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Injury patterns and incidence of intra-abdominal injuries in elderly ground level fall patients: Is the PAN-SCAN warranted?

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ABSTRACT

Background: This study aimed to determine the incidence of intra-abdominal injuries in elderly patients after a ground-level fall.
Methods: A 6-year retrospective review was conducted on patients 65 years of age or older involved in a fall from standing and evaluated at a level 1 trauma center. Each patient presented with a pelvic, thoracolumbar, and/or lower rib fracture. Data collection included demographics, injury characteristics, FAST exam results, CT imaging results, and hospitalization outcomes.
Results: A total of 324 patients met study inclusion criteria. The majority of patients were white (95.1%) females (65.4%) with an average age of 82.0 ± 7.3 years. Only 22 patients (6.8%) reported abdominal pain, although an abdominal CT was performed in 91 patients (28.1%). Only 1 patient (0.3%) was found to have an intra-abdominal injury when no abdominal pain was reported and the FAST exam was negative. This injury was not clinically significant enough to warrant surgical intervention.
Conclusion: Elderly patients who suffer a ground-level fall do not benefit from PAN-SCAN, even when presenting with rib, thoracolumbar, and/or pelvic fractures.

Introduction

The number of people aged 65 and older in the United States is rapidly increasing and is projected to continue to increase for the foreseeable future.[1,2] In fact, it is projected to double from 46 million in 2014 to more than 98 million by the year 2060.[1] According to a Centers for Disease Control and Prevention report, there are over 2 million falls among older adults each year.[3] Even though a majority of falls do not result in evaluation by a trauma team, they remain the number one trauma injury mechanism in this population.[4,5] It is predicted that the number of elderly patients age 65 and older presenting to trauma centers after a fall will increase as the population continues to age.[3,6] In the 2016 National Trauma Data Bank, there were over 350,000 trauma incidents involving patients older than 65 and there were nearly 211,000 falls.[5] This is a large increase from just a year prior, where there were 256,000 trauma incidents, and nearly 202,000 falls.[4]

Although the prevalence of elderly falls is increasing, there are still only a limited number of studies looking at injury patterns from ground level falls in the elderly.[7–9] Given the increased incidence of ground level falls in this population, knowledge about the resultant injury patterns and how to diagnosis them are even more important. Intra-abdominal injuries are typically evaluated with CT scans due to the accuracy, reliability, and low complication rate. However, CT scans are not entirely benign and many people would argue that they have become overused.[10] Given the radiation exposure, possible contrast load and high cost of CT,[11] studies have attempted to identify guidelines of when to use CT imaging.[12,13] Clinical predictors of a positive abdominal CT in blunt trauma patients has been studied; however, few of these studies have focused on low impact elderly falls.[8,9,14]

Due to the risk of occult intra-abdominal injuries, a CT PAN-SCAN is commonplace for all victims of blunt trauma presenting with known or suspected lower rib fractures, thoracolumbar fractures, or pelvic fractures. This is largely based on the results of studies that show that such distracting injuries were associated with occult intra-abdominal injuries, and as such, abdominal CT is indicated when rib fractures, thoracolumbar fractures, or pelvic

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fractures are present.[15–17] Low-energy mechanisms of injury may produce similar injury patterns in elderly patients, but it remains uncertain whether the incidence of intra-abdominal injuries in this population warrants the use of CT PAN-SCANs.[18,19] This study aimed to determine the incidence of intra-abdominal injuries in elderly patients who suffer a ground-level fall and suffer rib fracture, thoracolumbar fracture and/or pelvic fracture. We hypothesized that the incidence of intraabdominal injury in this population would be very low. With a better understanding of injury patterns, we can also more selectively use CT scans to evaluate elderly fall patients and therefore potentially save the healthcare system valuable financial resources.

Methods

Patients and setting

This study was approved for implementation by the Institutional Review Board of Via Christi Hospitals Wichita, Inc. A 6-year retrospective review was conducted using the trauma registry and electronic medical records at our American College of Surgeons-verified level 1 trauma center. We identified all patients 65 years of age and older who were involved in traumatic falls from standing and presented with rib fracture, thoracolumbar fracture, or pelvic fracture. Patients who met inclusion criteria and were evaluated by the trauma team between January 1, 2010 and December 31, 2015 were included.

Data collection

Following patient identification, a retrospective review was conducted of patient medical records within the trauma registry as well as the patient chart for data collection. Data collected included demographics (age, gender, race), injury severity score (ISS), Glasgow Coma Scale (GCS) score, injury details, presence or absence of abdominal pain, focused assessment with sonography for trauma (FAST) exam results, CT imaging results, discharge destination, and hospital outcomes (length of ICU stay, mechanical ventilation use, hospital length of stay, and mortality). Findings from CT imaging were obtained from the final radiology report.

Of note, nearly all trauma consults receive a FAST exam. The FAST exam is conducted by a first-year resident, under the direct supervision and monitoring of a chief resident and attending. If the exam was negative, but concern still existed, the exam may have been repeated, but a negative exam did not mandate a repeat exam. Occasionally, the trauma team is consulted and a FAST exam is not indicated (e.g. the patient already has a CT of the abdomen/pelvis) and therefore it's not performed. The FAST exam focuses on detection of free intraperitoneal fluid only. Areas examined during the FAST exam included in this study were: the pelvis/pouch of Douglas, Morison's pouch, and the splenorenal recess. In patients with rib fractures, thoracolumbar fractures, pelvic fractures, or abdominal pain, it was the institutional protocol to perform a CT even if the FAST exam was negative. This was done based upon the work of Chiu et al.[15] whose study quoted a 29% intra-abdominal injury rate in blunt trauma patients with a negative FAST exam. This protocol was not mandatory, but was based on provider judgement, and as such not all patients underwent PAN-SCAN.

Analysis

Descriptive statistics are presented as the mean ± standard deviation or the median (interquartile range) for continuous variables. For categorical variables, the variables are presented as count (%). All analyses were conducted using SPSS release 19.0 (IBM Corp., Armonk, New York).

Table 1
Demographics and injury severity for elderly ground level fall patients.

Parameter	Number (%)
Number of subjects	324 (100%)
Age (years)[a]	82.0 ± 7.3
Male sex	112 (34.6%)
Race	324 (100%)
White	308 (95.1%)
Black or African American	8 (2.5%)
Asian	3 (0.9%)
Other	5 (1.5%)
Injury severity score[b]	6 (4,10)
Glasgow Coma Scale score[b]	15 (15,15)

[a] Mean ± standard deviation.
[b] Median (IQR).

Results

A total of 324 patients met inclusion criteria during the study period and were the focus of data analysis. The majority of patients studied were female (65.4%, n = 212) and white (95.1%) with an average age of 82.0 years (Table 1). Overall, patients sustained mild injuries, as evidenced by low ISS (Median = 6) and high GCS scores (Median = 15).

The most common injuries from ground level falls were rib fractures with an incidence of 39.2% (Table 2). Among the least common injuries were intra-abdominal injuries, which were only seen in 0.9% (n = 3) of patients (Table 3). Of the 324 patients, only 22 patients (6.8%) reported abdominal pain, although an abdominal CT was performed in 91 (28.1%) patients. A FAST exam was performed on 72.3% (n = 233) of the patients, but was positive in only 4 of these (1.2%; Table 3).

Nearly 50% of the patients were admitted to the ICU for a median of 2 days (Table 4). The overall mortality rate was 5.2% (n = 17) and none of the deaths were due to intra-abdominal injuries. Discharge destination was also evaluated, with most patients being discharged either back to home (22.5%) or to a nursing home, skilled nursing or rehabilitation facility, or specialty hospital (74.6%).

Of particular interest to this study are the 3 patients who sustained intra-abdominal injuries. One patient fell from standing and presented with abdominal pain. A FAST exam was negative for

Table 2
Injury details by anatomic region for elderly ground level fall patients.

Parameter	Number (%)
Number of subjects	324 (100%)
Arrived intubated or intubated on arrival	1 (0.3%)
Head and Neck injury	57 (17.6%)
Loss of consciousness	11 (3.4%)
Concussion	16 (4.9%)
Subarachnoid hemorrhage	4 (1.2%)
Subdural hemorrhage	13 (4.0%)
Intraparenchymal hemorrhage	0 (0%)
Spine injury	23 (7.1%)
Patients with cervical fractures	12 (3.7%)
Thoracic injury	127 (39.2%)
Patients with thoracic fractures	57 (17.5%)
Patients with rib fractures	127 (39.2%)
Sternal injury	2 (0.6%)
Lung injury	6 (1.9%)
Pneumothorax	30 (9.3%)
Patients with lumbar fractures	56 (17.3%)
Patients with pelvic fractures	25 (7.7%)
Significant vascular injury	4 (1.2%)

Table 3
Abdominal injury diagnostics and details for elderly ground level fall patients.

Parameter	Number (%)
Number of subjects	324 (100%)
Abdominal pain	
Yes	22 (6.8%)
No	293 (90.4%)
Unable to ask	9 (2.8%)
Focused Abdominal Sonography for Trauma scan	
Positive	4 (1.2%)
Negative	227 (70.5%)
Indeterminate	2 (0.6%)
Not performed	89 (27.6%)
Abdominal CT performed	91 (28.1%)
Abdominal injuries	3 (0.9%)
Liver	1 (0.3%)
Spleen	1 (0.3%)
Kidney	1 (0.3%)
Pancreas	0 (0%)
Hollow viscus	0 (0%)

Table 4
Complications and hospital outcomes for elderly ground level fall patients.

Parameter	Number (%)
Number of subjects	324 (100%)
In-hospital myocardial infarction	6 (1.9%)
Urinary tract infection	5 (1.5%)
Deep vein thrombosis	3 (0.9%)
Intensive care unit admission	159 (49.1%)
Intensive care unit days[a]	2 (1,3)
Hospital length of stay (days)[a]	4 (3,6)
Mortality	17 (5.2%)
Discharge destination	
Home or Home with health care	69 (22.5%)
Nursing home or Skilled nursing facility	180 (58.6%)
Rehabilitation or Specialty hospital	49 (16.0%)
Hospice	8 (2.6%)
Left against medical advice	1 (0.3%)

[a] Median (IQR).

hemoperitoneum, but she underwent a CT of the chest/abdomen/pelvis due to her pain. She was found to have 4 right-sided rib fractures, a right pneumothorax and a grade 2 liver laceration. The second patient fell from standing and upon evaluation denied abdominal pain. However, she was confused and therefore even though she had a negative FAST, she underwent a CT of her abdomen/pelvis and was found to have a 4×10 cm subcapsular hematoma of the right kidney and 5 right-sided rib fractures. The final patient with intra-abdominal injury presented without abdominal pain, and had a negative FAST, but underwent a CT scan of the abdomen/pelvis and was found to have a grade 1 splenic laceration, 3 left-sided rib fractures and 1 right rib fracture. Of note, the splenic laceration was near the inferior pole and there was no perisplenic hematoma or hemoperitoneum and therefore it was not seen with the FAST. Although there were 3 intra-abdominal injuries, none were clinically significant enough to warrant surgical intervention.

Comments

Intra-abdominal injuries are rare in elderly patients who fall from standing.[7,8,18] In our study, such injuries only occurred in 3 patients (0.9%). This is consistent with the incidence found in other studies. For example, a study by Gelbard et al.[18] found an intra-abdominal injury rate of 0.6%. Although the study by Gelbard et al. demonstrates a low level of intra-abdominal injuries from ground level falls, it did not evaluate the use of imaging in relation to the patient's symptoms.

Bhattacharya et al.[8] demonstrated similar low rates of abdominal injuries in adult patients who suffered ground level falls. Abdominal solid organ injuries were rare in their study, present in only 0.8% of patients. Additionally, only 19% of patients with abdominal injuries required intervention; however, the rates of injury and intervention were increased in elderly patients and were associated with distracting injuries like cervical fractures, rib fractures, and pelvic fractures. These findings are consistent with a study of elderly patients on Warfarin who suffered from low level falls.[9] Bahl and Schafer[9] found that abdominal injuries in elderly patients who fell from standing were associated with distracting injuries and abdominal tenderness, which is also consistent with others' findings in a general population.[14,15]

Although it appears the incidence of abdominal injuries is low in elderly patients who suffer low level falls, the morbidity and mortality associated with such falls is more severe than their younger counterparts. In a study of ground level falls in the National Trauma Databank (NTDB), Spaniolas et al.[7] found mortality in those older than 70 years was 4.4%, significantly greater than those younger than 70 years (1.6%). Their reported mortality rate was comparable to what we found in our population (5.2%), however, the injury severity in our population (median ISS = 6) was lower, on average, than those reported by Spaniolas et al. (mean ISS = 9). This discrepancy in injury severity could be due to two possible reasons. In the Spaniolas study, mortality in the elderly was largely associated with head injuries. If institutions routinely perform abdominal CT on all ground level fall traumas, then more injuries would be included in a calculation of ISS, regardless of whether they require clinical intervention, than would be included with a selective algorithm for abdominal CT use.[20] Secondly, the authors suggest that their findings could be skewed toward more severe injuries due to the bias of patients that are recorded in the NTDB, and thus the reported mean would also be skewed.

In an effort to evaluate which patients would likely not need abdominal CT, we found that intra-abdominal injuries were even less common if the patient denied abdominal pain and had a negative FAST exam, which occurred in only one patient (0.3%). In contrast, Chui et al.[15] demonstrated that ~29% of abdominal injuries were missed if blunt trauma victims were evaluated with admission FAST as the sole diagnostic tool. However, their study included high impact mechanism of injuries, whereas our study only included patients with ground level fall mechanisms of injury. Also of note, a CT of the abdomen/pelvis was not performed on all of the patients and therefore the true incidence of intra-abdominal injuries cannot be determined. However, given the current data, one could assume that these injuries would be similar to the injuries found in our study, which were minor and not clinically significant. Also, it is possible that patients could have presented with a delayed injury. However, if the patients would have returned to an emergency department in the surrounding area with a previously undiagnosed injury, it is commonplace to notify the original attending physician.

By using a selective algorithm for CT of the chest, abdomen, and pelvis, Sise et al.[21] found that, without reducing diagnostic quality, they were able to reduce the use of chest, abdomen, and pelvis CT scans by 26% in patients that were hemodynamically stable with normal physical exams and FAST results. The use of such a selective algorithm could result in beneficial cost reductions for hospitals. Evidence in this area is preliminary but promising,[11] and future studies should focus on evaluations of the cost benefit of more selective algorithms for evaluating victims of ground level falls.

Our study has several limitations. First, it is a retrospective review, with all of the weaknesses inherent in that study design.

Second, the data were collected from our level 1 trauma registry and therefore it is possible patients were left out that were incorrectly coded or mislabeled. It is possible that there were elderly patients who fell and were admitted to non-trauma services and therefore not included in this study. Although trauma registrars screen hospital admissions daily for trauma patients, it's possible that some of them could have been admitted to a non-trauma service. In fact, one patient in our study was admitted to the orthopedic surgery service and general surgery was consulted once the patient developed abdominal pain. The patient then underwent a CT scan of the abdomen and pelvis and was found to have an intra-abdominal injury, but the injury did not require any surgical interventions.

Conclusions

Elderly patients who fall from standing, have no abdominal pain, and a negative FAST, are unlikely to have an intra-abdominal injury. In the unlikely event a patient has an intra-abdominal injury, the injuries are likely to be clinically insignificant due to the low impact mechanism. Use of routine PAN-SCANs of the abdomen/pelvis in asymptomatic, elderly fall victims is not warranted and is a cause of unnecessary medical cost and radiation exposure.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.amjsurg.2018.11.041.

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