INTRODUCTION: Acetabular dysplasia has been implicated as an etiologic factor in the development of secondary osteoarthritis (OA) of the hip1,2. Dysfunction of the hip secondary to dysplasia derives from multifactorial problems such as excessive stresses on the articular cartilage1 and dynamic hip instability2. To our knowledge, however, there have been only a few studies investigating hip instability3,4.

Evaluation of dynamic hip instability may not only analyze one of the causes of secondary OA but also unveil the etiology of primary OA of the hip. The purpose of the present study was to elucidate hip instability of the in vivo normal hip joint and acetabular dysplasia by evaluating the three-dimensional (3D) translations using 3D magnetic resonance imaging (MRI)6.

METHODS: Twenty normal hips from young healthy volunteers (mean ages 31.8 years), 10 normal hips from elderly healthy volunteers (mean ages 68.6 years), and 22 dysplastic hips (mean ages 32.9 years) at pre- or early stages of OA were examined. All subjects were females. Criteria for enrollment as a dysplastic hip were as follows: less than 20° edge (CE) angle on the mid-coronal MR image; Group I subluxation according to the classification of Crowe et al.; no evidence of joint space narrowing; no deformity of the femoral head; and no previous operation on the hip joint.

MR imaging was performed with 3D true fast imaging with steady-state precession (FISP) using a flexible surface body coil on a 1.5-T MR system (MAGNETOM Espree, Siemens, Erlangen, Germany), making images with the hip in four different positions bilaterally: neutral, 45° of flexion, 15° of extension, and the Patrick position (Fig. 1).

Fig 1 Data acquisition of magnetic resonance imaging.

The center of the femoral head sphere (head center, FHc) and that of the acetabular sphere (acetabular center, AC) were calculated with a least square method. The distance between AC and FHc at the neutral position was defined as the 3D migration. The 3D translation from a neutral position to each position was measured as the distance of the FHc between a neutral position and each position (Fig. 2).

RESULTS: The acetabular sphere radius was the determinant of 3D-migration ($\beta=0.865$, p=0.001), and there was a statistical significant difference in 3D-migration between normal female hips and dysplastic hips (p=0.047).

From neutral to 45° of flexion, the FHc of normal young, elderly, and dysplastic hips translated antero-inferiorly by 1.10±0.31 mm (0.60–1.57 mm), 1.70±0.48 mm (1.04–2.45 mm) and 1.30±0.41 mm (0.76–2.39 mm), respectively, and the difference between normal young female hips and elderly hips was statistically significant (p=0.008). Age and acetabular sphere radius were the determinant factors for 3D-translation from neutral to 45° of flexion ($\beta=0.473$, p=0.001 and $\beta=0.351$, p=0.003, respectively).

From neutral to the Patrick position, the FHc of normal young, elderly, and dysplastic hips translated postero-inferio-medially by 1.12±0.39 mm (0.45–1.85 mm), 0.62±0.31 mm (0.28–1.14 mm) and 1.97±0.84 mm (0.95–3.34 mm), respectively, and there were statistically significant differences between normal young female and elderly hips (p=0.010) and between normal young female and dysplastic hips (p=0.005). CE angle was the determinant for 3D-translation from neutral to the Patrick position ($\beta=0.774$, p=0.001).

The average root mean square error in 3D-translation was 0.193 mm for inter-observer reproducibility.

Fig 2 3D translation from neutral to the Patrick position in a right dysplastic female hip. The x-, y-, and z-axis points anteriorly, superiorly, and laterally, respectively.