ACETABULAR DYSPLASIA AND HIP OSTEOARTHRITIS IN BRITAIN AND JAPAN

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SUMMARY

Objective. Geographic differences in the prevalence of hip osteoarthritis (OA) have been ascribed to differences in the frequency of acetabular dysplasia among different ethnic groups. However, there are few data on the shape of the acetabulum in various populations around the world. We examined this issue in samples of pelvic radiographs from Britain and Japan.

Methods. Measurements were made on the pelvic radiographs of 1303 men and 195 women, aged 60–75 yr, who attended for i.v. urography in two British centres. These were compared with 99 men and 99 women aged 60–79 yr who were included in a population-based study in a rural community in Japan, and who agreed to undergo standardized pelvic radiography. Acetabular dysplasia was assessed by morphometric measurement of the centre–edge (CE) angle and acetabular depth.

Results. The mean CE angle among men was 36° (95% CI 35–37°) in Britain and 31° (95% CI 29–32°) in Japan; that in women was 37° (95% CI 36–38°) in Britain and 31° (95% CI 29–33°) in Japan. The mean values of acetabular depth were also significantly (P < 0.001) lower in Japan than in Britain. However, the prevalence of hip OA was lower in Japan (0% in men, 2% in women) than in Britain (11% in men, 4.8% in women). In a random effects model, there were negative relationships between measures of acetabular dysplasia and minimum joint space among individuals.

Conclusions. We conclude that there are marked differences in pelvic morphometry between Britain and Japan. The acetabular dimensions of Japanese subjects are considerably shallower than those of their British counterparts of similar age and sex. Nevertheless, hip OA is more frequent in Britain than in Japan. Further studies are required on the risk factors for hip OA in Oriental populations, in order that the aetiology of this disorder can be better understood.

Key words: Acetabular dysplasia, Hip, Osteoarthritis, Pelvic morphometry, Britain, Japan.

OSTEOARTHRITIS (OA) of the hip is an important cause of pain and disability, especially among the elderly. In Britain, ~4% of people over 65 yr of age suffer from OA of the hip [1], and the disease is a major factor in the 35 000 total hip replacements carried out annually [2]. Only a small proportion of cases are explained by established causes such as developmental abnormality, infection and metabolic disorders [3]. In contrast, OA of the hip appears to be less frequent among Oriental populations, and clinical case series in Japan have suggested that a large proportion of cases are attributable to congenital dislocation of the hip [4, 5]. However, differences in pelvic morphometry between Oriental and British populations have been little studied [6], and the extent to which measures of acetabular dysplasia correlate with hip OA in individuals from the two countries has not been explored.

We addressed these issues in a cross-sectional epidemiological study which compared acetabular dimensions and the prevalence of hip OA among samples of elderly men and women from Britain and Japan.

SUBJECTS AND METHODS

We studied men and women aged 60–79 yr, selected from population studies in Britain and Japan. In Britain, the selection of participants has been described previously [7, 8]. From registers held at radiology departments in North Staffordshire and Southampton, we identified all men and women who had undergone i.v. urography over defined periods of time (5 yr for men, 3 yr for women), and who were aged 60–75 yr at the time of examination. Their hip joints were assessed from the control or post-micturition film. Radiographs were excluded if neither hip could be adequately visualized. If a patient had been examined more than once during the study period, the earliest suitable radiograph was used. Where hips had been replaced, pre-operative radiographs were assessed if available.

In Japan, we utilized an age-stratified random sample of 1543 men and women from the general population of a rural Southern district (Wakayama), aged 40–79 yr, who were enrolled in a prospective study of osteoporosis [9, 10]. Using this sample, we recruited 100 men and 100 women randomly within two age strata (60–69 and 70–79 yr). The response rate in these subjects was 98%. Pelvic radiographs of each participant were obtained using standardized conditions (non-weight bearing, with a fixed film-to-focus and subject-to-film distance).

A single trained observer in each country read all radiographs. Acetabular dysplasia was assessed using two measures: the centre–edge angle (CE) [11] and the acetabular depth [12]. The former was defined as the angle between a line joining the centre of the femoral head to the lateral margin of the acetabular roof and a line perpendicular to that joining the centres of the two femoral heads. The centres of the femoral

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heads were located with the aid of a transparent plastic sheet marked with concentric circles.

Acetabular depth was defined as the greatest perpendicular distance from the acetabular roof to a line joining the lateral margin of the acetabulum roof and the upper corner of the symphysis pubis on the same side. In the presence of acetabular dysplasia, the CE angle and acetabular depth are both low. OA was quantified by measurements of minimum joint space and an overall grade using the method of Croft et al. [13]. The latter represents a global grading system similar to the Kellgren and Lawrence scale [14]. We assessed the reproducibility of these radiographic grading systems both within and between observers using a subset of 50 radiographs from the study. Each radiograph was read on two occasions by the same observer in each country (NY, LC) at an interval of 3 months, and also read at the same time interval by the observer from the other country. All markings were erased between the readings.

To assess observer variation in the grading of acetabular dysplasia and minimum joint space, we used the method of Bland and Altman [15]. This entails plotting the difference in readings against the mean value of a particular reading for each observation. We analysed the data relating measures of acetabular dysplasia to the risk of hip OA in three different ways. First, we explored these relationships at the level of individual hip joints. However, as there is likely to be an association between the radiographic findings from the two hip joints in a single person, we then explored these relationships, restricting the data to the worst affected hip joints in any individual. The definition of the worst affected joint was based on sequential consideration of overall OA grade, minimum joint space, CE angle and acetabular depth. Finally, we performed a random effects model in which adjustments were made for age, sex and country. This permitted us to derive coefficients for the relationship between measures of acetabular dysplasia and minimum joint space, after allowing for these covariates, as well as for a within-patient random effect.

RESULTS

Figure 1 shows the within- and between-observer reproducibility for assessment of CE angle and acetabular depth in the subset of 50 Japanese radiographs. The figures express the difference between the first and second measurements for each parameter, against the mean of the first and second measurement. The figure also provides the 95% confidence intervals (CI) around the mean difference (limits of agreement). For each of the four comparisons, there was no significant systematic deviation between the two sets of readings.

Complete data were available on the hip joints of 1303 men and 195 women from Britain, and 99 men and 99 women from Japan. When data were analysed at the level of individual hip joints, this resulted in 2603 hip joints among British men, 390 hip joints among British women, 198 hip joints among Japanese men and 197 hip joints among Japanese women.

Table I shows the demographic characteristics of the study sample, the mean value of minimum joint space and the proportion of subjects with moderate to severe OA on the Croft scale (grade 3 or more severe). It also shows the mean CE angle and acetabular depth of subjects in the study, and the prevalence of abnormality in these two measures. The data presented relate to individuals, using values for the worst affected hip. The values for minimum joint space did not differ significantly between Britain and Japan for either sex. However, there was a lower prevalence of OA in Japanese men and women (0% and 2%, respectively) than was found among British men and women (11% and 4.8%, respectively). There was a large and highly statistically significant (P < 0.001) difference in CE angle and acetabular depth between the two populations. Thus, the mean CE angle among Japanese subjects (men 31°, 95% CI 29–32°; women 31°, 95% CI 29–33°) was almost 20% lower than that observed among their British counterparts (men 36°, 95% CI 35–37°; women 37°, 95% CI 36–38°). Similar, highly significant (P < 0.001) differences were observed between acetabular depth measurements in the two populations (mean value Japanese men 9.2 mm, 95% CI 8.7–9.7 mm; Japanese women 8.9 mm, 95% CI 8.5–9.4 mm; British men 14.4 mm, 95% CI 14.2–14.6 mm; British women 14.1 mm, 95% CI 13.7–14.5 mm). When thresholds were applied to the distribution of CE angle (25°) and acetabular depth (9 mm), which are conventional to denote acetabular dysplasia in Western populations, as many as 40% of Japanese subjects fulfilled Western criteria for dysplasia.

Figure 2 shows the relationship between minimum joint space and measures of acetabular dysplasia among the Japanese men and women, again using data from the worst hip of an individual for presentation. If dysplasia were a major risk factor for OA of the hip, a positive association would be expected for each of these relationships. The figure shows that there was no significant relationship between minimum joint space and acetabular depth, among Japanese men or women. For CE angle, negative relationships were observed among both men and women. In a random effects model, we were able to adjust for age, sex and country, while exploring the relationship between CE angle, acetabular depth and minimum joint space. In this model, we found a strong within-subject effect for all three measurements: minimum joint space within-patient variance = 0.46 (P < 0.001); CE angle within-patient variance = 32.95 (P < 0.001); acetabular depth within-patient variance = 19.8 (P < 0.001). However, the coefficients for the relationship between acetabular dysplasia or CE angle and minimum joint space were little changed after adjustment for age, sex, country and this within-patient random effect. The coefficient for the relationship between each measure of acetabular dysplasia and minimum joint space remained negative among both men and women. These analyses were repeated to explore the relationship between acetabular dysplasia and the presence of radiographic hip OA.
Fig. 1.—Reproducibility of measurements of CE angle and acetabular depth within and between observers, using 50 pelvic radiographs.

**TABLE I**
Minimum joint space, prevalence of hip OA and measures of acetabular dysplasia in Britain and Japan

<table>
<thead>
<tr>
<th></th>
<th>Japan</th>
<th>Britain</th>
<th>Japan</th>
<th>Britain</th>
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<tr>
<td>Number</td>
<td>99</td>
<td>1303</td>
<td>99</td>
<td>195</td>
</tr>
<tr>
<td>Age mean (95% CI), yr</td>
<td>68.8 (67.4–69.8)</td>
<td>67.1 (66.9–67.3)</td>
<td>68.7 (67.7–69.7)</td>
<td>66.8 (66.2–67.4)</td>
</tr>
<tr>
<td>MJS* mean (95% CI), mm</td>
<td>3.3 (3.2–3.5)</td>
<td>3.3 (3.2–3.4)</td>
<td>3.1 (2.9–3.2)</td>
<td>2.8 (2.7–2.9)</td>
</tr>
<tr>
<td>Prevalence of hip OA† (95% CI), %</td>
<td>0</td>
<td>11.0 (9.8–12.3)</td>
<td>2.0 (0.04–4.0)</td>
<td>4.8 (2.5–6.7)</td>
</tr>
<tr>
<td>CE angle Mean (95% CI), degrees</td>
<td>31 (29–32)</td>
<td>36 (35–37)</td>
<td>31 (29–33)</td>
<td>37 (36–38)</td>
</tr>
<tr>
<td>Prevalence &lt;25 (95% CI), %</td>
<td>16 (8–24)</td>
<td>4 (3–5)</td>
<td>19 (11–28)</td>
<td>4 (1–6)</td>
</tr>
<tr>
<td>Acetabular depth Mean (95% CI), mm</td>
<td>9.2 (8.7–9.7)</td>
<td>14.4 (14.2–14.6)</td>
<td>8.9 (8.5–9.4)</td>
<td>14.1 (13.7–14.5)</td>
</tr>
<tr>
<td>Prevalence &lt;9 mm (95% CI), %</td>
<td>40 (28–53)</td>
<td>2.4 (1.6–3.3)</td>
<td>41 (29–54)</td>
<td>3.0 (0.6–5.5)</td>
</tr>
</tbody>
</table>

*Minimum joint space.
†Croft grade 3 or more.

using the Croft grade. There were no statistically significant differences between the acetabular depth of men or women who had Croft grades 3+ when compared with those with Croft grades 0–2.

**DISCUSSION**

The results of this study suggest that the prevalence of hip OA is substantially higher in Britain than in Japan, but that this difference cannot be explained by differences in the frequency of acetabular dysplasia in the two populations. If anything, the acetabular dimensions of Japanese men and women are shallower than those of their British counterparts; yet, there is a significantly lower frequency of hip OA, and no association in individuals between measures of acetabular dysplasia and the occurrence of OA.

Our studies were based on pelvic radiographs obtained from samples chosen to represent the general population. However, in Britain, the subjects were chosen on the basis of a requirement for i.v. urography, while in Japan they constituted part of a radiographic prevalence survey. It is difficult to see how this differ-
ence would have led to the marked differences in acetabular dimensions which we observed between the two populations. It could, however, contribute to the extremely low frequency of hip OA which was observed in the Japanese sample. The observers who graded both acetabular dimensions and OA in our studies were different in the two countries. Clearly, a study comparing results of radiographic findings in two countries would ideally use the same readers for the radiographs in both countries. We were unable to achieve this, and separate readers were therefore used in each country. This does give rise to the possibility that there are differences in the way that radiographs were being read and that these spuriously gave rise to differences between the two countries. However, the reproducibility between the two observers, after a strict training protocol, was sufficient to exclude a major systematic bias in measurements made in the two countries. As the British sample was an opportunistic one, and had already been obtained [7, 8] before the Japanese radiographs became available, the two populations had slightly different age ranges. British subjects were aged 60–75 yr, while those in Japan were aged 60–79 yr. However, the mean age of the two groups was similar and we adjusted for age in our random effects model with little influence on the results. Finally, we found a low prevalence of OA among Japanese men and women (0% and 2%, respectively). These estimates are likely to be relatively imprecise, given the sample size studied, but the 95% confidence intervals around the prevalence estimates from Britain suggest that the disorder is genuinely less frequent in Japan than in Western populations. An important strength of our study is that it was population based and, therefore, was able to avoid biases due to selection for treatment of hip OA.

Our observations are in complete accord with those from other studies in Oriental populations. Hoaglund et al. [16] estimated the prevalence of severe OA among Hong Kong Chinese men aged 65–74 yr to be around 2.7%, and Lau et al. [6] reported severe joint space narrowing to occur in only 0.7% of hips chosen in each country. This does give rise to the possibility that there are differences in the way that radiographs from a sample of Hong Kong men of similar age who underwent pelvic radiography. However, morphometric studies of acetabular anatomy have not been performed in the Japanese population previously. Our reproducibility between the two observers, after a strict training protocol, was sufficient to exclude a major systematic bias in measurements made in the two countries. As the British sample was an opportunistic one, and had already been obtained [7, 8] before the Japanese radiographs became available, the two populations had slightly different age ranges. British subjects were aged 60–75 yr, while those in Japan were aged 60–79 yr. However, the mean age of the two groups was similar and we adjusted for age in our random effects model with little influence on the results. Finally, we found a low prevalence of OA among Japanese men and women (0% and 2%, respectively). These estimates are likely to be relatively imprecise, given the sample size studied, but the 95% confidence intervals around the prevalence estimates from Britain suggest that the disorder is genuinely less frequent in Japan than in Western populations. An important strength of our study is that it was population based and, therefore, was able to avoid biases due to selection for treatment of hip OA.

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![Graphs](image)

Fig. 2.—Relationship between measures of acetabular dysplasia and minimum joint space in samples of Japanese men and women.
explained by differences in measurement method, the grading systems utilized for CE angle and acetabular depth in these studies were identical, and the differences in pelvic morphometry are plausible given known differences in body build between Oriental and Western populations. The apparent combination of a smaller acetabular depth and lower prevalence of hip OA among Oriental men and women raises the intriguing possibility that shallower acetabulae may actually protect hips from osteoarthritic change in later life, by altering mechanical loading. Alternatively, Hoaglund et al. [16] suggest that the difference in hip OA between Asians and Caucasians may be due to differences in loading of the hip joints related to greater squatting among Asians as compared to sitting among Caucasians. However, further studies of individual risk factors for hip OA in Oriental populations are required before the aetiology of this disorder may be clarified.

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REFERENCES