Netherlands
The Journal of Medicine

ORIGINAL ARTICLE

Electrocardiographic abnormalities in patients admitted for hip fracture

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ABSTRACT

Background: Several risk factors for falls and hip fractures have been recognised, but controversy still exists regarding the importance of rhythm and conduction abnormalities as potentially modifiable risk factors for recurrent falls. The aim of this study was to determine the prevalence of clinically relevant ECG abnormalities in patients with a hip fracture versus controls.

Methods: The study was designed as a case-control study within consecutive hip surgery patients in an academic hospital. Cases: patients with traumatic hip fractures. Controls: patients undergoing planned hip surgery (non-traumatic). Cases and controls were 1:1 matched for age and gender. Inclusion criteria: age ≥ 50 years. Exclusion criteria: high-energy trauma, pathological and/or previous hip fracture. ECGs were scored using predefined categories. Multivariate logistic regression was performed to calculate odds ratios (OR) and to correct for confounders.

Results: We included 888 patients (444 cases). Mean age was 70.9 years (SD 9.3), 70% were female. After correction for potential confounders we found the following associations between clinically relevant ECG abnormalities and hip fractures: atrial fibrillation OR 2.7 (95% CI 1.2-6.1), abnormal QTc prolongation OR 3.9 (2.2-6.8), sinus tachycardia OR 5.0 (2.1-11.8) and sinus bradycardia OR 0.3 (0.1-0.5). Univariately, several markers for decreased cardiac function were also associated with hip fractures.

Conclusions: Hip fracture patients are at higher risk for ECG abnormalities than matched patients undergoing hip surgery for other indications. To potentially reduce the risk of future (injurious) falls, increased awareness of these ECG abnormalities is warranted to assess the need for further cardiovascular fall risk assessment.

KEYWORDS

Atrial fibrillation, ECG, falls, hip fracture, QTc prolongation

INTRODUCTION

Hip fractures in older persons form a substantial and growing healthcare burden.[1] Hip fractures lead to an excess one-year mortality rate of 25%, and 50% of survivors of hip fractures suffer from a significant decline in quality of life.[1,2] Prevention of hip fractures is therefore of great importance. Since > 90% of hip fractures are due to a fall, a multifactorial intervention is warranted when assessing treatable risk factors to prevent a (recurrent) injurious fall.[3] Several risk factors for falls and hip fractures have been recognised, including muscle weakness, history of falls and visual deficits.[3,4] However, controversy still exists regarding the importance of cardiac arrhythmias as a potentially modifiable risk factor for falls.[3] Only a few studies have investigated the association between cardiac rhythm and conduction abnormalities and hip fractures.[5-8] Although these studies suggest a potential association between cardiac arrhythmias and hip fractures, results were inconclusive due to small sample sizes and lack of adequate comparison groups.

If we could determine whether cardiac arrhythmias, conduction abnormalities and other electrocardiographic (ECG) abnormalities are indeed associated with hip fractures, this may provide us with new evidence on (potentially treatable) risk factors for injurious falls. In the current study we therefore investigated whether ECG abnormalities were more prevalent in hip fracture patients compared with planned hip surgery patients. We

hypothesised that hip fracture patients have more clinically relevant ECG abnormalities, potentially explaining fall incidents, than study controls.

METHODS

Population

The study was conducted according to the principles expressed in the Declaration of Helsinki. The medical ethics committee of the Academic Medical Center (Amsterdam) approved this study and waived the necessity for informed consent because of the observational design. The study was designed as a case-control study within consecutive patients undergoing hip surgery. All patients admitted for either planned or emergency hip surgery from January 1996 to May 2011 in a tertiary university teaching hospital were screened for eligibility. Cases were defined as patients with traumatic hip fracture who underwent subsequent proximal femur fracture surgery. Controls were defined as patients who underwent elective hip surgery for non-traumatic reasons, mainly total hip replacement. Inclusion criteria were age ≥ 50 years and preoperative ECG present in the hospital records. Exclusion criteria were previous hip fracture, high energy trauma and pathological fracture. Patients were individually matched 1:1 for age and gender. Age was categorised in groups of five years to increase likelihood of matching.

Baseline characteristics

For data collection, all electronic and paper medical records were retrieved. Admission duration was recorded in days. All functional limitations and comorbid diagnoses (noted in the medical records and/or referral letters) were recorded. Functional limitations included a previous fall (mention of a fall in the past medical history), use of a mobility aid (walker, cane or wheelchair), visual impairment or deafness. Further comorbid diagnoses included coronary artery disease (previous medical history of angina pectoris, myocardial infarction/percutaneous transluminal coronary angioplasty and/or coronary artery bypass graft surgery), hypertension, heart failure, heart valve disorder, cerebrovascular accident, atrial fibrillation, pacemaker or internal cardiac defibrillator, parkinsonism, cognitive impairment, alcohol abuse, diabetes mellitus, chronic obstructive pulmonary disease, hemiplegia/paraplegia and depression.[10] As an overall measure of comorbidity, the Charlson Comorbidity Index (CCI) was computed.[9] Among other conditions, the CCI includes myocardial infarction, congestive heart failure, cerebrovascular disease, peripheral vascular disease, diabetes, liver disease, renal disease and chronic pulmonary disease.

Drugs were listed and grouped according to the Anatomical Therapeutic Chemical (ATC) classification system. Medication categories adjusted for in our analysis were psychotropic medications: psycholeptics (N05*) and psychoanaleptics (including antidepressants) (N06*), and cardiovascular medications: cardiac therapy (cardiac glycosides, class I and III antiarrhythmics, cardiac stimulants, vasodilators and other cardiac preparations) (C01*), antihypertensives (C02*), diuretics (C03*), peripheral vasodilators (C04*), beta blockers (C07*), calcium channel blockers (C08*), agents acting on the renin-angiotensin system (C09*), alpha-adrenoreceptor antagonist urologicals (G04CA) and beta blocker antiglaucoma preparations (S01ED). QTc-prolonging drugs were defined according to the composite list with QT drugs known to cause torsades de pointes.[11]

Electrocardiographic findings

Preoperative 12-lead ECGs were used for determination of ECG abnormalities (paper speed 25 mm/s and calibration 10 mm/mV), including ECGs that were performed before the date of admission. All ECGs were assessed and analysed by a trained reviewer (SJ). If any doubts were present, a cardiologist (RWK/FJL) decided on the final scoring. One in four ECGs were randomly checked by RWK. ECGs that showed a pacemaker rhythm were excluded from further analysis beyond assessment of potential pacemaker malfunction, as conduction intervals are usually distorted in these ECGs due to placement of the pacemaker lead.

Clinically relevant ECG findings were defined as: quantitative findings (ventricular rate, conduction intervals and electrical axis), rhythm and conduction abnormalities, electrical axis and voltage abnormalities, ectopic beats, QRS morphology and pathological Q wave and ST-T segment abnormalities. Information concerning ventricular rate, PR interval, QRS duration and electrical axis was taken from the automated ECG analysis. The QT interval was measured manually and corrected for rate by Bazett's formula. Sinus tachycardia was defined as sinus rhythm with a rate of > 100 beats/min. Sinus bradycardia was defined as sinus rhythm with a rate of < 60 beats/min. Abnormally prolonged QTc interval was defined as a QTc interval of > 450 ms in males and > 470 ms in females.[12]

Statistical analysis

To assess differences between cases and controls, paired t-tests were used for continuous variables and McNemar's test for dichotomous variables. For non-normally distributed continuous data, the Wilcoxon signed-rank test was used. For associations, ORs were calculated through conditional multivariate logistic regression analysis. A hierarchical modelling strategy was used, in

which the first model contained the main determinant only (ECG abnormality) and the final model included potential confounders. The following covariates were considered potential confounders: age, time between ECG and surgery, CCI, use of mobility aid, previous fall, hemiplegia, impaired cognition and use of psychotropic drugs. A p-value of < 0.05 was used as threshold for statistical significance. For ECG abnormalities, the Bonferroni correction was used to adjust for multiple testing. Statistical analyses were performed using IBM SPSS Statistics (Version 19.0 for Windows. IBM Corp. Released 2010. Armonk, NY).

RESULTS

The total cohort consisted of 3505 consecutive patients who underwent hip surgery between January 1996 and May 2011. Of those, 1894 met the inclusion criteria. Within this eligible cohort, we were able to match 444 cases (311 females, mean age 70.9 years [SD 9.3]) to 444 controls (311 females, mean age 70.8 years [SD 9.2]). Further details on inclusion are shown in *figure 1*. Of the cases, 305 patients underwent surgery for a femoral neck fracture, 129 for intertrochanteric fracture and 11 for subtrochanteric fracture. Among the controls, 431 underwent total hip replacement for osteoarthritis and 12 for avascular necrosis.

Baseline characteristics are shown in *table 1*. Cases and controls showed significant differences in age, time of ECG to surgery and CCI. Use of mobility aid, hemiplegia and

Figure 1. *Inclusion flow chart*

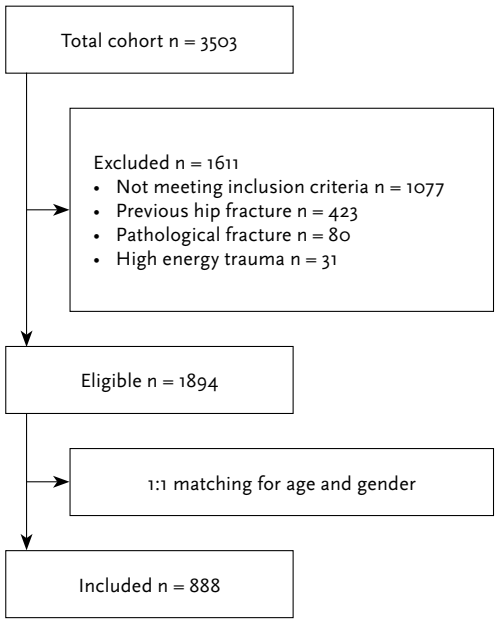


Table 1. *Baseline characteristics of hip fracture patients and controls*

	Cases n = 444	**Controls n = 444**	***P***
Age (years)	70.9 (± 9.3)	70.8 (± 9.2)	0.012
Gender, female	311 (70.0%)	311 (70.0%)	1.000
Time of ECG to surgery (days)	0.8 (0.4; 1.6)	31.9 (6.1; 68.8)	< 0.001
Comorbidity			
Charlson Comorbidity Index	1.4 (± 1.8)	0.8 (± 1.3)	< 0.001
Use of mobility aid	46 (10.4%)	145 (32.7%)	< 0.001
Previous fall	29 (6.5%)	13 (2.9%)	0.020
Visual impairment	36 (8.1%)	30 (6.8%)	0.539
Coronary artery disease	58 (13.1%)	46 (10.4%)	0.281
Hypertension	102 (30.0%)	104 (23.4%)	0.944
Heart failure	34 (7.7%)	13 (2.9%)	0.003
Cerebrovascular accident	59 (13.3%)	25 (5.6%)	< 0.001
Heart valve disorder	18 (4.1%)	29 (6.5%)	0.144
Atrial fibrillation	28 (6.3%)	19 (4.2%)	0.243
Pacemaker or ICD insertion	5 (1.1%)	7 (1.6%)	0.774
Hemiplegia/ paraplegia	22 (5.0%)	3 (0.7%)	< 0.001
Parkinsonism	26 (5.9%)	6 (1.4%)	0.001
Cognitive impairment	55 (12.4%)	1 (0.2%)	< 0.001
Alcohol abuse	42 (9.5%)	7 (1.6%)	< 0.001
Diabetes mellitus	69 (15.5%)	33 (7.4%)	< 0.001
COPD	52 (11.7%)	30 (6.8%)	0.020
Drug use			
Number of drugs	3.7 (± 3.3)	3.4 (± 2.9)	0.269
Number of psychotropic drugs	0.4 (± 0.7)	0.3 (± 0.6)	0.008
Number of cardiovascular drugs	1.0 (± 1.3)	0.97 (± 1.2)	0.752
Antiarrhythmic agents	49 (11.0%)	32 (7.2%)	0.075
Diuretics	82 (18.5%)	71 (16.0%)	0.419
Beta blockers	83 (18.7%)	87 (19.6%)	0.818
Calcium channel blockers	47 (10.6%)	51 (11.5%)	0.762
ACE inhibitors	64 (14.4%)	71 (16.0%)	0.606
Lipid lowering drugs	62 (14.0%)	72 (16.2%)	0.437

ICD = internal cardiac defibrillator; COPD = chronic obstructive pulmonary disease; RAAS = renin-angiotensin-aldosterone system; FRID = fall risk increasing drugs.
Data are *n* (%), mean (SD) or median (IQR).

cerebrovascular accident were more prevalent in cases than controls. Other common fall risk factors, such as previous fall, visual impairment, parkinsonism, alcohol abuse and cognitive impairment, were more prevalent among cases. Medical history of heart failure was significantly more prevalent in cases than controls, but medical history of other cardiovascular conditions such as hypertension, coronary artery disease and atrial fibrillation was equal in both groups. Use of psychotropic drugs was more common in cases, use of other drugs was equal in the two groups.

Table 2 shows the proportion of ECG findings and abnormalities in cases and controls. Four cases and five controls showed pacemaker rhythm and were therefore excluded from further ECG analyses. None of the paced ECGs showed signs of pacemaker malfunction. Because of the paired character of the analysis, 18 patients were therefore excluded from analysis, yielding a population of 435 cases and 435 controls for ECG analysis.

Cases and controls showed significant differences in the occurrence of several rhythm and conduction abnormalities: abnormal QTc prolongation (22.1% of cases vs. 4.8% of controls), sinus bradycardia (4.1% of cases vs. 18.4% of controls), sinus tachycardia (10.8% of cases vs. 2.1% of controls) and atrial fibrillation or flutter (6.2% of cases vs. 2.9% of controls). Electrical axis and voltage abnormalities that were significantly different between cases and controls were: right-axis deviation (2.8% of cases vs. 0.5% of controls), low QR voltage (4.8% of cases vs. 0.9% of controls) and left ventricular hypertrophy (5.3% of cases vs. 2.3% of controls). Pathological Q waves were more frequently observed in cases (8.7% of cases vs. 4.6% of controls), as were non-specific ST-T changes (21.6% of cases vs. 13.1% of controls).

Table 2. *ECG abnormalities in hip fracture patients and controls*

	Cases n = 435	Controls n = 435	p	#
Quantitative findings				
Heart rate (BPM)	81.8 (± 16.8)	70.7 (± 13.1)	< 0.001	#
PR interval (ms)†	170.0 (± 30.4)	162.2 (± 30.4)	< 0.001	#
QRS duration (ms)	93.0 (± 18.9)	94.6 (± 17.3)	0.186	
QTc interval (ms)	442.9 (± 30.7)	423.5 (± 33.5)	< 0.001	#
Conduction and rhythm abnormalities				
1st degree AV block†	34 (8.6%)	41 (10.4%)	0.489	
Abnormal QTc prolongation[1]	96 (22.1%)	21 (4.8%)	< 0.001	#
Sinus bradycardia	18 (4.1%)	80 (18.4%)	< 0.001	#
Sinus tachycardia	47 (10.8%)	9 (2.1%)	< 0.001	#
Atrial fibrillation/ flutter	27 (6.2%)	12 (2.9%)	0.024	
Supraventricular tachycardia	4 (0.9%)	1 (0.2%)	0.375	
Electrical axis and voltage abnormalities				
Left-axis deviation[2]	55 (12.8%)	41 (9.5%)	0.184	
Right-axis deviation[2]	12 (2.8%)	2 (0.5%)	0.013	
Low QRS voltage	21 (4.8%)	4 (0.9%)	0.001	#
Left ventricular hypertrophy	23 (5.3%)	10 (2.3%)	0.035	
Right ventricular hypertrophy	1 (0.2%)	0 (0%)	1.000	
Atrial hypertrophy	10 (2.3%)	7 (1.6%)	0.629	
Ectopic beats				
Premature atrial complex	24 (5.5%)	21 (4.8%)	0.766	
Premature ventricular complex	26 (5.9%)	17 (3.9%)	0.222	
Bundle branch abnormalities				
Intraventricular conduction delay	49 (11.2%)	51 (11.7%)	0.920	
Left anterior fascicular block	11 (2.5%)	9 (2.1%)	0.824	
Right bundle branch block	15 (3.4%)	15 (3.4%)	1.000	
Incomplete right bundle branch block	4 (0.9%)	8 (1.8%)	0.388	
Left bundle branch block	12 (2.7%)	9 (2.1%)	0.664	
Incomplete left bundle branch block	4 (0.9%)	2 (0.5%)	0.687	
Bifascicular block	5 (1.1%)	4 (0.9%)	1.000	
Trifascicular block	1 (0.2%)	4 (0.9%)	0.375	
Q wave and ST-T segment abnormalities				
Pathological Q wave	38 (8.7%)	20 (4.6%)	0.025	
Inverted T waves	15 (3.4%)	6 (1.5%)	0.078	
Nonspecific ST-T changes	94 (21.6%)	57 (13.1%)	0.003	
ST-segment elevations and depressions	1 (0.2%)	1 (0.2%)	1.000	

[1]Abnormal QTc prolongation: male > 450 ms, female > 470 ms. [2]For five ECGs no electrical axis could be determined because of arm lead reversal and/or ventricular tachycardia. †For 41 ECGs, the PQ interval could not be measured because of distortion and/or atrial fibrillation. Nine ECGs were excluded from analysis because of pacemaker rhythm. # Significant after Bonferroni correction (p < 0.0016). Data are *n* (%) or mean (SD).

Prevalence of first-degree atrioventricular (AV) block and supraventricular tachycardia was equal in both groups, as were all bundle branch abnormalities, bifascicular and trifascicular blocks. One case had a third-degree AV block (vs. none in the control group) and left posterior fascicular block was observed in one case (vs. none in the control group).

All quantitative ECG abnormalities that were univariately associated with hip fractures were tested multivariately (*figure 2*). The following cofactors were included in the final model: age, time of ECG to surgery, CCI, use of mobility aid, previous fall, hemiplegia, impaired cognition and use of psychotropic drugs. ECG abnormalities that remained significantly associated with hip fractures after adjustment in the final model were abnormal QTc prolongation (OR 3.9 [95% CI 2.2-6.8]), sinus bradycardia (0.3 [0.1-0.5]), sinus tachycardia (5.0 [2.1-11.8]) and atrial fibrillation (2.7 [1.2-6.1]). Adjustment for use of QTc-prolonging drugs did not alter odds ratios between abnormal QTc prolongation and hip fractures.

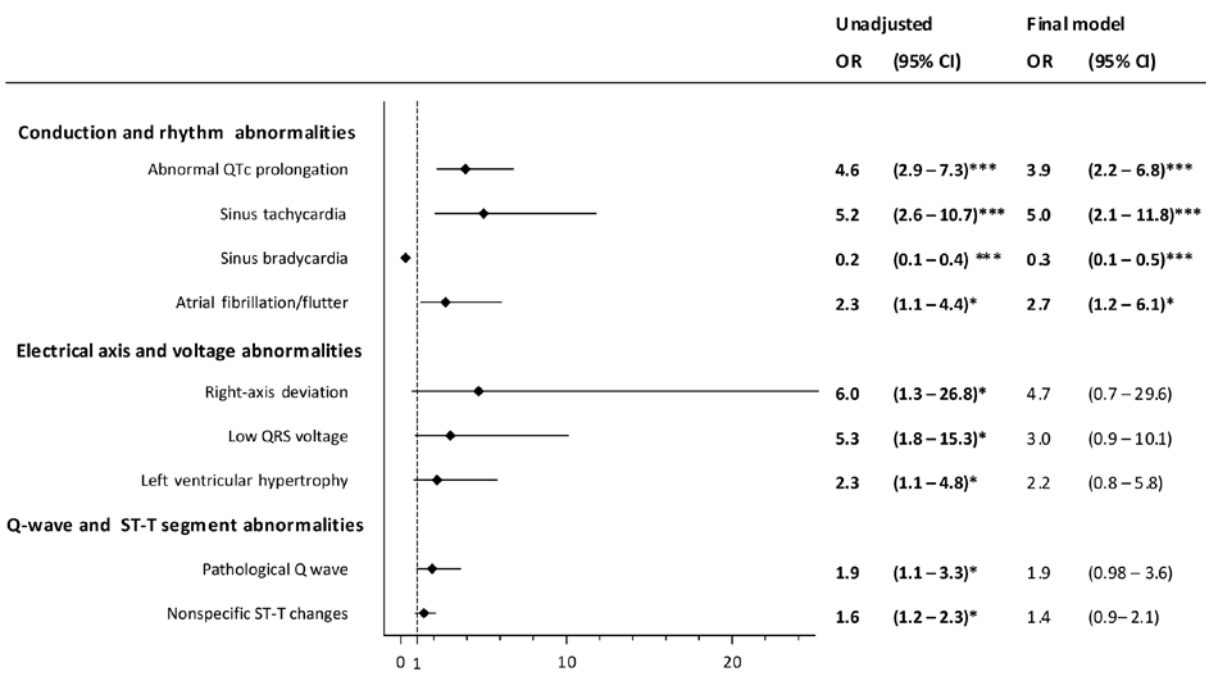
DISCUSSION

Our study showed that clinically relevant rhythm and conduction abnormalities, such as atrial fibrillation, QTc prolongation, sinus bradycardia and tachycardia, were associated with hip fractures in patients undergoing hip surgery.

An association between atrial fibrillation and hip fractures has not been shown before. Two recent studies, however, found atrial fibrillation to be an independent risk factor for falls in older patients.[13,14] Our results support this finding, as > 90% of hip fractures are due to a fall.[14] Atrial fibrillation can lead to decreased cardiac output because of an increased ventricular rate, irregular ventricular response and loss of the atrial kick. Furthermore, atrial fibrillation is associated with decreased baroreflex sensitivity, which can result in a decrease in orthostatic tolerance.[15,16] Since orthostatic hypotension is a cause for syncope and falls in older persons, this may provide an extra pathophysiological explanation for the association between atrial fibrillation and falls.

Abnormal QTc prolongation was also associated with hip fractures. QTc prolongation can cause torsades-de-pointes, which in turn can lead to syncope.[17] Ventricular tachyarrhythmias may contribute to syncope as the cause of a fall. Nevertheless it is unlikely that all patients with traumatic hip fractures suffered from torsades. Although speculative, it is possible that the effects of acute-phase response due to hip fracture or poor general condition contributed to QTc prolongation through as yet unknown

Figure 2. *Association between ECG abnormalities and hip fractures*



Final model: adjusted for age, time of ECG to surgery, CCI, use of mobility aid, previous fall, hemiplegia, impaired cognition and use of psychotropic drugs.
95% CI = 95% confidence interval.

mechanisms. A previous study has found an association between QTc prolongation and increased C-reactive protein levels which supports this theory.[18]

To our surprise, we found that study controls had a higher prevalence of sinus bradycardia on the ECG, whereas patients with hip fractures significantly more often showed sinus tachycardia. This difference may be explained by the fact that hip fracture patients will more often have an increased heart rate due to pain, anaemia and stress, leading to sinus tachycardia, or to the finding of sinus rhythm in patients who would normally have sinus bradycardia. Use of beta blockers, which potentially could have explained this finding as well, did not change the results in a multivariate model.

Univariately, we found that other markers for decreased cardiac function were associated with hip fractures, namely low QRS voltages, inverted T waves, non-specific ST-T changes, pathological Q waves and left ventricular hypertrophy. As these abnormalities are usually the result of either previous myocardial damage (e.g. due to ischaemia) and/or heart failure, patients with these abnormalities could be prone to (near) syncope when physical demands outweigh the capability of the heart to generate the required cardiac output. Three large population cohort studies found that the risk of (hip) fracture was significantly increased in patients after a diagnosis of heart failure.[19-21] Although markers for decreased cardiac function were only univariately associated with hip fractures in our cohort, this trend is in line with the findings of these population cohort studies.

Many of the potential explanatory findings in rhythm or conduction abnormalities such as complete heart block, severe bradycardias or tachycardias that may cause syncope can be transient and therefore be missed on the admission ECG. Abnormalities in ECG findings that were significantly more prevalent in hip fracture patients are by themselves not an explanation for a fall, but may be considered as 'proxies' for an abnormality that can cause a fall or syncope. However, this was not the case for conduction abnormalities. A complete third-degree heart block can be suspected when less advanced block is observed such as a bifascicular or trifascicular block, first or second degree AV block, but this was only present in a small number of subjects. It can therefore only potentially explain the fall in a small minority of patients.

Some limitations must be mentioned. One limitation of this study is the design. Although registration of all patients was performed prospectively, detailed data on comorbidity and drug use were collected from the medical records, and we can therefore not rule out incomplete data collection during admission. It is known that retrospective collection of data on falls is less reliable than prospective collection.[22] However, there is little reason to assume that missing data are differential for the groups, and therefore potential confounding by indication is unlikely. Another limitation is the fact that we compared patients in an acute setting with study controls in a more stable situation. This reflects in differences in median time from ECG to surgery between the two groups. ECGs for hip fracture patients were more often performed directly preoperatively or on the day of admission, whereas ECGs for patients undergoing planned hip surgery were more often taken during preoperative assessment by anaesthesiologists in the outpatient department. For most of the hip fracture patients, the ECG recording was performed after the actual outcome event (hip fracture). As some of the ECG abnormalities that we found (e.g. atrial fibrillation and sinus tachycardia) are known to be elicited by stress,[23] the increased prevalence of these abnormalities in hip fracture patients could be partly due to the stress of the hip fracture. To account for the differences in timing of the ECG we adjusted for time of ECG to surgery in our analyses. As it is questionable whether hospital populations are fit to serve as controls because controls should preferably resemble the general population, we hypothesised that patients undergoing planned hip surgery would resemble the general population most.[24] Also, as the prevalence of ECG abnormalities in our control group was similar to ECG abnormalities found in the general population, we believe that our control group was adequate to make meaningful comparisons.[25,26] Finally, we used Bazett's formula for correction of the QT interval for heart rate, as it is the most frequently used formula in clinical practice. However, it is known that this correction method can overestimate QT interval at higher heart rates,[27] and we should take this into consideration when interpreting the results of this study.

Hip fractures, with their associated morbidity and mortality, are among the most feared consequences of falls, and recognition of potentially modifiable risk factors in this group is therefore of great importance. The results of our study show that hip fracture patients are at much higher risk for heart rhythm and conduction abnormalities than a matched cohort of patients undergoing hip surgery for other indications.

Thus, a higher degree of caution and observation during perioperative management is warranted, as well as increased awareness of the need to undertake cardiovascular fall risk assessment when an older adult presents with one of these ECG findings to potentially reduce the risk of future falls. Further research, however, is warranted to confirm our findings in a prospective study. Additionally, it is necessary to study the effects of treatment of these abnormalities on fall incidence rates and fall-related morbidity and injury.

ACKNOWLEDGEMENTS

We thank Ms. Annemiek Schutte, Ms. Roos van der Zwan, Ms. Laura van Iersel and Ms. Judith Kwakman for their assistance in data collection.

DISCLOSURES

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

REFERENCES

1. Hartholt KA, van Beeck EF, Polinder S, et al. Societal consequences of falls in the older population: injuries, healthcare costs, and long-term reduced quality of life. J Trauma. 2011;71:748-53.
2. Panula J, Pihlajamaki H, Mattila VM, et al. Mortality and cause of death in hip fracture patients aged 65 or older: a population-based study. BMC Musculoskelet Disord. 2011;12:105-2474.
3. Panel on Prevention of Falls in Older Persons, American Geriatrics Society and British Geriatrics Society. Summary of the Updated American Geriatrics Society/British Geriatrics Society clinical practice guideline for prevention of falls in older persons. J Am Geriatr Soc. 2011;59:148-57.
4. Marks R. Hip fracture epidemiological trends, outcomes, and risk factors, 1970-2009. Int J Gen Med. 20108;3:1-17.
5. Abdon NJ, Nilsson BE. Episodic cardiac arrhythmia and femoral neck fracture. Acta Med Scand. 1980;208:73-6.
6. Ceder L, Elmqvist D, Svensson SE. Cardiovascular and neurological function in elderly patients sustaining a fracture of the neck of the femur. J Bone Joint Surg Br. 1981;63B:560-6.
7. Kyo T, Takaoka K, Ono K. Femoral neck fracture. Factors related to ambulation and prognosis. Clin Orthop Relat Res. 1993;292:215-22.
8. Taylor IC, Stout RW. Cardiac arrhythmias and femoral neck fracture. Age Ageing. 1983;12:118-23.
9. Charlson ME, Pompei P, Ales KL, MacKenzie CR. A new method of classifying prognostic comorbidity in longitudinal studies: development and validation. J Chronic Dis. 1987;40:373-83.
10. van der Velde N, Stricker BH, Pols HA, van der Cammen TJ. Risk of falls after withdrawal of fall-risk-increasing drugs: a prospective cohort study. Br J Clin Pharmacol. 2007;63:232-7.
11. Arizona Center for Education and Research on Therapeutics website. Arizona Center for Education and Research on Therapeutics website. List of drugs with a risk of Torsades des Pointes. Available at: http://www.crediblemeds.org/everyone/composite-list-all-qtdrugs/, 2013.
12. Committee for Proprietary Medicinal Products. The European Agency for the Evaluation of Medicinal Products. The Assessment of the Potential for QT Interval Prolongation by Non-Cardiovascular Medicinal Products. [http://www.fda.gov/ohrms/dockets/ac/03/briefing/pubs/cpmp.pdf]. London, 1997.
13. Hung CY, Wu TS, Wang KY, Huang JL, Loh EW, Chen YM, et al. Falls and Atrial Fibrillation in Elderly Patients. Acta Cardiological Sinica. 2013;29:436-43.
14. Sanders NA, Ganguly JA, Jetter TL, et al. Atrial fibrillation: an independent risk factor for nonaccidental falls in older patients. Pacing Clin Electrophysiol. 2012;35:973-9.
15. Goldstein DS. Cardiac ectopy in chronic autonomic failure. Clin Auton Res. 2010;20:85-92.
16. Brignole M, Gianfranchi L, Menozzi C, et al. Role of autonomic reflexes in syncope associated with paroxysmal atrial fibrillation. Journal of the American College of Cardiology. 1993;22:1123-9.
17. The Task Force for the Diagnosis and Management of Syncope of the European Society of Cardiology (ESC). Guidelines for the diagnosis and management of syncope (version 2009). Eur Heart J. 2009;30:2631-71.
18. Kim E, Joo S, Kim J, et al. Association between C-reactive protein and QTc interval in middle-aged men and women. Eur J Epidemiol. 2006;21:653-9.
19. Carbone L, Buzkova P, Fink HA, et al. Hip fractures and heart failure: findings from the Cardiovascular Health Study. Eur Heart J. 2010;31:77-84.
20. van Diepen S, Majumdar SR, Bakal JA, McAlister FA, Ezekowitz JA. Heart failure is a risk factor for orthopedic fracture: a population-based analysis of 16,294 patients. Circulation. 2008;118:1946-52.
21. Sennerby U, Melhus H, Gedeborg R, et al. Cardiovascular diseases and risk of hip fracture. JAMA. 2009;302:1666-73.
22. Ganz DA, Higashi T, Rubenstein LZ. Monitoring falls in cohort studies of community-dwelling older people: effect of the recall interval. J Am Geriatr Soc. 2005;53:2190-4.
23. Hansson A, Madsen-Hardig B, Olsson SB. Arrhythmia-provoking factors and symptoms at the onset of paroxysmal atrial fibrillation: a study based on interviews with 100 patients seeking hospital assistance. BMC Cardiovasc Disord. 2004;4:13.
24. Grimes DA, Schulz KF. Compared to what? Finding controls for case-control studies. Lancet. 2005;365:1429-33.
25. Frewen J, Finucane C, Cronin H, et al. Factors that influence awareness and treatment of atrial fibrillation in older adults. QJM 2013 May;106(5):415-424.
26. De Bacquer D, De Backer G, Kornitzer M. Prevalences of ECG findings in large population based samples of men and women. Heart. 2000;84:625-33.
27. Rautaharju PM, Surawicz B, Gettes LS. AHA/ACCF/HRS Recommendations for the Standardization and Interpretation of the Electrocardiogram: Part IV: The ST Segment, T and U Waves, and the QT Interval: A Scientific Statement From the American Heart Association Electrocardiography and Arrhythmias Committee, Council on Clinical Cardiology; the American College of Cardiology Foundation; and the Heart Rhythm Society: Endorsed by the International Society for Computerized Electrocardiology. Circulation. 2009;119:e241-50.