The role of routine spinal imaging and immobilisation in asymptomatic patients after gunshot wounds

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**Introduction**

The need for radiographic clearance and prolonged immobilisation or surgical fixation of the spine for all patients with gunshot wounds has been debated. In an investigation by Klein et al., the authors reported that spine injuries occurred in approximately 10% of patients surviving initial injury after gunshot wounds to the trunk, head or neck; with two-thirds of these spine injuries requiring either surgical intervention or prolonged immobilisation. The accuracy of these findings, however, has been criticised. The purpose of this study was to determine the incidence of spinal column injury requiring stabilisation in evaluable patients following gunshot injury. **Methods:** A retrospective study from of a Level I trauma centre from January 1995 to December 2004. All patients with GSW to the head, neck or torso and bony spinal column injury underwent medical record review to determine injury type, presentation, presence of concomitant spinal cord injury, treatment and outcome. **Results:** A total of 4204 patients sustaining GSW to the head, neck or torso were identified. Complete medical records were available for the 327 (7.8%) patients with bony spinal column injury. Among these patients, 173 (52.9%) sustained spinal cord injury. Two patients (0.6%) with GSW to the torso and bony spinal column injury required operative spinal intervention. The indication for operative intervention in both cases was removal of a foreign body or bony fragment for decompression of the spinal canal. None of the 4204 patients sustaining GSW to the head, neck or torso demonstrated spinal instability requiring operative intervention, and only 2/327 (0.6%) required any form of operative intervention for decompression. **Conclusion:** Spinal instability following GSW with spine injury is very rare. Routine spinal imaging and immobilisation is unwarranted in examinable patients without symptoms consistent with spinal injury following GSW to the head, neck or torso.

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diagnoses, and management were recorded for analysis. Patients with spinal injury had a complete review of their medical records, if available.

Results

Over the 10-year study period, 4204 patients surviving for 24 h were admitted with GSW to the head, neck or torso (Fig. 1). Among these patients, 339 (8.1%) patients had bony spinal column injury radiographically and 327 (96.4%) had complete medical records available for review. Spinal cord injury was documented in 150/327 (45.8%). Only two of these patients required operative spinal intervention. Both had additional imaging confirming bony or projectile fragment invasion of the spinal canal and underwent subsequent operation for decompression. Patients with a Glasgow Coma Score (GCS) of 15 constituted 188 (55.5%) of those patients with GSW and bony spinal column injury. Among these patients, 99 (52.7%) also sustained spinal cord injury. The two patients requiring operative intervention had a GCS of 15, but presented with clinical evidence of cord injury. No patients with GCS 15 and normal neurological examinations on admission required operative spinal intervention.

No significant association between location of GSW and subsequent differences in the rate of spinal cord injury or instability was demonstrated. GSW with head and neck involvement resulted in radiographically confirmed bony spinal column injury in 51 patients, with 66.7% (34/51) of these demonstrating spinal cord injuries radiographically or clinically. Fifteen patients with isolated head or neck GSW had spinal injury and spinal cord injury occurred in five of these patients (33.3%). None of the patients with bony spinal column injury after gunshot wound to the head or neck required operative spinal intervention. By comparison, GSW with truncal involvement resulted in bony spinal column injury in 288 patients, with 149 (51.7%) sustaining spinal cord injuries. Isolated GSW to the torso occurred in 212 patients, demonstrating a higher rate of spinal cord injury than those with isolated cervical injuries, at 56.1% (119 patients). Only two patients with spinal cord injuries after GSW to the torso required operative spinal intervention, both for decompression of the spinal canal from bony or projectile fragmentation (Table 1).

Fig. 1. Patient study population Los Angeles County Medical Center, University of Southern California; January 1995 to December 2004.

Table 1
Demographics and procedures for patients requiring operative spinal intervention after GSW.

<table>
<thead>
<tr>
<th>Age</th>
<th>Gender</th>
<th>GSW location</th>
<th>Spinal injury location</th>
<th>SCI Type</th>
<th>Type of surgical intervention</th>
<th>Neurologic improvement?</th>
</tr>
</thead>
<tbody>
<tr>
<td>45</td>
<td>Male</td>
<td>Abdomen</td>
<td>Lumbar</td>
<td>Incomplete</td>
<td>Decompression</td>
<td>No</td>
</tr>
<tr>
<td>19</td>
<td>Male</td>
<td>Chest</td>
<td>Thoracic</td>
<td>Incomplete</td>
<td>Decompression</td>
<td>No</td>
</tr>
</tbody>
</table>
Discussion

GSWs remain among the leading causes of spinal cord injury in jury in the United States.25 Between 6% and 17% of all spinal cord injuries each year are caused by penetrating trauma.6,15,16,21 According to an examination of the National Spinal Cord Injury Model System Database this number may be increasing.24 While spinal cord injuries have been noted to occur secondary to blast effect of GSWs without direct trauma to the bony spinal column,17 the majority of spinal cord injuries following GSW occur in the setting of spinal fracture.

The need for spinal imaging and spinal immobilisation for the evaluation and treatment of all patients with gunshot wounds to the head, neck or torso has been debated. While the NEXUS study group has effectively demonstrated that alert patients without the head, neck or torso has been debated. While the NEXUS study group has effectively demonstrated that alert patients without
planning of the circumstances of “prolonged immobilisation” have called these findings into question.20

GSWs are known to be associated with appreciable rates of spinal fractures, particularly in the cervical region, where the relative tighter anatomic confines make these injuries more likely. In a recent examination at our own center, we found that GSW to the neck resulted in a higher rate of both cervical spinal fracture and spinal cord injury than occurred following stab wounds and blunt mechanisms.19 Despite this fact, surgical stabilisation or tong immobilisation was required much less frequently than following blunt mechanism (15.5% vs. 31.6%, respectively); and was only required in patients with neurological deficits or pain in proximity to the spine on presentation. The impact of prolonged immobilisation or stabilisation even in this setting remains in doubt, however, as in this study we were unable to note any significant recovery in patients with cervical spinal cord injury following immobilisation.

Although an outcome benefit of routine spinal immobilisation following GSW has never been demonstrated, theoretically this intervention would provide benefit primarily in the patient with an incomplete spinal cord injury and an unstable fracture following GSW. Unfortunately, in an examination of the National Spinal Cord Injury Model System Database, Waters and Adkins demonstrated that the majority of spinal cord injuries due to firearms are complete at presentation.24 Waters et al. found that, even among those minority of patients with incomplete injuries, surgical intervention was required sparingly. In their study, they noted that the majority of patients requiring spinal surgery following GSW needed only posterior decompression (19%), and that only 4% required fusion for spinal stabilisation.12,24

Most authors agree that GSWs to the spine are usually inherently stable.5,10,11,13 In one of the largest reports to date, Cornwell et al. found that instability occurred in only 0.2% of torso gunshot injuries.5 In an examination of combat casualty data collected during the Vietnam conflict by the Wound Data and Munitions Effectiveness Team (WDMET), Arishita et al. found that only 1.4% of all casualties might have potentially benefited from immobilisation.1 In yet another study examining the outcomes of 60 adolescents with GSW to the spine and bony involvement, Aryan et al. found no evidence of spinal instability on follow-up dynamic imaging conducted after injury. This group additionally noted that even in two patients with apparent two-column disruption radiographically, no evidence of instability could be elucidated.2 It has been suggested that the majority of cases of instability after gunshot wounds are due not to the injury itself but, in fact, to overly aggressive attempts at operative decompression of the spinal canal.22

The vast majority of patients with significant spinal injury following GSW will present with either a compromised examination or with neurological and musculoskeletal examination findings suggestive of such an injury. These patients warrant immobilisation and further spine imaging at a convenient time; an approach that is well validated by the existing medical literature. In a series of 81 patients with cervical spine fractures following GSW to the head and neck, Medzon et al. found that only three patients required operative intervention for stabilisation. More importantly, they noted that among 65 awake and alert patients without a neurological deficit only three had fractures, none of which were unstable.16 In another study by le Roux and Dunn examining the outcomes in patients with GSW and spinal injury, the investigators noted 6 of 49 GSW injuries were diagnosed as unstable. While these six patients required subsequent fixation, all had neurological deficits on initial examination.14

Despite the fact that some have contended to the contrary,12 the recommendation that all patients with gunshot wounds undergo routine full radiographic spinal clearance represents an extremely difficult, expensive and clinically unnecessary demand on a health system that is already heavily burdened. As is the common practice at many institutions, including our own, other imaging modalities such as CT are often used to define the trajectory of a projectile through the soft tissues and identify indications for intervention for vascular or solid organ injury. While these studies may subsequently lead to the effective exclusion of spine or spinal cord injury, our present data show that dedicated radiographic spinal evaluation and routine spine immobilisation in asymptomatic patients is unwarranted. Another frequently used argument for the immobilisation of the spine is that the patient may suffer blunt trauma to the spine following a GSW as they fall or are even involved in a motor vehicle collision. However, the medical literature fails to demonstrate a single case in which this scenario has occurred.

The routine use of cervical collar immobilisation following GSW in the absence of symptoms could, in fact, prove detrimental. Life-threatening complications due to penetrating neck injury are common, and may be overlooked if the neck is routinely covered with a stabilisation device. In an examination of the role of prehospital cervical spine stabilisation conducted by Barkana et al.5 the investigators documented the clinical course and outcomes of 54 Israeli soldiers suffering penetrating neck injuries. Barkana et al. found that immobilisation was not only unnecessary in this group, with no patients requiring prolonged immobilisation or operative intervention for instability, but that in a significant number of cases the collar use demonstrated the potential to mask potentially life-threatening injuries associated with penetrating trauma.5 In another study of patients with gunshot wounds to the head, Kaups and Davis15 found that unnecessary collar immobilisation was associated with an increased number of intubation attempts. Impedance to the establishment of an adequate airway, particularly in the setting of a cervical gunshot wound and potential airway injury or compromise, represents a potentially devastating complication of unnecessary collar use.

Our trial has several important limitations, primarily related to the retrospective design. We were unable to elucidate from the
medical record the specific rationale for spinal immobilisation in all cases. Whether the reason for collar use was comfort, stabilisation of existing injury, or simply as a precaution until additional imaging could be obtained could not be accurately ascertained in all cases. Additionally, although the patients in our study were appropriately documented as evaluable and neurologically intact, or with partial or complete deficits, the specific findings of the neurologic exam were not universally precise. For these reasons, a prospective examination of this issue is needed.

From our experience, we conclude that no patients who are (1) fully awake and alert and (2) have a normal neurological examination (3) have no paraspinal tenderness will manifest a vertebral column or spinal cord injury following GSW that will require operative stabilisation. As has been well documented in the literature,1,5,8,10,11,13 spinal instability following gunshot injury is exceedingly rare, even in the setting of documented spinal column injury. In our experience, no patients with spinal column or direct spinal cord injury required stabilisation, and only 0.6% (2/327) required operative intervention for decompression.

Conflict of interest

None of the authors of this work have any financial or personal relationships with other people or organisations that inappropriately influenced this work.

References