

# 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 non-survivors. 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.

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The reported risk of cervical spine injury (CSI) associated with blunt head trauma is estimated to range from 1.7% to 15%.<sup>1–8</sup> However, with only three exceptions, the medical literature does not comment on the incidence of CSIs secondary to isolated penetrating head trauma.<sup>9–11</sup> Despite this limitation, medical folklore has extended the dictum that one should always rule out CSI in the “head-injured” patient to encompass patients with isolated gunshot wounds (GSWs) to the head.<sup>8</sup>

Contrary to this “common wisdom,” one must also consider the potential consequences of routinely immobilizing these patients in rigid collars and obtaining diagnostic radiographs. After initial assessment, the emergency management of the patient with penetrating head injury is aimed at establishing a specific anatomic diagnosis of the head injury, ensuring the metabolic needs of the brain, and preventing secondary brain damage from treatable causes of elevated intracranial pressure.<sup>8</sup> In addition to preventing aspiration, achieving these goals centers around emergency endotracheal intubation, which cervical spine (C-spine) immobilization and diagnostic radiography often delay and render more difficult.<sup>9–11</sup>

Consequently, the incidence of CSI in these patients is crucial in determining the utility of diagnostic intervention to rule out CSI. The purpose of this retrospective study and review of the literature was to determine the incidence of CSI associated with GSWs to the head.

## 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 sphenoidal, temporal, and parietal bones.<sup>12</sup> 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

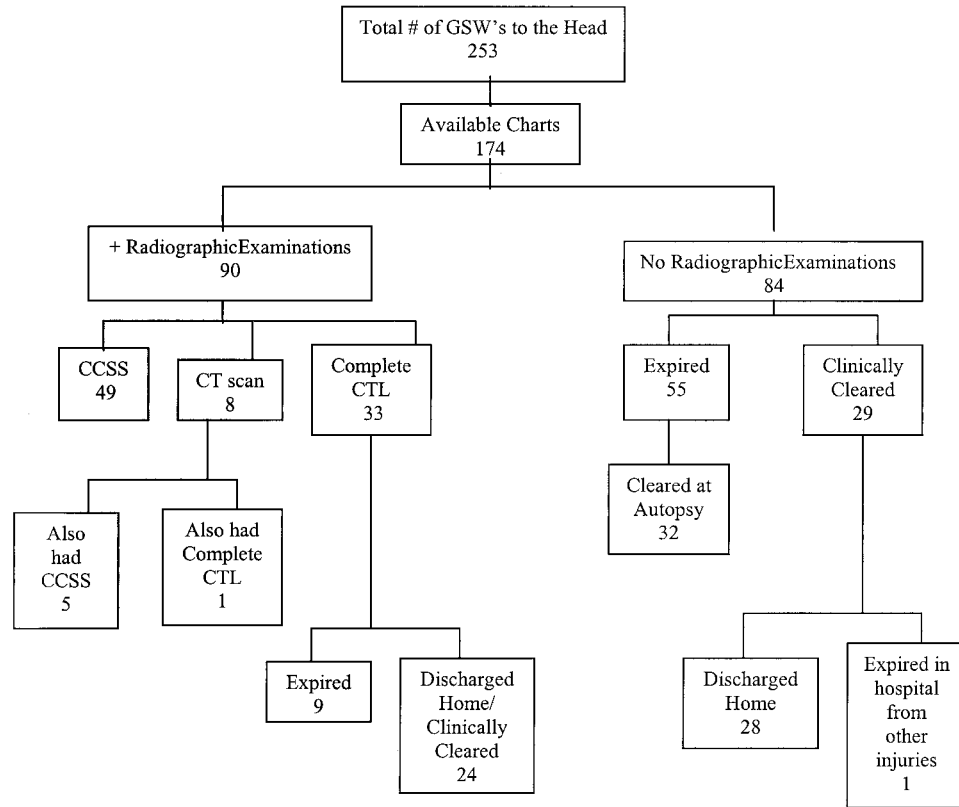
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**Fig. 1.** Results of the current study.

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.<sup>9-11</sup> 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.

**Table 1 Literature Review**

	Kaups and Davis, 1988 <sup>10</sup>	Chong et al., 1998 <sup>11</sup>	Kennedy et al., 1994 <sup>9</sup>	Lanoix et al. (present study)	Totals
Total No. of patients	215	53	308	253	829
Available charts	202	53	266	174	695
Patients with isolated GSW to the head	202	53	105	174	534
CCSS/CT scan	84	3		57	144
Cross-table lateral radiograph		49	105	33	187
Cleared clinically	45			29	74
Cleared at autopsy	73			32	105
CSI excluded	202	49	105	151	507
No/limited radiography, but discharged home without CSI			109	24 <sup>a</sup>	133

CCSS, complete C-spine series (3 or 5 view); GSW, isolated gunshot wound; CSI, spine injury.

<sup>a</sup> These patients had a complete cross-table lateral radiograph and were discharged home without a diagnosis of CSI.

## Literature Review and Discussion

All three articles were similar in that they were retrospective chart reviews with similar objectives, methodologies, and conclusions.

Kennedy et al. reviewed the records of 266 consecutive patients who had CT scans of the head to evaluate brain injury after GSWs. An adequate cross-table lateral was utilized to rule out CSI. Of the 266 patients, only 105 had GSWs limited to the cranium. None of them had a CSI. Of the 109 survivors who had no C-spine radiographs, none were later found to have CSI. There were 52 patients with GSWs to the face and neck, in whom 5 (10%) had a C-spine or cervical cord injury. Furthermore, 86 of 192 (45%) patients with CT-proven intracranial injury required immediate intubation before radiographs were obtained and 67 (35%) died. They conclude that C-spine immobilization may not be required during endotracheal intubation of brain-injured gunshot victims with wounds limited to the cranium.

Chong et al. reviewed the medical records and C-spine radiographs of 53 patients who sustained gunshot wounds limited to the cranium. Patients with GSWs to the face or neck were excluded. Of the 53 patients, 49 (92%) had complete AP and cross-table lateral radiographs of the C-spine, and 3 of these patients also had a CT scan of the C-spine. Although 4 of the 53 (6%) patients had inadequate cross-table lateral radiographs, the authors state these patients did not have CSI because the upper vertebrae visualized on the cross-table lateral radiograph were negative, and the lower vertebrae not visualized on cross-table lateral were negative on the AP radiograph. They conclude that radiographic examination of the C-spine is not indicated in these patients, and that endotracheal intubation of these patients should proceed as promptly as indicated and feasible.

Kaups and Davis included 215 patients with GSWs to the head, and excluded patients with GSWs to the neck and those who were dead on arrival. A complete radiographic series consisted of a five-view cervical spine series in alert patients; in obtunded patients, dynamic fluoroscopy was used in conjunction with plain radiography. In 92 survivors, C-spine clearance was determined clinically in 45 and radiographi-

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%.<sup>13-16</sup> Consequently, these radiographs should not be relied upon as the sole means of excluding CSI. Chong et al.'s attempt to combine 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 clearance. 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-

ably not necessary in patients with isolated gunshot wounds to the head and may complicate and delay emergency airway management.

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