Increased mortality after lower extremity fractures in patients < 65 years of age

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Background and purpose — The association between mortality and lower extremity fractures (other than hip fractures in older individuals) is unclear. We therefore investigated mortality in adults of all ages after lower extremity fractures that required inpatient care.

Patients and methods — Diagnosis code (ICD10), procedure code (NOMESCO), and 7 additional characteristics of patients admitted to the trauma ward at Central Finland Hospital were collected between 2002 and 2008 (n = 3,567). Patients were followed up until the end of 2012. Mortality rates were calculated for patients with all types of lower extremity fractures using data from the population at risk.

Results — During the study, 2,081 women and 1,486 men sustained a lower extremity fracture. By the end of follow-up (mean duration 5 years), 42% of the women and 32% of the men had died. For all lower extremity fractures, the standardized mortality ratio (SMR) was 1.9 (95% CI: 1.8–2.0) for women and 2.6 (CI: 2.4–2.9) for men. In patients aged ≥ 65 years, mortality was increased and of similar magnitude after fractures of the hip, femoral diaphysis, and knee (distal femur, patella, and proximal tibia). In patients aged < 65 years, mortality was increased after fractures at all sites. The SMR after fractures at different sites ranged between 2.1 (CI: 1.4–3.2) (ankle) and 6.7 (CI: 5.0–9.0) (hip) in patients aged < 65 years and between 0.6 (CI: 0.30–1.1) (leg) and 2.2 (CI: 2.0–2.3) (hip) in patients aged ≥ 65 years.

Interpretation — The post-fracture SMR of patients aged < 65 years was at least double that of older patients. Furthermore, the higher mortality observed after proximal fractures of the lower extremity was greater in younger patients. The reasons behind these findings remain unclear.

Hip fracture in the elderly is the most common fracture requiring hospitalization (Somersalo et al. 2014). These fractures are frequently related to low bone mineral density and are caused by low-energy trauma. Hip fractures are associated with increased mortality and high economic cost (Cummings and Melton 2002, Haentjens et al. 2010). Most of the research on associations between fracture and mortality has concentrated on post-hip-fracture mortality in elderly patients.

Although there is a substantial incidence of lower extremity fractures other than hip fractures, the current literature on mortality after these fractures is limited and inconclusive (Barrett et al. 2003, Deakin et al. 2007, Melton et al. 2013). We therefore determined the mortality (compared to the general population) after all lower extremity fractures in a cohort of 3,567 adults who were hospitalized for treatment of such fractures over an 9-year period.

Patients and methods

All patients older than 15 years of age who were seen at the trauma ward of Central Finland Hospital (CFH), Jyväskylä, between 2002 and 2008 were included in the study. CFH is a public hospital that offers trauma treatment to a population of 250,000 (approximately 5% of the population of Finland). Fracture patients living in the catchment area of the hospital district who are in need of surgical treatment are referred to CFH. Fracture patients are hospitalized due to a planned surgical procedure, the severity of the fracture, or the characteristics of the patient (e.g. general condition or comorbidities). In 82% of the admissions during the study period, the fracture was treated operatively.

Table 1. Distribution and SMRs of women and men treated for any lower extremity fracture

Fracture site	< 65 years at time of fracture				≥ 65 years at time of fracture				p-value [a]
	n (men/women)	Person-years	Death	SMR (95% CI)	n (women/men)	Person-years	Death	SMR (95% CI)	
Hip	160 (99/61)	875	44	6.7 (5.0–9.0)	1,435 (404/1,031)	4,941	999	2.2 (2.0–2.1)	< 0.001
Femur [b]	51 (36/15)	313	9	7.1 (3.7–14)	84 (16/68)	291	59	2.1 (1.7–2.8)	< 0.001
Knee	191 (110/81)	1,221	19	3.3 (2.1–5.2)	138 (32/106)	670	64	1.6 (1.3–2.06)	0.006
Leg	361 (238/123)	2,387	22	2.1 (1.4–3.2)	57 (24/33)	335	10	0.56 (0.30–1.1)	< 0.001
Ankle	876 (465/411)	5,641	67	2.6 (2.0–3.3)	214 (62/152)	1,239	60	1.2 (0.94–1.6)	< 0.001

[a] p-value between age groups.
[b] Diaphysis.
SMR: standardized mortality ratio.

The social security number, municipality, diagnosis (ICD10 code), surgical procedure code (NOMESCO), code of external cause of injury (ICD10), side of injury, and time of arrival at the emergency department and ward were recorded in a register that included every patient who attended the trauma ward. Weber's classification of ankle fractures and the Gustilo classification of open fractures were used (Gustilo and Anderson 1976, Malek et al. 2006). Complications during treatment were recorded.

If a patient had sustained more than 1 lower extremity fracture during the study period, the first one was regarded as the index fracture. Patients who presented with multiple fractures were not included in the study. For the purpose of the study, different locations of fractures were pooled into 5 groups of fractures (ICD 10 codes); i.e. hip (S72.0–S72.2), femoral diaphysis (S72.3), knee (distal femur, patella, and proximal tibia) (S72.4, S82.0, S82.1), leg (S82.2–S82.4), and ankle (S82.5, S82.6, S82.8). The mortality status of patients by the end of 2012 was obtained from Statistics Finland. An age limit of 65 years was used to compare the mortality associated with a lower extremity fracture between patients of working age (younger than 65 years) and patients older than this. Primary causes of death were obtained from Statistics Finland.

Statistics

The ratio between observed and expected numbers—standardized mortality ratio (SMR)—was calculated using subject-year methods with 95% confidence intervals (CIs), assuming a Poisson distribution. The expected number of deaths was calculated on the basis of sex-, age-, and calendar-period-specific mortality rates in the Finnish population (Official Statistics of Finland). The expected number was determined by multiplying the number of person-years of observation by the appropriate mortality rate in the general population according to the categories sex, 1-year age group, and calendar period. Statistical comparison between SMRs was done with Poisson regression models. The Poisson regression was tested using goodness-of-fit test of the model and the assumption of overdispersion in the Poisson model was tested using the Lagrange multiplier test. Time-to-event analysis was based on the prod-

uct limit estimate (Kaplan-Meier) of the cumulative function. Cox proportional hazards model was used to estimate age- and sex-adjusted risk of mortality between the groups. The proportional hazards assumption was tested graphically and by using a statistical test based on the distribution of Schoenfeld residuals. All analyses were performed using STATA 14.0 software.

Results

Over the duration of the study, 2,081 women and 1,486 men sustained a lower extremity fracture. The mean age of patients at the time of fracture was 64 (SD 21) years—70 (SD 18) years for women and 55 (SD 21) years for men. The mean duration of follow-up was 5 (0–10) years. With the exception of patients who had ankle fractures, the majority of patients treated for lower extremity fractures were over 65 years of age (Table 1). 877 women and 476 men died during the study period. For patients over 65 years of age, the steepest increase in mortality was seen during the first 6 months after the fracture occurred. For younger patients, the mortality rate was constant (Figure 1).

The crude hazard ratio (HR) for death (men vs. women) was 0.71 (CI: 0.64–0.80). After adjusting for age, the HR was 1.75 (CI: 1.55–1.96). The SMR for all lower extremity fractures was 1.89 (CI: 1.76–2.02) for women and 2.61 (CI: 2.38–2.85) for men. Except for fractures of the leg in men and women and fractures of the ankle in women, all fractures were associated with increased mortality (Figure 2). However, when the post-fracture mortalities of patients younger and older than 65 years of age were analyzed separately, all types of fractures were associated with increased mortality in the younger age group. In patients older than 65 years of age, mortality was increased only after fractures of the hip, femoral diaphysis, and knee (Table 2). For all fracture sites, the SMR in patients younger than 65 years of age was at least double that in patients older than 65 years of age. The 3 most common causes of death in patients younger than 65 years of age were external (deaths due to injuries, poisoning, and other consequences of an external cause) (30%), diseases of the circulatory system (21%),
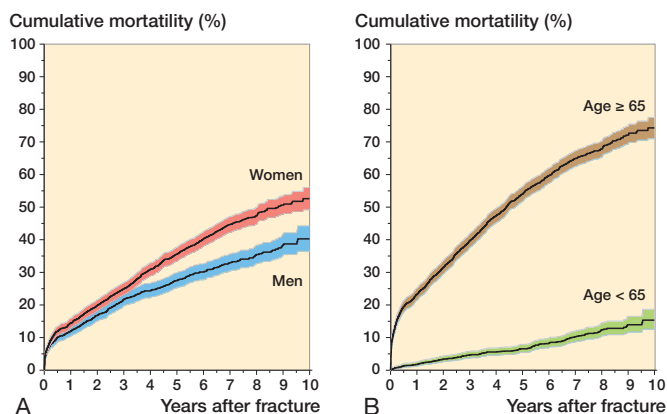
Figure 1. Cumulative mortality of 2,081 women and 1,486 men (A) and of patients younger than (n = 1,639) and older than (n = 1,928) 65 years of age (B) who were treated for a lower extremity fracture.
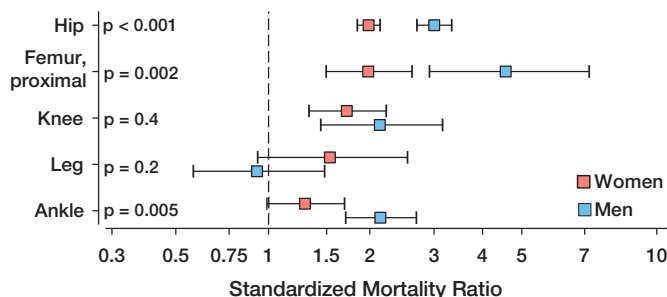

Figure 2. Standardized mortality ratios (SMRs) for different types of lower extremity fractures.

and neoplasms (14%). In patients who were 65 years of age or older, the 3 most common causes of death were diseases of the circulatory system (44%), external causes (12%), and neurological diseases (12%) (Table 2)

Discussion

In accordance with the previous literature, we observed increased mortality after hip fractures in patients over 65 years of age (Center et al. 1999, Bliuc et al. 2009, Melton et al. 2013). In this age group, mortality was also increased after fractures of the femoral diaphysis and knee. Mortality after both of these types of fractures was of a magnitude similar to that of mortality after hip fracture. However, in patients less than 65 years of age, we observed increased mortality after all types of lower extremity fractures. Furthermore, the SMR in these younger patients was at least double that in the older patients.

We found that fractures of the proximal lower extremity were associated with increased mortality in both younger and older patients. This phenomenon was pronounced in patients less than 65 years of age. Elderly people usually sustain hip fractures from low-energy trauma and frequently have reduced bone mineral density (Cummings and Melton 2002, Cheng et al. 2009, Kanis et al. 2013). Traditionally, it has been argued that older people who have proximal fractures are frail and suffer from comorbidities (Cummings and Melton 2002, Melton et al. 2013). Conversely, those who sustain fractures of the distal lower extremity may be healthier and more active than their peers who have more proximal fractures.

In younger patients, hip fractures are more frequently sustained from high-energy or sports-related trauma (Cheng et al. 2009, Al-Ani et al. 2013). Al-Ani et al. (2013) found that the majority of these patients had at least one risk factor for fracture and also low mineral density, although they patients were generally reasonably healthy. We therefore hypothesize that the higher mortality observed in patients less than 65 years of age with proximal fractures might be due different factors, such as a risky lifestyle and substance abuse (Levy et al. 1996).

Table 2. The primary causes of death of 877 women and 476 men with lower extremity fractures

Age, years	Women (n = 877)			Men (n = 476)		
	< 65	≥ 65	Total (%)	< 65	≥ 65	Total (%)
Certain infectious and parasitic diseases	0	5	5 (0.6)	1	3	4 (0.8)
Neoplasms	9	80	89 (10)	14	44	58 (12)
Endocrine, nutritional, and metabolic diseases	1	5	6 (0.7)	5	0	5 (1.1)
Mental and behavioral disorders	3	71	74 (8.4)	3	18	21 (4.4)
Diseases of the nervous system	5	108	113 (13)	3	39	42 (8.8)
Diseases of the circulatory system	7	383	390 (45)	26	146	172 (36)
Diseases of the respiratory system	3	36	39 (4.4)	2	36	38 (8.0)
Diseases of the digestive system	4	25	29 (3.3)	15	8	23 (4.8)
Diseases of the skin and subcutaneous tissue	0	1	1 (0.1)	1	0	1 (0.2)
Diseases of the musculoskeletal system and connective tissue	0	3	3 (0.3)	0	6	5 (1.1)
Diseases of the genito-urinary system	0	14	14 (1.6)	1	3	4 (0.8)
Congenital malformations, deformations, and chromosomal abnormalities	1	1	2 (0.2)	0	0	0 (0)
Symptoms, signs, and abnormal clinical and laboratory findings not classified elsewhere	0	1	1 (0.1)	3	1	4 (0.8)
External causes of morbidity and mortality	11	91	102 (12)	38	57	95 (20)
Unknown	1	8	9 (1.0)	4	0	4 (0.8)

In patients over 65 years of age, fractures of the hip, femoral diaphysis, and knee were associated with approximately double the mortality of the general population. For hip fractures, our SMRs of 2.0 (CI: 1.8–2.1) for women and 3.0 (CI: 2.7–3.3) for men are similar to results from Australia (Center et al. 1999, Bliuc et al. 2009). However, Melton et al. (2013) reported a slightly lower SMR for women in the USA. Except for hip fractures, comparison of the results regarding mortality after other types of lower extremity fractures is difficult due to differences in study populations, ways of expressing mortality, and categorization of fracture sites (Center et al. 1999, Rantanen et al. 2002, Barrett et al. 2003, Deakin et al. 2007, Bliuc et al. 2009, Melton et al. 2014). In the same register from which we obtained our data, mortality after lower extremity fractures was found to be higher than that after upper extremity fractures in both women and men (Somersalo et al. 2015).

A weakness of the present study is that the register data did not include further information on patient characteristics, such as comorbidities, alcohol use, and education. We are therefore unable to elaborate on the reasons for increased post-fracture mortality.

A strength of our study is that we included adults of all ages. In Finland, all deaths and causes of death are recorded by Statistics Finland. Thus, we had access to accurate data on the mortality of fracture patients and also of the general population. This allowed us to calculate SMRs, which are a measure of mortality in a cohort in relation to the mortality in the general population. SMRs enable accurate comparisons of mortality among different populations. Because of our population-based material, we believe that our results can be generalized to similar patients in other developed countries.

In conclusion, we found that hip fractures in people aged 65 and over were associated with double the mortality. Notably, fractures of the femoral diaphysis and knee were associated with significantly increased mortality in this age group. In people less than 65 years of age, we found that all types of lower extremity fractures were associated with increased mortality; SMRs were at least twice as high for younger fracture patients than for those over 65 years of age. The reasons behind these findings remain unclear and merit further investigation.

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