The past century has seen a substantial increase in the number of persons older than 65 years. Rapid growth of this population is expected by the year 2011 when the baby-boomers will begin to retire [1]. Cervical spine fractures and concomitant spinal cord injuries can cause significant morbidity and mortality in the elderly (>65 years old). This population disproportionately suffers more cervical spine fractures than any other age group [2]. These fractures are attributed to a combination of both degenerative changes and osteopenia [3,4]. In addition, elderly patients often sustain cervical spine fractures from lower-energy mechanisms such as falling from standing or sitting height [5–7]. As a result, these fractures often are overlooked by clinicians [6,8,9].

Numerous studies such as the National Emergency X-Radiography Utilization Study (NEXUS) [10], the Ngo et al [11] subgroup analysis, and the Canadian C-Spine Rule [12] accurately have identified those patients who are at low risk of having a cervical spine injury after blunt trauma. Other studies have suggested that clinical examination of the alert and asymptomatic blunt trauma patient is sufficient criteria to exclude a cervical spine injury [13–15]. However, it is important to note that none of the aforementioned studies addressed the stratification of high-risk patients, specifically, the geriatric blunt trauma patient with a low-energy mechanism.

In 2004, Bub et al [13], devised a clinical prediction tool for blunt trauma patients 65 years and older. He found that predictors for cervical spine fracture included the presence of a focal neurologic deficit, severe head injury, and high- or moderate-energy mechanism. Eleven patients (11%) in their study sustained fractures from standing or sitting. However, 7 of these 11 patients (64%) had none of the predictors present. More than half of these low-energy mechanism blunt trauma patients were missed by the clinical prediction tool.

A major reason for this is the paucity of reliable clinical predictors available for this growing population of patients. In this study, we hypothesized that clinical predictors were not adequate in the identification of cervical spine fractures in geriatric blunt trauma patients with low-energy mechanism.
Methods

The institutional review board approved this study with waiver of consent. The trauma registry at our level I regional trauma center was queried to identify geriatric patients who sustained a low-level fall from January 2000 to January 2006. All records of patients with and without cervical spine fractures were reviewed. A retrospective case-control analysis was performed on geriatric blunt trauma patients who sustained cervical spine fractures as the result of a low-energy mechanism. We defined geriatric patients as being 65 years and older and low-energy mechanism as a fall from a standing or sitting height. Inclusion criteria included age 65 years and older, computed tomography (CT) evaluation of the cervical spine, and a Glasgow Coma Score (GCS) of 8 or higher. All CT scans were reviewed by board-certified radiologists. Nonsignificant fractures were defined using the NEXUS criteria. The study group was compared with a group of randomly selected patients without cervical spine fractures (control group). Eight clinical and radiologic predictors were selected for comparison. This included CT evaluation of the head, cervical spine tenderness, cephalohematoma, confusion, focal neurologic deficit, facial fractures, other fractures, and ethanol consumption. Ethanol consumption was excluded from the final analysis because it was present in only 2 patients. The chi square and the Student t test statistical analysis were performed using the SPSS statistical software program (SPSS Inc., Chicago, IL). A P value of less than .05 was set to indicate statistical significance.

Results

During the study period, 1264 patients 65 years of age and older underwent CT evaluation of the cervical spine. Forty of the 1264 patients (3.17%) were diagnosed with a cervical spine fracture. Thirty-five of the 40 patients having all 7 clinical predictors documented formed the study group. Both the study and control groups were matched for age, injury severity score, and GCS (Table 1). The most common level of fall from both groups was from standing (study, 91.4%; control, 95.3%).

With regard to fracture level, most fractures occurred at the C2 level (Fig. 1). The majority of fractures occurred in persons older than 75 years (85.5%). A trend of increasing number of fractures with increasing age was observed (Fig. 2). Almost half of the study patients (48.5%) sustained fractures at multiple levels of the cervical spine.

The most frequent of the clinical predictors present were head CT (96%), cervical spine tenderness (45.5%), cephalohematoma (36.4%), and focal neurologic deficit (20.2%). Facial fractures and other associated fractures were present 14% and 16% of the time, respectively. Of the 7 predictors studied, only cervical spine tenderness reached statistical significance (P = .001) (Table 2). Thirty-three of 35 patients (94.2%) in the study group had clinically significant fractures, whereas 2 (5.8%) had nonsignificant fractures.

Table 1
Demographics

<table>
<thead>
<tr>
<th>Predictor</th>
<th>Cervical spine fracture</th>
<th>No cervical spine fracture</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>n</td>
<td>35</td>
<td>64</td>
<td></td>
</tr>
<tr>
<td>Age, mean ± SD</td>
<td>83.6 ± 7.731</td>
<td>81.2 ± 7.730</td>
<td>.144</td>
</tr>
<tr>
<td>ISS, mean ± SD</td>
<td>9.06 ± 4.179</td>
<td>9.61 ± 8.147</td>
<td>.709</td>
</tr>
<tr>
<td>Sex, M/F</td>
<td>9/26</td>
<td>24/40</td>
<td></td>
</tr>
<tr>
<td>GCS</td>
<td>15</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>Level of fall</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Standing</td>
<td>32</td>
<td>61</td>
<td></td>
</tr>
<tr>
<td>Chair</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Bed</td>
<td>2</td>
<td>2</td>
<td></td>
</tr>
</tbody>
</table>

NS = not significant; ISS = injury severity score.

Table 2
Predictors studied

<table>
<thead>
<tr>
<th>Predictor variable</th>
<th>Chi square</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cephalohematoma</td>
<td>2.653</td>
<td>.103</td>
</tr>
<tr>
<td>Focal neurologic deficit</td>
<td>.469</td>
<td>.493</td>
</tr>
<tr>
<td>Confusion</td>
<td>.155</td>
<td>.694</td>
</tr>
<tr>
<td>Cervical spine tenderness</td>
<td>18.151</td>
<td>.0001*</td>
</tr>
<tr>
<td>Head CT</td>
<td>.391</td>
<td>.532</td>
</tr>
<tr>
<td>Facial fractures</td>
<td>2.611</td>
<td>.106</td>
</tr>
<tr>
<td>Other fractures</td>
<td>.584</td>
<td>.445</td>
</tr>
</tbody>
</table>

* Statistically significant.
Comments

Elderly patients are at greater risk of fracturing the upper-cervical vertebrae after low-mechanism injuries. In our study, more than 70% of fractures involved either the C1 or C2 vertebra, with C2 being the most frequently involved level. This finding is supported by Daffner et al [9], who previously described the epidemiology of cervical spine injuries in the elderly. In his study, C1 and C2 fractures accounted for almost 70% of the cervical injuries, with 48% involving C2 vertebra.

In the year 2000, the NEXUS group established a set of clinical criteria to rule out cervical spine injuries in blunt trauma patients [10]. If 5 criteria were met (no midline cervical tenderness, no neurologic deficit, normal alertness, no intoxication, and no distracting injury), then a patient was classified as having a low probability of cervical spine injury. All patients in the NEXUS study were evaluated with plain 3-view radiography.

In the same year, Ngo et al [11] performed a subgroup analysis of patients 80 years or older using the NEXUS data. They found a 4.7% prevalence of fractures in this “very elderly” population. This was almost double the prevalence of fractures in the study population as a whole (2.4%). Our results are comparable, with a fracture prevalence of 3.17% when taking into account persons 65 years and older. Although both the NEXUS and the Ngo et al [11] subgroup analysis accurately identified low-risk patients, neither study addressed the stratification of high-risk patients.

The Canadian C-Spine Rule, on the other hand, considers patients 65 years and older to be at high risk for cervical injuries and therefore recommends routine cervical spine radiography [12]. As mentioned previously, Bub et al [13] recently devised a clinical prediction rule for blunt trauma patients 65 years and older. Surprisingly, 64% of the patients in their study who sustained a fracture from a standing or sitting height were missed by their clinical prediction tool. One predictor not included in their analysis was cervical spine tenderness.

Previous studies have used plain films to evaluate the alert and asymptomatic blunt trauma patient. CT rarely was used as the imaging modality of choice. All patients in our study underwent CT imaging of the cervical spine. Numerous studies have documented the importance of CT in evaluating the cervical spine. It is estimated that between 40% and 60% of cervical injuries can be missed on radiographs [14–16]. Liberal use of CT imaging of the cervical spine has been shown to improve diagnostic accuracy [17]. If suspected, CT is the most cost-effective screening technique for patients with a high probability of injury [18].

Of the 7 clinical predictors analyzed, only cervical spine tenderness reached statistical significance. Although the vast majority of fractures in our study group met the definition of clinically significant, cervical spine tenderness was present in 45.5% of the patients. A performance table using cervical tenderness alone in ruling out a fracture was completed (Table 3). This finding serves as a prime example of how statistical significance does not equate to clinical significance.

Our study had several limitations. First, our data were collected retrospectively from a single institution. Thus, only clinical predictors consistently reported in the chart could be evaluated. The retrospective nature of the study did not allow one to account for intraobserver agreement. This may have resulted in some patients being evaluated by plain radiographs if they met the criteria as per the NEXUS study. Second, the number of patients in our study group was small. In light of the low power, cervical spine tenderness was found to be statistically significant. However, this finding did not extend to the clinical scenario because its application would have missed approximately half of the clinically significant fractures. A prospective multi-institutional trial examining the clinical predictors studied, particularly cervical spine tenderness, would aid in the validation of our results.

In conclusion, geriatric patients are more prone to fractures of the upper-cervical spine after low-level falls. Although cervical spine tenderness was present in less than half of the study group, the vast majority of these fractures were clinically significant. Cervical spine fractures are difficult to predict in this population because of the lack of accurate clinical predictors. Routine CT evaluation of the cervical spine may be warranted in this population.

<table>
<thead>
<tr>
<th>Table 3</th>
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<tbody>
<tr>
<td>Performance table using cervical spine tenderness to rule out a fracture</td>
</tr>
<tr>
<td>Sensitivity</td>
</tr>
<tr>
<td>Specificity</td>
</tr>
<tr>
<td>PPV</td>
</tr>
<tr>
<td>NPV</td>
</tr>
</tbody>
</table>

PPV = positive predictive value; NPV = negative predictive value.

References

14. Berne JD, Velmahos GC, El-Tawil Q, et al. Value of complete cervical helical computed tomographic scanning in identifying...


