Timing of Surgery After Spinal Cord Injury

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KEYWORDS

• Spinal cord injury • Spine trauma • Surgical timing • Surgical decompression

KEY POINTS

- Early surgical decompression of spinal cord injury, in particular incomplete injury, may lead to improved neurologic recovery.
- Although the data for early surgery are less clear in patients with complete injury, even small gains in neurologic function can have significant impact on quality of life.
- Sacral sparing has a significant impact on prognosis, and patients with an unreliable assessment should undergo early intervention if stable for surgery.
- Early surgery after spinal cord injury may also reduce the rate of non-neurologic complications and health care resource utilization.

INTRODUCTION

Spinal cord injury, affecting approximately 54 per 1 million people annually in the United States, can be a devastating injury for the trauma patient and is associated with a significant morbidity and high mortality rate, particularly among the elderly.[1] Approximately 71.7% of patients with spinal injury suffer polytrauma and the incidence of spinal cord injury among the elderly is rising, making this patient population particularly challenging to manage.[2,3] Moreover, the socioeconomic burden of spinal cord injury in the United States is substantial.[4] There is a need to optimize treatment paradigms for this patient population. Once patients are resuscitated and stabilized, the cornerstones of management of spinal cord injury include rapid clinical assessment and characterization of injury and, if indicated, definitive surgical decompression and/or stabilization. The surgical approach for decompression and fusion depends on the injury pattern. A critical question faced by the neurosurgeon is the optimal timing for decompression and stabilization. Despite having been studied extensively in the literature, there remains considerable controversy regarding the safety and efficacy of early decompressive surgery. This article examines the evidence for early surgery in patients presenting with spinal cord injury.

PATHOPHYSIOLOGIC BASIS FOR SPINAL CORD INJURY AND EXPERIMENTAL EVIDENCE FOR TIMELY DECOMPRESSIVE SURGERY

Blunt traumatic spinal cord injuries, distinct from penetrating injuries, begin with a mechanical insult that results in biomechanical failure of the spinal column leading to bony fractures and/or discoligamentous disruption. Resultant osteoligamentous instability and/or displaced bone fragments can exert compressive, sheer, or distractive forces on the spinal cord itself and can lead to immediate disruption of neural tissue or vasculature. This initial mechanical event constitutes the primary phase of spinal cord injury and the degree of primary injury is correlated with the magnitude of the force of insult.[5] After this inciting event, the secondary phase of injury ensues propagated by

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vascular ischemia, inflammation, neuronal hyperexcitability, and free radical generation, ultimately leading to further neuronal cell death.[6] Treatment of spinal cord injury focuses on curtailing the extent of secondary injury. Emerging novel therapies target these pathophysiologic processes on a molecular level. Although targeting these secondary processes is appealing and is the focus of intense research, preserving any residual viable neural tissue, even in those patients with complete injury, may optimize the chances of neurologic recovery with these newer treatment modalities.

Persistent compression or forces imparted on the spinal cord through motion from instability are the primary immediate concerns with regard to protecting a patient from further spinal cord injury. Experimental evidence in animal models suggests that the extent of spinal cord injury is correlated both with the degree of cord compression and timing to decompression.[7–9] Animal studies have demonstrated that a cerebrospinal fluid pressure differential is generated at the level of the compression; this higher pressure cephalad to compression may impair perfusion of viable tissue, leading to ischemia and further secondary injury.[10] Early decompression (<8 hours compared with >72 hours) has been associated with decreased levels of tumor necrosis factor α and fewer apoptotic cells in injured spinal cord tissue, and these factors were associated with improved neurologic recovery.[8] Timely decompression and/or stabilization of spine injuries may preserve remaining viable tissue and reduce the risk of secondary injury.

INITIAL NEUROLOGIC ASSESSMENT AFTER SPINAL CORD INJURY

Given the neurologic examination may influence the timing of surgical decision making, the initial assessment and management of spinal cord injury are reviewed briefly here.[11] Once a patient with suspected spinal cord injury is identified, a critical first step in management is a thorough neurologic assessment. This allows the neurosurgeon to determine the severity of spinal cord injury and to establish the baseline neurologic status, both of which are important for guiding further management and surgical decision making. Using well-established and validated injury severity grading scales is important because they provide a standardized way to classify spinal cord injury and facilitate communication among practitioners. The American Spinal Injury Association Classifications Standards/International Standards for Neurological Classification of Spinal Cord Injury (ASIA/ISNCSCI) is a widely used and validated clinical grading scale both for the initial evaluation of patients with spinal cord injury and for the assessment of postinjury recovery long term.[12,13] The ASIA Impairment Scale (AIS) integrates the detailed neurologic assessment captured by the ASIA/ISNCSCI into a simple grading scale of neurologic injury severity (**Table 1**).[14] The presence of sacral sparing distinguishes a complete injury (ASIA grade A) from incomplete injuries (ASIA grade B–E). A complete spinal cord injury is classified by no evidence of neurologic function,

Table 1
American Spinal Injury Association Impairment Scale grade and relationship with long-term functional ambulation

American Spinal Injury Association Impairment Scale Grade	Definition[14]	Percent Ambulation at 6 mo to 12 mo[58] (%)
A	No preservation of neurologic function at the S4-5 segments	3.7
B	Preservation of some sensory but no motor function no more than 3 levels below the level of injury, including S4-5 segments	24
C	Preservation of motor function below level with <50% of muscle groups with power rating of 3 or greater	58
D	Preservation of motor function below level with >50% of muscle groups with power rating of 3 or greater	100

Adapted from Kirshblum SC, Burns SP, Biering-Sorensen F, et al. International standards for neurological classification of spinal cord injury (revised 2011). J Spinal Cord Med 2011;34(6):535–46; and van Middendorp JJ, Hosman AJF, Pouw MH; EM-SCI Study Group. ASIA impairment scale conversion in traumatic SCI: is it related with the ability to walk? A descriptive comparison with functional ambulation outcome measures in 273 patients. Spinal Cord 2009;47(7):555–60.