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The role of component positions in revision hip arthroplasty; Minimum 5-year follow-up

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Abstract

This study aimed to investigate the effect of distance between the femoral head and predicted hip rotation center on clinical and radiological survival of the acetabular implants (Jumbo cups and acetabular cages) retrospectively in patients who had revision hip arthroplasties. The retrospective study included a total of 52 consecutive patients (16 in acetabular cage group I, 36 in Jumbo cup group II). Radiological evaluation was performed by assessing the hip rotation center, polyethylene wear, lateral offset of the hip, and the migration of acetabular component on pelvis AP radiographs. Harris Hip Score (HHS) was used to assess the clinical evaluation at one, three, six, twelve months, and each year. The mean postoperative HHS at the last clinical assessment was 67.0±12.9 in group I and 68.2±11.9 in group II, respectively. The change in the hip rotation center did not affect the HSS scores between the groups ($p>0.05$), whereas acetabular cup migration and lateral offset comparison between groups were found statistically significant (p: 0.007). There was no significant correlation between lateral offset and acetabular implant migration ($p>0.05$), however, there was a negative correlation in comparison between lateral offset and polyethylene wear. Our study results suggest that both jumbo porous-coated acetabular components with screw fixation or reinforcement cages can be used in hips with notable bone loss. However, it is concluded that the shorter offset had higher liner wear which may contribute to a higher revision rate after revision hip arthroplasty.

Keywords: Revision hip arthroplasty, Jumbo cup, acetabular reconstruction cage, center of hip rotation, lateral femoral offset, polyethylene wear

Introduction

In revision hip arthroplasty, acetabular reconstruction is probably the most important part of the surgery that would affect the component survival. Loosening and migration of the previous implant cause bone loss. As a result of this, the technique and the implant choice becomes challenging for surgeons [1]. Various implants have been used for acetabular reconstruction including cemented polyethylene components, jumbo components, reconstruction cages, cementless cups, reinforcement rings, and cup-cage constructs till yet [2-5].

There isn't any optimal acetabular implant as well as femoral implants in hip revision surgery. The remaining pelvic bone stock and the experience of the surgeon helps to choose the implant in revision hip arthroplasty. Moreover, hip revision surgery should provide maximum abductor strength, minimum joint reaction forces, and a stable construct [6]. The most preferred option is uncemented highly porous-coated acetabular implants with their three-dimensional ingrowth surface which provides maximum surface contact in component and bone interface [7]. Jumbo cups with their extra-large size usually ensure these conditions [8,9]. On the other hand, in larger acetabular defects causing pelvic discontinuity, sufficient anatomic and mechanical stability may be provided by acetabular reconstruction cages [10]. Several studies that evaluated acetabular cages demonstrated good long-term outcomes, but it is technically demanding and challenging [11,12].

To our knowledge, there isn't any study comparing the biomechanical results between Jumbo cups and acetabular cages in terms of center of hip rotation distance effects on hip biomechanics which were applied during revision hip surgeries. This study aimed to evaluate the effect of distance between the femoral head and predicted hip rotation center on clinical and radiological survival of the acetabular implants (Jumbo cups and acetabular cages) retrospectively in patients who had revision hip arthroplasties.

Materials and Methods

Patients who had revision surgery hip in our institution between March 2011 and March 2015 were retrospectively analyzed. 57

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consecutive patients whose acetabular cage (Burch-Schneider) or Jumbo acetabular cup (≥66 mm for men and ≥62 mm for women according to Mayo Clinic's definition) were included in this study [13]. Patients with degenerative arthritis (2 patients), acetabular dysplasia (2 patients), and previous hip surgery (1 patient) on contralateral hips were excluded. 52 patients who met the criteria were included in the study. The Clinical Researches Ethics Committee of Ankara Yildirim Beyazit University Ethics committee approved this study (Decision number: 2017/173).

Acetabular defect and treatment options were determined according to the Paprosky classification [14]. Twelve hips were type I, 14 type IIA, 6 type IIB, 4 type IIC, 11 type IIIA, and 5 type IIIB, respectively. We divided the patients into two groups according to the acetabular cups. Group I included 16 types III hips (14 female, 2 male) whom the acetabular cage was performed, and group II included the remaining 36 hips (28 female,8 male) whom the Jumbo acetabular cup was performed.

The average age was 59.5 in group I (between 45 and 76), and the average age was 62 in group 2 (between 33 and 89). The mean body mass index (BMI) of the patients was similar between the groups (29 range 23 to 34 and 27.5 range 22 to 32 respectively). The revision surgeries were performed for an average of 9 years after the index operation. Approximately 40% of the patients (8 patients in group I, 13 patients in group II) underwent 2-stage revision surgery for septic reasons. The mean operation time was found 120 ± 22 min.

The patients were evaluated at one, three, six, twelve months, each year and last follow-up clinically and radiologically. Anteroposterior radiographs of the pelvis were used for radiological evaluation. The center of hip rotation, polyethylene wear, and lateral offset of the hip, and migration of the acetabular component was measured on radiographs. The Ranawat triangle was used to identify the correct position of the anatomical hip center [15]. The hip rotation center was measured according to Ranawat's method (Figure 1). Also, Acetabular cup migration and polyethylene wear were measured in both groups' patients on immediate postoperative and follow-up radiographs (Figure 2).

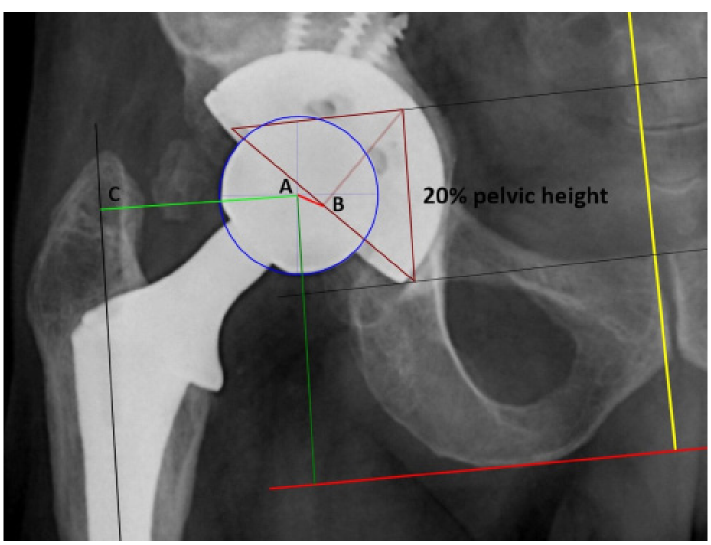

Figure 1. Measurements made on AP pelvic radiographs. The prosthetic hip joint rotation center (A), the native hip rotation center (B) according to the Ranawat method, AB line shows the distance between the prosthetic hip rotation center and the native hip rotation center, and the AC line shows the femoral offset

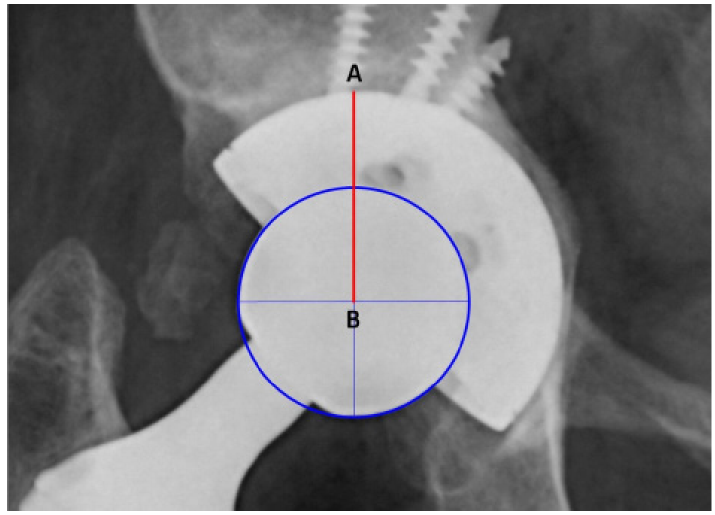

Figure 2. Polyethylene wear measurements. The changes in the AB line indicates the amount of linear polyethylene wear. The measurement for jumbo cup

All revision hip surgeries were done by the posterior approach of the hip with a senior surgeon. Functional outcomes of revision hip arthroplasty were graded according to the Harris Hip Score. (HHS) [16]. All patients were allowed and encouraged to walk only with a walker for 6 weeks. Patients were advised to continue using the walker additional 6 weeks (Figure 3).

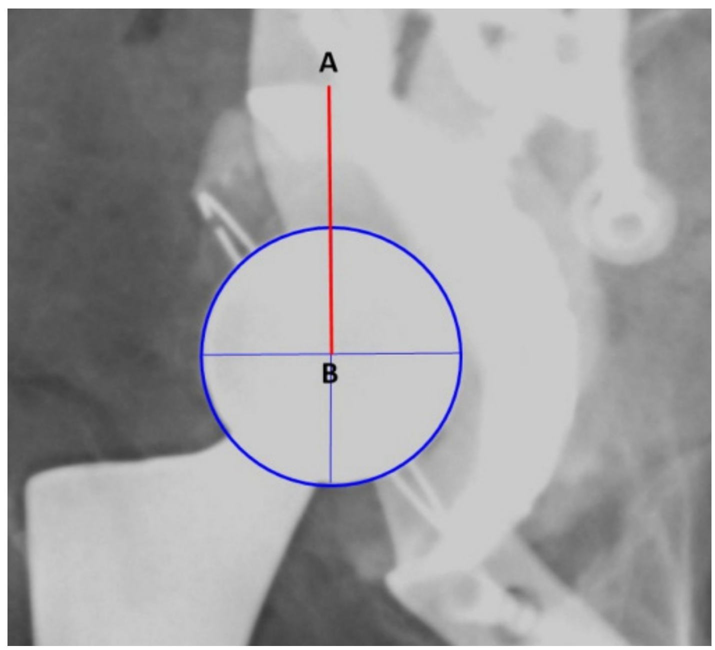

Figure 3. Polyethylene wear measurements. The changes in the AB line indicates the amount of linear polyethylene wear. The measurement for acetabular cage

Statistical analysis was performed using IBM SPSS Statistics 21.0 (IBM Corp. Released 2012 IBM SPSS Statistics for Windows, Version 21.0 Armonk, NY: IBM Corp.). Descriptive data were expressed in mean and standard deviation (SD) and number and frequency. The Fischer exact test and the Chi-square test were used in the comparison of categorical variables, and The Mann-Whitney U test was used in the comparison of numerical variables. The relation between numerical variables was evaluated with Spearman's rank correlation coefficient. The correlation coefficient between 0.00-0.19 is classified as not related, 0.20-0.39 unlikely related, 0.40-0.69 likely related, 0.70-0.89 related, 0.90-1.0 related. The interim analysis was performed by an independent statistician blinded for the treatment allocation. A P-value of <0.05 was considered statistically significant.

Results

The mean age at the time of the surgery in groups I and II were 59.5±10.0 and 62±14.4 years, respectively. There were 14 females and 2 males in group I, and 28 females and 8 males in group II. The average BMI in group I was 29 while in group II was 27.5. The mean follow-up time in the group I and group II was similar, 85,0 ±18 and 82±17 months, respectively (P =0.11). During the follow-up period, revision surgery was not required in any patient. Age, sex, and BMI were not found statistically significant between groups (P>0.05). Statistical analysis of age, sex, and acetabular defect type are shown in Table 1.

Table 1. Statistical analysis of age, sex, and acetabular defect type

	Groups			Statistical analysis	
	Group I Cage (n= 16)	**Group II Jumbo Cup (n= 36)**	**Total (n= 52)**	**Z; χ^2**	**p**
Age					
Median	57.5 (16.8)	62.0 (24.5)	60.5 (21.5)		
Mean±SD	59.5±10.0	61.9±14.4	61.2±13.2	0.843	0.399[&]
Min; max	45.0; 76.0	33.0; 89.0	33.0; 89.0		
Sex					
Female n(%)	14 (87.5)	28 (77.8)	42 (80.8)	-	0.705*
Male n(%)	2 (12.5)	8 (22.2)	10 (19.2)		
Acetabular defect type (Paprosky classification)					
Type 1 n(%)	0 (0.0)[a]	12 (33.3)[b]	12 (23.1)		
Type 2 n(%)	0 (0.0)[a]	24 (66.7)[b]	24 (46.2)	52.000	<0.001*
Type 3 n(%)	16 (100.0)[a]	0 (0.0)[b]	16 (30.8)		

* Fisher's exact test result. / &Mann Whitney U test result / a,bLettering shows the difference on the basis of rows

The Center of hip rotation was lateralized in all hips in group I, whereas it was medialized in 91.7% of the hips in group II. Distance between the prosthetic hip center and predictive native hip center was 5.3±2.6 (range 2.2-12) mm in group I. In Group 2, this distance was measured as 4.0±1.9 (range 1-10.1) mm. Although the distance from the prosthetic hip center to the native hip center was shorter in patients whose jumbo cup was used, no statistically significant difference was found (p=0.076).

The lateral femoral offset distance measured as the distance between the center of the prosthetic hip and the vertical line drawn from the middle of the femoral intramedullary canal was measured as 39.6±5.4 (range 25 - 48) mm in group I patients and 44.3±5.3 (range 31-55) mm in group II patients. The lateral femoral offset of the patients in group II is significantly higher (p=0.007). Polyethylene insert wear was 0.8±0.4 (range 0.1-1.6) mm in group I, while it was 0.7±0.4 (range 0.1-1.3) mm in group II (p=0.430).

The mean acetabular implant migration was measured 5.8±2.8 (range 2- 11.2) mm in group I, and 3.6±2.2 (range 0.4- 12) mm in group II, which was found statistically significant between groups (p<0.015). When 5mm is considered as the cut-off value, acetabular implant migration over 5mm was detected in 9 of the patients in both groups. Although the migration of the remaining 27 patients (75%) in group II was less than 5mm, there was no significant difference between the two groups (p=0.061).

When patients in both groups are evaluated together there was no significant correlation between lateral femoral offset and acetabular implant migration (p>0.05), however, there was a negative statistically significant correlation in comparison between lateral femoral offset and polyethylene wear. It was concluded that the shorter lateral femoral offset had higher polyethylene wear (rho=-0.341; p=0.013).

The mean postoperative HHS at the last clinical assessment was 67.0±12.9 in group I and 68.2±11.9 in group II, respectively. There were no significant results between groups in terms of HHS and the change of hip rotation center at the follow-up period (p=0.06). Comparison of HHS and polyethylene wear between groups were not statistically significant (p=0.620 for group I and p=0.430 for group II).

Discussion

The implants commonly used in acetabular revision surgeries are jumbo cups and acetabular reconstruction cages. While acetabular reconstruction cages are used for Paprosky type 3A and 3D defects where the acetabular defect is large, jumbo cups are used in conditions where the defect is smaller. Recent approaches for acetabular defects include trabecular metal implants and the custom tri flange components. Providing a native hip rotation center is often difficult after acetabular component revision surgeries. Component migration and polyethylene wear are common causes of revision surgeries. Restoration of prosthetic hip biomechanics may be effective in reducing the frequency of revisions.

In the present study, we evaluated the biomechanical results of two acetabular revision implants including Jumbo cups and cages in terms of cup migration, polyethylene wear, and loosening. The implant migration was higher and lateral femoral offset shorter in patients with cages compared to patients with Jumbo cups. It is concluded that the shorter offset had higher liner wear which may contribute to a higher revision rate after revision hip arthroplasty.

There were reports on lower failure rates of uncemented Jumbo cups. Lachiewicz and Poon [17] reviewed fifty-seven patients and found that no one had loosened after seven years. Also, uncemented revision Jumbo cups were found to have lower or no revision at mid-term follow-ups [18-19]. Whaley et al. concluded that the extra-large uncemented sockets can provide durable fixation and Jasty reported only one failure after the implantation of the Jumbo cup at a mean of ten years [13,20]. As an option, to provide better stability in large acetabular defects especially with hemispheric shells reconstruction cages with or without total acetabular grafts can be used. In addition, reconstruction cages can cover large acetabular defects, but rely on intact acetabular walls and a solid ischial tuberosity, no matter how thin they are used. Morcelized allografts can be used to fill the cavitary defects. However, if there is insufficient bone stock to support the cage early failure is possible [12,13,21].

There are many studies in the literature in which migration analyzes are applied after primary total hip arthroplasty. Migration in the first 2 years after primary total hip arthroplasties have been associated with aseptic loosening of the component [22,23]. Many studies have shown that the restoration of the hip rotation center closest to the native center after primary hip arthroplasty contributes to the life of the implant, muscle function, and stability [24-26]. Implant selection, the experience of the surgeon, and surgical technique are other factors that determine implant survival.

The literature on evaluating acetabular implant position after revision hip arthroplasties are limited. In this study, it was found that the hip rotation center was lateralized in all patients who used acetabular reconstruction cages, and it was medialized in most (91.7%) of the patients who used jumbo cups. Although acetabular implant migration was higher in patients undergoing revision surgeries using acetabular reconstruction cage, it was not statistically significant (5.8 ± 2.8 for the cage group, 3.6 ± 2.2 for the jumbo cup group). The mean total medial and cranial migration distances were found to be 2.5 mm in a mean follow-up of 35 months by Dammerer et al [27]. Buttaro et al. [28] and Hosny et al. [29] determined that the average migration was 3.6 mm, and 4 mm, respectively. In the current study, the average follow-up period is at least 5 years, the average follow-up time is 82 months for the acetabular cage group. Considering the differences in follow-up time between studies, we think that the amount of migration in our study is compatible with the literature.

There is a limited number of studies evaluating the effect of hip rotation center reconstruction and femoral offset length on polyethylene wear in revision hip arthroplasties. Theoretically, increasing the femoral offset is biomechanically advantageous as it will increase the moment arm. Increased femoral offset causes less abductor moment arm required for movement, and thus the reactive power on the articular surface of the femoral head decreases [30]. In the study conducted by Clement et al. [31] on primary hip arthroplasties, a significant relationship was found between lateral femoral offset and hip function. In the study conducted by Sakalkale et al. [32], an inverse relationship was found between the increase in femoral offset and polyethylene wear. Unlike these studies, Little et al. [33] showed that increasing the femoral offset more than 5 mm after arthroplasty resulted in a 33% increase in polyethylene wear. In our study, no relationship was found between the restoration of the hip rotation center and polyethylene wear, but a relationship was found between the increase in femoral offset and the decrease in polyethylene wear.

However, this study has some limitations. First, our study was retrospective and there was no control group. Second, revision surgeries were performed by a single surgeon and were a series of patient series. Although we appreciate the limitations of this study, we believe that the results of this study will contribute to future studies. There is not much data comparing results of revision surgeries using jumbo acetabular components and reinforcement cages in revision hip arthroplasty. Moreover, it is difficult to make a comparison between the groups. Only two parameters were found statistically significant and our findings conclude that shorter lateral offset had higher acetabular liner wear probably with the need for more re-revision surgeries.

In the conclusion, the results of this study suggest that both jumbo porous-coated acetabular components and reinforcement cages can be used in acetabular revisions with significant bone loss successfully. Proper positioning of the implants brings along high survival rates.

Conflict of interests
The authors declare that they have no competing interests.

Financial Disclosure
All authors declare no financial support.

Ethical approval
Ethics committee approval was received for this study from the Clinical Researches Ethics Committee of Ankara Yildirim Beyazit University (Decision number: 2017/173).

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