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Risk of second hip fracture persists for years after initial trauma

Boris Sobolev [a,b], Katie Jane Sheehan [a,b,*], Lisa Kuramoto [b], Pierre Guy [c,d]

[a] School of Population and Public Health, University of British Columbia, Vancouver, BC, Canada
[b] Centre for Clinical Epidemiology and Evaluation, Vancouver Coastal Health Research Institute, University of British Columbia, Vancouver, BC, Canada
[c] Department of Orthopedics, University of British Columbia, Vancouver, BC, Canada
[d] Centre for Hip Health and Mobility, University of British Columbia, Vancouver, BC, Canada

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ABSTRACT

Background: Secondary prevention often targets women who suffer from higher rates of second hip fracture than men, especially in the early years after first fracture. Yet, the occurrence of second hip fracture by certain times also depends on the death rate, which is higher in men than women. We compared the risk of sustaining second hip fracture by a certain time between women and men remaining alive at that time.
Methods: We retrieved 38,383 hospitalization records of patients aged 60 years or older, who were discharged alive after admission for hip fracture surgery between 1990 and 2005 in British Columbia, Canada. The outcome variable was the time to a subsequent hip fracture.
Results: During ten years of follow-up, 2,902 (8%) patients sustained a second hip fracture, and 21,428 (56%) died before sustaining a second hip fracture. The risk of second hip fracture in the surviving post-fracture patients was higher in women than in men: 2% vs 2%, 5% vs 4%, 9% vs 7%, 15% vs 13%, and 35% vs 30% at 1, 2, 3, 5, and 10 years after initial trauma, respectively, crude OR = 1.25 (95% CI: 1.13–1.39). However, the risk did not differ between women and men after adjustment, OR = 1.09 (95% CI: 0.98–1.21).
Conclusions: The risk of second hip fracture persists for at least ten years among hip fracture survivors, and therefore secondary prevention should continue beyond an early post-fracture period. Women and men have similar risks of second hip fracture and both should be considered for secondary prevention.

Introduction

Functional decline, loss of independence, and related morbidity render hip fracture one of the most detrimental events in the life of older adults [1]. If not addressed, underlying risk factors may cause future fractures [2]. In fact, 5% to 10% of all hip fractures are second fractures and these account for up to 15% of hip fracture surgeries [3,4]. Despite the evident benefit for public health, secondary prevention is limited [5–7]. Less than one-fifth of hip fracture patients undergo screening for osteoporosis [8]. Prescriptions of falls prevention [9], exercise [10], or hip protectors are even less frequent [11].

Secondary prevention often targets groups and periods with higher rates of second hip fracture [12,16–18]. Yet, focusing solely on the fracture rate overlooks other forces influencing when and if fracture occurs. Indeed, the occurrence of another fracture by a certain time also depends on the death rate as patients remain at risk of fracture only until they die. More than a decade ago, George and Patel proposed to link secondary prevention strategies to the occurrence of second hip fracture in survivors of first fractures [13]. This approach links prevention to the risk of sustaining another hip fracture by a certain time after initial injury in patients remaining alive at that time. Currently, no estimates of this risk are available.

Instead, some researchers estimated the cumulative incidence of second hip fracture [14–17]. The distinction between the two measures matters as the cumulative incidence gives the fracture risk in the entire post-fracture population, not among survivors. For example, several studies have reported that the cumulative incidence of second hip fracture for women exceeded that for men [14,16,17]. This difference, however, could reflect a faster reduction of men at risk due to a higher death rate rather than a true difference in the risk of second hip fracture between surviving women and men.

Here, we estimate the risk of second hip fracture for the surviving post-fracture population at various times after initial injury and compare this risk between women and men. The University of British Columbia Ethics board approved this study.

Materials and methods

Data sources

We identified index and subsequent hip fractures using hospitalization records of the Discharge Abstract Database maintained by the

* Corresponding author at: School of Population and Public Health, University of British Columbia, Vancouver, BC, Canada.
E-mail address: sheehakj@mail.ubc.ca (K.J. Sheehan).

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Canadian Institute of Health Information [18]. The database contains data received directly from acute care facilities or their respective health authorities. All facilities in British Columbia report on all hospital discharges including patients' age and sex, date and type of admission, date and type of discharge (e.g., in-hospital death), and diagnostic and procedure codes. Diagnoses are coded according to the *International Classification of Diseases Ninth Revision, Clinical Modification* (ICD-9-CM) [19], procedures are coded according to the Canadian Classification of Diagnostic, Therapeutic, and Surgical Procedures [20]. The Canadian Institute of Health Information removed all patient identifying information from the dataset prior to its release to us.

Admissions for hip fracture surgery were identified by ICD-9-CM code 820 for most responsible diagnosis, primary diagnosis, or post-admit comorbidity diagnosis. For patients with multiple admissions, the first admission was regarded as the index admission. Readmissions defined as admissions for hip fracture within 90 days after discharge following the index admission were likely due to medical postoperative complications and were not included in the analysis [21]. Readmissions defined as admissions for hip fracture beyond 90 days were likely due to revision surgery or for a subsequent hip fracture [21]. Readmissions for revision surgery are identified by ICD-9-CM diagnostic codes, e.g. non-union of bone (733.8X) or mechanical failure of fixation (9964, 9965), these readmissions were not included in the analysis. Subsequent hip fractures were defined as readmissions for a hip fracture surgery after 90 days following the index admission. Deaths were identified from the British Columbia Vital Statistics File. The University of British Columbia Ethics board approved this study.

Patients

We retrieved 38,383 records of patients aged 60 years or older, who were discharged alive after the index admission for surgical treatment of a non-pathological hip fracture from April 1, 1990 to March 31, 2005 in British Columbia, Canada, and had no history of hospitalization for hip fracture before April 1, 1990 (Table 1). Women made up 74% (28,240) of the patients, were older ($p < 0.001$) and were more likely to sustain transcervical fracture than men (54% vs 52%, $p = 0.004$). Women spent more time in the hospital for index hip fracture than men ($p < 0.001$). There was no difference in the distribution of women and men over fiscal years ($p = 0.33$).

Outcome

The occurrence of a second hip fracture was the study endpoint. The outcome variable was the time to a second hip fracture calculated in years between the date of discharge following the index admission and the date of hospital admission for subsequent hip fracture, the date of death, 10 years of follow-up, or March 31, 2005, whichever was earliest.

Statistical analysis

We estimated the annual rates for second hip fracture and for death dividing the number of events by the total patient-years at risk for each year of the follow-up. We tested for differences in the rates between women and men using a Poisson regression model. By fitting this model, we obtained a series of rate ratios (RR) comparing the event rates between women and men for every year of the follow-up. We estimated the cumulative incidence functions for second hip fracture and for death using non-parametric methods [22]. Observations without death or fracture at the end of the follow-up were treated as censored. Gray's two-sample test was used to compare the cumulative incidence functions between women and men [23].

We estimated the conditional probability function for second hip fracture using the ratio of the cumulative incidence of second hip fracture over the complement of the cumulative incidence of death by follow-up year [22]. From a clinical perspective, the conditional probability function gives the percentage of patients with a second hip fracture among those who were alive by a certain time. We tested for differences in the conditional probability function of second hip fracture between women and men using Pepe's two-sample test [22] and a proportional odds model [24]. By fitting this model, we obtained a series of odds ratios (OR) comparing the risk of another fracture between surviving women and men for every follow-up year and the weighted average of these ORs. We tested whether the serial ORs are equal using a time-dependence test [24].

Adjusted RRs and ORs were obtained from multivariable regression analyses, which included the baseline characteristics from Table 1, namely, age group, fracture subtype, fiscal year of discharge, and hospital length of stay, each collapsed into two categories for ease of results presentation. The competing risk analysis was performed using R cmprsk and Cprob packages [24].

Table 1
Baseline characteristics of patients, according to sex.

Characteristic	Sex; no. (%) of patients					
	All patients ($n = 38,383$)*		Women ($n = 28,240$)		Men ($n = 9,637$)	
Age group (years)†						
60–69	3,937	(10.3)	2,413	(8.5)	1,515	(15.7)
70–79	11,440	(29.8)	8,159	(28.9)	3,207	(33.3)
80–89	17,373	(45.3)	13,233	(46.9)	3,890	(40.4)
90+	5,633	(14.7)	4,435	(15.7)	1,025	(10.6)
Fracture subtype‡						
Pertrochanteric	17,771	(46.3)	12,946	(45.8)	4,580	(47.5)
Transcervical	20,530	(53.5)	15,240	(54.0)	5,030	(52.2)
Unknown	82	(0.2)	54	(0.2)	27	(0.3)
Fiscal year of discharge§						
1990–91	2,181	(5.7)	1,574	(5.6)	530	(5.5)
1991–92	2,250	(5.9)	1,663	(5.9)	511	(5.3)
1992–93	2,377	(6.2)	1,748	(6.2)	576	(6.0)
1993–94	2,454	(6.4)	1,810	(6.4)	592	(6.1)
1994–95	2,481	(6.5)	1,841	(6.5)	600	(6.2)
1995–96	2,453	(6.4)	1,815	(6.4)	603	(6.3)
1996–97	2,582	(6.7)	1,889	(6.7)	667	(6.9)
1997–98	2,514	(6.5)	1,880	(6.7)	613	(6.4)
1998–99	2,673	(7.0)	1,955	(6.9)	694	(7.2)
1999–00	2,617	(6.8)	1,931	(6.8)	667	(6.9)
2000–01	2,617	(6.8)	1,916	(6.8)	683	(7.1)
2001–02	2,791	(7.3)	2,069	(7.3)	706	(7.3)
2002–03	2,714	(7.1)	1,977	(7.0)	721	(7.5)
2003–04	2,889	(7.5)	2,102	(7.4)	772	(8.0)
2004–05	2,790	(7.3)	2,070	(7.3)	702	(7.3)
Hospital length of stay¶						
<1 week	7,442	(19.4)	5,164	(18.3)	2,174	(22.6)
1 to 2 weeks	12,181	(31.7)	9,069	(32.1)	2,986	(31.0)
>2 weeks	18,760	(48.9)	14,007	(49.6)	4,477	(46.5)

* A total of 506 patients with unknown sex.
† Distribution of age group differed by sex (chi-square test statistic = 597.9, $df = 3$, $p < 0.001$).
‡ Distribution of fracture subtype differed by sex (chi-square test statistic = 11.3, $df = 2$, $p = 0.004$).
§ Distribution of year did not differ by sex (chi-square test statistic = 15.8, $df = 14$, $p = 0.33$).
¶ Distribution of hospital length of stay differed by sex (chi-square test statistic = 85.1, $df = 2$, $p < 0.001$).

Results

A total of 2,902 (8%) patients sustained second hip fracture over 147,140 patient-years of follow-up. The fracture rate was 21 (95% CI: 20–22) per 1,000 patient-years in women (2,337/111,746), and 16 (95% CI: 15–17) per 1,000 patients-years in men (537/33,372). After adjustment, the fracture rate was higher in women than in men for the first 3 years after index hip fracture: RR = 1.29 (95% CI: 1.07–1.55), 1.23 (95% CI: 1.00–1.50), and 1.28 (95% CI: 1.01–1.63), respectively (Fig. 1). The cumulative incidence of second hip fractures was higher in