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ORIGINAL ARTICLE

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Increased incidence of arthrosis in women could be related to femoral and pelvic shape

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Abstract In this study various femoral and pelvic geometrical parameters important for hip joint contact stress were determined. The parameters were measured from standard anteroposterior radiographs of healthy adult subjects and analysed by using descriptive statistical procedures. Women proved to have a significantly smaller femoral head radius and larger distance between the inner acetabular rims than men, both features which lead to an increase of contact stress in the hip joint articular surface. Since too high, long-lasting contact stress is unfavourable regarding the development of arthrosis, we propose that these differences in the femoral and pelvic geometry could be one of the reasons for the increased incidence of arthrosis in women.

Introduction

It was recently shown that too high contact stress at the articular surface of the hip joint can accelerate the development of arthrosis there [1]. Increased contact stress at the joint articular surface can result from a too small hip joint weight-bearing area and/or a too high resultant hip joint force.

The hip joint weight-bearing area is small, and consequently the hip joint contact stress is large if the femoral head is small and lateral coverage of the femoral head with the acetabular roof is small [4, 9]. The resultant hip joint force depends on the fermoral and pelvic geometry. In the past, the most attention has been paid to the influence of the femoral geometry on the resultant hip joint articular surface [8, 9]. However, it was recently indicated that pelvic geometry is important, too [3].

The scope of this study involves the differences between male and female femoral and pelvic geometrical parameters that are important for the stress distribution in the hip joint articular surface.

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Materials and methods

The standard anterioposterior radiographs were taken from the archive of the Department of Orthopaedic Surgery, University Medical Center Ljubljana, from 1985 on. Only radiographs of subjects whose femoral and pelvic shape was found to be normal were used. Thus, the final analysis of geometrical parameters was performed for 79 adult women and 21 adult men. The Cartesian coordinates of some characteristic points on the femur and on the pelvis were measured by the computer-aided system [6]. The data were processed in order to determine the pelvic height (H) and width (W), the horizontal distance between the most lateral point on the crista iliaca and femoral head centre (C), radius of the femoral head (r), collodiaphyseal angle (ϑ_{CCD}) and centre-edge angle of Widberg (ϑ_{CD}). The height of the pelvis (H) is defined as the difference between the vertical coordinate of the femoral head centre and the highest point on that side of the pelvis (Fig. 1). The width of the pelvis (W) is defined as the distance between the inner rims of the two acetabula at the level of the femoral head centres (Fig. 1). For the parameters H, C, r, ϑ_{CE} and ϑ_{CCD}, the average value of the right and the left sides was taken for each person. All measured distances were corrected for magnification.

In order to exclude the effect of size, the normalized femoral head radius r_n was introduced as the ratio between the femoral head radius r and the square root of the area A spanned by the characteristic points on the pelvis and femurs (Fig. 2), i.e. both femoral head centres, the highest points on both sides of the pelvis and both most lateral points on the pelvis.

The data were analysed by using descriptive statistical methods. The female and male populations' median values of the measured parameters were compared. The probability P describing the statistical significance of the difference between the median values of certain femoral or pelvic geometrical parameters was determined using the Mann-Whitney test.

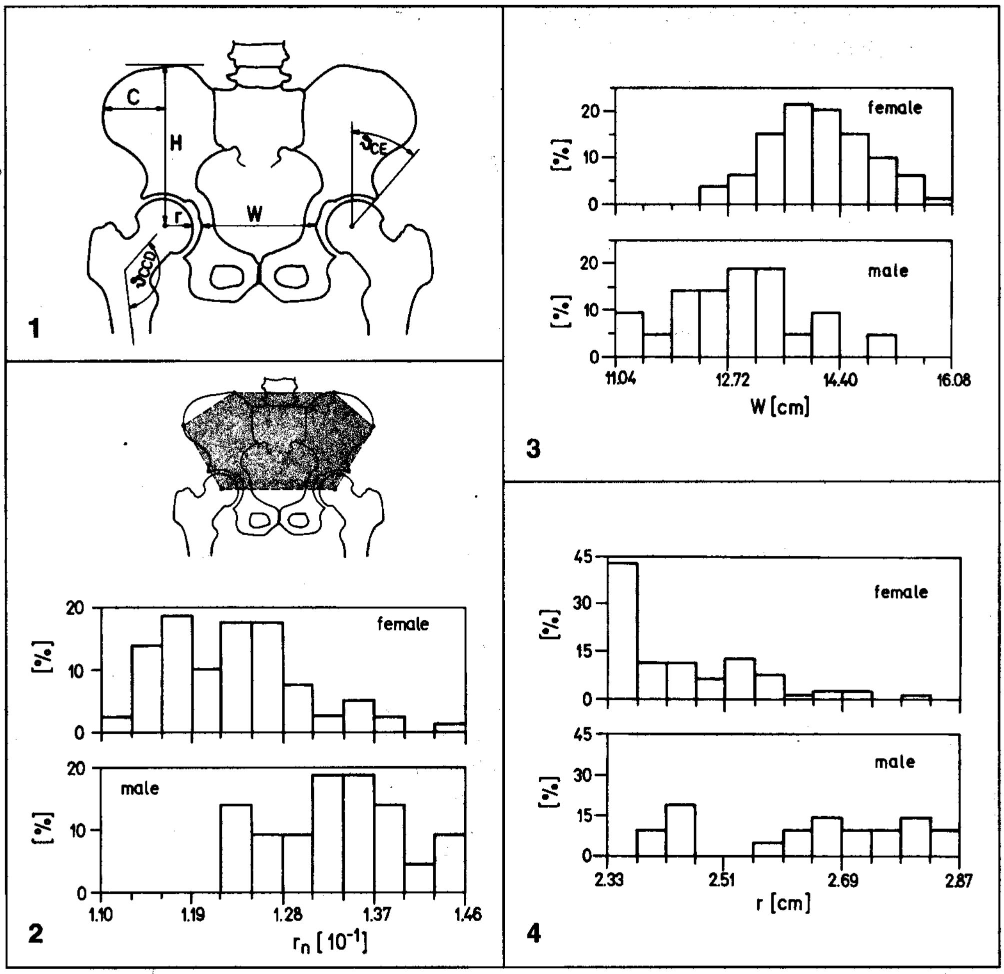

Fig. 1 Schematic presentation of the femoral and pelvic geometrical parameters studied in this work

Fig. 2 Histogram of the normalized femoral head radius ($r_n = r/A^{1/2}$) in women and men. *Shading* indicates the area *A*

Fig. 3 Histogram of the pelvic width *(W)* in women and men

Fig. 4 Histogram of the femoral head radius *(r)* in women and men

Results

The results show some important differences between women and men regarding the femoral and pelvic geometry. Figure 3 shows the histograms of the pelvic width W; the median value is higher in women (14.05 cm) than in men (12.94 cm), the difference being statistically significant ($P < 0.0001$).

Figure 4 shows the distribution of the femoral head radius r in men and in women. The median value is smaller in women (2.38 cm) than in men (2.68 cm), the difference being statistically significant ($P < 0.0001$). This is not a surprising result since the smaller femoral head radius in women is supposed to be correlated with their smaller body size relative to men.

In order to exclude the correlation between femoral head radius and body size, Fig. 2 shows the distribution of the normalized femoral head radius r_n in men and in women. The median value is smaller in women (0.123) than in men (0.132), and the difference is statistically significant ($P < 0.0001$). These results indicate that the femoral head radius is for the given size of the pelvis smaller in women than in men, meaning that a woman would have a smaller femoral head radius than a man with the same height and weight.

The median values of the pelvic height H (15.13 cm for women and 15.42 cm for men) are not significantly different ($P = 0.11$), nor are the median values of the horizontal distance between the most lateral point on the crista iliaca and the femoral head centre C (6.12 cm for women and 5.47 cm for men) ($P = 0.07$). Also, the median values of the centre-edge angle ϑ_{CE} (37.0° for women and 36.5° for men) as well as of the collodiaphyseal angle ϑ_{CCD} (129° for women and 126° for men) are not significantly different ($P = 0.31$ and $P = 0.14$, respectively).

Discussion

It was shown that the contact stress at the articular surface of the hip joint greatly increases with increasing distance between the inner acetabular rims W [3, 5] and with decreasing femoral head radius r [4, 9]. Since we have shown in this study that women have in general a larger W and a smaller r than men, it can be concluded that their hip joint contact stress is higher. Because increased stress in the hip joint accelerates the development of arthrosis [1], we propose that the female femoral and pelvic shape is more unfavourable than the male in these respect. This could be one of the reasons, especially in combination with increased body weight [2], for the increased incidence of arthrosis in women. This assumption is in agreement with some observations which indicate that aetiological factors associated with hip arthrosis may differ for men and women [10].

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