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Abductor Biomechanics Clinically Impact the Total Hip Arthroplasty Dislocation Rate
A Prospective Long-Term Study

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A B S T R A C T

Background: Factors related to the patient, implant, and surgery have been associated to the rate of dislocation for total hip arthroplasty (THA). We ask if the position of the cup and the reconstruction of the abductor mechanism actually lower the THA dislocation rate.
Methods: We evaluated 1318 patients (1414 hips) undergoing cementless THA between 1992 and 2012. All THAs had a 28- or a 32-mm femoral head size. Hip reconstruction was radiologically assessed evaluating cup position and the hip rotation center according to Ranawat. The reconstruction of the abductor mechanism was measured using 2 variables: the lever arm distance and the height of the greater trochanter.
Results: There were 38 dislocations (2.7%). After controlling the relevant confounding variables, such as demographic and implant data, multivariate regression analysis showed that the most important factors associated with dislocation were a greater distance to the anatomic hip rotation center and hips outside 2 safe windows for cup position (acetabular inclination and version angles) and abductor mechanism (lever arm distance and height of the greater trochanter).
Conclusion: A proper reconstruction of the hip is essential to decrease the risk of dislocation after primary THA. The weakness of the abductor muscles of the hip may be one of the most important causes for dislocation.

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Introduction

Despite the excellent outcome of primary total hip arthroplasty (THA), the occurrence of a dislocation affects the patients' quality of life and health-related issues [1]. The risk is higher in the first postoperative year, and most are early dislocations because two-thirds usually remain stable after a closed reduction [2]. However, dislocation after THA has gained importance given the cumulative rate over time, which has increased the risk of late dislocations [3].

Different factors such as the characteristics of the patient (sex, body mass index, age, or diagnosis), of the implant (femoral head size, femoral stem offset, or bearing surface) or surgical technique (approach or cup position) have been related to dislocation after primary THA [1,4-6]. Soft tissue imbalance is also a well-known cause; however, there is a lack of clinical reports that assesses this problem. An abductor mechanism insufficiency can be observed when cup position is high, there is a low height of the greater trochanter, or there is proximal femur bone loss [7]. Postoperative cup position is not always related to dislocation, suggesting muscular imbalance rather than malposition as cause [8,9]. The low rate of this complication and some intraoperative issues such as capsular laxity, soft tissue tension, fascia lata involvement, or possible osteophyte excision during surgery add more difficulties when trying to analyze dislocation after THA.

We hypothesized that radiographic assessment of the lever arm of the hip and the height of the greater trochanter after primary THA, in a large series of patients, might help to understand some problems of dislocation. We assessed different clinical issues related to patients; implant characteristics such as femoral head size, bearing surface, and femoral stem designs; and the quality of the postoperative hip reconstruction in an attempt to evaluate the most frequent factors for dislocation after primary THA.

Materials and Methods

In this retrospective cohort analysis of our prospective register, we assessed 1414 cementless primary THAs in 1318 patients operated in our institution between 1992 and 2012. We evaluated all patients who underwent cementless THA with an end arthritis of the hip. We excluded patients with a cemented THA, a femoral neck fracture, metastatic or tumoral disease, and severe cognitive or neuromuscular diseases.

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A total of 135 patients were lost to follow-up due to a follow-up of less than 5 years, and 5 died due to unrelated causes without dislocation. During the same period, a total of 1915 THAs were performed in our department. Oral and written informed consent was always obtained from all patients, and they were informed preoperatively that they might receive a cementless THA. The mean age of the patients was 60.1 years, and the physical activity level, according to Devane et al [10], was 4 or 5 in 974 patients. The minimum follow-up of the patients was 2 years (range, 2-22 years).

All procedures were performed by the same surgical team using a posterolateral approach with reconstruction of the external rotators [11] or by preserving the external rotator muscles [12]. The same postoperative protocol was used for all patients: after surgery, patients walked on crutches with toe-touch partial weight bearing for 3 weeks, after which they were allowed to walk using 2 crutches for the next 6 weeks. All patients were instructed to have an abduction pillow while in bed or sitting and to avoid a hip flexion higher than 90° during the first month. Cefazolin (or vancomycin in allergic patients) was administered for antibiotic prophylaxis during the anesthetic induction and continued for 24 hours, with low-molecular-weight heparin to decrease the risk of thromboembolic disease in all patients according to the guidelines of our institution. Different designs, cup/stem, with different bearing surfaces and femoral head sizes were compared: Duraloc/Profile (Depuy/Johnson & Johnson, Warsaw, IN) with a 28-mm metal head-on-polyethylene (PE) liner; Allofit/Alloclassic (Centerpulse/Zimmer, Winterthur, Switzerland) with a 28-mm metal head-on-PE liner; Pinnacle or Duraloc/Summit (Depuy/Johnson & Johnson) with 28-mm metal head-on-PE liner; EP-Fit/SL-Plus (Endoplus-Smith & Nephew, Rotkreuz, Switzerland) with either a 28-mm metal head-on-PE liner or an alumina-on-alumina coupling; Cerafit/Multicone (Ceraver, Roissy, France) with a 28- or 32-mm alumina-on-alumina coupling; and Bihapro/Bimetric (Biomet, Warsaw, IN) with a 32-mm metal head-on-PE liner making a total of 6 groups.

Patients were followed up at 6 weeks, 3, 6, and 12 months, and then annually after surgery. At every interval, we evaluated pain, function, and range of mobility according to the 6-level scale described by Merle D'Aubigné and Postel [13]. We recorded the appearance of dislocation during the first year (early dislocation), all further episodes (recurrent), and revision of the cup for this cause.

Standard anteroposterior (AP) radiographs of the pelvis were made preoperatively, immediately after the operation, at 6 weeks, at 3, 6, and 12 months, and annually thereafter following the same protocol. The patient was positioned supine, with his/her feet together. The x-ray tube was positioned over the symphysis pubis 1 m from and perpendicular to the table with a symmetric obturator foramen and visible lesser trochanter and iliac crest [14]. A single author made all measurements, which were repeated 3 times for each radiograph. Cup position was assessed according to the acetabular abduction angle, the height of the center of the hip (as measured from the centre of the femoral head to the interteardrop line), and the horizontal distance of the cup (measured from the center of the femoral head to the Köhler line) [15]. The reconstruction of the hip rotation center was evaluated according to the Ranawat triangle [16,17]. The true acetabulum region was the area enclosed by a right triangle with a height and width equal to 20% of the height of the pelvis on the AP radiograph. The midpoint of the hypotenuse coincides with the approximate center of the femoral head and is the center of rotation of the hip. The approximate center of the femoral head was used as the reference point to measure distance to the center of the prosthetic femoral head (CPFH) (Fig. 1). This distance was recorded in the preoperative and postoperative radiographs to assess the reconstruction actually achieved. Cup anteversion was measured according to Widmer [18] using a trigonometric function: the relationship between the short axis of a projected ellipse and the total length of a projected cup cross-section along the short axis ratio and the cup inclination. The radiographic reconstruction of the abductor mechanism was also measured using 2 variables: (1) the lever arm as

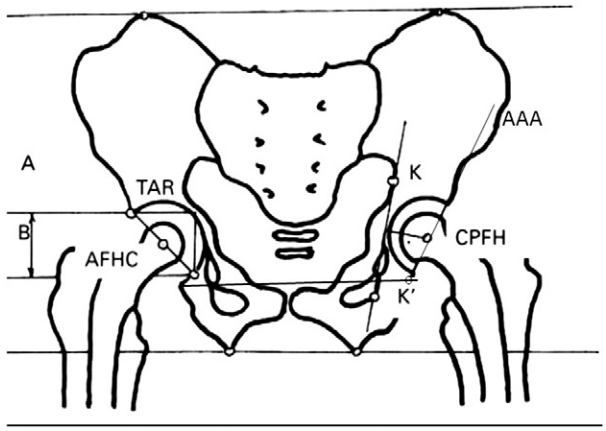

Fig. 1. Cup position assessment on the anteroposterior radiograph. AAA, acetabular abduction angle; K-K′: Köhler line; TAR, true acetabulum region; AFHC, approximate femoral head center.

the distance from the CPFH to the line joining the lateral part of the greater trochanter to the anterosuperior iliac crest and (2) the height of the greater trochanter as the distance between the line joining the 2 teardrops and the parallel line crossing the tip of the greater trochanter (Fig. 2). The intraobserver reliability for this method, using the mean of the 3 measurements, was 0.948 (intraclass correlation, 95% confidence interval [CI], 0.885-0.979). Interobserver reliability was also assessed by using 74 postoperative radiographs that were evaluated by another observer using the same method. This interobserver reliability was 0.979 (intraclass correlation 95% CI, 0.726-0.995). Although these measurements were made using the sixth week postoperative radiograph, images with a low quality of the greater trochanter or anterosuperior iliac crest or an untrue anteroposterior view were excluded, and the 12th week postoperative radiograph for the hip was used. Of the 1414 hips analyzed, 89 were evaluated in the 12th postoperative week. Because different designs may produce different values regarding the abductor mechanism due to the characteristics of their femoral offset, these variables were calculated for each group to assess whether there was any difference.

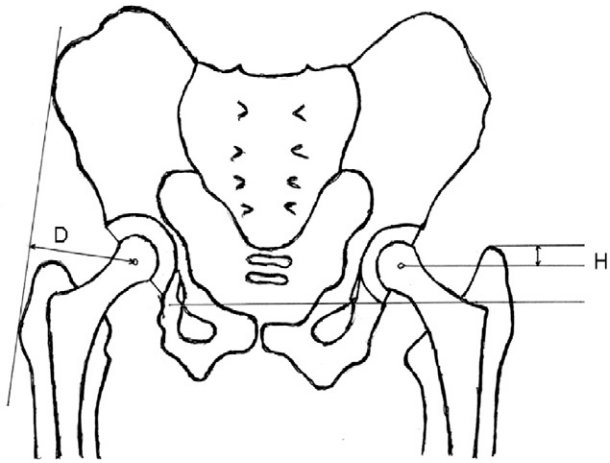

Fig. 2. Measurement of the radiographic reconstruction of the abductor mechanism: The lever arm as the distance (D), from the femoral head to the line joining the lateral part of the greater trochanter to the anterosuperior iliac crest, and the height of the greater trochanter as the distance (H), between the line joining the 2 teardrops and the parallel line crossing the tip of the greater trochanter.