Utility of Abdominal Computed Tomography in Geriatric Patients on Warfarin with a Fall from Standing

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Abstract

Context: Geriatric head trauma resulting from falls has been extensively studied both in the presence and absence of blood thinners. In this population, however, the prevalence and extent of abdominal injury resulting from falls are much less defined. Aim: We aim to evaluate the utility of abdominal computed tomography (CT) imaging in geriatric patients on Warfarin with a recent history of fall. Setting and Design: A retrospective analysis was completed of consecutive geriatric patients who presented to a Level 1 Trauma Center emergency department after fall from standing while taking Warfarin. Methods: Inclusion criteria included age 65 years or older and fall while taking Warfarin. Incomplete medical records were excluded from the study. Data collection included the type of anticoagulant medications, demographics, physical examination, laboratories, CT/X-ray findings if ordered, and final diagnosis on admission. Categorical variables were examined using Pearson’s Chi-square where appropriate (expected frequency >5), or Fisher’s Exact test. Continuous variables were examined using nonparametric Wilcoxon rank tests. Results: Eight hundred and sixty-three charts were reviewed. One hundred and thirty-one subjects met inclusion criteria. Mean age was 83 years. Nearly 39.6% of patients were male. A total of 48 patients had abdominal CT imaging. Seven of the 131 patients (5.3%) had an abdominal injury. Abdominal tenderness was predictive of injury, with 4 of 7 cases with abdominal injury demonstrating abdominal tenderness versus only 10 of 124 cases without abdominal injury demonstrating tenderness (P = 0.003). Abdominal CTs were ordered in 11 of 19 cases of patients that exhibited head trauma yet none of these patients were shown to have sustained abdominal trauma (P = 0.08). There was no association between international normalized ratio level and presence of abdominal injury (P = 0.99). Conclusions: A small percentage of elderly fall patients on Warfarin have a significant abdominal injury. Anticoagulated geriatric patients are sometimes subjected to abdominal scans liberaly without supporting physical examination findings such as abdominal tenderness or presence of a distracting injury. Specifically, the utility of abdominal CT is questionable in isolated head injury patients. Further, taking Warfarin or other anticoagulant medications do not seem to increase the risk of intraabdominal injury.

Keywords: Anticoagulation, computed tomography imaging, geriatric trauma

Introduction

Effective emergency management of geriatric trauma patients is an issue of increasing pertinence in the United States (U. S.). The number of elderly individuals in the U. S. above age 64 is projected to nearly double by the year 2050, to make up over 20% of the population.[1] In addition, studies have shown a predominance of trauma related to falls in this demographic which accounted for the majority of nonfatal injuries admitted to the American emergency departments (EDs) in 2001.[2] The prevalence of injury accounts for an enormous healthcare cost burden accumulating to over 23.3 billion every year.[3] An estimated 40% of men and women 65 and above sustain at least one traumatic fall every year.[4] Furthermore, the presence of comorbidities, particularly cardiovascular-related disease, complicates the management of these geriatric trauma patients. Naturally, anticoagulants such as warfarin and antiplatelet medications are widely prescribed in this population of elderly patients at-risk.[5]

ED physicians often conservatively manage geriatric patients on Warfarin and use computed tomography (CT) scans liberally.[6-8] The relative physiologic frailty that accompanies advanced age, in combination with pharmacological anticoagulation,
has been shown to predispose the elderly trauma patient to a multitude of major bleeding disorders including severe head, solid organ, and bone injury.\textsuperscript{9,10} Physical examination is sufficient to suspect a diagnosis in the majority of these cases but physician confidence, as evidenced by a study investigating abdominal trauma, rises significantly from 36% to 77% after CT is administered.\textsuperscript{11} Although the known shortcomings of CT use include increased high radiation exposure and potential adverse effects of intravenous contrast, its diagnostic value in these patients drives the propagation of its use.\textsuperscript{12} The high cost of CT imaging is also a notable burden on the patient and health-care system. One study evaluated the cost of imaging at 171 hospitals in Florida and found the mean charge for CT was $1565. As an imaging modality, CT was the second most frequently performed imaging test after plain radiography and ultrasound. It was also associated with the second highest cost approaching the mean cost per procedure of magnetic resonance imaging at $2048.\textsuperscript{13}

Geriatric head trauma resulting from falls has been extensively studied both in the presence and absence of blood thinners.\textsuperscript{11} In this population, however, the prevalence and extent of abdominal injury resulting from falls are much less defined in the current literature. Moreover, the influence of anticoagulants on injury severity in the absence of a head injury remains controversial.\textsuperscript{14,15} Thus, the purpose of this study is to gain an understanding of practice patterns in ordering abdominal CT scans in patients age 65 and over on warfarin therapy that have a fall from standing. We aim to further define the utility of abdominal CT scans in this subset of patients.

**Methods**

Following exemption by the institutional review board at our site, this retrospective analysis was completed evaluating consecutive geriatric patients who presented to the ED of this level one trauma center. The inclusion criteria for the study were comprised of patients aged 65 and older who had sustained a fall from standing while taking warfarin over a 12-month period from January 2010 to December 2010. Patients with incomplete medical records were excluded. Data collection included review of electronic medical record for time of fall relative to presentation, specific anticoagulation with Warfarin and any additional blood thinning medications, age, sex, vital signs, Glasgow Coma Score, presence or absence of abdominal tenderness on physical examination, presence or absence of traumatic findings on CT if ordered, review of other radiographic modalities for traumatic injuries, international normalized ratio (INR), and diagnosis. For patients that were discharged from the hospital without an abdominal CT scan, further chart review was completed on all patients to rule out delayed presentation of abdominal injury from the initial fall. Provider notes up to 1-year postdischarge were reviewed to assess for mortality and the presence or absence of delayed abdominal injury with specific attention to those readmitted within 30 days.

For clarification, “abdominal trauma” as it relates to this study is defined as injury proven by CT to solid organs, visceral organs, or pelvic structures. We did not include soft tissue injury or hematoma in this definition.

In our statistical analysis of the data, we first compared patients that received an abdominal CT to those that did not. Categorical variables are shown as counts and % frequencies. They were examined using Pearson’s Chi-square where appropriate (expected frequency >5), otherwise a Fisher’s exact test was used. Continuous variables were examined using nonparametric Wilcoxon rank tests. All continuous variables are shown as means ± the standard deviation followed by the median and (25th, 75th percentiles) where needed.

We next compared patients that were diagnosed with abdominal trauma on CT versus those that either had no abdominal CT or had an abdominal CT but did not have a diagnosis of abdominal trauma. Categorical variables are shown as counts and % frequencies. They were examined using Fisher’s exact tests. Continuous variables were examined using nonparametric Wilcoxon rank tests. All continuous variables are shown as means ± the standard deviation followed by the median and (25th, 75th percentiles) where needed.

**Results**

A total of 836 charts were reviewed, of which 131 subjects met the inclusion criteria. The data set and associated statistical significance are listed in Table 1. Mean age was 83 years, and 39.6% were male. Within the study population, 48 patients underwent abdominal CT imaging after injury, and 7 of these 48 patients (14.6%) had an identifiable abdominal injury. Table 2 lists each patient with abdominal injury identified on CT imaging with traumatic diagnoses and intervention. Abdominal tenderness was predictive of injury. Four of 7 cases with abdominal injury demonstrated abdominal tenderness on examination. Providers ordered abdominal CTs on patients with distracting injuries, namely fractures of the thoracic spine, extremities, scapula, and clavicle at higher rates compared to those who did not have such injuries. These additional fractures were present in 16.7% (8 of 48) of patients given abdominal CTs versus 6.0% (5 of 83) of those who were not scanned ($P = 0.04$). Of the five abdominal CTs were ordered in 11 of 19 (57.9%) cases of patients within the cohort who exhibited head trauma on physical exam as a result of their fall yet none of these patients were shown to have sustained abdominal trauma ($P = 0.08$). Nine of 19 (47%) patients were ultimately diagnosed with intracranial hemorrhage.

There was no association between INR level and presence of abdominal injury ($P = 1.00$) nor did INR play a significant role in the decision to order an abdominal CT on presentation to the ED ($P = 0.60$). Similarly, the presence of multiple blood thinners also did not impact abdominal injury ($P = 1.00$) nor did it seem to influence evaluation with CT imaging to a large degree ($P = 0.33$). Blood pressure ($P = 0.73$), heart rate ($P = 0.19$), oxygen saturation ($P = 0.60$), and soft tissue injury ($P = 0.99$) additionally did not show any correlation with the propensity to order abdominal CTs or with the presence of abdominal trauma.
Eighty-three patients did not receive an abdominal CT as a result of the fall. Follow-up data were available for 74/83 (89%) of these patients. Seventeen patients were readmitted within 30 days of discharge. One was readmitted for a missed injury—thoracic spine fracture. Nine patients did not have follow-up information in the electronic medical record.

Table 1: Comparison of physical examination findings and coagulation status between studied patients who did and did not receive an abdominal computed tomography after entrance to the emergency department

| No abdominal CT ordered (n=73) | Abdominal CT ordered (n=48) | P |
|--------------------------------|-----------------------------|---|
| Males (%)    | 27 (37)                   | 21 (44)                  | 0.46 |
| Age (mean±SD) | 83±7.2                    | 83±7.9                   | 0.86 |
| Trauma consult (%) | 7 (9.6)                 | 37 (77)                  | <0.0001 |
| Abdominal tenderness (%) | 2 (2.7)                   | 12 (25)                  | 0.0002 |
| SBP, n (mean±SD) | 70 (144±28)               | 46 (142±25)              | 0.73 |
| Low SBP (<90) (%) | 1 (1.4)                   | 0                        | 1.00 |
| HR, n (mean±SD) | 70 (76±15)                | 46 (80±16)               | 0.19 |
| Tachycardia (HR >90) (%) | 14 (20)                  | 9 (20)                   | 0.95 |
| Pox, n (mean±SD) | 70 (96±9)                 | 46 (97±3)                | 0.60 |
| Pox (<95) (%) | 12 (17)                    | 8 (17)                   | 0.97 |
| INR (mean±SD) | 68 (2.9±1.8)              | 46 (2.9±2.0)             | 0.99 |
| 2.5 (1.8, 3.4) | 2.4 (1.8, 3.2)            |                           |     |
| Increased INR (INR >4) (%) | 8 (12)                   | 7 (15)                   | 0.59 |
| <1.5 | 11 (16.2)                  | 5 (10.9)                 | 0.60 |
| 1.5-3.0 | 34 (50.0)                 | 27 (58.7)                | 0.99 |
| >3.0 | 23 (33.8)                  | 14 (30.4)                | 0.08 |
| Mental status impaired (%) | 16 (22)                  | 5 (10)                   | 0.10 |
| Soft tissue injury (%) | 44 (60)                  | 29 (60)                  | 0.99 |
| Head injury (%) | 8 (11)                    | 11 (23)                  | 0.08 |
| Long bone fracture (%) | 6 (8.2)                   | 8 (17)                   | 0.16 |
| Hip fracture (%) | 3 (4.1)                    | 4 (8.3)                  | 0.43 |
| Rib fractures (%) | 0                        | 11 (23)                  | <0.0001 |
| Pelvic fracture (%) | 2 (2.7)                    | 4 (8.3)                  | 0.21 |
| Other fractures (%) | 1 (1.4)                    | 7 (15)                   | 0.006 |
| Hemothorax/pneumothorax/ lung contusion (%) | 0                        | 3 (6)                    | 0.06 |
| Additional anticoagulation (%) | 33 (45)                  | 26 (54)                  | 0.33 |

CT: Computed tomography, SD: Standard deviation, SBP: Systolic blood pressure, HR: Heart rate, INR: International normalized ratio, Pox: Pulse oximetry

Table 2: Patients with computed tomography findings of abdominal and interventions

| Patient | Diagnosis                              | Interventions | Abdominal tenderness | GCS |
|---------|----------------------------------------|---------------|----------------------|-----|
| 1       | Intra-abdominal hematoma, Extremity fracture | Supportive care | No                   | 15  |
| 2       | Liver contusion, rib fractures          | FFP           | Yes                  | 15  |
| 3       | Pelvic hematoma, soft tissue injury     | Supportive care | Yes                  | 15  |
| 4       | Pelvic fracture, ext fx                 | PRBCs, FFP    | No                   | 15  |
| 5       | Spleenic laceration, femur fracture    | PRBCs, FFP, platelets | Yes                | 15  |
| 6       | Pelvic fracture, ext fx                 | FFP           | Yes                  | 15  |
| 7       | Pelvic hematoma, thoracic spine fracture| Supportive care | Yes                  | 15  |

GCS: Glasgow Coma Score, FFP: Fresh frozen plasma, PRBCs: Packed red blood cells

Discussion

Trauma following fall is a common presentation of geriatric patients to the ED. In this population, decreased muscle tone, body mass, and reaction time contribute to increased frequency and severity of falls.[16] Osteoporosis and age-related bone degeneration leading to skeletal fragility additionally put these patients at greater risk for injury, fractures, and their sequelae following falls.[17] These facts can be reasonably extrapolated to deduce that the likelihood of abdominal trauma would increase with age. These tendencies are further confounded by the common utilization of blood-thinning therapy in the elderly population. Given this picture, the presentation of these patients to the ED following fall often leads to conservative management with CT imaging.

Our main objective was to review current tendencies of emergency physicians in ordering an abdominal CT scan in the hope of better understanding the utility of this diagnostic test in geriatric fall patients on warfarin. Certain physical examination findings were strong predictors of abdominal trauma. Physical examination findings such as tenderness and ecchymosis were associated with CT proven abdominal injuries. Nearly 30% of patients with significant abdominal physical examination findings had CT proven abdominal injuries. Although certain findings such as abnormal vitals or abdominal tenderness are predictive of morbidity and mortality in the geriatric population, the absence of these variables has not been proven to rule out the significant disease.[14] Three patients with CT proven intra-abdominal injury in our study did not have abdominal tenderness and had normal vital signs. These patients exhibited other distracting pain and soft tissue injury and CT was ordered. Not surprisingly, providers ordered abdominal CT scans more liberally in patients with distracting injuries. The fact that nearly 43% of patients did not exhibit abdominal tenderness but had CT findings of intraabdominal injury supports use of this imaging modality when physical examination identifies other potentially distracting injuries. Abdominal CTs were ordered frequently in patients that sustained isolated head injury. Contrary to other distracting injuries, the isolated head injury had no correlation with an abdominal injury. Nearly 60% of isolated head injury patients were given an abdominal CT scan. This group potentially represents a subset of patients that may not need an abdominal CT scan in the work-up.
In general, abdominal injury related to falls is not well-documented in the medical literature, and there is little known about the influence of various types and degrees of anticoagulation on both the presence of injury and the manner in which this information directs the use of CT in these patients. Although the impact of anticoagulation therapy on injury prevalence and severity has been well-defined in geriatric head trauma, the role of blood thinners in abdominal trauma remains to be elucidated. The current study indicated no statistical link between the degree of warfarin anticoagulation, as indicated by the INR on presentation to the ED, and the decision to order an abdominal CT or the presence of abdominal trauma. Co-administration of the additional anticoagulant agents Plavix and aspirin also did not have an impact on either of the aforementioned parameters.

**Limitations**

The retrospective nature of the study was a notable limitation. Variation in the documentation, nonstandardized treatment protocols and some missing patient follow-up data are logical shortcomings of such a study. A prospective study with a survey filled out by the ED staff regarding the reasons behind their decision regarding whether or not to scan through CT would help to better clarify these shortcomings.

Further, only a small minority of anticoagulated elderly patients sustain abdominal injury from a standing fall. One of the limitations of this study from a statistical standpoint remains the low number of patients who were shown to have suffered abdominal trauma after falling (7 in 131; 5.3%).

Notably, 83 patients did not have a CT scan to assess for an abdominal injury. It is a possibility that injury may have been missed in some of these cases. To minimize this possibility, we performed chart reviews on all patients discharged without a CT scan. Due to the encompassing size of our health system, the vast majority of patients (89%) had at least one provider note in the electronic medical record to confirm the patient was alive and had not suffered abdominal injury as a result of the fall. Many of these patients had multiple provider notes, imaging, and lab work that supported our conclusions. Only nine patients lacked follow-up in our system. On reviewing these cases, none of these patients had a traumatic diagnosis that led to admission. All patients were admitted to the medical, not trauma service, with four patients admitted for syncope, 4 for delirium, and 1 with a Non-ST elevation myocardial infarction (NSTEMI). Although abdominal injury cannot be definitively ruled out in these cases, it is highly unlikely.

Importantly, this study provides preliminary data from a well-defined, common cohort toward the assessment of the judicious use of abdominal CT in these patients. It also speaks to the efficacy of such scans in detecting injury and the relation of parameters such as fracture presence, abdominal tenderness, and anticoagulation status toward clinical decision making as it pertains to abdominal CT and abdominal injury prevalence.

**Conclusions**

A small percentage of elderly patients on warfarin have significant abdominal injury following fall from standing position. Unfortunately, anticoagulated geriatric fall patients are sometimes subjected to abdominal scans liberally without the support of physical examination findings such as abdominal tenderness or presence of a distracting injury. Specifically, the utility of abdominal CT is questionable in isolated head injury patients. Further, taking Warfarin or other anticoagulant medications do not seem to increase the risk of intraabdominal injury. This study supports a larger prospective analysis to predict the utility of abdominal CT in this population.

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**Conflicts of interest**

There are no conflicts of interest.

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