The Influence of Acetabular Component Position on Wear in Total Hip Arthroplasty

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Abstract: Our experience has implicated cup inclination as an important factor in wear, whereas others have suggested that the hip center of rotation (COR) must be closely reestablished to reduce wear. We conducted a retrospective study to determine the relative importance of these 2 factors. One hundred thirty-nine total hip arthroplasties were studied after a mean follow-up of 9.2 years (range, 6-3 years). Forty-nine of 139 operated hips had a contralateral normal hip, which allowed the most accurate measurement of the influence of change in the COR. Wear was related to the inclination of the cup but not to a change in the COR. Secondarily, wear was less with a ceramic-polyethylene polyarticular surface than with metal-polyethylene. The importance of this data is related to cup implantation techniques. The hip COR can be moved superiorly and/or medially to permit cup inclination below 45° with correct cup coverage. **Key words:** cup position, THA, acetabulum, wear, center of rotation.

We learned the importance of cup inclination with a study of 10-year results with the anatomical porous replacement (APR) cup [1]. Several studies now show that cup inclination should be 45° or less because inclination greater than that is directly related to accelerated wear [1-5]. The principle that inclination must be kept below 45° creates a technical dilemma in acetabular preparation for cup implantation for total hip arthroplasty.

The goal of cup implantation is to achieve stable fixation of the cup in a position that provides hip stability by avoidance of impingement, provides correct combined anteversion [6-9], and is favorable for wear. Restoration of the center of rotation (COR) of the hip with the COR of the cup has been an important goal of the cemented-cup technique because of reports of the relationship of this to wear [10,11]. In fact, Karachalios et al [11] found that a change in the COR that exceeded 7.5 mm horizontally was the most important variable in causing wear. There are no published data similar to this for noncemented cups.

To achieve a press-fit for a noncemented cup with coverage of the cup by bone, the reaming preparation must be more medial and superior than with a cemented cup because noncemented cups are bigger. This reaming changes the COR to a more medial and superior position. Bony coverage of the cup is important to avoid impingement of the metal neck against the polyethylene/metal rim of the cup.

A second choice to achieve maintenance of COR and achieve cup coverage is to increase the inclination of the cup to more than 45°. Finite element studies promoted this solution by showing that inclination of 45° to 55° was best to avoid impingement [6,8]. The flaw in these studies was that the cup COR was never changed from the bony COR, which effectively acted as a fulcrum around which

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the cup was rotated. D'Lima et al [6] subsequently observed that their recommendation of 45° to 55° inclination resulted in clinically higher wear rates, and they no longer recommended inclination of more than 45° [4]. Robinson et al [8] reported that inclination of more than 45° significantly increased wear. The clinical implication of these studies was that to achieve correct inclination with cup coverage, the COR had to be changed medially and superiorly.

We conducted this study to determine if wear with a noncemented hemispherical cup was influenced more by inclination or position of the COR with a noncemented hemispherical cup. The answer to this question would influence the principles of acetabular preparation for the implantation of acetabular components in total hip arthroplasty.

Materials and Methods

We retrospectively reviewed 122 patients with 139 primary total hip arthroplasties with at least 6 years' clinical follow-up. This was a selected study because we needed radiographs of patients who were alive and active and had current follow-up. More than 5 years' follow-up is optimal to be able to measure the influence of different variables on wear [12]. These operations were performed from 1994 to 1996 using a posterior approach (LDD). All patients were implanted with the noncemented APR cup (Sulzer, Austin, Tex). The technique was to ream the bony acetabulum and implant the hemispherical cup without screws, and this was successful in 131 of 139 hips, with 8 of 139 requiring screws. The cup was titanium, with 3.5-mm-thick walls. There was a cluster of 3 to 5 screw holes in the posterior-superior quadrant and 1 inferior screw hole for the ischium and 1 for the pubis (maximum of 7 screw holes). The polyethylene liners were manufactured from 1020 resin, which was stearate-free, and were packaged in an oxygenless environment. The locking mechanism was a circumferential polyethylene tab below the rim of the liner, which engaged a recess in the shell. The articulating femoral head was cobalt-chrome in 107 hips and alumina ceramic in 32 hips. The metal heads were 28 mm in 103 hips and 32 mm in 4 hips, whereas all 32 ceramic heads were 28 mm. The femoral stem was the APR noncemented stem (Zimmer, Warsaw, Ind) in 103 hips; APR cemented stems were used in 36 hips.

The mean duration of follow-up was 9.2 years (range, 6-13 years). There were 68 men (76 hips) and 54 women (63 hips). The mean age at the time of the operation was 58.5 years (range, 28-84 years), and the mean weight was 82 kg (range, 47.6-159.2 kg). The diagnosis at the time of the operation was primary osteoarthrosis in 106 hips, avascular necrosis of the head in 19, acetabular dysplasia in 3, inflammatory arthritis in 1, and posttraumatic arthritis in 10 hips.

A routine supine anteroposterior (AP) radiograph of the pelvis and a Lauenstein lateral radiograph were reviewed for this study using the 6 weeks' postoperative and annual films. The AP pelvic radiograph was taken with the x-ray tube positioned 40 inches above the symphysis pubis perpendicular to the table, with the feet in maximum internal rotation. All measurements were done from the AP pelvic radiographs. Variations in magnification were corrected by using the prosthetic femoral head. Radiographs were reviewed by one of us (ZW) who is an expert at radiographic wear measurements [12-14].

Two-dimensional femoral head penetration was manually measured with use of the method described by Dorr and Wan [13]. This method has been validated as more accurate for the evaluation of clinical radiographs than computerized methods by both Barrack et al [15] and Ebramzadeh et al [16]. Wear was measured using a Mitutoyo Digimatic caliper (Mitutoyo Corp, Kanagawa, Japan).

Anteversion and inclination of the acetabular cup, as well as the location of the COR of the hip, were measured on the postoperative AP pelvic radiographs.

A horizontal line was drawn across the bottom of the acetabular teardrops, and a line that connected the superior and inferior edges of the acetabular component was connected to this horizontal line to measure the angle of inclination(Fig. 1) [17]. Anteversion was measured as previously described [13,18]. The location of the COR of the hip relative to the teardrop (height of COR and horizontal distance of COR) was measured [19-21] (Fig. 1). The height of COR of the hip (used to measure proximal displacement) is defined as the vertical distance along a line extending from the center of the femoral head perpendicular to the interteardrop line; the horizontal distance of the COR of the hip (used to measure lateral or medial displacement) is defined as the distance along the interteardrop line that begins at an inferior point on the teardrop line and extends perpendicular to the line drawn vertically from the center of the femoral head. The amount of the acetabular component without bony coverage was measured using a modified method proposed by Sarmiento et al [22] (Fig. 2). The distance from the lowest edge of