Geriatric Orthopaedic Surgery
& Rehabilitation
Volume 10: 1-4

DOI: 10.1177/2151459319861562
journals.sagepub.com/home/gos
SAGE

Clinical Indications of Computed Tomography (CT) of the Head in Patients With Low-Energy Geriatric Hip Fractures: A Follow-Up Study at a Community Hospital

Kris Danielson, DO[1], Teresa Hall, DO[2], Terrence Endres, MD[3], Clifford Jones, MD[3], and Deb Sietsema, PhD[4]

Abstract

Introduction: A seemingly large percentage of geriatric patients with isolated low-energy femur fractures undergo a head computed tomography (CT) scans during initial work up in the emergency department. This study aimed to evaluate the pertinent clinical variables that are associated with positive CT findings with the objective to decrease the number of unnecessary CT scans performed. **Methods:** A retrospective review performed at a level II trauma center including 713 patients over the age of 65 sustaining a femur fracture following a low-energy fall. The main outcome measure was pertinent clinical variables that are associated with CT scans that yielded positive findings. **Results:** A total of 713 patients over the age of 65 were included, with a low-energy fall, of which 76.2% (543/713) underwent a head CT scan as part of their evaluation. The most common presenting symptom reported was the patient hitting their head, 13% (93/713), and 1.8% (13/713) were unsure if they had hit their head. Of those evaluated with a head CT scan, only 3 (0.4%) had acute findings and none required acute neurosurgical intervention. All three patients with acute changes on the head CT scan had an Injury Severity Score (ISS) greater than 9, Glasgow Coma Scale (GCS) less than 15, and evidence of trauma above the clavicles. **Discussion:** None of the patients with a traumatic injury required a neurosurgical intervention after sustaining a low-energy fall (0/713). **Conclusion:** Head CT scans should have a limited role in the workup of this patient population and should be reserved for patients with a history and physical exam findings that support head trauma, an ISS > 9 and GCS < 15.

Keywords

geriatric trauma, hip fracture, head CT scan, Injury Severity Score, Glasgow Coma Scale

Submitted May 03, 2019. Accepted June 10, 2019.

Introduction

Life expectancy in the United States has increased from 70.8 years in 1970 to 78 years in 2008. This is projected to continue and result in a doubling of the population of people over the age of 85 in the next decade.[1,2] Traumatic injury is currently the fifth leading cause of death in geriatric patients.[3] Falls in this age-group constitute a great deal of the medical problems, including a slow stepwise progression of deterioration of health and independence. Injuries sustained by these patients tend to be more severe than younger patients from similar level of energy falls. Head, pelvic, and/or lower extremity injuries are frequently associated with geriatric falls.[4,5]

There has been a continuous debate about triage of geriatric trauma patients. Studies show that patients who sustain serious injury are best managed in a trauma center and development of a statewide trauma system has led to improved survival for geriatric trauma patients.[6] Some argue that triage of isolated injuries (ie, hip fractures) with low-energy mechanisms to

[1] Metro Health Hospital, Wyoming, MI, USA
[2] Metro Health University of Michigan Health, Wyoming, MI, USA
[3] Orthopaedic Associates, Michigan State University/CHM of Michigan, Grand Rapids, MI, USA
[4] The CORE Institute, Phoenix, AZ, USA

Corresponding Author:
Teresa Hall, Metro Health University of Michigan Health, 5900 Byron Center Ave SW, Wyoming, MI 49519, USA.
Email: teresa.buiocchi@gmail.com

trauma centers overburdens the trauma system, while others support this concept.[7] A large subset of patients with fractures may have an intracranial hemorrhage due to a minor head trauma with no other signs and symptoms.[8] Intracranial hemorrhage is more common in this population with low-energy falls due a significant percentage taking antiplatelet and anticoagulants for comorbidities. An orthopedic surgeon plays an important role in management of these individuals and may even be the primary point of contact in a private or group practice. Whether to admit such patients or transfer them to trauma centers with appropriate back up is an important decision an orthopedic surgeon may have to make. This is especially true in developing countries where there is a lack of specialized emergency department (ED) physicians.

Liberal use of computed tomography (CT) scan of the head is generally suggested in the geriatric age-group as there are no clear clinical criteria for making a decision regarding obtaining a CT scan.[5] In the setting of private or a group practice or in developing countries, CT scan may not be readily available and is an expensive modality adding to the initial cost of hospitalization which is estimated at $8900 USD.[9] Recently, there has been an increased emphasis on preventing unnecessary tests as an aid for decreasing health-care costs.

In order to gain a better understanding of the clinical presentation that should warrant a head CT scan in patients with low-energy hip fractures, it is important to compare the patients with positive findings to those with negative findings. In this study, our aim was to report a series of head CT scans obtained in patients with geriatric femur fractures follow ground level falls, in order to define clinical variables that are associated with positive head CT scans. In this manner, we aim to have a number of positive risk factors based on history or clinical examination that indicate a possible intracranial hemorrhage. We hypothesized that many of these patients received an unnecessary CT scan of the head, adding increased radiation to the patient and increased cost to the health-care system.

Methods

After obtaining an institutional review board approval, we conducted a retrospective review of prospectively collected trauma registry data to identify all geriatric patients (age 65 years or older) who sustained a femur fracture from January 2004 to January 2017 (total patients, n = 713). Patients who sustained a femur fracture due to high-energy injury were excluded from the study. We then reviewed the electronic medical records of all patients to identify those patients who had a CT scan of the head during the same ED visit (n = 543). These patients were included in the final analysis. Multiple sources within the electronic health record were examined to establish baseline (pre-CT) characteristics for every patient. Electronic health record and ED notes were reviewed to note age, sex, mechanism of injury, circumstances of the fall including head trauma, and presence or absence of symptoms including headache, nausea/vomiting, loss of consciousness (LOC), alcohol intake prior to fall, dizziness, amnesia or confusion, and seizure. Examination findings were reviewed for features including presence or absence of a focal neurologic deficit (unequal or asymmetrically reactive pupils, nystagmus or other abnormal eye movements, focal extremity weakness, or Babinski's reflex) and physical or radiologic evidence of any soft tissue (abrasions, bruise, contusion, or laceration) or bony injury above the level of the clavicles. Patients' Injury Severity Scores (ISS) and Glasgow Coma Scale (GCS) values upon admission were noted. We also reviewed the past medical history during the ED visit to note for history of dementia or psychiatric disorder, hematologic disease, or liver disease. Medication history including the use of anticoagulant (warfarin sodium) and antiplatelet (clopidogrel and aspirin) medications at the time of admission, as well as international normalized ratio (INR) values for patients on anticoagulants. Requests for trauma and neurosurgery consults before and after the head CT were noted, respectively.

Finally, the head CT report for every patient was reviewed for acute changes. Positive CT findings were defined as cerebral contusion, extra-axial hematoma, intraventricular or subarachnoid hemorrhage, and brain edema as well as cerebral infarction. Performance of any neurosurgical intervention based on result of the CT was also recorded. Associated injuries including head, chest, abdomen, and pelvic injuries were also noted along with destination after ED and destination after discharge.

The goal of the statistical analysis was to compare clinical characteristics between patients with versus without a positive CT finding, independently and when taken together, to identify possible risk factors for positive CT findings that could be used to develop decision rules about when to order a head CT in a low-energy trauma patient.

Statistical analysis was performed using 2 sample t tests, χ^2, or Fisher exact tests to compare means or percentages between the group with acute CT finding (CT positive) and no acute CT finding (CT negative). Finally, a multivariate logistic regression model was used to analyze whether the clinical features persisted as risk factors when considered together.

Results

A total of 713 total patients were found to have a proximal femur fracture, over 65 years old, from a reported low-energy mechanism of injury. The average patient age was 82 years (range 65-102 years), 511 females and 202 males. Patient comorbidities included diabetes mellitus 24.7%, history of deep vein thrombosis or pulmonary embolism 1.5%, warfarin coagulopathy with INR > 3 upon arrival 5.6%, dementia 32.4%, and hepatic disease 1.8%. All of the patients included sustained a low-energy femur fracture, most commonly due to a ground level fall, 96.6%. Other reported mechanisms were unknown/no trauma, twisting, or sitting in a chair. The general surgery trauma team was consulted in 2.1% (15/713) of the cases.

The most common presenting symptom reported was the patient hitting their head 13% (93/713) and 1.8% (13/713) were unsure if this had occurred. Other signs and symptoms on

presentation included 2.2% complained of headache, 1% vomiting, 3.4% LOC or unsure of LOC, 3.5% dizziness, 1.4% had a neurologic deficit, 5.8% had evidence of trauma above the clavicles, 5.6% had an INR of 3 or greater, 8.2% with ISS of greater than 9, and 6.4% with a GCS of less than 15.

In total, 76.2% (543/713) underwent a head CT scan as part of their evaluation. The most common reasons to order a head CT were a ground level fall (not specifically hitting their head), unwitnessed fall, an LOC, or if the patient is unsure if there was an LOC, the patient is a poor historian, the patient is anticoagulated, symptoms of encephalopathy, or a history of previous intracranial hemorrhage.

Of the 76.2% patients who underwent head CT scan, 3 (0.4%) had acute findings. One patient with acute findings was due to an infarct after admission, the other 2 with small parenchymal bleeds. Each of the 3 underwent a neurology evaluation and none required neurosurgical intervention.

Of all the presenting signs and symptoms, 3 findings were present in 100% of the patients with acute changes on the head CT. Those findings were an ISS >9 (mean ISS of 17.33), GCS <15 (mean GCS of 13.3 at presentation), and evidence of trauma above the clavicles.

Patients were most commonly admitted to the orthopedic surgery service, 54.6% (389/713) followed by the internal medicine service, 43.9% (313/713). Other admitting services included the intensive care unit and general surgery trauma.

The mode for length of hospital stay was 4 days. In hospital mortality was documented for 11/713, 1.54%. Time to surgical fixation was 1.16 days (average of 27.84 hours). The most common place of discharge was to assisted living or subacute rehabilitation (86.1%, 614/713). Those discharged home comprised 9.7% (69/713). Patients who were discharged to a hospice service included 1.6% (12/713).

Discussion

In our study at a level II trauma center, 713 elderly patients during the evaluated time interval sustained a low-energy fall resulting in a femur fracture. A very small percentage of those patients reported signs or symptoms that would make ED physicians suspicious of an intracranial hemorrhage. The most common reported sign or symptom was hitting their head, 13%, with 3.4% sustaining a LOC or unknown LOC. Of all 713 patients, 76.2% underwent a head CT, despite the fact that the majority of these patients did not report an LOC, dizziness, hitting their head, headache, trauma above the clavicles, or a history of anticoagulation. The most commonly cited reason was a ground level fall. Of 713 patients, 3 had acute changes seen on their head CT and none required acute neurosurgical intervention.

The initial hypothesis of the authors was there would be an association between acute changes on head CT and patient being anticoagulated, demented (therefore a poor historian), or acute neurologic deficits on presentation. The only factors that were associated with acute changes seen on head CT were evidence of trauma above the clavicles, an ISS >9 and a GCS< 15. All 3 factors were present in all 3 patients with acute changes on their head CT. Due to the low number of positive head CT scan findings, no statistically significant positives were noted.

It is the opinion of the authors that the current political environment within healthcare fosters the practice of defensive medicine. The authors believe a thorough history and physical examination can assist ED physicians to have better indications to use head CT scans more judiciously, even in the setting of a poor historian for a patient. By reducing the incidence of obtaining head CT scans in these low-energy falls, it is possible to help reduce the financial burden on the health-care system as well as decrease the associated morbidity of radiation to the patients.

A 2015 article by Maniar et al also evaluated associated factors with intracranial pathology in geriatric hip fractures and found similar findings to our study. In their study, a smaller percentage of the patients underwent a head CT (21% compared to our 76%) and 69% of those undergoing a head CT were also anticoagulated or on an antiplatelet medication. Acute findings were found in 6% of the patients undergoing a head CT and none required neurosurgical intervention. Similar to our study, they found ISS > 9, GCS < 15, and evidence of head trauma to be associated with acute changes on head CT. They found an additional 3 factors most likely to be associated with positive CT findings, which included new onset confusion, headache, and LOC.[10]

Many providers would reasonably suspect after a low-energy fall there would be a small risk of intracranial hemorrhage. Albers et al studied the incidence of intracranial pathology from minimal head trauma. Of 3088 head CT scans obtained in Canadian patients with mild traumatic brain injuries, 4.8% had acute findings. While they did note the incidence increased with age and the use of anticoagulation, there were no significant associations.[11] Other groups in addition to Maniar et al have investigated signs and symptoms that may reliably indicate acute changes on CT scans of the head in patients with minimal head trauma or low-energy falls. By studying multiple large patient populations, the goal would be to have a standard set of criteria to help ED physicians know when a patient with a ground level fall is at higher risk of an intracranial hemorrhage.

In 2007, the United Kingdom's National Collaborating Centre for Acute Care published recommendations regarding when to judiciously use a head CT in the elderly, which were also similar to findings of our study. They recommend head CT scans if GCS <13, evidence of trauma to the head such as a depressed skull fracture, signs of a basilar skull fracture, or a focal neurologic deficit. Additional findings in comparison to our study encouraged a head CT if there was a post-traumatic seizure or more than one episode of vomiting.[12] A study by Borczuk investigated this same topic with similar findings. The 1995 study evaluated the risk of an intracranial hemorrhage in patients older than 60 with minimal head trauma, and found high-risk variables were evidence of soft tissue injury to the head, acute neurologic deficit, and signs of a basilar skull fracture.[13] These studies highlight the need to scrutinize concrete evidence to rationalize ordering a head CT.

Another largely cited reason for obtaining CT scans of the head in the elderly who sustain an injury with minimal head trauma is that a larger percentage of elderly patients are anticoagulated due to medical comorbidities, in comparison to a younger patient population. Therefore, the anticoagulated elder patients have a higher theoretical risk of intracranial hemorrhage with minimal trauma. A study by Garra et al in 1999 investigated the incidence of acute pathology on head CT scans of patients with minimal head trauma who were also taking warfarin. Of 69 patients, none had an intracranial hemorrhage.[14] Again, despite having a theoretical higher risk of an intracranial hemorrhage, patients with a history of minimal head trauma and no LOC or neurologic deficits, no head CT is warranted. A later study in 2005 confirmed a similar set of signs and symptoms should be concerning for intracranial hemorrhage whether the patient is anticoagulated or not. Gittleman et al studied indications for a head CT in patients who were anticoagulated. While their study included any level of energy mechanism, their results found acute changes in patients with an acute neurologic deficit, and/or a GCS of 12 or less.[15]

Ample evidence has been published on the topic of indications for CT scans of the head in the elderly with minimal head trauma for the last 25 years. Despite all the published literature, our study indicates providers at our level II trauma center in a community setting is still over utilizing head CT scans based on history and physical examination. At our community hospital, the providers have incorporated evidence-based practices in regard to advanced imaging on a limited basis. This has significant strain on the health-care system financially and exposes patients to higher radiation levels and its associated morbidity. More work and future studies should focus on how best to implement these new studies into practical guidelines to assist health-care providers in the ED to use head CT scans more judiciously. We hope this study continues to raise awareness of the best indications to order a head CT for a patient exposed to minimal head trauma. Head CT scans should have a limited role in the workup of this patient population and should be reserved for patients with a history and physical findings that support head trauma.

Limitations of this study are the retrospective nature and moderate sample size. Future investigation is warranted and should focus on prospective trials. This would hopefully yield a validated assessment tool, which would properly stratify risk for presenting patients for which a CT scan of the head is considered. Additional work could be focused on how best to raise awareness of this issue and how to implement the use of a new clinical assessment instrument for ordering head CT scans in smaller communities.

Conclusions

Head CT scans should have a limited role in the workup of this patient population and should be reserved for patients with a history and physical exam findings that support head trauma, an ISS > 9 and GCS < 15.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author(s) received no financial support for the research, authorship, and/or publication of this article.

ORCID iD

Teresa Hall https://orcid.org/0000-0003-2626-8067

References

1. U.S. Census Bureau. *Statistical Abstract of the United States*. 131st ed. Washington, DC; 2012. http://www.census.gov/compendia/statab/. Accessed May, 2014.
2. Day J. *Population Projections of the United States by Age, Sex, Race, and Hispanic Origin: 1995 to 2050*. Washington, DC: US Bureau of the Census, Current Population Reports, P25-1130, US Government Printing Office; 1996.
3. McMahon DJ, Schwab CW, Kauder D. Comorbidity and the elderly trauma patient. *World J Surg*. 1996;20(8):1113-1120.
4. Adams PF, Kirzinger WK, Martinez ME. *Summary Health Statistics for the U.S. Population: National Health Interview Survey, 2012. Vital and Health Statistics. 10. 259*. Hyattsville, Maryland: National Center for Health Statistics; 2013.
5. Aschkenasy MT, Rothenhaus TC. Trauma and falls in the elderly. *Emerg Med Clin North Am*. 2006;24(2):413-432. [vii. Review].
6. Mann NC, Cahn RM, Mullins RJ, Brand DM, Jurkovich GJ. Survival among injured geriatric patients during construction of a statewide trauma system. *J Trauma*. 2001;50(6):111-116.
7. Bergeron E, Lavoie A, Belcaid A, Ratte S, Clas D. Should patients with isolated hip fractures be included in trauma registries? *J Trauma*. 2005;58(4):793-797.
8. Mack LR, Chan SB, Silva JC, Hogan TM. The use of head computed tomography in elderly patients sustaining minor head trauma. *J Emerg Med*. 2003;24(2):157-162.
9. Braithwaite RS, Col NF, Wong JB. Estimating hip fracture morbidity, mortality and costs. *J Am Geriatr Soc*. 2003;51(3):364-370.
10. Maniar H, McPhillips K, Torres D, Wild J, Suk M, Horwitz D. Clinical indications of computed tomography (CT) of the head in patients with low-energy geriatric hip fractures. *Injury*. 2015;46(11):2185-2189.
11. Albers CE, von Allmen M, Evangelopoulos DS, Zisakis AK, Zimmermann H, Exadaktylos AK. What is the incidence of intracranial bleeding in patients with mild traumatic brain injury? A retrospective study in 3088 Canadian CT head rule patients. *Biomed Res Int*. 2013;2013:453978.
12. National Collaborating Centre for Acute Care (UK). *Head Injury: Triage, Assessment, Investigation and Early Management of Head Injury in Infants, Children and Adults*. London, England: National Collaborating Centre for Acute Care (UK); 2007.
13. Borczuk P. Predictors of intracranial injury in patients with mild head trauma. *Ann Emerg Med*. 1995;25(6):731-736.
14. Garra G, Nashed AH, Capobianco L. Minor head trauma in anticoagulated patients. *Acad Emerg Med*. 1999;6(2):121-124.
15. Gittleman AM, Ortiz AO, Keating DP, Katz DS. Indications for CT in patients receiving anticoagulation after head trauma. *Am J Neuroradiol*. 2005;26(3):603-606.