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Review article

Osteosynthesis in sacral fracture and lumbosacral dislocation

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ABSTRACT

Sacral fracture and lumbosacral hinge trauma are rare but serious lesions. Neurologic disorder is frequently associated, and nerve release may be required, with reduction and stabilization of the fracture. Management requires knowing the fracture lines and reduction maneuvers and the fixation techniques that may need to be associated. Three classifications allow these fractures to be well understood: the Roy-Camille classification identifies high transverse fractures and their displacement; the Denis classification identifies vertical fracture line location within the sacrum, which correlates with neurologic risk; and the Tile classification analyzes pelvic ring trauma when associated with the sacral fracture. Treatment, when surgical, requires careful patient positioning, sometimes on an orthopedic table. Reduction maneuvers are founded on the fracture classification. Isolated U-shaped fracture of the sacrum is to be distinguished from sacral fracture associated with pelvic ring lesion. Osteosynthesis may be lumbopelvic or restricted to the pelvic ring (sacroiliac or iliosacral). Open osteosynthesis allows reduction to be finalized by intraoperative maneuvers on the implant, while closed osteosynthesis requires perfect preoperative reduction. Complications are frequent and neurologic recovery is uncertain. Fatigue and osteoporotic fractures show little displacement and are good indications for cementoplasty, either isolated or associated to iliosacral screwing. In lumbosacral hinge trauma, and dislocation in particular, reduction surgery with fixation (usually 360°) is indicated. The present study details the analysis and classification of these fractures, the technical pitfalls of reduction and fixation, and treatment indications.

1. Introduction

Sacral fracture and lumbosacral hinge trauma are rare but serious lesions.

They are caused by high-energy trauma or multiple trauma, which may be overlooked, are often associated with neurologic disorder, and can require nerve release associated to fracture reduction and stabilization.

Treatment requires good analysis of the fracture lines and good knowledge of the reduction maneuvers and of the fixation techniques that are sometimes needed.

2. Anatomic reminders

2.1. Osteology

The sacrum comprises 5 parts, which fuse around the age of 15 years.

The sacral spine is in kyphosis:

- on the anterior side, there are 4 sacral foramina through which the anterior branches of the 4 sacral roots (S1 to S4) exit. The fused discs form anterior transverse crests (Fig. 1a);
- on the posterior side:
  - the fused sacral spines form the medial sacral crest;
  - the fused joint bone masses form the intermediate crest, beyond which lie the posterior sacral foramina;
  - the fused transverse apophyses form the lateral sacral crests (Fig. 1b).

2.2. Ligaments

The sacrum is linked to the spine and pelvic ring by a large capsule-ligament system:

- frontally, the anterior sacroiliac ligament inserts on the first 3 sacral parts and adjacent iliac bone (Fig. 1a);
- dorsally, the posterior sacroiliac ligament links the posterior sacral crest and the iliac spine (Fig. 1b).

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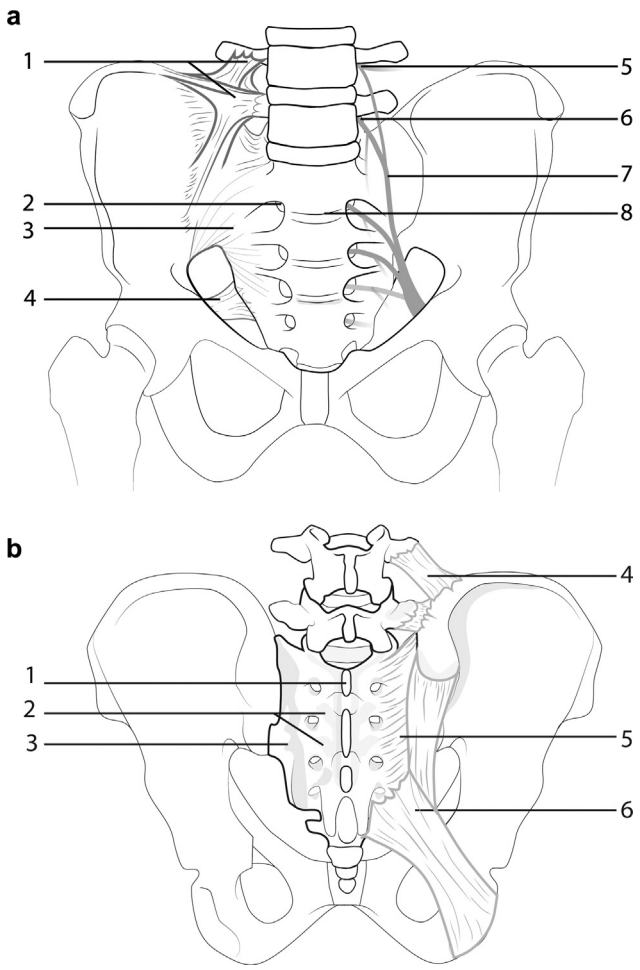

Fig. 1. a: anterior view: 1: iliolumbar ligaments; 2: anterior sacral foramina; 3: anterior sacroiliac ligament; 4: sacrospinous ligament; 5: L4 root; 6: L5 root; 7: lumbosacral trunk; 8: transverse anterior crests; b: posterior view: 1: medial crest; 2: intermediate crest; 3: lateral crest; 4: iliolumbar ligaments; 5: posterior sacroiliac ligament; 6: sacrotuberous ligament. © Julie Borgese.

The other ligaments serve only as reinforcements:

- the iliolumbar ligament links the L4 and L5 transverse apophyses and the iliac crest;
- the sacrospinous ligament stretches from the ischial spine to the lateral edge of the sacrum;
- the sacrotuberous ligament inserts on the whole lateral edge of the sacrum and posterosuperior iliac spine. Its fibers meet behind the hipbone and join the ischial tuberosity.

2.3. Neurologic environment (Fig. 2a and b)

The dural sac stops at S2 in more than 80% of subjects. The sacral canal contains the sacral roots, which exit the sacrum via the 4 foramina.

The sacral plexus is formed from the anterior branches of S1-4, joined by the lumbosacral trunk, which unites the anterior branches of L4 and L5.

The sacral plexus also contains the parasympathetic innervation centers of the pelvic organs governing sphincter control and the genital organs.

2.4. Biomechanical implications

The main weak points are the alignment of the sacral foramina in the sagittal plane and the anterior sacral crests in the transverse plane.

3. Epidemiology and lesion mechanisms

Until the advent of computed tomography (CT), sacral fracture was underestimated or misdiagnosed. In 1847, Malgaigne first described a sacral fracture [1]. In 1945, Bonnin reported that pelvic fracture was associated in almost half of cases [2]. In 1988, Denis et al. analyzed 236 pelvic ring fractures and found associated sacral fracture in 30% of cases [3].

Roy-Camille et al. [4] classified transverse sacral fractures and attributed them to high falls, usually defenestrations; they account for only 3–5% of sacral fractures, but are associated with severe neurologic complications: sphincteral, sexual and/or sensorimotor.

4. Trauma and associated neurologic lesions

Associated fracture is almost systematic [5]: half of patients have pelvic ring fracture (pelvis or acetabulum), 30% at least 1 spinal or lower limb (calcaneus) fracture, almost 20% thoracic or, more rarely (16%), abdominal trauma [6] and almost 11% cranial trauma.

Neurologic involvement is the rule in transverse fracture [7] and rarer in longitudinal fracture [7]. Neurologic presentation varies greatly: central (paraparesis, paraplegia) in case of overlying spinal fracture, cauda equina syndrome, or nerve-root or plexus lesion.

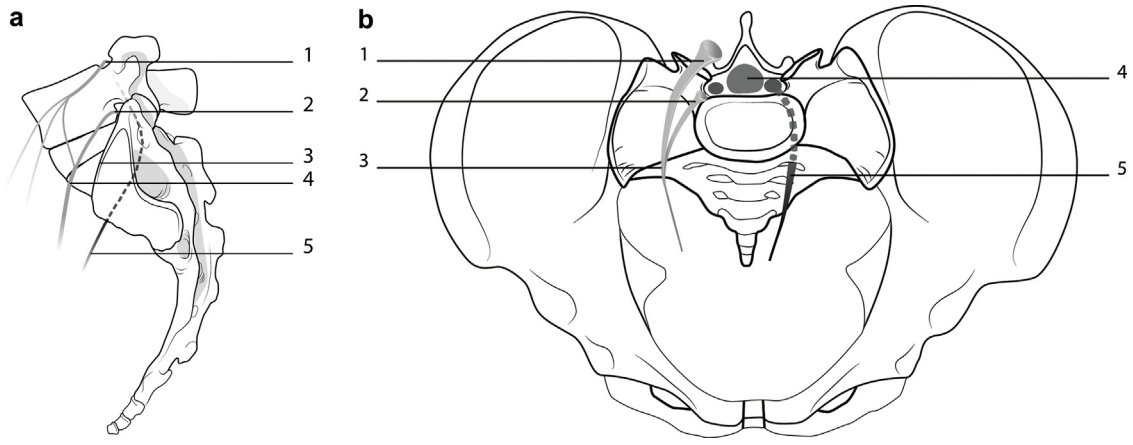

Fig. 2. a: lateral view: 1: L4 root; 2: L5 root; 3: superior pelvic brim; 4: lumbosacral trunk; 5: S1 root; b: inlet view; 1: L4 root; 2: L5 root; 3: lumbosacral trunk; 4: dural sac; 5: S1 root. © Julie Borgese.