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ORIGINAL STUDY

Proximal femoral geometry and hip fractures

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There is increasing evidence that proximal femoral geometry has an important role in the aetiology of hip fractures. We performed a simple radiological study to investigate the relationship between proximal femoral geometry and intracapsular and extracapsular fractures of the proximal femur.

Measurements of proximal femoral geometry were made on pelvic radiographs on the contralateral hip of 50 consecutive patients with intracapsular and 50 with extracapsular fractures. The groups were matched for age and sex with a mean age of 79 and a female :male ratio of 4 :1.

There were no statistical differences in head diameter, neck width or Head Trochanter Length between the two groups of fractures. Hip Axis Length, neck length and the neck length :width ratio were significantly greater in the intracapsular group, suggesting an aetiological link.

This may have implications for future screening and prevention of proximal hip fractures, particularly intracapsular fractures.

Keywords : hip fractures ; proximal femoral geometry.

INTRODUCTION

Proximal femoral fractures (PFF) in the elderly, both intracapsular and extracapsular, have historically been considered together as "osteoporotic fractures", in spite of their differing biological behaviour and treatment. There is a clear relationship between decreased bone mineral density and increased risk of hip fracture, with a reduction in bone density of one standard deviation being associated with at least a doubling in risk of hip fracture (*2, 6*). More recent evidence suggests that variations in Proximal Femoral Geometry (PFG) also play an important role in hip fracture aetiology. The Study of Osteoporotic Fractures demonstrated that increased Hip Axis Length (HAL) is associated with hip fracture risk, independent of age and bone density (*5*). Other authors have subsequently supported these results and HAL is now accepted as an independent risk factor for fracture of the hip.

Despite the recent interest in proximal femoral geometry, there have been relatively few studies comparing the variations between patients with intracapsular and extracapsular fractures. Evidence to date suggests an association between longer neck length and intracapsular fractures, as opposed to extracapsular fractures (*3, 5*), although a study in

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elderly Chinese women suggested no significant difference in femoral neck length between intracapsular and extracapsular fractures of the proximal femur (*12*).

The aim of this study was to examine differences in PFG, from simple radiographic measurements, between patients with intracapsular and extracapsular fractures of the proximal femur.

METHODS

Patients admitted to the Orthopaedic Trauma Unit of Aberdeen Royal Infirmary, having sustained an intracapsular or extracapsular fracture of the proximal femur were eligible for inclusion to this study. Patients were excluded if they had sustained high-energy trauma, evidence of malignancy or disease processes or drug use known to affect bone metabolism. The radiographs of 50 consecutive patients with intracapsular and 50 patients with extracapsular fractures were reviewed. We studied standard anteroposterior radiographs of the pelvis, performing geometrical analysis using a standard rule, graduated in millimetres, on the uninjured hip. Previous analysis of standard radiographs found them consistently accurate, and unaffected by femoral anteversion.

Neck width was taken as the narrowest diameter at the mid point of the femoral neck, and head diameter was determined at the widest point of the femoral head. The centre of the head and the mid point of the neck where connected and the line extrapolated to obtain the Hip Axis Length, the distance between the edge of the trochanter and the inner table of the pelvis. From the same line, the Head Trochanter Length (HTL) was taken as the distance between the edge of the trochanter and the femoral head. Neck length was determined by the distance between perpendicular lines which transected the hip axis length at the level of the lesser trochanter and the flare of the head (fig 1).

Statistical analysis was by the independent sample t-test, using the Statistical Package for Social Sciences (SPSSv9.1)

RESULTS

The majority of the patients studied (79%) were female. This ratio of 4 :1 was similar in both intracapsular and extracapsular groups. The age demographics of both groups were again similar with an overall mean of 79 years, the breakdown of which is demonstrated in table I. There was a slight preponderance of left sided fractures in the extracapsular group (55%), with equal numbers of left and right sided fractures in the intracapsular group. Table I details the proximal femoral dimensions broken down by type of fracture and sex.

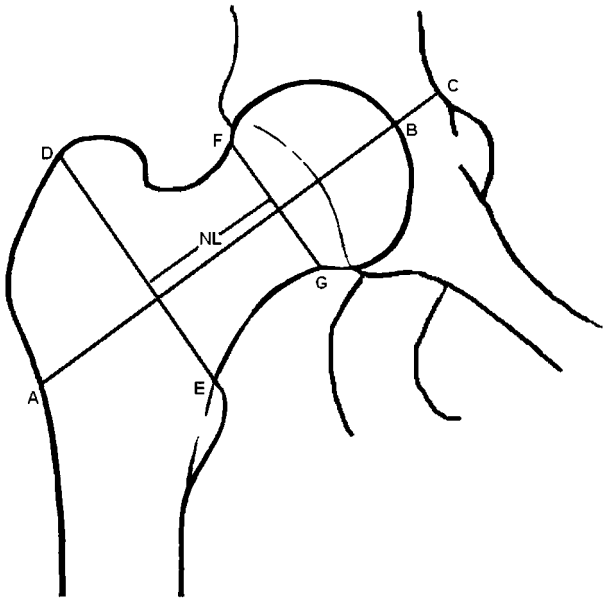

Fig. 1. — Hip joint demonstrating Hip Axis Length (AC), Head-Trochanter Length (AB) and Neck Length (NL) (Neck length was determined by the distance between perpendicular lines which transected the hip axis length at the level of the lesser trochanter (DE) and the flare of the head (FG)).

There were no significant differences in head diameter, neck width, or Head Trochanter Length between the two groups of patients.

Patients with intracapsular fractures had a longer neck length and higher neck length:neck width ratio. Females with intracapsular fractures also had a narrower neck width than those with extracapsular fractures, with this difference not seen in males. This increase in neck length and decrease in neck width of the femoral neck contributes to the greater neck length :neck width ratio of females over males with intracapsular fractures.

Males had significantly larger dimensions for all but neck length, which was equivalent to females.

Table I. — Proximal femoral dimensions in patients with intracapsular and extracapsular proximal femoral fractures

		Extracapsular Fractures Mean (*SD*)	*Intracapsular Fractures Mean* (*SD*)	*p value*
Age (years)	Male Female	75 (10) 82 (10)	75 (14) 80 (9)	
Neck Width (mm)	Male Female	43.80 (4.34) 38.77 (2.37)	42.18 (2.09) 37.44 (2.86)	N/S N/S
Head Diameter (mm)	Male Female	60.20 (4.13) 53.93 (2.63)	59.64 (3.98) 53.64 (3.73)	N/S N/S
Hip Axis Length (mm)	Male Female	140.50 (6.59) 127.48 (8.91)	145.55 (7.58) 132.00 (8.11)	NS 0.021
Head Trochanter Length (mm)	Male Female	120.90 (5.11) 111.73 (6.93)	122.82 (4.45) 113.95 (6.16)	N/S N/S
Neck Length (mm)	Male Female	28.10 (3.90) 27.73 (4.04)	32.27 (3.13) 32.46 (4.19)	0.014 < 0.001
Neck Length : Neck Width Ratio	Male Female	0.6436 (0.11) 0.7176 (0.11)	0.7654 (0.13) 0.8718 (0.13)	0.002 < 0.001

The greater hip axis length in those with intracapsular fractures was also significant, but the mean difference was only 4.9 mm, representing a difference of less than 4%.

DISCUSSION

Proximal femoral fractures occur in about 18% of postmenopausal white women, and the morbidity and mortality from these fractures is higher than from all other osteoporotic fractures (*7*). The incidence of these osteoporotic fractures in northern Europe has been increasing over the past few decades faster than the rate adjusted for life expectancy.

It has also been demonstrated radiologically, that proximal femoral geometry is changing, with an increase in the length of the femoral neck in elderly women occurring between the 1950's and the 1990's (*8, 9*). This increase was further supported by osteometric studies of dried femurs donated in 1900 compared to those donated in 1980 (*4*). This change in geometry has been attributed to improvement in nutrition before puberty.

Given that femoral neck length is an independent risk factor for PFF (*1, 5*), this increase in neck length may in part explain the increase in age adjusted rates of intracapsular PFF.

This study has observed that HAL, neck length and neck length : neck width ratio are significantly different between patients with intracapsular and extracapsular PFF. Our findings agree with previous observations, and may suggest a somewhat different pathogenesis for intracapsular as opposed to extracapsular fractures (*3, 10*).

The increase in femoral neck length in the ageing population, coupled with the higher risk of intracapsular PFF that such an increase brings, may lead to an increasing preponderance of intracapsular fractures within the predicted "epidemic" of hip fractures in the growing elderly population.

There is ongoing debate regarding the efficacy and cost effectiveness of bone densitometry screening and pharmacological intervention in preventing hip fracture (*11*). Treatment to prevent osteoporosis increases the bone mineral density of the trochanteric region more than that of the neck of the femur and may therefore be less effective in

preventing intracapsular fractures (*10*). If the incidence of these fractures indeed increases at a higher rate than that of extracapsular fractures, the cost-effectiveness of osteoporosis screening and treatment will be further questioned.

Our study has shown that the previously described increase in femoral neck length in the population may be associated with an increased risk of intracapsular as opposed to extracapsular PFF in the elderly. As current osteoporosis treatment has less effect upon the femoral neck than the trochanteric region, these findings suggest a need for a new approach to prevention of these fractures.

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