even when the radiographs are available due ankylosed soft tissues and pseudoarthroses. Fractures of the posterior elements are difficult to diagnose because of their location. This can be exacerbated by poor radiograph quality of thoracic spine due to overlying soft tissues.

Berne et al demonstrate that CT has a positive predictive value of 100% in detecting spinal fractures following all types of injuries. In known AS patients with back pain we propose that CT should be the first line imaging investigation following any trauma regardless of the mechanism. In patients shown to have AS on radiography (but previously undiagnosed) CT should be considered if there is a history of any trauma or ongoing back pain despite analgesia.

MRI scans are very sensitive in picking up soft tissue and disc injuries in this group of patients and in identifying the presence of epidural hematomas. However, MRI on its own is less sensitive at identifying bony injuries, especially posterior element fractures.

Case 1:

- Normal examination other than hypertension and AF (chronic). Normal neurological examination. The spine showed no obvious deformity but patient was tender over L4/5.
- Lumbar spine radiograph (Fig 1, 2) was commented on by ED doctor as showing, 'No fracture seen, osteoporotic' therefore discharged home following analgesia and management of hypertension.
- Patient represents to physicians 2 weeks later with continuing back pain, leg weakness, decreased sensation and inability to mobilise
- On examination - power 0/5 bilaterally in the lower limbs, absent reflexes, absent sensation below L1, reduced anal tone.
- Urgent MRI demonstrates transverse fracture involving T12 vertebral body and posterior elements with marked soft tissue oedema and epidural haematoma (Fig 3, 4)
- Preoperative CT confirms a transverse fracture through ankylosed anterior and posterior longitudinal ligaments and supraspinous ligaments (Fig 5)
• Underwent open reduction and stabilisation
• Wheelchair bound with loss of sphincter function. Ongoing litigation.
• This case demonstrates the importance of correct interpretation of radiographs in a patient with previously undiagnosed AS. First line CT may have avoided the tragic consequences of this case.

Case 2:

• 61 year old male retired teacher, fall 2 metres from ladder. Spine immobilised by ambulance crew (subsequently removed in A&E due to patient intolerance)
• Pain upper thoracic spine, shoulders but no neurological symptoms
• Long history of cervical and lumbar back pain and morning stiffness
• PMH - Ulcerative colitis, T2DM, hypothyroid
• On examination pain and limited range of movement in cervical and thoracic spine. Normal neurological examination.
• Plain radiographs cervical and thoracic spine demonstrate inadequate cervical views with no obvious fracture demonstrated. Changes in keeping with AS (Fig 6)
• Ongoing severe pain therefore admitted under orthopaedic team for analgesia. MRI requested as ongoing unexplained pain despite analgesia demonstrated disruption of anterior longitudinal ligament at T2/3 with a horizontal fracture extension through the middle column (Fig 7)
• Preoperative planning CT confirms AS with fracture through ossified para-spinal ligaments (Fig 8)
• Subsequent stabilisation and a good outcome with no secondary neurological deterioration.
• This case demonstrates the benefit of early CT or MRI imaging in a patient with AS and ongoing back pain following minor trauma.

Case 3:

• 72 year old male sustained a fall and presented to ED with back pain, chest pain, SOB
• Past medical history of ankylosing spondylitis.
• On examination patient was kyphotic with limited range of movement throughout spine and pain lower thoracic spine on palpation.
• Neurological examination was normal.
• Plain radiograph of thoracic spine was initially deemed normal by the clinical team but subsequently reported as demonstrating changes of AS with a distraction injury mid thoracic spine with disruption of anterior and posterior columns (Fig 9, 10)
• Admitted for drainage of pleural effusion. 3 days later deteriorated neurologically with a lower limb flaccid paralysis.
• MRI demonstrated disc space T11/12 disruption, anterior/middle column involvement, posterior displacement of posterior elements, signal change and cord transaction (Fig 11, 12)
• CT - confirms extent of fracture (Fig 13)
• Transverse distraction injury
• Decompression and stabilisation. Wheelchair bound.
• This case shows the disastrous effect of incorrect radiograph interpretation and failure to request spinal CT in a patient with AS and ongoing pain following minor trauma.

Case 4:

• 60 year old female fell from a stool
• Presented to ED with pain in thoracic spine
• Thought to have no significant injury and discharged
• Radiographs show AS but not read by a radiologist until later (Fig 14)
• Re-admitted 1 day later with complete motor and sensory loss below T4
• CT demonstrates complete fracture dislocation through the T3/4 disc space and posterior elements with complete occlusion of the spinal canal secondary to distraction (Fig 15)
• Underwent fixation and stabilization
• Subsequently died with post operative sepsis and complications
• This case highlights the danger of dismissing minor trauma and failing to interpret the radiographic findings of AS.

Case 5

• 72 year old male fell running for a bus
• Assessed in ED. No significant past medical history.
• On examination tender over L1/2
• Radiographs demonstrate an ankylosed lumbar spine with possible disruption of ALL ossification and a horizontal lucency extending to posterior elements at L1/2 (Fig 16)
• CT performed for further clarification of AS. Shows a transverse fracture through L1/2 disc space and posterior elements (Fig 16)
• MRI confirms fracture of disc and anterior and posterior longitudinal ligaments at both T1/12 and L1/2 (Fig 18, 19)
• Subsequent stabilisation and favourable outcome.
• Demonstrates the importance of recognising AS in a previously undiagnosed patient. First line or early CT imaging reveals extent of injury and allows stabilisation before secondary spinal cord injury occurs.
Images for this section:

**Fig. 1:** Case 1: AP Plain radiograph of lumbar spine

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Fig. 2: Case 1: Lateral radiograph lumbar spine. Flowing anterior syndesmophytes and ankylosed posterior elements. Horizontal fracture of T12 was initially missed in ED

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Fig. 3: Case 1: Sagital T2W MRI of lumbar spine

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**Fig. 4:** Case 1: Sagital TRIM MRI lumbar spine

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Fig. 5: Case 1: Sagital recons CT lumbar spine

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**Fig. 6:** Case 2: Radiograph thoracic spine with inadequate views of the upper thoracic spine secondary to overlying soft tissues.

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Fig. 7: Case 2: Sagital T2 Fat Sat MRI spine.

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**Fig. 8:** Case 2: Sagital recons CT thoracic spine

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Fig. 9: Case 3: Lateral radiograph lumbar spine

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Fig. 10: Case 3: AP radiograph lumbar spine

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**Fig. 11:** Case 3: Sagital T1W MRI lumbar spine

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**Fig. 12:** Case 3: Sagital T2W MRI lumbar spine

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Fig. 13: Case 3: Thoracic spine recons preoperative CT

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**Fig. 14:** Case 4: Lateral radiograph thoracic spine.

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**Fig. 15:** Case 4: CT sagital recons of the thoracic spine show 3 column disruption that was not visible on plain radiographs due to overlying soft tissue

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**Fig. 16:** Case 5: Lateral radiograph lumbar spine showing subtle fracture of anterior syndesmophyte and ankylosed posterior element.

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Fig. 17: Case 5: CT with sagital recons confirms radiograph findings.

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**Fig. 18**: Case 5: T1W MRI demonstrates further 3 column injury at T11/12 and confirms transdiscal fracture at L1/2

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**Fig. 19:** Case 5: Sagital TIRM MRI also demonstrates further 3 column injury at T11/12 and confirms transdiscal fracture at L1/2

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Conclusion

- Recognition of AS and an understanding the biomechanics is key to both physician and radiologist.

- The presence of ankylosed segments may herald an unstable spinal fracture in every trauma patient regardless of the mechanism of injury.

- We advocate first line CT (rather than plain radiography) in all patients with AS with unexplained or ongoing back pain following any trauma thus avoiding delayed diagnosis, secondary neurological deterioration and high mortality.
References


