SPINE Volume 31, Number 11 Suppl, pp S28–S35

The Timing of Surgical Intervention in the Treatment of Spinal Cord Injury: A Systematic Review of Recent Clinical Evidence

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Study Design. Evidence-based literature review.

Objective. To provide updated evidence-based recommendations regarding spinal cord decompression in patients with acute spinal cord injury (SCI).

Summary of Background Data. It is controversial whether early decompression following SCI conveys a benefit in neurologic outcome.

Methods. MEDLINE search of experimental and clinical studies showing the effect of decompression on neurologic outcome following SCI. We focused on articles published within the last 10 years, with a particular emphasis on research conducted within the past 5 years.

Results. A total of 66 articles were retrieved. Animal studies consistently show that neurologic recovery is enhanced by early decompression. There was 1 randomized controlled trial that showed no benefit to early (<72 hours) decompression. Several recent prospective series suggest that early decompression (<72 hours) can be performed safely and may improve neurologic outcomes. A recent systematic review showed that early decompression (<24 hours) resulted in statistically better outcomes compared to both delayed decompression and conservative treatment.

Conclusions. There are currently no standards regarding the role and timing of decompression in acute SCI. We recommend urgent decompression of bilateral locked facets in a patient with incomplete tetraplegia or in a patient with SCI with neurologic deterioration. Urgent decompression in acute cervical SCI remains a reasonable practice option and can be performed safely. There is emerging evidence that surgery within 24 hours may reduce length of intensive care unit stay and reduce post-injury medical complications.

Key words: acute spinal cord injury, timing, decompression. **Spine 2006;31:S28–S35**

The role and timing of surgical decompression after an acute spinal cord injury (SCI) remains one of the most controversial topics pertaining to spinal surgery. Despite an enormous amount of interest and research in SCI, the prognosis for neurologic recovery in patients with a severe SCI remains poor. Acute SCI remains an important cause of morbidity and mortality, with approximately 10,000–12,000 cases occurring annually in the United States.[1–4] Furthermore, the majority of patients with SCI are young,[3] making the economic and societal impact immense. During 1995, the total direct costs associated with all causes of SCI were $7.736 billion in the United States alone.[2]

Acute SCI involves both primary and secondary injury mechanisms of injury.[5–8] The primary mechanism, usually caused by rapid spinal cord compression caused by bone displacement from a fracture-dislocation or burst fracture, is irreversible. It also initiates a cascade of secondary injury mechanisms, including ischemia, electrolyte derangements, and lipid peroxidation. Secondary injury is preventable and may be reversible.

The increased understanding of the pathophysiology of acute SCI has led to clinically relevant neuroprotective therapies to attenuate the effects of the secondary injury. The National Acute Spinal Cord Injury Studies (NASCIS II and NASCIS III) have shown a modest beneficial effect of high-dose methylprednisolone if given within 8 hours of injury in patients with SCI[9,10] and suggested that treatment within 3 hours may be better than treatment initiated 3–8 hours after trauma.[11] These studies support the concept of targeting secondary mechanisms in acute SCI and also emphasize the importance of the timing of intervention. Although it is recognized that the use of methylprednisolone remains controversial, many novel neuroprotective therapies, including rho antagonists, minocycline, and sodium/glutamate blockers, are in late preclinical or Phase I clinical trials.[12]

The development of these secondary injury events, which lead to tissue destruction during the first few hours after injury, is of relevance to the surgical treatment of SCI as well. There is experimental evidence that persistent compression of the spinal cord is a potentially reversible form of secondary injury.[13–34] However, despite its widespread use in patients with acute SCI in North America, the role of surgery in improving neurologic recovery remains controversial because of the absence of well-designed and well-executed randomized controlled trials. The presence and duration of a therapeutic window, during which surgical decompression could mitigate the secondary mechanisms of SCI, remain unclear. Moreover, the practical and logistical challenges related to early decompression of patients with an acute SCI remain important issues. This article will review the experimental and clinical evidence with regard to the value of decompressive surgery in treating patients with acute, nonpenetrating SCI and compare these data with results of the conservative, nonoperative treatment of SCI. This article represents an updated and completely revised analysis of previous reports from our institutions.[32–34]

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Table 1. Experimental Studies Assessing the Role of Decompression in Animal Models of SCI Published in 1995–2005

Investigator (y)	Species	Injury Model	Timing of Decompression	Conclusion
Carlson *et al*[31] (2003)	Dogs	Piston	30 min, 3 h	Early decompression promotes NR
Dimar *et al*[19] (1999)	Rats	Extradural pacer and impactor	0–72 h	Early decompression with minimal canal compromise promotes NR
Carlson *et al*[16] (1997)	Dogs	Piston	5 min, 1 hr, 3 h	Recovery of evoked potentials in 5-min and 1-h groups
Delamarter *et al*[18] (1995)	Dogs	Circumferential cable	1 h–1 wk	Decompression at 1 h improves NR

NR indicates neurologic recovery.

■ Methods

We conducted a MEDLINE search of the literature from 1966 to 2005, dealing with the role of decompression in SCI using the medical subject headings (MeSH) of "decompression" and "spinal cord injury." Articles with English, German, and French abstracts were selected for review. Both authors reviewed the articles and arrived at a consensus opinion. This computerized literature review yielded a total of 1045 studies, which were then pared down, based on relevance to the issue of SCI treatment. A detailed examination of the reference lists from select articles and standard spine textbooks supplemented this analysis. Evidence from clinical trials was defined as class I (well-designed and well-conducted randomized controlled trials), class II (prospective cohort studies or controlled studies with well-defined comparison groups), or class III (case series, retrospective reviews, and expert opinion).[35]

■ Results

A total of 67 articles, including 19 experimental studies in animal models[13–29,31,36] and 48 clinical studies, were selected for detailed analysis. For the purposes of this review, we attempted to summarize the results of studies published in the last 10 years (Tables 1–4). Of the clinical articles, 10[37,46,51,53–59] dealt with nonoperative treatment, 32[37,40–51,55,56,60–76] with the role of early (<4 weeks) surgical intervention, 12[40,43,45,63,77–84] with the effect of closed reduction, and 7[60,85–90] with the role of delayed decompression. Based on our analysis, we suggest evidence-based recommendations regarding the role of acute decompression in SCI (Table 5).

Experimental Studies of Decompression in Acute SCI in Animal Models

There is convincing evidence from laboratory studies in various animal models that persistent compression of the spinal cord is a potentially reversible form of secondary injury.[13–29,31,36] Table 1 summarizes those studies published in the last 10 years. These studies have consistently shown that neurologic recovery is enhanced by early decompression.

In 1999, Dimar *et al*[19] provided the most compelling experimental evidence that spinal cord decompression after SCI is beneficial. Using a weight drop model followed by placement of an epidural spacer to simulate persistent compression, a thoracic SCI was performed in

Table 2. Clinical Studies of Surgical Decompression in Acute SCI Published in 2000–2005

Investigator (y)	No. Patients (level)	Timing of Intervention	Study Design (class of evidence)	Conclusions
McKinley *et al*[37] (2004)	779 (all): 603 decompressed, 176 nonoperative	73 underwent surgical decompression <24 h	Retrospective case series (III)	Early (<72 h) decompression did not improve NR but was associated with shorter hospital stay and fewer complications
La Rosa *et al*[38] (2004)	1683 (all): 793 decompressed, 890 nonoperative	226 underwent surgical decompression <24 h	Systematic review of literature up to 2000 (II)	Early decompression improves NR in patients with incomplete neurologic deficits
Pollard and Apple[39] (2005)	412 (cervical) incomplete injuries		Retrospective case series; baseline neurologic assessment not available in 51% of cases (III)	Baseline neurologic assessment only available in 202 cases; 169 patients not available for follow-up. With these caveats, early surgery (<24 h) not associated with improved recovery
Papadopoulos *et al*[40] (2002)	91 (cervical): 66 decompressed, 25 nonoperative	34 underwent surgical decompression <10 h	Prospective, nonrandomized (II)	Early surgical decompression is feasible, may improve NR, and reduces hospital stay
Pointillart *et al*[41] (2000)	106 (levels): 58 (cervical)	49 underwent surgical decompression <8 h	Prospective, nonrandomized (II)	Early surgery did not improve NR

NR indicates neurologic recovery.

Table 3. Clinical Studies of Surgical Decompression in Acute SCI Published in 1995–2000

Investigator (y)	No. Patients (level of injury)	Timing of Intervention	Study Design (class of evidence)	Conclusions
Waters *et al*[42] (1999)	2204 (all)	88% admitted <72 h	Prospective, nonrandomized (II)	Surgery does not increase complication rates of SCI patients
Tator *et al*[43] (1999)	585 (all)	23.5% underwent surgery <24 h	Retrospective case series (III)	65% of patients in North America with SCI undergo surgery; no consensus on timing of intervention
Mirza *et al*[44] (1999)	30 (cervical)	15 <72 h, 15 >72 h	Retrospective case series (III)	Early (<72 h) decompression improves NR and does not increase complication rates
Ng *et al*[45] (1999)	26 (cervical)	7 underwent surgical decompression <12 h	Prospective, nonrandomized (II)	Surgical decompression within 8 h of injury was feasible in 8% and not associated with increased complication rates
Chen *et al*[46] (1998)	37 (cervical): 16 decompressed, 21 nonoperative	<2 wk	Prospective, nonrandomized (II)	Surgery associated with improved NR, shorter hospital stay, and fewer complications
Vaccaro *et al*[47] (1997)	62 (cervical): early 34, late 38	Early <72 h, late >5 d	Prospective, randomized (II; 20 lost to follow-up)	No difference in NR or length of hospital stay between early and late surgery groups
Vale *et al*[48] (1997)	77 (all): 58 operated	11 <24 h, 13 24–72 h, 34 >72 h	Prospective, nonrandomized (II)	No clear relationship between NR and timing of surgery, but aggressive medical treatment enhanced any potential benefit provided with surgery
Botel *et al*[49] (1997)	255 (all): 178 decompressed 51.4% early, 10.5% late	Early <24 h, late >2 wk	Retrospective case series (III)	No NR in complete SCI; no association of NR to timing of decompression
Waters *et al*[50] (1996)	269 (all): 127 decompressed, 142 nonoperative	Average >14 d	Prospective, nonrandomized (II)	Surgery of no benefit; however, all patients underwent delayed surgery
Petitjean *et al*[51] (1995)	49 (thoracic)	Early average 12 h, late average 9 d	Retrospective case series (III)	Decompression of no benefit in complete thoracic paraplegia

NR indicates neurologic recovery.

rats. Quantitative analysis of locomotor recovery, lesion volume, and electrophysiology was then used to assess the effect of decompression at 0, 2, 6, 24, and 72 hours after SCI. Neurologic recovery was inversely related to the duration of compression, with statistically significant differences seen in all experimental groups. Carlson *et al*[31] also reported similar results in dogs. Animals undergoing early decompression showed significantly better functional recovery and significantly smaller lesion volumes.

Role of Conservative Treatment in Acute SCI

To evaluate the possible role of surgery in the treatment of SCI in the appropriate context, it is essential to examine the outcomes of conservative, nonoperative treatment.[46,51,53–59] Guttman[91,92] advocated the use of postural techniques combined with bed rest to achieve reduction and spontaneous fusion of the spine. Operative treatment was avoided because laminectomy was associated with a higher incidence of neurologic complications and worse clinical outcomes.[54,91–95] Frankel *et al*,[53] who adhered to these principles, reported on a cohort of 612 patients with closed spinal injuries. Delayed instability developed in only 4 patients. Importantly, 29% of patients with Frankel A (*i.e.*, complete motor and sensory paralysis below the level of the injury) had

Table 4. Studies of Early Closed Reduction in Acute SCI in 1995–2005

Investigator (y)	No. Patients	Treatment	Study Design (class of evidence)	Outcome
Papadopoulos *et al*[40] (2002)	91	32 reduced by traction alone at average <8 h	Prospective, nonrandomized (II)	Early reduction results in NR
Tator *et al*[43] (1999)	173	Traction used in only 47%	Retrospective case series (III)	Traction associated with 8.1% incidence of neurologic deterioration, although most were transient radicular changes; no consensus as to timing, role, and upper limit of traction
Ng *et al*[45] (1999)	26	11 reduced by traction at average <12 h	Prospective, nonrandomized (II)	Traction is the most practical method of achieving urgent decompression after SCI
Grant *et al*[52] (1999)	121 (46 with SCI)	97.6% reduced with traction	Retrospective case series, no controls (III)	Traction is safe; 1 of 46 patients (2.2%) with SCI had deterioration with traction; patients had neurologic improvement after traction

NR indicates neurologic recovery.

Table 5. Evidence-Based Recommendations for Decompression after Acute SCI*

Level of Recommendation	Class of Evidence	Details
Standards		There are no standards regarding the role and timing of decompression in acute SCI
Guidelines	II	Early surgery (<72 h) can be performed safely in patients with SCI if they have hemodynamic optimization
		The data support a recommendation for urgent reduction of bilateral locked facets in a patient with incomplete tetraplegia
		The data support a recommendation for urgent decompression in a patient with SCI with neurologic deterioration
Options	III	Decompression is a reasonable practice option in acute cervical SCI; when possible, excluding patients with life-threatening multisystem trauma, it is recommended that urgent decompression be performed within 24 h of SCI
		There is class III evidence that early (<24 h) surgery reduces length of stay in patients with acute SCI and may reduce post-injury medical complications

*Modified with permission from *Spine* 2001;26:S101–10.[32]

improvement of at least 1 Frankel grade during their hospital stay. This high rate of apparent conversion from complete to incomplete status may reflect some of the recognized challenges in obtaining an accurate neurologic examination in the first 24 hours. Nonetheless, these data illustrate the importance of controls in assessing any intervention for SCI.

Other investigators[47,54,93,94,96–100] have also reported spontaneous neurologic improvement with nonoperative treatment. Some investigators have indicated that neither spinal surgery nor anatomic realignment of the spinal column improved neurologic outcome in patients with acute SCI, with the possible exception of bilateral locked facets.[78,79,94] However, to our knowledge, all nonoperative treatment studies to date have been limited to noncontrolled, retrospective analyses of clinical databases (class III evidence). Furthermore, surgeons are now aware that laminectomy without fusion is contraindicated in most cases of acute SCI because it usually provides inadequate decompression of the spinal cord and may exacerbate the underlying spinal instability.[49,101] Although meticulous nonoperative treatment remains an essential component to the care of patients with SCI, modern spine surgery has advanced significantly over the past 2 decades. Furthermore, nonoperative treatment is not without its attendant risks; up to 10% of patients with incomplete cervical SCI have neurologic deterioration while being treated in an exclusively nonoperative manner.[58]

Role of Decompression in the Treatment of Acute SCI

Our review of the literature identified 10 prospective, controlled studies of surgical decompression in acute SCI.[40–42,45–48,50,74,75] Recently, Papadopoulos *et al*[40] evaluated 91 patients with acute cervical SCI to assess the feasibility and outcome of an immediate decompression treatment protocol. All patients, except 1, were admitted within 9 hours of their injury. The investigators reported that 39/66 patients in the protocol group had improvement, including some presenting with a complete SCI, compared to 6/25 in the control group. This study was classified as class II evidence because of the lack of randomization. La Rosa *et al*[38] performed a systematic review of all available studies published between 1966 and 2000. They concluded that early (<24 hours) surgical decompression in patients with incomplete injuries resulted in better neurologic outcomes than patients treated with either delayed decompression (>24 hours) or nonoperative treatment. This study is considered class II evidence because of the lack of randomized controlled trials available for inclusion in the systematic review.

In contrast, several prospective studies[37,41,47,48,50] have failed to document a beneficial effect of surgical decompression. However, to our knowledge, no study to date has truly examined in a systematic way a large cohort of patients who underwent decompression earlier than 24 hours. For example, all patients underwent delayed operative treatment in the study by Waters *et al*[50] Moreover, although the study by Vaccaro *et al*[47] was a prospective, randomized trial, 20 of the 62 patients were lost to follow-up, and "early" surgery was defined as being within 72 hours after SCI. In view of the large number of patients lost to follow-up, we have considered this study to provide class II evidence.

In addition, Pollard and Apple[39] undertook a retrospective analysis of 412 patients with incomplete cervical SCI. Unfortunately, only 49% of patients (n = 202) had baseline neurologic assessments, and 168 were lost to follow-up. The number of patients with complete data is difficult to discuss in this article. Although the investigators concluded that early surgery (<24 hours) was not associated with improved neurologic outcome, these conclusions must be interpreted very cautiously, given the major concerns regarding incompleteness of the data set. Table 2 summarizes the data from studies published in the last 5 years, while Table 3 shows data from studies published in the last 6–10 years.

A number of investigators have advocated early reduction (4–10 hours) and operative fixation of spinal fractures in patients with acute SCI.[63,68,71,83] These studies suggest that early decompression may enhance neurologic recovery in select patients with SCI. However, most of these studies lack randomization or appropriate controls and, thus, represent class III evidence only.

The clinical benefits of early reduction of fracture-dislocations of the spine by closed techniques or open surgery are difficult to assess in the absence of class I data.[44,45,63,69,80–82,102,103] Although reports of significant neurologic improvement in some cervical cases decompressed by early traction are encouraging, they do not provide sufficient evidence to support standards or guidelines.[40,71,77,81,83] Moreover, a number of studies did not find any neurologic benefit with reduction,[50,78,104] with the possible exception of patients with bilateral facet dislocation.[87]

Cotler *et al*[103] examined the safety and efficacy of early reduction, and undertook a prospective study of early reduction by traction in 24 patients (class II evidence). They found no neurologic deterioration in any of the patients, most of whom had successful reduction with closed techniques within 24 hours of injury. Papadopoulos *et al*[40] prospectively examined 91 patients with cervical SCI, 32 of whom had immediate spinal cord decompression by traction alone. They suggested that patients who had decompression with closed reduction alone (mean time to decompression 6.0 hours) had better neurologic outcomes than those requiring surgical decompression (mean time to decompression 12.6 hours). Moreover, in a retrospective case series that included 46 patients with SCI, Grant *et al*[52] concluded that cervical traction was safe (1 patient = 2.2% deteriorated neurologically) and was associated with improved neurologic recovery. Based on these data and a number of other class II studies,[40,43,45,63,78–84] we can support a recommendation for urgent reduction of bilateral locked facets in a patient with incomplete tetraplegia or in a patient with neurologic deterioration.

Despite the potential appeal of aggressive, closed reduction of locked cervical facets, Tator *et al*[43] documented an 8.1% rate of neurologic deterioration with attempts at closed reduction in 585 cases. However, it should be emphasized that the majority of the neurologic changes related to transient radicular deficits cleared with reduction in weight. Moreover, the retrospective nature of the study design did not allow for precise control of critical variables, such as presence or absence of sedation, fluoroscopic control *versus* general radiograph imaging, and the method of applying traction. It is recognized that in experienced hands with control of the aforementioned variables, the rate of serious permanent neurologic deterioration with traction is low.[52] Nonetheless, these sobering data emphasize the difficulty in interpreting accounts of the beneficial effects of rapid closed reduction by traction in the absence of class I data. Table 4 summarizes the results of those studies published in the last 10 years, which assessed the effect of urgent closed reduction in the setting of acute SCI.

In contrast to the aforementioned studies of early decompression, Larson *et al*[60] advocated operating a week or more after SCI to allow medical and neurologic stabilization of the injured patient. This remains the practice in many institutions, particularly in light of early reports suggesting an increased rate of medical complications with early surgery (<5 days after SCI).[105] Interestingly, a number of investigators have documented recovery of neurologic function after delayed decompression of the spinal cord (months to years) after the injury.[60,86–89,106] Although these studies are retrospective in design (class III evidence), the improvement in neurologic function with delayed decompression in patients with cervical or thoracolumbar SCI who have had a plateau in their recovery is noteworthy and suggests that compression of the cord is an important contributing cause of neurologic dysfunction.

Effect of Surgery on Complications and Length of Stay After SCI

The issue of whether surgery, especially early surgery, increases the rate of complications in patients with SCI has been one that has generated considerable controversy and debate. Many patients with SCI with high tetraplegia or significant associated systemic injuries are critically ill because of cardiorespiratory compromise. Many investigators have argued against surgery, especially early intervention in these critically ill patients.[91,92,94,99,105] However, modern techniques of spine surgery, as well as advances in critical care and neuroanesthesia have allowed these patients to undergo surgery with minimal differences in complication rates between operative and nonoperative cases.[48,64,74,103,107–111] Indeed, Duh *et al*[75] showed that those patients operated on in the first 24 hours had a lower rate of complications than those undergoing operative intervention at later times. In a prospective study of 2204 cases, Waters *et al*[42,50] found that there was no difference in the complication rates of cases treated by nonoperative or surgical techniques.

In a study from our unit, the only difference in morbidity between the surgical and nonsurgical cases was a slight increase in the incidence of deep venous thrombosis in the operated group.[74] Furthermore, the length of stay in the 2 groups did not differ. In the prospective, randomized trial by Vaccaro *et al*,[47] there was no significant difference in length of acute postoperative intensive care stay or length of inpatient rehabilitation between the early and late groups, which has been reiterated by others as well.[44,46] McKinley *et al*[37] have reported that early surgery is associated with shorter hospitalization, reduced pulmonary complications, and equivalent neurologic outcomes as delayed surgery. Accordingly, there is class II evidence to support the safety of operative treatment within the first 72 hours, and whenever possible, we recommend decompression within 24 hours of injury. The literature from the last 10 years is summarized in Tables 2 and 3.

Systematic Review of the Current Literature of the Role of Decompression in Acute SCI

La Rosa *et al*[38] recently published a systematic review of the literature addressing the issue of early decompression and its role in acute SCI. They reviewed all the published clinical studies up to the year 2000 and were able to

extract data on 1687 patients. Patients were divided into 3 treatment groups: early decompression (<24 hours), delayed decompression (>24 hours), and conservative treatment. Statistically, early decompression resulted in better outcomes compared to both delayed decompression and conservative treatment. However, the investigators performed an analysis of homogeneity, and only data regarding patients with incomplete SCI who underwent early decompression were reliable. They concluded that early decompression can only be considered as a practice option.[38] Their conclusions are in concordance with ours, which are summarized in Table 5.

Potential Impact of Injury Mechanism and Type of SCI

There is clear evidence that the severity of the primary injury is critical to determining the ultimate outcome after traumatic SCI. In their retrospective analysis of a cohort of 412 patients with traumatic cervical SCI, Pollard and Apple[39] could not identify an association between mechanism of injury and neurologic outcome. However, interestingly, these investigators did find that patients with a Brown-Sequard syndrome or a central cord syndrome had relatively improved outcomes. This fascinating observation requires further analysis in large, carefully, controlled series. Moreover, it seems intuitive that the effect of surgery and decompression may differ between cervical or thoracic/thoracolumbar injuries. However, because of the paucity of high-quality prospective studies, we did not stratify our analysis by level of the spine. Again, this important question needs to be examined in prospective studies with adequate follow-up and appropriate outcomes assessments.

Current Studies of the Role of Decompression in Acute SCI

In an attempt to provide a definitive answer regarding the role of early decompression, our institution (University of Toronto), in collaboration with Thomas Jefferson University in Philadelphia and the Spine Trauma Study Group, has initiated a multicenter, prospective trial to evaluate the effect of early (≤24 hours after injury) *versus* late (≥24 hours) decompressive surgery for cervical SCI (Surgical Timing in Acute Spinal Cord Injury Study). Although such aggressive treatment protocols demand expedient care and cooperation between spine surgeons and radiologists, they are feasible.[40,45] The study is not randomized because of ethical concerns about allocating a deteriorating patient to delayed decompression. In addition, logistical and technical factors limit the number of patients who arrive at a spinal cord center for definitive treatment within 24 hours of injury, thus limiting the number of patients eligible for randomization. A total of 450 patients are required to complete this study, which is currently open for enrollment.

■ Discussion

There is strong experimental evidence from animal models that decompression of the spinal cord improves recovery after SCI. However, it is difficult to determine a time frame for the effective application of decompression in the clinical setting from these animal models. Studies of secondary injury mechanisms, including ischemia, free radical-mediated lipid peroxidation, and calcium-mediated cytotoxicity, suggest that early intervention within hours after SCI is critical to obtain a neuroprotective effect. Whether a similar time frame applies to surgical treatment is, as yet, unclear but seems likely.

To date, the clinical studies that have examined the role of surgical decompression in SCI are limited to class II and III evidence. Surgery remains a valid practice option, although, to our knowledge, there are no conclusive data showing a benefit over conservative treatment approaches. We recommend that surgical decompression be performed within 24 hours of injury whenever possible. There is class II evidence suggesting that early surgical intervention is safe and effective, and even delayed decompression may convey a neurologic benefit. There is class II evidence to support the guideline that urgent closed reduction of bilateral locked facets should be performed in a patient with incomplete tetraplegia, and urgent decompression should be performed in patients with neurologic deterioration following acute SCI. There is no standard of care regarding the timing of surgical decompression following acute SCI.

Clearly, what is needed to answer definitely the question regarding the timing of surgery following SCI is a well-designed, prospective, randomized controlled, multicenter trial producing class I data. Although such a study may never be feasible because of ethical and logistical concerns about randomization, a large, prospective multicenter study (*i.e.*, STASCIS) is currently in progress. We encourage other institutions to contribute patients to this trial with the goal of definitively answering this controversial and highly clinically relevant topic.

■ Key Points

- There are currently no standards regarding the role and timing of decompression in acute SCI.
- Studies in animal models have consistently shown that neurologic recovery is enhanced by early decompression.
- There is evidence that early (<24 hours) decompressive surgery can be performed safely after acute SCI (guideline).
- There is evidence to support urgent closed reduction of bilateral locked facets in a patient with incomplete tetraplegia or urgent decompression in a patient with neurologic deterioration following a SCI (guideline).
- We recommend urgent decompression (<24 hours) following isolated acute cervical SCI, provided hemodynamic stability is maintained (option).

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