The Debate:
How to treat sacral fractures with nerve injuries?

Case 1

This is a 19-year-old female involved as a passenger in a motor vehicle collision. She was stabilized at a referring hospital then transferred to the level 1 trauma center. Her major injury was to the pelvis. She is haemodynamically stable. This was a closed injury with no leg length or rotational abnormality. She had no bowel or bladder injury. There was instability to compression and distraction of her left hemi pelvis. She had too much pain to allow in-line traction to detect cephalad-caudal instability. She complained of “burning pain” in the plantar aspect of her left foot, and was “hypersensitive” to plantar touch. In addition, the dorsum of her left foot had subjectively decreased sensation compared to the right foot. She had full power of dorsiflexion of the foot (5/5) but 4/5 power of plantarflexion. Representative plain radiographs and CT cuts are provided.

What is the treatment required? Do the L5 and/or S1 nerve roots need to be decompressed? If so, what should the timing be—within six hours, 24 hours or one week? What type of pelvic stabilization is required (if any)?

Case 2

This is an 18-year-old male involved as a belted driver in a motor vehicle collision. The impact was on the driver’s side and there was an extrication time of one hour as a result of lateral intrusion of the door. His injury is confined to the pelvis and he is complaining of pain radiating down his right leg to the plantar aspect of the foot. He is haemodynamically stable. This was a closed injury with no leg length or rotational abnormality. He had no bowel or bladder injury. He had no instability to compression and distraction of the left hemi pelvis, but there was pain with compression on the right. There was subjectively decreased sensation on the dorsal and plantar aspect of the right foot, but there was full power of all motor groups. Does this individual require decompression on an urgent (within six or 24 hours) or semi-elective basis (within 1-2 weeks)? If decompression is indicated, is pelvic stabilization required, and if so, what type?

If this individual presented at three months with similar clinical findings (ie, radiation of pain down the right leg to the bottom of the foot) what should be the management—investigation, observation, medical and/or surgical treatment?
Case 1

The patient has a left-sided displaced Denis Zone 2 sacral fracture, with what appears to be primarily a left S1 radiculopathy, with a lesser degree of L5 involvement. Due to a combination of sacral malalignment and adjacent comminution, the patency of the left S1 ventral foramen is noted to be diminished on the single axial CT image. There are many factors that come into play when considering the potential usefulness of a left S1 foraminal decompression. It is important to keep in mind that only one-third of the cross-sectional area of the S1 ventral foramen is occupied by the S1 nerve root. This allows for a considerable degree of stenosis without associated nerve root compression. It is likely that restoring sacral alignment alone will result in acceptable patency of the S1 foramen and of any substantial compression of the L5 root as it courses between the L5 transverse process and the sacral ala. The presence of ongoing radicular symptoms alone does not constitute an indication for decompression, since the preponderance of these symptoms are likely the result of trauma to the nerve root at the time of injury and at the maximal fracture displacement, rather than due to ongoing compression. The anterior sacral comminution adjacent to the course of the L5 root corroborates this likelihood as it pertains to the L5 symptoms as well. For this same reason, I also see little role for electrodiagnostic testing.

Case 2

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Postoperative photos shown on page 42.

Fig 1–4
1 Injury AP pelvis
2 Injury outlet pelvis
3 Injury inlet pelvis
4 Injury CT
The decision for decompression is complex and is contingent on the proposed treatment of the pelvic ring injury. Given the displacement of the left hemipelvis that is particularly evident on the AP and inlet radiographs, an open reduction is strongly considered. The findings on the axial CT image further support an open reduction of the posterior pelvis. In addition to left sided displacement of the hemipelvis, the anterior comminution, and the fragmentation extending into the S1 tunnel, there is anterior opening of the right sacroiliac joint. In addition, there are multiple associated anterior pelvic fractures which further contributed to the overall instability pattern. Since an open reduction of the sacrum through a posterior approach is planned, we would recommend a decompression at the same time. Adding a decompression to the open reduction would ensure S1 foraminal patency without adding appreciably to the morbidity of the procedure. Since the reduction is likely to produce interdigitiation of the fracture surfaces, the creation of a bony window and following the S1 root through its ventral foraminal exit with removal of any obstructing fragments is unlikely to substantially alter the stability of the reduction. Therefore, the addition of a decompression should not significantly escalate the patient care associated with the operative plan for internal fixation. Ultimately, stabilization of the left sacral fracture could be accomplished with an iliosacral screw in isolation or combined with a second iliosacral screw, a tension band plate, or lumbopelvic fixation. The anterior right sacroiliac widening could be treated with a percutaneous iliosacral screw. Depending on the stability of the entire pelvis following fixation of the posterior ring injuries, the anterior pelvis could be stabilized with open reduction and plating, external fixation, or perhaps no fixation at all.

In short, although the potential for improvement of the radiculopathy is uncertain, the low morbidity of doing so would warrant proceeding with decompression. If there is concern that decompression in a given fracture pattern would compromise the stability of the reduction, the decision becomes more complicated, but we would have a low threshold for proceeding with decompression and then stabilizing the fracture in a more robust manner, such as with lumbopelvic fixation.

Further Comment to Case 1 by Bellabarba and Nork

In the unlikely event that the sacral fracture must be treated (due to associated soft tissue trauma, inability to be positioned prone, etc) with closed reduction and stabilization methods, we would not recommend primary decompression. A post-operative CT scan could be obtained to reassess the degree of residual foraminal stenosis. If substantial foraminal stenosis is noted and the patient’s symptoms show no improvement over the course of 2-4 weeks, a foraminal decompression could be performed. This delay in decompression allows for clinical evidence of the (probable) gradual resolution of the radiculopathy to manifest itself prior to subjecting the notoriously compromised posterior soft tissue to an incision and the associated soft tissue complications. This same delay allows for improvement of the soft tissue condition, thus lowering the potential for associated wound complications in the event that radicular symptoms do not improve and a decompression is eventually performed. Again, given the likelihood that the radicular symptoms, in the majority of cases, are more a function of the initial trauma than to ongoing compression, the indications for urgent decompression of the S1 nerve root in the above circumstances are limited.

Tim Pohlemann

Case 1 This is a typical unstable, displaced AO/OTA C-type injury. Injury patterns are a transforaminal sacrum fracture (as seen in the selected CT cuts) with comminution and a displaced free fragment within foramen S2), combined with displaced bilateral transpubic fractures. The neurology described is more or less typical for this type of fracture pattern. Supposing the general condition is adequate, an early decompression would be the protocol at my institution. This would be 24 to 48 hours after injury, when the best infrastructure can be supplied. The technique would be first prone position, posterior approach, removal of free fragment(s) after distraction of fracture (further CT analyses required) anatomic reduction oriented on the posterior lamina as primary fracture line and stabilization. In this young an individual, a “local plate stabilization” would be performed. Alternatives are percutaneous S1 screws or an ilio-iliacal plate, preferably LCP. After closure the patient would be turned over and a percutaneous supraacetabular external fixator would be used for final reduction and stabilization of the anterior ring. This fixator would be kept in place for three weeks. If at this point a removal of the connection bar will not lead to pain with mobilization the external fixator will be removed, otherwise it will be kept in place for another 7 to 14 days. The patient is mobilized with partial weight bearing left for 6 to 8 weeks.

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Case 2 The degree of S1 foraminal narrowing in this patient is not particularly severe, particularly in light of the anatomic issues discussed in the previous case. The radicular symptoms are also less severe, as there is no radicular weakness. Although he has some sensory loss, the CT scan axial images show no overt compression although some alteration of the normal anatomy does exist. As far as the pelvic ring injury, there is minimal associated deformity. Although the sacral fracture line does traverse from anterior to posterior, it is unlikely that this lateral compression injury will be associated with any significant pelvic ring instability. Examination of the pelvis under anesthesia could be used to assist with the
assessment of the ring stability, although it is probably not warranted in this instance. Based on the physical exam and imaging findings, the pelvic ring injury would be treated nonoperatively by most surgeons. Decompression would be a low yield procedure and would not be recommended in this case. A sacral decompression in this instance could actually negatively impact the care of this patient as it has the potential to produce pelvic instability requiring posterior pelvic fixation. Therefore, we would treat this patient nonoperatively. Given the relatively small degree of right S1 neuroforaminal narrowing, we would likely recommend continued nonoperative care even if the patient’s radiculitis did not resolve completely over time.

Tim Pohlemann
Case 2  This is also unstable, but only a minimally displaced C-type pelvic ring fracture with transforaminal (as seen on the provided CT-cuts) sacrum fracture combined with a minimally displaced transpubic injury left. The neurology is not obvious, but more or less minimal and only verified subjectively. The provided CT-cuts show only a minimal deformity of the depicted foramen, with neglectable multifragmentary bone fragments not significantly compromising the foramen diameter. Taking into account that the quantity of “spare volume” in this anatomical region is high, in our protocol a closed in situ percutaneous transiliac sacral screw fixation in a supine position would be performed early (24-48 hours after injury) depending on the infrastructure. Also in this case a percutaneous simple supraacetabular fixator would be applied, allowing immediate, pain-free mobilization.

At late presentation with pain and neurological findings, one would expect different findings in the CT-scan. In those cases, extended diagnostic including electrophysiology and MRI would be used to ensure nerve root compression. If the findings are sound, a posterior laminectomy and decompression would be performed, which from the clinical experience was never necessary in similar cases.

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Summary by David Stephen

Case 1  This is a high energy injury referred following a motor vehicle collision of a type-C pelvic injury, with a zone 2 (transforaminal) sacral fracture and bilateral superior and inferior pubic rami fractures. The radiographs and CT scan show posterior ring displacement and instability with a fragment of bone in the foramen. On clinical exam this patient had significant dysesthesia of the plantar aspect of her foot corresponding to the S1 distribution. Motor power was present but abnormal (3/5 power) in the S1 distribution. The L5 function was normal. This corresponds to the findings on CT scan of a fragment in the sacral foramen.

Controversy exists as to the merits of sacral decompression. The original classification of sacral fractures proposed by Denis et al based on 236 cases noted that some fractures (zone 2 and 3) benefit from decompression [1]. Unfortunately, the literature remains inconclusive as to which sacral fracture patterns, if any, should be decompressed. Most studies are small, retrospective cohorts with a combination of injury patterns. Most report a benefit of decompression for injury patterns that involve the central sacrum—the so-called “transverse, H, or U type” injuries [2,3]. These occur most often as a result of a fall from a height and less commonly from a motor vehicle collision.

A recent article from Zelle et al, reported a benefit in 6 patients undergoing decompression (compared to 7 who did not) for neurologic injury [4]. Of the 177 patients admitted with sacral fractures, only 13 had neurologic injury reflecting a very low incidence of the problem.

The merits of decompression for this patient were based on the fact that there was a significant neurologic injury corresponding to radiographic findings—S1 dysesthesia with a fragment of bone in the foramen. Although the nerve root occupies only a third of the foramen, it was felt in this case that the nerve was being compressed by the fragment accounting for the neurologic findings. Moreover, the injury pattern was a displaced zone 2 sacral fracture that required posterior surgical stabilization. Thus at the time of open reduction internal fixation a decompression could be performed.

The surgery was performed in stages, with the first done prone. A vertical incision was used, off the prominence of the posterior superior iliac spine. After elevation of the gluteus maximus, the sacral fracture was identified. Distraction of the fracture allowed visualization of the S1 nerve root and removal of bone fragments. Direct reduction of the sacral fracture was undertaken. Stabilization was achieved with a S1 body screw and a posterior tension band plate (3.5 mm), with a second vertical incision. The patient was then flipped to the supine position and an external fixator was applied to control the bilateral superior and inferior pubic rami fractures.

In the recovery room the patient noted an improvement in the sensation in the plantar aspect of the foot and a resolution of the dysesthesia. At three months the patient continues to have intact sensation and power in the L5 and S1 distribution.

Case 2  This is a lateral compression injury following a high energy injury. The patient complained of low back and anterior lower abdominal pain attributed to the pelvic fracture. The initial AP radiograph shows only slight internal rotation of the left hemipelvis, but the CT reveals compression of the S1 sacral foramen as well as an undisplaced zone 2 fracture of the right sacrum.

Treatment consisted of gradual protected weight-bearing and close follow-up with radiographs (every week for the first two weeks then 3-4 week intervals up to three months).

At 3-month follow-up the patient complained of low back pain and radiation of pain down the left leg in the distribution of the S1 nerve root. There was no internal rotation deformity of either leg, and there was no leg length discrepancy. The radiographs reveal only slight internal rotation of the hemipelvis. The sacral foramen are well visualized. The patient was treated with gabapentin and nortriptyline for neurogenic pain.

The benefit of decompression is far less clear than in case 1. The procedure would involve decompressing the S1 nerve root through a healed sacrum. More importantly there would be an unpredictable outcome. At present the patient continues to be followed.

Bibliography


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