The incidence of subsequent contralateral hip fracture and factors associated with increased risk

The IMPACT Contralateral Fracture Study

The incidence of subsequent contralateral hip fracture and factors associated with increased risk: The IMPACT Contralateral Fracture Study

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ABSTRACT

Introduction

Hip fractures are associated with high morbidity and mortality and patients that sustain a subsequent contralateral fracture experience inferior outcomes. The risk of contralateral fracture is highest within the first year, however the incidence and associated factors remain poorly understood. The aims were to investigate i) the incidence of a subsequent contralateral hip fracture within the first year ii) identify factors associated with an increased risk of contralateral fracture, and iii) compare early mortality risk after index versus contralateral hip fracture.

Methods

This study included all patients aged over 50 years admitted to NHS hospitals in Scotland between 1st March 2020 and 31st December 2020 (n=5566) as routine activity of the Scottish Hip Fracture Audit (SHFA). Multivariate logistic regression was used to examine factors associated with 30-day mortality and cox regression was used to identify factors associated with a contralateral fracture.

Results

During the study period 2.5% (138/5566) of patients sustained a contralateral hip fracture within 12 months of the index hip fracture. Socioeconomic deprivation was inversely associated with increased risk of contralateral fracture (odds ratio 2.64, $p<0.001$), whilst advancing age ($p=0.427$) and sex ($p=0.265$) were not. After adjusting for significant cofounders there was no significant difference in 30-day mortality following contralateral fracture compared to index fracture (OR 1.22, $p=0.433$).

Conclusion

One in 40 (2.5%) hip fracture patients sustained a contralateral fracture within 12 months of their index fracture and deprivation was associated with a reduced risk of contralateral fracture. No difference in 30-day mortality was found.

KEYWORDS

Hip fracture, contralateral fracture, recurrent fracture, second fracture, mortality, trauma, socioeconomic deprivation.

MINI ABSTRACT

Patients who sustain a contralateral hip fracture experience significanly inferior outcomes, however the incidence and predictors of contralateral hip fracture remain poorly understood. In the present study 2.5% of patients sustained a contralateral hip fracture within 12 months and socioeconomic deprivation was associated with reduced risk of contralateral hip fracture.

INTRODUCTION

Hip fracture is a significant public health concern with over 70,000 patients sustaining a primary hip fracture in the United Kingdom every year [1]. A hip fracture is associated with high mortality, extended hospital stays and frequent readmissions [2]-[4].The impact of the hip fracture in those who survive is often devastating and patients experience significant pain, reduced mobility and increased dependence on community care services [4], [5]. As population demographics become older and more multimorbid, it is crucial to understand outcomes following hip fracture in order to enhance post-fracture care.

Contralateral hip fractures, also known as second hip fractures, occur when an individual sustains a hip fracture affecting the contralateral limb after previously sustaining a fracture of the other hip. This is considered as a separate entity from a periprosthetic fracture around an implant in a previously treated hip fracture, or a recurrent fracture in a hip that has united. Patients who sustain a contralateral hip fracture have been reported to suffer inferior outcomes when compared to the primary hip fracture with additional pain, further reduction in mobility, functional decline and greater mortality [6]–[9]. The independent effect of a contralateral hip fracture on patient mortality is not clear from the literature, with studies reporting unadjusted mortality risks and not adjusting for the potential confounding factors [6], [8].

It is well-established that sustaining a first fragility fracture (of any bone) carries a significant risk of sustaining a further fragility fracture, and this is especially true in fractures of the hip [10], [11]. Following a primary hip fracture, the risk of sustaining a contralateral fracture is considered greatest within the first 12 months, but there is no reliable reported incidence for contralateral hip fractures sustained within this period or overall [12], [13]. Mitani et al demonstrated a 12.8% contralateral fracture rate over 7 years, while Nymark et al reported 8.7% contralateral fracture rate over an 11-year study period. Several studies have explored one-year incidence with reported annual incidence between 2.5-5.7% [8], [14]–[16].

Previous studies have demonstrated that the risk of contralateral fracture following an initial fragility fracture does not return to population risk until 15 years following the index fracture [6]. Relevant risk factors include those common to all fragility fractures, such as osteoporosis, cognitive impairment and falls, but also factors directly related to the primary hip fracture including insufficient rehabilitation, functional decline and reduced physiological reserve [17], [18]. The identification of predisposing clinical risk factors would be beneficial in order to allow risk stratification of individuals following a first hip fracture, and to permit targeted preventative action with the aim of preventing a subsequent hip fracture.

The primary aim of this study was to investigate the incidence of contralateral hip fracture within the first year following index hip fracture. Secondary aims were to assess whether demographic factors independently influence the risk of a contralateral hip fracture, and to compare early mortality rates following primary hip fracture with those who sustain a subsequent contralateral hip fracture.

METHODS

Data collection

The study included all patients who were admitted with a hip fracture to NHS hospitals in Scotland during a 9-month study period between 1st March 2020 and 31st December 2020 during the COIVD-19 pandemic. Data were collected as part of routine activity of the Scottish Hip Fracture Audit (SHFA), and outcome follow-up data were available for a minimum of 12 months (n=5566). The SHFA database was used to identify patients that sustained a contralateral hip fracture during the study period up to 31st December 2021. This included all patients who sustained an intracapsular or extracapsular hip fracture involving the proximal femur until the distal extent of the subtrochanteric region, defined as less than 5 cm distal to the lesser trochanter. Patients with isolated fractures of the acetabulum, pubic ramus, greater trochanter, and fractures around an existing implant were excluded. Patients who sustained a hip fracture prior to the study period were excluded from analysis, as were those who sustained an ipsilateral hip (n=1) or pathological fracture (n=1).

The data were collected and assessed for completeness by a senior analyst as part of the routine activity of the SHFA. The data were further verified by two study authors (LH, RK) to ensure accuracy. Additional data were collected regarding fracture laterality, pattern, fixation method and presence of periprosthetic fracture by reviewing radiographs available via a national electronic database (Picture Archiving Communications System, PACS). All data were handled in accordance with the UK Caldicott principles, and no patient-identifying information was shared out with the authors of the current study [19].

Outcome measures and variables

Outcome measures included 30-day mortality and time to contralateral fracture (days). Patient demographic variables were: age, sex, American Society of Anaesthesiologists (ASA) grade and Scottish Index of Multiple Deprivation decile (SIMD). Patients who sustained more than one fracture during the study period were identified and further data was collected including: fracture pattern (intracapsular, extracapsular, subtrochanteric), surgery (conservative management, total hip replacement, hemiarthroplasty, dynamic hip screw, cannulated hip screws, other) and laterality. It was also documented whether index and contralateral fractures were periprosthetic (n=1) or considered pathological based upon radiographic appearance (n=1).

Statistical analysis

IBM SPSS Statistics version 25 was used for statistical analysis (SPSS Inc., Chicago IL, USA). Data were assessed for normality and parametric tests where appropriate. Unpaired Student's t-tests were used to assess the difference in means between continuous numerical variables (normally distributed), and categorical variables were assessed using Chi-square tests. Multivariate logistic regression analysis was performed to assess

the association between contralateral fracture and 30-day mortality status, adjusting for significant demographic co-variates. Cox regression analysis was used to assess factors associated with a higher risk of contralateral fracture when adjusting for cofounding factors. Significance was set as a p-value of <0.05.

RESULTS

Study cohort characteristics

The study cohort included a total of 5566 patients who sustained a primary hip fracture between 1/3/2020 – 31/12/2020. Seventy percent of the cohort were female (3900) and 30% were male (1666), the mean age of the study cohort was 80.5yrs (range, 50-103; Table 1). The study population was relatively deprived, with almost 50% of the study population in the two most deprived quintiles. The majority of patients were ASA grade III (58%) (Table1).

Table 1.

Patient and fracture characteristics in subjects with contralateral fracture

In total 172 patients sustained a contralateral hip fracture during the study period. One hundred and thirty-eight (2.5%) sustained a contralateral hip fracture within 12 months of the first. The mean age at time of index fracture was higher in those who sustained a contralateral fracture than those who did not (81.9 vs 80.4, independent t-test, p=0.024). In those who sustained a contralateral fracture, there was no statistically significant difference in age, SIMD or ASA grade between sexes, however males experienced increased 30 day mortality (p=0.001). In those who did not sustain a contralateral fracture, males had significantly higher 30 day mortality and were younger (Table 2). Of the 172 patients who sustained a contralateral hip fracture the most common index fracture pattern was intracapsular (100/172, 58%), followed by extracapsular (57/172, 33%) then subtrochanteric (15/172, 9%).

Table 2.

Demographic predictors of contralateral fracture

Sex (p=0.265) and age (p = 0.427) were not associated with sustaining a contralateral fracture on Cox regression analysis (Table 3). Those in the least deprived quintile (fifth), had a significantly increased risk of sustaining a contralateral fracture compared to the most deprived quintile (reference category) after adjusting for age and sex (OR 2.64, 95% CI; 1.66 – 4.20, p=0.000) (Table 3). Those in the least deprived quintile were almost four years older than those in the most deprived quintile (Table 4). Kaplan-Meir analysis demonstrated the rate of contralateral fracture to be relatively consistent over the first year (Figure 1).

Table 3.

Table 4.

Figure 1.

Contralateral fracture and 30-day mortality risk

A multivariate logistic regression model adjusted for the covariates of age, sex and SIMD quintile demonstrated no significantly increased risk of mortality at 30 days according to contralateral fracture status (OR 1.22 95% CI; 0.74-2.02, p=0.433) (Table 5). Older age and male sex were both demonstrated to be significantly associated with an increased 30-day mortality risk (OR 1.05 95% CI; 1.04-1.06, p=0.000 and OR 2.23, 95% CI; 1.84 – 2.70, p<0.001, respectively), while SIMD status did not show an independent association (OR 0.85, 95% CI; 0.62 – 1.15, p=0.291) (Table 5).

Table 5.

DISCUSSION

This nationwide population-level case-control study aimed to define the incidence and factors associated with an increased risk of contralateral hip fracture, and to establish the influence of contralateral fracture on early mortality risk. A total of 5566 patients sustained an index hip fracture during the study period with 138 sustaining a contralateral hip fracture within 12 months, giving an incidence of 2.5% within the first year (a 1 in 40 risk). Patients who sustained a contralateral hip fracture were significantly older at the time of index hip fracture compared to those who did not sustain a subsequent fracture. After adjusting for baseline variables, there was no difference in 30-day mortality rates between those who did and did not sustain a contralateral fracture. Socioeconomic deprivation was associated with a reduced risk of contralateral fracture, with those in the least deprived quintile demonstrating a significantly increased risk.

The finding of a 2.5% contralateral fracture rate within one year of index fracture is consistent with a number of non-registry studies that reported an incidence between 2.5-5.7% [8], [14]–[16]. Other studies are heterogenous with varying follow-up times [6], [7], [16], [17], [20] and a direct comparison is challenging. To the knowledge of the authors there is one comparable study from Denmark which used large-scale registry data (n= 169,145) and reported a higher 12-month contralateral fracture incidence of 9% [6]. The discrepancy in the findings may be attributable to differences in inclusion criteria between the data registries, as the Danish registry included all hospital inpatient discharges. This difference may also represent advances in primary and secondary fracture prevention and the management of frailty, because Rgy et al collected data from 1977-2001. Furthermore, the SHFA is a dedicated hip fracture registry, whereas the work by Ryg et al utilized a data registry aimed to capture all hospital in-patients, regardless of diagnosis.

Current literature suggests that patients who sustain a second hip fracture have an increased early mortality risk [6], [8], [9], [21]. However, the current study conducted an adjusted analysis that controlled for confounding factors and did not demonstrate a significant difference in 30-day mortality risk between those who sustained a contralateral hip fracture and those who did not. It is likely that the small sample size of contralateral fracture patients in the present study (n=172) may account for the difference in reported findings. It was demonstrated that advancing age and male sex were associated with increased 30-day mortality in the study population, which was consistent with previous registry-based studies [22], [23].

Demographic factors associated with a higher risk of contralateral fracture have been well-documented with increasing age, female sex and living alone being associated with a greater risk [6], [8], [24]. It may be that male sex confers a protective influence against contralateral hip fracture due to increased early mortality rates, precluding these patients from sustaining a further fracture. In the present study mortality was only recorded as a dichotomous outcome at 30 days and therefore competing risk analysis was not able to be performed to investigate this further. To the knowledge of the authors there is no literature describing the influence of socioeconomic deprivation on risk of suffering a contralateral hip fracture. Socioeconomic deprivation is known to influence outcomes following hip fracture, with increasing socioeconomic deprivation associated with higher

mortality and younger age at the time of fracture [22], [23], [25].The current study shows deprivation to be associated with a reduced risk of contralateral fracture. The authors recognise that those who are more socioeconomically deprived experience increased frailty, are younger at the time of hip fracture and have increased risk of not returning home following index hip fracture [22], [23], [25], [26]. This would suggest that socioeconomic deprivation may increase risk of sustaining a contralateral hip fracture, however this does not seem to be the case. The findings of the present study are supported by Murena et al. who demonstrated that high BMI and malnourishment are associated with a lower risk of a contralateral fracture which are both traits associated with increased socioeconomic deprivation[27]. Deprived patients have a tendency to have greater multimorbidity, which may reduce their mobility and independence, increase the likelihood of being indoor home or residential care dwellers, and thus reduce their risk of activity-related falls [28].Further to this socioeconomic deprivation caries an increased risk of mortality following primary hip fracture which may contribute towards the reduced risk of sustaining a contralateral hip fracture reported in this study [22], [23].

The major strengths to the current study are the use of a large, highly-validated data sample derived from a population-level specialist hip fracture registry, and the use of regression analyses to evaluate the association whilst adjusting for confounding factors. There are limitations to the current study. The data collection period was during the COVID-19 pandemic and therefore differences in population behaviours and healthcare provision may have influenced the findings. The SHFA excludes patients who sustained a fracture surrounding a pre-existing implant (periprosthetic fractures), therefore the findings cannot be generalised to periprosthetic primary hip fractures. The use of registry data relies upon the accuracy of data collection, however SHFA data is collected by trained clinical auditors and validated by analysts at Public Health Scotland, and were then validated further by two study authors. The use of registry data precluded the inclusion of highly-granular patient-level variables related to co-morbid disease and therapeutics, though this was mitigated by the inclusion of age, SIMD and ASA grade which are markers of frailty and systemic disease.

CONCLUSION

The incidence of a subsequent contralateral fracture within 12 months following an index hip fracture was 2.5%. Those who sustained a contralateral fracture were significantly older at the time of index fracture, however when adjusting for age and socioeconomic deprivation the significance of this association was negated. Socioeconomic deprivation was independently associated with a reduced risk of sustaining a contralateral fracture. There was no difference between the risk of death within 30 days of the index hip fracture compared to after the subsequent contralateral fracture.

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319

320 Table 1. Study cohort characteristics

Case-mix variable	Total	Percentage
Age, mean (SD)	5566	80.5 (10.1)
Sex		
Male	1666	29.9%
Female	3900	70.1%
SIMD Quartile		
1 (most)	1324	23.8%
2	1424	25.6%
3	1102	19.8%
4	853	15.3%
5 (least)	848	15.2%
missing	15	0.3%
ASA grade		
I	89	1.6%
II	1200	21.6%
III	3227	58.0%
IV	804	14.4%
V	101	1.8%
VI	47	0.8%
missing	98	1.8%

321

322

323 Table 2. Contralateral fracture patient characteristics (p-values represent Chi-squared test or *independent
324 samples t-test)

Variable	Contralateral fracture (n=172)				No further fracture (n=5,394)			
	Total	Male (n=40)	Female (n=132)	*p-value*	Total	Male (n=1626)	Female (n=3768)	*p-value*
Age	81.9	80.58 (7.73)	82.24 (7.97)	0.245*	80.4	78.37 (10.78)	81.34 (9.70)	0.001*
30-day mortality	18	11 (27.5%)	7 (5.3%)	0.001	481	208 (12.8%)	273 (7.25%)	0.001
SIMD								
1 (most)	39	10 (25%)	29 (22.0%)	0.765	1285	420 (25.8%)	865 (23.0%)	0.008
2	37	9 (22.5%)	28 (21.2%)		1387	433 (26.6%)	954 (25.3%)	
3	36	7 (17.5%)	29 (22.0%)		1066	289 (17.8%)	777 (20.6%)	
4	22	7 (17.5%)	15 (11.4%)		831	260 (16.0%)	571 (15.2%)	
5 (least)	38	7 (17.5%)	31 (23.5%)		810	218 (13.4%)	592 (15.7%)	
missing	0	-	-		15	6	9	
ASA								
1	2	0 (0%)	2 (1.5%)	0.770	87	23 (1.4%)	64 (1.7%)	0.007
2	31	6 (15%)	25 (18.9%)		1169	330 (20.3%)	839 (22.3%)	
3	106	27 (67.5%)	79 (59.8%)		3121	916 (56.3%)	2205 (58.5%)	
4	29	7 (17.5%)	22 (16.7%)		775	258 (15.9%)	517 (13.7%)	
5	0	0 (0%)	0 (0%)		101	41 (2.5%)	60 (1.6%)	
6	0	0 (0%)	0 (0%)		47	20 (1.2%)	27 (0.7%)	
missing	4	0	4		94	38	56	

325

326 Table 3. Cox regression analysis for factors associated with sustaining a contralateral hip fracture within one
327 year of the index hip fracture.

328

Variable	Unadjusted HR (95% CI)	Adjusted HR (95% CI)	*p* value
Sex			
Male	reference	reference	n/a
Female	0.85 (0.58-1.18)	0.81 (0.57 – 1.17)	0.265
SIMD			
1 (most)	reference	reference	n/a
2	0.97 (0.62-1.54)	0.99 (0.63 – 1.56)	0.967
3	1.53 (0.96-2.42)	1.52 (0.96 – 2.42)	0.076
4	1.40 (0.83-2.40)	1.44 (0.85 – 2.46)	0.176
5 (least)	2.56 (1.62-4.05)	2.64 (1.66 – 4.20)	0.000
Age	0.99 (0.98-1.02)	0.99 (0.98 – 1.01)	0.427

329 Table 4. Mean age by SIMD quintile (n=5551. 15 cases with missing data) (ANOVA)

330

SIMD Quintile	Mean	n	Std. Deviation	p-value
1 (most)	78.4	1324	10.6	0.000
2	80.6	1424	9.7	
3	81.4	1102	10.1	
4	80.6	853	9.9	
5 (least)	82.2	848	9.5	

331 Table 5. Logistic regression model adjusted for SIMD, age and sex examining the influence of contralateral
332 fracture on 30-day mortality.

333

Demographic	30-day mortality		Odds ratio (95% CI)		*p* value
			Unadjusted	Adjusted	
	Died	**Alive**			
	n=499	**n=5067**			
Contralateral Fracture					
No	481 (8.9%)	4913 (91.1%)	reference	reference	n/a
Yes	18 (10.5%)	154 (89.5%)	1.19 (0.73-1.96)	1.22 (0.74 -2.02)	0.433
SIMD					
1 (most)	122 (9.2%)	1202 (90.8%)	reference	reference	n/a
2	136 (9.6%)	1288 (90.6%)	1.04 (0.81-1.35)	0.96 (0.74 – 1.25)	0.771
3	97 (8.8%)	1005 (91.2%)	0.95 (0.72-1.26)	0.86 (0.65 – 1.15)	0.316
4	69 (8.1%)	784 (91.1%)	0.87 (0.64-1.18)	0.79 (0.58 – 1.08)	0.146
5 (least)	75 (8.8%)	773 (91.2%)	0.96 (0.71-1.29)	0.85 (0.62 – 1.15)	0.291
Age (mean, SD)	83.8 (8.9)	80.2 (10.1)	1.04 (1.03-1.05)	1.05 (1.04-1.06)	0.000
Sex					
Female	280 (7.2%)	3620 (92.8%)	reference	reference	n/a
Male	219 (13.1%)	1447 (86.9%)	1.96 (1.62-2.36)	2.23 (1.84 – 2.70)	<0.001

Figure 1. Kaplan-Meir analysis of time to contralateral fracture