Effect of elevated-rim acetabular liner and 32-mm femoral head on stability in total hip arthroplasty

Duwairi M. Qassem, MD, BCh, Karlson B. Smith, MD, BCh.

ABSTRACT

Objective: Although the theoretical attractions of the elevated rim are obvious and have been widely accepted as a mean to improve the postoperative stability, the clinical advantages have not been demonstrated. The aim of this study is to further evaluate the elevated liners contribution to stability.

Methods: Forty-six patients with 50 hips undergoing primary total hip arthroplasty (THA) were enrolled in this study, conducted in Rush Hospital, Chicago, Illinois, United State of America, between March 2001 and February 2003. We tried to determine the amount of additional stability that can be provided by elevated-rim liner compared to the non-elevated liners and the stability of the hip with a 32 mm femoral head compared to 28 mm head.

Results: Our results showed that a 10 degree elevated-rim acetabular liners increased hip stability by an additional 8.2 degrees of internal rotation. The 32 mm head provided 7.3 degrees of internal rotation. The increases were statistically significant (p<0.0001).

Conclusion: The findings of this study clearly show that an elevated-rim liner, and independently the 32 mm head, may contribute to hip stability.

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An elevated-rim acetabular liner is used as a potential means of improving stability after primary total hip arthroplasty (THA) as well as revision procedures. An elevated-rim on a high-density-polyethylene acetabular liner is currently available from most manufacturers. Augmentation of the acetabular component was introduced by Charnley,[5] who extended the posterior aspect of a high-density-polyethylene cup in an attempt to prevent posterior dislocation of the femoral head.[1,2] Cobb et al[3] was the first to demonstrate the improved stability after THA when an elevated liner is used. The asymmetrical build-up of these components is thought to provide additional support in regions of compromised stability.[12] The orientation of the elevated-rim can be individualized depending on the unique anatomy of each patient, with the elevated-rim placed where it is most needed (usually posteriorly and superiorly).

Methods. The study was conducted in Rush Hospital, Chicago, Illinois, United States of Amercia, between March 2001 and February 2003, we sought to determine the amount of additional stability provided by the elevated-rim liner as compared to the neutral liner. Acetabular liners were manufactured by different companies vary with regard to the degree of elevation of the rim, and due to a greater likelihood

From the Department of Orthopedic Surgery, Rush Presbyterian St. Luke's Medical Center, Chicago, Illinois, *United States of America*.

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Address correspondence and reprint request to: Dr. Duwairi M. Qassem, Midwest Orthopedics, 1725 W. Harrison St. Ste 1063, Chicago, Illinois 60612, *United States of America*. Tel/Fax +1 (312) 7046384. E-mail: diwairi@go.com

that a greater degree of elevation will be selected for patients thought to have a more unstable hip, only components with the smallest degree of elevation of the rim (10 degrees) provided by any manufacturer were assessed. Also, the relationship between the size of the femoral head and the stability of the hip was examined and assessed, so the stability of the hip with a 32 mm femoral head was compared to a 28 mm head. Forty-six patients with 50 hips undergoing primary THA were enrolled in this study. The mean age of the patients was 61 years and 65% of the patients were male. Surgery was performed in a lateral decubitus position, using a posterior approach. All components were determined intraoperatively in a standard fashion and then fixed into position. Both components were placed into proper anteversion to closely approximate the patient's native anatomy. A trial reduction was performed with a 32 mm femoral head and a neutral acetabular liner, which constitute the initial components placed during the operative procedure. The offset and head length were determined based on preoperative templating and then adjustments were made intraoperatively when necessary to optimize abductor tension to achieve optimum stability. Then after removing the control group components, 3 more trial reductions were performed using replacement component consisting of the following: 1) 28 mm head and non-elevated liner; 2) 28 mm head and 10 degree elevated liner; 3) 32 mm head and 10 degree elevated liner (**Figure 1**). All trial acetabular components were placed into position and secured by a screw to prevent displacement of the trial components from the desired position during trial reductions. After positioning of both the acetabular cup and femoral head for each group, trial components were compared to determine the position of posterior dislocation. The point of instability was determined by visual inspection. The amount of internal rotation at which the hip began to dislocate (at 90 degree flexion and 0 degree abduction or adduction) was recorded for each group. Hips were also tested for anterior dislocation in the position of extension and external rotation. The point of hip instability was defined as the position at which the head began riding out of the liner. All trials were repeated 3 times on all patients for each component group and an average measurement was used for statistical comparison. Analyses were performed with paired t-tests.

Results. The average amount of internal rotation at which the hip began to dislocate (at 90 degree flexion and 0 degree abduction or adduction) for each group in this study is illustrated in **Table 1**. Comparison between the elevated-lip liner versus the neutral liner groups, revealed that there was an average of 8.2 degree increase in the amount of internal rotation necessary to cause posterior dislocation. Similarly, there was an average of 7.3 degree increase of internal rotation needed to cause posterior dislocation in the group of patients receiving the 32 mm head, compared to patients receiving a 28 mm head. The increases were statistically significant ($p<0.0001$). None of the hips in any group could be dislocated anteriorly during range of motion testing.

Discussion. Dislocation following THA remains a serious complication and may result from several factors as identified by Amstutz and Markoff[4] including poor tissue tension, bony impingement, and component impingement. The majority of modern total hip systems provide the surgeon with a variety of

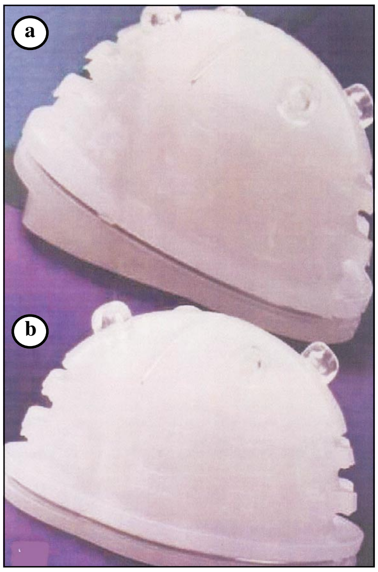

Figure 1 - An autograph showing a) elevated and b) neutral liner.

Table 1 - Average degrees of rotation for disclocation

Head size	Liner type	Average internal rotation for dislocation
28 mm	10 degree elevated	42.3 degree ± 5.4
28 mm	Neutral	35.2 degree ± 5.3
32 mm	10 degree elevated	51.1 degree ± 6.1
32 mm	Neutral	41.2 degree ± 9.1

options with regard to neck lengths, head sizes, and acetabular liner configurations, allowing the surgeon to use the proper component for final implantation with the goal of providing the patient with optimum stability and range of motion. Unfortunately, the impact of such component combinations on dislocation and possible impingement remains unclear. However, the use of an acceptable trial reduction in terms of clinical stability could serve as a valuable control and in this study we sought only to evaluate differences in the stability of the trial component groups relative to the control. Our results show that a 10 degree elevated-rim acetabular liner placed in the posterior-superior quadrant increased hip stability by an additional 8.2 degree of internal rotation. This finding is consistent with the findings of Cobb et al,[3] which demonstrated improved stability following THA in which an elevated liner was used. Krushell et al[5] demonstrated that the stable arc of motion was not increased, but rather reoriented, with the use of an elevated-rim. When the elevated-rim was placed posteriorly, stability was increased with the hip in flexion and in flexion with internal rotation with some designs and only internal rotation in flexion with other designs. Extension and external rotation in extension were decreased by elevated-rim liners. Therefore, the range of motion was increased in some directions and decreased in complementary directions. Several concerns have been raised with regard to the use of elevated-lip liners in THA particularly with regard to the long-term effect on wear and loosening. Indeed, some investigators have suggested that the biomechanical characteristics of hips in which an elevated-lip liner is used may predispose the implant to early failure.[5] Bosco and Benjamin[7] implicated the use of elevated liners in the loosening of a femoral stem. Despite these concerns, one recent study showed no increase in the rate of revision in hips that use elevated liners as compared to hips with neutral liners at an average follow-up of 5 years.[8] The potential for the femoral neck to impinge on the posteriorly placed elevated-rim as the hip is externally rotated causing the femoral head to be levered out of the cup in an anterior direction. This complication, however, was not observed in any case in our study. A direct relationship between the use of a larger head-to-neck ratio and an increase in hip range of motion was initially identified by Swanson and Mech.[9] Although, some reports in the literature have confirmed a direct but inverse relationship between femoral head size and the rate of total hip dislocation.[4,10] However, this relationship has not been observed by all investigators.[11] In the present study, additional stability was also achieved with use of the 32 mm head, which provided 7.3 degree of additional internal rotation prior to dislocation. Although the use of a larger femoral head improves hip stability, it remain concerns of adverse effects resulting from the use of this larger component. Livermore et al[12] noted that there was a greater amount of volumetric wear with the 32 mm femoral head as compared with 22 mm and 28 mm sizes. The 22 mm head was associated with the greatest amount of linear wear. Furthermore, they noted that osteolysis of the proximal part of the femoral neck was found to correlate positively with the extent of linear and volumetric wear. Based on these findings, Livermore et al[12] recommended the use of a prosthetic femoral head of intermediate size, the 28 mm head, as it appeared to provide the best wear characteristics.

In conclusion, the findings of this study indicate that, in cases where a posterior approach is used, an elevated-rim liner placed in the posterior quadrant may contribute to hip stability. In addition, use of a 32 mm head may also independently contribute to hip stability. However, it must be emphasized that additional studies are warranted regarding the possibility of excessive polyethylene wear or increased torque causing loosening of the acetabular component.

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