**Intraoperative Stability Test of Total Hip Arthroplasty**

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**Disclosures:**
H. Tanino: None. T. Sato: None. Y. Nishida: None. H. Ito: None.

**Introduction:** Dislocation continues to be a common complication of total hip arthroplasty (THA). Many factors are known contributors to THA stability [1]. Intraoperative stability tests have been used to assess ROM using two critical positions: 90° flexion plus internal rotation and extension plus external rotation [2], and higher intraoperative range of motion (ROM) is believed to minimize dislocation risk. However, it is not clear whether intraoperative stability tests are useful to indicate hip stability after THA or not. And it is not clear what angles are required in intraoperative tests for stable hip after THA, because different angles have been indicated as acceptable ROM [2,3,4]. In this study, we evaluated the effect of intraoperative ROM on dislocation rates after THA. We also examined the combined effect of other risk factors conjunction with intraoperative ROM. Our hypothesis was that intraoperative stability tests were effective to indicate hip stability after THA, and high intraoperative ROM decreased the likelihood of dislocation after THA.

**Methods:** Between May 2009 and December 2012, the senior surgeon performed primary THA in 212 consecutive patients (226 hips) at one hospital. To be included in the analysis, the following was required: primary THA, single surgeon at one hospital, ROM data available, no second surgeries before the first dislocation event, and follow-up was longer than six months. 8 hips were excluded (ROM data availability 5 hips, second surgery 1 hip, and short follow-up 2 hips), so 218 hips (204 patients)(55 men and 149 women; age 63.6±12.5 years; height 153.8±9.2 cm; weight 58.0±11.5 kg; 115 right and 103 left hips) were included and analyzed in this study. The project was approved by IRB. All of the procedures were performed by one senior surgeon in a lateral decubitus position, using a posterolateral approach without posterior capsule repair. The average length of follow-up was 19 months (6-45 months). The preoperative diagnoses were osteoarthritis in 176, osteonecrosis of the femoral head in 22, femoral neck fracture in 10, and rheumatoid arthritis in 10. One hundred seventy three femoral components were cemented (4-U; Nakashima Medical Co., Japan) [5,6] and 45 uncemented (S-ROM; Depuy, IN or 4-U CLS; Nakashima). All acetabular components were uncemented. There were 150 4-U cup (Nakashima), 47 Trilogy cup (Zimmer, IN), 14 4-U CLS cup (Nakashima), and 7 ZTT-2 cup (Depuy). The diameter of the prosthetic femoral head was 22 mm in 1 hip, 26 mm in 83 hips, 28 mm in 13 hips, and 32 mm in 121 hips. The standard flat liner was used in 63 hips and the elevated liner was used in 155. The variables that were studied as risk factors included age, height, weight, gender, cerebral dysfunction, preoperative diagnosis, and history of previous hip surgery. Cerebral dysfunction included mental confusion, dementia, and mental disorder, similar to other study [3]. Another category entitled IR angle was investigated as intraoperative stability. After all components were placed into position, the range of internal rotation with 90° hip flexion was measured using a goniometer (IR angle), similar to Sultan et al [7]. Dislocation rates were obtained through clinic and hospital records. Statistical analysis was done using a chi-square test for nominal variables and an unpaired t-test for continuous variables. Logistic regression was performed using 8 of these variables. Statistical analyses were performed with SPSS Version 19 (SPSS Inc, IL).

**Results:** Nineteen patients sustained a hip dislocation resulting in a prevalence of 8.7%. Ten women and nine men had 17 posterior dislocations and 2 anterior dislocations. The average age of the nineteen patients who had a dislocation was 66 years (45-84 years) and height and weight averaged 155 cm and 60 kg. The preoperative diagnoses for THA in these 19 patients were osteoarthritis in 13 patients, osteonecrosis of the femoral head in 4 hips, and rheumatoid arthritis and femoral neck fracture in 1 each. 4 of these patients had history of previous hip surgery. The patient’s average age, height and weight were not statistically different between patients with dislocation and patients without dislocation after THA (p=0.35, p=0.67 and p=0.56). The gender of the patient was statistically related to prevalence (16.7% vs 5.7%; p=0.01). There were significant differences in the dislocation rates in the 29 patients who were classified as having cerebral dysfunction compared to the 189 patients who had no cerebral dysfunction (21% vs 6.9%; p=0.014). The preoperative diagnoses were categorized into 2 classes: 1) osteoarthritis, or 2) osteonecrosis of the femoral head, rheumatoid arthritis, and femoral neck fracture. Using this classification, there was no significant relationship between the class of diagnosis and the rate of dislocation (p=0.42). And the history of previous hip surgery was statistically related to prevalence (25% vs 7.4%; p=0.016). Mean IR angle was statistically different between patients with dislocation and patients without dislocation after THA (54.1° vs 64.5°; p=0.002). Patients were divided into two groups by IR angle (60°, 55°, 50°, and 45°). Dislocation rates in larger IR groups were significantly lower than the rates in smaller IR groups, when patients were divided by 60°, 55° and 50° (p=0.000, p=0.01, and p=0.044). But there was no significant difference between two groups when patients were divided by 45° (p=0.770). For logistic regression analyses, patients were divided into two groups by 55°. Logistic regression analyses determined that significant risk factors were the presence of cerebral
dysfunction, and IR angle (p=0.048, Odds 3.29; p=0.008, Odds 4.03). Four patients sustained a dislocation with IR angle greater than 60°, but two were anterior dislocations. Two patients with posterior dislocations were female, and do not have a history of previous hip surgery, but were classified as having cerebral dysfunction. In other words, no posterior dislocation was observed with IR angle greater than 60° without cerebral dysfunction.

**Discussion:** Intraoperative stability tests are effective for indicating hip stability after THA. And cerebral dysfunction, gender, and presence of previous hip surgery are also risk factors for the incidence of dislocation after THA, same as other studies [3]. IR angle was never used in the literature to the best of our knowledge for a risk factor of dislocation. Although it has not been clear what angles are required for stable hip after THA, this study showed IR angle greater than 60° was desirable and should be at least greater than 50°. Limitations were related with surgical approach, and posterior capsule repair. Posterior capsule repair was not used in all patients. This led a unique opportunity to investigate the relationship between intraoperative stability and the incidence of dislocation. But posterior capsule repair should decrease the dislocation rate. And it is not clear whether intraoperative stability tests are effective also for anterior and lateral approaches. More studies are needed to investigate these limitations, and also for anterior stability.

**Significance:** This study investigated the effectiveness of intraoperative tests for indicating hip stability after THA and required ROM during surgery. Results showed intraoperative stability tests were effective to indicate stability after THA. And IR angle (the range of internal rotation with 90° flexion) greater than 60° was desirable and should be at least greater than 50° for stable hip.

**Acknowledgments:**


*ORS 2014 Annual Meeting*
Poster No: 1808