

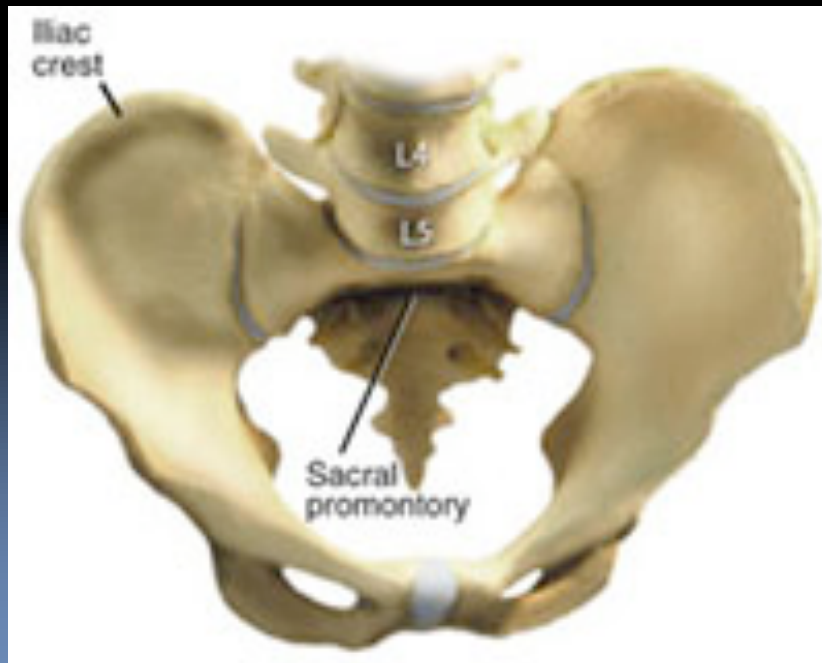


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SACRAL TRAUMA

Anatomy

- develops from 5 fused vertebrae
- each vertebrae 3 primary ossification centres that give rise to anterior and posterior segments
- fibrocartilaginous discs between S₄/S₅ fuse at approx. 15 years old – the remaining discs fuse in a cephalad direction until completion at age 25



- forms posterior arch of pelvis and distributes load from axial skeleton to pelvis through SI joints
- stability through strong ant. and post. ligamentous attachments between sacrum and pelvis
- sacrum lies at 40 deg. Incline – subject to rotational force that counteracted by sacrotuberous and sacrospinous ligaments
- neural foramina and diameter of nerve roots diminish distally – end effect nerve roots at distal foramina less likely to become entrapped

Anatomy – Neural elements

- Lumbosacral plexus (L₄-S₁)
- Sacral plexus (S₂-S₄)
- The anterior rami of S₂-S₅ contribute to sexual function as well as bowel and bladder control by providing parasympathetic innervation to the bladder and rectum.
- The sympathetic ganglia of the inferior hypogastric plexus extend from the anterolateral L₅ and S₁ vertebral bodies caudally to the anterior surface of the sacrum along the medial margin of the anterior foramina of S₂, S₃, and S₄.
- The posterior rami of the sacral roots consist of small sensory fibres, with contributions to the cluneal nerves.

Sacral fractures epidemiology

- Uncommon
- Caused by shear forces or lateral compressive forces
- Identified in 90% patients with pelvic fractures
- Up to 49% undiagnosed

Clinical presentation

- Hemodynamically unstable
 - Fractures including the posterior pelvis are associated with severe blood loss
- Hemodynamically stable
 - More subtle signs of pelvic or sacral disruption include: presence of pain, swelling, ecchymosis, open wounds, tenderness to palpation or the sacrum or palpable deformity

Physical Exam

- Foot eversion or plantar flexion of the foot (S₁)
- Hip extension (S₂)
- Superior gluteal nerve injury can result in weakness of hip abduction and internal rotation
- Anal sphincter tone, anal wink (S₂-S₅)
- Parasympathetic through pelvic splanchnic afferents carry sensation for bladder filling
- Sympathetic innervation control contraction of urethral and anal sphincters

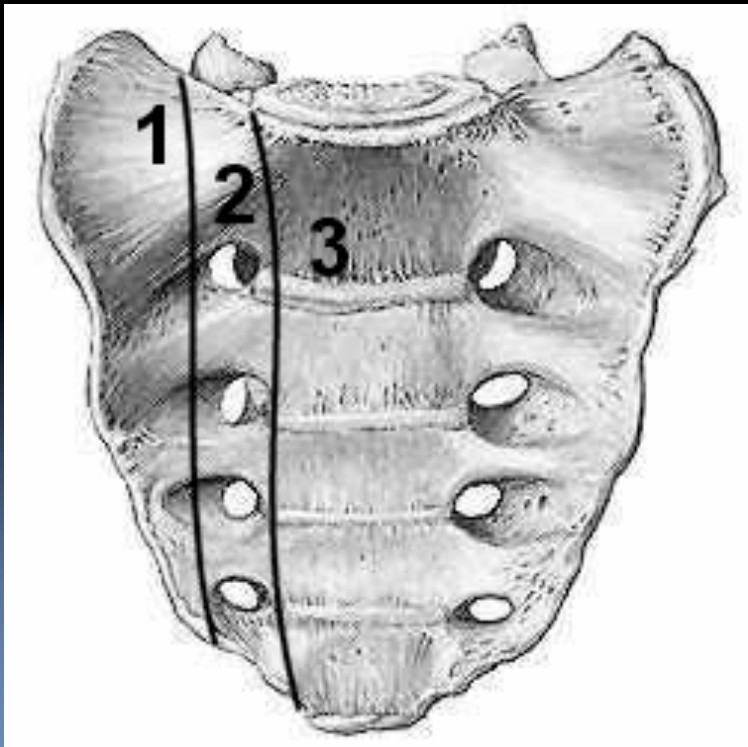
Classification

- Several classification schemes
 - Bonnin
 - 6 types of fracture patterns
 - Classification did not correlate with mechanism or aid in their clinical evaluation and prognosis
 - Schmidek
 - Based largely on dividing fractures into those that resulted from direct or indirect trauma
 - Fracture characteristics could be combined
 - complicated

Classification

▪ Denis

- Simplified classification scheme through analysis of series of 236 sacral fractures
- Based on anatomic zones
- In this series 21 percent had neurological deficit



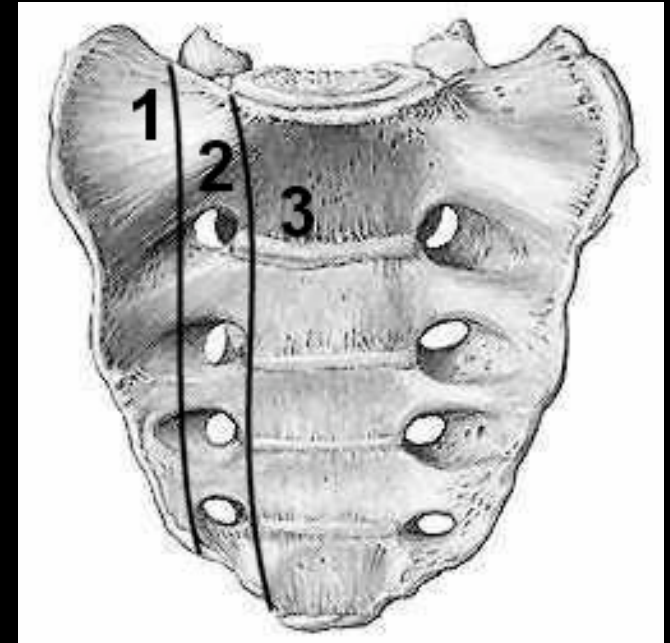
Zone-I injuries are entirely lateral to the neuroforamina

Zone-II injuries involve the neuroforamina but not the spinal canal

Zone-III injuries extend into the spinal canal with primary or associated fracture lines

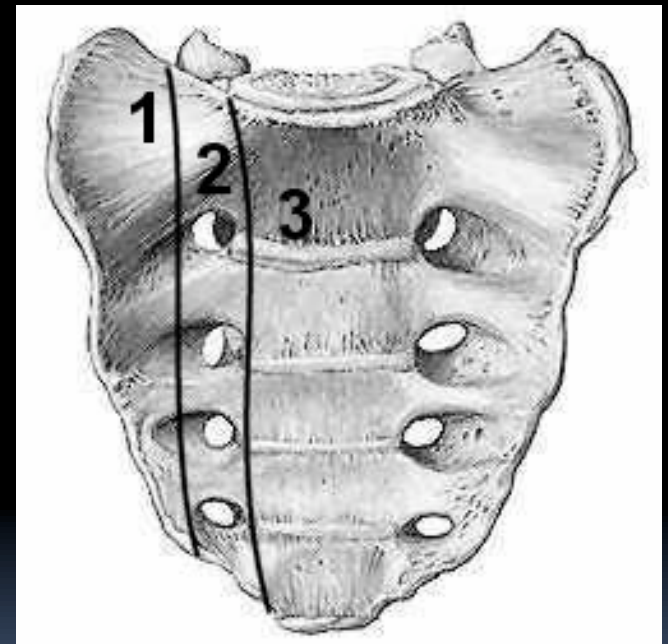
Zone 1 fractures

- fractures that occur lateral to the sacral foramina
- account for 50% fractures in Denis series – 5% had neurological deficit
- can be subclassified as stable or unstable
- mechanism is typically lateral compression injuries of the pelvis
- if posterior sacroiliac ligaments remain intact fracture is considered stable
- fractures that include avulsion of the bulbous enlargement of the sacrum adjacent to the S₄ foramina (point of attachment of sacrospinous and sacrotuberous ligaments) the fracture is considered unstable
- neurological injury can occur in vertical shear injuries that can cause superior displacement of the ala and compression of the exiting L₅ nerve root between the fracture fragment and the transverse process of L₅



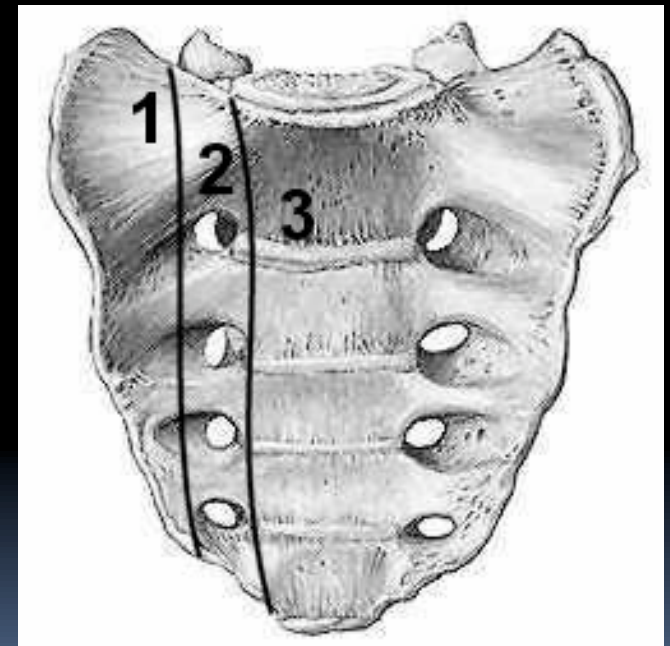
Zone 2 fractures

- fractures that involve one or several sacral foramina but not the sacral canal
- accounts for 34% fractures in Denis series – up to 30% have neurological injury
- can be subclassified into stable and unstable
- mechanism more often vertical shear but can be lateral compression such as those that cause Zone 1 injuries
- vertical shear fractures are unstable and the degree of disruption of the SI joint correlates with instability and neurological deficit



Zone 3 fractures

- fractures that involve the sacral canal medial to the foramina and may involve Zones 1 and 2
- accounts for 16% fractures in Denis series – up to 57% have neurological injury
- most Zone 3 fractures are unstable
- mechanism more often vertical shear, high and low transverse fractures and traumatic lumbosacral fracture-dislocation
- features correlating with a high degree of instability include sacroiliac joint disruption, sacrospinous and sacrotuberous avulsion fractures, high transverse and bilateral sacral fractures and vertical shear fractures



Imaging

- AP films
 - Fracture of lower lumbar TP
 - Significant anterior pelvic ring fracture without an identifiable posterior pelvic lesion
 - Asymmetry of the sacral notch
 - Clouding of the radiating trabecular pattern in the lateral masses
 - Irregularity of the arcuate lines of the upper three sacral foramina
- Dedicated higher yield GR is Ferguson's view (beam directed 30 deg cephalad) and lateral view including coccyx

Management

- No randomized control trials
- Stability and neurological deficit used to decide on surgery
- May be emergent if injury to iliac vessels or presacral venous plexus
- Initial management involves pelvic binder or external fixation

Surgical Management

- Most stable fractures can be managed with pelvic immobilization and bed rest
- Reduction and internal fixation is goal of surgical treatment
- Unstable fractures involving separated ant. Pelvis will typically require ant. Pelvic fixation
- Anterior approach for sacral fractures in hemodynamically unstable contraindicated
- Zone 1 injuries – reduction and fixation of fragment entrapping L5 nerve root
- Zone 2 injuries – conservative management for those with nerve root injury and surgical management with laminectomy and/or foraminotomy for those with associated weakness or persistent pain
- Zone 3 injuries
 - low transverse fractures do not destabilize the pelvis so often treated conservatively
 - High transverse fractures are unstable and require decompression reduction and fixation
 - cauda equina is an indication for urgent decompression
- Severe neurological deficit is an indication for urgent decompression as even unilateral preservation of the S2-4 nerve roots can allow functional recovery