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Complications and Healthcare Cost of Total Hip Arthroplasty in Patients with Depressive Disorder

Antoinette R. Portnoy, BS*,†, Shirley Chen, BS, MS†, Ameer Tabbaa, MD†, Matthew L. Magruder, MD†, Kevin Kang, MD†, Afshin E. Razi, MD†

*Sidney Kimmel Medical College, Thomas Jefferson University, Philadelphia, PA, USA**
Department of Orthopaedic Surgery, Maimonides Medical Center, Brooklyn, NY, USA†

Purpose: The purpose of this study was to determine whether the rates of (1) in-hospital lengths of stay (LOS), (2) readmissions, (3) medical complications, and (4) costs of care are higher for patients with depressive disorder (DD) undergoing primary total hip arthroplasty (THA) for treatment of femoral neck fractures (FNFs).

Materials and Methods: A retrospective query of a national administrative claims database for patients undergoing primary THA from 2006 to 2014 was conducted. Patients with DD undergoing THA for treatment of FNF were 1:5 ratio propensity score matched to a cohort (DD=6,758, controls=33,708). Primary endpoints included LOS, 90-day medical complications, 90-day readmissions, and healthcare reimbursements. A *P*-value less than 0.05 was considered statistically significant.

Results: Longer LOS were observed for patients with DD compared to those without DD (5.6 days vs. 5.4 days, *P*<0.001). Similar readmission rates (29.9% vs. 25.0%, odds ratio [OR] 1.03, *P*=0.281) were observed between groups. The odds of 90-day medical complications were higher for patients with DD compared to control subjects (60.6% vs. 21.4%, OR 1.57, *P*<0.0001). Within the 90-day episode of care interval, patients with a history of DD incurred significantly higher healthcare expenditures ($21,382 vs. $19,781, *P*<0.001).

Conclusion: Our findings showed longer LOS, higher odds of 90-day medical complications, and higher healthcare expenditures within the 90-day episode of care following a primary THA for treatment of FNF for patients with DD compared to the matched cohort. Thus, accordingly, patients with DD should receive counseling prior to undergoing surgery.

Keywords: Femur neck, Arthroplasty, Depression, Postoperative complications

INTRODUCTION

Increased prevalence of treating a femoral neck fracture (FNF) with total hip arthroplasty (THA), compared with hemiarthroplasty (HA) or open reduction internal fixation, has been reported in recent years[1-3]. An increase in the incidence of FNFs is expected due to the increasing number of older people in the population, leading to an increase in the expected number of THA procedures of 176% by 2040 and 659% by 2060[4,5].

Although the majority of THA's are performed for treatment of osteoarthritis, the impact of THA when treating FNF remains unclear[6]. While some recent studies have reported that treating FNF with THA resulted in more favorable functional outcomes, lower risk of revision surgery, and higher cost-effectiveness compared to traditional treatments, other studies have reported that the highest rate of adverse events across all treatment types was observed for THA[1,7-15]. Likewise, depressive disorders (DD) have become a major topic of concern in all aspects of life, and the World Health Organization has projected that depression will

Correspondence to: Antoinette R. Portnoy, BS https://orcid.org/0009-0004-9211-3834
Sidney Kimmel Medical College, Thomas Jefferson University, 1025 Walnut St #100, Philadelphia, PA 19107, USA
E-mail: arp122@students.jefferson.edu

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be the number one cause of burden by the year 2030[16]. There is conflicting evidence regarding postoperative orthopaedic outcomes for patients with DD, therefore, assessment of its relation to THA in the setting of FNFs is important, given the increasing incidence of depression along with use of THA, respectively[4,5,16].

Although this issue was examined in previous studies, in most studies all psychological disorders were grouped together, subjective diagnoses of DD were used, or joint replacement surgeries with differing indications were grouped altogether. Therefore, the objective of this study is to determine whether (1) in-hospital lengths of stay (LOS), (2) readmissions, (3) medical complications, and (4) costs of care are increased for patients with DD undergoing THA for treatment of FNFs. We hypothesize that the rates of LOS, readmissions, medical complications, and cost of care will be higher for patients with DD compared to the matched cohort.

MATERIALS AND METHODS

1. Database

A retrospective query, using the PearlDiver database (PearlDiver Technologies), for patients undergoing primary THA from 2006 to 2014 was conducted. Private insurance and government claims are collected in the database, which includes over 100 million patient records from databases including the National Inpatient Sample in a deidentified format[17,18]. The PearlDriver database, which includes information on trends in surgical treatment, demographics, and reimbursement, has been well utilized in previous orthopaedic studies[17,19,20]. The study group included patients with DD undergoing primary THA for treatment of FNFs (n=6,758). Patients were queried for DD, FNF, and THA using International Classification of Diseases, Ninth Revision diagnosis codes (ICD-9), and Current Procedural Terminology (CPT) codes (Supplementary File). To minimize confounding variables, the control group consisted of patients without DD (n=33,708) (Table 1). Patients in the study group were 1:5 ratio matched to control subjects according to age, sex, generalized anxiety disorder, diabetes, hyperlipidemia, hypertension, obesity, and tobacco use. The study is exempt from the requirement for approval by the Institutional Review Board (IRB) due to the unidentified format of the database used.

2. Outcomes Assessed

Primary endpoints of the study were a comparison of patient demographics, in-hospital LOS, 90-day readmissions, 90-day medical complications, and healthcare reimbursements. Ninety-day medical complications included respiratory failure, pneumonia, myocardial infarction, surgical site infections, acute kidney injury, venous thromboembolism, pulmonary embolism, deep venous thrombosis, and cerebrovascular accidents. Healthcare reimbursements, considered the highest predictor of what is paid to providers by insurance companies, as demonstrated in previous studies, were used to assess the cost of care[18,21].

3. Statistical Analysis

Statistical analyses were performed using the open programming language R (R Foundation for Statistical Computing). Multivariable logistic regression models were used for calculating the odds ratio (OR) and *P*-values for DD regarding development of medical complications and readmission within 90-days. Welch's *t*-tests were used for assessing significance for length

Table 1. Patient Demographics with and without Depressive Disorder

Demographics	History of depressive disorder (n=6,758)	Control (n=33,708)	*P*-value
Age (yr)			0.99
<64	304 (4.5)	1,508 (4.5)	
65-69	831 (12.3)	4,151 (12.3)	
70-74	982 (14.5)	4,886 (14.5)	
75-79	1,299 (19.2)	6,474 (19.2)	
80-84	1,482 (21.9)	7,403 (22.0)	
≥85	1,860 (27.5)	9,286 (27.5)	
Sex			0.99
Female	4,667 (69.1)	23,311 (69.2)	
Male	2,091 (30.9)	10,397 (30.8)	
Comorbidities			
Anxiety disorder	62 (0.9)	284 (0.8)	0.98
Diabetes mellitus	2,131 (31.5)	10,614 (31.5)	0.97
Hyperlipidemia	4,028 (59.6)	20,091 (59.6)	0.99
Hypertension	5,890 (87.2)	29,371 (87.1)	0.82
Obesity (BMI>30 kg/m^2)	190 (2.8)	916 (2.7)	0.96
Tobacco use	956 (14.1)	4,743 (14.1)	0.99

Values are presented as number (%).
P-values by Pearson's chi-square analysis.
BMI: body mass index.

Table 2. Medical Complications for Patients with and without a History of Depressive Disorder Undergoing Total Hip Arthroplasty for Femoral Neck Fracture

	History of depressive disorder (%)	Control (%)	OR	95% CI	*P*-value
Respiratory failure	10.3	3.1	2.37	2.14-2.63	<0.0001
Pneumoniae	14.5	4.1	2.73	2.49-2.99	<0.0001
Myocardial infarctions	3.2	1.2	1.83	1.54-2.18	<0.0001
Surgical site infections	3.1	1.4	1.68	1.41-2.00	<0.0001
Acute kidney injury	11.4	3.9	1.99	1.81-2.20	<0.0001
Venous thromboembolism	4.9	2.5	1.53	1.34-1.74	<0.0001
Pulmonary embolism	1.6	0.7	1.58	1.25-2.00	0.001
Deep venous thrombosis	4.3	2.2	1.57	1.36-1.82	<0.0001
Cerebrovascular accident	7.3	2.3	2.40	2.12-2.71	<0.0001
Total	60.6	21.4	1.57	1.36-1.82	<0.0001

OR: odds ratio, CI: confidence interval.

of stay and healthcare expenditures, while Pearson's chi-squared analysis was used for assessing the demographic profile for depression and matched controls. A *P*-value less than 0.05 was considered statistically significant.

RESULTS

1. Patient Demographics

A total of 40,466 patients who underwent primary THA for treatment of FNFs from 2006 to 2014 were identified.

Matching was successful, and no significant difference was observed between cohorts (DD=6,758, controls=33,708) (Table 1). The highest proportion of patients undergoing primary THA for treatment of FNF was ≥85 (27.5%) while a minority of patients were younger than 64 years (4.5%). Most patients were female (69.1%) and the primary comorbidities included hypertension (87.2%), hyperlipidemia (59.6%), and diabetes mellitus (31.5%).

2. Medical Complications and Cost of Care

Significantly higher incidence and odds of 90-day medical complications were observed for patients with DD compared to those without DD (60.6% vs. 21.4%, OR 1.57, *P*<0.0001). The results of the study showed that the frequency and odds of specific complications including respiratory failure (10.3% vs. 3.1%, OR 2.37, *P*<0.0001), pneumoniae (14.5% vs. 4.1%, OR 2.73, *P*<0.0001), myocardial infarction (3.2% vs. 1.2%, OR 1.83, *P*<0.0001), surgical site infections (3.1% vs. 1.4%, OR 1.68, *P*<0.0001), acute kidney injury (11.4% vs. 3.9%, OR 1.99, *P*<0.0001), venous thromboembolism (4.9% vs. 2.5%, OR 1.53, *P*<0.0001), pulmonary embolism (1.6% vs. 0.7%, OR 1.58, *P*=0.001), deep venous thrombosis (4.3% vs. 2.2%, OR 1.57, *P*<0.0001), and cerebrovascular accidents (7.3% vs. 2.3%, OR 2.40, *P*<0.0001) were higher with statistical significance for patients with DD (Table 2).

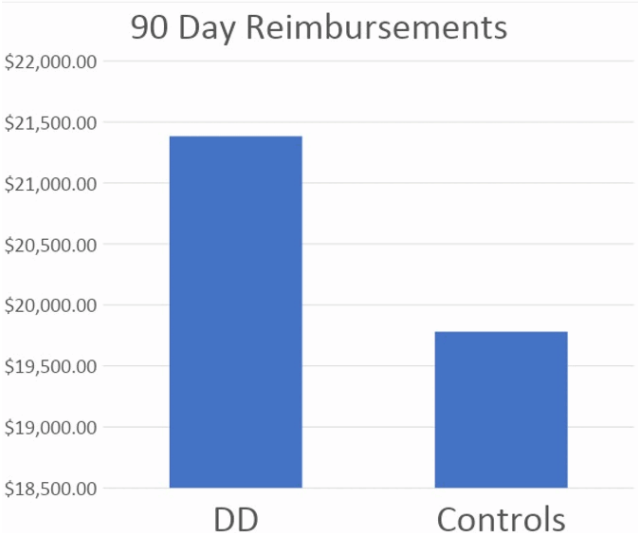

Fig. 1. A Comparison of reimbursements for patients with and without a history of depressive disorder (DD) undergoing total hip arthroplasty for femoral neck fracture.

3. In-hospital LOS and Readmissions

Longer LOS were observed for patients with DD compared to those without DD (5.6 days vs. 5.4 days, *P*<0.001).

Similar readmission rates were observed among patients with DD compared to those without DD (29.9% vs. 25.0%, OR 1.03, *P*=0.281). Within the 90-day episode of care interval, significantly higher healthcare expenditures, assessed through reimbursements, were observed for patients with a history of DD compared to those without ($21,382 vs. $19,781, *P*<0.001) (Fig. 1).

DISCUSSION

Depression is defined as a depressed mood accompanied by additional symptoms lasting for a prolonged period of time, as described in the DSM[16]. With increasing incidences of DD diagnoses and FNFs in the elderly population, there is a need to understand the impact of DD on the postoperative outcomes of THA when used specifically in treatment of FNF[4,5]. The findings of our study showed statistically significant longer LOS, higher odds of 90-day medical complications, and higher costs of care for patients with DD undergoing primary THA for treatment of FNFs compared to a matched cohort.

Previous studies have reported that psychological distress resulting from depression can lead to a hypercoagulable state and increased risk of bleeding complications, and association of several medications used for treatment of depression with a higher risk of VTE has been reported[22-29]. According to similar database studies reported by Buller et al.[30] and Browne et al.[31], depression showed an independent association with higher odds of thrombotic complications (OR 1.022 and OR 1.20, respectively). However, these studies combined THA with TKA procedures and did not focus specifically on treatment for an FNF. Of particular interest, Browne et al.[31] also reported that the risk of cardiac complications was lower for patients with DD (OR 0.93), which differs from other studies, including our own, which showed a correlation between depression and cardiovascular complications.

Although THA has been regarded as a cost-effective treatment for FNF, the increasing cost of spending is expected to continue given that an increase in the number of THA cases to 635,000 procedures annually by 2030 is projected[32-34]. Our study concluded that the cost of care following THA was higher for patients with DD compared to those without DD ($21,382 vs. $19,781, $P<0.001$), consistent with current findings reported in the literature. However, in previous studies depression was combined with anxiety, and the diagnosis of the disorders was made subjectively based solely on the patient's history and medications. With the concomitant increase in cases of DD, understanding why higher costs are expected for patients with DD will be important in the effort to minimize the financial burden on patients and the healthcare system. In an international randomized controlled trial that included 141 patients, Burgers et al.[35] calculated the total medical costs for treating FNFs with HA or THA. According to their findings, the main cost determination was rehabilitation, accounting for 46% of the total costs, followed by primary hospital admission days (22%). A longer length of stay in the hospital is more likely for patients with DD, which can thereby increase the cost of care[36-39]. Of particular interest, we found that the readmission rates for depressed patients were similar to those for non-depressed patients, which differs from the findings reported by Gupta et al.[6] and Gold et al.[39], where the likelihood of readmission was increased for patients with DD (OR 1.25 and OR 1.24, respectively). Readmission rates are a known reason for increased costs of care, therefore the higher cost of care observed for depressed patients in our study can be linked to in-hospital medical complications that occur prior to primary discharge and longer LOS. Although the LOS showed statistical significance, the results may not have clinical significance. The similar readmission rates can therefore be explained by the difference of only 5.6 to 5.4 days as the likelihood of readmission is higher with longer length of stays[40].

Limitations of this study include the large administrative database and the inevitable potential for misclassification when using ICD-9 diagnosis codes, since differentiation between a recent diagnosis or a patient's history is not possible[6,41]. According to one report, the prevalence of depression can be underestimated when relying solely on the use of diagnostic codes since some patients experience depressive symptoms but never receive a diagnosis[42]. Likewise, there is uncertainty on the severity of each patient's DD, on other confounders such as alcohol or drug use, if patients were on medication for treatment, or if patients were in rehabilitation, which can serve as the basis for conduct of prospective studies in the future. Although FNFs were identified using ICD/CPT codes, it is uncertain whether the FNF's occurred in isolation or if patients presented with other injuries. An inherent limitation of the database is that it did not provide information on the mechanism of injury, surgical technique, or postoperative management including anticoagulants or antibiotics, which can influence outcomes and complications. In addition, although the large sample size ensures that the study was adequately powered, the results may have shown statistically significant differences that have no clinical relevance[31,41]. Despite these limitations,

this study provides novel information on a topic that has not been thoroughly studied with a large sample size and matched cohort, which examined only the effects of DD in patients undergoing THA for treatment of FNF.

CONCLUSION

The findings of this study showed longer LOS, higher rates of 90-day medical complications, and higher healthcare expenditures following a primary THA for treatment of FNF for patients with DD compared to a matched cohort. These results suggest that patients with DD should receive counseling on potential postoperative outcomes from their physician prior to undergoing surgery. Awareness of the results presented here will be helpful to surgeons when performing risk adjustment for potential adverse outcomes in patients with DD undergoing THA for treatment of FNF. Conduct of additional research will be needed to determine whether treating DD preoperatively can be helpful in the effort to alleviate adverse effects. However, the findings of this study underscore the importance of coordination with other medical subspecialties to help minimize the length of stay, readmission rate, medical complications, and cost of care for high-risk patients with known DD.

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Conflict of Interest

No potential conflict of interest relevant to this article was reported.

Supplementary Materials

Supplementary data is available at https://hipandpelvis.or.kr/.

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