CASE REPORT

Seat belt syndrome with unstable Chance fracture dislocation of the second lumbar vertebra without neurological deficits

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SUMMARY

The seat belt syndrome is a recognised complication of seat belt use in vehicles. Unstable Chance fractures of the spine without neurological deficits have been reported infrequently. We describe a young woman with completely disrupted Chance fracture of the second lumbar vertebra in association with left hemidiaphragmatic rupture/hernia, multiple bowel perforations, splenic capsular tear, left humeral shaft and multiple rib fractures. These injuries which resulted from high-speed vehicle collision and led to death of one of the occupants were readily detected by trauma series imaging. The patient was successfully treated by a dedicated multidisciplinary team which adopted a staged surgical approach and prioritisation of care. There were no manifested neurological or other deficits after 1 year of follow-up. To the authors' knowledge, this is the first report of such a case in Australasia. We discuss the challenging surgical management, highlighting the role of radiological imaging in such cases and provide a literature review.

BACKGROUND

Globally, it is estimated that about 1.2 million persons, half of whom are within the productive ages of 15–44, die each year from road traffic collisions.¹ The mandatory and proper use of seat belts has invariably led to the greatest reduction in the severity of injuries and deaths especially in rollover collisions in which they prevent the ejection of the restrained occupants from the vehicle.^{2–3} Despite the safety of seat belts, there have been many reports of injuries and fatalities ascribed to their use or inadvertent misuse.^{4–6}

Result of one such injury is the 'seat belt syndrome' which is described as the association of seat belt sign with bowel rupture and lumbar spine fracture.⁷ GQ Chance in 1948 had described a fracture type occurring in patients wearing a lap belt during motor accidents. This eponymous variant deserves a special mention as it is a horizontal fracture extending posteriorly from the vertebral body into the pedicles, transverse processes, laminae and the spinous processes.⁸ The presence of complete fracture-dislocation of the lumbar spine without neurological deficits is a rarity.^{9–13}

In this report, we describe seat belt syndrome occurring with Chance fracture dislocation of the second lumbar vertebra without neurological deficits in a young woman involved in a high-speed head-on vehicle collision leading to death of one of the occupants. The patient was successfully treated

by a dedicated multidisciplinary team who adopted a staged surgical approach and prioritisation of care. We discuss the challenging surgical management, highlighting the role of radiological imaging in such cases, and provide a literature review.

CASE PRESENTATION

Our patient was a young woman in her 20s who was airlifted to our hospital which is a major trauma centre, from the scene of a high-speed head-on motor vehicle collision, in which the driver of the colliding vehicle had died at the spot. The patient was a restrained front seat passenger who had a long period of extrication from the vehicle which was completely decimated. On clinical assessment at the emergency department, the patient was fully conscious, with a 5 cm right frontal scalp laceration, midline lumbar spinal tenderness and painful swelling and deformity of the left mid-arm. There were also seat belt bruises in her anterior chest and abdominal walls and generalised peritonitic abdomen. Neurologically, the cranial nerves, reflexes, anal sphincter tone, limb motor power (except the left upper limb) and sensory examination were all normal. However, she was haemodynamically unstable with clinical features of hypovolaemic shock and required significant fluid resuscitation and emergency exploratory laparotomy. There was no relevant medical history or use of regular medications by the patient.

INVESTIGATIONS

Admission X-ray, CT trauma series and MRI of spine demonstrated the following injuries which are components of the seat belt syndrome:

1. Unstable comminuted L2 Chance fracture with 30° angulation, slight left lateral displacement, grade 2 retrolisthesis, total disruption of the L1/2 facet joints, bilateral L1, L2 and right L3 transverse process fractures (figure 1). MRI of the spine demonstrated disruption of the entire ligamentous, muscular and soft tissue structures at L2, epidural haematoma at L2 and conus medullaris oedema (figure 2).
2. Displaced fracture of the middle third of the left humeral shaft (figure 3).
3. Ruptured left hemidiaphragm with a diaphragmatic hernia and small pneumomediastinum (figure 3).
4. Small capsular splenic tear.

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Figure 1 Preoperative images. (A) X-ray showing the displaced fracture of the middle third of the left humerus. (B) Non-contrast CT of the chest and abdomen showing the left hemidiaphragmatic rupture with the stomach herniated into the chest (blue arrow) compressing the left lower lung zone (yellow arrow). Air is seen under the diaphragm due to bowel rupture (red arrow).

5. Significant perforation of the mid-jejunum and sigmoid colon with intraperitoneal and retroperitoneal haematoma.
6. Bilateral pulmonary contusions, small pleural effusions and small right pneumothorax.
7. Mildly displaced left sixth and seventh rib fractures.

TREATMENT

Given the extensive multitrauma and circulatory failure, the patient was admitted into the intensive care unit (ICU) and co-managed by different surgical specialties who adopted a staged operative approach and prioritisation of care. Total spinal

precaution was maintained all through her admission. She first underwent an emergency laparotomy, drainage of significant intraperitoneal and retroperitoneal haemorrhage, resection of perforated mid-jejunum and sigmoid colon with end-to-end anastomoses, repair of ruptured left hemidiaphragm and diaphragmatic hernia by the general surgical unit. At the end of this lengthy procedure, the orthopaedic unit reduced and temporarily immobilised the left humeral shaft fracture using a plaster of Paris U-slab.

The next day, the neurosurgical unit proceeded with emergency operative fixation of the L2 Chance fracture dislocation. This was conducted through the open posterior approach on

Figure 2 Volume-rendered three-dimensional reconstruction of preoperative CT of the lumbar spine. (A) Sagittal view and (B) coronal view. Both views showing the unstable comminuted L2 Chance fracture with 30° angulation, slight left lateral displacement, grade 2 retrolisthesis, total disruption of the L1/2 facet joints, bilateral L1, L2 and right L3 transverse process fractures.

Figure 3 Preoperative T2-weighted MRI of the lumbosacral spine. (A) Axial view across L2 and (B) sagittal view. Both views showing the L2 Chance fracture dislocation with disruption of the entire ligamentous, muscular and soft tissue structures at L2 (arrow). Epidural haematoma at L2 can also be appreciated.

the Jackson table, under NIM neuromonitoring (Medtronic Inc) and X-ray image intensifier guidance. The extensive hardware used comprised of bilateral T11–L4 Schanz pedicle screws, two connecting rods and cross links, posterolateral Vitoss (Stryker), Actifuse (Baxter) bone grafts and interspinous wiring all employed to fully correct the obvious spinal malalignment. Epidural haematoma was also evacuated at L2 and the central spinal canal was inspected and freed. Five days after admission, the orthopaedic unit proceeded with open reduction and internal fixation of the left humeral shaft fracture using a nine-hole compression plate and eight screws (Synthes). The plastic unit also performed a facial flap to close the right frontal scalp wound. The bilateral pulmonary contusions, small pleural effusions, small right pneumothorax and left sixth and seventh rib fractures were all managed conservatively.

Postoperative care in the ICU consisted of triple parenteral antibiotics, blood transfusion, patient-controlled analgesia, deep vein thrombosis prophylaxis and temporary total parenteral nutrition for debilitating postoperative nausea and vomiting. Furthermore, patient's recovery was complicated by catheter-related *Escherichia coli* urinary tract infection which responded promptly to antibiotic treatment.

On satisfactory clinical recovery, the patient was transferred to another hospital for inpatient physical and psychological rehabilitation. Owing to the extensive ligamentous, muscular and bony injuries at L2, the patient had an extended period of continuous bed rest in air mattress with log roll and mobilisation with the use of thoracolumbosacral orthosis (TLSO) brace for 3 months. She also benefited from allied support from the physiotherapists, occupational therapists and social workers.

Figure 4 Postoperative X-rays (A) showing the left humeral fracture completely reduced and internally fixed with lateral compressive plate and eight screws. (B) Chest X-ray showing complete resolution of the left hemidiaphragmatic rupture/hernia. The left lower lung is also fully expanded.

Figure 5 Postoperative three-dimensional CT reconstruction of the lumbar spine. (A) Volume maximal intensity projection and (B) Volume rendered. Both images showing complete reduction of the L2 Chance fracture dislocation by the bilateral T11–L4 pedicle screws linked with two rods and cross links. The L1–2 interspinous wiring can also be appreciated.

OUTCOME AND FOLLOW-UP

At neurosurgical clinic follow-up visits, the patient was completely asymptomatic and no longer required any analgesics. There is a current plan to remove the T11, T12 and L4 Schanz screws and to shorten the connecting rods in the coming months before any plans for pregnancy. This procedure would allow the patient more spinal flexibility so as the fracture healing has been so far satisfactory. The patient has since been discharged from the Orthopaedic, General Surgical and Plastic clinics and is currently thriving well 1 year after the horrific accident.

Postoperative imaging demonstrated satisfactory fixation of the left humeral fracture and complete repair of the left hemidiaphragmatic rupture/hernia (figure 4). It also shows complete reduction and progressive healing of the L2 fracture dislocation. The implanted hardware is in satisfactory position (figures 5).

DISCUSSION

The seat belt syndrome was first reported in 1962 by Garnett and Braunstein⁴ who described trauma affecting mostly the lower torsos of patients who wore a lap belt two-point restraint during vehicle accidents. It characteristically involves seat belt sign in association with intestinal perforation or mesenteric tear and lumbar spine fracture or dislocation.^{14 15} The seat belt sign describes skin bruising or avulsion mostly across the anterior chest or abdominal wall caused by the diagonal or horizontal trap of the shoulder-lap three-point restraint and its presence should always arouse the suspicion of the clinician to the probable presence of intra-abdominal or spinal injuries.^{7 16} Following such suspicion, the patient should be maintained on full spinal precaution as early as possible and CT scan of the spine and abdominal cavity should be performed to search for covert injuries. Such injuries mostly along the plane of the two-point lap belt are thought to be due to deceleration force directed to the abdomen through the seat belt.^{5 14}

The commonest spinal injury associated with the seat belt syndrome is the Chance fracture. This is a flexion-distraction fracture in which the upper and lower parts of the occupant's body are thrust forward during the impact while the pelvis which is restrained by the lap seat belt acts as a fulcrum.^{6 17} This subjects the spine to a great tension and distraction while the intra-abdominal organs are compressed between the rigid spine and lap belt. There is a high predilection for Chance fractures to occur between L1 and L3. However, the pattern of spinal fractures is somewhat different in the paediatric population as they tend to manifest worse spinal injuries owing to their higher centre of gravity and hyperflexibility.^{18–20}

The shoulder-lap three-point restraint directly transmits force to the upper trunk, leading to chest wall injuries, splenic avulsion and diaphragmatic rupture/hernia as were seen in our patient.^{21 22} Occasionally, injuries to the carotids and proximal aorta, liver, heart, brachial plexus and cervical spine have also been reported.²² Fixed segments of the intestine such as the proximal jejunum, distal ileum, ascending and descending colons are more susceptible to perforation from raised intraluminal pressure.¹⁵ By the same token, perforation of the intra-abdominal oesophagus and the rectum has also been described.^{23 24}

There have been infrequent reports of disrupted fractures of the lumbar spine without neurological deficits.^{9–13} The probable mechanism for neurological sparing in such completely disrupted fractures is spontaneous decompression of the bony, ligamentous and muscular structures, as it occurred in our case, thereby allowing the spinal cord or thecal sac enough room to lie outside the spinal canal.¹¹ Stable Chance fractures especially those without ligamentous disruption or neurological deficits and those occurring in elderly patients who may not be good surgical candidates can be managed conservatively with immobilisation, TLSO brace and physiotherapy. However, when there is a gross instability, significant ligamentous disruption or in the setting of seat belt syndrome with other multiple injuries, operative reduction and fixation of the fractured spine is the recommended treatment.^{25 26}

The immediate restoration of circulatory status in our patient by aggressive fluid resuscitation in the ICU and emergency exploratory laparotomy as well as the adoption of a staged surgical approach to other associated injuries are consistent with the recommendations of the Committee on Early Management of Severe Trauma (EMST) of the Royal Australasian College of Surgeons and the American College of Surgeons Advanced Trauma Life Support (ATLS) course.^{27 28}

Learning points

- ▶ Seat belt syndrome is a complication of seat belt use or inadvertent misuse.
- ▶ Completely disrupted spinal Chance fracture may not be associated with neurological deficits if spontaneous decompression of the spinal canal occurs.
- ▶ Spinal precaution should be maintained in the presence of seat belt sign until spinal injuries have been ruled out by appropriate imaging or treated if present.
- ▶ Staged surgical approach is recommended in multitrauma with life-threatening injuries receiving utmost priority.
- ▶ Emergency spinal fixation and decompression, where necessary, is recommended in completely disrupted Chance fracture dislocation.

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REFERENCES

- 1 Peden M, Scurfield R, Sleet D, *et al.* *World report on road traffic injury prevention 2004*. World Health Organization, Geneva, 2004.
- 2 Bandstra R, Meissner U, Warner CY, *et al.* Seat belt injuries in medical and statistical perspective. 2009. Paper number 98-S6-W-25. <http://www-nrd.nhtsa.dot.gov/pdf/Esv/esv16/98S6W25.PDF>
- 3 Backstrom CG. Traffic injuries in south Sweden; with special reference to medico-legal autopsies of car occupants and value of safety belts. *Acta Chir Scand Suppl* 1963;(Suppl 308):1–104.
- 4 Garrett JW, Braunstein PW. The seat belt syndrome. *J Trauma* 1962;2:220–38.
- 5 Abbas AK, Hefny AF, Abu-Zidan FM. Seatbelts and road traffic collision injuries. *World J Emerg Surg* 2011;6:18.
- 6 Sato TB. Effects of seat belts and injuries resulting from improper use. *J Trauma* 1987;27:754–8.
- 7 Witherspoon S, Chu K, Brown AF. Abdominal injury and the seat-belt sign. *Emerg Med* 2001;13:61–5.
- 8 Chance GQ. Note on a type of flexion fracture of the spine. *Br J Radiol* 1948;21:452.
- 9 Akay KM, Baysefer A, Kayali H, *et al.* Fracture and lateral dislocation of the T12-L1 vertebrae without neurological deficit—case report. *Neural Med Chir* 2003;43:267–70.
- 10 Phadnis AS, Tan CJ, Raman AS, *et al.* Fracture and complete dislocation of the spine with a normal motor neurology. *Injury Extra* 2006;37:479–83.
- 11 Hsieh CT, Chen GJ, Wu CC, *et al.* Complete fracture-dislocation of the thoracolumbar spine without paraplegia. *Am J Emerg Med* 2008;26:633 e5–7.
- 12 Abdel-Fattah H, Rizk AH. Complete fracture-dislocation of the lower lumbar spine with spontaneous neurologic decompression. *Clin Orthop Relat Res* 1990;(251):140–3.
- 13 Chen WC. Complete fracture-dislocation of the lumbar spine without paraplegia. *Int Orthop* 1999;23:355–7.
- 14 Intas G, Stergiannis P. Seat belt syndrome: a global issue. *Health Sci J* 2010;4:202–9.
- 15 Witte CL. Mesentery and bowel injury from automotive seat belts. *Ann Surg* 1968;167:486–92.
- 16 Stassen NA, Lukan JK, Carrillo EH, *et al.* Abdominal seat belt marks in the era of focused abdominal sonography for trauma. *Arch Surg* 2002;137:718–22.
- 17 Fractures of the thoracic and lumbar spine, OrthoInfo, American Academy of Orthopaedic Surgeons [Internet] 2013 Oct 14 [updated 2010 Feb; cited 2013 Oct 16] <http://orthoinfo.aaos.org/topic.cfm?topic=A00368>
- 18 Hubbard DD. Injuries of the spine in children and adolescents. *Clin Orthop Relat Res* 1974;100:56–65.
- 19 Arkader A, Warner WC Jr, Tolo VT, *et al.* Pediatric Chance fractures: a multicenter perspective. *J Pediatr Orthop* 2011;31:741–4.
- 20 Le TV, Baaj AA, Deukmedjian A, *et al.* Chance fractures in the pediatric population. *J Neurosurg Pediatr* 2011;8:189–97.
- 21 Couselo M, Valdes E, Gutierrez C, *et al.* Diaphragmatic avulsion with Chance fracture: a rare association in the seat belt syndrome. *Pediatr Emerg Care* 2011;27:553–5.
- 22 Arajari E, Santavirta S. Chest injuries sustained in severe traffic accidents by seatbelt wearers. *J Trauma* 1989;29:37–41.
- 23 Gill SS, Dierking JM, Nguyen KT, *et al.* Seatbelt injury causing perforation of the cervical esophagus: a case report and review of the literature. *Am Surg* 2004;70:32–4.
- 24 Hefny AF, Al-Ashaal YI, Bani-Hashim AM, *et al.* Seatbelt syndrome associated with an isolated rectal injury: case report. *World J Emerg Surg* 2010;5:4.
- 25 Varraco AR, Lehman RA Jr, Hurlbert RJ, *et al.* A new classification of thoracolumbar injuries: the importance of injury morphology, the integrity of the posterior ligamentous complex, and neurologic status. *Spine* 2005;30:2325–33.
- 26 Smith JS, Fessler RG, Shaffrey CI. Posterior lumbar instrumentation. In: Winn HR, Berger MS, eds. *Youmans neuro surg*. 6th edn. Philadelphia: Elsevier Saunders, 2011:4731–41.
- 27 Trauma Committee, Royal Australasian College of Surgeons. *Early management of severe trauma*. Melbourne: Royal Australasian College of Surgeons, 1992.
- 28 Collicott PE, Hughes I. Training in advanced trauma life support. *JAMA* 1980;243:1156–9.

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