Neurosurgical intervention in penetrating spinal trauma with associated visceral injury

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Associated injuries to the neck, chest, or abdomen are found in approximately one-quarter of all civilians with penetrating spinal cord or cauda equina injuries. While the value of and indications for general surgical exploration and repair of these injuries are fairly self-evident, the value of neurosurgical intervention in terms of neurological outcome and infection prophylaxis remains the subject of debate. To study this issue, 160 civilian patients with penetrating spinal injuries and neurological deficits were retrospectively reviewed. Associated injuries of the esophagus, trachea, bronchi, or bowel were seen in 107 individuals (67%); 33 (31%) of these patients had abdominal injuries, 25 (21%) had neck injuries, 23 (21%) had thoracic injuries, and 26 (24%) had injuries occurring at multiple sites. Of these 107 patients, 67 (63%) had complete neurological injuries and the remaining 40 (37%) demonstrated incomplete deficits. All 107 patients underwent surgical exploration and repair of their visceral injuries; in 19 of them a neurosurgical procedure was also performed for decompression of the neural elements and/or debridement of the wound. Regardless of the presence of associated visceral injuries, the mechanism of injury, and the extent of the neurological deficit, no statistically significant difference in neurological outcome was found in patients with or without neurosurgical intervention. Complications associated with neurological injury were reported in 17 (11%) of the total group of 160 patients. Four (21%) of the 19 patients who had neurosurgical intervention suffered a related complication, compared to only six (7%) of the 88 patients who were managed conservatively (p < 0.05). Within the limitations of a retrospective review, the results of this study do not clearly support the value of routine neurosurgical intervention as an adjunct to general surgical repair in cases of spinal injury associated with penetrating visceral trauma.

KEY WORDS: spinal cord injury, visceral injury, cauda equina injury, gunshot wound, neural decompression, debridement

Penetrating wounds to the neck, chest, and abdomen have long been associated with a high morbidity rate, and often a fatal outcome. When these wounds are accompanied by a spinal cord injury, the complexity of management and resultant mortality increase substantially. Most of the information and practice relating to the care of these patients has been derived from wartime experience, and Army policy since the Korean War has been to subject nearly all patients with penetrating spinal cord injury to decompressive laminectomy and intradural exploration. The wisdom of extending this practice to penetrating spinal wounds in civilians has recently been questioned. Nevertheless, one of the recommended indications for the neurosurgical exploration of penetrating spinal cord or cauda equina injuries in civilians remains the potential contamination of the adjacent vertebrae and spinal canal by the contents of a perforated abdominal viscus or bronchus. The present retrospective study was undertaken to examine this issue based on a large civilian experience with penetrating spinal injury.

Clinical Material and Methods

Patient Series

Between 1980 and 1986, 171 patients with penetrating spinal injuries were treated at Ben Taub General Hospital. Of these, 160 cases had adequate documentation of both preoperative and postoperative neurological status and of the surgical procedures, as well as descriptions of any complications; these patients constitute the basis of this analysis. Of the 160 patients, 107 (67%) sustained concomitant injuries to the respiratory or digestive tracts, requiring an exploratory procedure or tube thoracostomy. Severity of neurological injury was considered “complete” if complete paraple-
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FIG. 1. Location of visceral injuries. The abdominal region was the most frequent site of injury, with injuries of this site occurring in approximately one-third of all cases with associated nonneurological injuries. Injuries to the cervical and thoracic areas, and injuries to multiple sites were each found in about one-quarter of the total group. Of the patients with thoracic injuries, 17 (16%) suffered pneumothoraces and six (6%) suffered thoracic visceral injuries.

Definitions

Neurological improvement or deterioration was determined based upon comparisons between the initial neurological examination and the final examination at the time when the patient was released from Ben Taub General Hospital or transferred to a rehabilitation facility. A significant change in neurological function was considered the gain or loss of function at a minimum of one segmental level. Complications refer to infectious and structural disorders of the spine or of the neural elements within.

Statistical Analysis

Statistical difference in outcome between the different treatment groups was based on simple chi-square analysis for contingency tables and the Mantel-Haenszel statistic for stratified tables. Results were considered to be significant at p < 0.05 and were confirmed with logistic regression.

Results

The 160 patients in this study included 142 with gunshot wounds (including five shotgun injuries) and 18 with stab wounds to the spine. Males (94%) greatly outnumbered females (6%). The average age was 29 years and ranged from 7 to 75 years. The distribution of injuries was as follows: 27% of patients sustained cervical injuries, 54% thoracic, and 19% lumbosacral. At the time of admission, 94 (66%) of the gunshot wounds and four (22%) of the stab wounds were complete injuries; the rest caused incomplete deficits.

Associated injuries of the esophagus, trachea, bronchi, or bowel were seen in 107 patients (67%). The most frequent associated injuries were to the abdomen (33 or 31%), followed by injuries to the cervical area (25 or 23%) and injuries to the thoracic region (23 or 22%). Seventeen patients (16%) had isolated pneumothoraces and six (6%) suffered thoracic visceral injuries. Injuries to multiple sites occurred in 26 (24%) of the 107 patients (Fig. 1). There were 16 injuries to the colon and 12 to the pharynx.

All 107 patients with associated injuries underwent plain spinal radiographic examination of the injured area in the emergency center, with an additional 20 (19%) undergoing further neuroradiological or electrophysiological procedures. All patients with a documented pneumothorax received immediate tube thoracostomy and, if a significant cardiac or intrathoracic vascular injury was present, were subjected to immediate thoracotomy. Any patient with a penetrating wound to the abdomen or neck underwent an exploratory surgical procedure. These procedures took precedence over any proposed neurosurgical procedure. Each patient received prophylactic antibiotic coverage. The specific agents, dosage, interval, and length of treatment varied.

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In the group of 107 patients who suffered associated injuries in addition to spinal trauma, 67 (63%) were found to have neurologically complete injuries at initial evaluation and the remaining 40 (37%) presented with incomplete deficits (Table 1). Similarly, 31 (59%) of the 53 patients who did not sustain associated injuries first presented with complete neurological deficits (Table 2). Gunshot wounds accounted for slightly over 95% (102) of the 107 penetrating spinal injuries with associated nonneurological injuries; the remaining 5% resulted from stab wounds. Neurosurgical procedures were performed in 19 (18%) of the 107 patients with associated injuries. As might be expected, patients with incomplete deficits had the best prognosis for neuro-

<table>
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<th>Injury &amp; Treatment</th>
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<th>No Change</th>
<th>Worse</th>
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<tr>
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<td>6 (67%)</td>
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<td>46 (80%)</td>
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<td>4 (40%)</td>
<td>4 (40%)</td>
<td>2 (20%)</td>
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<td>17 (57%)</td>
<td>7 (23%)</td>
<td>6 (20%)</td>
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<tr>
<td>totals</td>
<td>21 (53%)</td>
<td>11 (27%)</td>
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TABLE 2
Neurological outcome in 53 patients without associated injuries

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<th>Worse</th>
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<tbody>
<tr>
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<tr>
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<td>20 (91%)</td>
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<tr>
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<td>3 (10%)</td>
<td>28 (90%)</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>Totals complete (22 cases)</td>
<td>5 (16%)</td>
<td>28 (90%)</td>
<td>0 (0%)</td>
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<td>Neurosurgical procedure (9 cases)</td>
<td>4 (45%)</td>
<td>3 (22%)</td>
<td>2 (22%)</td>
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<tr>
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<td>9 (69%)</td>
<td>4 (31%)</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>Totals</td>
<td>13 (59%)</td>
<td>7 (32%)</td>
<td>2 (9%)</td>
</tr>
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Discussion

Associated nonneurological injuries occur in two-thirds of all penetrating spinal injuries sustained in combat, but have previously been reported in only one-quarter of those in civilians.1 In the United States, gunshot wounds cause the majority of combined penetrating neurological and nonneurological trauma, while stab wounds are encountered more frequently in third-world nations.6,8 The presence of these associated injuries can complicate and prolong the initial hospitalization of individuals with penetrating spinal injuries. Although the value of and indications for general surgical exploration of visceral injuries is fairly well defined, few studies have examined the role of neurological intervention in this group of patients.

Of all the potential complications of penetrating spinal injuries, infections may be the most preventable, since prophylactic broad-spectrum antibiotics can be started on initial presentation, thus minimizing the risk of contamination from a wound track.5,11 In patients with multisystem trauma involving the spine or its contents, exploration of the neck, chest, or abdomen generally takes precedence over any neurodiagnostic or neurosurgical procedure.11

Whether neurosurgical intervention to debride or decompress the neural elements has any benefit in reducing infectious complications or improving the neurological outcome of these patients is not clear. Romanick, et al.,10 reviewed 20 patients who had sustained a fracture or disruption of the disc space in conjunction with an abdominal injury, who underwent exploratory laparotomy but not laminectomy, and who all received broad-spectrum antibiotics for a minimum of 2 days. Of eight patients who suffered injuries to the colon, seven (88%) developed meningitis, paraspinal infection, or osteomyelitis. These infections were not observed in patients who did not suffer a perforated viscus or who only had injury to the stomach or small bowel. Jones, et al.,7 noted cervical osteomyelitis in four cases of transpharyngeal gunshot wounds treated by antibiotics alone, without thorough debridement of the bone and soft tissues. Some authors have advocated primary debridement of the spine and paravertebral tissues through the operative incision of the primary procedure, thus eliminating the need for a second procedure.1,5

On the other hand, Yashon, et al.,14 in reviewing 65 patients with missile injuries to the spinal cord, found that infection did not develop in patients with missile fragments retained within the spinal canal, provided that large doses of antibiotics were administered. Heiden, et al.,3 in 1975 and Stauffer, et al.,11 in 1979 suggested that operative intervention to debride devi-
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FIG. 2. Penetrating spinal injury and colon injury. Sixteen patients suffered injuries to the colon in addition to neurological deficits. Only two complications occurred, one each in the neurosurgically treated and the nonneurosurgically treated groups.

FIG. 3. Penetrating spinal injury and pharyngeal injury. Twelve patients sustained both pharyngeal and spinal trauma. One-quarter of these also suffered complications; three were in the nonneurosurgical group and the fourth was the only patient with this injury in whom neurosurgical intervention was undertaken.

talized bone and soft tissue did not improve the rate of infections if prophylactic antibiotics were used alone, and in fact it increased both infectious and noninfectious complications. In none of these three studies did spinal decompression and debridement improve neurological outcome. In addition, a higher rate of delayed osteomyelitis has been reported in patients who had undergone aggressive debridement of their wounds.7

The present study suggests that neurosurgical intervention, with or without the presence of associated injuries, does not improve the overall neurological outcome. Furthermore, despite potential contamination from a perforated bronchus or viscus, neurosurgical intervention led to a higher complication rate than was found in those treated by nonneurosurgical debridement and repair of these organs. It has been suggested that pharyngeal and colonic injuries associated with spinal cord injury cause a higher complication rate without extensive neurosurgical debridement.5,10 Yet in this series, one (8%) of 12 patients suffering colonic injury who did not undergo a neurosurgical procedure developed a complication, as compared to one (25%) of four patients who did undergo neurosurgical debridement. This experience is clearly different from that of Romanick, et al.10 A higher complication rate was found in patients with pharyngeal injuries; three (27%) of the 11 patients with this injury and no neurosurgical intervention suffered infectious complications, as did the single patient who underwent laminectomy and debridement. The small sample size in this group does not permit any further interpretation.

Although this study involves one of the largest reported series of penetrating spinal trauma and associated injuries in the literature, our results must be interpreted in the context of a retrospective review.

Thus, in order to definitively answer whether decompression and extensive debridement of the spine is indeed of benefit in cases of penetrating injury, a well-designed randomized prospective study must be performed. Nevertheless, these retrospective data provide an insight into this difficult clinical entity and do not clearly support the value of neurosurgical intervention as an adjunct to general surgical repair in cases of penetrating spinal injury associated with visceral injury.

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References


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