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Original Research

No Decrease in Early Survivorship of Dual Mobility Implants in Primary Total Hip Arthroplasty

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A B S T R A C T

Background: Dual mobility (DM) implants in primary total hip arthroplasty (THA) have gained recent popularity; however, safety concerns persist. The purpose of this study was twofold: 1) assess trends in DM implant adoption; and 2) evaluate the impact of modular DM implants on dislocation and all-cause revision rates at short-term follow-up.

Methods: This retrospective study identified patients in our institutional arthroplasty database who underwent primary posterior approach THA for degenerative conditions from November 2013 to December 2020. Patients undergoing primary THA for fracture were excluded. Patients were divided into two cohorts: modular DM and non-DM implants. Annual DM utilization and dislocation rates were recorded. Patient records were reviewed to determine implant selection and identify indications for dislocations and reoperations.

Results: Institutional adoption was rapid, increasing from 3.4% in 2013 to 47.1% in 2020. Of the 4548 primary THA cases from 2013 to 2020, 2859 (62.9%) had minimum one-year follow-up data for inclusion. There were 724 (25.3%) with DM implants and 2135 (74.7%) with non-DM implants. The DM group had a significantly lower dislocation rate (0.14% vs 0.84%, $P = .04$), with similar all-cause revision rates (2.49% vs 2.72%, $P = .74$) at one-year follow-up. No cases of DM-specific complications (metallosis or intraprosthetic dislocations) were noted.

Conclusions: From 2013 to 2020, DM implant utilization in primary THA steadily increased. Use of modular DM implants is associated with a decreased dislocation rate without compromised survivorship at one-year follow-up when compared to non-DM implants. No instances of modular DM-specific complications were identified; however, longer-term surveillance is necessary to verify these findings.

Level of Evidence: Prognostic Level III.

Introduction

Instability is a major complication following total hip arthroplasty (THA) and is a common reason for early revision, accounting for just over 25% of early THA revisions [1]. Studies have found that dislocation risk is roughly 1% at 1-month postoperatively and 2% at 1-year postoperatively, with a steady increase of 1% every 5 years thereafter [2,3]. In an effort to decrease the risk of dislocation, dual mobility (DM) implants were introduced.

DM implants typically consist of either a monoblock or modular acetabular shell, a polyethylene-bearing mobile liner, and a ceramic or metal femoral head. Unlike standard bearing implants, which only have one bearing surface, DM implants have two: the outer bearing surface between the acetabular shell and polyethylene liner and the inner bearing surface between the polyethylene liner and femoral head. Movement primarily occurs at the inner bearing surface, with movement at the outer bearing surface only occurring at extremes of movement [4,5]. The primary benefit that is conferred by this construct is a greater range of motion before prosthetic impingement and a larger jump distance, thereby reducing dislocation risk [6].

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This advantage of increased stability has led to the usage of DM implants in many high-risk patient populations such as the elderly, young active individuals, obese patients, neuromuscular deficient patients, dysplastic patients, patients with femoral neck fractures, and patients with advanced degenerative spine pathology and spinal fusion [7-9]. Some authors have now begun to promote expanding the indications for utilizing DM for all patients undergoing THA [10].

Despite the reported benefits of DM implants, concerns over the safety of these implants persist. There have been reports of higher debris generation within the two articulations, metallosis, and intraprosthetic dislocation, a complication unique to DM implants [6]. As a result, an increased risk for revision THA has been associated with DM implants, though the increased risk may simply reflect underlying patient characteristics and their baseline risk for dislocation [11].

The purpose of this study was to assess the association between modular DM components on overall dislocation and all-cause revision rates following primary THA at 1-year follow-up. Additionally, we sought to evaluate the rate of adoption in our hospital system and its utilization by decade of life. We hypothesize that patients who receive modular DM implants will have lower rates of dislocation than those who receive non-DM implants, without any increased risk of complications and revisions.

Material and methods

Study population

A retrospective review of all patients in our institutional arthroplasty database who underwent primary posterior approach THA in our hospital system from November 2013 to December 2020 was performed. This study was approved by and conducted according to regulations set forth by our institutional review board. Patients aged 18 and above who underwent primary THA for degenerative hip conditions were included. Patients undergoing primary THA for fractures were excluded. Direct anterior approach THA cases were also excluded to control for approach between groups.

Surgical technique/implant selection

For all primary THAs, either the direct superior approach or the posterior approach was utilized, depending on the surgeon's individual preference. The direct superior approach for THA is a superior-based, iliotibial band-sparing technique that may offer advantages over traditional THA approaches [12-16]. There are different variations to this approach, which have led to different names being used in the literature. At our center, navigation and robotics were not utilized. Preoperative lumbar evaluation methodology varied based on surgeon preference but was taken into account routinely. Selection of acetabular and femoral implants was also at the surgeon's discretion based on the patient's preoperative clinical presentation and intraoperative anatomy.

Data collection

Data from our prospectively maintained total joint registry was queried to gather patient demographics such as age, gender, body mass index, American Society of Anesthesiology (ASA) score, laterality, date of surgery, surgeon, and length of stay. Follow-up was determined from the date of surgery to the last clinic visit in the patient chart. All patients included in the study had a minimum one-year clinical follow-up. Current Procedural Terminology codes and clinical records were reviewed to determine implant selection and identify dislocations and reoperation rates. Patients with modular DM implants were designated as our DM group, and patients with standard bearing implants were designated as our non-DM group. DM utilization and dislocation rates in primary THA cases at our institution were also recorded for each year. The usage profile of DM implants was further analyzed by categorizing usage based on patient age group. All patients with dislocations had pelvic radiographs reviewed to confirm the diagnosis of dislocation. All patients with revisions had the primary indication noted and recorded. Our primary outcome is postoperative dislocation rate between the DM and non-DM groups. Secondary outcomes included aseptic and septic revision rates and all-cause revision rates at one-year follow-up.

Table 1
Demographics of primary THA patients.

Variables	DM (n = 724)	Non-DM (n = 2135)	*P*-value
	N (%)	N (%)	
Age	64.1 ± 12.7	65.3 ± 11.9	.02
Sex			<.001
Male	250 (34.53)	900 (42.15)	
Female	474 (65.47)	1235 (57.85)	
BMI	27.7 ± 6.0	28.8 ± 7.0	<.001
ASA	2.2 ± 1.0	2.3 ± 0.7	.21
Approach			.07
Direct superior	356 (49.17)	968 (45.34)	
Posterior	368 (50.83)	1167 (54.66)	

BMI, body mass index.

Patient demographics

DM and non-DM groups were statistically similar regarding the ASA score (DM vs non-DM: 2.2 vs 2.3, $P = .21$). The DM group was younger (64.1 vs 65.3 years, $P = .02$) and had a lower body mass index (27.7 vs 28.8, $P < .001$); however, these differences were clinically insignificant. The DM group also had a greater percentage of females compared to the non-DM group (65.47% vs 57.85%, $P < .001$). Both groups had a similar proportion of cases using the direct superior approach (49.17% vs 45.34%, $P = .07$) and posterior approach (50.83% vs 54.66%, $P = .07$) (Table 1). The primary indication for THA, primary osteoarthritis, was similar between groups (89.50% vs 90.54%, $P = .42$) (Table 2). Femoral head size was also recorded and compared between groups. The DM group utilized a 22-mm inner femoral head in 5.39% of cases and a 28 mm inner femoral head in 94.61% of cases. The DM group utilized a ≤32 mm outer femoral head in 0.28% of cases, a 36 mm outer femoral head in 1.38% of cases, a 38 mm outer femoral head in 10.91% of cases, and a ≥40 mm outer femoral head in 87.43% of cases. The non-DM group utilized a ≤32 mm femoral head in 6.42% of cases, a 36 mm femoral head in 75.46% of cases, and a ≥40 mm femoral head in 18.13% of cases (Table 3).

Table 2
Indications for primary THA.

Variables	DM (n = 724)	Non-DM (n = 2135)	*P*-value
	N (%)	N (%)	
Primary OA	648 (89.50)	1933 (90.54)	.42
Avascular necrosis	30 (4.14)	139 (6.51)	.02
Post-traumatic OA	39 (5.39)	48 (2.25)	<.001
Rheumatoid arthritis	4 (0.55)	12 (0.56)	.98
Septic OA	1 (0.14)	2 (0.09)	.75
Ankylosing spondylitis	2 (0.28)	1 (0.05)	.10

OA, osteoarthritis.

Table 3
Implant characteristics: femoral head size.

Variables	DM (n = 724)	Non-DM (n = 2135)
	N (%)	N (%)
Femoral head size, mm		
Inner head 22	39 (5.39)	-
Inner head 28	685 (94.61)	-
Outer head ≤32	2 (0.28)	137 (6.42)
Outer head 36	10 (1.38)	1611 (75.46)
Outer head 38	79 (10.91)	0 (0)
Outer head ≥40	633 (87.43)	387 (18.13)

Statistical analysis

All analyses were conducted using SPSS Statistics 27.0.1 (IBM Corporation, Armonk, NY). Chi-square test of independence was utilized to compare categorical variables between groups. Student's two-sample t-test was used to analyze continuous variables between the groups. *P*-value of <0.05 was considered statistically significant. This study was not externally funded and was conducted in accordance with the Strengthening the Reporting of Observational studies in Epidemiology guidelines for reporting on observational studies. [17]

Results

Dual mobility trends and utilization

Of the 4548 primary THA cases from November 2013 to December 2020, 2859 (62.9%) had minimum one-year follow-up data for inclusion. There were 724 (25.3%) with DM implants and 2135 (74.7%) with non-DM implants. The percentage of DM implants utilized by year at our institution steadily increased from 3.4% in 2013 to 47.1% in 2020 with a concurrent downward trend in dislocation rate from 1.15% in 2013 to 0% in 2020 (Fig. 1). When examining DM utilization in patients by decade of life at our institution, patients aged <50 had the highest percentage of DM utilization at 34.7% (Fig. 2).

Postoperative outcomes and complications

At one-year follow-up, the dislocation rate in the DM group was significantly lower than the non-DM group (0.14% vs 0.84%, $P = .04$). The all-cause revision rate was similar between groups (2.49% vs 2.72%, $P = .74$). Aseptic revision rates (2.21% vs 1.83%, $P = .52$) and septic revision rates (0.28% vs 0.89%, $P = .09$) were similar between groups (Table 4). Length of stay (2.9 vs 2.6 days, $P < .001$) was longer in the DM group. Ninety-day emergency department visits (2.76% vs 3.23%, $P = .53$) and 90-day readmissions (6.35% vs 5.48%, $P = .38$) were similar between groups (Table 4). Indications for aseptic revision of the acetabular component, aseptic revision of the femoral component, aseptic revision for other causes, and septic revision were broken down between groups (Table 5).

Discussion

To our knowledge, this is the largest case-control study to date comparing DM implants to non-DM implants in patients undergoing primary THA. We found that patients with both DM and non-DM implants had low dislocation rates at our institution; however, patients with DM implants were associated with a significantly lower dislocation rate and similar survivorship at one-year follow-up when compared to non-DM implants.

Indication for DM usage remains a controversial topic with limited long-term data on contemporary DM implants. Despite this trepidation, some authors have advocated for the use of DM implants in a much broader patient population. Proponents of a more widespread adoption allude to the fact that modern DM implants decrease dislocation risk with no increase in complications following surgery [11]. Issues such as wear and intraprosthetic dislocation that plagued earlier generations of DM implants have been largely mitigated with the introduction of highly cross-linked polyethylene and an increased 28 mm inner femoral head diameter, respectively [6]. Even with these changes, there is still great reluctance in the orthopaedic community to embrace DM implants due to fear of another catastrophe akin to the metal-on-metal movement observed in the 2000s. At our institution, we observed a steady increase in the adoption of DM implants for primary THA cases from 2014 to 2020. Our rate of increase was much more pronounced than national DM utilization rates and was accompanied by a concurrent decrease in our institutional dislocation rate. This rapid increase in utilization was in part due to select high-volume surgeons at our institution who utilized DM implants in a majority, if not all, of primary THA cases. Preliminary results

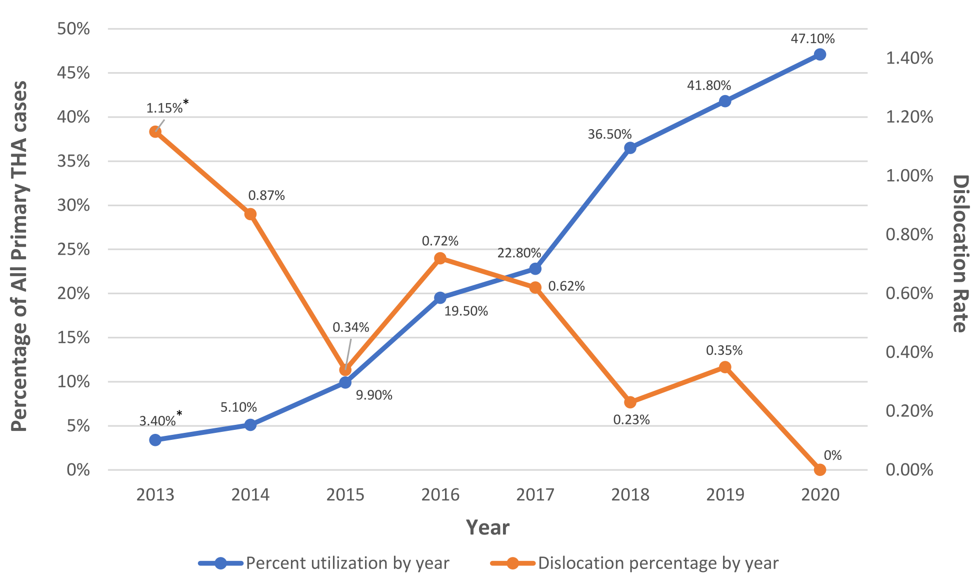

Figure 1. Dual mobility utilization and dislocation rate in primary THA (2013-2020).

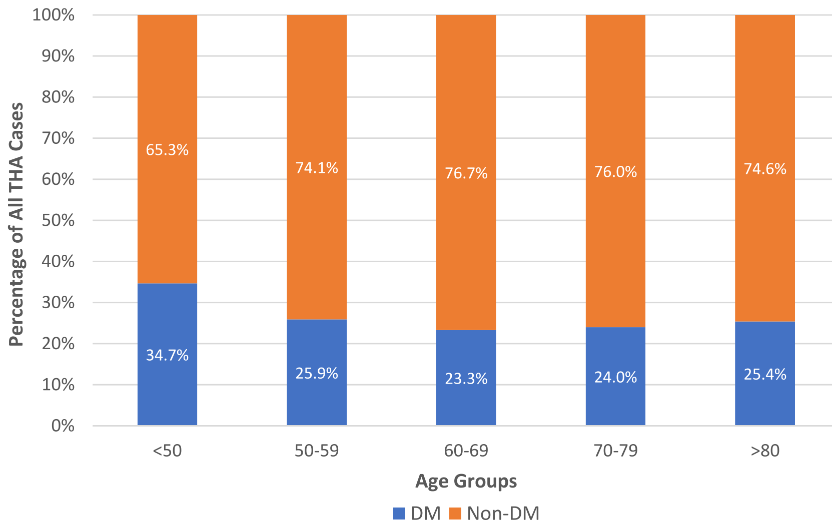

Figure 2. Dual mobility utilization by decade of life.

regarding such use have been excellent, as seen from the concurrent downtrend in institutional dislocation rates. We also report the greatest usage of DM implants in young patients (<50 years), which has not yet been suggested as an indication for DM implants. Though DM bearings are not routinely indicated in young patients, Rowan et al. suggest that young patients (<55 years) who perform recreational activities that place their hips at increased risk for instability (such as yoga) should be considered as an indication for DM bearings [8]. Another aspect that is worth noting is that most young patients do not yet exhibit irregular spinopelvic characteristics that predispose the elderly to dislocation. However, as they age, it is unclear whether or not they will develop such changes. In an effort to prophylactically prevent future episodes of instability and dislocation, some surgeons at our institution utilize DM implants in young patients undergoing primary THA in anticipation of spinopelvic changes associated with aging.

Two of the main concerns surrounding contemporary DM implants are metallosis from the metal-on-metal taper connection between the metal acetabular shell and metal modular liner and intraprosthetic dislocation of the outer polyethylene liner from the inner ceramic femoral head. Of the 724 DM cases included in our study, 0 cases of metallosis requiring revision surgery were noted. In a small case series of 18 DM implants, Lombardo et al. observed corrosion in the metal modular liner where the CoCr implant abutted the screw head in the cup in 1 case. The corrosion was clinically insignificant and minor; however, the findings represent a unique site of corrosion for the modular implants [18]. In regard to intraprosthetic dislocation, our study reported 0 cases of intraprosthetic dislocation. Combes et al.'s study reported similar findings with only 7 (0.28%) cases of intraprosthetic dislocation noted out of 2480 primary THAs with DM implants [19]. Of note, in Combes' study, 39.49% of cases utilized a 22 mm inner femoral head, 58.09% of cases utilized a 28-mm inner femoral head, and 0.24% of cases were unknown. In our study, within the DM group, only 5.39% of cases utilized a 22-mm inner femoral head, and 94.61% of cases utilized a 28-mm inner femoral head. This stark difference in DM inner femoral head usage can be attributed to the fact that contemporary DM implants use a 28-mm inner femoral head as it has been shown to decrease rates of intraprosthetic dislocation [5]. In a systematic literature search conducted by Darrith et al., reviewing all articles dealing with DM THAs published between 2007 and 2016, no cases of intraprosthetic

Table 4
Postoperative outcomes.

Variables	DM (n = 724) N (%)	Non-DM (n = 2135) N (%)	*P*-value
Dislocation	1 (0.14)	18 (0.84)[a]	.04
All-cause revision	18 (2.49)	58 (2.72)	.74
Aseptic revision	16 (2.21)	39 (1.83)	.52
Septic revision	2 (0.28)	19 (0.89)	.09
Length of stay	2.9 ± 2.8	2.6 ± 1.5	<.001
90-day emergency department visit	20 (2.76)	69 (3.23)	.53
90-day readmission	46 (6.35)	117 (5.48)	.38

[a] Five patients were successfully treated with closed reduction, and 13 patients were treated with revision THA.

Table 5
Indications for revision.

Variables	DM (n = 724) N (%)	Non-DM (n = 2135) N (%)	*P*-value
Aseptic revision (acetabular component)	5 (0.69)	17 (0.80)	.78
Dislocation	1 (0.14)	13 (0.61)	.12
Aseptic loosening: acetabular component	1 (0.14)	1 (0.05)	.42
Impingement	2 (0.28)	1 (0.05)	.10
Instability	1 (0.14)	2 (0.09)	.75
Component malpositioning	0 (0)	0 (0)	-
Modular liner complications	0 (0)	-	-
Intraprosthetic dislocations	0 (0)	-	-
Aseptic revision (femoral component)	10 (1.38)	19 (0.89)	.25
PPFx	9 (1.24)	16 (0.76)	.22
Aseptic loosening: femoral component	0 (0)	0 (0)	-
Leg length discrepancy	0 (0)	1 (0.05)	.56
Subsidence: femoral component	1 (0.14)	2 (0.09)	.75
Aseptic revision (other)	1 (0.14)	3 (0.14)	.99
Painful hardware	1 (0.14)	1 (0.05)	.42
Fascia lata tear	0 (0)	1 (0.05)	.56
Heterotopic bone	0 (0)	1 (0.05)	.56
Septic revision (superficial)	0 (0)	4 (0.19)	.24
Hematoma	0 (0)	1 (0.05)	.56
Stitch abscess	0 (0)	1 (0.05)	.56
Superficial wound infection	0 (0)	2 (0.09)	.41
Septic revision (deep)	2 (0.28)	15 (0.70)	.20
PJI	2 (0.28)	14 (0.66)	.24
Persistent wound drainage	0 (0)	1 (0.05)	.56
Seroma with communication to joint	0 (0)	0 (0)	-

PPFx, periprosthetic fracture; PJI, periprosthetic joint infection.

dislocation were reported for THAs utilizing a 28-mm inner femoral head. Conversely, the study found a 3.3% (95% confidence interval: 2.7% to 3.9%) incidence of intraprosthetic dislocation in the older series involving the 22 mm inner femoral head [20]. Furthermore, our study noted that the outer femoral head diameter of DM implants, which serves as the effective femoral head size, was on average larger than their non-DM counterparts. In the DM group, the outer femoral head measured ≥40 mm in 87.43% of cases, 38 mm in 10.91% of cases, and 36 mm in 1.38% of cases. For comparison, in the non-DM group, the femoral head size measured ≥40 mm in only 18.13% of cases and equal to 36 mm in 75.46% of cases. Due to the use of a thin modular metal liner, DM implants are able to accommodate a larger femoral head size, effectively increasing the jump distance. This aspect, paired with the unique biomechanics of the DM articulation, provides enhanced stability and helps protect against dislocation.

Limitations to this study include the implicit limitations of retrospective case-control studies. Perhaps the largest limitation of the present study was its susceptibility to selection bias. Patient selection criteria were poorly defined in this study and were left up to the discretion of the primary surgeon. Some surgeons opted to use DM implants in all patients, whereas others opted to only use DM implants in patients deemed to be at high risk for dislocation postoperatively (ie, elderly patients, dysplastic patients, patients with neurologic conditions, or patients with spinopelvic abnormalities). Another limitation to our study pertains to our limited follow-up period. We are limited to making short-term conclusions regarding DM implants, and longer-term data are still needed to fully assess the safety and survivorship of these implants. It is also important to acknowledge that our study was unable to control for confounding variables beyond acetabular component selection. However, it is worth noting that we took diligent measures to ensure clinical comparability as age, ASA score, and surgical approach were all clinically similar between groups. Lastly, our study was a single institution study and was thus subject to limited generalizability, institutional bias, and a lack of variation. Taken together, while this study provides valuable insights, it is important to interpret the findings within the context of these limitations.

Conclusions

Overall, patients with both DM and non-DM implants had low dislocation rates at our institution; however, patients with DM implants were associated with a significantly lower dislocation rate and similar survivorship at one-year follow-up when compared to non-DM implants. While there has been a steady increase in the adoption of DM implants nationwide, the indications for their usage and their role in primary THA remain hotly debated. Future studies are warranted to evaluate the in vivo biomechanics of DM implants and to obtain longer-term data, which will provide insight into the appropriate indications for DM usage and the safety of utilizing DM implants in all patients undergoing primary THA.

Conflicts of interest

S. S. Rajaee is an Ethicon speaker, is an educational consultant for Zimmer Biomet, DePuy, and J&J, and receives research support from Zimmer Biomet. A. I. Spitzer is a speaker for Pacira and DePuy, receives research support from Pacira and DePuy, and is a paid consultant for Pacira, DePuy, and TraumaCad. All other authors declare no potential conflicts of interest.

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CRediT authorship contribution statement

Anderson Lee: Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Software, Resources, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Jaymeson Arthur:** Writing – review & editing, Writing – original draft, Validation, Project administration, Formal analysis, Conceptualization. **Jawad Najdawi:** Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Formal analysis. **Caleb R. Durst:** Writing – original draft, Visualization, Supervision, Investigation, Formal analysis, Data curation, Conceptualization. **Sean S. Rajaee:** Visualization, Validation, Supervision, Resources, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Andrew I. Spitzer:** Writing – review & editing, Visualization, Validation, Supervision, Resources, Project administration, Methodology, Investigation, Formal analysis, Conceptualization.

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