



## ■ HIP

# Primary total hip arthroplasty outcomes in octogenarians

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## Aims

As our population ages, the number of octogenarians who will require a total hip arthroplasty (THA) rises. In a value-based system where operative outcomes are linked to hospital payments, it is necessary to assess the outcomes in this population. The purpose of this study was to compare outcomes of elective, primary THA in patients  $\geq 80$  years old to those aged  $< 80$ .

## Methods

A retrospective review of 10,251 consecutive THA cases from 2011 to 2019 was conducted. Patient-reported outcome (PRO) scores (Hip disability and Osteoarthritis Outcome Score (HOOS)), as well as demographic, readmission, and complication data, were collected.

## Results

On average, the younger cohort (YC,  $n = 10,251$ ) was a mean 61.60 years old (SD 10.71), while the older cohort (OC,  $n = 609$ ) was 84.25 years old (SD 3.02) ( $p < 0.001$ ). The OC had greater surgical risk based on their higher mean American Society of Anesthesiologists (ASA) scores (2.74 (SD 0.63) vs 2.30 (SD 0.63);  $p < 0.001$ ) and Charlson Comorbidity Index (CCI) scores (6.26 (SD 1.71) vs 3.87 (SD 1.98);  $p < 0.001$ ). While the OC stayed in the hospital longer than the YC (mean 3.5 vs 2.5 days;  $p < 0.001$ ), there were no differences in 90-day emergency visits ( $p = 0.083$ ), myocardial infarctions ( $p = 0.993$ ), periprosthetic joint infections ( $p = 0.214$ ), dislocations ( $p = 0.993$ ), or aseptic failure ( $p = 0.993$ ). The YC was more likely to be readmitted within 90 days (3.88% vs 2.18%,  $B = 0.57$ ;  $p = 0.048$ ). There were no observed differences in 12-week ( $p = 0.518$ ) or one-year ( $p = 0.511$ ) HOOS scores.

## Conclusion

Although patients  $\geq 80$  years old have a greater number of comorbidities than younger patients, they had equivalent perioperative complication rates and PRO scores. This study demonstrates the safety and success of elective THA in octogenarians.

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## Introduction

Total hip arthroplasty (THA) is considered the gold standard for the treatment of degenerative joint disease (DJD).<sup>1</sup> The success of this procedure has been defined by favourable patient-related outcomes, as well as low morbidity and mortality rates.<sup>1,2</sup> Due to the efficacy of THA, it has earned the title, “operation of the century”.<sup>2</sup>

In the USA, the number of THAs performed is expected to increase 174% by the year 2030.<sup>3</sup> As the number of THAs increase, there is a concurrent increase in the number of patients  $\geq 80$  years old who will receive a THA. This subsection of the

population (individuals  $\geq 80$  years old) is the most rapidly expanding group in developing countries.<sup>4</sup> This fact, combined with improvements in anaesthetic/surgical technique, blood management, and postoperative opioid-sparing pain pathways, makes THA in this patient population increasingly successful.<sup>5–8</sup> In a value-based healthcare system where insurance companies and the Center for Medicare and Medicaid (CMS) link operative outcomes to hospital payment, it is imperative for hospitals to improve outcomes in order to stay financially solvent.<sup>9–12</sup> With increased surgical risk associated with age, especially those older than 80, it is necessary

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to assess the outcomes of patients in this age cohort who undergo THA.

The purpose of this study is to evaluate and compare both patient-related outcomes and operative outcomes of patients  $\geq 80$  years old who underwent elective, primary THA to a younger cohort of patients  $< 80$  years old.

## Methods

After receiving approval from the Institutional Review Board (IRB), a retrospective review of 10,860 consecutive elective, primary THAs was conducted at a single academic medical institution from January 2011 to May 2019. These cases were identified using the Current Procedure Terminology (CPT) code 27130. All cases were then manually reviewed and those with a primary diagnosis that denoted a fracture were excluded from this study. Our institution's electronic medical records (EMR) system was used to screen for International Classification of Disease codes (ICD) to identify any cause of a 90-day postoperative complications including myocardial infarction (ICD-10: I21.9; ICD-9: 410.90), periprosthetic joint infection (ICD-10: T84.50XA; ICD-9: 996.66), dislocation (ICD-10: M24.4; ICD-9: 835), aseptic failure (ICD-10: T84.03; ICD-9: 996.41), and mortality (ICD-10: R99; ICD-9: 799.9). All cases were then manually chart-reviewed to ensure the accuracy of the data. It should be noted that all patients who had a 90-day complication and returned to our hospital have the incidence noted within the EMR. The 90-day postoperative emergency department (ED) and non-emergency department (non-ED) readmission were also noted. Pre- and postoperative patient-reported outcomes (PRO) scores, including the Hip disability and Osteoarthritis Outcome Score (HOOS),<sup>13</sup> and their change in improvements ( $\Delta$ ) at 12 weeks and one year postoperatively were collected. We also collected patient demographic data including age, BMI, American Society of Anesthesiologists (ASA) score,<sup>14</sup> Charlson Comorbidity Index (CCI),<sup>15</sup> sex, and race. Patients were divided into cohorts based on their age. Those who were 80 years old or older at the time of surgery were placed in the older cohort (OC) while those younger than 80 were placed in the younger cohort (YC).

**Patient profile.** The YC consisted of 10,251 patients with a mean age of 61.60 years (standard deviation (SD) 10.71). The OC had 609 patients with a mean of 84.25 years (SD 3.02). The OC had a statistically greater surgical risk than the YC as defined by a higher mean ASA score for physical status (2.74 (SD 0.63) vs 2.30 (SD 0.63);  $p < 0.001$ , independent-samples *t*-test) and a higher mean CCI score (6.26 (SD 1.71) vs 3.87 (SD 1.98);  $p < 0.001$ , independent-samples *t*-test) (Table I). Only 19.5% of patients (2,001) in the YC had an ASA grade of 3 or greater while 39.9% of patients (243) in the OC either met or surpassed this threshold. There was also a significant difference between the cohorts in regard to sex, with the

**Table I.** Demographic data.

Variable	< 80 (n = 10,251)	$\geq 80$ (n = 609)	p-value
Mean age, yrs (SD)	61.60 (10.71)	84.25 (3.02)	< 0.001*
<b>Sex, n (%)</b>			< 0.001†
Male	4,588 (44.8)	197 (32.3)	
Female	5,663 (55.2)	412 (67.6)	
Mean BMI, kg/m <sup>2</sup> (SD)	29.74 (49.51)	26.89 (4.39)	0.175*
<b>Race, n (%)</b>			< 0.001†
White	7,695 (75.1)	535 (87.8)	
Black	1,239 (12.1)	19 (3.2)	
Asian	192 (1.9)	5 (0.8)	
Other	1,125 (10.9)	50 (8.2)	
<b>Mean ASA grade (SD)</b>			< 0.001†
1	363 (3.5)	4 (0.6)	
2	3,556 (34.7)	121 (19.8)	
3	1,888 (18.4)	209 (34.3)	
4	113 (1.1)	34 (5.6)	
<b>Mean CCI score (SD)</b>	3.87 (1.98)	6.26 (1.71)	< 0.001*

\*Independent-samples *t*-test.

†Chi-squared test.

ASA, American Society of Anesthesiologists; CCI, Charlson Comorbidity Index; SD, standard deviation.

OC consisting of more female patients compared to the YC (67.6% (412) vs 55.2% (5,663);  $p < 0.001$ , chi-squared test) (Table I). There was also a significant difference in race between cohorts, but no significant difference between BMI (Table I).

**Statistical analysis.** Descriptive statistics were reported as mean and SD for continuous variables while categorical variables were recorded as counts (%). Independent-samples, two-tailed *t*-tests were performed to compare the means of continuous data, such as patient demographic data, while chi-squared tests were used for categorical data, including revision rates. Multivariate linear regression analysis was used to account for demographic differences such as race and sex, when assessing the differences in dependent variables between the two groups. ASA and CCI were not controlled for due to the fact that age is factored into these scores. All statistical analyses were performed using SPSS v. 25 (IBM, USA). A cutoff *p*-value less than 0.05 was considered to be statistically significant.

## Results

After controlling for sex and race, the OC had a significantly longer length of stay (LOS) when compared to the YC (3.5 vs 2.5 days;  $p < 0.001$ , multivariate regression analysis). In comparison to the OC, patients in the YC were more often discharged within 24 hours after the operation (9.4% (963 patients) vs 0% (0 patients)), between 24 and 48 hours postoperatively (26.9% (2,757 patients) vs 15.9% (96 patients)), and between 48 and 72 hours postoperatively (28.9% (2,962 patients) vs 25.1% (153 patients)). Contrarily, the OC more often stayed 72

**Table II.** Regression analysis of clinical outcomes.

Outcome	< 80 yrs	≥ 80 yrs	B	p-value
Mean LOS, hrs (SD)	60.82 (42.29)	85.33 (55.27)	24.75	< 0.001
90-day ED admissions	1.135%	2.010%	-0.54	0.083
90-day readmission	3.881%	2.181%	0.57	0.048
90-day MI	0.010%	0.000%	11.55	0.993
90-day PJI	0.856%	0.329%	0.89	0.214
90-day dislocation	0.137%	0.000%	14.49	0.993
90-day aseptic loosening	0.000%	0.000%	12.64	0.993
90-day mortality	0.020%	0.329%	-3.7	0.001

ED, emergency department; LOS, length of stay; MI, myocardial infarction; PJI, periprosthetic joint infection; SD, standard deviation.

hours or longer in the hospital postoperatively (60.0% vs 34.8%). Patients in the YC cohort were more often discharged to their home (96.6% vs 87.8%;  $p < 0.001$ , multivariate regression analysis). However, the OC more often was discharged to skilled nursing facilities (9.3% vs 2.6%;  $p < 0.001$ , multivariate regression analysis) and rehabilitation centres (2.5% vs 0.7%;  $p < 0.001$ , multivariate regression analysis). However, when comparing 90-day readmissions using regression modelling, the YC had a significantly higher rate of readmissions (3.88% vs 2.18%;  $p = 0.048$ ) (Table II). For all other clinical outcomes, such as 90-day ED visits, 90-day myocardial infarction (MI), 90-day periprosthetic joint infection (PJI), 90-day dislocation, and 90-day aseptic loosening, there was no statistically significant difference between the two cohorts (Table II). Examination of clinical outcomes in each study year separately (e.g. only 2016) also showed that there was no significant difference in postoperative complication between cohorts. The initial regression models did not include ASA as a variable because it has been shown that the anaesthesiologist often gives higher ASA scores to older patients. However, in a subanalysis we included ASA in the models. We found that these models had similar results to the previous models with the OC less likely to be readmitted within 90 days ( $p = 0.029$ ) than the YC but statistically similar 90-day ED visit ( $p = 0.746$ ), 90-day MI ( $p = 0.993$ ); 90-day PJI  $p = 0.102$ ); 90-day dislocation ( $p = 0.993$ ), and 90-day aseptic loosening ( $p = 0.994$ , all multivariate regression analysis) risk between the two groups.

Additionally, when controlling for demographic disparities, there was no significant difference between PRO scores between the YC and OC (Table III). Preoperative, 12-week, and one-year HOOSs were evaluated, as well as 12-week and one-year Forgotten Joint Score (FJS)-12.<sup>16</sup> Mean preoperative HOOS score for the YC was 50.75, while the mean score for the OC was 51.12 ( $p = 0.956$ ) (Table III). Preoperatively 25.2% of the YC (2,583 patients) and 17.6% of the OC (107 patients) responded to the HOOS survey. Average 12-week and one-year scores for the YC and OC were 79.04 and 80.73 ( $p =$

**Table III.** Regression analysis of patient-reported outcome scores.

Mean outcome score (SD)	< 80 yrs	≥ 80 yrs	B	p-value
HOOS Pre-Op	50.75 (13.49)	51.12 (13.57)	-0.076	0.956
HOOS 12 week	79.04 (14.47)	80.73 (12.84)	1.09	0.518
HOOS 1 year	85.75 (15.23)	85.32 (15.21)	-1.3	0.511
FJS 12 week	50.23 (29.54)	55.85 (26.29)	4.836	0.367
FJS 1 year	64.93 (28.70)	72.21 (26.44)	5.473	0.258

FJS, Forgotten Joint Score; HOOS, Hip disability and Osteoarthritis Outcome Score; SD, standard deviation.

**Table IV.** Regression analysis of  $\Delta$ patient-reported outcome scores.

Mean outcome score (SD)	< 80 yrs	> 80 yrs	B	p-value
HOOS Pre-op to 12 weeks	50.75 (13.49)	51.12 (13.57)	-1.387	0.509
HOOS Pre-op to 1 year	79.04 (14.47)	80.73 (12.84)	-3.461	0.152
HOOS 12 weeks to 1 year	85.75 (15.23)	85.32 (15.21)	-1.532	0.413
FJS 12 weeks to 1 year	50.23 (29.54)	55.85 (26.29)	-1.217	0.840

FJS, Forgotten Joint Score; HOOS, Hip disability and Osteoarthritis Outcome Score; SD, standard deviation.

0.518), and 85.75 and 85.32 ( $p = 0.511$ ), respectively. The HOOS 12-week follow-up rate for the YC was 86% while it was 76% for the OC. At one year the follow-up rate of the YC dropped to 69% and 63% for the OC. The change in HOOS scores ( $\Delta$ HOOS) were also similar between each group (Table IV). When a subanalysis using models that included ASA was performed, the results remained consistent with the initial models.

## Discussion

As the population continues to age a greater number of patients older than 80 will require a THA. However, there are concerns about operating on this subsection of the population. Advanced age serves as a potential risk factor for perioperative and postoperative complications.<sup>17,18</sup> While smaller studies of this population, such as by Murphy et al,<sup>17</sup> have shown similar THA outcomes in comparison to the younger cohort, those older than 80 were at 2.87 times greater odds of having a postoperative medical complication and 3.49 times more likely to experience mortality. These increased odds are not only concerning for patients, but also for hospital systems as well. In a patient outcome-centred healthcare system, the CMS links operative outcomes to hospital payments.<sup>17,19</sup> It is therefore necessary to examine outcomes in this population to determine if THA is advantageous to the patient as well as the hospital.

When controlling for differences in demographic data, the older cohort was found to stay in the hospital for one day longer than the younger cohort (3.5 vs 2.5 days;  $p < 0.001$ , multivariate regression analysis). While it is well known that advanced age is associated with longer LOS, some studies have also shown that increasing age is associated with higher in-hospital complication rates.<sup>20,21</sup>

However, there are relatively few studies examining the effects of age on complications once the patient leaves the hospital. Our results showed that the YC was readmitted within 90 days of their operation more often than the OC (3.88% vs 2.01%, OR 1.77; CI 1.01 to 3.10;  $p = 0.048$ , binary logistic regression analysis). Yet, among serious complications and reasons for readmission, we found no difference in myocardial infarctions, periprosthetic joint infections, dislocation, or aseptic failure rates. When Avram et al<sup>22</sup> examined 4,288 arthroplasty patients, they found that, aside from septic complications, patients were often readmitted for reasons not necessarily related to the procedure itself, but for medical reasons such as hypotension and anaemia. The discrepancy in the readmission rates between the OC and YC could therefore potentially be attributed to the fact that young age has been associated with poorer outcomes and more persistent post-THA pain.<sup>23,24</sup> The lack of difference in serious complications also helps to explain why we found no difference in 90-day ED rates. There was however a higher likelihood that a patient  $\geq 80$  would pass away within the first 90 days postoperatively (0.329% vs 0.020%, OR 0.025; CI 0.003 to 0.221;  $p = 0.001$ , binary logistic regression analysis). The cause of death for the two patients in the OC were a systolic cardiac arrest and sepsis. The cause of death for the two patients in the YC were not listed within our EMR. However, both of these rates are significantly lower than average 90-day post-THA mortality rates which range from 0.46% to 0.65% in the literature.<sup>25,26</sup>

While young age has been associated with greater postoperative pain, our results showed that age did not affect PRO scores. HOOS is a patient-reported outcome measure (PROM) specifically used to evaluate symptoms and functional limitations of patients suffering from hip dysfunction.<sup>13</sup> When examining this hip-specific PROM between the YC and the OC, we found that both groups had similar scores and related disabilities at 12 weeks and one year postoperatively. Additionally, we found that patients in both groups had similar changes in improvement from their preoperative to 12-week scores ( $p = 0.509$ , multivariate regression analysis), preoperative to one-year scores ( $p = 0.152$ ), as well as from their 12-week to one-year scores ( $p = 0.840$ ). It follows that older patients experience the same improvement and have similar hip functionality to their younger counterparts after THA.

Improvements in anaesthetic/surgical technique, blood management, and postoperative pain management have made THA in older patients increasingly feasible.<sup>5-8</sup> Our results show that older patients achieve similar outcomes to their younger peers receiving THA due to these improved surgical protocols. The decision of whether to operate on a patient should not solely rely on age or surgical risk indexes such as ASA or CCI scores.

Rather, surgical risk indexes should be used to determine the right surgical perioperative optimization protocols for a patient, and not only assess postoperative outcomes.

This study has several limitations that should be noted. First, this is a retrospective study which inherently has potential selection bias. In order to minimize this, we included a retrospective cohort of prospective, consecutive cases over a nine-year study period. Second, since this study was performed over a nine-year period, pre-, post-, and perioperative protocols have changed which could have altered the results. However, by including consecutive cases we were able to reduce this effect as protocols would have changed equally between the YC and OC since there were no specific protocols for one group. Additionally, we acknowledge the relatively low number of patients in the OC, which may influence our study results. Since patients older than 80 years are less frequently operated on, our cohort sizes mirror these disparities.

In conclusion, while older patients are assumed to have greater operative risk, we found that octogenarians have similar complication rates and PROM improvement in comparison to their younger counterparts following elective primary THA. Therefore, our results support the safety and efficacy of elective primary THA for treatment of DJD in the elderly.



#### Take home message

- Although patients aged  $\geq 80$  years old have a greater number of comorbidities than younger patients, they had equivalent perioperative complication rates and patient-reported outcome scores.
- This study demonstrates the safety and success of elective total hip arthroplasty in octogenarians.

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- A. Tang: Formal analysis.
- M. Meftah: Investigation.
- W. J. Long: Investigation.
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**Ethical review statement:**

- This study has obtained all required IRB approval at our institution (IRB number 17-01223).

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