Surgical and Nonsurgical Treatment of Penetrating Spinal Cord Injury: Analysis of Long-term Neurological and Functional Outcomes

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Objective: To describe long-term neurological and functional outcomes for patients with penetrating spinal cord injury (PSCI) following surgical (SX) and nonsurgical (NSX) treatment. **Methods:** We identified all patients with PSCI in the Spinal Cord Injury Model Systems database from 1994-2015. Patients with PSCI were divided into surgical (SX) and nonsurgical (NSX) groups. Outcomes were measured using the International Standards for Neurological Classification of Spinal Cord Injury (ISNCSCI) and the Functional Independence Measure (FIM) motor scores. Outcomes were then analyzed separately for patients with complete and incomplete PSCI during acute hospitalization, SCI rehabilitation, and 1-year follow-up. **Results:** For patients with complete PSCI, acute hospital length of stay (LOS) was increased in the SX group (19 days vs 14 days; $p < .0001$) while median FIM motor scores were similar at 1-year follow-up (74 vs 75; $p = .4$). The percentage of patients with complete PSCI remained similar between groups at discharge from SCI rehabilitation (88% vs 88%; $p = 0.5$). For patients with incomplete PSCIs, acute hospital LOS was similar between groups (13 vs 11; $p = .3$) and no difference was observed in ASIA Impairment Scale improvement at discharge from rehabilitation (38% vs 37%; $p = .9$) or in FIM scores at 1 year (84 vs 85; $p = .6$). **Conclusion:** Surgery for patients with complete PSCI is associated with increased acute hospital LOS for complete PSCI and is not associated with improvement in neurological or functional outcomes in patients with either complete or incomplete PSCI. **Key words:** long-term outcomes, penetrating spinal cord injury, rehabilitation, SCI Model Systems, spine surgery

Long-term outcomes for patients with penetrating spinal cord injury (PSCI) remain largely understudied. Despite the severe functional limitations and high societal costs associated with this injury, few data exist that describe long-term outcomes in this population.¹ Clinical decision-making and prognostication is based upon a small number of retrospective clinical studies, which suggest that patients with PSCI show variable improvement in the postinjury recovery period and that patients with complete PSCI demonstrate less improvement than patients with incomplete PSCI.²⁻⁴

Stabilization surgery for patients with PSCI is not typically required since most penetrating

injuries are not associated with instability of the spine.^{5,6} However, debate continues over whether or not surgical decompression, including bone and projectile removal, in patients with PSCI provides any benefit for neurological function compared with nonsurgical treatment. Some studies suggest little benefit with increased risk of postoperative complications in patients with PSCI who undergo surgery.^{2,7} Other studies suggest that surgery can be beneficial particularly for patients with incomplete PSCI^{8,9} or in patients experiencing progressive neurological decline.⁵

In this study, we analyzed the Spinal Cord Injury Model Systems (SCIMS) database to determine neurological and functional outcomes for patients

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after surgical and nonsurgical management of PSCI in medical centers across the United States. We hypothesized similar neurological and functional outcomes for patients with PSCI in both groups.

Material and Methods

Data source

The SCIMS national database was queried to identify all penetrating SCI admissions to rehabilitation facilities in the United States participating in the SCIMS program from January 1994 through January 2015. The SCIMS is a national project funded by the US Department of Health and Human Services National Institute on Disability, Independent Living and Rehabilitation Research (NIDILRR). The project is the first prospective, multicenter study of recovery and outcomes in patient with SCI following participation in a coordinated system of acute hospital care and SCI rehabilitation. Institutions that are designated as SCIMS centers must have access to Level 1 Trauma Center care, acute spine surgery care, comprehensive inpatient rehabilitation services, and long-term interdisciplinary follow-up and rehabilitation services. Currently there are 15 SCIMS centers and five additional follow-up centers across the United States. SCIMS database inclusion criteria are (1) traumatic SCI that is associated with a motor or sensory deficit, (2) admission to SCIMS center within 1 year of injury, (3) acute hospital care and inpatient rehabilitation received within a participating SCIMS center, and (4) informed consent signed by the patient and/or guardian. More information is available at: <https://www.nscisc.uab.edu/nscisc-database.aspx>.

Patient selection and characteristics

We identified all patients with PSCI who were admitted on the day of injury to participating SCIMS centers between January 1994 and January 2015 and divided these patients into those who underwent spine surgery (SX) and those who did not undergo spine surgery (NSX). The “Spinal Surgery” variable in the SCIMS database includes both decompression and fusion procedures,

and further detailed surgical information is not available. All acute hospital-related factors known to influence postdischarge outcomes in SCI patients who were available in the SCIMS database were analyzed including clinical information, demographics, and socioeconomic factors. Race was dichotomized into African American and non-African American; ethnicity is available in the SCIMS database but was not reported in this study. The neurological level of injury (NLOI) was measured according to the International Standards for Neurological Classification of Spinal Cord Injury (ISNCSCI) and completeness of injury was documented using the American Spinal Injury Association Impairment Scale (AIS).¹⁰ The NLOI was recoded into groups as “cervical” for C1-C8 injuries, “thoracic” for T1-T11 injuries, and “lumbar” for T12-L5 injuries for clinical descriptive purposes. Only the raw NLOI score was used to calculate changes in the NLOI over time. Penetrating injury was defined as any gunshot wound, knife wound, explosion, and any other penetrating type wound. Insurance type was coded as none, private, and government (ie, Medicaid or Medicare) payment types. Education level was recoded into high school or less, college degree or some college, and graduate levels of education.

Outcomes

Outcomes were measured at acute hospital admission, SCI rehabilitation admission, SCI rehabilitation discharge, and at 1-year follow-up time periods. Follow-up AIS and NLOI scores were obtained at discharge from SCI rehabilitation. Most 1-year follow-up visits were conducted over the telephone, and so many AIS and NLOI scores were not available at 1-year follow-up since these scores require a direct, in-person clinical exam. The Functional Independence Measure (FIM) motor score was measured at all three follow-up time periods.¹¹ Patients with complete SCIs as measured by the AIS were coded AIS A and were analyzed separately from patients with incomplete spinal cord injuries coded AIS B through D based upon previously published reports suggesting differences in neurological outcomes between these two groups.^{12,13} Changes in AIS grade over time were measured by recoding each AIS alpha

score into a numerical score and subtracting the AIS numerical score at SCI rehabilitation discharge from the initial AIS score obtained during acute hospitalization. Changes in NLOI over time were measured by recoding each neurological level of injury grade into a numerical score and subtracting the numerical score at SCI rehabilitation discharge from the initial numerical score obtained during acute hospitalization. The percentage of patients requiring any kind of mechanical ventilation assistance was recorded at admission and discharge from SCI rehabilitation. The percentage of patients requiring rehospitalization, living at home, and mortality were all measured at 1-year follow-up only.

Statistical analyses

Patient baseline characteristics and outcomes were compared across SX and NSX groups using Pearson's chi-square tests for categorical variables, Mann Whitney *U* test for all nonparametric continuous variables, and Student's *t* test for all parametric continuous variables. Multivariate, non-stepwise linear regression analysis was performed to determine independent predictors of length of stay in both the acute hospital and SCI rehabilitation time periods. Analyses were performed using SPSS software (version 23.0; SPSS, Inc., Chicago, IL). Statistical significance was set at $p < .05$.

Results

A total of 1,052 PSCI admissions were identified in the SCIMS database: 212 SX patients and 840 NSX patients (**Table 1**). SX rates for PSCI ranged from 6% to 45% of PSCIs admitted to each SCIMS institution during the study period, and no statistically significant difference in injury severity was observed across SCIMS institutions. The PSCI patients were predominately young, male, African American, and presented as complete PSCIs that occurred at a thoracic spinal level. Baseline acute hospital admission characteristics including age, sex, race, marital status, mechanism of injury, and insurance status were not significantly different between SX and NSX groups. However, the distribution of AIS scores differed significantly

Table 1. Baseline admission characteristics for all PSCI patients 1994-2015^a

Characteristics	Surgery (<i>n</i> = 212)	No surgery (<i>n</i> = 840)	<i>p</i>
Age, years	24 (20-32)	24 (20-31)	.7
Male	188 (89%)	733 (87%)	.6
AA race	142 (67%)	533 (64%)	.9
AIS score ^b			
A	106 (50%)	508 (61%)	
B	24 (11%)	97 (12%)	
C	23 (11%)	83 (10%)	.02*
D	14 (7%)	45 (5%)	
E	0	0	
NLOI			
Cervical	44 (21%)	165 (20%)	
Thoracic	65 (31%)	381 (45%)	.02*
Lumbar (T12-L5)	48 (23%)	163 (19%)	
Mechanism			
GSW	205 (97%)	808 (96%)	.7
Insurance type			
None	28 (13%)	88 (11%)	
Private	42 (20%)	162 (19%)	.09
Government	84 (40%)	435 (52%)	
Education level			
High school or less	168 (79%)	777 (93%)	
College	11 (5%)	32 (4%)	.003*
Graduate	3 (1.4%)	2 (0.2%)	
Marital status			
Married	16 (8%)	79 (9%)	.5

Note: AA = African American; AIS = American Spinal Injury Association Impairment Scale; GSW = gunshot wound; NLOI = neurological level of injury; PSCI = penetrating spinal cord injury.

^aAll continuous variables are reported at median values with interquartile range in parentheses.

^bDoes not total 100% due to missing scores during hospital admission.

*Statistically significant.

between the SX and NSX groups with more NSX patients having complete SCI (61% vs 50%; $p = .02$). NLOI in patients with PSCI also differed significantly between SX and NSX groups with more thoracic injuries in the NSX group (45% vs 31%) and more lumbar injuries in SX group (23% vs 19%) ($p = .02$).

In the complete PSCI patient cohort, SX patients demonstrated a significantly longer acute hospital length of stay (LOS) (median days: 19 vs 14; $p < .0001$),

but no difference in SCI rehabilitation LOS (37 vs 39; $p = .4$) (**Table 2**). No difference in FIM motor scores was noted upon admission to SCI rehabilitation (27 vs 28; $p = .5$). SX patients showed slightly lower FIM motor scores upon discharge from SCI rehabilitation (57 vs 65; $p = .001$), however, FIM scores at 1-year follow-up showed no difference (74 vs 75; $p = .4$). The percentage of complete PSCI patients in SX and NSX groups was similar at discharge from SCI rehabilitation (88% vs 88%; $p = .5$).

No difference between groups was observed in the percentage of patients who experienced an AIS improvement by one grade (8% vs 10%; $p = .5$) or two grades (6% vs 5%; $p = .6$) at the time of discharge from SCI rehabilitation (**Table 2**). Moreover, SX and NSX groups demonstrated no significant change in NLOI at discharge from rehabilitation (mean $\pm$ SD: 0 ± 1.9 vs 0 ± 2.1 ; $p = .1$). Mortality rates at 1 year were not significantly different between groups (2% vs 0.2%; $p = .08$).

In the incomplete PSCI patient cohort, LOS was similar during acute hospitalization (13 vs 11; $p = .3$) and during SCI rehabilitation (31 vs 32; $p = .8$) (**Table 3**). FIM motor scores were similar upon admission to SCI rehabilitation (31 vs 31; $p = .9$), upon discharge from SCI rehabilitation (73 vs 73; $p = .4$), and at 1 year follow-up (84 vs 85; $p = .6$). No difference between groups was observed in the percentage of patients who experience an AIS improvement by one grade (38% vs 37%; $p = .9$) or two grades (8% vs 8%; $p = .9$) or in the percentage of patients who experienced a decrease in AIS grade (5% vs 7%; $p = .8$) at the time of discharge from SCI rehabilitation. As with the complete PSCI cohort, patients with incomplete PSCI in the SX and NSX groups demonstrated no significant change in NLOI at discharge from SCI rehabilitation (mean $\pm$ SD: 1.2 ± 3.7 vs 0.6 ± 3.0 ; $p = .2$). Mortality rates at 1 year were also similar between groups (2% vs 0.4%; $p = .3$).

Linear regression analysis showed that SX was an independent predictor of increased acute hospital LOS (**Table 4**). Patients had an increase of 7.6 more acute hospital days than NSX patients (β coefficient = 7.6; confidence interval: 4.4-10.7; $R^2 = 0.076$). Patients with PSCI of the cervical spine spent 6 more days in the acute hospital compared to patients with lumbar PSCI (6.0; 2.6-9.5; $R^2 = 0.076$). Moreover, patients with complete PSCI had

Table 2. Complete PSCI outcomes 1994-2015^a

	Surgery (<i>n</i> = 106)	No surgery (<i>n</i> = 508)	<i>p</i>
Acute hospital LOS	19 (13-36)	14 (8-25)	<.0001*
SCI rehabilitation LOS	37 (29-56)	39 (28-62)	.4
FIM Motor			
Rehab AD	27 (18-33)	28 (21-35)	.5
Rehab DC	57 (40-70)	65 (49-75)	.001*
1 year	74 (63-80)	75 (59-81)	.4
AIS at rehab DC			
No change	93 (88%)	448 (88%)	.5
1 grade improvement	8 (8%)	51 (10%)	.5
2 grade improvement	6 (6%)	23 (5%)	.6
AIS at 1 year ^b			
No change	36 (34%)	249 (49%)	.09
1 grade improvement	11 (10%)	40 (8%)	.09
2 grade improvement	8 (8%)	23 (5%)	.09
NLOI improvement			
Rehab DC	0 ± 1.9	0 ± 2.1	.1
1 year	0 ± 2.3	0.5 ± 2.3	.1
Mechanical ventilation			
Rehab AD	27 (26%)	107 (21%)	.3
Rehab DC	4 (4%)	15 (3%)	.6
≥ 1 Rehospitalization			
1 year	28 (26%)	171 (34%)	.9
Living at home at 1 year	65 (61%)	374 (74%)	.6
Mortality			
1 year	2 (2%)	1 (0.2%)	.08

Note: AD = admission; AIS = American Spinal Injury Association Impairment Scale; DC = discharge; FIM = Functional Independence Measure; LOS = length of stay; NLOI = neurological level of injury; PSCI = penetrating spinal cord injury; Rehab = rehabilitation.

^aAll continuous variables are reported as median values with interquartile range in parentheses or mean values $\pm$ SD.

^bDoes not total 100% due to lost follow-up.

*Statistically significant.

an increase of 5.3 more acute hospital days than incomplete PSCI patients (5.3; 2.6-8.0; $R^2 = 0.076$).

Linear regression analysis showed that SX was not an independent predictor of SCI rehabilitation LOS (-1.5; -7.1-4.1; $R^2 = 0.20$) (**Table 5**). Patients with PSCI of the cervical spine spent 30 more days in SCI rehabilitation compared to patients with lumbar PSCI (30.2; 24.2-36.2; $R^2 = 0.20$). Moreover, patients with complete PSCI had an increase of 8.1 more days in SCI rehabilitation than incomplete

Table 3. Incomplete PSCI outcomes 1994-2015^a

	Surgery (<i>n</i> = 61)	No surgery (<i>n</i> = 225)	<i>p</i>
Acute hospital LOS	13 (6-25)	11 (6-19)	.3
SCI rehabilitation LOS	31 (22-45)	32 (21-51)	.8
FIM Motor			
Rehab AD	31 (23-40)	31 (23-40)	.9
Rehab DC	73 (57-79)	73 (64-79)	.4
1 year	84 (78-88)	85 (78-89)	.6
AIS at rehab DC			
Grade loss	3 (5%)	16 (7%)	.8
No change	30 (49%)	108 (48%)	.9
1 grade improvement	23 (38%)	84 (37%)	.9
2 grade improvement	5 (8%)	17 (8%)	.9
AIS at 1 year ^b			
Grade loss	2 (3%)	6 (3%)	1.0
No change	12 (20%)	28 (12%)	.2
1 grade improvement	14 (23%)	56 (25%)	.3
2 grade improvement	5 (8%)	12 (5%)	.6
NLOI improvement			
Rehab DC	1.2 ± 3.7	0.6 ± 3.0	.2
1 year	0.7 ± 3.0	1.0 ± 2.9	.6
Mechanical ventilation			
Rehab AD	6 (10%)	20 (9%)	.8
Rehab DC	0	0	-
≥1 Rehospitalization			
1 year	6 (10%)	33 (15%)	.4
Living at home at 1 year	36 (59%)	144 (64%)	.3
Mortality			
1 year	1 (2%)	1 (0.4%)	.3

Note: AD = admission; AIS = American Spinal Injury Association Impairment Scale; DC = discharge; FIM = Functional Independence Measure; LOS = length of stay; NLOI = neurological level of injury; PSCI = penetrating spinal cord injury; Rehab = rehabilitation.

^aAll continuous variables are reported as median values with interquartile range in parentheses or mean values ± *SD*.

^bDoes not total 100% due to lost follow-up.

PSCI patients (8.1; 3.3-12.8; $R^2 = 0.20$). Uninsured patients with PSCI spent 11.6 fewer days in SCI rehabilitation compared to PSCI patients with private insurance (-11.6; -18.7 to -4.5; $R^2 = 0.20$).

Discussion

Our results suggest that outcomes for patients with PSCI remain poor overall and that SX

Table 4. Linear regression for acute hospital LOS

Model	β	SE	Sig.	95% CI for β	
				Lower	Upper
Age at injury	.001	.065	.018	-.127	.129
Spine surgery	7.556	1.608	.000	4.399	10.714
Health insurance ^a					
Uninsured	.789	2.049	.700	-3.235	4.812
Government	.892	1.437	.523	-1.929	3.713
Neurological level of injury ^b					
Cervical	6.062	1.741	.001	2.643	9.482
Thoracic	.137	1.573	.931	-2.951	3.225
AIS score	5.303	1.369	.000	2.616	7.990
Constant	11.060	2.400	.000	6.170	15.950
$R^2 = .076$			.000		

Note: AIS = American Spinal Injury Association Impairment Scale; CI = confidence interval; LOS = length of stay; SE = standard error.

^aPrivate pay is referent.

^bLumbar is referent.

Table 5. Linear regression for SCI rehabilitation LOS

Model	β	SE	Sig.	95% CI for β	
				Lower	Upper
Age at injury	-.008	.116	.947	-.235	.219
Spine surgery	- 1.475	2.853	.605	-7.077	4.126
Health insurance ^a					
Uninsured	-11.585	3.632	.001	-18.716	-4.45
Government	2.752	2.551	.281	-2.256	7.760
Neurological level of injury ^b					
Cervical	30.224	3.066	.000	24.203	36.244
Thoracic	2.302	2.769	.406	-3.134	7.738
AIS score	8.075	2.426	.001	3.311	12.840
Constant	32.169	4.146	.000	23.498	40.839
$R^2 = .196$			.000		

Note: AIS = American Spinal Injury Association Impairment Scale; CI = confidence interval; LOS = length of stay; SCI = spinal cord injury; SE = standard error.

^aPrivate pay is referent.

^bLumbar is referent.

for patients with PSCI is not associated with improvement in neurological level, completeness of injury, or function. For patients with complete PSCI, no consistent differences were observed over time between SX and NSX groups across FIM scores, AIS grade improvement, change in

NLOI, ventilator dependency, rehospitalization, and mortality. However, median acute care hospital LOS was 5 days longer in the SX group for complete PSCI. For incomplete PSCI patients, no differences were observed in FIM scores, AIS grade improvement, change in NLOI, ventilator dependency, rehospitalization, mortality, and acute hospital LOS or SCI rehabilitation LOS. Linear regression confirmed that SX for PSCI was independently associated with increased acute hospital LOS.

Debate over the benefit of SX for PSCI has continued over decades. Older studies by Benzel et al and Cybulski et al suggested that surgery could benefit neurological function, particularly in patients with incomplete PSCI.^{12,13} Studies also suggested a benefit for surgery in the setting of progressive neurological decline^{12,14,15} or for PSCI between the T12-L5 vertebral levels.^{13,16-18} In addition, spinal instability, bullet migration, and CSF fistula in PSCI are rare but accepted indications for surgery.^{6,19} Other studies showed no benefit for surgery and an increased risk of postoperative complications.^{18,20-22} Currently, no national guidelines exist for the surgical management of PSCI.

Much of the debate about surgery in PSCI stems from limitations in study design and available data. Most PSCI studies have been small, retrospective, performed at a single institution, lacked standardized outcome metrics, and did not control for SCI rehabilitation or standardized follow-up. Early access to specialized SCI rehabilitation is a known predictor of good outcome in the SCI population.²³ Moreover, most of the studies on surgery in PSCI were published 20 years ago or more and do not reflect current advancements in medical care, surgery, and SCI rehabilitation. In contrast, our study was large, multicentered, and included SCI rehabilitation and standardized follow-up.

Despite modern improvements in medical care, trauma systems, spine surgery techniques, and SCI rehabilitation, SX is not associated with an improvement in neurological status or function for patients with PSCI in the SCIMS database, regardless of injury severity or spinal level. Subset analysis of PSCI at the T12-L5 spinal levels did not show significant improvements in AIS grade

at discharge from rehabilitation or FIM scores at 1-year follow-up (data not shown). Moreover, no differences were observed between groups in NLOI improvement at discharge from rehabilitation for patients with incomplete PSCIs, which is the subpopulation in which we would expect to see better functional outcomes based on prior studies.^{12,13} Our results show that for patients with incomplete PSCI and lumbar PSCI injuries, improvement in functional and neurological outcomes is more limited than some studies suggest. Moreover, a recently published paper from our own institution found similar results using a single institution, merged trauma and rehabilitation registry database.²⁴

Surgical decision-making for patients with PSCI will likely remain challenging, particularly given the lack of alternative treatment options beyond surgical decompression and instrumented fusion. While surgical indications for PSCI exist, no absolute indications or national guidelines direct surgical practice. Practice variation in surgery for PSCI is likely widespread and exists within our own institution.²⁴ In this present study, SX rates varied from 6% to 45% of all PSCIs admitted to each institution without significant differences observed in the severity of SCI across institutions. These data suggest that local and regional practice patterns and institutional bias likely drive surgical practice patterns more than injury characteristics or other clinical factors that may influence surgical decision-making.

Finally, early neurological assessment of SCI with serial clinical exams in the setting of an acute trauma is an essential component in the assessment and treatment of patients with PSCI. However, standard AIS assessment for prognostication after injury is only recommended 72 hours after injury due to variability in AIS assessments at earlier time points, which proves a limitation in any time-related study of SCI and surgery where AIS grading is applied.²⁵ Our study did not specifically focus on patients with an acute, progressively worsening, or fluctuating neurological exam, which may be a subgroup that might benefit from surgical decompression. However, improving outcomes for patients with PSCI requires more than current surgical techniques can offer and awaits advancements in innovative technologies

and therapeutics to improve outcomes in this challenging population.

Limitations

This study was a retrospective analysis of prospectively collected data and suffers from several biases related to retrospective analysis including selection bias. Unmeasured baseline differences between the study groups could have affected the outcome. The majority of patients in both SX and NSX groups had complete SCIs and injuries to the thoracic spine, although relatively more NSX patients had complete injuries and thoracic injuries. The decision to perform surgery for patients with PSCI is complex and multifactorial and no current national guidelines exist to direct surgical practice in this population. In our study, separating patients with complete from incomplete PSCI allowed for a more homogenous cohort for outcome analysis. Our study was also large and multicentered, which supports the generalizability of our results. Furthermore, patients in both SX and NSX groups showed limited neurological improvement regardless of treatment pathway over time, suggesting that a penetrating injury mechanism may be the most important factor in outcomes for patients with PSCI. Although a randomized controlled trial would better address some of these biases, a lack of clear treatment guidelines in this patient population combined with the impact of surgeon selection bias and patient/family preferences in randomized controlled trials, particularly in the acute setting of neurotrauma, remains a considerable challenge.²⁶

Clinical studies in SCI have been criticized for population heterogeneity and a lack of more specific outcome measures. We stratified the injury severity of our study population in order to analyze a more homogenous population and analyze their outcomes across several outcome measures and scores. However, the results of this study might not apply to patients with PSCI who are not admitted to SCI rehabilitation at acute care hospital discharge or who are not treated in a SCIMS institution.

The spine surgery variable available in the SCIMS defines a decompression or instrumented spine surgery procedure and more detailed information about the type of spine surgery

performed and intraoperative findings were not available. The database does not provide the indications for surgery. However, neurological deficit is one of the major indications for spine surgery in penetrating injury and all patients included in this study had a neurological injury. We utilized several functional outcome measures in this study in order to overcome the limitations of a single measure. However, standardized scales such as the FIM score have known ceiling effects in SCI patients, particularly at long-term follow-up, and may not be sufficiently sensitive to changes at the upper end of the scale and at long-term follow-up.

Follow up for the SCIMS database approaches 80% at 1 year. However, approximately 50% of AIS scores and approximately 60% of NLOI scores were not reported at 1 year due to the nature of SCIMS database follow-up. FIM scores can be completed via telephone interview during follow-up whereas AIS assessment and determination of NLOI must be done in person, which accounts for the low response rate for AIS and NLOI scores at 1 year. As such, AIS and NLOI scores were only reported at discharge from rehabilitation. Finally, the only variable that relied upon patient recall at 1-year follow-up was the number of rehospitalization events. To minimize recall errors, we did not report the number of rehospitalization events in the past year, but only whether a patient recalled being hospitalized more than once in the past year. All other variables reported at 1 year did not require patient recall of past events.

Conclusion

Surgery for patients with complete PSCI is associated with increased acute hospital LOS. In addition, surgery for patients with complete or incomplete PSCI is not associated with improvement in neurological or functional outcomes at up to 1-year follow-up.

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Conflicts of Interest

Drs. Roach and Chen report grant funding from NIDILRR. The other authors declare no conflicts of interest

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