

Transverse sacral fractures: case series and literature review

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Objectives: To report experience with transverse sacral fracture, an uncommon injury frequently associated with neurologic deficit, and to perform a meta-analysis of the literature in order to define the role of decompression for the management of sacral fractures. **Design:** A review of 7 cases. **Setting:** A university-affiliated tertiary care centre. **Patients:** Seven patients with transverse fractures of the sacrum. The mean follow-up was 13 months. **Interventions:** A review of the clinical data and a search of the literature for studies that reported on 4 or more patients with a transverse sacral fracture. **Main outcome measures:** Mechanism of injury, type of neurologic deficit and its management. **Results:** The most common mechanism in the 7 study patients was a fall from a height. Six patients had neurologic deficits, mostly in the form of bowel or bladder disturbance. Five of these were treated with surgical decompression, and 4 of them had an improvement in neurologic function. The 7 original studies from the literature dealt with a total of 55 patients. As in the study patients, falls from a height and motor vehicle accidents predominated as the mechanisms of injury. In contrast to patients in this study, 20 of 48 patients in the literature review with neurologic deficits were treated conservatively. **Conclusions:** The outcomes in this study are similar to those reported in the literature. The place of surgical decompression for patients with neurologic deficit cannot be clearly determined from the evidence currently available.

Objectifs : Présenter l'expérience reliée à la fracture sacrale transversale, traumatisme rare souvent associé à un déficit neurologique, et effectuer une méta-analyse documentaire afin de définir le rôle de la décompression dans la prise en charge des fractures sacrales. **Conception :** Étude de sept cas. **Contexte :** Centre de soins tertiaires affilié à une université. **Patients :** Sept patients victimes d'une fracture sacrale transversale. Le suivi moyen a été de 13 mois. **Interventions :** Étude des données cliniques et recherche dans les publications d'études comportant des rapports sur quatre patients ou plus victimes d'une fracture sacrale transversale. **Principales mesures de résultats :** Mécanisme du traumatisme, type de déficit neurologique et prise en charge. **Résultats :** Le mécanisme le plus fréquent chez les sept patients visés par l'étude a été une chute verticale. Six patients présentaient des déficits neurologiques, principalement sous forme de troubles intestinaux ou vésiculaires. Cinq de ces patients ont été traités par décompression chirurgicale et la fonction neurologique s'est améliorée dans quatre cas. Les sept études originales tirées des publications portaient sur un total de 55 patients. Comme dans l'étude, les mécanismes du traumatisme avaient été causés principalement par des chutes verticales et des accidents de la circulation. Comparativement aux patients visés par la présente étude, 20 des 48 patients mentionnés dans les documents qui avaient des déficits neurologiques ont été traités de façon conservatrice. **Conclusions :** Les résultats de l'étude ressemblent à ceux qui sont mentionnés dans les publications. Les données probantes actuellement disponibles ne permettent pas de déterminer clairement le rôle de la décompression chirurgicale chez les patients qui ont un déficit neurologique.

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Transverse fractures of the sacrum are rare injuries of the spine. The most common mechanism is a fall from a height. Roy-Camille and colleagues¹ named these "suicide jumper's fracture." They are often missed on initial radiologic investigations.²⁻⁴ In contrast to the more common vertical fractures of the sacrum, transverse fractures are frequently associated with neurologic injury. Delay in diagnosis and treatment can lead to unacceptable neurologic deterioration and pain.¹ Approximately 70 cases of transverse sacral fractures have been reported in the literature in small case series.^{1,4-17} Our study describes 7 cases of transverse sacral fracture diagnosed and managed at the Sunnybrook and Women's College Health Sciences Centre in Toronto. Their outcomes are compared with those

of previously reported cases in the literature.

Patients and methods

Between 1996 and 1999, 7 patients were seen with transverse sacral fractures at our institution. All clinical data on these patients were reviewed from hospital and office records. A literature search from 1966 to the present was conducted to identify those original papers describing series of patients with transverse sacral fractures. Original papers reporting on 4 or more patients were included in this study so that meaningful conclusions could be drawn. For some analyses, insufficient data were available for all of the cases. Only those for which full data were available were included in the literature review.

Results

The intraoperative findings and neurologic outcome in the 7 patients with transverse sacral fractures treated in our institution are described in Table 1. Case 1 represents a typical example of a patient with a transverse sacral fracture (Figs. 1 and 2).

The average age of the 7 patients in the study was 33 years (range from 18–43 yr). The average follow-up for our 7 patients was 13 months (range from 6–33 mo). The mechanism of injury was a fall from a height in 5 cases; 1 was an accidental fall and the other 4 were attempted suicides. The remaining 2 cases occurred as a result of a motor vehicle accident (MVA). The fracture occurred at S1 in 3 cases, S2 in 2 cases and S3 in 2 cases. In 4 cases there was an associated spinal injury and in

Table 1

Data on 7 Patients Who Had Sacral Fractures

Case	Age/sex	Fracture level	Mechanism of injury	Other spinal injury	Neurologic deficit	Decompression	Intraop. findings	Mode of stabilization	Follow-up, mo	Outcome
1	18/M	S1-S2	MVA — rear passenger ejected from car		Bowel and bladder dysfunction	L5-S3 laminectomy (day 15)	Canal occlusion and dural tear	None	33	Improved to normal
2	42/M	S3	Suicide attempt — jumped from 7 m	L5 fracture-dislocation	Intact	No		L4 pedicle screws to iliac crests	8	Intact
3	26/M	S1-S2	Suicide attempt — jumped from 30-m	L5 lamina and TP fracture	Incomplete L4 paraplegia	L4-S2 laminectomy (day 28)	Canal occlusion, S1 sacral root transection	Transverse fixation of sacrum, lumbar pedicle screws	6	Improved — bowel control, partial bladder control
4	40/M	S3-S4	Suicide attempt — jumped from 7 m		Bowel and bladder dysfunction	Sacral laminectomy (day 5)	Bony fragment in canal, nerves transected and compressed	Percutaneous sacroiliac screws	6	Improved — bowel control, partial bladder control
5	21/F	S1-S2	Accidental fall from 22 m		Bowel and bladder disturbance	Sacral laminectomy (day 3)	Complete occlusion of canal and S2 roots	Percutaneous sacroiliac screws	17	Improved to normal
6	43/F	S2	Suicide attempt — fall from 15 m	Minor wedge fracture L1, TP fracture L4, L5	Bowel and bladder disturbance	Sacral laminectomy (day 1)	Roots transected	Percutaneous sacroiliac screws	7	No change
7	43/M	S2	MVA	L1 fracture-dislocation	Complete paraplegia	No — incision and drainage of open wound		None	12	No change

MVA = motor vehicle accident, TP = transverse process.

2 cases an associated pelvic injury.

Six of our 7 patients had a neurologic deficit and 5 of these underwent surgical decompression. Four of the 5 patients had an improvement in bowel and bladder function after decompression. The fifth patient remained unchanged neurologically after surgery. In this patient multiple sacral nerve roots had been transected by the fracture fragments. The patient with neurologic deficit (case 7) who did not undergo decompression had an open sacral wound and was therefore treated with irrigation and débridement of the overlying soft tissues.

At operation we noted 2 mechanisms of neurologic injury: compression and nerve root transection. The goal of surgery is to achieve decompression allowing potentially viable nerve roots to recover. Transected nerve roots cannot recover. In 3 patients nerve roots were found to be transected by the fracture. None of our patients was made worse by surgery. One patient (case 4) had a wound infection. This required a secondary irrigation and débridement and subsequent removal of hardware. Our data suggest that patients with neurologic deficit benefit from surgi-

cal decompression. However, our numbers are too small to draw any statistical conclusions.

Literature comparisons

The literature yielded 7 studies that reported on 4 or more patients with transverse sacral fractures.^{1,5-10} Actual numbers were 13,¹ 6,⁵ 16,⁶ 5,⁷ 7,⁸ 4⁹ and 4¹⁰ for a total of 55 patients (62 including our patients).

For the whole group the follow-up was recorded adequately in 2 of the 7 series. It ranged from 1 to 18 months. The nature of the injury and the patient population involved contribute to the inability to obtain long-term follow-up. The average age was 44 years (range from 15-62 yr).^{5,9,10} Five of the papers had adequate recording of injury mechanism.^{1,5,8-10} The commonest was a fall or intentional jump from a height, 23 of 34 cases recorded (5 of 7 in our series). MVAs accounted for 11 of 34 of the literature cases (2 of 7 in our series).

The level of injury was adequately recorded in 4 papers.^{1,5,6,10} It is most commonly the S2 level (41% of all cases). Associated injuries were reported in 6 papers.^{1,5,7-10} There was an associated pelvic injury in 28% and an associated spinal injury in 51%.

Forty-eight patients (87%) from the literature^{1,5-10} presented with neurologic deficits. Of the 28 who underwent decompression, no neuro-

logic information was recorded for 1 patient; 23 (82%) showed neurologic improvement, and 4 (14%) showed no improvement. In the conservatively treated group of 20, no information was available for 2 patients, 13 (65%) showed improvement and 5 (25%) showed no improvement. Unfortunately the numbers are insufficient to allow statistical analysis. However, on χ^2 testing, there was a trend suggesting that surgical intervention results in greater neurologic improvement ($p = 0.28$, $p > 0.05$).

Discussion

Classification of transverse sacral fractures

Many classification systems for sacral fractures have been proposed but none has been universally accepted.¹⁸ Denis and associates⁷ proposed one of the most useful classification systems: zone I injuries involve sacral ala, zone II the sacral foramen and zone III the sacral canal. Zone III injuries can be further classified into vertical or transverse fractures. Injuries are classified into the highest zone that the fracture line transgresses. Zone I injuries were most common in their series.

Schmidek and colleagues² divided transverse sacral fractures into low versus high fractures. High transverse fractures are those occurring at S1-S2 and are caused by indirect forces acting through either the pelvis or the lumbar spine; for example, an injury sustained with the hip in flexion and the knee in extension may cause a high transverse sacral fracture. A low transverse sacral fracture has a fracture line anywhere from S3-S5 and usually results from direct trauma to the sacrum (e.g., from a hard fall onto the buttocks). These fractures are stable if the sacrum and the sacroiliac joints above the level of the S1 foramen remain intact. For fractures that are predominantly transverse, the fracture line can be identified in the region of S2-S3.¹⁸



FIG. 1. Sagittal magnetic resonance image of the lumbosacral spine shows the transverse sacral fracture at the level of S1-S2 with an acute kyphotic deformity.



FIG. 2. Computed tomography through the level of fracture shows complete occlusion of the spinal canal (arrow).

Transverse versus vertical sacral fractures

There are important differences between transverse and vertical sacral fractures. Transverse fractures are less common. They constitute 5% to 16% of all sacral fractures.^{2,8} Between 40% and 45% of pelvic fractures occur in combination with a fracture of the sacrum. Isolated fractures of the sacrum are less frequent, representing 5% to 10% of all sacral injuries.¹⁸ These fractures tend to be transverse.⁸ In one study, all of zone I, zone II and vertical type zone III sacral fractures were associated with pelvic fractures compared with only 43% of zone III transverse fractures.⁸ Our meta-analysis shows that pelvic fractures are associated with only 28% of transverse sacral fractures. In our 7 patients, 2 had associated pelvic fractures. Thus, transverse fractures may be isolated or associated with pelvic fractures whereas vertical fractures are almost always associated with pelvic fractures.

Neurologic injuries

More neurologic injuries are associated with higher zone injuries. In a study by Gibbons and associates,⁸ 24% of zone I, 29% of zone II, 60% of vertical zone III and 57% of transverse zone III fractures were associated with neurologic injury. In some of the larger series of transverse sacral fractures, 96% to 100% of the patients had some neurologic deficit, mainly in the form of bowel and bladder disturbance and saddle anesthesia.^{1,5,6,10} The literature review showed that 87% of the patients had neurologic deficits associated with their sacral fractures, most being bowel and bladder disturbances.^{1,5,10} Similarly, 86% of our patients had neurologic deficit.

Associated spinal injuries

In the series of Denis and associates,⁷ 5 patients with transverse sacral

fractures with loss of bladder and bowel function also had a thoracolumbar burst fracture with severe canal obstruction and neurologic deficit. Nine of 13 cases from the series of Roy-Camille and colleagues¹ had associated lumbar spine fractures. Overall, 51% of the patients had associated spinal injuries, most commonly a fracture of the L5 vertebrae.^{1,5,7-10} In our series, more than half of the patients had associated spinal fractures, all involving the lumbar spine.

Imaging

In the report of Denis and associates,⁷ the diagnosis was made during initial hospitalization in 5% of 195 patients without neurologic deficit. Of the patients with neurologic deficit, 49% of the fractures were not noted on the chart. Most (97%) of the fractures that were missed on radiographic studies were either alar or minimally displaced foraminal fractures. However, in the series of 13 patients reported by Roy-Camille and colleagues,¹ 7 (54%) had transverse sacral fractures that were unrecognized initially, delaying the diagnosis by 1 to 18 months.⁴

Treatment

Some authors advocate routine decompression for sacral fractures associated with neurologic deficit.^{1,10} In the series reported by Ebraheim and associates,¹⁰ all 4 patients underwent decompression and 2 of them recovered bowel and bladder function. Others have recommended conservative treatment for these patients because intraoperative findings have shown torn, stretched, contused or lacerated nerve roots.^{6,9} In the series reported by Sabiston and Wing,⁶ all 16 patients were treated conservatively. The neurologic deficits were not all permanent. Only 1 patient, who had a complete cauda equina lesion, showed no significant improvement 4 months after injury.

Approximately half of the patients with neurologic deficit in our review of the literature had decompression. The majority of these (87%) had improvement in neurologic function.^{1,5-10} However, up to 75% of the patients treated conservatively also had neurologic improvement. There is, therefore, no literature evidence that surgical decompression leads to a better neurologic outcome. In our series, 5 of the 6 patients with neurologic deficit underwent sacral laminectomy; all but 1 showed improvement. The patient who did not have surgery had an open sacral wound that prevented decompression.

Stabilization should be considered in patients with high transverse fractures, especially those associated with a vertical extension into the alae of the sacrum ("H"-type fracture pattern). This fracture pattern is unstable because the fragment containing the sacroiliac joint and the centrum of S1 and S2 is effectively floating with respect to the rest of the pelvis. At the lumbosacral junction, the body weight is transferred from the sacrum across the sacroiliac joints to the pelvis, connecting the axial and appendicular skeletons.¹⁸ In low transverse sacral fractures, the involved portion of the sacrum is not part of the weight transmission from the lower extremities to the spine. This type of fracture is considered a stable fracture.² In our series, patients with sacral fractures that were considered to be unstable underwent internal fixation.

Conclusions

Transverse sacral fractures are uncommon injuries that result from falls from a height or MVAs. The upper sacrum is usually involved and most of the patients present with neurologic deficit. Our practice has involved surgical decompression for patients with a neurologic deficit. An analysis of the literature, however, does not yield statistical evidence to support this practice.

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Notices
Avis

Interactive surgery symposium

The Mayo Clinic Interactive Surgery Symposium will be held from Feb. 24 to Mar. 1, 2002. This course is sponsored by the Mayo Clinic Scottsdale and will be held at the Marriott's Renaissance Wailea Beach Resort, 3550 Wailea Alanui Dr., Wailea, Maui, HI. The course directors are Drs. William Stone and John Donohue. Credit: 26.5 hours in AMA Category 1. The registration fee for the course is US\$895. For further information contact

Sarah Dorste, Mayo School of CME, Mayo Clinic Scottsdale, 13400 East Shea Blvd., Scottsdale AZ 85259; tel 480 301-4661, fax 480 301-8323.

Foot and ankle symposium

Continuing Education, Faculty of Medicine, University of Toronto, will host the Fifth Biennial Foot & Ankle Symposium to be held on Apr. 20 and 21, 2002, in the Medical Sciences Building – Auditorium, University of Toronto, 1 King's College

Circle, Toronto. Credits: Royal College of Physicians & Surgeons of Canada, Maintenance of Certification Program and Category 1 of the Physician's Recognition Award of the AMA. For further information contact Continuing Education, Faculty of Medicine, University of Toronto, Ste. 650, 500 University Ave., Toronto ON M5G 1V7; tel 416 978-2719, fax 416-971-2200, ce.med@utoronto.ca, www.cme.utoronto.ca

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