CASE REPORT

Longitudinal Midline Sacral Split Fracture – A Rare Entity

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SUMMARY

Fractures involving the central canal of the sacrum are rare injuries and can be transverse or longitudinal. Transverse fractures are by far common and associated with high incidence of neurological injuries. On the contrary, longitudinal midline split fracture is an extremely rare injury with minimal or no neurological injury. They are always associated with anterior pelvic ring fracture and are vertically stable needing only fixation of the anterior pelvic injury. Plating of the anterior pelvic ring in two planes would be beneficial than single plate to prevent gradual loss of reduction.

BACKGROUND

Sacral fractures usually occur in combination with pelvic injuries. Denis *et al* classified sacral fractures depending on the zones through which fracture lines propagate.¹ High incidence of nerve injury is reported with the common transverse sacral fractures which run along the central canal (type III).² An extremely rare type of midline sagittal split fracture of the anterior sacrum through the central canal can occur which is associated with minimal neurological deficits. The purpose of this article is to describe a similar fracture and understand the pathomechanics and principles of treating this fracture.

CASE PRESENTATION

A 55-year-old man presented after a road traffic accident with complaints of low back ache, left hip pain, inability to bear weight on both lower limbs and haematuria. After the injury he had passed urine twice and on both occasions it was blood stained. There was no history of loss of consciousness.

Figure 1 Anteroposterior radiograph of the pelvis showing pubic diastasis (symphysis distance 3.2 cm), intact sacroiliac joints, normal L5 transverse process and normal hip joints without vertical pelvic instability. The sacral fracture is not quite evident.

Figure 2 Thin slice axial CT scan image showing the anterior midline sacral split fracture in zone III involving the anterior and left posterior elements with intact sacroiliac joint (A). Coronal image showing longitudinal midline split fracture with intact sacroiliac joint (B). Coronal image showing pubic diastasis (C). Coronal 3D image showing the sacral fracture involving anterior and posterior segments extending to the sacrococcygeal joint and pubic diastasis (D, E). Vertical stability is obtained by the incomplete fracture of the posterior element of S1 body.

On clinical examination, he was conscious and oriented, but hypotensive (96/60 mm Hg) with tachycardia (HR 110/min). There were no open wounds. The abdomen was soft, but there was hypogastric tenderness, a palpable bladder, scrotal haematoma and blood at the urethral meatus. The pelvis distraction test was positive and there was tenderness posteriorly over the lumbosacral spine. There were no motor or sensory deficit and deep tendon reflexes and bulbocavernosus reflex were normal. Urgent resuscitation with colloids and blood was initiated and a pelvic binder was applied to stabilise the patient. He was evaluated by the urologist who inserted a per-urethral Foley catheter.

INVESTIGATIONS

Anteroposterior (AP) pelvic radiograph showed pubic diastasis with intact ramus, sacroiliac joints and normal hip joint (figure 1). Radiographs of the

Figure 3 Axial MRI image showing the zone III sacral fracture with sparing of nerve roots.

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Figure 4 Immediate postoperative anteroposterior radiograph following open reduction and recon plating of pubic symphysis showing good reduction of the anterior pelvis (symphysis distance 9 mm).

dorsolumbar spine were normal. Ultrasonogram of the abdomen revealed minimal free fluid and a distended bladder with few echogenic shadows suggestive of haemorrhagic clots without evidence of solid organ injury. Bilateral lower limb arterial Doppler scan was normal.

Contrast enhanced CT scan showed haemoperitoneum, haemoscrotum, presacral soft tissue thickening, pubic diastasis of 3.2 cm and longitudinal midline split fracture of the body of the sacrum extending into the posterior elements on left from S1 to S3 and thereafter involving midline posterior elements (sacral hiatus) from S4 to S5. The fracture line extended into C1 of coccyx in the right paramedian aspect (figure 2A–E).

MRI showed intact sacroiliac ligaments and sparing of the nerve roots (figure 3).

TREATMENT

Two days after the injury, he underwent open reduction and internal fixation of the pubic diastasis with a five-hole non-locking recon plate by Pfannenstiel approach. Since the sacral fracture was vertically stable, only anterior pelvic fixation was done (figure 4). Postoperatively the pelvic binder was reapplied and the patient was mobilised on the second postoperative day with the support of a walker. Foley catheter was removed after 1 month and he was able to pass urine normally.

OUTCOME AND FOLLOW-UP

Patient was under regular follow-up. By 6 months the sacral fracture had united, but there was mild loss of reduction anteriorly (symphysis distance 2 cm). At final follow-up, 1 year after the surgery, he remained asymptomatic without pain or neurological deficits and normal urethral function (figure 5).

Figure 5 Anteroposterior radiograph of the pelvis at 1 year showing partial loss of reduction of anterior fixation (symphysis widening of 2 cm), but union of the midline sacral fracture without vertical instability.

DISCUSSION

Pelvic fractures commonly occur as part of polytrauma. The incidence of sacral fractures in pelvic injuries varies from 10% to 45%.^{2,3} Isolated fractures of the sacrum are less common and are mostly transverse (4.5%). The classification system proposed by Denis *et al* is widely used for sacral fractures (table 1).¹ Most common sacral fractures are either compression or avulsion fractures of the sacral ala or the sacral foramina due to lateral compression force and are associated with neurological injury. Most longitudinal fractures occur in zones I and II.⁴

The midline sagittal fracture of the sacrum which occurs as a result of anteroposterior compression (APC) pelvic injury (orthopaedic trauma association type 61-B1) is a variant of zone III longitudinal fracture and usually does not have significant neurological injury.² They are usually associated with pubic diastasis and/or pubic rami fracture. They are very uncommon and only few cases are reported in English literature (table 2).^{3,5–9} Unlike the reported cases which had only fracture of the anterior segment of sacrum, our case was unique in that the fracture line involved both anterior and posterior half of the sacrum, but still was vertically stable.

Ebraheim *et al* and Carter *et al* stated that vertical sacral fractures can be associated with low-lying dural sac and spina bifida (due to stress riser effect).^{3,4} Transverse fractures, also called as jumpers fracture, occur due to direct blow to sacrum (fall from height), commonly seen in suicidal attempts, and occur at S2–S3 level. S1 and S2 are stable as they articulate with the ilium and the S2–S3 level forms the apex of the sacral kyphosis. Thus, when the impact occurs, the coccyx acts as a lever arm leading to fracture at S2–S3 level.^{3,4} Oblique and transverse fractures can run through all the three sacral zones (central canal, neural

Table 1 Denis's classification of sacral fractures

Type	Zone	Features	Treatment
1	Sacral ala (lateral to sacral foramina)	Low incidence of neurologic injury (5.9%) Partial damage to L5 nerve root	Non-operative Iliosacral screws (open or percutaneous) Transiliac rod fixation Ala transverse fusion
2	Through sacral foramina but not medial to it	Incidence of neurological injury (28%) Involve unilateral sacral or L5 nerve roots Associated with sciatica Bladder dysfunction is uncommon as it is a unilateral injury	Non-operative Iliosacral screws (open or percutaneous) Nerve root decompression and transiliac rod fixation
3	Through the central canal	Can be transverse (the most common), transverse with transforaminal longitudinal (U, H or Y fracture configuration) or oblique longitudinal (least common) fractures which run medial to neural foramina or through the central canal Transverse fractures have the highest incidence of neurological deficit (57%), bilateral pudendal nerve injury leading to saddle anaesthesia and loss of sphincter function	Decompressive laminectomy Transiliac rod fixation Anterior pelvic fixation +/- decompression and transiliac rod fixation

Table 2 List of longitudinal midline sacral slit fractures reported in English literature

Serial number	Author	Year reported	Mode of injury	Associated pelvic injury	Treatment
1	Krezel	1967	RTA	Superior pubic rami #	Bed rest
2	Northrop	1975	RTA	None	Bed rest
3	Wiesel <i>et al</i>	1979	Fall from height	Pubic diastasis	Pubic ORIF
4	Moed and Morawa	1984	Fall from height	Pubic diastasis	Pelvic sling
5	Carter <i>et al</i>	1990	Fall from height	Pubic diastasis	Pubic ORIF
6	Ebraheim Nabil	1993	RTA	Anterior pelvic #	Decompression and transiliac rod
7	Ebraheim Nabil	1994	RTA	Complex pelvic #	Total sacral laminectomy
8	Ebraheim Nabil	1994	RTA	# dislocation of left L5-S1, left L5 lamina #	Posterior sacral decompression and transiliac fixation
9	Ebraheim Nabil	1997	RTA	None	Non-operative
10	Hatem	1996	Fall from horse	Pubic diastasis	Pubic ORIF
11	Kaneko <i>et al</i>	2001	RTA	Left superior and inferior pubic rami #	Bed rest
12	Bellabarba <i>et al</i>	2003	RTA	Pubic diastasis	Pubic ORIF
13	Bellabarba <i>et al</i>	2003	RTA	Pubic diastasis	Pubic ORIF
14	Bellabarba <i>et al</i>	2003	RTA	Pubic diastasis	Pubic ORIF
15	Bellabarba <i>et al</i>	2003	RTA	Pubic diastasis	Pubic ORIF
16	Bellabarba <i>et al</i>	2003	RTA	Unilateral undisplaced pubic ramus #	Pubic ORIF
17	Bellabarba <i>et al</i>	2003	RTA	Unilateral displaced pubic ramus #	Pubic ORIF
18	Bellabarba <i>et al</i>	2003	RTA	Bilateral pubic rami # with intact symphysis	Bed rest
19	Bellabarba <i>et al</i>	2003	RTA	Bilateral pubic rami # with intact symphysis	External fixation
20	Bellabarba <i>et al</i>	2003	RTA	Pubic diastasis with bilateral pubic rami #	Pubic ORIF
21	Bellabarba <i>et al</i>	2003	RTA	Pubic diastasis with unilateral pubic ramus #	Pubic ORIF

ORIF, open reduction and internal fixation; RTA, road traffic accident,

indicates fracture.

foramina and sacral ala) and have the highest incidence of nerve injury. Transverse fractures can present with flexion angulation or posterior/anterior displacement of proximal fragment.

Midline longitudinal sacral fractures often get missed and a high index of suspicion is necessary to detect them on plain AP pelvis radiograph.³ The sacrum is curved in the frontal plane, and the upper segments are superimposed on one another and thus an AP radiograph may not show the sacral fracture.³ The presence of a displaced anterior pelvic injury (pubic symphysis/ramus) with intact sacroiliac joints and fracture of L5 transverse process should alert the surgeon about the likelihood of a sacral fracture.^{3,4} In our patient's pelvic radiograph also, the midline sacral split fracture was not visualised and it was picked up on the CT scan. An outlet view provides a better AP view of the sacrum, while the inlet view provides better visualisation of the sacral spinal canal. Displaced transverse fractures are best seen on lateral radiographs, while on AP radiograph they show the characteristic step ladder sign.³

For proper fracture delineation, thin slice axial CT images should be asked for which shows the double neural foramina due to overlap of the displaced fracture fragments. The CT scan may also show the associated spina bifida. An MRI may be helpful in diagnosing pre-existing neural abnormalities and nerve root injuries. It can help in planning the treatment as well.³

Neurological injuries occur in around 3%–15% of pelvic fractures and depend on the force, fracture pattern, extent of comminution and displacement.^{2,10} Associated neurological injuries include bowel and bladder dysfunction, loss of perianal sensation and sphincter tone, bilateral foot drop, sexual dysfunction and lumbosacral radicular pain.^{4,11} L5 nerve root is frequently involved in zone I and II fractures due to its compression between L5 transverse process (cranially), sacral ala (caudally), iliolumbar ligament (laterally) and L5-S1 disc (medially).² Unilateral sacral root deficits which are common in zone

II injuries occur due to traction injury or foraminal compression. Neurological deficits in zone III fractures occur due to extrusion of the sacral nerve roots from the canal and stripping of dura mater. Transverse fractures in zone III lead to bowel, bladder and sexual dysfunction due to bilateral sacral root involvement.^{4,10} Other intra-abdominal injuries include rupture of the urethra, the sigmoid colon and retroperitoneal haemorrhage.¹²

Unlike transverse fractures, the longitudinal midline split fracture through the central canal appears less vulnerable to neurological injury. This variant, which is usually seen following an APC pelvic injury, is characterised by external rotation of each hemipelvis and half of the fractured sacral vertebral bodies. Unlike the classic vertically stable APC injury where the intact posterior sacroiliac ligaments provide the posterior hinge, here the posterior sacral elements provide the hinge for the pelvic ring displacement. When the anterior sacroiliac ligaments remain intact, external rotation of the hemipelvis creates a tensile force across the anterior sacrum which produces the midline fracture.² If the force continues, the fracture line could as well run into the posterior elements as noted in our case. The incomplete fracture of the S1 vertebra probably prevented the vertical shearing of the hemipelvis in our patient. Maintenance of the spatial orientation between sacral foramina and greater sciatic notch prevents significant stretching or compression of the lumbosacral roots and plexus, thereby reducing the risk of nerve injury.² In addition, bilateral sacral root involvement is absent which usually causes the bowel and bladder dysfunction. Also, spontaneous drainage of intracanal haematoma is possible in longitudinal midline split fracture which could otherwise lead to secondary compressive neural damage. Sexual dysfunctions are common after APC injuries and its incidence cannot be attributed to sacral root or plexus injury. It has been postulated that the severe pelvic trauma seen in APC injury leads to thrombosis of the arteries in the perineum causing impotence.²

Our patient apart from the pelvic fractures had only bladder and scrotal injury which is most likely due to the direct blunt trauma to his lower abdomen. There was no evidence of lumbosacral root or plexus injury. He regained normal bladder function after removal of the indwelling catheter. Also, he did not have any residual sexual or neurological dysfunction until last follow-up.

Apart from the more complex and displaced transverse fractures, the treatment of most sacral fractures is dependent on the associated pelvic ring disruption (bony and ligamentous).^{10 13} Rapid healing can be expected in midline fractures due to the broad cancellous fracture surface. In general, posterior sacral laminectomy and decompression of the affected sacral nerve roots provide the best possible chance of nerve root recovery.^{10 11 13} Longitudinal fractures in zones I and II may be stabilised with two transiliac sacral compression bars or iliosacral screws. The nerve roots should not get compressed between the fractured fragments during reduction and fixation.⁴ On the contrary, vertical fractures thru the central canal usually involve anterior half of sacrum and do not need fixation as they are stable due to the intact posterior half. Only the associated anterior pelvic fracture needs to be fixed similar to what was done

for our patient. Moreover, since these fractures are vertically stable, patients may be mobilised as soon as permitted by associated injuries and immediate weight bearing as tolerated may be allowed. The reason for subsequent loss of reduction of pubic symphysis in our case could have been due to the superior placement of the plate. Placing the plate anteriorly or using dual anterior and superior plates might have prevented the loss of reduction by counteracting the tensile forces on the anterior aspect of pubic symphysis.

Contributors SV was involved in patient care, planning, conduct, reporting, designing, acquisition of data, analysis, compiling and interpretation of data. VB was involved in patient care, conduct, reporting, acquisition of data, analysis and interpretation of data. MN was involved in patient care, planning, conception, designing, analysis and interpretation of data. SKR was involved in patient care, planning, conduct, conception, designing, analysis and interpretation of data.

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Learning points

- ▶ Midline vertical split fracture of sacrum through zone III is a very rare variant of longitudinal fracture due to an anteroposterior compression force. It is always associated with anterior pelvic injury with intact sacroiliac ligaments and joints.
- ▶ Unlike transverse fractures, associated nerve injuries are minimal with longitudinal fractures.
- ▶ Since midline longitudinal split fractures are vertically stable due to the intact posterior part of sacrum, only the anterior pelvic injury needs to be stabilised.
- ▶ Use of combined anterior and superior plates for anterior pelvic fixation gives better stability and might prevent early loss of reduction due to the tensile forces as early weight bearing is generally allowed.
- ▶ Ultimately, the choice of treatment of sacral fractures should be based on the extent of ring disruption, fragment displacement, ligamentous injury and neurological deficit.

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