TRAJMA

Epidemiology and outcome of fracture of the hip in women aged 65 years and under

A COHORT STUDY

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We examined prospectively collected data from 6782 consecutive hip fractures and identified 327 fractures in 315 women aged ≤ 65 years. We report on their demographic characteristics, treatment and outcome and compare them with a cohort of 4810 hip fractures in 4542 women aged > 65 years.

The first significant increase in age-related incidence of hip fracture was at 45, rather than 50, which is when screening by the osteoporosis service starts in most health areas. Hip fractures in younger women are sustained by a population at risk as a result of underlying disease. Mortality of younger women with hip fracture was 46 times the background mortality of the female population. Smoking had a strong influence on the relative risk of ‘early’ (≤ 65 years of age) fracture.

Lag screw fixation was the most common method of operative treatment. General complication rates were low, as were re-operation rates for cemented prostheses. Kaplan-Meier implant survivorship of displaced intracapsular fractures treated by reduction and lag screw fixation was 71% (95% confidence interval 56 to 81) at five years. The best form of treatment remains controversial.

A fracture of the hip comes at great cost to the individual, the health service and the general population.1,2 Patients report a decreased quality of life, significant restriction in mobility and increased dependence on family, carers and social services.3

Most studies of hip fracture concentrate on the elderly population.4-9 The few studies that have looked at a younger population10-13 have combined men and women into one cohort, despite their biological and epidemiological differences.14 There are no reported data on the epidemiology and outcome which concentrate solely on a younger female population.

In this study we examined a large cohort of women of working age (≤ 65 years) with a hip fracture and compared them with a parallel cohort of patients > 65 years. Our aim was to define the epidemiological characteristics and outcome of this distinct population, which should aid the development of much-needed prospective studies focusing on intervention in this group.

Patients and Methods
At our hospital, data on all patients who are admitted with a fracture of the hip are prospectively collected by independent audit officers, using a proforma based on the Standardised Audit of Hip Fractures in Europe.15 Audit data is confidential, managed in accordance with Caldicott principles16 and authorised by the local research ethics committee. The database is linked to the National Office of Statistics17 and therefore includes deaths after hospital discharge, ensuring accurate mortality data.

Our hospital is the only facility providing emergency care for a catchment population of approximately 750 000, which maximises the capture of post-operative complications. In addition, we cross-reference our data with the National Joint Registry Database18 to ensure that all patients who may have undergone conversion of their original fixation to a total hip replacement (THR) at another hospital are identified.

Between 1999 and 2008, 6782 consecutive hip fractures were treated at our hospital. We identified 327 fractures in 315 adult female patients aged ≤ 65 years which comprised 5% of the fractures and 6% of the 5137 female hip fractures in the database. Their median age was 58 years (19 to 65). We compared this ‘early’ (≤ 65) population with a cohort of 4810 consecutive hip fractures from the same period in females > 65. In order to validate the database, we performed a retrospective analysis of the medical records of these patients and collated additional information on mechanism of injury and bone density.
The mechanism of injury was classified as being of high or low energy. High energy fractures occurred as a consequence of a fall from a height greater than standing, motion greater than walking, or the result of a road traffic accident. All other fractures were classified as low-energy injuries.

Cardiovascular comorbidity was defined as a pre-existing cardiovascular condition and included previous myocardial infarction, angina, atrial fibrillation, valvular heart disease and hypertension. Outcome measures were mortality at 30 days and one year, post-operative complications and re-operation.

There were a small number of patients with bilateral sequential fractures. For the purposes of analysis each fracture was considered independently, except where the patient died and in the calculation of mortality, where the results clearly pertain to patients and not to individual fractures.

We used age- and gender-matched data from the 2001 national census\textsuperscript{17} to calculate the incidence of hip fracture for females in our catchment area, which is predominantly urban. Statistical analysis. For the univariate analyses we used the chi-squared test for each demographic categorical variable.\textsuperscript{19} The level of significance was set at \( p < 0.01 \), instead of the conventional 0.05 in order to avoid spurious results arising from multiple testing. For the analysis of mortality and implant survival, we used Kaplan-Meier curves and the log-rank test for equality of survival functions.\textsuperscript{20} In the case of bilateral fracture, survival was calculated from the time of the first fracture. Patients were censored at the end of the follow-up period or on death or failure of the implant. For the multivariate analysis, we used Cox regression analysis to examine the effect of smoking on the hazard of hip fracture at a younger age, with adjustment for confounding factors.\textsuperscript{21} Rate ratio analysis was used to compare age-related incidence and Pearson’s correlation coefficient to explore the association between age and bone density.

Data were stored in Microsoft Access, coded in Excel, Windows 2000 (Microsoft Corp., Redmond, Washington) and analysed using STATA version 10.1 (StataCorp LP, College Station, Texas).\textsuperscript{22}

\textbf{Results}

Women aged ≤65 years had a high incidence of pathological fracture, 35 of 327 (11%), when compared with women >65, 66 of 4810 (1.4%). A pathological lesion which results in a fracture makes women seven times more likely to sustain an early hip fracture than any other cause.

\begin{table}
\caption{Demographics of the two age groups, excluding pathological fractures} 
\centering
\begin{tabular}{lll}
\hline
Patient characteristics (n) & ≤ 65 years (292) & > 65 years (4744) & p-value \\
\hline
Median age in years (range) & 58 (19 to 65) & 84 (66 to 106) & \\
Living at home (%) & 255 (87.3) & 2815 (59.3) & < 0.001 \\
Institution (%) & 25 (8.6) & 1341 (28.3) & < 0.001 \\
Walking with aids (%) & 68 (23.3) & 2573 (54.2) & < 0.001 \\
Assistance with ADL\textsuperscript{*} (%) & 80 (27.4) & 3158 (66.6) & < 0.001 \\
CVD\textsuperscript{†} comorbidity (%) & 49 (16.8) & 2024 (42.7) & < 0.001 \\
Smoking (%) & 85 (29.1) & 353 (7.4) & \\
AMT\textsuperscript{‡} (%)
& < 8 & 29 (9.9) & 1843 (38.8) & < 0.001 \\
& 8 to 10 & 263 (90.1) & 2901 (61.2) & < 0.001 \\
ASA\textsuperscript{§} score (%)
& 1 to 2 & 129 (44.2) & 1203 (25.6) & < 0.001 \\
& 3 to 5 & 95 (32.5) & 2259 (47.6) & < 0.001 \\
& Unknown & 68 (23.3) & 1282 (26.8) & 0.033 \\
Place of fall (%) & & & \\
& Indoors & 184 (63.0) & 3953 (63.3) & < 0.001 \\
& Outdoors & 98 (33.6) & 760 (16.0) & < 0.001 \\
& RTA\textsuperscript{¶} & 8 (2.7) & 9 (0.2) & < 0.001 \\
& Unknown & 2 (0.7) & 22 (0.5) & 0.647 \\
Mechanism of injury (%) & & & \\
& High energy & 28 (9.6) & Not known \\
& Low energy & 250 (85.6) & Not known \\
& Unknown & 14 (4.8) & Not known \\
\hline
\end{tabular}
\end{table}

\textsuperscript{*} ADL, activities of daily living
\textsuperscript{†} CVD, cardiovascular disease
\textsuperscript{‡} AMT, abbreviated mental test score
\textsuperscript{§} ASA, American Society of Anesthesiologists
\textsuperscript{¶} RTA, road traffic accident
As pathological fractures are a distinct group with a higher morbidity, we excluded these from the analysis of demographic characteristics, leaving 292 fractures in the ‘early’ group and 4744 in the ‘late’ group.

The demographic characteristics for each fracture, place of fall and type of fracture are given in Table I. We also noted that in 54 of 292 (18%) ‘early’ fractures, the women had a history of alcohol abuse. This was assessed by the presence in medical notes of repeated attendance to the health service with intoxication and/or related injuries, referral to an alcohol liaison service, diagnosis of alcoholic liver disease, or the requirement of a detoxification regime during admission.

The incidence distribution for our cohort (Fig. 1) forms part of the overall distribution for all ages, which is unimodal and typical of an osteoporotic fracture. We noted that the first significant increase in age-related incidence (p < 0.001) occurred in the interval between the age-classes of 40 to 44 and 45 to 49 (Fig. 1), rather than at the age of 50, the age at which screening of hip fracture patients for osteoporosis starts in our health authority.

We examined 225 dual-energy x-ray absorptiometry (DXA) scans of women of all ages with a fracture of the hip, 82 of which were performed in patients ≤ 65 years of age. A total of 67 of these (82%) were abnormal, with osteopenia or severe osteoporosis. In addition, there was no significant correlation between age and bone density of the proximal femur in our larger sample (r = 0.122, p = 0.068).

A significantly larger proportion of the early hip fracture patients were smokers at the time of injury (p < 0.001). A female patient was almost five times more likely to sustain a fracture up to the age of 65 if she was a smoker than if she was a non-smoker (hazard ratio 4.7, 95% CI 3.7 to 6.1, p = 0.007). The effect of smoking on the risk of hip fracture is demonstrated in Figure 2, which is adjusted for confounding factors (cardiovascular disease, American Society of Anesthesiologists (ASA) score, the use of a walking aid or assistance with activities of daily living, use of steroids or the presence of a pathological lesion). Since all the women in this cohort suffered a hip fracture, this is not an investigation into the effects of these variables on having or not having a fracture in younger women but a comparison of the effect of being younger rather than older at the time of fracture.

Kaplan-Meier survival analysis (Table II) showed the mortality in the younger group to be significantly lower than that in the older group at 30 days and at one year (p < 0.001) as might be expected. In Figure 3, we show the significant contribution (p < 0.001) of pathological fracture to the overall mortality of younger female patients with a hip fracture.
compared with published figures, which show great variation and predominately pertain to an older population. Intracapsular fractures are an interesting subgroup, as the desire to preserve the femoral head whenever possible must be balanced against the risk of complications. They were treated almost exclusively with a lag screw if they were undisplaced (42 of 44, 95%). If they were displaced (the most interesting group from a decision-making perspective), 61 of 158 (39%) were reduced and fixed with a lag screw and 97 of 158 (61%) were treated by arthroplasty. The two groups (lag screw and arthroplasty) differed significantly in age, walking ability, level of independence and the presence of cardiovascular co-morbidity. However, smoking, use of steroids or living in an institution were not deciding factors in treatment selection (Table IV). The three remaining intracapsular fractures (two displaced, one undisplaced) were treated non-operatively.

There were few failures in the undisplaced group with implant survival of 95% (95% CI 81 to 99) at two years and 92% (95% CI 76 to 97) at five years. Figure 4 shows the implant survival curve for displaced intracapsular fractures treated by lag screw fixation. Two-year survival was 82% (95% CI 82 to 90) and five-year survival 71% (95% CI 56 to 81). The number of failures was too small to identify statistically significant variables leading to failure.

Rates of re-operation for displaced intracapsular fractures with a mean follow-up of four years were 26% (16 of 61) for internal fixation and 1% (1 of 97) for arthroplasty.

**Discussion**

Though a rare injury, hip fractures in younger women are of particular interest. Unlike the elderly, this population is of working age and the socioeconomic implications of the injury are greater. Although the overall incidence of hip fracture in women in the western world is stabilising, the absolute numbers are rising. We may be seeing an increase in the number of female hip fractures as a result of the baby boom from 1948 to 1962.

We saw a significant number of fractures due to metastatic lesions in younger women. These contributed significantly to the mortality of the younger cohort, but had little effect on the mortality of the older group.

The literature suggests that fractures at a younger age are the result of high energy forces acting on normal bone, such as in road traffic accidents. This has not been the case in our group. Most injuries occurred indoors and were low energy. The fracture distribution was typically unimodal (Fig. 1). This is in contrast to the bimodal fracture distribution seen in the tibial plateau or the humeral diaphysis, which is the result of high energy forces acting on normal bone early in life and lower energy forces on osteoporotic bone in the elderly. The literature suggests that hip fracture due to a low or even moderate amount of force is predominantly the result of reduced bone density irrespective of age. In the younger female population, hip fracture therefore bears the hallmarks of an osteoporotic fracture.

Figures for bone mineral density in our series were only available for 30% of patients, as there were few scans performed in our hospital before 2004. This information is further compromised by selection bias as screening between the ages of 50 and 65 occurred only in the last four years of the database. However, in keeping with the literature for hip fractures in women, bone density in our sample was predominantly low and showed no distinct relationship with age. In addition, any high energy fractures occurring in the cohort were evenly distributed by age.

Younger patients were statistically more likely to be living at home than in an institution. They were generally more mobile, and had better ASA and Abbreviated Mini Mental Test Scores than their older counterparts. However, a large proportion required assistance with the activities of daily living, walked with aids, or had significant cardiovascular co-morbidity. In over half, the fracture occurred indoors, usually at home, and was of low energy. This was a group of women who were physiologically compromised for their age.

The National Institute for Health and Clinical Excellence (NICE) recommends osteoporosis screening as a secondary prevention measure in post-menopausal women who have sustained a clinically apparent fragility fracture. As the mean age for the menopause in the Western world is 50 years, most programmes start screening at this age which allows for the majority of female patients to be included. However, the literature on hip fracture in females suggests that fractures of low or even moderate energy are the result of compromised bone, regardless of age. Our data also suggest that a woman < 50 years of age who sustains a low-energy hip fracture is as likely to...
benefit from screening as her older counterpart. Screening does not solely involve bone scanning, but includes a detailed assessment of all risk factors for fracture, including hereditary, biological and social factors, some of which are potentially reversible.36,37

Significantly more women aged ≤ 65 years of age with a hip fracture were smokers. This had a strong influence on the relative risk of early as opposed to late fracture. The effect was adjusted for confounding factors, including mobility and cardiovascular disease. Most, but not all studies of smoking and hip fracture in the general population have found that smokers are at a higher risk of hip fracture than non-smokers.37 The increased risk of hip fracture in smokers may be due to its harmful effect on their general health leading to falls or to a direct effect in bone density.38 However, the hazard ratio resulting from smoking in our cohort is very high and, if we take into account that both young and older women are already osteoporotic enough to sustain a low energy fracture such as that of the hip,35 the contribution of smoking to fracturing at an earlier age could be a target for fracture prevention.

Almost one in five of the younger women with a hip fracture had a history of alcohol abuse. It would have been interesting to explore the effects of alcohol on the risk of hip fracture. However, we were unable to do this due to a lack of comparative data on alcohol consumption for the older cohort; this could be a target for future studies. In the meantime, we would recommend that younger women who

<table>
<thead>
<tr>
<th>Fracture type</th>
<th>Non-pathological</th>
<th>Pathological</th>
<th>Non-pathological</th>
<th>Pathological</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>292</td>
<td>35</td>
<td>4744</td>
<td>66</td>
</tr>
<tr>
<td>Intracapsular (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Displaced</td>
<td>147 (50.3)</td>
<td>12 (34.3)</td>
<td>2346 (49.5)</td>
<td>20 (30.3)</td>
</tr>
<tr>
<td>Undisplaced</td>
<td>46 (15.8)</td>
<td>0</td>
<td>378 (8.0)</td>
<td>3 (4.5)</td>
</tr>
<tr>
<td>Extracapsular (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Subtrochanteric (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table IV. Characteristics of the 202 intracapsular fractures treated with lag screw versus arthroplasty (n, %)

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Lag screw*(n = 103)</th>
<th>Arthroplasty (n = 99)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age in years (SD)</td>
<td>54 (9.6)</td>
<td>59 (5.3)</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Fracture undisplaced</td>
<td>42 (40.8)</td>
<td>2 (2.0)</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Fracture displaced</td>
<td>61 (59.2)</td>
<td>97 (98.0)</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Walking with aids</td>
<td>12 (11.7)</td>
<td>30 (30.3)</td>
<td>0.002</td>
</tr>
<tr>
<td>Assistance with ADL†</td>
<td>16 (15.5)</td>
<td>35 (35.4)</td>
<td>0.002</td>
</tr>
<tr>
<td>n &gt; 4 medications</td>
<td>14 (13.6)</td>
<td>35 (35.4)</td>
<td>0.001</td>
</tr>
<tr>
<td>CVS‡ comorbidity</td>
<td>15 (14.6)</td>
<td>30 (30.3)</td>
<td>0.012</td>
</tr>
<tr>
<td>Institution</td>
<td>4 (3.9)</td>
<td>9 (9.1)</td>
<td>0.159</td>
</tr>
<tr>
<td>Steroids</td>
<td>2 (1.9)</td>
<td>6 (6.1)</td>
<td>0.164</td>
</tr>
<tr>
<td>Smoking</td>
<td>25 (24.3)</td>
<td>25 (25.3)</td>
<td>0.999</td>
</tr>
</tbody>
</table>

*The term ‘lag screw pertains to AO screw fixation in 90/103 fractures and sliding hip screw in 13/103 intracapsular fractures
† ADL, activities of daily living
‡ CVS, cardiovascular

Fig. 4

Kaplan-Meier curve showing implant survival of displaced intracapsular fractures in females aged ≤ 65 years, treated by lag screw fixation (95% confidence intervals and number at risk at each interval are shown).
fracture their hip are screened for alcohol abuse and referred for rehabilitation, if appropriate.

Mortality in the younger cohort was much lower than in the older cohort. However, after adjusting for the large proportion of pathological fractures, the mortality of the younger group was still 46 times the background mortality of the female population of Nottingham,17 which highlights the seriousness of this injury.

Lag screw fixation was the most common method of operative treatment. This reflects the higher percentage of intracapsular fractures and also the desire to preserve the femoral head in younger patients. General rates of complication for our study group were low, as were the re-operation rates for cemented prostheses.

Treatment of displaced intracapsular fractures in the younger population remains controversial. The goals are to preserve the femoral head, avoid osteonecrosis and achieve union.39 This must be balanced against the risk of failure. A meta-analysis40 of over 100 reports of displaced fractures of the femoral neck demonstrated a re-operation rate of 20% to 36% after internal fixation compared with 6% to 18% after joint replacement. However, re-operation data on internal fixation was only available for a follow-up of two years. Similarly, a more recent randomised trial of internal fixation versus arthroplasty in the elderly reported a short-term rate of re-operation of 40% for internal fixation and 4.5% for arthroplasty.41 Our data translates to a re-operation rate of 26% for internal fixation and 10% for arthroplasty at a mean follow-up of four years (1 to 9). This contrasts with other reports that younger patients have a worse prognosis because their fractures are more comminuted and they have higher demands.11,39 Selection bias is the most likely explanation for this difference in the observed revision rates, though we must point out that this comparison does not take into account the problem of differing follow-up times. Unfortunately, implant survivorship data for young patients is lacking in the literature, and does not permit a more valid direct comparison.

Finally, we acknowledge the complexity of the issues which can arise when bilateral cases are involved. We believe, however, that in the very rare occurrence of bilateral hip fractures in a young female, it is reasonable to preserve valuable data rather than to exclude it. It is worth noting that there were no distinguishing characteristics in those patients with bilateral sequential fractures, possibly due to the extremely small sample.

In conclusion, hip fractures are uncommon in the average woman of working age. They are sustained by a population at risk not because of age but as a result of pathophysiology. Treatment in this age group, particularly of intracapsular fractures, remains a topic for debate. Understanding the characteristics of these patients and the risk factors may lead to an improved opportunity, if not for prevention, at least for intervention.

A prospective study of such patients, to include systematic investigation of all demographic characteristics, risk factors and routine bone density scanning, would help clarify the contribution of various factors to the relative risk of early hip fracture in the female population.

Pending further experimental studies we would recommend that the following be considered: all female patients who sustain a low energy hip fracture should be referred to a fracture prevention service, irrespective of age; osteoporosis screening should be offered to patients 45 years or older who sustain a fragility fracture; there is a high incidence of pathological lesions in younger females with hip fractures and this diagnosis should always be considered; although the mortality and rates of complication are lower than in elderly females, hip fracture in women aged 65 and under is associated with significant comorbidity and every medical review is advised; and lastly, alcohol abuse is an important feature and should always be considered.

Supplementary material

Tables showing the distribution of operative fixation and post-operative complications are available on our website at www.jbjs.org.uk

No benefits in any form have been received or will be received from a commercial party related directly or indirectly to the subject of this article.

References


