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An Analysis of the Risk of Hip Dislocation with a Contemporary Total Joint Registry

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Dislocation rates after total hip arthroplasty in a community setting have not been well documented. We used a community based joint registry to evaluate hip dislocations that occurred within 1 year after total hip arthroplasty. We evaluated patient, implant, and technical factors associated with dislocation, including primary versus revision surgery, femoral head size (28 mm versus ≥ 32 mm), operative time, surgeon volume, surgical approach, age, gender, diagnosis, American Society of Anesthesiologists (ASA) classification, and body mass index (BMI). There were 1693 primary total hip arthroplasties and 277 revision procedures performed from 2001–2003. The overall dislocation rate was 1.7% for primary total hip arthroplasties and 5.1% for revision procedures. Patients with ASA scores of 3 or 4 had a 2.3-fold dislocation increase compared with patients with scores of 1 or 2. Patients with rheumatoid arthritis had an increased risk of dislocation. The dislocation rates for primary total hip arthroplasty were 2% for 28 mm heads and 0.7% for heads ≥ 32 mm. The surgeon's patient volume, surgical approach, operative time, and body mass index had no effect on dislocation.

Level of Evidence: Prognostic study, level III. See Guidelines for Authors for a complete description of levels of evidence.

While total hip arthroplasty (THA) is an effective procedure for the management of degenerative hip disease, dislocation after THA remains the second leading cause of revision.[5,10] With almost 200,000 THAs performed annually in the United States,[16] even low rates of instability can lead to substantial morbidity and untold societal costs. As implant designs, surgical techniques and indications continue to change, there is a growing need to identify and manage risk factors for dislocation in order to maximize outcomes for the population of patients undergoing THA in the United States.

The true rate of dislocation among total hip arthroplasties (THAs) in the U.S. is not known, largely because the population at risk is difficult to monitor. Dislocation rates reported in the literature have ranged from less than 1% to more than 9%.[1,6,8,21,25] The Mayo Clinic database generated a dislocation rate of 3.2% in 10,500 THAs.[27] This rate is frequently cited because of the large sample size in that registry. All these studies used samples of THAs performed at academic institutions, which introduces the possibility of selection and performance bias. Since the majority of THAs in the U.S. are performed by low volume surgeons,[14] it cannot be assumed these studies are representative of THAs being performed in this country.

One study using an administrative protocol to calculate rates of dislocation in the Medicare population reported an incidence of dislocation occurring at 6 month followup as 3.9% for primary THA and 14.4% for revision THA.[23] The Medicare database reduces the possibility of selection and performance bias by sampling across the spectrum of health care settings. However, in the U.S., a substantial number of THAs are performed in patients less than 65 years of age.[16] This subset of the population is not represented in the Medicare database. To the extent the younger patient population represents an increasingly important cohort for whom risks of complications need to be studied carefully, the Medicare database has serious limitations for the study of risk factors for dislocation following THA. We believe there is a need to ascertain whether rates of dislocation are higher or lower among patients undergoing THA in a community setting compared to rates reported by expert academic surgeons.

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We therefore ascertained community dislocation rates as well as risk factors associated with dislocation.

MATERIALS AND METHODS

From the Kaiser Permanente Total Joint Registry database for total hip arthroplasty procedures performed in Southern California we identified THA patients with a minimum 1-year follow-up from April 1, 2001 to March 31, 2003. At the time 3,098 patients were registered in the database. Five percent of the patient population was lost to follow-up as a result of health plan attrition. A total of 1, 970 patients met the study criteria. The final sample included 1693 primary and 277 revision THAs performed by 66 surgeons at 11 hospitals in Southern California (Table 1). The mean age of patients undergoing primary THA was 66 years (range,18–94), and the mean age of patients undergoing revision THA was 65 years (range, 24–95). Females accounted for 57% of the primary THAs and 55% of the revision THAs. Osteoarthritis (OA) was the primary diagnosis for most patients undergoing primary THAs (70%). Aseptic loosening (32%), osteolysis (22%), and polyethylene liner wear (18%) accounted for the majority of revision diagnoses.

Our community-based registry reflects all procedures performed in a prepaid group-model health maintenance organization (HMO). Surgeon and hospital volume, and surgeons' level of training (fellowship vs. nonfellowship level training) are representative of the wider orthopaedic community in the U.S. Our registry collects information in three main categories: patient, implant, and surgical technique. As of December 2004, the Kaiser Permanente Total Joint Registry contained data on 11,087 TKAs and 7210 THAs from five different regions. The Registry consists of several standardized data collection forms: (1) a preoperative form; (2) an operative form; (3) a status report form for all total joint follow-up visits. These forms are completed by surgeons and staff in the clinic and the OR. The forms capture information on patient demographics, surgical technique, implant characteristics, and patient outcomes. Registry data are validated using our hospital utilization database and independent chart reviews.

Dislocation within a 1-year following THA was the primary outcome variable. Dislocations were identified using the Registry which captures complications at each follow-up visit. Dislocations were also identified from the hospital utilization database using ICD-9-CM discharge diagnosis codes (8350x, 8351x). All dislocations were validated by an orthopedic research nurse.

We examined the influence of patient, implant and technical factors on THA dislocation. Patient factors including gender, age, primary diagnosis, Body Mass Index, and ASA score extracted from the Registry database.

Technical factors included surgeon annual case volume, procedure (revision versus primary), and surgical approach (posterior versus other). Surgeon volume was based on unique surgeon identification numbers identified in the Registry. Surgeon volume was calculated by counting the total number of THAs performed by each surgeon identification number for each year of the study. Surgeon volume was then divided into two categories: high (> 30 procedures annually) and low (≤ 30 procedures annually). Of the 66 surgeons, there were 22 high volume surgeons (> 30 patients annually) during the study period.

Femoral head size was examined as a potential implant-related factor and also was extracted from the Registry. Head size was categorized into small (28 mm) and large (≥ 32 mm) head sizes. Small femoral heads (28 mm) were used in 73% of the primary THA procedures and in 46% of the revision procedures.

Chi square and Fisher's exact tests were used to compare categorical variables. Independent t tests were applied to assess group differences in continuous variables. Mann-Whitney tests were used to evaluate group differences in ordinal variables and in continuous variables with non-normal distributions. Univariate and multivariate logistic regression analyses were used to examine patient, implant and technical variables associated with THA dislocations. The p value for this study was set at 0.05.

RESULTS

Community dislocation rates for primary THA surgery appear to be similar to those reported in academic centers. Our overall primary dislocation rate of 1.7% at one year follow-up is similar to the reported rate of 2.2% at one year from the Mayo database.[3]

The technical factor primarily associated with dislocation was revision surgery. Dislocation rates were 1.7% for primary THA and 5.1% for revision THA ($p < 0.001$) (Table 2). In the multivariate model, the odds of dislocation were 2.9 times larger for revision than for primary procedures ($p = 0.01$) (Table 3).

TABLE 1. Patient Demographics

Parameters	Primary THA	Revision THA
Mean age (years) (SD)	66 (13)	65 (14)
Female gender	872 (57%)	129 (55%)
Mean body mass index (SD)	29 (6)	29 (6)
Primary diagnosis		
Osteoarthritis	1178 (70%)	
Rheumatoid arthritis	44 (3%)	
Posttraumatic arthritis	20 (1%)	
Osteonecrosis	165 (9.7%)	
Inflammatory arthritis	12 (0.7%)	
Revision diagnosis		
Aseptic loosening		88 (32%)
Instability		35 (13%)
Osteolysis		60 (22%)
Polyethylene liner wear		50 (18%)
Infection		11 (4%)
Femoral fracture		18 (7%)
Acetabular fracture		6 (2%)
ASA score		
1 point	72 (5%)	14 (6%)
2 points	894 (60%)	127 (51%)
3 points	502 (34%)	105 (42%)
4 points	19 (1%)	4 (2%)

THA = total hip arthroplasty; SD = standard deviation; ASA = American Society of Anesthesiologists

TABLE 2. Dislocation Rates for Patient Groups

Parameters	Primary THA	Revision THA
Overall dislocation rate*	28 (1.7%)	14 (5.1%)
Age (years)**		
< 55 years	9 (3.4%)	0 (0%)
> 55 years	18 (1.4%)	13 (6.7%)
Gender		
Female	17 (1.9%)	5 (3.9%)
Male	10 (1.5%)	7 (6.6%)
BMI		
BMI < 30	5 (1.1%)	3 (4%)
BMI > 30	5 (1.3%)	4 (7%)
BMI > 40	1 (0.8%)	1 (5%)
Primary diagnosis		
Osteoarthritis	14 (1.2%)	
Rheumatoid arthritis***	4 (9%)	
Posttraumatic arthritis	0 (0%)	
Osteonecrosis	4 (2.4%)	
Inflammatory arthritis	0 (0%)	
Revision diagnosis		
Aseptic loosening		3 (3.4%)
Instability		3 (8.6%)
Osteolysis		3 (5%)
Polyethylene liner wear		1 (2%)
Infection		0 (0%)
Femoral fracture		1 (5.6%)
Acetabular fracture		0 (0%)
ASA score***		
1–2	10 (1%)	7 (5%)
3–4	17 (3.3%)	6 (5.5%)
Femoral head size		
Small (28 mm)	23 (2%)	5 (4.6%)
Large (≥ 32 mm)	3 (0.7%)	7 (5.6%)
Surgeon case volume		
Low	7 (1.3%)	4 (6.7%)
High	21 (1.9%)	10 (4.6%)
Surgical approach		
Posterior	26 (1.9%)	7 (3.3%)
Anterolateral	0 (0%)	2 (16.7%)

BMI = body mass index

*Revision versus primary THA, $p < .001$

**For primary THAs, $p < .05$

***For primary THAs, $p < .01$

Patient factors notably associated with dislocation include ASA score and primary diagnosis of rheumatoid arthritis (RA) (Table 1). Dislocation rates were 1% for primary THA patients with ASA scores less than 3 and 3.3% for those with ASA scores of 3 and 4. Dislocation rates were 9% for primary THA RA patients and 1.2% for those with osteoarthritis. In the multivariate logistic regression model (Table 3), the odds of dislocation for patients with ASA score of 3 and 4 were 2.3 times larger than for patients with ASA scores less than 3 ($p = 0.02$). In the same model, the odds of dislocation were 3.8 times larger for patients with RA than for those with other diagnoses ($p = 0.04$). Dislocation rates of primary THA patients younger than 55 similar to those in patients over 55 although might have been greater with greater study power.

Femoral head size did not relate to dislocation rates. Dislocations rates were 2% for 28 mm femoral heads and 0.7% for heads ≥ 32 mm in primary THA. The dislocation rates for revision THA were 4.6% for small head size and 5.6% for large head size. In the multivariate model, the odds of dislocation were 1.8 times larger ($p = 0.18$) for the small head size than the large head size.

Patients who had revision THAs had higher ($p < 0.01$) ASA scores than patients undergoing primary THAs. Body mass index was similar in patients undergoing primary and revision THAs.

Most primary (79%) and revision (77%) THAs were performed using the posterior approach. The anterolateral approach was used in 88 (5%) primary procedures and in 12 (4%) revision procedures. Operative time was longer ($p < 0.001$) for revision THAs (mean, 190 minutes ± 116 minutes) than primary THAs (mean, 99 minutes ± 35 minutes).

DISCUSSION

Hip dislocation remains a major complication after THA. In a study evaluating a Medicare population, dislocations occurred in 3.9% of patients 6 months after primary THA and in 14.4% of patients 6 months after revision THA.[24] The majority of dislocations occur within 1 year after THA.[12] A recent study following over 20,000 hips spanning 30 years confirmed this finding.[3] The goal of this study was to evaluate the risk of dislocation in total hip procedures performed using contemporary techniques and implants with a community based registry which includes both Medicare and non-Medicare patients.

Factors associated with early prosthetic dislocation can be divided into three categories: patient, implant and technique. Patient factors include age, gender, diagnosis, ASA score, and BMI. We found no increased risk in dislocation rate with advancing age. A reported 9.2% dislocation rate in patients over 80 years old declines to only 3.7% when excluding the diagnosis of proximal femur fracture.[7] Accordingly, a diagnosis of fracture may be more noteworthy than age. Fracture patients are not included in the registry.

Patients with RA undergoing primary THA were found to have a 6 fold greater risk of dislocation in the univariate and multivariate analyses. The Mayo database recently reported a relative risk of 1.4 for patients with inflammatory arthritis as compared with osteoarthritis.[3] A study on Danish patients reported inflammatory arthritis was an independent risk factor for hip dislocation.[28] The authors hypothesized the combination of inferior quality soft tissue and impairment of other joints may lead to hyperflexion of the operative hip and subsequent instability.[28]

TABLE 3. Multivariate Results

Parameters	p Value	Adjusted Odds Ratio	95% Confidence Interval
Age (years)	0.84	.91	0.37, 2.2
Gender	0.91	.96	0.46, 2
ASA score	0.02	2.3	1.1, 4.7
Rheumatoid arthritis	0.04	3.8	1.1, 13.7
Procedure (primary versus revision)	0.01	2.9	1.3, 6.6
Head size (28 mm versus ≥ 32 mm)	0.18	1.8	0.75, 4.4
Surgeon volume (low versus high)	0.27	1.6	0.71, 3.5
Surgical approach (posterior versus others)	0.94	1	0.42, 2.6

ASA = American Society of Anesthesiologists

The ASA score is related to medical comorbidities and is a prognostic scale for perioperative complications.[26] One Swiss study showed patients with a high ASA score had a 10-fold increase in dislocation risk.[12] We found an elevated dislocation risk (relative risk, 2.3) with ASA score of 3 or 4 versus 1 or 2. An elevated ASA may indicate in an impaired ability to observe hip precautions after THA. This can be a result of impaired cognitive and/or physical abilities in these patients.

An elevated BMI was not associated with increased risk of dislocation. This finding is in concurrence with the literature.[22] While elevated BMI has been associated with lower patient satisfaction[14] and higher complication rates,[11] it does not appear to increase the risk of dislocation.

Implant related factors include the femoral head size, positioning of the acetabular component, and elevated liners. Larger femoral head size showed a nonsignificant trend towards improved stability. Bartz et al reported increased femoral head size improved range of motion (ROM) in the laboratory, and would theoretically reduce dislocation rates.[2] A recent report from the Mayo database suggested a difference in dislocation rates when comparing small (22 mm) to large (32 mm) head sizes.[3] While acetabular position, size, and use of elevated rim liner have been associated with prosthetic instability,[4,16,17,20] our study did not evaluate these variables.

Technical factors associated with THA also play a major role in risk of dislocation. Multiple studies have found revision surgery has a much higher risk of dislocation compared with primary surgery.[18,24,27] A 14.4% dislocation rate was reported for revision Medicare patients 6 months postoperatively compared with a 3.9% dislocation rate for primary surgery in the same Medicare population.[24] Our data supports the increased risk of dislocation after revision surgery. We found a 5.1% dislocation rate 12 months after revision THA compared with 1.7% for primary THA.

Surgical approach has also been extensively evaluated as a risk for postoperative dislocation. In a review of the literature in 1990, the anterolateral and transtrochanteric approaches had lower dislocation rates than the posterolateral approach.[4] We did not find a difference in dislocation rates between approaches. This may be because of the improved success of the posterolateral approach with posterior soft tissue repair.[23] While we did not collect data on posterior repair, it is a common practice in modern THA surgery.[3] Dislocation rates associated with the posterolateral approach utilizing posterior capsular repair are similar to the dislocation rates associated with the anterolateral approach.[23,27]

The surgeon's patient volume has been evaluated in association with perioperative morbidity and mortality.[13] In a comparison of surgeons who performed more than 50 THAs annually with surgeons performing less than 5 procedures annually, Katz et al. found a substantial difference in dislocation rates (1.5% versus 4.2%, respectively). We did not detect a difference in dislocation rates in high versus low volume surgeons. High and low volume surgeons were indicated as surgeons who performed ≥ 30 THAs annually (high) and surgeons who performed ≤ 30 THAs annually (low). A likely reason we were unable to detect a difference is our arbitrary cutoff (30 THAs) may not reflect the true difference between high and low volume surgeons. We were unable to compare surgeons with less than five THAs to those who performed more than 50 THAs.

The strengths of our study include the recent time period reflecting contemporary implants. Historical studies spanning several decades involve obsolete implant designs and surgical techniques which have been refined over the years. The contemporary time period in our study also takes into account the changing expectations of current patients, who desire quicker recovery and near full activity potential. Our study also includes the increasing number of younger patients undergoing THA[16] which are not reflected with Medicare population studies. Limitations of our study include the preponderance of posterior approaches used by our surgeons, the short follow-up period, and lack of radiographic analysis.

While academically based and Medicare based registries have provided valuable information on the dislocation risk after THA, we aimed to provide a community based risk profile and associate this risk with common patient, implant, and technical factors previously described in the literature. Community based surgeons need to advise their patients of relevant risks associated with THA. We found dislocation rates of 1.7% for primary THA and 5.1% for revision THA. Patients with elevated ASA scores ($p = 0.02$) or a preoperative diagnosis of RA had a ($p = 0.04$) higher risk of dislocation. Femoral head size did not affect dislocation, but patients with heads $\geq$ 32 mm trended toward a lower risk than patients with heads $\leq$ 28 mm. The patient factors of age, gender, and BMI were not associated with increased dislocation risk, nor were the technical factors of surgeon volume, operative time, and surgical approach.

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References

1. Ali Khan MA, Brakenbury PH, Reynolds IS. Dislocation following total hip replacement. *J Bone Joint Surg Br*. 1981;63:214–218.
2. Bartz RL, Nobel PC, Kadakia NR, Tullos HS. The effect of femoral component head size on posterior dislocation of the artificial hip joint. *J Bone Joint Surg Am*. 2000;82:1300–1307.
3. Berry D, von Knoch M, Schleck C, Harmsen W. Effect of femoral head diameter and operative approach on risk of dislocation after primary total hip arthroplasty. *J Bone Joint Surg Am*. 2005;87: 2456–2463.
4. Cobb TK, Morrey BF, Ilstrup DM. The elevated-rim acetabular liner in total hip arthroplasty: relationship to postoperative dislocation. *J Bone Joint Surg Am*. 1996;78:80–86.
5. DeWal H, Su E, DiCesare PE. Instability following total hip arthroplasty. *Am J Orthop*. 2003;32:377–382.
6. Eftekhar NS. Dislocation and instability complicating low friction arthroplasty of the hip joint. *Clin Orthop Relat Res*. 1976;121:120–125.
7. Ekelund A, Rydell N, Nilsson OS. Total hip arthroplasty in patients 80 years of age and older. *Clin Orthop Relat Res*. 1992;281:101–106.
8. Etienne A, Cupic Z, Charnley J. Postoperative dislocation after Charnley low-friction arthroplasty. *Clin Orthop Relat Res*. 1978; 132:19–23.
9. Fackler CD, Poss R. Dislocation in total hip arthroplasties. *Clin Orthop Relat Res*. 1980;151:169–178.
10. Hamilton WG, McAuley JP. Evaluation of the unstable total hip arthroplasty. *Instr Course Lect*. 2004;53:87–92.
11. Jibodh SR, Gurkan I, Wenz JF. In-hospital outcome and resource use in hip arthroplasty: influence of body mass. *Orthopedics*. 2004; 27:594–601.
12. Jolles BM, Zangger P, Leyvraz PF. Factors predisposing to dislocation after primary total hip arthroplasty: a multivariate analysis. *J Arthroplasty*. 2002;17:282–288.
13. Katz JN. E. L, Barrett J, Phillips CB, Mahomed NN, Lew RA, Guadagnoli E, Harris WH, Poss R, Baron JA. Association between hospital and surgeon procedure volume and outcomes of total hip replacement in the United States medicare population. *J Bone Joint Surg Am*. 2001;83:1622–1629.
14. Katz JN, Phillips CB, Baron JA. Fossel AH, Mahomed NN, Barrett J, Lingard EA, Harris WH, Poss R, Lew RA, Guadagnoli E, Wright EA, Losina E. Association of hospital and surgeon volume of total hip replacement with functional status and satisfaction three years following surgery. *Arthritis Rheum*. 2003;48:560–568.
15. Kelley SS, Lachiewicz PF, Hickman JM, Paterno SM. Relationship of femoral head and acetabular size to the prevalence of dislocation. *Clin Orthop Relat Res*. 1998;355:163–170.
16. Kurtz S, Mowat F, Ong K, Chan N, Lau E, Michael Halpern M. Prevalence of primary and revision total hip and knee arthroplasty in the United States from 1990 through 2002. *J Bone Joint Surg Am*. 2005;87:1487–1497.
17. Lewinnek GE, Lewis JL, Tarr R, Compere CL, Zimmerman JR. Dislocations after total hip-replacement arthroplasties. *J Bone Joint Surg Am*. 1978;60:217–220.
18. Mahomed NN, Barrett JA, Katz JN, et al. Rates and outcomes of primary and revision total hip replacement in the United States medicare population. *J Bone Joint Surg Am*. 2003;85:27–32.
19. Mahoney CR, Pellicci PM. Complications in primary total hip arthroplasty: avoidance and management of dislocations. *Instr Course Lect*. 2003;52:247–255.
20. McCollum DE, Gray WJ. Dislocation after total hip arthroplasty. Causes and prevention. *Clin Orthop Relat Res*. 1990;261:159–170.
21. Morrey BF. Instability after total hip arthroplasty. *Orthop Clin North Am*. 1992;23:237–248.
22. Paterno S, Lachiewicz P, Kelley S. The influence of patient-related factors and the position of the acetabular component on the rate of dislocation after total hip replacement. *J Bone Joint Surg Am*. 1997; 79:1202–1210.
23. Pellicci PM. Posterior Approach to Total Hip Replacement Using Enhanced Posterior Soft Tissue Repair. *Clin Orthop Relat Res*. 1998;355:224–228.
24. Phillips CB, Barrett JA, Losina E. Mahomed NN, Lingard EA, Guadagnoli E, Baron JA, Harris WH, Poss R, Katz JN. Incidence rates of dislocation, pulmonary embolism, and deep infection during the first six months after elective total hip replacement. *J Bone Joint Surg Am*. 2003;85:20–26.
25. Ritter MA. Dislocation and subluxation of the total hip replacement. *Clin Orthop Relat Res*. 1976;121:92–94.
26. Vacanti CJ, VanHouten RJ, Hill RC. A statistical analysis of the relationship of physical status to postoperative mortality in 68,388 cases. *Anesth Analg*. 1970;49:564–566.
27. Woo RY, Morrey BF. Dislocations after total hip arthroplasty. *J Bone Joint Surg Am*. 1982;64:1295–1306.
28. Zwartele RE, Brand R, Doets HC. Increased risk of dislocation after primary total hip arthroplasty in inflammatory arthritis: a prospective observational study of 410 hips. *Acta Orthop Scand*. 2004;75: 684–690.