Case Report

Percutaneous pedicle screw for unstable spine fractures in polytraumatized patients: A report of two cases

Boon Beng Tan, Chris Yin Wei Chan, Lim Beng Saw, Mun Keong Kwan

Abstract

Unstable spine fractures commonly occur in the setting of a polytraumatized patient. The aim of management is to balance the need for early operative stabilization and prevent additional trauma due to the surgery. Recent published literature has demonstrated the benefits of early stabilization of an unstable spine fracture particularly in patients with higher injury severity score (ISS). We report two cases of polytrauma with unstable spine fractures stabilized with a minimally invasive percutaneous pedicle screw instrumentation system as a form of damage control surgery. The patients had good recovery from the polytrauma injuries. These two cases illustrate the role of minimally invasive stabilization, its limitations and technical pitfalls in the management of unstable spine fractures in the polytrauma setting as a form of damage control surgery.

Key words: Minimally invasive stabilization, percutaneous pedicle screw, polytrauma, unstable spine fracture

Introduction

Unstable spine fractures commonly occur in a polytraumatized patient. The combination of insults leads to physiological derangement as a result of hypotension, hypoxia, acidosis, or subsequent infection. The consequence of this is systemic inflammatory response syndrome (SIRS) and subsequently leads to multi organ dysfunction syndrome (MODS) if decisive management strategies are not instituted.

The objective of treatment in such situation is to balance the need for early operative stabilization of spine and limit the additional load of surgery (second hit theory).[1] The benefits of early stabilization of an unstable spine fracture in patients with higher injury severity score (ISS) include shorter hospital stay, intensive care unit stay, shorter ventilation duration, and lower pulmonary complications.[2,3]

Department of Orthopaedic Surgery, Faculty of Medicine, University of Malaya, Kuala Lumpur, Malaysia

Address for correspondence: Dr. Mun Keong Kwan,
Department of Orthopaedic Surgery, Faculty of Medicine, University of Malaya, 50603 Kuala Lumpur, Malaysia.
E-mail: munkeong42@hotmail.com

Access this article online	
Quick Response Code:	Website: www.ijoonline.com
	DOI: 10.4103/0019-5413.104235

The open spinal surgery was not ideal in polytrauma patients, therefore, Kossmann *et al*. advocated staged surgery in implementing the concept of damage control spine surgery in polytrauma patients. The posterior stabilization and fusion in the first stage, followed by definitive anterior reconstruction in the second stage to minimize additional trauma to an unstable patient.[4] The evolution of spine instrumentation in the recent years has led to the development of minimally invasive percutaneous pedicle screw instrumentation which has offered a better solution in the management for the unstable spine fractures in polytraumatized patient.

Case Reports

Case 1

A 32-year-old man presented to us following a fall from height. He suffered from left posterior 4th to 12th rib fracture with subcutaneous emphysema, lung contusion and bilateral hemopneumothorax, intraabdominal injury with pneumoperitoneum, left renal injury (grade 3) with perinephric hematoma, and a T11 bony Chance fracture without neurological deficit. At the casualty department, bilateral chest tubes were inserted. At presentation, the patient was tachypneic with a respiratory rate of 26/min, blood pressure was 124/88 mmHg with a heart rate between 125 and 136 beats/min. He was resuscitated with fluids. An initial hemoglobin level of 9.5 g/dL was documented.

The patient underwent an emergency laparotomy with small bowel resection and end-to-end anastomosis at 13 hours posttrauma. Following this, minimally invasive

percutaneous instrumentation from T10 to T12 was done. Four percutaneous screws were inserted simultaneously through four stab incisions [Figure 1]. The instrumentation was performed using size 5.5 mm screws for both T10 as well as T12 vertebrae. The duration of the operation was 45 min, with a blood loss of 75 mls (measured by soaked gauze). The screws were inserted simultaneously to reduce the amount of image intensifier exposures required for the procedure. The total exposure (Siemens Siremobil 2000) was 25 exposures at 75–90 kV peak and 1.5–2.0 mA. Intraoperatively, 2 units of packed red blood cells were transfused. Intraoperative hemoglobin was maintained at 10.0 g/dL. No hemodynamic instability or hypoxic episodes were documented intraoperatively.

Postoperatively, the patient was allowed to turn to his side every two hourly and was also allowed to be propped up on day 1. On postoperative day 3, once the abdominal and chest drains were removed, the patient was allowed to sit up and stand independently. Subsequently, a thoracolumbar support orthosis was applied and the patient was discharged on day 15 post injury.

Case 2

A 58-year-old man was involved in a motor vehicle accident whereby his car rammed into a tree. On arrival to the casualty department, the patient was confused and his Glasgow Coma Scale was 12/15. His vital signs were stable with a respiratory rate of 16/min, heart rate of 95/min, and a blood pressure of 126/70 mmHg. There was marked tenderness over the abdomen with guarding and rigidity and he was diagnosed to have an intraabdominal injury. Computed tomography showed pneumoperitoneum, multiple facial bone fracture, left hemopneumothorax and a L2 bony Chance fracture with no neurological deficit. Computed tomography of the brain was normal. An emergency laparotomy was performed 16 hours post trauma. Small bowel resection and anastomosis were performed. Intraoperative findings were small bowel perforation 45 cm from ileocecal junction with contused small bowel mesentery and transverse colon. Following the laparotomy, percutaneous pedicle screw stabilization was performed in prone position. The operative time was 35 min, with a blood loss of less than 100 ml. The total number of image intensifier exposures was 30 at 75–90 kV peak and 1.6–2.2 mA. Intraoperatively, the patient was transfused 2 units of packed red cells with a documented hemoglobin level of 11 g/dL post transfusion. No hemodynamic instability or hypoxia episodes occured intraoperatively. Postoperatively, there were no complications and the patient was allowed to sit up 2 days after the operative procedure.

Discussion

The clinical course after a polytrauma is determined by three factors: the initial degree of injury (first hit; trauma load), the individual biologic response, and the type of treatment (second hit; surgical load).[1] The concept of damage control orthopedics is to minimize the degree of second hit impact. Polytraumatized patients often suffer from associated injuries of the spinal column following a major trauma (first hit) from direct and indirect mechanical forces. The accumulative host reaction is characterized by a local and systemic expression and release of a vast array of pro-inflammatory mediators which could result in SIRS.

Dimar *et al*. in 2010 reported on the benefits of early stabilization of spinal fractures in polytrauma patients. In their review of similar reports published in English literature, they concluded that early stabilization of spinal fractures in polytrauma patients led to shorter hospital stay, shorter ICU stay, shorter mechanical ventilation duration, and lower pulmonary complications.[2] This finding was

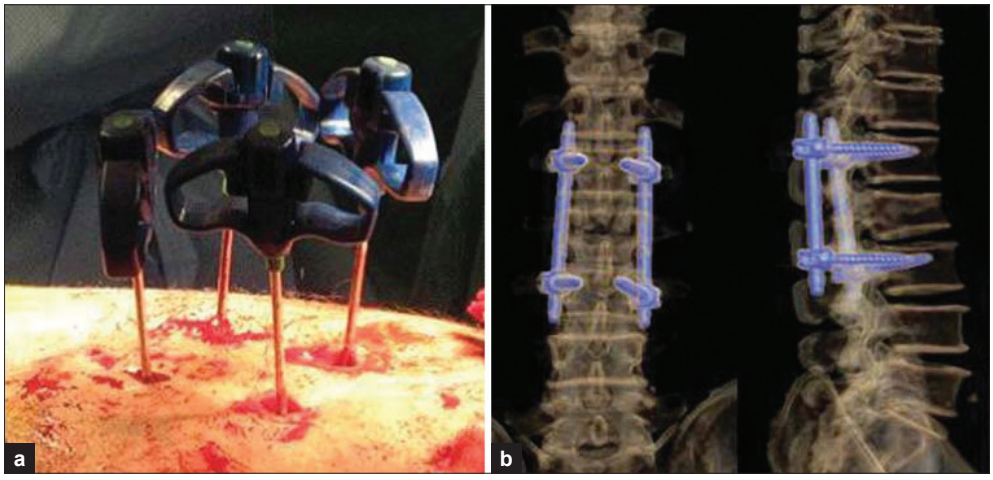

Figure 1: (a) Intraoperative images showing skin incision and simultaneous placement of introducer (b) reconstructed computed tomography showing pedicle screw fixation *in situ*

also confirmed by Carreon and Dimar in 2011.[3] In fact, definitive (total care) spine surgery in polytraumatized patients is accompanied by higher mortality rates in early surgical group.[5] Prior to the introduction of percutaneous spinal stabilization system, damage control orthopedics involved staging of the spinal procedure due to the nature of open spine surgery.[4] Open spine surgeries inevitably result in significant blood loss with long operating time which potentially would cause more morbidities.

The evolution of spinal instrumentation has led to the introduction of minimally invasive percutaneous pedicle screw system, which was first described by Magerl in the 1970s.[6] However, the application of percutaneous pedicle screws in the thoracolumbar junction has been not been well received for various reasons; smaller pedicle morphometry as well as close proximity of the spinal cord to the medial cortical wall of the pedicle increases the risk of cord injury when pedicle perforation occurs. Thoracic pedicle morphometry shows significant variability and differences between races, and Asian pedicles have been shown to have smaller pedicle dimensions.[7,8] Studies on open pedicle screw insertion have proven the safety of this technique in the Asian population.[9] However, the outcome and safety of percutaneous pedicle screws cannot be inferred from the outcome of open insertion technique as significant differences exist between the two techniques, the most notable ones being loss of tactile sensation and complete reliability on image intensifier imaging in the percutaneous technique. The feasibility and safety of this technique in the thoracolumbar region was also reported by Ringel *et al*. and Schmidt *et al*., who stabilized thoracolumbar spine fractures without neurological deficit using the percutaneous screws.[10,11] Schimdt *et al*. concluded that the low rate of approach-related complications in association with short operation time and virtually no blood loss in minimally invasive spine surgery is beneficial in geriatric patients with high perioperative risk.[11]

These 2 cases illustrated emphasize the ideal indication for the use of percutaneous pedicle screws in the event of polytrauma. In both cases, the anterior column of the spine was relatively intact. Before the advent of percutaneous pedicle screw systems, these two patients would have needed to undergo open posterior instrumentation and fusion for the fractures. Although posterior stabilization is not considered a major procedure compared to circumferential reconstruction, the amount of tissue trauma and systemic disturbance is significant and this is minimized by percutaneous application of pedicle screws. The recovery of the patients was uncomplicated. This could be attributed to minimal intraoperative tissue trauma as well as less postoperative pain and complications which could act as additional stressors to the patient. This is in line with the concept of damage control orthopedics which allows early spine stabilization leading to earlier mobilization of the polytraumatized patients. In view of this advantage, percutaneous spine stabilization should be introduced in polytrauma patients with spine fractures as part of damage control orthopedics.

However, the disadvantages of percutaneous posterior spine instrumentation in spine trauma remain the inability to make joint surfaces raw percutaneously and to apply bone graft to promote fusion. Therefore, it should be emphasized that the indication of usage of this technique would be temporary posterior stabilization of the spine as part of damage control orthopedics or as a definitive fixation if bony healing of the fracture is expected, i.e. bony Chance fracture. The technical pitfalls of percutaneous pedicle screw insertion must also be considered. The lack of tactile sensation and reliance of percutaneous pedicle screw insertion on image intensifier images means that familiarity with interpretation of image intensifier images is mandatory for this technique. Otherwise, medial breach of the pedicle might occur with potential injury to the neural structures. Preoperative evaluation of the pedicle morphometry is also essential when thoracic screws are contemplated. This should be feasible as most trauma patients would undergo a computed tomography scan of the spine to evaluate the fracture configuration.

These two cases illustrate the role of minimally invasive stabilization using percutaneous pedicle screw in the management of unstable spine fractures in the polytrauma patient as a damage control surgery. However, the limitations and technical pitfalls of this technique have to be understood and preoperative evaluation of the thoracic pedicle morphometry has to be undertaken to determine the feasibility of this technique.

References

1. Pape HC, Giannoudis P, Krettek C. The timing of fracture treatment in polytrauma patients: Relevance of damage control orthopedic surgery. Am J Surg 2002;183:622-9.
2. Dimar JR, Carreon LY, Riina J, Schwartz DG, Harris MB. Early versus late stabilisation of the spine in the polytrauma patient. Spine 2010; 35:S187-92.
3. Carreon LY, Dimar JR. Early versus late stabilisation of spine injuries. A systematic review. Spine 2011;36:E727-33.
4. Kossmann T, Trease L, Freedman I, Malham G. Damage control surgery for spine trauma. Injury 35:661-70.
5. Schmidt OI, Gahr RH, Gosse A, Heyde CE. ATLS® and damage control in spine trauma. World J Emerg Surg 2009;4:9.
6. Magerl FP. Stabilisation of the lower thoracic and lumbar spine with external skeletal fixation. Clin Orthop Relat Res 1984;189:125-41.

7. Liau KM, Yusof MI, Abdullah MS, Abdullah S, Yusof AH. Computed tomographic morphometry of thoracic pedicles: Safety margin of transpedicular screw fixation in Malaysian Malay population. Spine (Phila Pa 1976) 2006;31:E545-50.
8. Cinotti G, Gumina S, Ripani M, Postacchini F. Pedicle instrumentation in the thoracic spine: A morphometric and cadaveric study for placement of screws. Spine (Phila Pa 1976) 1999;24:114-9.
9. Chan CY, Saw LB, Kwan MK. Safety of thoracic pedicle screw application using funnel technique in the Asians: A cadaveric evaluation. Eur Spine J 2010;19:78-84.
10. Ringel F, Stoffel M, Stüer C, Meyer B. Minimally invasive transmuscular pedicle screw fixation of the thoracic and lumbar spine. Neurosurgery 2006;59 (4 Suppl 2): ONS361-7.
11. Schmidt OI, Strasser S, Kaufmann V, Strasser E, Gahr RH. Role of early minimal-invasive spine fixation in acute thoracic and lumbar spine trauma. Indian J Orthop 2007; 41:371-80.

How to cite this article: Tan BB, Chan CY, Saw LB, Kwan MK. Percutaneous pedicle screw for unstable spine fractures in polytraumatized patients: A report of two cases. Indian J Orthop 2012;46:710-3.

Source of Support: Nil, **Conflict of Interest:** None.