Maximizing Bearing Diameter Markedly Reduces Dislocations In Primary Total Hip Arthroplasty

Eric Wang, Theodor Di Pauli Von Treuheim, Catherine Di Gangi, Ran Schwarzkopf, Morteza Meftah, Matthew Stewart Hepinstall

INTRODUCTION: Modern polyethylene allows increased bearing diameters in fixed-bearing total hip arthroplasty (THA), but any stability benefits of fully maximizing bearing diameter (eg. 36-mm in 48/50-mm cups) are not well-established. We hypothesize that maximizing bearing diameter reduces odds of dislocation in primary fixed-bearing THA.

METHODS:

We retrospectively reviewed all patients who underwent fixed-bearing THA at a large, urban, academic institution between 2016-2022. We noted all cases receiving the largest fixed bearing available from any manufacturer for the acetabular diameter: 28-mm in 40 or 42-mm, 32-mm in 44/46-mm, a 36-mm in 48/50-mm, 40-mm in 52/54-mm, or 44-mm in 56/58-mm. Larger acetabular implants were excluded as proportionately larger bearings were unavailable. Multivariate analyses using least-absolute-shrinkage-and-selection-operator (LASSO) logistic regression were performed to explore the association between maximized bearing diameter and 90-day dislocation risk, while measuring and controlling for the impact of confounders.

RESULTS:

Bearing diameter was maximized in 835 (9.8%) of 8,607 patients, whereas 7,309 received the second-largest bearing available. There were 79 dislocations (0.9% overall); none occurred with maximized bearing diameters (P=0.003). On univariate analysis, dislocation risk also varied with intraoperative technology use, surgical approach, and liner geometry (P=0.017, P=0.008, P=0.007, respectively). On LASSO regression including these variables, along with age, sex, and body-mass-index, maximized bearing diameters provided marked protection against dislocation (OR=0.14). Robotic surgery (OR=0.35), computer navigation (OR=0.90), lateral (OR=0.48) and anterior (OR=0.62) approaches were also protective. Lipped (OR=1.2) and offset (OR=1.4) liners were associated with slightly higher odds of dislocation but were commonly used with a posterior approach and non-maximized bearing diameters. Sub-analysis of 4,185 patients with smaller bearings and a posterior approach revealed that liner geometry did not impact dislocation odds within this sub-group, nor did receiving the second-largest available bearing demonstrably reduce dislocation odds compared to smaller bearings.

DISCUSSION AND CONCLUSION:

Fully maximizing bearing diameter markedly reduced odds of dislocation in primary fixed-bearing THA. The magnitude of this effect was substantially larger than for other variables under surgeon control. Anterior and lateral surgical approaches, and robot or computer-navigation, protect against dislocations. Although in the full group, lipped and lateral liners increased dislocation odds, that relationship was not seen in subgroup analysis of patients with posterior approach and non-maximized bearing diameters. ROC analyses suggest that both regression models approach generalizability and that further analyses using larger datasets or meta-analyses should be pursued.

Table 1: Dislocations by Baseline Patient, Intraoperative, and Construct Characteristics

Characteristic	Dislocation - N = 8,528	Dislocation + N = 79	*P*-value[/]
Age at Surgery, Median (IQR)	65 (58 – 72)	66 (58 – 72)	0.92
Women, n (%)	5,569 (65)	49 (62)	0.54
BMI Category, n (%)			0.12
Normal	1,876 (22)	21 (27)	
Underweight	289 (3.4)	6 (7.6)	
Overweight	2,934 (34)	28 (35)	
Obese	2,007 (24)	12 (15)	
Morbidly Obese	1,422 (17)	12 (15)	
Intraoperative Technology, n (%)			**0.017**
Conventional	4,183 (49)	49 (62)	
Robotic	934 (11)	2 (2.5)	
Navigation	3,411 (40)	28 (35)	
Surgical Approach, n (%)			**0.008**
Posterior	4,462 (52)	55 (70)	
Anterior	3,521 (41)	22 (28)	
Lateral	545 (6.4)	2 (2.5)	
Liner Geometry, n (%)			**0.007**
Neutral	5,253 (62)	35 (44)	
Lipped	3,155 (37)	42 (53)	
Offset	120 (1.4)	2 (2.5)	
Bearing Diameter, n (%)			
Largest, n (%)	835 (9.8)	0 (0)	**0.003**
Second-Largest, n (%)	7,240 (85)	69 (87)	0.55
Smaller, n (%)	453 (5.3)	10 (13)	**0.009**

IQR, Interquartile Range; BMI, Body Mass Index
[/] Wilcoxon rank sum test; Pearson's Chi-squared test; Fisher's Exact Test for Count Data with simulated p-value (based on 2000 replicates); Fisher's exact test

Table 2: Odds Ratios of Dislocation from Regression Analyses

Variable	OR[1] (Full Group) N = 8,607 AUC = 0.69	*P*-value	OR[2] (95% CI) (Sub-Group) N = 4,185 AUC = 0.65	*P*-value
Age at Surgery	1	-	0.99 (0.97 to 1.01)	0.3
Sex				
Male	-		-	
Female	**0.896**	-	0.76 (0.43 to 1.35)	0.34
BMI Category				
Normal	-		-	
Underweight	**2.12**	-	1.41 (0.32 to 4.36)	0.59
Overweight	**0.995**	-	0.66 (0.33 to 1.31)	0.22
Obese	**0.616**	-	**0.34 (0.14 to 0.78)**	**0.014**
Morbidly Obese	**0.841**	-	0.47 (0.20 to 1.07)	0.078
Surgical Approach				
Posterior	-		Not Applicable	
Anterior	**0.621**	-	Not Applicable	
Lateral	**0.483**	-	Not Applicable	
Intraoperative Technology				
Manual Instrumentation	-		-	
Robot-Assisted	**0.353**	-	**0.14 (0.01 to 0.69)**	0.059
Navigation-Assisted	**0.898**	-	0.73 (0.39 to 1.31)	0.31
Liner Geometry				
Neutral	-		-	
Lipped	**1.178**	-	1.06 (0.58 to 2.10)	0.85
Offset	**1.407**	-	1.53 (0.23 to 5.81)	0.59
Bearing Diameter				
Not Largest	-		-	
Largest-Within-Group	**0.137**	-	1.02 (0.44 to 3.00)	0.96

OR, odds ratio; *CI*, confidence interval; *AUC*, area-under-receiver-operating-curve; *BMI*, Body Mass Index
[1]LASSO does not yield confidence intervals or p-values; all OR values should be interpreted as predictive
[2]Standard multivariate logistic regression

Table 3: Sub-group Analysis - Non-Maximally Sized Bearings and Posterior Approach

Characteristic	Dislocation - N = 4,130	Dislocation + N = 55	*P*-value[/]
Age at Surgery, Median (IQR)	66 (58 – 73)	65 (57 – 72)	0.38
Women, n (%)	2,683 (65)	33 (60)	0.44
BMI Category, n (%)			0.068
Normal	764 (18)	16 (29)	
Underweight	109 (2.6)	3 (5.5)	
Overweight	1,332 (32)	19 (35)	
Obese	1,052 (25)	8 (15)	
Morbidly Obese	873 (21)	9 (16)	
Intraoperative Technology, n (%)			0.089
Conventional	2,338 (57)	37 (67)	
Robotic	412 (10.0)	1 (1.8)	
Navigation	1,380 (33)	17 (31)	
Liner Geometry, n (%)			0.52
Neutral	1,117 (27)	13 (24)	
Lipped	2,923 (71)	40 (73)	
Offset	90 (2.2)	2 (3.6)	
Second-Largest Bearing Diameter Used, n (%)	3,813 (92)	50 (91)	0.61

IQR, Interquartile Range; BMI, Body Mass Index
[/] Wilcoxon rank sum test; Pearson's Chi-squared test; Fisher's Exact Test for Count Data with simulated p-value (based on 2000 replicates); Fisher's exact test