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Relation between increase in length of hip axis in older women between 1950s and 1990s and increase in age specific rates of hip fracture

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Abstract

Objective—To determine whether length of hip axis in elderly women has increased over the past 40 years and, if so, whether the increase may have contributed to the increase in the age adjusted rate of hip fractures during those years.

Design—Retrospective assessment of anteroposterior x ray films of the pelvis.

Setting—Radiology department of a rheumatology hospital, New Zealand.

Patients—Two cohorts of women aged >60 (mean 70) who were x rayed on the same apparatus in either the 1950s or the 1990s.

Main outcome—Length of hip axis (distance from the medial aspect of the pelvis to the lateral aspect of the femur along the axis of the femoral neck), length of femoral neck (length of hip axis excluding the femoral head and more medial structures), and width of femoral neck (see figure).

Results—Both the mean length of the hip axis and the mean length of the femoral neck were significantly greater in the women whose x ray films were taken in the 1990s than in those in the 1950s (124.0 mm (SE 1) v 130.5 (1), $P=0.0002$; 79.4 (1) v 84.9 (1), $P<0.0001$, respectively). The width of the femoral neck did not change, and the lengths expressed as ratios to width were greater in the more recent x ray films, indicating that these findings are not due to an unrecognised change in radiographic technique.

Conclusions—An increase in the length of the hip axis in elderly women in New Zealand during the past 40 years has occurred which is large enough to account for the increase in the age adjusted rate of hip fractures during those years.

Introduction

Hip fractures occur in about 15% of postmenopausal white women, and morbidity and mortality from these fractures is higher than from all other osteoporotic fractures. The rates of hip fracture have increased substantially in many countries in the past 50 years. The increases are accounted for only partly by the aging of the population, and age adjusted rate of fracture in women increased twofold in Britain during the 1950s to the 1980s,^{1,4} in Scandinavia during 1940-80,^{5,7} and in Hong Kong during 1966-91.⁸ A similar rise has occurred in New Zealand, where the annual number of hip fractures in women aged over 65 increased from 317 in 1950 to 2153 in 1987, while the population of women in this age group increased only twofold.⁹ The reason for the increases in the age adjusted rate of hip fracture is unknown.

Recently, Faulkner *et al* reported that the geometry of the proximal femur is an independent risk factor for hip fracture.¹⁰ They found that the longer the hip axis (the distance from the medial aspect of the pelvis to the

lateral aspect of the femur along the axis of the femoral neck (figure)) the more likely the risk of fracture. This may be due to the length of the hip axis being related to the femoral moment arm—the longer the arm the less force is needed to produce a fracture. The length of the hip axis is also related to height,¹⁰ which has increased substantially in the past 50 years due to improved nutrition. The length of the hip axis, therefore, may also have increased and, if so, may be a factor in the rising age specific rate of hip fracture. To assess this possibility we determined whether changes in the length of the hip axis have occurred in the population at risk of fractures during the period that the rate of fractures has increased.

Methods

We studied anteroposterior x ray films of the pelvis taken in white women aged over 60. We assessed only films that showed the left hip correctly positioned with a clear outline of the greater trochanter and without major deformity or disease. We found 52 films from 1950-62 (median 1956) that met these criteria. We initially searched for similar films taken during 1990-93 but extended our search back to 1986 to find 52 films for comparison. The median date of these films was 1991.

The patients whose films we studied were being investigated for osteoarthritis (36), rheumatoid arthritis (18), back or leg pain (35), or generalised arthralgias (13). All the x ray films that we studied were from the same rheumatology unit in New Zealand, which had used the same radiography equipment and retained all its films since 1950. A film to tube distance of 36 inches (914.4 mm) was used in the 1950s, but this was increased to 40 inches (1016 mm) before the films from 1986-93 were taken. The increase in this distance decreased the size of the image in the later films by about 2%.

The width of the femoral neck and the length of the hip axis were measured from the x ray films with precision callipers (figure). The line of the hip axis was defined as passing through the mid-point of the femoral neck and the point on the femoral head (identified with a compass) furthest from the neck's mid-point. This definition gave an objective and reproducible method for defining the axis. Because the length of the hip axis is potentially influenced both by abnormalities in the space around the hip joint and by deformity of the femoral head, a new dimension, the length of the femoral neck, was also measured. This was defined as the distance along the line of the hip axis from the lateral aspect of the femur to the line joining the superior and inferior extremes of the hip joint (defined as the points of intersection of the margins of the femoral head and the margins of the lateral pelvis (see figure)). The standard deviations for duplicate

Hip joint showing length of hip axis (AC), length of femoral neck (BC), and width of femoral neck (DE). DE was the shortest line across the femoral neck parallel to the broken line. Placing of the lines is described in text

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marking and measurement of these variables on 10 films taken at least one week apart were 0.7 mm for the length of the hip axis; 0.6 mm for the length of the femoral neck; and 0.7 mm for the width of the femoral neck. All the measurements were made by one observer (KC).

Results were analysed by Student's *t* test with the programmes of the SAS Institute (Cary, North Carolina).

Results

The women had a mean age of 70 (SD 7). The mean lengths of both the hip axis and the femoral neck were significantly greater in the women who had had radiography in the 1990s (table). The mean widths of the femoral neck, however, did not differ between the two groups of women. To rule out a difference in magnification in the two sets of films due to some unrecognised change in radiographic technique, the lengths were also expressed as ratios to the widths measured from the same film. These ratios were significantly greater in the more recent films.

Mean (SD) dimensions of proximal femur* in 52 elderly white women in New Zealand in 1950s compared with those of 52 in 1990s

Dimension (mm)	1950s	1990s	P value
Length of hip axis	124.0 (8.6)	130.5 (8.6)	0.0002
Femoral neck:			
Length	79.4 (7.6)	84.9 (6.3)	0.0001
Width	38.1 (4.1)	38.6 (3.6)	0.49
Length of hip axis/width of femoral neck	3.27 (0.25)	3.40 (0.28)	0.019
Length of femoral neck/width of femoral neck	2.10 (0.24)	2.21 (0.22)	0.015

*Measured from x ray films as described in text.

Discussion

Our data show that the length of the hip axis in elderly white women in New Zealand has increased during 35 years, during which time age specific rates of hip fracture rose about twofold. A similar increase was found in the length of the femoral neck so our finding does not reflect a change over time in the dimensions of the space around the hip joint or of the femoral head. No change occurred in the width of the femoral neck, which indicates that the shape of the proximal femur has changed and that the present findings cannot be attributed to a change in the magnification factor of the films between 1950-62 and 1986-93. Indeed, the change in the radiographic technique between these years would have resulted in a small reduction in femoral dimensions so the present findings may underestimate the true change.

The increase in the length of the hip axis is almost equal to 1 SD of the distribution of this variable within

Clinical implications

- An unexplained increase in age adjusted rates of hip fracture has occurred in many countries in the past 50 years
- The length of the femoral neck has been shown to be an independent risk factor for hip fracture
- This study shows that a significant increase in the length of the femoral neck in elderly women has occurred between the 1950s and the 1990s, which is sufficient to explain the increase in age adjusted rates of hip fracture
- The increase in length of the femoral neck probably results from improved nutrition in childhood
- No single intervention, therefore, can reverse the epidemic of hip fracture

each group of women. Faulkner *et al* found that a difference of 1 SD in the length of the hip axis changed the risk of fracture twofold.¹⁰ This suggests that most of the increase in age adjusted rates of fracture in New Zealand can be accounted for by the change in the geometry of the proximal femur. Our findings thus suggest that improved nutrition before puberty is the underlying cause of the epidemic of hip fractures and that this epidemic cannot be reversed by any single intervention.

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Value of screening for secondary causes of hyperlipidaemia in general practice

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The number of estimations of serum cholesterol concentrations being performed has risen dramatically in the past few years. The reason for the rise is partly that general practitioners are increasingly realising the importance of cholesterol and partly that authoritative reports—notably that of the Royal College of General Practitioners¹ and the European Ather-

osclerosis Society²—have encouraged general practitioners to screen for raised cholesterol concentrations.

Leading lipidologists and all the major textbooks emphasise the association between a raised serum cholesterol concentration and diabetes, hypothyroidism, excessive alcohol consumption, and renal failure,^{3,4} and virtually all authorities advise general practitioners to make sure that when hyperlipidaemia is present no treatable cause exists. All patients with hyperlipidaemia should therefore have at least blood tests for glucose, thyroid function, renal function, and liver function. These recommendations, however, have been based on theoretical considerations, and the yield of new diagnoses when these tests are done together in primary care has not been reported.

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