RESEARCH ARTICLE

Cost and Early Complication Analysis Following Total Hip Arthroplasty in Parkinson's Disease Patients: A Propensity-matched Database Study

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Abstract

Background: Parkinson's Disease is a well-known neuromuscular disorder, which affects the stability and gait of elderly patients. With the progressive increase in the life span of patients with PD, the problem of degenerative arthritis and the consequent need for total hip arthroplasty (THA) in this cohort are rising. There is paucity of data in the existing literature regarding the healthcare costs and overall outcome following THA in PD patients. The current study was planned to assess the hospital expenditure, details regarding hospital stay, and complication rates for patients with PD, who underwent THA.

Methods: We investigated the National Inpatient Sample data to identify PD patients, who underwent hip arthroplasty from 2016 to 2019. Using propensity score, PD patients were matched 1:1 to patients without PD by age, gender, non-elective admission, tobacco use, diabetes, and obesity. Chi-square and T-tests were used for analyzing categorical and non-categorical variables, respectively (Fischer-Exact test was employed for values<5).

Results: Overall, 367,890 (1927 patients with PD) THAs were performed between 2016 and 2019. Before matching, PD group had significantly greater proportion of older patients, males, and non-elective admissions for THA (*P<0.001*). After matching, PD group had higher total hospital costs, longer hospital stay, greater blood loss anemia, and prosthetic dislocation (*P<0.001*). The in-hospital mortality was similar between the two groups.

Conclusion: Patients with PD undergoing THA required greater proportion of emergent hospital admissions. Based on our study, the diagnosis of PD showed significant association with greater cost of care, longer hospital stay, and higher post-operative complications.

Level of evidence: II

Keywords: Parkinson's disease, Total hip arthroplasty

Introduction

Parkinson's disease (PD) is a well-known neurologic disorder developing due to reduction in the dopaminergic neurons in substantia nigra - pars compacta, with a reported prevalence rate of 1 to 2 in every 1,000 population.[1] As the lifespan of patients with PD has improved with advances in treatment options, its prevalence is increasing in the aging population. Studies estimate that PD affects nearly 1% of the population above 60 years.[2] Due to the various aspects of clinical presentation of this movement disorder, PD patients have been reported to have substantially greater predisposition to fractures, in comparison with the

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general population.[1,3] Hip fractures are the most common skeletal injuries in PD.[3,4] There is also a concern that PD patients are more prone to postoperative adverse events after total hip arthroplasty (THA) due to associated gait disturbances and osteoporosis.[3,5]

With the aging population and higher rates of advanced arthritis, the annual procedure volumes for TJAs are anticipated to rise further.[6] Recent studies showed increased incidence of THAs performed in PD patients over the past decade.[7] Considering that PD is a common neuromuscular (NM) disease seen in the elderly, the significance of understanding the effect of PD on postoperative functional outcomes and complications cannot be understated.[3]

Due to the escalating health care costs, bundled payment models for TJAs are becoming increasingly common.[8] To effectively implement these payment models while maintaining economic viability and quality of patient care, it is important to recognize conditions predisposing patients to increased peri-operative complications, more prolonged hospitalizations, and potentially increased hospital costs. While some earlier studies discussed the clinical outcome following THA in patients with PD, most of the available literature involves small cohort studies limiting their generalization.[3,5] Moreover, certain large-scale, previously-published studies on this subject have only included PD patients, who underwent THA for non-emergent or non-traumatic indications.[5,7] The current study aimed to examine the National Inpatient Sample (NIS) database to understand overall costs of medical care, assess peri-operative medical and surgical complications, and evaluate mortality rates after THA in this patient cohort.

Materials and Methods

National Inpatient Sample (NIS) data

The NIS database is the largest database containing information regarding all hospital admissions in the United States (US); and includes data of greater than 7,000,000 hospital stays of patients. The database has undergone strict quality assessment; and includes information on demographic profile, associated co-morbidities, admission-related information and complications. The 2018 database classifies the diagnoses and procedures on the basis of International Classification of Diseases – 10 (ICD-10) coding system. [Table 1].

Data extraction

The data on NIS database is de-identified and therefore, our study was exempt from IRB approval. The data

Table 1. ICD 10 codes used

Parkinson Disease	Obese Codes	Comorbidities codes	Medical Complications codes	Surgical Complications codes
G20	E660 E6601 E6609 E661 E662 E668 E669 Z6830 Z6831 Z6832 Z6833 Z6834 Z6835 Z6836 Z6837 Z6838 Z6839	Diabetes without complications E119 Tobacco related disorder Z87891	Acute renal Failure N170, N171, N172, N178, N179 Myocardial Infarction I2101, I2102, I2111, I2113, I12114, I12119, I2121, I12129, I21A1 Blood loss anemia D62 Pneumonia J189, J159, J22 Blood transfusion 30233N1 Pulmonary embolism I2602, I2609, I2692, I2699 DVT I82401,I82402, I82403, I82409, I82411, I82412, I82413, I82419, I82421, I82422, I82423, I82429, I82431, I82432, I82433, I82439, I82441, I82442, I82443, I82449, I82491, I82492, I82493, I82499, I824Y1, I824Y2, I824Y3, I824Y9, I824Z1, I824Z2, I824Z3, I824Z4	Periprosthetic fracture T84010A, T84011A, T84012A, T84013A, T84018A, T84019A, M9665, M96661, M96662, M96669, M96671, M96672, M96679, M9669, M9701XA, M9702XA, M9711XA, M9712XA Periprosthetic dislocation T84020A, T84021A, T84022A, T84023A, T84028A, T84029A Periprosthetic mechanical complications Periprosthetic fracture T84090A, T84091A, T84092A, T84093A, T84098A, T84099A Periprosthetic Infection T8450XA, T8451XA, T8452XA, T8453XA, T8454XA, T8459XA Superficial SSI T8141XA Deep SSI T8142XA Wound Dehiscence T8130XA, T8131XA, T8132XA

regarding patients' demographic details [including information on major associated comorbidities like chronic kidney disease (CKD) and tobacco-use] were retrospectively procured from the database. The details regarding major, early medical complications like anemia, deep venous thrombosis (DVT) or pulmonary embolism (PE), other cardiopulmonary adverse events and mortality were recorded. Data regarding surgical-site complications like prosthetic joint infections (PJI) and peri-prosthetic mechanical complications were also recorded.

Additionally, data regarding duration of hospital stays and admission-associated costs were recorded. [Table 1]. Propensity matching was carried out in order to identify a 1:1 matched sample control population. The patients underwent matching for age, sex, obesity, diabetes status, and tobacco-related disorders.

Statistical Analysis

SPSS software v27 (IBM, Armonk, NY, USA) was used to perform the statistical analyses. Initially, descriptive analysis was performed for demographic variables. While Chi-square test was used to analyze categorical data, t-test was used to compare non-categorical parameters. Additionally, 1:1 propensity matching of pre-operative parameters was performed. For parameters with prevalence less than 5, Fischer exact test was employed. The odds ratios and confidence intervals were corresponding calculated for the surgical and outcome variables.

Results

Overall, 367,890 THAs performed between 2016 and 2019 were included in the analysis. Among them, 1927 (0.5%) had been diagnosed with PD. Based on unmatched data, PD group had substantially greater proportion of older (mean age: 73.24 vs. 65.82 years; *P<0.001*) and male patients (52% vs. 44%, *P<0.001*) [Table 2]. Patients with PD also had significantly higher non-elective admission for hip replacement as compared with the control group (26% vs. 8.6%, *P<0.001*).

Propensity-score matching identified 1927 PD (who formed the control group) and 1923 non-PD patients. After propensity matching, the two groups were statistically with regard to age (mean age 73 vs. 73 years, *P=0.965*), gender (52% male vs. 52%, *P=1*), and non-elective admission status (26% vs. 26%, *P=1*). Both groups had similar distribution of uncomplicated diabetes (8.3% vs. 8.3%, *P=0.969*), tobacco-related disorders (10% vs. 11%, *P=0.982*), and obesity (12% vs. 12%, *P=0.98*).

The mean total hospital-related expenditure in PD group was $76,308.62, significantly higher than the hospital charges of $57,896.17 in the matched non-PD cohort (*P<0.001*). The duration of stay in hospital was substantially longer in PD group (3.5 vs. 2.9 days, *P<0.001*).

Anemia was the most commonly-observed postoperative adverse event in the two groups. PD patients developed substantially higher blood loss anemia than control group. No differences were noted concerning other medical adversities like myocardial infarction (MI), renal failure, pulmonary or thromboembolic complications [Table 3].

The most common local complication was a prosthetic dislocation. Incidence of dislocation was substantially greater in PD group (4.6% versus 2.5%, *P<0.001*). Peri-prosthetic mechanical complications were significantly more common in PD group (1.7% versus 0.6%, *P=0.002*). Paradoxically, patients without PD were found to have higher rates of PJI than PD patients (2.2% versus 1.1%, *P=0.008*). The two groups were similar with regard to surgical-site infections (SSI), wound complications, or

Table 2. Patient Demographics of unmatched cohort

	PD group	Control group	Odds Ratio (PD group / Control group)	Odds Ratio 95% Confidence Interval	Significance
Mean Age in years	73.24	65.82			**<0.001**
Males [N(%)]	1,004 (52.1%)	161,110 (44.02%)	0.723	0.661 to 0.791	**<0.001**
Diabetes without complications	160	36,668	0.813	0.691 to 0.956	0.012
Tobacco Use Disorder	202	63,506	0.558	0.482 to 0.645	**<0.001**
Obesity	235	79,684	0.499	0.435 to 0.572	**<0.001**

* - Numbers between 1 to 10 were not reported as per Health Care Utility Project (HCUP) data use agreement.

Table 3. Postoperative complications in a matched cohort

	Events in PD group	Events in non-PD matched cohort	Odds ratio (.00/1.0)	95% CI	*P value*
No. of patients	1927	1923	NA	NA	NA
Acute Renal Failure	99	96	1.03	0.773-1.375	0.837
MI	**	**	0.569	0.166-1.948	0.363
Blood Loss Anemia	569	356	1.844	1.586-2.145	**<0.001**

Table 3. Continued					
Pneumonia	14	**	1.752	0.733-4.186	0.201
Pulmonary Embolism	**	**	0.298	0.082-1.086	0.051
DVT	**	**	1.165	0.391-3.472	0.784
Peri-prosthetic fracture	56	60	0.929	0.642-1.345	0.698
Peri-prosthetic dislocation	89	48	1.891	1.324-2.703	**<0.001**
Peri-prosthetic mechanical complications	33	12	2.77	1.429-5.389	**0.002**
Peri-prosthetic infection	22	43	0.505	0.301-0.847	0.008
Superficial SSI	**	**	NA	NA	NA
Deep SSI	**	**	0.499	0.484-0.515	0.317
Wound Dehiscence	**	**	0.199	0.023-1.706	0.102
In-hospital mortality	**	**	0.399	0.077-2.057	0.255

* - Numbers between 1 to 10 were not reported as per Health Care Utility Project (HCUP) data use agreement.

peri-prosthetic fractures. Mortality rates were comparable between the groups (0.10% vs. 0.26%, *P=0.255*).

Discussion

PD is commonly-observed neurologic disease in patients undergoing total hip arthroplasty.[3] Previous reports in the literature have demonstrated increased postoperative complications including peri-prosthetic fractures, dislocations, and higher revision rates in PD patients following TJA.[9] Even though there is substantial evidence that THA substantially ameliorates the overall functional status of PD patients, the overall outcome in this patient cohort remains significantly poorer, as compared to the non-PD counterparts.[9] In a previous report, it was demonstrated that PD patients had less than satisfactory outcome following lumbar spine surgeries, as compared with non-PD patient population.[10] Our study was thus planned to (1) evaluate health care costs, and duration of stay in patients with Parkinson's disease undergoing hip arthroplasty, as well as to (2) investigate if diagnosis of PD is correlated with an higher complications after THA.

In our current study, there was substantially greater prevalence of older and male patients in the PD group, in comparison with the non-PD population. This is consistent with the observations made in the previous studies. In the study by Newman, patients with PD (average age: 73 years) undergoing THA were reported to be significantly older than non-PD group (mean age: 65 years).[5] They also demonstrated that the overall mean Charlson comorbidity index (CCI) was substantially higher in the PD population undergoing THA.5 Our study also demonstrated higher rates of emergent admission for THA in patients with Parkinson's disease (26% vs. 8.6%). This higher rate of emergent admissions in PD patients could be attributed to higher prevalence of hip fractures in this patient cohort. Certain earlier studies (Newman and Kleiner), which investigated outcomes of PD patients after THA, had excluded patients with non-elective admissions.[5,7] In comparison, more than 1/4th of PD patients in our study underwent THA in an emergent setting.

Patients with PD had a significantly longer hospital stay, in comparison with control population. This difference persisted even after matching the two groups for age, gender, non-elective admission status, and obesity (*P<0.001*). Newman concluded that, in comparison with matched cohorts, the mean duration of stay in hospital after THA in patients with Parkinson's disease was 8.6% longer (3.9 versus 3.6 days).[5] In the study by Kleiner et al., PD patients required a substantially longer hospital stay following THA. The average duration of hospital stay in their study was 3.1 days (as in our study).[7]

Jamsen et al. collected data using the Finnish health registry and found that patients with PD undergoing primary hip and knee arthroplasty had significantly prolonged duration of hospital stay (21 days versus 13 days).[11] Although in their study, both the groups had a significantly longer hospital stay than our cohort of patients, the mean hospital stay was even longer in patients with Parkinson's disease. In another study evaluating PD patients undergoing spinal fusion, McClelland et al. observed longer hospital stay and higher non-routine discharge disposition in this challenging patient population.[12]

In the present study, Parkinson's disease sustained mean hospital costs of $76,308.62, which was significantly higher than the hospital charges (of $57,896.17) in matched non-PD cohort (*P<0.001*). In a study by Newman et al. evaluating NIS database for PD patients undergoing hip arthroplasty from 2002 to 2013, it was concluded that these patients had 3.9% higher mean total hospital charges.[5] These high hospital expenditures were also demonstrated by Kleiner and Newman in their respective studies.[5,7] However, mean total hospital costs reported by Newman et al. (approximately $17,439) were lower than expenditure reported by Kleiner. ($49,061) and our present study ($76,308.62).[5,7] Some of these differences may be attributed to the rising healthcare costs and differences in methodology. Additionally, the inclusion of non-elective admissions in the current study could have inflated our overall healthcare costs. In a previously-published study, McClelland et al. reported significantly

greater health-care expenditure in PD patients (with reported hospital-associated costs greater than $200,000) following spinal surgeries.[12]

In our study, the most common surgical complication was a prosthetic dislocation. The dislocation rate was substantially greater in patients with PD (*P<0.001*). There has been a major concern about the enhanced dislocation rates after hip arthroplasty in patients with Parkinson's disease due to associated flexion deformity of hips, muscle rigidity, and gait instability.[3] Nevertheless, the literature is still controversial regarding this issue.[9,13] Randon et al., in a retrospective single-center review of 52 patients, concluded that PD patients sustained higher rates of periprosthetic fractures and dislocations after THA.[9] On the other hand, Meek et al. analyzed the Scottish database; and demonstrated no increase in dislocation rates following hip arthroplasty in patients with the diagnosis of Parkinson's disease.13 Previous trials by Newman and Kleiner, which investigated NIS database, also did not report higher dislocation rates in PD.[5,7] Kleiner et al. reported an overall "device malfunction" rate of around 1.5% in PD patients, which included prosthetic loosening, dislocation, and fracture.[7] Ryu et al. evaluated the results following hip replacement with dual-mobility articulation in elderly patients with neuromuscular (NM) diseases (including PD), and failed observe any enhanced prosthetic dislocation rate in this group. They also concluded that, in elderly patients with NM disease, hip arthroplasty with dual mobility system was an excellent option.[14] The rates of peri-prosthetic mechanical complications (the majority of which could be attributed to dislocations) were also significantly higher in patients with PD (1.7% versus 0.6%, *P-value 0.002*) in our study.[7]

The most common overall complication in our study was post-operative anemia related to blood loss. Additionally, these complications were substantially greater in the cohort of patients with Parkinson's disease. This is similar to the previous studies, which observed greater risk of hemorrhage and blood-product transfusion in PD patients following THA.[5,7] Higher prevalence of medical complications like delirium, cardiac adversities and urinary infections have previously been reported in PD patients following THA.5,7,15 In another NIS database-based study, Baker et al. evaluated the complication rates following elective lumbar spinal surgeries.16 They observed enhanced risks of acute post-operative blood loss anemia, enhanced need for blood product transfusion, as well as higher cardiological and neurological adversities in PD population. Higher prevalence of elderly population, poorer baseline systemic health status, greater need for emergent surgeries, and compromised pre-operative optimization are some of the possible explanations for the greater incidence of anemia during post-operative period in this patient cohort.

In large-scale study published by McClelland et al. on PD patients undergoing lumbar fusion procedures, it was concluded that this complicated patient cohort had higher complication rates, higher admission-related expenditure, longer hospital stay (beyond 1 week) and mortality, as compared with the general population.12 Although the higher overall complication rate following THA in PD patients has been well-recognised across the published literature, the rates and patterns of complications seem to vary depending upon the type of surgery and severity of PD.

Our study does have several limitations. The two cohorts were matched for age, sex, non-elective admission status, and obesity. However, other potential confounding factors like pre-operative diagnosis and CCI might not have been accounted for in our analysis. Additionally, since the availability of data in NOS database is restricted to the patients' in-hospital stay, only early postsurgical adversities could be evaluated in our current study. The evaluation of longer-term clinical or functional outcome was also beyond the scope of our study, owing to the aforementioned reasons. The data retrieval is also significantly impacted by the accuracy of the initial coding and data entry. However, NIS database provides a large multi-center database, allowing access to many surgeries and details regarding patient admissions. In the context of the current study, this database therefore offers an ideal source of data. We also highlight the importance of large-scale, prospective, randomized study to comprehensively evaluate the functional outcome; and short and long term complication rates in this patient cohort.

Most of the large-scale studies on THA in individuals with Parkinson's disease in the existing literature have excluded emergent hospital admissions and those presenting with proximal femoral fractures. Our study demonstrated higher rate of non-elective admission status in PD patients undergoing THA. This was not surprising, given the greater chance of falls in the patients with Parkinsonian disease. We believe that including this crucial patient group was one of the major strengths of our study.

This study provides an important insight into the health care costs, including length of hospitalization and inpatient post-operative complications in PD patients undergoing THA. Given the changing landscape of reimbursements for orthopedic procedures, it is important to recognize the increased costs associated with THA in this population. Further, due to the increased complications, risks and cost of care, the importance of careful patient selection and per-operative optimization cannot be understated.

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