Original Article

Head size and dislocation rate in primary total hip arthroplasty

Somesh P Singh, Haresh P Bhalodiya

Abstract

Background: Dislocation after total hip arthroplasty (THA) has a multifactorial etiology with variables such as surgical approach, component orientation and position, type of cup, stem and head size. Review of the literature regarding the relationship of head size and dislocation rate in THA is suggestive that large femoral head size is associated with lower dislocation rate after THA. However, limited data is available as a proof of this hypothesis. The purpose of this study was to determine that the use of large head size would lead to a decreased incidence of dislocations following THA.

Materials and Methods: 317 primary THAs were performed using the posterolateral approach with posterior soft-tissue repair between January 2006 and December 2009. Cases were divided into two groups (A and B). Femoral head diameter size 36 mm was used in 163 THA in group A and 28 mm in 154 THA in group B. Average period of followup being 2 years (6 month to 4 years). Patients were routinely followed at definite intervals and were specifically assessed for dislocation.

Results: One or more dislocations occurred in 11 out of 317 hips with the overall rate of dislocation being 3.47%. Dislocation rate was 0.6% in 36 mm head size and 6.49% with 28 mm head size (*P* value is 0.0107). Keeping the stem design variable as a constant, the difference in the rate of dislocation between the two groups was again found to be statistically significant for both un-cemented and cemented stem.

Conclusion: Dislocation rate decreased significantly as the size of the head increased in primary THA. However, longer followup is necessary as rate of dislocation or *in vivo* highly cross linked poly failure or fracture may increase in future affecting the rate of dislocations in primary THA.

Key words: Dislocation, head size, primary total hip arthroplasty, revision

Introduction

The incidence of dislocation after total hip arthroplasty (THA) in several large studies has ranged from 0.4% to 5.8%[1,2] for primary THA and from 4.8% to 13% for revision total hip arthroplasties.[1,3,4] The etiology of dislocation is dictated by patient related factors, surgery-related factors and implant design related variables.[5-8] Patient related factors include age, sex, height, previous hip surgery, indication for which THA, was carried out neuromuscular impairment and soft-tissue laxity. Surgeon related factors include experience of the surgeon, surgical approach, component orientation, soft-tissue repair, maintenance of leg length and offset; implant design variables include head size, head-neck ratio, head to acetabular ratio, neck geometry and femoral offset.[7] With the availability of newer materials like highly cross linked poly and hard bearings (ceramic, metal on metal), it is now possible to use larger head diameter (36 mm and more) in THA. It has been postulated that the large femoral head diameter reduces the risk of dislocation because of (1) improvement in the head-to-neck ratio, which increases the range of motion of the prosthetic components without prosthetic impingement; (2) a greater amount of translation of the femoral head is required before dislocation occurs as it increases the jump distance; and (3) there may be greater soft-tissue restraints to dislocation as the femoral head is better contained by the surrounding soft tissue envelope.[9-12] Kelley *et al.*[11] noted an increased dislocation rate with 22 mm heads as compared to 32 mm heads. They also found that smaller heads, when used with large diameter acetabular components, further increased risk of instability. The use of skirted

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Access this article online	
Quick Response Code:	Website: www.ijoonline.com
	DOI: 10.4103/0019-5413.118198

femoral heads effectively reduces the head-to-neck ratios and contributes to instability.[13] Increased femoral head size had reduced rate of dislocation associated with all operative approaches, but the effect was greatest in association with the posterolateral approach.[8] However, other authors have stated that the size of the femoral head was not related to the dislocation rate.[2,4,14] Hedlundh *et al*.[13,15] found no significant difference in the dislocation rate between the 22 mm and 32 mm femoral heads. The purpose of this study was to determine whether use of large head size would lead to a decreased incidence of dislocations following THA or not.

Materials and Methods

317 primary THAs performed in 281 patients (245 unilateral, 36 bilateral) with 28 mm or 36 mm diameter femoral head between January 2006 and December 2009 constituted the study material. Operative and followup records were reviewed for (1) indication for THA (2) type of THA-(cemented, hybrid or uncemented) (3) design of implant (4) head size (5) incidence of dislocation (6) management of dislocation (7) revision surgery for dislocation (8) revision due to any other cause (9) improvement in Harris hip score (HSS). All surgeries were performed by a single surgeon [HPB] using either cemented stem (MS-30, Zimmer, Warsaw, IN, USA)© or uncemented stem (CLS, Zimmer, Warsaw, IN, USA)©. Cups were either ZCA (Zimmer, Warsaw, IN, USA) cemented cup or the Trilogy uncemented cup (Zimmer Warsaw, IN, USA)©. Choice of using cemented or uncemented stem was based on the criteria as shown in Table 1. During the study period 36 head size was available only in the un-cemented cup, so all 36 head sizes were un-cemented (n=163), whereas in 28 mm head size cups were both cemented (n=97) and un-cemented (n=57).

All patients were operated under either spinal, epidural or the general anesthesia. Posterolateral approach was used for total hip replacement in all cases with enhanced repair of short external rotators and the posterior capsular structures using Ethibond no. 5 anchoring on posterior margins of the greater trochanter. All uncemented cups (n=220) were either press fitted (n=181), or fixation augmented by screws and/or pegs (n=39). All uncemented stems were press fit. Third generation cementing technique was used for cemented stem fixation, employing pressurization, vacuum preparation and the use of a pulsatile lavage. Cup was fixed in 45-50° inclination and 10-15° anteversion. Anteversion of the stem was kept about 10-15°.

All patients were allowed to walk on second postoperative day with a walking frame and by day 4 with the help of a stick. The low molecular weight Heparin was given for 5 days as prophylaxis for deep vein thrombosis. Postoperative limb length, range of motion pain, functional score and total HHS as well as any other observation or complications were assessed and recorded.

Patients were evaluated at 6 months, 1 year and 2 years followup interval. The minimum followup period required for inclusion in this study was kept as 6 months. At each point patients were specifically inquired about any episode of dislocation or any other complications. Dislocation was defined as an event in which the hip required reduction by a clinician.

Cases were divided into two different groups.

- Group A – 36 mm head size
- Group B – 28 mm head size.

The demographic distribution of both groups is shown in Table 2. The indications of primary THA of both groups are shown in Figure 1. In group A, out of 163 hips 64 were MS-30 stem while 99 were CLS stem. In group B, out of 154 hips 94 were MS-30 stem while 60 were CLS stem. Followup was carried out in all cases by either patient's personal visit at the hospital within 2 months of completion of the study phase or by personal visit to patients or by telephonic interview inquiring specifically about the function of hip, any episode of dislocation or any other surgical intervention. All patients (281 patients, 317 hip) were available for the clinicoradiological followup. Radiographs were analyzed for implant position, stem subsidence or migration, osteolysis around stem (zone 1-7 of Gruen) and/or acetabulum (zone 1-3 of DeLee and Charnley).

Table 1: CLS scoring system (Spotorno criteria)

Gender		Age		Singh's index		MCI=CD/AB	
Sex	Point	Age	Point	Singh index of osteoporosis	Point	Value	Point
Male	0	<50	0	6	0	>3	0
Female	1	50-60	1	6-5	1	3-2.7	1
		61-70	2	4-3	2	2.6-2.3	2
		>70	4	2-1	4	<2.3	4
Final evaluation		0-4	Cementless	5	Possible	>6	Cemented

MCI = Morphological cortical index, CD = Distance between the outer boundaries of the lateral and the medial cortex, The measurement is made at the level of the tip of the trochanter, vertical to the axis of the femur, AB = Diameter of the medullary cavity, The measurement is made 7 cm distal from the CD line, vertical to the axis of the femur, The MCI in this absolute form can be used only if it was calculated in a standard radiograph with the legs in the normal position and with rectilinear anteroposterior irradiation)

Statistical analysis

Clinical and radiological data were analyzed using the statistical software epi-info version 3.5.1 released in August 2008 using arithmetic means, standard deviations and confidence interval (CI). *P* values were evaluated. Fisher test and *t* test was used to compare the data of the two groups.

Results

Average period of followup was 24 months (range 6-48 months). Out of 317 hips, 173 hips had followup of at least 2 years or more. The average HHS improved overall in both groups. In group A, it improved from 42 preoperatively to 97 at 6 months followup and to 98 at the final followup (2 yrs average, range 6 months to 3 years 7 months). In group B, it improved from 40 preoperatively to 89 at 6 months followup and remained 89 at the final followup (2 years average, range 6 months to 4 years) [Table 3].

The average range of motion according to Harris hip score improved from 2.16 preoperatively to 4.9 at final followup for group A and from 2.1 preoperatively to 4.1 postoperatively for group B at final followup. The difference in the average range of motion between two groups was not statistically significant.

There were no complications reported in the form of deep vein thrombosis, postoperative infection or periprosthetic fractures, nerve injuries or early loosening during the study period. In our series out of 317 THAs, 11 dislocated, amounting to 3.47% of all within the 1st year of the study. All 11 cases had posterior dislocation. First episode of dislocation was treated conservatively with closed reduction under anesthesia and examination under image intensifier for a range of stability. All the 11 patients were evaluated radiographically with anteroposterior and cross table lateral views to assess femoral anteversion, acetabular inclination and acetabular version by the method similar to as described by McCollum and Grey and Jolles *et al*.[16,17] This was compared for any change in position from the previous X-rays. All patients were given complete bed rest for 6 weeks in abduction. After the rest period, they were rehabilitated gradually to full weight bearing.

In group A, there was 1 dislocation out of a total of 163 (rate of dislocation 0.6%) whereas in group B there were 10 dislocations out of 154 hips (rate of dislocation 6.4%). The *P* value was 0.0107.

In group A, 1 patient had dislocation, in the first postoperative week and was managed conservatively but had three more episodes of dislocation within 2 months of the first dislocation. He was evaluated by anteroposterior and cross table lateral radiographs of the hip joint after the first episode of dislocation

Table 2: Demographic distribution

Demographic data	Group A (36 head)	Group B (28 head)
Number of patients	140	141
Total hip	163	154
Unilateral	117	128
Bilateral	23	13
Male	102	84
Female	38	57
Average age	37	42

Table 3: Comparison between two groups according to HHS with domain

HHS (total)	Group A (36)	Group B (28)
Pain	44.2±4.2	42.8±3.8
Limp	12.1±1.4	10.4±2.2
Crutches	10.2±2.8	8.8±3.0
Walking	9.8±2.5	9.6±3.0
Stairs	3.4±1.1	3.0±1.1
Shoes and socks	4.8±1.1	3.8±0.6
Chair	4.4±1.2	4.4±0.9
Public transport	0.8±0.2	0.9±0.3

HHS=Harris hip score

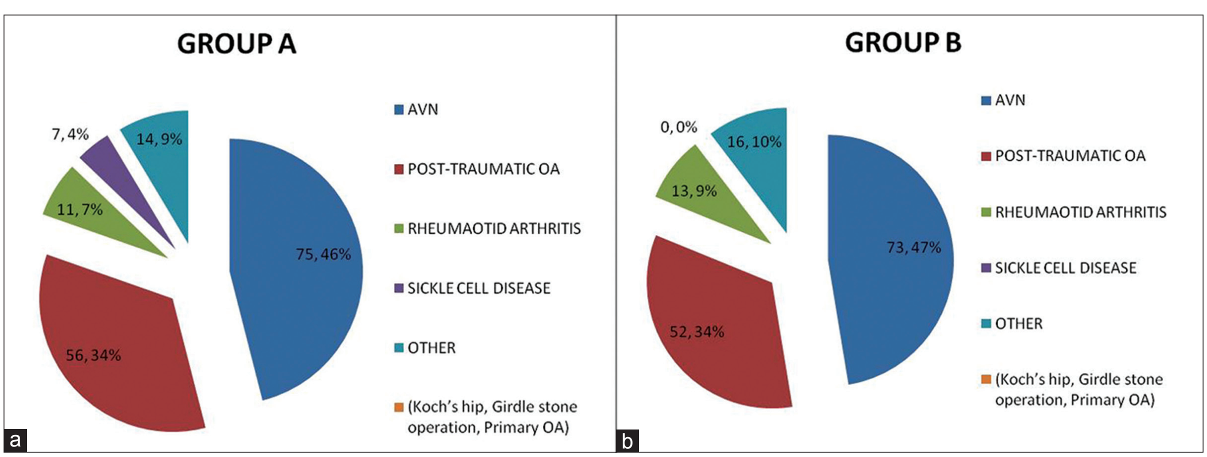

Figure 1: PI chart showing Indication of THA – difference in group A and group B. (a) Group A, 36 mm head. (b) Group B, 28 mm head

in which his acetabular shell appeared to be in neutral version, but he had 20° of femoral anteversion. Femoral version was calculated by calculating angle formed between the axis of the prosthetic neck and bottom of the radiographic plate representing the posterior plane of the condyles.[16,17] However, further episodes of dislocation warranted us in depth analysis of acetabular version using a computed tomography (CT) scan. On CT scan his acetabulum component was found to be in 10° of retroversion. This patient underwent revision of the acetabular component [Figure 2].

In group B, 10 patients (6 hips with single episode, 4 hips with multiple episodes of dislocation) had dislocation, all within first 6 weeks of postoperative period except one who presented with dislocation after 3 months with history of recent cerebro vascular accident. Out of 10 cases, 6 were treated conservatively and did well with no further episodes of dislocations or any other complications during the study period. Rest four had more than one episode of dislocation.

One patient had a loss of fixation of the cemented cup after 4 episodes of dislocation in 4 months of postoperative period and was revised from a cemented to an un-cemented cup along with the use of large head. Later his postoperative recovery was good with no further episodes of dislocation. The other 3 patients were further evaluated by CT scan for component position analysis. This group of patients showed lower angles of acetabular anteversion and lower combined anteversion angle values. All the 3 cases needed acetabular revision [Figure 3].

The difference in the rate of dislocation among stem variables irrespective of head diameter was 2.51% for CLS stem and 4.43% for MS- 30 stem. The P value was found to be 0.2156. The difference in the rate of dislocation between cemented and un-cemented cups irrespective of the head diameter was 3 (3.09%) out of 94 patients in cemented cup while with un-cemented cup, it was 8 (3.63%) out of 220. The P value was found to be 0.8896 [Table 4].

Discussion

Along with osteolysis and aseptic loosening, dislocation is one of the most common complications in THA and the most common cause of early revision. Woo and Morrey, Fackler and Poss, Ritter[2,4,14] stated that the size of the femoral head was not related to the dislocation rate. Hedlundh *et al*.[13,15] saw no significant difference in the dislocation rate between 22 mm and 32 mm femoral heads, but the recurrent dislocation rate increased by 2.3 in the smaller head group. In their study, they used the anterolateral approach with transtrochanteric osteotomy or the posterior approach randomly.

Berry *et al*.[18] recently reported that in THA, a larger head diameter was associated with a lower long term cumulative risk of dislocation. Malkani *et al.*[19] assessing 39271 primary THA in Medicare population in USA between 1998 and 2007 which had 2001 number of cases of dislocation; did multivariate cox regression analysis. Other than factors like age, surgeon volume, higher charlson index score (more co

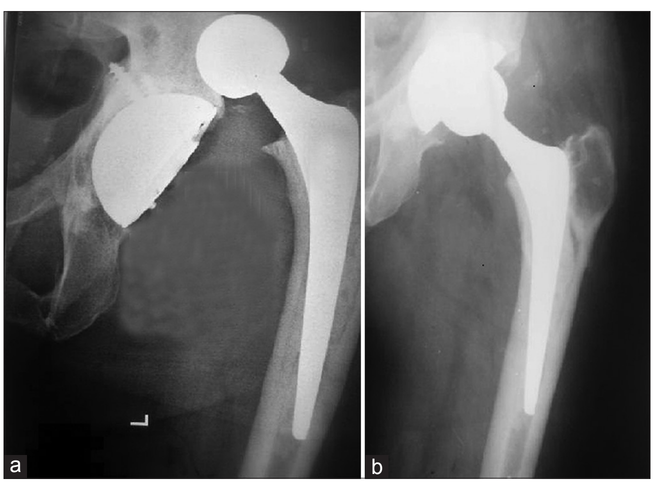

Figure 2: X-ray left hip joint anteroposterior view showing (a) Dislocation in 36 mm head after total hip replacement due to cup retroversion (b) Revision of uncemented cup with uncemented cup

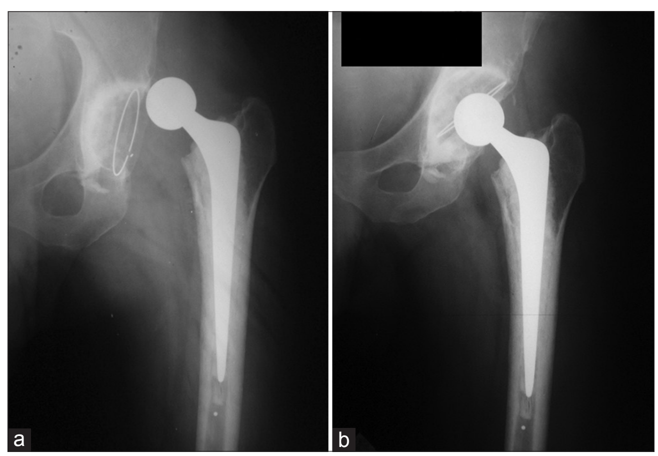

Figure 3: X-ray left hip joint anteroposterior view showing (a) Dislocation in 28 mm head total hip replacement due to lower anteversion of cup with higher abduction angle (b) Revision of cemented cup with cemented cup

Table 4: Incidence of dislocation in cemented and cementless stem (Stem variable constant)

Stem type (total no.)	Dislocation in 36 mm head (n=total no. of hips)	Percentage	Dislocation in 28 mm head (n=total no. of hips)	Percentage	P value
CLS stem (159)	1 (102)	0.98	3 (57)	5.26	0.0108
MS 30 stem (158)	0 ((61)	0	7 (97)	7.21	0.0004

morbid condition), they did find a decrease in the rate of dislocation with an increase in use of head size 32 mm or more. During this study period (1998-2007) the proportion of femoral heads, which were size 32 mm or greater, increased from approximately 12 to 77%. Sultan *et al*.[20] demonstrated that increasing the femoral head diameter from 28 mm to 32 mm essentially increases the arc of motion by 8.2° before impingement and subsequent dislocation. Crowninshield *et al*.[21] also demonstrated that increasing femoral head diameter using a fixed acetabular abduction angle increased the jump distance or vertical displacement before impingement and dislocation.

Our study represents a series of unselected primary THAs in patients operated for a variety of indications with two different head diameters and two different stem designs. Difference in the rate of dislocation was assessed in terms of head diameter as well as within the stem type. There was no difference between the two groups as far as age, sex or indication of primary THA. All the cases were operated by a single surgeon (HPB) negating the effect of surgeon related factors. Posterolateral approach with enhanced soft-tissue repair was used in all the cases negating the approach related difference among the two groups. Same rehabilitation protocol was followed in both groups. Both groups showed improvement in the HHS. There was no difference in the rate of any complications other than the difference in the rate of dislocation in the two groups.

Our study had two main variables, the difference in head diameter and difference in stem designs. There was no difference in dislocation in between cemented cups and un-cemented cups. However, there was statistically significant difference between the two groups (A and B) in dislocation rates. This difference in the rate of dislocation keeping the stem variable constant was again found to be statistically significant in both un-cemented CLS, as well as for cemented MS 30 stem.

Several studies have already demonstrated the clinical efficacy of larger femoral heads in reducing the dislocation rate.[6,8,22-25] Recently, Bistolfi *et al*.[26] in their study comparing the risk ratio (RR) of dislocation between the two groups (28 mm vs. 36 mm) found it to be approximately 8, which was a statistically significant. However, the limiting factor in their study was stem design variable which affects neck length and offset. Our study compares, the difference in dislocation keeping the stem design variable as constant. The difference in the rate of dislocation keeping the stem design variable as constant was statistically significant. When stem variable was not considered, the RR was found to be 5.82 (95% CI 0.90-37.85).

One of the major limitations in our study is relatively short duration of followup of the study. Another major drawback of our study was small numbers of patients who were evaluated in each group.

To conclude dislocation rate decreased significantly as the size of the head increased in primary THA. Use of 36 mm diameter head in primary THA also resulted in slightly greater improvement in the range of movements as compared to 28 mm diameter (although statistically not significant). However, longer followup is necessary as rate of dislocation or *in vivo* highly cross linked poly failure or fracture may increase in future affecting the rate of dislocations in primary THA.

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How to cite this article: Singh SP, Bhalodiya HP. Head size and dislocation rate in primary total hip arthroplasty. Indian J Orthop 2013;47:443-8.

Source of Support: Nil, **Conflict of Interest:** None.