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Diagnostic yield of computed tomography for suspected spine fracture in patients older than 50 years following fall down and predictors of emergency interventions: A retrospective study

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ABSTRACT

Background: The National Emergency X-Ray Utilization Study criteria is used to determine the need for Computed tomography scan and reduce radiation exposure in suspected cervical spine injury cases. However, it is insufficient, and does not apply to injuries of the thoracic or lumbar spine. *Objective:* To identify predictors that indicate the use of computed tomography scan for spine fractures and to determine the factors that predict emergency treatment. *Methods:* This retrospective study is based on hospital records of patients over 50 years who presented to King Fahd Hospital of the University Emergency Department after falling and underwent Computed tomography. 1425 patient files were reviewed; among them 142 met the research criteria. *Results:* The median age was 68 years with an almost equal participation of both genders. A male gender, the need for hospital admission and high creatinine level were all found to be significantly associated with fracture (P-value = 0.049; 0.008 and 0.026, respectively). *Conclusion:* High creatinine level and being male might be used to indicate use of Computed tomography scan but these needs to be further studied.

Keywords: fall down, fracture, elderly, computed tomography, spinal fracture

1. INTRODUCTION

Fall is defined as coming down to the ground or at a lower level by accident. Falls are one of the leading causes of death and illness among elderly

worldwide. As estimated by the world health organization (WHO) that 684,000 individuals die each year as a result of falls. In 2014, the cost of elderly falls in the United States was estimated to be around $50 billion for non-life-threatening cases, and $754 million for life-threatening cases as per Centers for Disease control (CDC). Even in the absence of fall-related life-threatening injuries such as spine fractures, falls can have serious effects as frequent falls are associated with functional deterioration, social withdrawal, being anxious, and depressed. As a result, elderly who fall are more likely to be hospitalized, regardless of whether or not they have been seriously injured or sustain fracture (Engelbart et al., 2022).

In the clinical setting, the National Emergency X-Radiography Utilization Study (NEXUS) criteria is used as a tool for determining the need to use Computed tomography (CT) in suspected cervical spine injury cases, and reducing radiation exposure. The NEXUS criteria, on the other hand, is not adequate and do not apply to thoracic or lumbar spine injuries (Cooper et al., 2015). Therefore, there is a need to identify predictive factors, to be used as indicators for spine fractures.

Our retrospective study relied on hospital health records of patients who aged 50 years or older and reported to King Fahd Hospital of the University (KFHU) emergency department because of a fall and underwent spine CT scan within the last 10 years. The aim of this study is to evaluate potential predictive factors that may indicate the use of CT scan to rule out fractures in the cervical, thoracic, and lumbar spine. In addition, we aim in this study to find the predators of emergency department treatment. Finding the predictive factors of a positive CT scan is important, as it will aid in reducing radiation exposure by avoiding unnecessary CT scans, and it will help in reducing emergency department congestion.

2. METHODS

Subjects

This is a retrospective study that was conducted in September 2021 at KFHU in Khobar, Saudi Arabia and ended in April 2022. Data was collected from the Quadramed System of the hospital. Medical records of patients who are over 50 years old and presented to KFHU after a fall in the past 10 years were reviewed and included. All patients who were younger than 50 years, those who did CT outside KFHU, or those with no adequate interpretation of CT findings, had been excluded.

Ethics

An open population sample size was used in this study. The study was reviewed and approved by ethics committee (approval number: IRB-USG-2021-01-348).

Variables

Predictive factors that were included in the analysis are: patient's demographic data, vital signs, patient's comorbidities, number of fall in the last 12 months, level of fall, physical findings at presentation, signs of neurological deficit, symptoms after fall, level of consciousness, how many days did the patient get admitted in the (Intensive care unit(ICU) or ward, associated injury, medications used before the fall, site of spine fracture if any, laboratory investigations after the fall, imaging done whether CT scan or X-ray with findings if any, and intervention done to the patient. In addition, identifying predictive factors for emergency intervention for those patients.

Data Collection

A permission letter is sent to the (information technology department (IT)] of KFHU in order to obtain a list of patients with (medical record number (MRN)] for the last 10 years. Any duplicates had been removed using a Microsoft Excel. Recruitment of trained data collectors was done. Data were collected in a Google forms that was created by our team members from the hospital system.

Data analysis

The data were analyzed using Jamovi (version 2.2.5). Categorical variables were presented as frequencies and compared using Chi-square test. Continuous variables were presented as mean and standard deviation. Binomial logistics regression analysis was used to determine the predictors associated with vertebral fractures. Alpha level of less than 0.05 was considered significant.

3. RESULTS

A total of 1425 patients were recruited from KFHU database, and 162 (11.4%) medical files of this population were included for screening. We excluded a large number of patients who did not meet the study inclusion criteria, especially the cause of CT scan.

After screening, 20 files were filtered out due to a significant loss of key information in patient's file (missing more than 20% of key data). As a result, 142 patient files were included. All included patients are aged 50 years, and a spine CT was done due to a history of fall. The median age for study participants is 68 years, the youngest is 50 years old and the oldest is 111 years old (Table 1).

Table 1 A summary for the statistical description of participants' age (n = 142).

Mean	68.7
Median	68.5
Mode	70.0
Standard deviation	12.3
Range	66
Minimum	50
Maximum	111
25th percentile	60
50th percentile	68.5
75th percentile	76.8

There is an almost equal participation of both genders in the study, with 52.8% and 47.2% for females and males, respectively (Figure 1). The largest Body Mass Index (BMI) category was overweight consisting of 25 patients (46.3%), followed by obese 18 (33.3%), then normal BMI 10 (18.5%), and only one patient (1.9%) considered underweight.

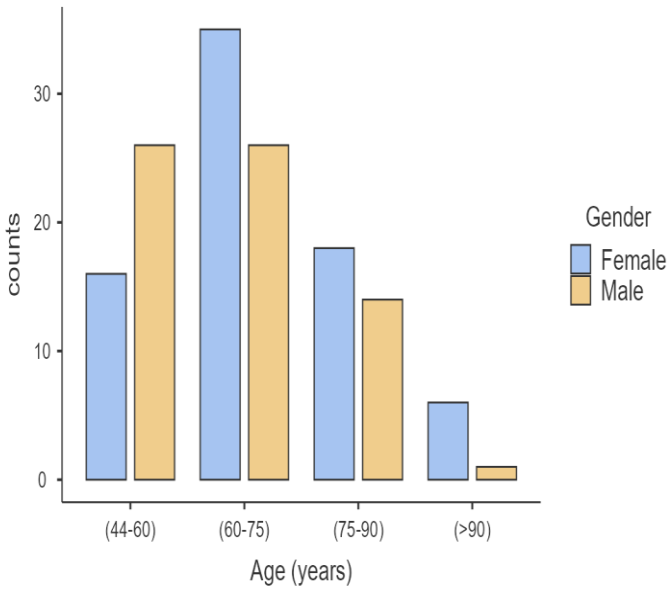

Figure 1 Bar-chart compare age of participants with gender**.**

The most common comorbidity in this study is hypertension (n = 71), followed by diabetes mellitus (n = 66), and then by osteoporosis (n = 36). This result can indicate that the patients with these comorbidities are more likely to have falls compared to other comorbidities; therefore they may have a higher risk to experience complications. The most common medications used are antihypertensive (n = 71), followed by insulin and oral hypoglycemic agents (n = 70), and Non-steroidal anti-inflammatory drugs (NSAIDs) (n = 51). Interestingly, the number of patients used antihypertensive and insulin and hypoglycemic agents, is nearly consistent with the number of patients who reported having these conditions (i.e., hypertensive and diabetics, respectively). In addition, and as expected in elder population, the increased use of NSAIDs could be referred to the need of pain killer medications for many pathological conditions such as osteoporosis.

Majority of the patients in this study had a minimum of one fall within the past 12 months (n = 133). There is a low prevalence of patients having multiple falls (patients who had two and three falls are 7 and 2, respectively). Only 38 (26.8%) out of 142 patients were reported to have a spinal fracture after fall. Particularly, the number of males who have fracture (n = 20) is slightly higher than females (n = 18). To investigate whether there is a relationship between fracture and osteoporosis, results showed that 26.3% (n = 10)

of patients with spinal fracture had osteoporosis. However, 25% (n = 26) of patients who had osteoporosis did not have spinal fracture, suggesting that osteoporosis may not be a strong predictor for spinal fracture in this study population.

The results showed that the numbers of females who have osteoporosis are three times higher (n = 27) than males (n = 9). As stated above, 38 of 142 patients had spinal fracture. The majority of single site fracture was in thoracic with 15 patients (10.6%), followed by lumbar (n =13), cervical (n = 3), and sacral (n = 1). These results were expected if they are related to how the patient perceives the fall, where the fall force is mostly directed to the middle of the spine secondary to slipping and falling. Reasoning is that patients may trip and perceive the fall to upper limb, which transfer the force to thoracic part of spine and that result in fracture.

Identifying the predictive factors for spinal fracture

To identify the key predictive factors for the fractures in elderly, further inferential statistical analysis was conducted. Chi-square is used to predict the statistical significance of each dependent and some important demographic variables such as age, gender, and body mass index. The association between these variables and the primary outcome (spinal fracture) showed insignificant results minimum P-value = 0.063 for Blood urea nitrogen (BUN). The reason behind the insignificancy that showed in the Chi-square test may be caused by the low number of patients who had spinal fracture in this study which is 38 patients out of 142.

Binominal regression model was used to determine the link between spinal fracture and the expected predictive factors. The analysis was divided into 4 parts based on the classification of the predictors into primary survey (meant to identify and manage the immediate life threats) and secondary survey (done after the primary survey, deal with the less obvious problems that may need first aid). These examinations have been taken at the emergency department to identify risk factors of fracture. First part of the binomial regression included some factors that were measured in the primary survey when patients were in the emergency department. This part included vital signs and their relation to fractures. Gender showed to be a significant factor (P-value = 0.049; OR = 0.170; 95% CI (0.0293-0.988)). In addition, patient's need for a hospital admission after the fall is another significant variable (P-value = 0.008; OR = 10.526; 95% CI (1.8265-60.667) (Table 2). However, the rest of the variables showed insignificant results.

Table 2 Binominal regression model compare vital signs to predict fracture**.**

Note. Estimates represent the log odds of "Fracture = No" vs. "Fracture = Yes						95% Confidence Interval	
Predictor	Estimate	SE	Z	p	Odds ratio	Lower	Upper
Intercept	-3.8466	3.7272	-1.0320	0.302	0.0214	1.43e-5	31.77
Age	0.0686	0.0391	1.7552	0.079	1.0710	0.9920	1.16
Fall level							
> 4 m – < 4 m	-0.0931	1.6083	-0.0579	0.954	0.9111	0.0390	21.31
Same level – < 4 m	-1.6733	1.0519	-1.5907	0.112	0.1876	0.0239	1.47
Stairs – < 4 m	-0.4665	1.3737	-0.3396	0.734	0.6272	0.0425	9.26
Number of falls in the past 12 months							
1 –More than 1	0.6963	1.2669	0.5496	0.583	2.0063	0.1675	24.03
Patient level of consciousness							
Normal – Abnormal	-1.2167	1.4843	-0.8197	0.412	0.2962	0.0161	5.43
Patient Temperature							
Normal – Abnormal	1.3615	1.5695	0.8675	0.386	3.9021	0.1800	84.58
Patient respiratory rate							
Normal – Abnormal	-1.3842	1.2588	-1.0996	0.272	0.2505	0.0212	2.95
Patient pulse rate							
Normal – Abnormal	0.7988	0.9695	0.8239	0.410	2.2228	0.3324	14.86
Patient Systolic blood pressure							
Normal – Abnormal	-0.9054	0.9534	-0.9497	0.342	0.4044	0.0624	2.62
Patient Diastolic blood pressure							
Normal – Abnormal	0.7061	0.9358	0.7546	0.451	2.0261	0.3237	12.68

The second part of the binominal regression model included factors that were collected from the secondary survey of the patient in the emergency department, and its association with the fracture. This model showed insignificant values for all the variables

included. The third part of the binominal regression model included lab investigations that might be associated with the fracture. The analysis showed significant comparison between the creatinine level and the patients who have spinal fracture with a P-value = 0.026 (OR = 12.483 and 95% CI (1.3465-115.74) (Table 3). The fourth part of binominal regression model that measured the association between the risk of fracture which was demonstrated in the vitamin D and calcium level, and the fracture. It shows insignificant results.

Table 3 Binominal regression model compare lab results to predict fracture.

						95% Confidence Interval	
Predictor	Estimate	SE	Z	p	Odds ratio	Lower	Upper
Intercept	-0.49723	3.8586	-0.1289	0.897	0.608	3.16e-4	1170.82
Age	-0.00657	0.0402	-0.1637	0.870	0.993	0.9182	1.07
Gender							
Male – Female	1.30585	1.0076	1.2960	0.195	3.691	0.5122	26.60
Patient WBC count							
Normal – Abnormal	0.56406	0.8762	0.6438	0.520	1.758	0.3156	9.79
Patient hemoglobin level							
Normal – Abnormal	-1.82515	1.0814	-1.6877	0.091	0.161	0.0194	1.34
Patient Platelets count							
Normal – Abnormal	0.66174	1.0022	0.6603	0.509	1.938	0.2718	13.82
Patient PT level							
Normal – Abnormal	-1.52204	0.9098	-1.6730	0.094	0.218	0.0367	1.30
Patient PTT level							
Normal – Abnormal	-0.10688	0.9350	-0.1143	0.909	0.899	0.1438	5.62
Patient RBS level							
Normal – Abnormal	0.26608	0.8096	0.3287	0.742	1.305	0.2670	6.38
Patient BUN level							
Normal – Abnormal	0.06406	0.8831	0.0725	0.942	1.066	0.1888	6.02
Patient creatinine level							
Normal – Abnormal	2.52440	1.1362	2.2218	0.026	12.483	1.3465	115.74
Patient need for intervention							
No – Yes	0.24319	1.3189	0.1844	0.854	1.275	0.0962	16.91
Note. Estimates represent the log odds of "Fracture (y\n) = No" vs. "Fracture (y\n) = Yes"							

4. DISCUSSION

CDC reported in 2009 that the frequency of fall increases four folds for patients of 85 years and older compared to patients 65 to 74 years old in the United States. However, a study by Alabdullgader et al., (2021) in Saudi Arabia recruited a total of 269 participants showed that the age of people who experienced falls was between 60 and 90 years old, with a mean age of 70.3 +/-8.18 years for males and 68.6 +/-6.8 years for females, respectively. The majority (57.6%) was aged between 60 and 70, with 13.4% being above 80. In our research, the median age for participants is 68 years old with half of the participants ranging from 60 to 76.8 years old.

The CDC report showed that women have more risk (around 3 folds) of falls compared to men in general. While in the study of Alabdullgader et al., (2021) they found approximately equal participation of both genders (males = 49.4% and females =50.6%). These findings are similar to our study where we found that the number participants are almost equally divided between females (52.8%) and males (47.2%). Additionally, the most common comorbidities associated with falls in Saudi Arabia are hypertension (59.1%) and diabetes (56.5%) as reported by Aabdullgader et al., (2021). In this context, we reported that the most common comorbidity associated with falls is hypertension (50%), followed by diabetes (46.7%), and osteoporosis (25.35%).

Jawa et al., (2017) found that cervical spines are the most frequent place of spine fracture (43 %) followed by thoracic spine (5.7 %), and lumbar spine (4.9%). In our study, we found that spinal fractures are most common in thoracic spine (10.6%), followed by lumbar (9.2%), then cervical (2.1%), and sacral (0.7%). Stevens et al., (2005) reported in their study that included 22.560 patients who presented to the emergency department after a fall. They found that fractures were 2.2 times higher in women. In Kudlacek et al., (2000) study, it was shown that fractures are 3 times more associated with being women than men. They suggested that this

difference is due to the risk of osteoporosis and decreased bone mineral density which is more common in women. Our study, however, found significant gender difference in spine fracture which was identified using the binominal regression model (P-value = 0.049). It more frequent in males, despite the fact that osteoporosis is three times higher in females than in males.

In Engelbart et al., (2022) study it was shown that 253 (10%) of 2.312 admitted patients after falling were identified to have a cervical spine injury. In our paper, we identified a significant association (P-0.008) between fractures and patients who needed admission and close observation after falling using the binominal regression model. This might be attributed to the severity of symptoms and the need for close observation that may indicate cervical spine injury. Chronic kidney disease can lead to increased falls and might cause renal osteodystrophy that leads to bone fragility and increase the risk of fracture as per Nickolas et al., (2008).

In our study, we discovered that spine fractures were significantly associated with high creatinine levels using the binominal regression model (P-value=0.026). That might be attributed to chronic renal disease because most of the patients included in our study suffer from diabetes and hypertension, which can cause kidney disease.

5. CONCLUSION

Fall is one of the leading causes of death worldwide representing a medical and an economical burden. The main purpose of this paper is to determine the predictive factors for a CT scan with spine fracture. Secondly, determine predictive factors for the need of emergent intervention. The most common comorbidities that were associated with spine fractures are hypertension, diabetes, and osteoporosis respectively. The most common reported medications that were associated with fall are antihypertensive, oral hypoglycemic agents and insulin, NSAIDs, benzodiazepine, and antipsychotic respectively. Significant associations between high levels of creatinine and male gender with spine fracture have been noticed.

Author's contribution

All Authors had contributed in developing the idea and literature review, data collection, and interpretation of the data, manuscript writing, editing and revision of the manuscript. Approved for publication and agreed to take responsibility for the content.

Ethical approval

The study was approved by the Ethics and Research Review Committee of Imam Abdulrahman Bin Faisal University, Faculty of Medicine (Approval number: IRB – UGS – 2021-01-348), Date of approval was Oct 18, 2021.

Informed consent

In this retrospective study the informed consent was waived by the ethical committee.

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This study has not received any external funding.

Conflicts of interest

The authors declare that there are no conflicts of interests.

Data and materials availability

All data associated with this study are present in the paper.

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