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Original Article

Reliability of radiographic evaluations of the stage of osteoarthritis of the hip joint and an approach to improve the staging criteria

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ABSTRACT

Background: A few reports have shown that the reliability of the Japanese Orthopaedic Association stage classification of hip osteoarthritis was not high. The objective of this study was to assess the reliability of the stage classification of coxarthrosis, and to evaluate whether a modification of the classification improves reliability.

Materials and methods: We retrospectively investigated 200 hips in 100 patients with hip pain. We collected radiographs of their hip joints with the patients in both a supine and a standing position. Four orthopaedic surgeons evaluated the stage of coxarthrosis employing the JOA classification. The percentage of agreement of examiners and the value of the kappa statistic were calculated. Furthermore, to improve the reliability of classification, we modified the classification based on previous reports. Partial narrowing of the joint space and disappearance of the joint space were defined as maintained if it was 2 mm or more, and as the width of the loss of joint space that was 10 mm or more respectively. Using this classification, the same examiners assessed the stage on the same radiographs again three months after the previous evaluation.

Results: The percentages of agreement were 28.5% and 27% and the interobserver value of the kappa statistic was 0.45 and 0.44 in supine and standing position respectively. After modification of the classification, the percentages of agreement were 36.5% and 44% and the interobserver value of the kappa statistic was 0.48 and 0.56 in supine and standing positions respectively, and the intraobserver value of the kappa statistic was 0.55. The modification significantly improved the reliability only in the percentage of the agreement for the standing position.

Conclusion: This study showed that the reliability of the JOA stage classification of coxarthrosis was not as high as previous reports have showed. Modification of the classification improved interobserver reliability.

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1. Background

The staging of hip osteoarthritis (OA) is important for the choice of treatment options and the assessment for efficacy of treatment. Nationwide, there are some classifications, including the Kellgren and Lawrence grade [1], Croft's grade [2], minimal joint space (MJS; according to Croft) [2], and Tönnis classification [3]. The criteria of

the Japanese Orthopaedic Association's (JOA) Committee on Evaluation are widely employed in Japan (Table 1) [4]. The JOA classification consists of four stages (prearthrosis, initial stage, advanced stage, and terminal stage) and three categories (joint space, bony architecture, and shape of the acetabular roof and the femoral head). The JOA classification adequately expresses the pathological condition and the stage of progression, however, the JOA classification has ambiguous descriptions. A previous report showed that this ambiguous wording was the reason that the reliability of the JOA classification was not high [5]. Some reports have shown that the reliability of the classification of hip OA is not high, and attempts to improve the reliability were undertaken [5–7]. The JOA classification has not been changed since 1971 when Ueno reported

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Table 1
JOA staging criteria for coxarthrosis.

Stage	Joint space	Bony architecture	Shape of the acetabular roof and the femoral head
0	Almost normal	Almost no change	Almost normal
1	Slight incongruity, no narrowing	Change of trabeculae	Congenital or acquired morphological change
2	Incongruity, partial narrowing	Sclerosis of the acetabulum	Small osteophyte
3	Incongruity, localized contact of the subchondral bones	Sclerosis of the acetabulum, bone cyst(s) in the acetabulum or the femoral head	Osteophyte, bone formation on the acetabular floor
4	Incongruity, extensive disappearance of the joint space	Extensive sclerosis, large bone cyst(s)	Prominent osteophyte(s), double floor, destruction of the acetabulum

Referenced from Takatori et al. [5].

0, almost normal; 1, prearthrosis; 2, initial stage; 3, advanced stage; 4, terminal stage.

it, although the classification of hip OA is very important. The purported reason is that there are very few reports that assess the improvement in the JOA classification. There is no consensus on the improvement in the classification, so more assessments and a better classification are necessary. The purpose of this study was to assess the reliability of the classification of hip OA in Japan and to evaluate whether a modification of the classification improves reliability.

2. Material and methods

This investigational protocol was conducted with the approval of our institutional ethical committee. In accordance with the requirements of this review, all patients gave informed consent. We retrospectively investigated 200 consecutive hips in 100 patients (16 males, 84 females) who presented to our hospital with hip pain from March 2014 to October 2015. The average age \pm the standard deviation (SD) was 65.2 ± 10.1 years. For this study, we selected only patients diagnosed with primary OA and secondary OA due to developmental dysplasia of the hip. Patients with a history of hip fracture, inflammatory rheumatic disease, osteonecrosis, or infectious diseases were excluded. Patients were also excluded if they had undergone an operation on their hip joint. We collected radiographic films of their hip joints, which had been obtained in our hospital with the patients in both a supine position and a standing position. In these films, the X-ray beam was directed to the proximal margin of the symphysis pubis and personal information was deleted. Four orthopaedic surgeons evaluated the stage of coxarthrosis. The numbers of years of experience of the observers were as follows: observer 1, six years; observer 2, fifteen years; and two others, over twenty years with over ten years as hip surgeons. We employed the evaluation criteria and classification scheme proposed by the Japanese Orthopaedic Association (JOA) to determine the stage of hip OA. We evaluated films in both the supine and standing positions. Furthermore, in order to improve the reliability of defining the stage of coxarthrosis, we developed a modified

Table 2
The modification of JOA criteria.

Stage	Joint space (pre-modification)	Joint space (post-modification)
0	Almost normal	Almost normal
1	Slight incongruity, no narrowing	Slight incongruity, no narrowing
2	Incongruity, partial narrowing	Incongruity The width of joint space is maintained 2 mm or more throughout the weight-bearing area
3	Incongruity, localized contact of the subchondral bones	Incongruity The width is less than 2 mm at the thinnest point, and the width of loss of joint space is less than 10 mm.
4	Incongruity, extensive disappearance of the joint space	Incongruity, the width of loss of joint space is more than 10 mm

Left: The category is the joint space of the JOA classification; Right: The modification of the joint space category of the JOA classification. Partial narrowing of joint space was defined as maintained if it was 2 mm or more, and disappearance of the joint space was defined as the width of loss of joint space that was 10 mm or more.

classification system based on previous reports [5]. In this modification, the ambiguous words were defined. Partial narrowing of the joint space was defined as maintained if it was 2 mm or more, and disappearance of the joint space was defined as the width of the loss of joint space that was 10 mm or more (Table 2). According to this classification, the same four examiners assessed the roentgenographic stage on the same radiographs again three months after the first evaluation.

3. Statistical analysis

To assess observer agreement, we calculated the percentage of agreement of four observers and the value of the kappa statistic for the hip OA stages to evaluate the strength of observer agreement [8]. Table 3 shows the strength of agreement of kappa statistics that were suggested by Landis and Koch [8]. Statistical analysis was performed using SPSS software (IBM SPSS Statistics 23.0; IBM, Armonk, New York). The Chi-square test was used to assess the difference. A p-value < 0.05 was considered statistically significant.

4. Results

Using the original JOA criteria, the rate of agreement of all observers was 28.5% and 27% for the supine and standing positions,

Table 3
Guidelines for strength of agreement indicated with kappa values.

Kappa value	Strength of agreement
<0	Poor
0–0.20	Slight
0.21–0.40	Fair
0.41–0.60	Moderate
0.61–0.80	Substantial
0.81–1.00	Almost perfect

To assess observer agreement, we calculated the value of the kappa statistic for the hip OA stages suggested by Landis and Koch [8].

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