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Original article

Bilateral incidence and severity of acetabular dysplasia of the hip

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Abstract

Background. Most Japanese patients have secondary osteoarthritis, mainly due to developmental dislocation of the hip (DDH) or acetabular dysplasia (AD). However, the precise pathomechanism of AD remains unknown. The purpose of this study was to investigate the frequency of bilateral AD and determine the correlation of the severity of AD between the right and left hips.

Methods. A total of 206 patients with prearthritis or early-stage osteoarthritis caused by AD were examined radiographically, and their history of treatment for DDH during infancy was reviewed. There were 187 women and 19 men included in the study, and the mean age at examination was 37.6 years (range 20–49 years).

Results. A total of 174 patients (84%) had bilateral AD. In all, 72 (35%) of the 206 patients had a history of treatment for DDH (DDH group), and the remaining 134 (65%) had no history of DDH (non-DDH group). Bilateral AD was observed in 55 patients (76%) in the DDH group and 119 patients (89%) in the non-DDH group; the difference was significant. The center-edge angle, acetabular head index, acetabular angle, and acetabular roof angle showed positive correlations between the right and left sides in the non-DDH group. There was no correlation of the acetabular roof angle between the two sides in the DDH group.

Conclusions. A high rate of bilateral AD and a positive correlation of the severity of AD between the right and left hips were observed, especially in patients with no history of DDH. Our data suggest that in many patients AD occurred as a result of bone malformation involving bilateral hip joints. More research from a genetic standpoint is needed to elucidate the pathomechanism of this disease.

Introduction

Primary osteoarthritis is a rare condition in Japan.[1] Most Japanese patients have secondary osteoarthritis, mainly due to developmental dislocation of the hip (DDH) or acetabular dysplasia (AD). More Japanese people with osteoarthritis were reported to have dysplasia than did American[2] or British[3] subjects.

The precise pathomechanism of AD remains unknown. Patients with AD have been reported to exhibit abnormal morphology of the pelvis,[4,5] and AD was considered to be associated with pathological transverse growth of the pelvis.[4,5]

The purpose of this study was to investigate the frequency of bilateral AD and the correlation of the severity of AD between the right and left hips. This retrospective diagnostic study received permission for publication from the institutional review board of Nagasaki University.

Material and methods

We selected patients with AD of the hip with prearthritis or early-stage osteoarthritis. Those with advanced or end-stage osteoarthritis were excluded so we could evaluate AD more accurately by excluding osteophyte formation. Patients ≤19 years of age were excluded to avoid premature hip joints, as were those >50 years because of the difficulty of confirming a history of treatment for DDH. Other patients who were excluded if they had a history of hip osteotomy, hip dislocation into the gluteal muscles, or secondary posttraumatic osteoarthritis, inflammatory rheumatic disease, osteonecrosis, or an infectious disease.

All patients visited our hospital for consultation about hip joint pain between 1996 and 2006. A total of 206 patients were examined radiographically and for any history of treatment for DDH during infancy. There were 187 women and 19 men, and the mean age at examination was 37.6 years (range 20–49 years).

Parameters evaluated were the center-edge (CE) angle,[6] acetabular head index (AHI),[7] acetabular angle,[8]

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and acetabular roof angle[9] (Fig. 1). AD was defined as a CE angle <20°, AHI <75%, acetabular angle >45°, or acetabular roof angle >15° on anteroposterior radiographs.[10]

Severity of osteoarthritis was graded using Japanese Orthopaedic Association (JOA) criteria.[11] Osteoarthritis of the hip was classified into the following four stages: prearthritis stage, with no osteoarthritic change; early stage, with slight narrowing of the joint space associated with sclerosis of the subchondral bone; advanced stage, with narrowing of the joint space with cystic radiolucencies and small osteophytes; and end stage, with almost total disappearance of the joint space and marked osteophyte formation.

Clinical symptoms were evaluated using Merle d'Aubigne and Postel's[12] hip joint scoring system, in which a maximum of six points in each case is assigned according to the following three criteria: pain, mobility, and walking ability.

All radiographs were obtained in the supine position. Anteroposterior radiographs were taken with a source-to-film distance of 110 cm. The patient's feet were internally rotated with the toes at 15° ± 5° to ensure that the X-ray beam was centered on the superior aspect of the pubic symphysis.

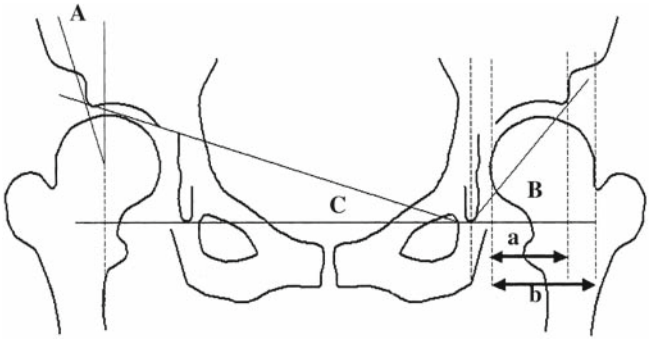

Fig. 1. Radiographic parameters. **A** Center-edge angle. **B** Acetabular angle. Acetabular head index = $a/b \times 100$. **C** Acetabular roof angle

To test the reproducibility of the radiographic measurements, three authors (K.O., M.T., N.O.) measured the CE angle, AHI, acetabular angle, and acetabular roof angle in five randomly selected hips. Each hip was measured three times, with an interval of 1 week between measurements, and the values were then averaged. The data were analyzed for intra- and interobserver variances, and the coefficient of variation was calculated to be less than 5%. Therefore, the reproducibility of the measurements was considered reasonable.

Differences between two means were tested using the Wilcoxon rank test. The correlations of X-ray parameters between the right and left sides were evaluated using Pearson's correlation coefficient (StatView software; Abacus Concepts, Berkeley, CA, USA). The significance level of the hypothesis test was $P < 0.05$.

Results

The mean total hip score on examination was 13.8 (range 8–17). The mean scores of pain, mobility, and ability to walk were 3.9 (range 1–5), 5.7 (range 5–6), and 4.2 (range 1–6), respectively. Almost none of the patients showed any limitation in the range of motion of the hip, and none had severe pain; however, they did have slight walking disturbances. In total, 22 patients with fatigue or dull pain in the contralateral hip consulted us. In these cases, the side with fatigue or dull pain was analyzed and considered as the side without pain. A total of 104 patients (51%) had hip joint pain on the right side at examination and 102 patients (49%) on the left side.

The CE angle and AHI were significantly smaller and the acetabular angle and acetabular roof obliquity significantly greater on the side with pain than on the side without pain; however, the differences between the right and left sides were not significant (Table 1). In all, 174 patients (84%) had bilateral AD. The CE angle, AHI, acetabular angle, and acetabular roof angle

Table 1. Measures of acetabular dysplasia on the right and left sides and on the sides with and without pain

	Side		Pain	
Measure	Right hip ($n = 206$)	Left hip ($n = 206$)	Hip with pain ($n = 206$)	Hip without pain ($n = 206$)
CE angle	12.7 ± 12.9 (–13 to 38)	13.1 ± 12.9 (–21 to 50)	8.4 ± 9.2 (–21 to 25)*	17.4 ± 9.0 (–3 to 50)
AHI	63.8 ± 11.3 (35–90)	64.8 ± 10.5 (36–90)	60.0 ± 10.6 (35–90)*	68.6 ± 9.8 (49–90)
Acetabular angle	48.3 ± 3.5 (37–57)	48.5 ± 4.0 (39–60)	49.7 ± 3.8 (43–60)*	46.9 ± 3.2 (37–55)
Acetabular roof angle	21.2 ± 8.3 (5–41)	20.2 ± 8.4 (3–45)	23.7 ±7.9 (5–45)*	17.6 ± 7.6 (3–40)

CE, center-edge; AHI, acetabular head index
All values are the mean ± SD, with the range in parentheses
* $P < 0.001$, for pain vs. without pain side

showed positive correlations between the right and left sides in all 206 patients (Table 2).

Altogether, 72 of the 206 patients (35%) had a past history of treatment for DDH (DDH group), and the remaining 134 patients (65%) had no history of DDH (non-DDH group). Bilateral AD was observed in 55 patients (76%) in the DDH group and in 119 patients (89%) in the non-DDH group; the difference was significant ($P = 0.019$). The CE angle, AHI, acetabular angle, and acetabular roof angle showed positive correlations between the right and left sides in the non-DDH group ($n = 134$) (Fig. 2). There was no correlation between the two sides for the acetabular roof angle in the DDH group ($n = 72$) (Table 2).

Figure 3 shows radiographs of a patient in the DDH group and a patient in the non-DDH group.

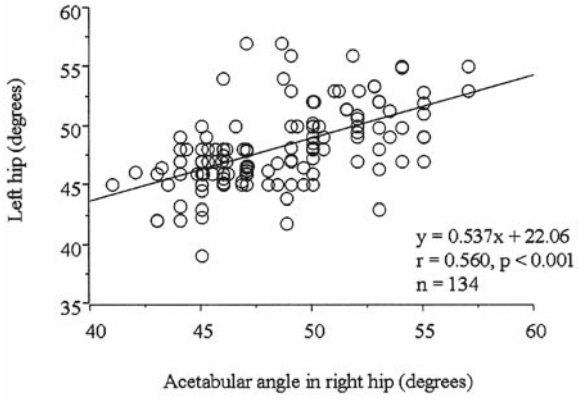

Fig. 2. Correlation of the acetabular angle between the right and left hips in patients with no history of developmental dislocation of the hip (DDH)

Discussion

Developmental dislocation of the hip and AD are thought to occur as a result of faulty development of the hip, also called developmental dysplasia of the hip, due to environmental factors extrinsic to the hip joint and hereditary factors altering the anatomy of the hip joint.[13] In this report, we have used the terminologies DDH and AD separately to clarify the relation between a history of DDH during infancy and radiographic evidence of AD during adulthood.

There are some reports of bilateral cases of AD. Stulberg and Harris[14] reported that approximately 50% of patients with osteoarthritis of the hip due to AD had a contralateral hip that was also dysplastic. Jacobsen et al.[10] reported the prevalence of AD as 3.4% among 4151 people randomly selected in Copenhagen; approximately 2% of cases were unilateral and 1.4% bilateral. In our study, 84% of the patients with pain caused by AD also had AD in the contralateral hip. Bilateral osteoarthritis of the hip that might have included primary osteoarthritis was reported in 50 (85%) of 59 patients in Japan[15] and 52% of 136 patients in England.[16] Japanese people with osteoarthritis have been reported to have more dysplasia than American[2] and British[3] subjects. Thus, according to our results and previous reports, cases of bilateral AD appear to be more frequent in Japan than in European countries.

Developmental dislocation of the hip is the major cause of secondary osteoarthritis. Incomplete remodeling of the acetabulum after reduction of DDH with the Pavlik harness, traction, closed reduction, and open reduction sometimes leads to residual AD in adults. In the present study, 35% of patients with AD had a history

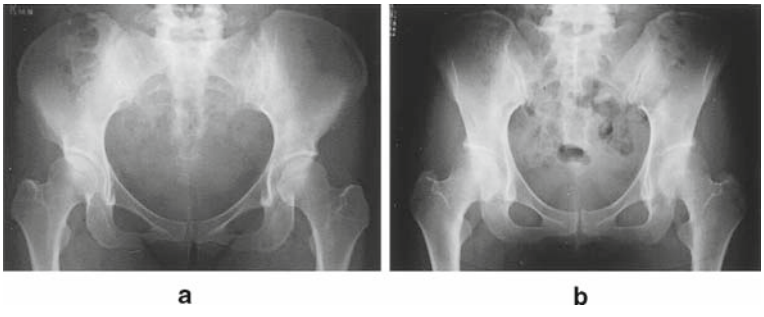

Fig. 3. a Anteroposterior (AP) radiograph of a 37-year-old woman with right acetabular dysplasia of the hip with a history of treatment for DDH. Acetabular angles are 50° in the right hip and 44° in the left hip. **b** AP radiograph of a 34-year-old woman with bilateral acetabular dysplasia of the hip without a history of treatment for DDH during infancy. Acetabular angles are 50° in the right hip and 49° in the left hip

Table 2. Correlation of radiographic parameters between right and left hips in patients with (DDH group) and without (non-DDH group) a history of DDH

Parameter	Total ($n = 206$)	DDH group ($n = 72$)	Non-DDH group ($n = 134$)
CE angle	$r = 0.307$, $P < 0.001$	$r = 0.297$, $P = 0.011$	$r = 0.344$, $P < 0.001$
AHI	$r = 0.338$, $P < 0.001$	$r = 0.235$, $P = 0.046$	$r = 0.411$, $P < 0.001$
Acetabular angle	$r = 0.410$, $P < 0.001$	$r = 0.275$, $P = 0.019$	$r = 0.560$, $P < 0.001$
Acetabular roof angle	$r = 0.220$, $P = 0.002$	$r = 0.006$, $P = 0.958$	$r = 0.416$, $P < 0.001$

DDH, developmental dislocation of the hip

of DDH (however, 65% of the patients had no such history). In a study in Japan, bilateral DDH was reported in 12 of 51 patients treated by open reduction,[17] in 5 of 40 patients treated by overhead traction,[18] and in 15 of 115 patients treated with the Pavlik harness.[19] Unilateral DDH was more frequent than bilateral DDH.

In Japan, patients with AD have been reported to exhibit abnormal morphology of the pelvis. Funayama et al.[4] reported hypoplasia of the wing of the ilium on radiographs in patients with AD. Kojima et al.[5] reported that the transverse diameter of the pelvic inlet was significantly less than the corresponding measurement in patients without AD, using computed tomography (CT) images. They suggested that AD is a manifestation of a developmental characteristic of the pelvis.[4,5] The high rate of bilateral AD and the positive correlation of the severity of AD between right and left hips in patients without a history of DDH in our data support the hypothesis that AD is associated with the morphology of the pelvis.

Our study has several limitations with regard to the treatment history of DDH patients. (1) We questioned the patients and their parents about the treatment undergone for DDH during infancy. Patients ≥50 years of age were excluded from this study because of the difficulty of obtaining reliable information on treatment history. Although we were able to obtain treatment history from all patients in the DDH group, we were not able to confirm certain details, such as the side of the dislocated hip or the exact treatment method employed. These patients could describe the treatment history but were unable to provide the detailed aspects of the treatment methods used. (2) There is a possibility that the non-DDH group in the present study might have included patients with untreated DDH that improved spontaneously.

In the DDH group there was no relation found between the right and left hips in regard to the acetabular roof angle, which reveals the slope of the weight-bearing area of the acetabulum. Treatment of DDH may influence the development of the weight-bearing area of the acetabulum more strongly than the whole structure of the acetabulum evaluated, for example, by the acetabular angle.

In this study, a high rate of bilateral AD and a positive correlation of the severity of AD between right and left hips were observed, especially in patients with no history of DDH. Our data suggest that in many patients AD occurred as a result of bone malformation involving bilateral hip joints. More research is needed from a genetic standpoint to elucidate the pathomechanism of this disease.

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