

Minimally Invasive Treatment of Spine Trauma



Jason E. McGowan, MD^a, Christian B. Ricks, MD^b,
Adam S. Kanter, MD^{c,*}

KEYWORDS

• MIS • Minimally invasive • Spine trauma • Percutaneous

KEY POINTS

- In the setting of trauma where patients can be structurally unstable and hemodynamically labile, operative techniques that minimize morbidity without compromising clinical efficacy have significant value.
- Minimally invasive surgery (MIS) techniques have been associated with decreased intraoperative blood loss, operative time, and morbidity, while providing patients with comparable outcomes when compared with conventional open procedures.
- MIS interventions enable earlier mobilization, decreased hospital stay, decreased pain, and an earlier return to baseline function when compared with traditional techniques.
- MIS techniques designed to reestablish anterior column support include percutaneous vertebral body augmentation procedures and mini-open lateral corpectomy.
- MIS posterior stabilization largely consists of percutaneous fixation techniques that minimize the surgical access footprint and adjacent tissue injury.

INTRODUCTION

Traumatic spine fractures represent 75% of all spinal injuries, thus accounting for 160,000 annually,¹ most of which occur at the thoracolumbar junction (T10–L2) due to the transition from the mobile lumbar spine to the rigid thoracic spine. These fractures are typically caused by high-impact injuries, such as motor vehicle accidents and falls, and can result in persistent pain and disability even without neurologic compromise.² Early surgical management can potentially prevent, and sometimes reverse, neurologic injury; this may involve decompression, reduction, anterior column support, and/or restoration of the posterior

tension band.³ Operative stabilization with pedicle screw instrumentation via a posterior approach for reduction and fixation of fractures has traditionally demonstrated good clinical and radiographic outcomes and remains the prevalent treatment for most fractures.^{4,5} However, open surgical approaches have been associated with a mixed array of perioperative complications, including infection, significant blood loss, and extended hospitalizations.⁶

Minimally invasive surgery (MIS) has been increasingly used in the treatment of degenerative spinal pathology; however, its utilization in traumatic injury was not reported until 2004 and

Disclosure: The authors have no commercial or financial conflicts of interest to disclose as it relates to this article.

^a Georgetown University, Washington, DC, USA; ^b University of Pittsburgh Medical Center, Pittsburgh, PA, USA; ^c Neurological Surgery Spine Services, University of Pittsburgh Medical Center, UMPC – Presbyterian, Suite B400, 200 Lothrop Street, Pittsburgh, PA 15213, USA

* Corresponding author.

E-mail address: kanteras@upmc.edu

Neurosurg Clin N Am 28 (2017) 157–162

<http://dx.doi.org/10.1016/j.nec.2016.08.010>

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indications for its usage remained controversial. Due to evolving advancements in MIS technology and practice over the past decade, spine surgeons have established 360° MIS access to the vertebral column enabling anterior, lateral, and posterior less-invasive surgical approaches. Select examples of MIS procedures include percutaneous segmental fixation, vertebroplasty/kyphoplasty, and mini-open lateral access corpectomy/fusion, enabling a less destructive method of fixation and stabilization with limited adjacent tissue destruction. Moreover, proper use of these techniques has been shown to shorten hospital and recovery times, as well as reduce blood loss and perioperative complications.^{7–22} Here we summarize the techniques, controversy, and indications for the use of minimally invasive procedures in traumatic spine injuries.

Preoperative Considerations and Indications

The goals of spinal surgery in the setting of trauma remain consistent with those associated with all forms of spinal pathology, and irrespective of surgical invasiveness: decompression of neural elements, and realignment and stabilization of the vertebral column. The maintenance of adequate spinal perfusion remains critical before, during, and even after decompression of neural elements is achieved. Any injury that results in compression or spinal cord swelling can interrupt the blood supply to the spinal cord; it is thus recommended to elevate Mean Arterial Pressure (MAP) to greater than 90 mm Hg to mitigate hypoperfusion ischemic injury. If intravenous fluids alone cannot achieve target MAP, the use of vasopressors can be initiated to augment spinal perfusion.

The role of intraoperative neurophysiologic monitoring has expanded considerably with the advancements in MIS techniques, as direct visualization of neural structures is limited or absent. The use of electromyography (EMG), motor evoked potentials, and somatosensory evoked potentials (SSEPs) enables the detection of alterations in spinal cord and peripheral nerve function secondary to mechanical or ischemic events.

Patients with minor stable injuries are routinely managed nonoperatively. Those with unstable spinal injuries requiring surgical intervention can largely be divided into 2 groups: those requiring anterior column reconstruction and those requiring posterior segmental stabilization. MIS techniques designed to reestablish anterior column support include percutaneous vertebral body augmentation procedures and mini-open lateral corpectomy. Posterior stabilization largely consists of percutaneous fixation techniques that minimize

access footprint and adjacent tissue injury. The following select techniques represent the preponderance of trauma-related MIS procedures in modern day spine practice:

- *Vertebroplasty*: indicated in patients with focal back pain without evidence of cord compression, minimal loss of vertebral body height (<50%), absence of abnormal angulation (<20°), and no evidence of posterior wall involvement.
- *Kyphoplasty*: indicated in patients with focal back pain, significant loss of vertebral body height (>50%), and/or kyphotic angulation (>20°) without evidence of canal compromise or posterior wall involvement.
- *Lateral Mini-Open Corpectomy*: indicated in patients with canal stenosis secondary to comminuted or “burst” fracture patterns, kyphotic angulation, and a greater degree of instability (ie, disco-ligamentous involvement) seen on static or dynamic imaging.
- *Percutaneous Posterior Segmental Fixation*: indicated in patients with comminuted or “burst” fracture patterns with canal compromise, but with evidence of an intact posterior longitudinal ligament (PLL). Instrumentation serves as a form of “internal brace” to stabilize the segment while fracture healing occurs.

Vertebral Body Augmentation

Vertebral compression fractures commonly occur in the aging osteoporotic population and account for more than \$1 billion annual medical expenditures in the United States. MIS treatments are ideal for this population due to their numerous medical comorbidities and risk of perioperative complications, particularly in those suffering and deemed unsuitable for operative intervention. Vertebral body fracture treatment considerations include evaluation of spinal stability, focal kyphotic angulation, presence of canal retropulsion, and involvement of the posterior vertebral wall and ligament. These procedures have historically low operative morbidity and high patient satisfaction rates, and remain an excellent option for elderly patients and those with multiple medical comorbidities in whom greater interventions could not be tolerated. In osteoporotic patients, some institutions advocate prophylactic cement augmentation adjacent to the index fracture level to fortify neighboring vertebral bodies. Rates of new vertebral body fractures in osteoporotic patients following initial vertebral body augmentation have been reported in the literature at rates ranging from 5% to 18%.

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