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A Radiological Study of Rapidly Destructive Coxarthropathy

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Abstract: Rapidly destructive coxarthropathy (RDC) is a clinical concept propounded by Postel and Kerboull. RDC is characterized by joint destruction progression within a year, although the etiology of this disorder remains unknown. We evaluated 21 hips in 20 patients radiologically diagnosed with RDC. All patients underwent a total hip arthroplasty. The average age at surgery was 75 years. The affected side was more osteoporotic in all patients, and the pelvic angle, which indicates the spinopelvic alignment, was distributed below the normal range, i.e., the posterior tilt was more than the normal range. The affected side showed a higher center-edge (CE) angle and anterior-acetabular head index (AAHI) than the unaffected side, possibly due to severe head collapse. Our result supported that osteoporosis and / or mechanical factors influence the course of RDC. More investigations such as biochemical and immunopathological analyses would be necessary to clarify the etiology of RDC, which could be a terminal stage of some lesions.

Key words: rapidly destructive coxarthropathy (RDC), osteoporosis, center-edge (CE) angle, anterior-acetabular head index (AAHI)

Introduction

Rapidly destructive coxarthropathy (RDC) is a general term to describe hip joint lesions of unknown etiology characterized by a rapid destruction of the acetabular and femoral aspects of the hip joint within a year, affecting mainly elderly people[1)]. Some studies have investigated the pathophysiology and pathomechanisms underlying RDC, and these include various factors such as subchondral insufficiency fracture (SIF)[8–10)], osteoporosis or bone brittleness[2)], backward pelvic tilt[11–13)], and proteinase action[15–19)]. In this study we examined the influence of mechanical factors in patients diagnosed with RDC by evaluating diagnostic images.

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Patients

We performed 3159 total hip arthroplasties (THAs) from April 1997 to September 2011 in Ebina General Hospital. Among them, 37 hips in 36 patients (1 male and 35 females) were diagnosed as having RDC based on the criteria of Ohzono[20], as follows:

1. Obvious destruction of both the femoral head and the acetabulum occurs in a normal hip joint (although a similar finding can be detected with osteoarthritis or aseptic necrosis of the femoral head just after pathopoiesis) within 12 months.
2. At least one-third of the femoral head has disappeared.
3. Acetabular destruction with dilated acetabulum and/or destruction of acetabulum in weight-bearing segments with subdislocation.

Patients with infectious, neurological, metabolic, ischemic, or inflammatory disease were excluded from the RDC study based on past history, blood examination, and diagnostic images. We thus evaluated 21 hips in 20 patients (1 male and 19 females) in which available information of DEXA and spine-pelvis alignment before and after THAs was available. The average age at surgery was 75 years (range, 67 to 85 years), and the period from onset to confirmed diagnosis was 8 (1 to 10) months. The patients had an average body weight of 54 (33 to 71) kg, height of 149 (144 to 155) cm, and body mass index (BMI) of 24.1 (17.8 to 30.3).

Methods

Bone brittleness was evaluated by dual X-ray absorptiometry (DEXA) (DPX-IQ, GE Healthcare, Madison, WI, USA), Singh's classification, and the existence of compression fracture in the spinal column. By DEXA, bone mineral density was measured anteroposteriorily in L1 to L4 vertebras and the mean of these four vertebras was calculated. To minimize the artifact, deformed vertebra were excluded from the calculation. The bone mineral density (BMD) was also evaluated by % of YAM (a ratio against young adult mean bone mineral density)[22]. According to the diagnostic criteria, patients with BMD $<$ 70% of YAM or 70–80% along with a history of osteoporotic fractures were diagnosed as having osteoporosis. Patients with a BMD of YAM or 70–80% along without any history of osteoporotic fractures were diagnosed as having osteopenia[22]. To evaluate morphological factors, the backward tilt of the pelvis was calculated by the approximation of Doiguchi *et al* using the anteroposterior radiographs taken in standing position (Fig. 1)[21]. Congruent spinopelvic alignment was evaluated based on Jackson's pelvic angle (PA) measurement from the radiographs of full spinal column taken in standing position (Fig. 2)[6]. The anterior congruency of the hip joint was evaluated by comparison of the center-edge angle (CE angle)[23] and anterior acetabular head index (AAHI) (Fig. 3) between the affected and unaffected sides[24, 25]. One patient with bilateral lesions was also excluded from the evaluation because neither CE angle nor AAHI was immeasurable. CE is an angle determined by the vertical

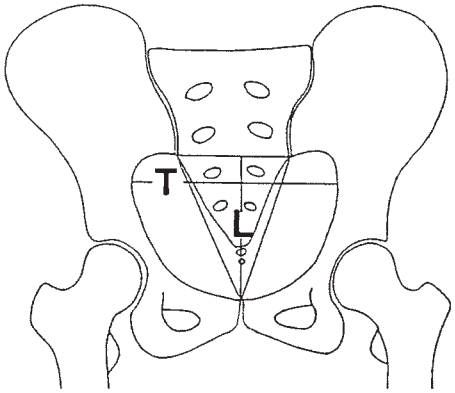

Fig. 1. Backward Tilting Angle of Pelvis
Ratio L / T = longitudinal diameter (L) / transverse diameter (T) of the pelvic cavity. T: the maximum transverse diameter of the pelvic cavity parallel to the line *ac*. L: a vertical line from the upper border of pubic symphysis to the line *ac*. Men : $-67.0^{\circ} \times L / T + 55.7$; women : $-69.0^{\circ} \times L / T + 61.6$.

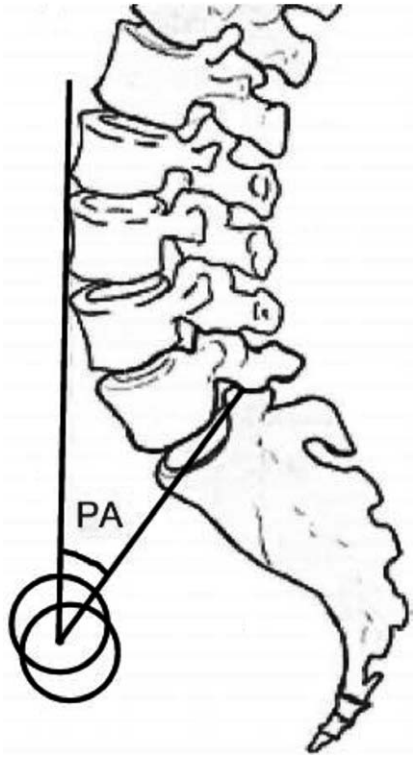

Fig. 2. Pelvic Angle (PA)
Two lines are determined: one is a plumb line; the other goes through "the midpoint of bilateral acetabulum centers" and "the posterior angulus on the upper margin of the sacrum". The angle between the two lines is the pelvic angle (PA).

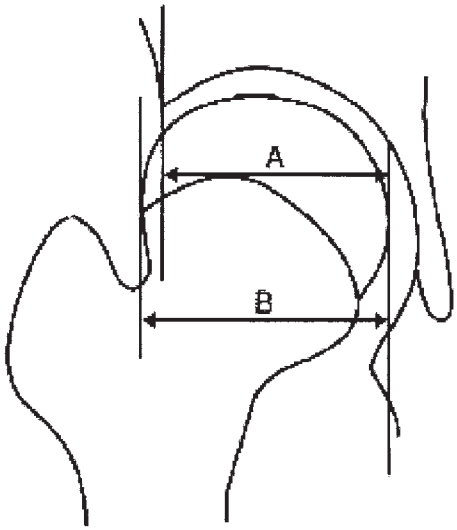

Fig. 3. Anterior Acetabular Head Index (AAHI)
AAHI is the ratio of the distance from the anterior acetabular border to the posterior border of the femoral head in the diameter of the femoral head, i.e., a percentage of A / B.

axis passing the center of the femoral head and the line from the center to the anterior border of the acetabulum[23]. AAHI is considered to be the ratio of the distance from the anterior acetabular border to the posterior border of the femoral head" to the diameter of the femoral head[24, 25].

Statistical analyses were carried out with the chi-square test or the Student's t test or Pearson's correlation coefficient and Fisher's Z transformation. A significant difference was reported at $p < 0.05$ in all statistical analyses.

Results

The average YAM was 80.5% (59 to 126). Seven hips were Singh's Grade IV, four were Grade V, and nine were Grade VI for the affected side, while three hips were IV and seventeen were VI for the unaffected side. This indicated that the affected side was more porotic (Chi-square test, $t = 8.06$, $P = 0.018$). The number of vertebral deformities after compression fracture was 0.4 (0-3), and there was a relationship detected between osteoporotic factors and the RDC. The backward pelvic tilting angle was 16 degrees in the male patient and 24 (13 to 40) degrees in females in this study. On the other hand, the normal tilting angle was reported as 19.47 ± 6.26 degrees in the male and 24.4 ± 5.93 in females[21]. The average of our measured PA was -51 (-34 to -74) degrees while the reported normal value of PA ranged from -5 to -29 degrees. PA in all patients was distributed below the normal range. That is, the posterior tilt was more than the normal range, although this result could have been affected by the capital deformity. CE angle was 28

Fig. 4. Case 1. An 81-year-old female. AP radiograph taken at the family doctor. Only small cysts were detectable in the acetabulum and head with slight collapse.

(17 to 39) degrees on the affected side and 34 (17 to 51) degrees on the unaffected side, although more CE angles were detected on the affected side than the unaffected side ($t = 2.270$, $P = 0.037$). The severe head destruction seemed to have brought about the excessive CE angle in seven hips. AAHI was 69.7% (50.6 to 88.2) on the affected side and 76.4% (59.3 to 88.2) on the unaffected side, with more indices detected on the affected side than the unaffected side ($t = 2.712$, $P = 0.013$).

Case Presentation

Case 1 : An 81-year-old female with a past history of hypertension and no family history presented at her first examination with severe hip pain for the past two months. The pain had been present to a slight degree for the previous two years according to notes from the family doctor (Fig. 4). At her first examination, the Trendelenburg Sign was positive and a cane was indispensable to walk despite the motion range being largely preserved. Blood testing showed no inflammation, with red blood cell count, white blood cell count, hemoglobin levels, and C-reactive protein all within normal ranges. The AP radiograph revealed a worn femoral head and bone cysts (Fig. 5). Because of our surgical schedule, the patient had to wait two months until a THA could be performed. The destruction of the head progressed rapidly in these two months and we diagnosed the lesion as RDC. Despite this

Fig. 5. AP radiograph in Case 1 two months later, showing obvious progression of the capital collapse and destruction.

rapid aggravation, THA was performed successfully (Fig. 6).

Case 2: An 80-year-old female with no past or family history had experienced very slight left hip pain for two months prior to our first examination and a family doctor diagnosed it as osteoarthritis (Fig. 7). After a slight fall after that diagnosis, the destruction of the femoral head rapidly progressed. She was diagnosed as RDC at our first examination (Fig. 8). The Trendelenburg Sign was positive and a cane was indispensable to walk although the motion range was relatively preserved. Blood testing showed no inflammation, with red blood cell count, white blood cell count, hemoglobin levels, and C-reactive protein all within normal ranges. THA was performed successfully (Fig. 9).

Discussion

In 1957 Forestier first described the clinical concept of RDC[26], but it only became widespread following the report of Postel and Kerbpull[1]. Postel and Kerboull characterized RDC by rapid destruction progressing within 6–12 months, severe gait disturbance due to severe pain, well preserved motion range, occurrence mostly in elderly people, unilateral lesion, and poor inflammatory findings. In addition Postel and Kerboull reported that most RDC develops in a normal hip joint, although some develop in an osteoarthritic hip that has a long silent history and then rapidly progress[1]. Ohzono proposed a revised definition of RDC in 1998[20]. According to this draft amendment, obvious destruction of both the

Fig. 6. One year after THA, neither loosening nor migration was detectable.

Fig. 7. Case 2 : An 80-year-old female. AP radiograph taken at the family doctor. Small cysts were detectable in the acetabulum and head, with narrow joint space and slight collapse.

Fig. 8. AP radiograph of Case 2 two months later, showing obvious progression of the capital collapse and destruction.

Fig. 9. One year after THA, neither loosening nor migration was detectable.

femoral head and the acetabulum occurs in a normal hip joint (although a similar finding can be detected with osteoarthritis or aseptic necrosis of the femoral head just after pathopoiesis) within 12 months, with at least one third of the femoral head destroyed, and acetabular destruction with dilated acetabulum and / or destruction of acetabulum in weight-bearing segments with subdislocation.

Most reports excluded infectious, neurological, metabolic, ischemic, or inflammatory disease from RDC[27, 34]. On the other hand, Totsugi *et al*[28] pointed out that most RDC occurred based on avascular necrosis (AN) of the femoral head. According to this report, the lesion area is the same in AN and in RDC, but tissue distruction develops earlier and is more widespread in RDC than in AN. Additionally, AN lacks a marginal line between the necrotic and normal area, while RDC lacks recurrent necrosis[28]. In another study Totsugi *et al* reported that RDC reflects developing osteoarthritis or AN to some extent[29]. Aside from such prominent reports, other etiologies have also been suggested for RDC[2, 8-13, 15-19]. In particular, two prime factors have been attracting attention[8, 9]. One is a mechanical failure, such as backward pelvic tilt and / or hip dysplasia with an increased weight-bearing area on the femoral head causing SIF, resulting in progressive destruction and collapse[3, 4, 9, 10]. The other factor is bone brittleness[2]. In this study, we focused on these two factors. Concerning the mechanical failure, all patients showed excessive pelvic backward tilt, although PA was distributed widely. The CE angle was more pronounced on the unaffected side than the affected side also in our patients, which is in contrast with the findings of Watabe *et al*[14]. Similarly AAHI was higher on the affected side than the unaffected side in our study. Our results therefore indicated that a change in sagittal alignment could contribute to the etiology of RDC while the degree of head collapse could be an interventional factor in the CE angle and AAHI. In RDC the superior part of the head has been lost. In such situations, the CE angle must be greater on the affected side than on the unaffected side as far as no dysplasia exists because the head center must migrate proximally under such mechanical circumstances. Similarly, AAHI must be greater in the affected side because the head has been lost beyond the equatorial plane.

With regard to bone brittleness, Sofue and Kimura reported some influence of osteoporosis on RDC, detected on the unaffected side[2]. Our results support the findings of Sofue and Kimura, although we also found that the affected side is more porotic than the unaffected side, and this could be because of the influence of the observed disuse atrophy. At the same time, some authors pointed out that osteoporosis had no relation to RDC[27, 31, 32]. The role of osteoporosis in the etiology of RDC thus remains controversial. Some phenomena are detectable in RDC. More investigations such as biochemical and immunopathological analyses are clearly necessary because RDC could be a terminal stage of some lesions[27, 28, 33] and it is difficult to determine whether the phenomena are the cause or result of RDC.

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