Age-specific incidence of first and second fractures of the hip

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We determined the age-specific incidence of a second fracture of the hip and compared it with that of a primary fracture in a study population drawn from 6331 patients admitted to Nottingham University Hospital with a primary fracture of the hip over a period of 8.5 years. The incidence of a second fracture was determined using survival analysis. The mean age-specific incidence rates of primary hip fracture were calculated using census data.

The overall incidence of a second fracture was 2.7% at one year and 7.8% at 8.5 years. That of a primary fracture was 50 per 100 000 in women aged 55 to 64 years rising to 3760 in those aged 84 years and over. The incidence of a second fracture in women aged 55 to 64 years was 2344 per 100 000. Patients of this age had a relative risk of 45 (95% confidence interval 13 to 155) for further fracture when compared with the population at risk of a first fracture. The incidence of a second fracture in women aged > 84 years was 2451 per 100 000 (relative risk 0.7, 95% confidence interval 0.5 to 0.9). A similar trend was seen in men.

Patients sustaining a primary fracture of the hip between the ages of 55 and 64 years have a much greater risk of further fracture than the normal population, whereas those over 84 years have a similar risk. These findings have important implications for the provision of fracture prevention services in primary and secondary care.

A fracture of the hip is often the initial presentation of osteoporosis with affected patients at risk of subsequent osteoporotic fractures at sites such as the wrist, vertebra and the contralateral hip.¹⁻³ Numerous studies have investigated the incidence and lifetime risk of primary fracture of the hip.⁴⁻⁷ Several others have addressed the incidence of a second fracture. Many have been retrospective in nature⁸⁻¹³ and have failed to take account of the mortality after a fracture of the hip. There are a few prospective studies¹⁴⁻¹⁸ concerning the incidence of a second fracture, but these have not identified the base population in which such fractures occur. To date no study has been able to calculate the age-specific relative risk for a first and second fracture of the hip within the general population.

Identification of those at higher risk of secondary fracture may allow more strategic provision for prevention to be implemented. Our aim was to determine the age-specific incidence of a second fracture and to compare it with the incidence of a primary fracture within the general population.

Patients and Methods

A prospective study of all patients admitted to the Nottingham University Hospital, with a

fracture of the hip was undertaken over a period of 8.5 years between May 1999 and November 2007. Data were collected by independent research assistants (CTB, RW) and included the clinical details and the type of fracture sustained. Accurate mortality data were obtained from the Office for National Statistics.¹⁹

Nottingham has a single Accident and Emergency Department and all patients from the two local primary care trusts serving the Nottingham area were included in the analysis of population data. Patients who were treated at Nottingham University Hospital but lived outside the catchment area of the Trust (as defined by postal address) were excluded from the analysis to ensure as far as possible that the study population and census data were comparable.

A total of 6331 patients were admitted during the period of study. Of these, 171 aged under 50 years were excluded since most fractures in this group were a result of high-energy trauma. A further 93 with periprosthetic fractures, four with failure of an implant and 13 with bilateral simultaneous fractures were also excluded, as were 617 whose general practitioner's practice was outside the area of the Nottingham primary care trusts. In addition,

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Table I. Details of control and second hip fracture groups

	Second hip fracture	Control
Number of patients	280	4746
Mean age at first hip fracture in years (range)	81 (55 to 100)	81 (50 to 107)
Gender (%)		
Men	45 (16)	1154 (24)
Women	235 (84)	3592 (76)

127 were excluded because they had a previous contralateral fracture of the hip prior to April 1999. The remaining 5306 patients formed the study group, with 280 from this group sustaining a second hip fracture within the period of study. The remaining 4746 patients had sustained only one fracture during this period.

Statistical analysis. Kaplan-Meier²⁰ curves with the 95% confidence intervals (CI), were used to determine the incidence of a second fracture of the hip for all 5306 patients. Patients were censored at the end of the follow-up period or death. Microsoft Excel (Microsoft, Redmond, Washington) and SPSS version 14.0 (SPSS Inc., Chicago, Illinois) were used for the analysis with guidance from a statistician (SA).

Calculation of age-specific incidence rates of a first and second hip fracture. Population data for Nottingham from the census in year 2001²¹ was used for the analysis and matched to the districts covered by the two primary care trusts in Nottingham. Details from the 2001 census²¹ suggested that the elderly population in Nottingham did not change because of migration. The incidence of a first fracture of the hip was calculated from a single-year period (May 1999 to May 2000) and the incidence per 100 000 people per year by gender and age group. These were used as the control group.

Patients who were admitted in the following 7.5 years (May 2000 to November 2007) with a primary fracture formed a second series to ensure independence of data. These patients were followed for one year and the incidence of a second fracture within one year of the first was calculated per 100 000 people, stratified by age and gender. This allowed the formulation of an age-specific relative risk between the first and second fractures.

Results

The mean age of the patients was 81 years (50 to 107) and 4062 (77%) (235 sustained two fractures) were women (Table I). The mortality after fracture was 542 (10%) at 30 days, 1063 (20%) at 90 days and 1649 (31%) at one year.

The mean age of the 280 patients who sustained a second fracture of the hip within the study period was 81 years (55 to 100) at the time of the first fracture and 235 (84%) were women. The mean interval between fractures was 603 days (3 to 2773). A similar pattern of fracture occurred in both hips in 200 (71%) of these patients. Both fractures were intracapsular in 116 (41%) and extracapsular in 84 (30%).

Fig. 1

Graph showing the incidence of a second fracture of the hip in surviving patients with 95% confidence intervals (CI).

The mortality after the second fracture was 30 (11%) at 30 days and 95 (34%) at one year.

Survival analysis (Fig. 1) showed that the incidence of a second hip fracture was 0.9% (95% CI 0.6 to 1.2) at 90 days, 2.7% at one year (95% CI 2.3 to 3.2) and 7.8% at 8.5 years (95% CI 6.8 to 8.9). The overall annual incidence was 0.9% per year in surviving patients. A second fracture appeared to be more common in the first 12 months after the first and 131 (47%) second fractures occurred within this period. The age- and gender-specific incidence of primary fracture of the hip in the population of Nottingham is shown in Table II. The incidence of first fracture increases with age from 50 to 3760 per 100 000 population in women between the ages of 55 and 85 years, which equates to a 75-fold increase. In men, the incidence of primary hip fracture increased 43-fold between the same age groups. The calculated age- and gender-specific rates of incidence of a second hip fracture are shown in Table III, together with the risk ratio of a second *versus* a first fracture. Unlike that of the first fracture, the incidence of a second fracture did not increase with age. Female patients over the age of 85 had the same or slightly lower risk (0.7, 95% CI 0.5 to 0.9).

Table II. Numbers per year and age- and gender-specific rates of incidence per 100 000 population of fractures of the hip in Nottingham

	Age (yrs)			
	55 to 64	65 to 74	75 to 84	85+
Women				
Number per year	15	63	192	192
Population	29 729	25 780	19 301	5107
Incidence (%)	0.05	0.24	0.99	3.76
Rate per 100 000	50	244	995	3760
Men				
Number per year	12	32	37	39
Population	28 903	22 892	13 329	2161
Incidence (%)	0.04	0.14	0.28	1.80
Rate per 100 000	42	140	278	1805

Table III. Calculated age and rates of gender-specific incidence per 100 000 and the relative risk of a second fracture

	Age (yrs)			
	55 to 64	65 to 74	75 to 84	85+
Women				
First fracture rate per 100 000	50	244	995	3760
Second fracture rate per 100 000	2290	2427	3389	2451
Calculated risk ratio (95% CI*)	45.3 (13 to 154.7)	9.9 (5.1 to 19.2)	3.4 (2.5 to 4.7)	0.7 (0.5 to 0.9)
Men				
First fracture rate per 100 000	42	140	278	1805
Second fracture rate per 100 000	1099	1081	2466	1813
Calculated risk ratio (95% CI)	26.5 (3.5 to 201.5)	7.8 (1.9 to 32.0)	8.9 (4.6 to 17.3)	1.0 (0.4 to 2.4)

* 95% CI, 95% confidence interval

of a further fracture when compared with the risk of a first fracture of the hip in the population of the same age. By contrast, female patients aged 55 < 64 years with a fracture had a 45 times increased risk of sustaining another fracture. A similar trend was observed in men.

Discussion

Previous studies examining second fractures of the hip have mainly been retrospective^{8-10,12,13} and such reports are dependent on adequate hospital records, take no account of the variable length of follow-up and fail to account for mortality after the first fracture. Therefore the true incidence of a second fracture cannot be accurately calculated. In our study, complete data on mortality was available, which showed precise determination of the incidence of a second fracture. Furthermore, the age-specific incidence of a second fracture was determined and compared with that of a primary fracture of the hip within the general population.

There have been prospective studies investigating the rates of a second fracture. Chapurlat et al¹⁴ studied a group of 632 women and calculated the risk of a second fracture to be 2.3% per year. Chiu et al¹⁵ followed 1514 patients admitted over five years and found that 2.3% suffered a fracture of the contralateral hip. Another prospective study

of 501 primary hip fractures found the incidence of a second fracture to be 5% at one year and just over 8% at two years.²²

Nymark et al²³ set out to determine the interval between first and the second fracture in a study of 9990 fractures over ten years. An incidence of a second fracture of 8.7% was found. The risk of sustaining a second fracture was highest during the first 12 months after the first fracture, decreasing to a level equal to or below the incidence of the first fracture after this period of 12 months. Accordingly, the authors suggested that preventive strategies at the time of the first fracture should be implemented immediately. We also found that nearly half of the second fractures occurred within 12 months of the initial fracture.

In the population of Nottingham, the risk of sustaining a fracture of the hip increases between the ages of 55 and 85 years. Female patients who suffer a fracture between the ages of 55 and 64 years have 45 times the relative risk of sustaining a further fracture when compared with the normal population of this age. This is clearly an important subgroup of the population and all such patients should be referred for investigation and/or treatment for osteoporosis and the prevention of falls. By contrast, female patients over 84 years have a similar risk of a second fracture to that of the normal population. These findings are

broadly parallel for men, although they have a lower relative risk of a second fracture between the age of 55 and 64 years. This significant difference in the age-specific incidence of a second fracture has not been observed before and has important implications for public-health measures. Current programmes for prevention of fractures are based on secondary care^{24,25} and the use of the guidelines of the National Institute for Clinical Excellence,²⁶ which depend on the identification of fragility fractures as an indicator of potential osteoporosis and a risk factor for further fracture. However, in the very elderly, such programmes may need to be incorporated into primary care and address the entire population since the risk of a fracture appears to be similar, whether or not they have sustained a previous fracture. In our unit, the mean age for a primary fracture of the hip is now 81 years (17 to 105) and 60% of such patients are aged over 80 years. In the United Kingdom in 2003 there were more than one million people aged 85 years or older, representing 5.5% of the population aged over 50 years, and this number is steadily rising.²⁷ Thus, the incorporation of programmes for prevention of fracture of the hip into primary care would be a major challenge for public-health.

We believe that this is the first prospective, observational study of a second hip fracture with accurate mortality data on all patients. Nevertheless, the limitations of our study must be recognised. Although we have a fairly stable study population, not all patients sustaining a second hip fracture will have been re-admitted to our institution; a small number might have moved away after the first fracture. This potential loss to follow-up meant that our estimate for the incidence of a second hip fracture was a best-case scenario and the lower 95% CI represented the lowest likely incidence in our population. However, it is highly improbable that this limitation in the design of our study could explain the 45-fold increase in the relative risk of a second fracture of the hip occurring in women aged between 55 and 64 years compared with those aged 85 years and over.

The risk of a second fracture of the hip is 0.9% per year and patients appear to be at increased risk for the first 12 months after the initial fracture. The major difference in the age-specific incidence of a second fracture has not been observed before and has important implications for public-health measures and programmes for prevention of fracture.

Supplementary material

A further opinion by Mr M. Lovell is available with the electronic version of this article on our website at www.jbjs.org.uk

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