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Total Hip Arthroplasty for Osteonecrosis in Patients Under 50 years old is Associated with an Increased risk of post-surgical Complications

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Abstract

Introduction: Osteonecrosis (ON) of the femoral head is responsible for roughly 2 to 10% of total hip arthroplasty (THA) indications. The purpose of this study is to compare complication rates for patients under 50 years old undergoing THA for ON versus osteoarthritis (OA).

Methods: Patients between the ages of 18- and 50-years old undergoing THA for ipsilateral osteonecrosis were identified in the PearlDiver database. A control cohort of patients between the same age thresholds were identified who underwent THA for osteoarthritis. Any patient with a history of proximal femur fracture or prior operative fixation of a proximal femur fracture was excluded. Patients were included if they had a 5-year postoperative database followed up after THA. The 90-day rates of post-operative medical and 5-year surgical complications were recorded. Multivariate analysis was conducted to account for confounding variables and covariates. Subgroup analyses were also performed stratified by age (<30, 30–40, and 40–50 years) to assess revision outcomes.

Results: A final cohort of 6,955 patients met inclusion criteria, 1,769 (25.4%) underwent THA for osteonecrosis while 5,186 (74.6%) underwent THA for OA. Patients undergoing THA for ON had a higher incidence of 5-year post-surgical instability (3.1% vs. 2.2%, OR 1.51, P=0.025) when compared to THA for OA. Similarly, those undergoing THA for OA had a higher incidence of 5-year revision (4.4% vs. 3.0%, OR 1.45, P=0.018) and 90-day readmission (8.0% vs. 4.4%, OR 1.41, P=0.006), and emergency department visits (18.4% vs. 11.1%, OR 1.33, P=0.001) when compared to those undergoing THA for OA.

Conclusion: Patients younger than 50 years old undergoing THA for ON experience increased post-surgical complications such as revision, dislocation, hospital readmission and emergency department visits compared to patients under 50 years old undergoing THA for OA. These findings provide insight for preoperative considerations for arthroplasty surgeons in this patient population.

Keywords: Hip osteoarthritis, hip osteonecrosis, total hip arthroplasty, avascular necrosis, implant survival, clinical outcomes, revision total hip arthroplasty

Introduction

Total hip arthroplasty (THA) is widely considered to be one of the most successful procedures currently in orthopedics both in terms of cost and patient outcomes [1,2]. THA has been particularly helpful for patients with hip arthritis and improves hip stability [1]. Osteonecrosis of the femoral head (ONFH) is another condition that leads to hip arthritis that is commonly treated with THA, especially if it progresses to secondary degeneration [3, 4, 8].

ONFH, also described as avascular necrosis (AVN), is caused by an interruption of the blood supply to the femoral head, which can lead to femoral head collapse and hip arthritis [4,5,8]. Non-traumatic ONFH is often seen in adults under the age of 50 and is seen in over 10,000 patients in the United States annually, as well as accounting for 2 to 10% of all THAs [4,5]. In addition to trauma, the more common non-trauma related risk factors associated with ONFH include increased steroid usage [6-8], alcohol abuse [8], smoking, radiation, and other diseases [7, 9].

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Recent research has shown that the incidence of ONFH has been increasing with the cumulative number of afflicted patients in the United States being in the range of 300,000 to 600,000 [9, 10]. ONFH commonly shows up in patients ages 30-50 with a reported mean age around 38 years old [10, 11]. Increased steroid use for a variety of medical conditions in younger patients has caused an increase of ONFH observed in younger demographics [6].

The most common surgical treatment option for ONFH is THA [11, 12]. With the seemingly earlier age of ONFH onset there is a strong interest to further study THA complications in younger osteonecrosis demographics, as there seems to be a current lack of studies focused on this particular cohort. Thus, the goal of this study was to compare THA complications in non traumatic ONFH patients versus osteoarthritis (OA) patients under the age of 50.

Methods

Patients who underwent primary THA from 2015-2022 with five-year postoperative database follow up were identified in the PearlDiver (PearlDiver Technologies; www.pearldiverinc.com, Colorado Springs, CO) national insurance database. This insurance database accesses government and commercial insurers to provide unidentifiable patient information. All data is deidentified making this study exempt from institutional review board approval. Due to the retrospective nature of the study, this study is exempt from individual consent by the institutional review board.

Study Cohorts

Patients were identified using international classification of diseases (ICD) and current procedural (CPT) codes, which are provided in Appendix 1. Patients with a diagnosis of avascular necrosis of the hip were first identified using ICD-10 diagnosis codes. Patients were then sorted into those undergoing right and left THA with the associated indication of avascular necrosis. Only patients ranging from 18 to 50 years old with five-year database follow-up were included in this data. Patients were excluded if they have any prior history of proximal femur, neck or head fracture or if they had undergone prior fixation of the proximal femur, neck, or head. Patients were also excluded if they underwent prior hip arthroscopy. Bilateral THA procedures were excluded in order to ensure that complications occurred on the ipsilateral side of the THA. A control cohort of patients between the ages of 18 and 50 undergoing THA for osteoarthritis without a prior diagnosis of avascular necrosis was identified. The control cohort also required five-year database follow-up and excluded any patients with a history of fracture or prior fixation of the proximal femur, neck or head or hip arthroscopy.

Study Outcomes

The five-year postoperative revision rate was the primary outcome of this study. Secondary outcomes included five-year rates of instability, prosthetic joint infection (PJI), periprosthetic fracture, aseptic loosening and 90-day rates of major and minor medical complications, readmission and emergency department visits. Revision was defined as any revision arthroplasty using both CPT and ICD-10 codes listed in Appendix 1. Instability was defined as any ICD-10 diagnosis code of prosthetic hip dislocation or CPT code for closed treatment of post hip arthroplasty dislocation with or without anesthesia. PJI was defined in the ICD-10 diagnosis code for infection of hip prosthesis or a hip irrigation and debridement after index THA. Major medical complications included cardiac arrest, pulmonary embolism, pneumonia, and sepsis. Minor medical complications included acute kidney injury, blood transfusion, urinary tract infection, and deep vein thrombosis.

Demographics and Comorbidities

Descriptive data including age, gender, and the presence of obesity were assessed for each cohort. The following comorbidities were also recorded: tobacco use, diabetes mellitus, hypertension, chronic kidney disease, coronary artery disease, drug abuse, liver disease, rheumatoid arthritis and depression.

Statistical Analysis

Univariate analysis using chi-square tests and Student t tests were performed to analyze any differences in patient demographics and comorbidities. Multivariate analysis using logistic regression was subsequently conducted for differences in comorbidities or demographics to account for any confounding variables and covariates. Odds ratios (ORs) were calculated with associated 95% confidence intervals (CI). The open-source R software embedded within the PearlDiver database (R Foundation for Statistical Computing, Vienna, Austria) was used for all statistical analysis, with statistical significance at $P<0.05$.

To further explore the impact of age on revision rates, subgroup analyses were performed stratifying patients into three age groups: <30 years, 30–40 years, and 40–50 years. Propensity score matching and multivariate logistic regression were repeated within each subgroup to compare revision rates between ON and OA patients, adjusting for demographic and comorbidity differences.

Results

6,955 patients undergoing THA for osteoarthritis or AVN between the ages of 18 and 50 years old with 5-year

postoperative follow-up were identified for this study. Out of those patients, 1,769 underwent THA for a diagnosis of ON, while 5,186 underwent THA for a primary diagnosis of OA without any history of ON.

Demographics and Comorbidities

The average age of patients undergoing THA for ON was 41.1 ± 7.6 and the average age of patients undergoing THA for OA was 45.2 ± 5.1 (P<0.001). 64.2% of patients in the ON cohort were male, while 52.0% of patients in the OA cohort were male (P<0.001). The rates of obesity, tobacco use, hypertension, chronic kidney disease, drug abuse, liver disease and alcohol abuse were all statistically different between the cohorts as seen in Table 1.

	ON (N=1769)		OA (N= 5186)		
	Mean	SD	Mean	SD	P-value
Age	41.1	7.6	45.2	5.1	<0.001
CCI	1.9	2.5	1.1	1.6	<0.001
Sex					<0.001
Female	633	35.80%	2487	48.00%	
Male	1136	64.20%	2699	52.00%	
		0.00%		0.00%	
Comorbidities		0.00%		0.00%	
Obesity (BMI, ≥ 30)	299	16.90%	1250	24.10%	<0.001
Tobacco Use	542	30.60%	1069	20.60%	<0.001
Diabetes Mellitus	140	7.90%	408	7.90%	0.991
Hypertension	590	33.40%	1580	30.50%	0.026
Chronic Kidney Disease	71	4.00%	69	1.30%	<0.001
Coronary Artery Disease	47	2.70%	108	2.10%	0.187
Abuse of Drugs	122	6.90%	151	2.90%	<0.001
Liver Disease	70	4.00%	83	1.60%	<0.001
Rheumatoid Arthritis	21	1.20%	73	1.40%	0.566
Depression	257	14.50%	677	13.10%	0.126
Alcohol Abuse	129	7.30%	97	1.90%	<0.001
*BMI – Body mass index, ON – Osteonecrosis, OA- Osteoarthritis, CCI – Charlson					

Table 1: Demographics and Comorbidities

Complications

After univariate analysis, the rate of revision (4.4% vs. 3.0, P=0.006) was higher in the ON cohort when compared to the OA cohort. Similarly, the rate of prosthetic dislocation was higher in the ON cohort when compared to the OA cohort (3.1% vs. 2.2%, P=0.044). Rates of PJI (3.2% vs. 2.3%, P=0.035), major medical complications (2.4% vs. 1.3%, P=0.001), minor medical complications (5.0% vs. 3.5%, P=0.003), hospital readmissions (8.0% vs. 4.4%, P<0.001) and emergency department visits (19.4% vs, 11.1%, P<0.001) were all higher in the ON cohort when compared to the OA cohort.

After multivariate analysis which took into consideration all differences in listed comorbidities and demographics, the rate of revision (OR 1.45, 95% CI 1.07-1.97, P=0.018) remained statistically higher in the ON cohort when compared to the OA cohort. Similarly, the rate of dislocation remained higher in the ON cohort (OR 1.51, 95% CI 1.05-2.16, P=0.025). The difference in rates of readmission (OR 1.41, 95% CI 1.10-1.81, P=0.006) and emergency department visits (OR 1.33, 95% CI 1.12-1.57, P=0.001) remained statistically higher in the ON cohort. The difference in rates of PJI, major and minor medical complications were no longer statistically different in the cohorts after multivariate analysis.

	OR	95% CI	P-value
Dislocation	1.51	1.05-2.16	0.025
Revision	1.45	1.07-1.97	0.018
Prosthetic Joint Infection	1.24	0.86-1.77	0.244
Aseptic Loosening	1.2	0.71-2.01	0.502
Periprosthetic Fracture	1,34	0.71-2.53	0.371
Major Medical	1.54	0.98-2.40	0.059
Minor Medical	1.12	0.83-1.52	0.458
Readmission	1.41	1.10-1.81	0.006
ED Visit	1.33	1.12-1.57	0.001
*ED- Emergency Department, OR – Odds ratio, CI- Confidence Interval			

Table 2: Univariate Comparison of Complications

Subgroup Analysis by Age

In subgroup analyses stratified by age group, no statistically significant difference in revision rates between ON and OA patients was observed within the <30, 30–40, or 40–50 years subgroups (p>0.05 for all). Odds ratios remained elevated for ON patients compared to OA controls across all subgroups, but did not reach statistical significance (Table 4).

Discussion

Among the indications for THA, ON is significantly concerning due to the secondary consequences that can arise if left untreated [13]. With increased diagnosis of ON in younger

	ON (N=1769)		OA (N= 5186)	
	N	%	N	%
Dislocation	55	3.10%	115	2.20%
Revision	78	4.40%	156	3.00%
Prosthetic Joint Infection	57	3.20%	118	2.30%
Aseptic Loosening	25	1.40%	57	1.10%
Periprosthetic Fracture	20	1.10%	34	0.70%
Major	42	2.40%	65	1.30%
Minor	88	5.00%	174	3.40%
Readmission	142	8.00%	229	4.40%

Table 3: Multivariate Comparison of Complications (Osteoarthritis as control)

Age Group	Odds Ratio (OR)	95% CI Lower	95% CI Upper	P-value
<30 years	1.45	0.8	2.58	0.188
30–40 years	1.16	0.3	4.5	0.828

Table 4: subgroup multivariate analysis based on age

populations, there is a renewed motivation to better understand the risks associated with THA in younger patients. This study demonstrated that patients with ON under 50 years old were more likely to encounter post operative complications compared to a set of matched patients with OA in the same age group. Specifically, patients with ON were noted to have greater rates of dislocation, revisions, prosthetic joint infections, as well as readmissions, emergency department visits, and both major and minor medical complications. Notably, subgroup analysis by age demonstrated that although ON patients consistently exhibited higher odds of revision across all age strata, these differences were not statistically significant after adjustment for comorbidities.

Dislocation was found to occur at higher rates in ON patients versus OA patients. Hip dislocation following primary hip arthroplasty affects 2-10% of patients within the first year [19, 21]. This higher risk in ON patients has been noted in past literature and shown to have variable levels of statistical significance [11, 20, 21, 24]. Multiple proposed reasons for higher rates of dislocation have included reduced bone and soft tissue quality, although there is supporting literature or well-defined mechanism for this hypothesis [20]. Other authors have proposed that the risk is associated with increased functional demand, as patients undergoing THA for osteonecrosis are on average younger and more active [11, 20, 21]. In a meta-analysis by Zhang et. al, dislocation rates in patients with osteonecrosis are inversely correlated with increasing patient age, supporting that more active, younger patients are at higher risk for dislocation [11]. Additionally, prominent comorbidities in this demographic, such as alcoholism and intravenous drug use, may affect the patients' ability to adhere to postoperative restrictions [21].

The incidence of revision was also increased in ON patients relative to OA patients. These findings are in line with the current literature, but there is no clear consensus as to what these differences could be attributed to [20, 21]. These findings were previously attributed to the younger age of ON patients, however age was a controlled factor in this cohort and revision rates were still found to be statistically increased on the ON cohort compared to the OA cohort. This demonstrates that there is some degree of inherent risk to ON patients outside of increased strain on implants due to young age at time of THA, no other explanation is currently supported in the literature. The higher risk of revision for the ON group emphasizes the need for increased length of follow-up with these patients after a THA.

Prosthetic joint infection (PJI) is a potentially devastating complication of THA that can be life threatening [22]. On initial analysis, PJI was found to be increased on patients with ON, however these differences were mitigated after multivariate analysis was completed. Current literature has indicated a higher risk of PJI in ON patients, however, some studies indicate similar rates of PJI in ON and OA groups [20, 21]. Due to the underlying pathophysiology leading to ON, it would be logical to find a higher incidence of infection [20]. A large cohort of ON patients are immunosuppressed, on chronic steroids, undergoing radiation, or in a chronic state of inflammation due to their comorbidities which all contribute to an ideal environment for the development of infection postoperatively [20]. Due to the morbidity associated with PJI, it is a complication that clinicians should be highly conscious of in all patient populations but should exercise even more caution in ON patients.

Although no statistically significant difference in rates of aseptic loosening between groups was found in this study, other studies have demonstrated higher rates of aseptic loosening in ON patients compared with OA patients [23]. This could be attributed to the focus on patients under the age of 50 in this cohort as opposed to prior studies. This would suggest that wear and longevity of the implant may not fully explain the higher rates of aseptic loosening in ON patients and further studies should be conducted. Periprosthetic fracture similarly

demonstrated no statistical differences between the ON and OA groups. Periprosthetic fracture is another complication that has been shown to have higher rates in ON patients post operatively in literature [20, 21]. The similar rates for these two factors observed in our study could be attributed to the small number of patients that presented with these complications in both groups, indicating the need for a larger cohort to better understand the risks of these postoperative complications.

Minor and major medical conditions were found to be statistically higher in the ON group but similarly to PJI these differences were no longer statistically significant following a multivariate analysis. Previous literature has indicated higher rates of medical comorbidities in ON patients, particularly in older age groups (>65 years old) [21, 24]. Our study's focus on younger demographics (<50 years old) could explain why our findings are not in direct agreement with past studies. The statistical difference in minor and major medical complications on univariate analysis was likely mitigated after multivariate analysis, as the logistic regression model accounted for differences in demographics and comorbidities.

Additionally, the ON group was found to have statistically higher rates and risks of readmission and emergency department visits. This trend is concordant with existing literature and is not surprising considering the general increased risk of complications for ON patients after a THA, which would lead to more ED visits and hospital readmissions [24, 25]. Furthermore, ED visits and readmission were the first and second most common complications respectively in both the ON and OA groups. The increased cost and burden associated with these complications for patients and the healthcare system should be taken into account for both groups of patients, especially considering their prevalence.

The advantages of our study include the use of the PearlDiver database, a national database with a large number of patients and information regarding surgical procedures and patient outcomes. This allows the researcher to investigate less common surgical complications, which is one of the main focuses of our study and this data that would be difficult to accumulate at a single institution [26]. Another advantage of the PearlDiver database is the presence of data regarding postoperative complications between encounters, allowing for a longitudinal following of cases and the development of complications [27]. However, there are also some limitations with the use of a large-scale database. PearlDiver is a private analytics database and does not collect data using random sampling, leading to conclusions based on its data to be interpreted in context of this limitation [26, 27]. Moreover, the data categorization is based on the databases' coding of cases, which is subject to human error even if only to a limited degree [27]. There are numerous surgeons of variable skills levels in this database which can be viewed as an advantage, which we were unable to differentiate between. This study also could not differentiate between types of implants, surgical approach or severity of pathology. However, with a large database to investigate these differences, our study provides meaningful data that may help improve the treatment algorithm in complex patients.

Conclusion

Patients younger than 50 years old undergoing THA for ON experienced increased post-surgical complications when compared to THA for OA in the same age group. These included complications such as revision, dislocation, hospital readmission and emergency department visits. In addition to treating patients with arthroplasty at a young age, increased attention should be paid for those with ON to help mitigate post-operative complications and optimize patient care.

Declaration of patient consent: The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient has given his consent for his images and other clinical information to be reported in the Journal. The patient understands that his name and initials will not be published, and due efforts will be made to conceal his identity, but anonymity cannot be guaranteed.

Conflict of Interest: NIL; **Source of Support:** NIL

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