

Sacral Fracture

A patient guide

In brief: A sacral fracture is a break in the large triangular bone at the base of the spine, where the spinal column meets the pelvis. These injuries cover an enormous range, from quiet cracks in thinned bone that cause vague back or buttock pain in older people, through to severe high-energy injuries that uncouple the spine from the pelvis and threaten the nerves controlling the legs, bladder and bowel. Because the sacrum sits awkwardly between the worlds of spinal surgery and pelvic trauma, and because it is poorly seen on ordinary X-rays, a sacral fracture is one of the more frequently missed injuries in the whole of musculoskeletal practice.

What a sacral fracture is (and why it sits between spine and pelvis)

The sacrum is the keystone of the lower skeleton. It is a single triangular bone formed from five vertebrae that fuse together during growth, wedged between the two halves of the pelvis and joined to them through the sacroiliac joints. Above it sits the lumbar spine; below it hangs the small tail bone, the coccyx. In structural terms the sacrum has a dual job. It is the back wall of the pelvic ring, transmitting the weight of the upper body down through the sacroiliac joints into the hip bones and onwards into the legs, and at the same time it is the lowest part of the spinal column, housing the terminal spinal nerves.

This dual identity is the single most important idea behind sacral fractures. A break here is simultaneously an injury to the pelvic ring and a potential injury to the spinal nerves. The pelvic surgeon sees a posterior pelvic ring lesion; the spinal surgeon sees the caudal end of the spine. Neither description, on its own, captures the whole picture, and an injury that is understood only as a pelvic problem may have its neurological dimension overlooked, while one understood only as a spinal problem may have its effect on pelvic stability missed.

The nerves involved deserve particular attention. The sacrum protects the sacral nerve roots, numbered S1 to S5, together with the lower end of the cauda equina, the bundle of nerves descending from the spinal cord. The upper sacral roots contribute to the muscles and sensation of the legs. The lower sacral roots, principally S2, S3 and S4, govern the bladder, the bowel and sexual function, along with sensation in the saddle area, the region of the body that would contact a saddle when sitting astride. A fracture that disturbs these lower roots can therefore have consequences that reach well beyond pain and stiffness.

Sacral fractures span a vast severity range. At one end lies the low-energy insufficiency fracture, a hairline break in osteoporotic bone in an older person, sometimes after a trivial stumble and sometimes after no remembered injury at all. At the other end lies the high-energy fracture sustained in a road collision or a fall from a height, often part of a wider unstable pelvic injury, and sometimes involving a pattern that separates the spine from the pelvis entirely. Understanding where a given fracture sits on that spectrum is the foundation of everything that follows.

Why it is frequently missed

Few fractures are missed as often as those of the sacrum, and the reasons are worth setting out plainly, because they explain why diagnosis is sometimes delayed by days or weeks.

The first reason is that the sacrum is genuinely difficult to see on ordinary X-rays. The bone is curved, it lies obliquely within the pelvis, and it is overlaid by bowel gas, faecal shadowing and the dense bones of the pelvic brim. The sacroiliac joints and the natural contours of the bone create lines that can hide a fracture or mimic one. As a result, a plain radiograph that looks unremarkable does not reliably exclude a sacral fracture, and a significant proportion of these injuries are invisible on the films that are taken first.

The second reason applies to high-energy trauma. When a person arrives after a major collision or fall, attention is naturally drawn to the most obvious and most immediately threatening injuries. A fracture of the sacrum, and the subtle neurological signs that accompany it, are easily overshadowed by more dramatic findings elsewhere. Unless the lower sacral nerve function is examined deliberately, including saddle sensation, anal tone and bladder function, a neurological injury can go unrecorded in the early hours.

The third reason applies to older people with insufficiency fractures. Here the fracture announces itself only as low back, buttock or groin pain, often without any clear injury to explain it. This picture is easily attributed to ordinary degenerative back pain, to a flare of arthritis, or, more worryingly, mistaken for the bone pain of cancer that has spread. Because the pattern is non-specific and the X-rays are frequently normal, the correct diagnosis can be reached only when someone thinks of it and arranges the right scan.

The fourth reason is conceptual rather than technical. Because the sacrum belongs to two specialties at once, it can fall into the gap between them. A pubic ramus fracture seen at the front of the pelvis may be treated as an isolated injury when in fact it is paired with a hidden sacral fracture behind, the so-called missing posterior lesion. A normal examination of the arms and legs may be taken as reassurance when the relevant nerves are the sacral roots that were never specifically tested.

The practical consequence of all this is that the diagnosis of a sacral fracture depends heavily on a deliberate index of suspicion, on cross-sectional imaging rather than plain films, and on a focused examination of the lower sacral nerves. None of this is advice to any individual; it is simply the explanation that runs through the literature for why this particular fracture earns its reputation as one of the most commonly overlooked.

The Denis zones and the nerve-injury gradient

The most enduring way of describing a sacral fracture was set out by Denis and colleagues in 1988, in a retrospective analysis of 236 cases. They divided the sacrum, from the outside inwards, into three vertical zones, and showed that the zone in which a fracture lies predicts how likely it is to injure nerves and which nerves are at risk. This zone-to-nerve-injury gradient remains one of the most useful single concepts in the field.

****Zone I, the alar zone****, lies to the outer side of the holes through which the nerves exit, in the wing of the sacrum. Fractures here are the most common and carry the lowest risk of nerve injury, on the order of one in twenty. When a nerve is affected, it is typically the L5 root, which runs across the front of the sacral wing, producing leg symptoms rather than disturbance of bladder or bowel.

****Zone II, the foraminal zone****, runs through the line of the nerve exit holes themselves, the sacral foramina. Fractures here carry an intermediate risk of nerve injury, classically reported at around one in four. The roots most likely to be affected are L5, S1 and S2, again producing predominantly leg symptoms, although the involvement of the foramina means that displacement can pinch the nerves as they pass through.

****Zone III, the central or transcanal zone****, involves the midline of the sacrum and the central canal that carries the cauda equina and the lower sacral roots. This is the zone with by far the highest risk of nerve injury, reported in the region of one in two, and crucially it is the zone most associated with disturbance of bladder, bowel and sexual function, because the fracture crosses the territory of the S2 to S4 roots. Many of the transverse and U-shaped fractures described below fall into this central zone.

The gradient, then, runs from roughly six per cent in Zone I, to around twenty-eight per cent in Zone II, to about fifty-seven per cent in Zone III in the original series. The numbers vary between studies, but the direction is consistent and clinically meaningful: the more central and the more transverse the fracture, the greater the likelihood that nerves are involved, and the more likely that the nerves involved are those governing the bladder, bowel and sexual function rather than simply the legs.

A more recent system, the AO Spine Sacral Classification, published in 2016 and refined since, brings the pelvic and spinal viewpoints together into a single language. It describes lower, ring-sparing injuries as Type A, posterior

pelvic vertical injuries as Type B with sub-types that echo the Denis zones, and spinopelvic dissociation as Type C, and it records the neurological status separately using its own modifiers. The Denis zones and the AO Spine types are complementary rather than competing, and both are used in current practice.

Insufficiency fractures vs high-energy fractures

Running underneath every classification is a more fundamental division, one that shapes how urgently a fracture is investigated and how it is treated. This is the split between the low-energy insufficiency fracture and the high-energy fracture.

The insufficiency fracture was first described as a distinct entity by Lourie in 1982, under the heading of spontaneous osteoporotic fracture of the sacrum, an unrecognised syndrome of the elderly. The typical picture is an older person, more often a woman, with osteoporotic bone, who develops low back or buttock pain after a minor stumble or with no injury at all. The bone has simply become too weak to bear ordinary loads, and it gives way under the normal stresses of standing and walking. Certain factors increase the risk, including long-term corticosteroid use, previous radiotherapy to the pelvis, and inflammatory conditions such as rheumatoid disease. These fractures are frequently bilateral, running down both wings of the sacrum, sometimes joined by a horizontal component to form an H or U shape, and they are usually neurologically intact, meaning the nerves are not affected.

The high-energy fracture is a different animal. It is sustained through major force, in road collisions, in falls from a height, or in crush injuries, and the patient is more often younger and frequently has other serious injuries. These fractures are commonly part of an unstable pelvic ring disruption, in which the front and the back of the pelvis are both broken and the bone fragments can shift. They carry a much higher rate of nerve injury, especially when the fracture is central or transverse, and they may involve the spinopelvic dissociation patterns described next.

The reason this distinction matters so much is that it drives completely different pathways. The low-energy insufficiency fracture is, in the great majority of cases, a problem of pain control, gradual return to movement and attention to bone health, and the underlying message is one of healing and recovery. The high-energy fracture is a problem of stability and of nerve protection, often demanding more intensive assessment and, in unstable or nerve-threatening patterns, surgery. Two injuries that share the name sacral fracture can therefore sit at opposite ends of the clinical world.

U-type fractures and spinopelvic dissociation

Among the high-energy patterns, one group stands apart for its severity and for the way it behaves more like a spinal injury than a pelvic one. These are the transverse and U-shaped fractures that produce spinopelvic dissociation.

The transverse fracture of the upper sacrum was described by Roy-Camille and colleagues in 1985, who recognised it in people who had fallen or jumped from a height and landed in a way that loaded the sacrum from above, hence the historical label of the suicidal jumper's fracture. They divided it into sub-types according to how the upper fragment had angled and slipped, and a further sub-type involving comminution of the first sacral segment was later added by Strange-Vognsen and Lebech in 1991.

A U-shaped fracture, and its close relatives described as H, lambda or T shaped, combines two vertical fractures running down both sides of the sacrum through the foraminal zone with a horizontal fracture crossing between them. The effect is to cut the upper sacrum, and with it the entire spine above, free from the lower sacrum and the pelvis below. This is what is meant by spinopelvic dissociation: the connection between the spinal column and the pelvis is broken across the sacrum itself.

These injuries matter for three reasons. First, they are highly unstable, because the weight-bearing link between spine and pelvis has been disrupted. Second, they tend to collapse into a kyphotic, forward-bent position as the upper fragment tips, which can drive bone backwards into the central canal. Third, and most importantly, because

they pass through the central zone where the cauda equina and the lower sacral roots lie, they carry a high rate of nerve injury, including disturbance of bladder, bowel and sexual function. For all these reasons, U-type fractures and spinopelvic dissociation are recognised as a category demanding the most careful assessment, and they are the pattern most often treated with surgery to realign and stabilise the bone and, where needed, to relieve pressure on the nerves.

How it tends to present (incl. bladder/bowel involvement)

The way a sacral fracture announces itself depends almost entirely on which of the two phenotypes it is.

The low-energy insufficiency fracture usually presents quietly. The dominant symptom is pain felt in the low back, the buttock, the groin or the back of the pelvis, often worse on standing and walking and eased by lying down. There may be no memory of injury, or only a minor one. The person may simply find themselves unable to mobilise as before, and the pain may be put down to age or to ordinary back trouble for some time before the fracture is identified. In most of these cases the nerves are unaffected.

The high-energy fracture presents in the setting of major trauma, alongside the other injuries of a serious collision or fall. Here, pain at the back of the pelvis, bruising, swelling and an inability to bear weight may all feature, but the most important findings are neurological. Involvement of the sacral nerves can show itself as weakness or altered sensation in the legs when the upper roots are affected, and as a distinct cluster of features when the lower roots are affected.

This lower-root cluster is the one that gives sacral fractures their particular significance, and it deserves describing factually. The S2 to S4 roots carry the nerve supply to the bladder, the bowel and the sexual organs, together with sensation in the saddle area. When these roots are injured, the recognised consequences can include difficulty passing or controlling urine, including retention of urine or loss of bladder control; disturbance of bowel control; loss of normal sensation in the saddle region; reduced tone of the anal sphincter; and disturbance of sexual function. Together with leg symptoms, this combination is the picture of a cauda equina injury arising from the sacral end of the spine. These features are most strongly associated with central, Zone III and U-shaped fractures, which is precisely why such fractures are regarded as the most serious and are examined and monitored with the greatest care. None of this describes any particular person's situation, and the presence or absence of such features in any individual is a matter for direct assessment.

How it is assessed (X-ray limits, CT, MRI)

The assessment of a sacral fracture is shaped by the well-recognised limitation of the plain X-ray. As described above, the sacrum is poorly shown on ordinary radiographs because of its curved shape, its oblique position and the overlying bowel and pelvic bone. Plain films have a low sensitivity for these fractures, which means a normal film does not exclude one, and this is the single largest contributor to delayed diagnosis.

The reference standard for showing the bony injury is **computed tomography, the CT scan**. With modern scanners and reconstructed images in the side-to-side and front-to-back planes, CT demonstrates the fracture lines clearly, reveals the transverse components that signal a U-shaped pattern, and shows the degree of displacement and any bone projecting into the canal. CT is essential for distinguishing a simple vertical fracture from a spinopelvic dissociation, and it is the investigation that most reliably defines what kind of fracture is present.

Magnetic resonance imaging, the MRI scan, has two particular strengths. It is the most sensitive test for the gentle insufficiency fracture, because it shows the swelling within the bone marrow that marks a fresh break long before any change is visible on X-ray, and it can therefore confirm a fracture that other tests have missed. It is also the best way to look at the nerves themselves and to assess whether they are being compressed, which is central to the evaluation of any fracture suspected of involving the cauda equina.

Bone scintigraphy, the bone scan, retains a place, particularly in insufficiency fractures. It can show a characteristic pattern of increased uptake shaped like the letter H, produced by uptake in both sacral wings joined

by a horizontal band, known as the Honda sign after the car maker's logo. The complete H, however, is seen in only a minority of cases, somewhere between a fifth and two fifths, with partial patterns being common, so its absence does not exclude a fracture.

Alongside imaging, a focused neurological examination of the lower sacral nerves, covering saddle sensation, anal tone, and bladder function, is a recognised and important part of assessment, because the imaging and the nerve examination together define both the structural and the neurological dimensions of the injury.

What the evidence shows about management (conservative vs sacroplasty vs lumbopelvic fixation) — impersonal

It is important to be clear at the outset that the evidence base for treating sacral fractures is built almost entirely on retrospective series, classification and reliability studies, biomechanical experiments and narrative reviews. There are no adequately powered randomised trials comparing operative with non-operative treatment of unstable sacral fractures, nor comparing cement augmentation with conservative care using firm functional endpoints. The recommendations that exist are therefore consensus-based and series-driven, and decisions in practice are individualised. What follows is a description of what the literature reports, not guidance for any person.

****Conservative, non-surgical management**** is the mainstay for the great majority of stable fractures, and in particular for low-energy insufficiency fractures in older people. The reported approach centres on pain relief, a gradual and supported return to movement, and attention to the underlying causes, including assessment of bone health and the risk of further falls. The natural history of most insufficiency fractures is one of healing over a period of weeks to a few months, and the literature is broadly reassuring about their outlook when managed in this way.

****Sacroplasty**** is a minimally invasive, keyhole procedure in which bone cement is injected into the fractured sacrum through the skin, with the aim of stabilising the fracture and reducing pain. Systematic reviews of the published case series report substantial reductions in pain in carefully selected patients with insufficiency fractures, with a low rate of clinically significant complications. The commonest complication is leakage of cement beyond the bone, which in most reported cases causes no symptoms. The evidence remains drawn from case series rather than randomised comparison, so its place is described as an option for selected patients with persistent pain rather than as an established standard.

****Surgical fixation**** is reserved in the literature for unstable, displaced fractures and for those compressing the nerves. Several techniques are described. For unstable vertical fractures, lumbopelvic fixation, also called triangular osteosynthesis, was developed by Schildhauer and colleagues; it combines vertical fixation linking the lumbar spine to the pelvis with horizontal screw fixation across the sacrum, and it is reported to be strong enough to allow earlier weight-bearing. For less displaced, non-comminuted fractures, percutaneous iliosacral screws placed through the skin offer a less invasive form of fixation. Where there is significant or progressive compression of the cauda equina with a neurological deficit, decompression to relieve pressure on the nerves is generally advocated alongside fixation, although the literature on the optimal timing of decompression is observational and the question remains debated. Open posterior surgery carries a recognised burden of wound and soft-tissue complications, which the published series document carefully.

In summary, the evidence points towards conservative care for stable and insufficiency fractures, with sacroplasty as an option for refractory pain, and reconstructive surgery with or without decompression for unstable and nerve-threatening patterns, all within a framework of individualised, shared decision-making rather than fixed rules.

Outlook

The outlook after a sacral fracture varies as widely as the fractures themselves. For the low-energy insufficiency fracture, the general picture reported in the literature is encouraging: the bone tends to heal, the pain settles over

weeks to months, and most people return towards their previous level of activity, particularly when bone health and fall risk are addressed. The principal challenges in this group are the discomfort and reduced mobility during healing, and the recognition that an insufficiency fracture is often a marker of underlying bone fragility.

For high-energy fractures, the outlook depends heavily on the pattern, the stability and, above all, the neurological involvement. Fractures that have not damaged the nerves and that heal in good alignment generally do well in structural terms. Where the lower sacral nerves have been injured, recovery can be incomplete, and disturbances of bladder, bowel or sexual function may persist to varying degrees; this is one of the reasons such injuries are taken so seriously and monitored so closely. Spinopelvic dissociation, being both unstable and frequently associated with nerve injury, sits at the more demanding end of the spectrum.

Across the whole field, the consistent themes are that early and accurate diagnosis improves the chances of a good result, that the zone and pattern of the fracture predict the neurological outlook, and that recovery is best understood as a gradual process shaped by the individual injury. The variation is wide, and any individual outlook is a matter for assessment by the treating team rather than something that can be read from a category alone.