C-Spine Injury Associated with Gunshot Wounds to the Head: Retrospective Study and Literature Review

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Objective: To determine the incidence of C-spine injury (CSI) associated with gunshot wounds (GSWs) to the head.

Methods: A retrospective chart review including patients with GSWs to the head and excluding those with penetrating facial/neck trauma was performed. Cervical clearance was by clinical/radiologic criteria in survivors, and autopsy in nonsurvivors. A MEDLINE literature search was performed and relevant articles reviewed.

Results: One hundred seventy-four charts were available for review; 90 had C-spine radiographs (complete series [49], lateral [33], and computed tomographic scan [8]). Of 84 with no radiographs, 29 were clinically cleared, and 55 died (32 cleared at autopsy). Twenty-three died without evaluation. None of the remaining 151 (87%) had CSI. Literature search yielded only three relevant articles. Combining the data from these articles yielded 534 patients, and CSI was excluded in 507 (95%).

Conclusion: C-spine immobilization and diagnostic radiography are probably not necessary in patients with isolated GSWs to the head and may complicate and delay emergency airway management.

Materials and Methods

Study Protocol

A 10-year retrospective review was performed at the Lincoln Medical and Mental Health Center between January 1, 1988, and April 30, 1999, on medical records with the diagnosis of “gunshot wound to the head” or “penetrating head trauma.” Medical records during the same period with a diagnosis of “cervical spine fracture and/or injury” were also reviewed to determine whether any of them also had concomitant gunshot wounds to the head. In addition, autopsy results, when available, were reviewed for patients who died and had no radiographic examinations.

Patients were included in this review if they sustained an isolated GSW to the head. This was defined as one that penetrated the cranium, which consists of eight bones: the frontal, the occipital, and the paired sphenoid, temporal, and parietal bones. Medical records indicating penetrating facial and/or neck trauma were excluded. Medical records were reviewed for mechanism of injury, radiographic and clinical examinations performed, patient disposition, and discharge diagnosis.

Cervical clearance was by clinical or radiologic criteria in surviving patients, and by postmortem examination (including the cervical ligaments, vertebrae, and spinal cord) in nonsurvivors. Radiologic criteria included an adequate cervical spine series consisting of an adequate cross-table lateral, anteroposterior (AP), and open-mouth odontoid views; computed tomographic (CT) scan of the C-spine; or a single cross-table lateral radiograph. Criteria for clinical clearance included alert mental status and absence of neurologic findings or cervical pain.

Literature Search and Review

A MEDLINE literature search was performed for 1966 to 1999. The titles and abstracts of citations were reviewed for relevance to the study. The search yielded only three relevant articles.
individually for manuscripts addressing the incidence of C-spine injuries in patients with GSWs to the head. In addition, the references of related articles were reviewed for other relevant citations.

The following data were pooled from these articles: the total number of patients identified in the study as having GSWs to the head; the number of charts available for review; the number of patients with isolated GSWs to the head; the number of complete C-spine series and/or CT scan of the C-spine, and complete cross-table lateral radiographs; the number of patients cleared clinically, and those cleared by postmortem examination; the number of patients in which CSI was excluded in each of the studies; and the number of patients with no and/or incomplete radiographs who were nonetheless discharged home without a diagnosis of CSI.

This study was approved by the institutional review board at the Lincoln Medical and Mental Health Center, and patient informed consent waived.

RESULTS

Present Study

Figure 1 presents the results of this study in schematic format. Of the 174 patients for whom charts were available, 23 patients died and did not have C-spine radiographs or autopsy. There were no cervical spine injuries found in the remaining 151 patients. During the same time frame, there were 353 patients with cervical spine fractures and/or injuries. None had an associated GSWs to the head.

It should be noted that 24 of the 33 patients (73%) who only had a cross-table lateral radiograph, and 28 of the 29 (97%) cleared clinically, were discharged home. No mention of CSI was noted on discharge or on follow-up.

Literature Search and Review

The literature search yielded only three relevant articles that addressed the issue of CSI in patients with GSWs to the head.9–11 A comparison of these three articles and pooling of their data were facilitated by the fact that each addressed the issue of the incidence of C-spine injuries in patients with GSWs to the head, and all used C-spine radiographs to rule out CSI.

Kennedy et al. only utilized cross-table lateral radiographs; Chong et al. utilized the cross-table lateral and AP views; and Kaups and Davis utilized a five-view series and clinical criteria in alert patients, dynamic fluoroscopy in conjunction with plain radiography in obtunded patients, and autopsy results in nonsurvivors. The present study utilized a three-view series, a single complete cross-table lateral radiograph, a CT scan, as well as clinical criteria in alert patients and autopsy results in nonsurvivors. Table 1 represents the pooling of data from these studies and the present study.
C-spine immobilization and diagnostic radiography are prob-

cally in 47. In 110 nonsurvivors, C-spine clearance was
determined radiographically in 37 and by autopsy in 73.
C-spine clearance was possible for 199 (93%) patients.
There were three patients who had direct bullet injuries to
the C-spine, and all had entrance or exit wounds suggesting a
cervical trajectory. Of the remaining 13 nonsurvivors, 12
did not have autopsies, and the autopsy report could not be
found in 1. They concluded that indirect spinal injury does not
occur in patients with GSWs to the head.

The major limitation of the studies by Kennedy et al. and
Chong et al. is that to rule out CSI, only adequate cross-table
lateral radiographs were utilized in the former, and only an
AP and cross-table lateral in the latter. The sensitivity of the
cross-table lateral ranges from 33% to 85%.13–16 Conse-
sequently, these radiographs should not be relied upon as the
sole means of excluding CSI. Chong et al.’s attempt to com-
bine an inadequate cross-table lateral with the AP radiograph
to exclude CSI is ill-advised and fraught with hazard.

The present study also utilized a complete cross-table
lateral as a means of ruling out CSI. However, as mentioned
above, 24 of 33 (73%) of these patients were discharged home
without mention of CSI.

A major limitation of the three studies reviewed, and the
present one, is the relatively small sample size of each. The
combined experience of all of these studies, utilizing the
number of patients who in fact had isolated GSWs to the head
and whose charts were available for review, total only 534
patients. CSI was excluded in 507 of these patients (95%) by
the following criteria: complete C-spine series/CT scan,
cross-table lateral radiograph, and clinical or autopsy clear-
ce. If more rigid criteria are applied, thereby eliminating
the cross-table lateral as a sole means of C-spine clearance,
CSi can be excluded in only 320 of these 534 patients (60%).

This study confirms what is intuitive for many clinicians,
as well as the findings of the only three studies attempting to
determine the incidence of CSI in patients with isolated
GSWs to the head: CSI does not occur in these patients.
Despite the relatively small sample size of the pooled data
from these three studies, the results strongly suggest that
C-spine immobilization and diagnostic radiography are prob-

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CCSS, complete C-spine series (3 or 5 view); GSW, isolated gunshot wound; CSI, spine injury.
* These patients had a complete cross-table lateral radiograph and were discharged home without a diagnosis of CSI.
ably not necessary in patients with isolated gunshot wounds to the head and may complicate and delay emergency airway management.

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REFERENCES