



## Operative Versus Nonoperative Management of Civilian Gunshot Wounds to the Spinal Cord: Novel Use of the Functional Independence Measure for Validated Outcomes

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■ **BACKGROUND:** Surgery for patients with gunshot wound spinal cord injury (GSCI) remains controversial. Few recent studies provide standardized follow-up and detailed functional outcomes. To our knowledge, the research we present in this study is unique in that we are the first to incorporate Functional Independence Measure (FIM) scores as an outcomes measure for neurologic recovery in patients with GSCI.

■ **METHODS:** Patients with GSCI were divided into surgical and nonsurgical groups. Neurologic function was measured according to the American Spinal Injury Association impairment scale and defined as either complete or incomplete injury. Outcomes were then analyzed separately for complete and incomplete GSCI groups during hospitalization and rehabilitation.

■ **RESULTS:** Baseline admissions characteristics were similar between surgical and nonsurgical groups except for a greater median injury severity score in the nonsurgical group (34 vs. 27;  $P = 0.02$ ). For complete GSCI, total length of stay (LOS) was significantly longer in the surgical group (52 vs. 42 days;  $P = 0.04$ ), and no difference was observed in overall FIM scores (58 vs. 54;  $P = 0.7$ ). For incomplete GSCI, rehabilitation LOS was longer (35 vs. 21;  $P = 0.02$ ) and a trend towards longer total LOS was observed in the surgical group (40 vs. 32;  $P = 0.07$ ). No

difference was observed in overall FIM scores (61 vs. 62;  $P = 0.9$ ).

■ **CONCLUSIONS:** Surgery for patients with GSCI is associated with increased LOS and is not associated with improved FIM scores for patients with either complete or incomplete spinal cord injuries.

### INTRODUCTION

According to the National Spinal Cord Injury Statistical Center, gunshot wounds to the spine account for roughly 13% of all spinal cord injuries (SCIs) during the past 10 years, behind automobile accidents and falls.<sup>1</sup> The most commonly affected region is the thoracic spine, followed by cervical, and then lumbosacral region.<sup>2-7</sup> The most recent data from the National Spinal Cord Injury Statistical Center estimate the lifetime costs for a 25-year-old tetraplegic patient to be greater than \$4.7 million, not including opportunity costs.<sup>8</sup> Gunshot wounds resulting in spinal cord injury (GSCI) present a life-changing event for each individual patient, as well as a significant financial burden on the health care system.

Operative intervention for patients with GSCI remains controversial. The balance between the possible benefits of neurologic recovery and the risk of complications has been debated for decades.<sup>3-7</sup> Classically, indications for surgery include individuals with progressive neurologic deficit, infection, persistent dural leaks,

### Key words

- Functional Independence Measure
- Long-term outcomes
- Penetrating spinal cord injury
- Quality of life

### Abbreviations and Acronyms

**AIS:** American Spinal Injury Association impairment scale

**CGSCI:** Complete gunshot spinal cord injury

**FIM:** Functional Independence Measure

**GSCI:** Gunshot wounds resulting in spinal cord injury

**IGSCI:** Incomplete Gunshot Spinal Cord Injury

**ISS:** Injury Severity Score

**LOS:** Length of stay

**SCI:** Spinal cord injury

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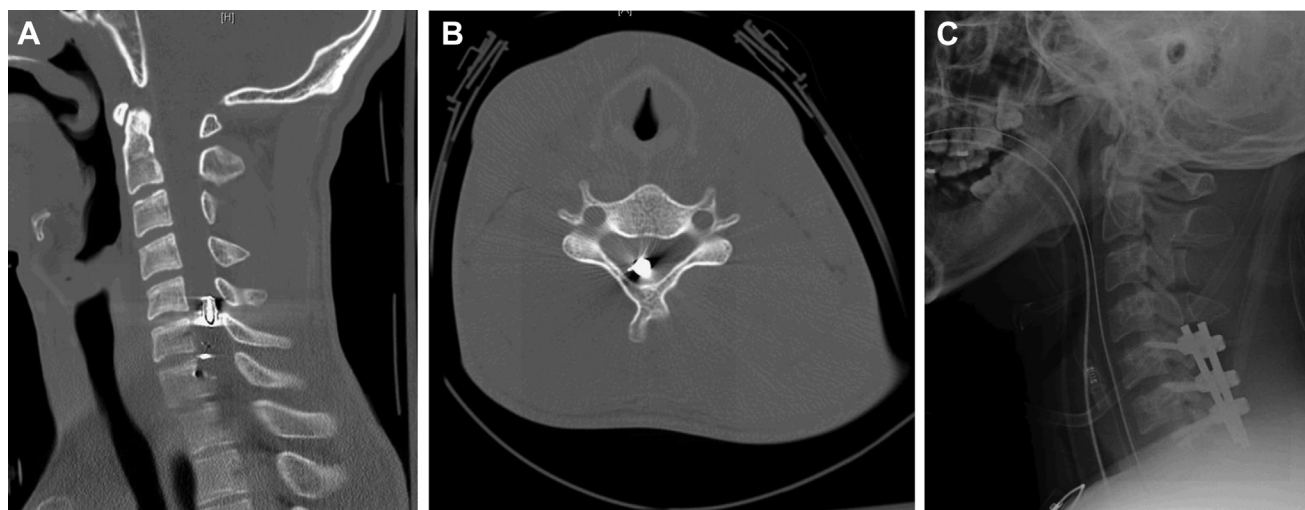
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**Figure 1.** (A) Sagittal CT scan showing bullet within the spinal canal between C5 & C6. (B) Axial CT cuts showing same bullet at the C5 level. (C) Post

operative radiograph of after treatment with C6 laminectomy, bullet removal, repair of traumatic durotomy, and C5–C7 fusion.

spinal instability, and metal toxicity.<sup>9–16</sup> Treatment options include decompressive laminectomy with or without removal of the bullet, and, depending on the pattern of the injury, subsequent spinal stabilization if deemed appropriate.<sup>17–20</sup> The majority of authors advocate that the benefits of surgical intervention are of questionable significance, and surgery is most appropriate for those with incomplete injuries.<sup>5,6,11,18,19,21–24</sup> Some studies suggest significant improvement in motor and sensory recovery after surgery in the setting of lumbosacral and cervical spine injuries.<sup>2,17,20,25</sup>

We hypothesized that those individuals with both complete gunshot spinal cord injury (CGSCI) or incomplete gunshot spinal

cord injury (IGSCI) who underwent operative intervention would show no improvement in functional outcomes measures after hospital discharge. We also hypothesized that the surgical groups would have greater rates of complication and longer hospital and rehabilitation stays.

## MATERIALS AND METHODS

After we obtained approval from the institutional review board, the trauma and rehabilitation registries at an urban level 1 academic trauma center were queried and matched for all patients

**Table 1.** Baseline Admission Characteristics of Patients with Complete Spinal Cord Injury from Gunshot Wounds

	Surgery (n = 16)	No Surgery (n = 51)	P Value
Age, years (interquartile range)	21 (18, 32)	23 (20, 31)	0.6
Male	13 (81%)	46 (90%)	0.4
Injury Severity Scale	27 (25, 34)	34 (25, 42)	0.02*
Trauma and Injury Severity Score	0.99 (0.96, 1.0)	0.98 (0.95, 0.99)	0.8
Glasgow Coma Scale	15 (15, 15)	15 (5, 15)	—
Level of spinal cord injury			
Cervical	6 (38%)	17 (33%)	0.4
Thoracic	10 (63%)	29 (57%)	
Lumbar	0	5 (10%)	
Insurance type			
None/unknown	5 (31%)	27 (53%)	0.06
Private	4 (25%)	2 (4%)	
Government	5 (31%)	18 (35%)	

\*Statistically significant with the use of nonmatched *t* test with Levene test for nonhomogeneity of variance.

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