




Depressive Disorders Lead to Increased Complications After Geriatric Hip Fractures

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Abstract

Introduction: Intertrochanteric hip fractures are a common injury treated by orthopedic surgeons and the incidence rate is rising. Preoperative depression is a known risk factor for postoperative complications in orthopaedic surgery, however its effects on outcomes after geriatric hip fractures is relatively unknown. The purpose of this study was to investigate the relationship between preoperative depression and potential complications following open reduction internal fixation (ORIF) and intramedullary nailing (IMN) of geriatric hip fractures. **Methods:** In this retrospective study, the Truven Marketscan claims database was used to identify patients over age 65 who underwent ORIF or IMN for a hip fracture from January 2009 to December 2019. Patient characteristics, such as medical comorbidities, were collected and from that 2 cohorts were established (one with and one without depression). Chi-squared and multivariate analysis was performed to investigate the association between preoperative depression and common postoperative complications following intertrochanteric hip fracture surgery. **Results:** In total, 78,435 patients were identified for analysis. In those patients with preoperative depression, the complications associated with the greatest increased odds after undergoing ORIF were surgical site infections (OR 1.32; CI 1.23-1.44), ED visit for pain (OR 1.27; CI 1.16-1.39), wound complications (OR 1.26; CI 1.14-1.35), and non-union (OR 1.25; CI 1.17-1.33). In the patients with preoperative depression undergoing IMN, the complications associated with the greatest increased odds after were surgical site infections (OR 1.37; CI 1.31-1.45), ED visit for pain (OR 1.31; CI 1.19-1.44), wound complications (OR 1.23; CI 1.10-1.39), and pneumonia (OR 1.22; CI 1.10-1.31). **Conclusions:** Preoperative depression in patients undergoing hip fracture surgery is associated with increased complications. Recognizing a patients' preoperative depression diagnosis can allow physicians to adapt perioperative and postoperative surveillance protocols for these higher risk patients. Further studies are warranted to investigate the degree to which depression is a modifiable risk factor

Keywords

geriatric trauma, fragility fractures, trauma surgery, geriatric medicine, osteoporosis

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Introduction

Hip fractures are a very common injury seen in the elderly population. The annual incidence continues to increase and is anticipated to be over 6.5 million by the year 2050.^{1,2} Intertrochanteric fractures and femoral neck fractures are the most common subtypes, occurring in about equal frequency. Although orthopaedic surgeons are able to reliably fix these injuries operatively, there is still significant morbidity and mortality associated with these fractures. One year mortality rates have been documented as high as 30% due to decreased morbidity or other peri-operative complications associated with this injury.³⁻⁵ For example, these fractures are commonly associated with pulmonary complications, infections, bleeding, and thromboembolism. Because of the high frequency of this

injury's associated morbidity, there are significant annual health care expenditures related to the significant peri-operative complication rates in hip fractures. Further study of risks factors associated with increased morbidity and poor outcomes in this injury population may help reduce this expenditure. There is research on patient outcomes with factors such as time to surgery, gender, age, and American Society of

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Anesthesiologists Physical Status Classification (ASA),⁶ but there is paucity of literature describing the relationship between depression and other mental health disorders and patient outcomes.

A preoperative diagnosis of depression is often overlooked as a comorbidity in the orthopedic patient. Prior research has shown poor post-operative function in patients with depression and high rates of initiation of antidepressant therapy after hip fractures.^{7,8} However, there is no literature to show an association between a preoperative diagnosis of depression and post-operative complications following hip fracture fixation. In the adult reconstruction and foot and ankle literature, preoperative depression in patients undergoing total hip and knee arthroplasty, revision hip and knee arthroplasty, and total ankle arthroplasty has been found to be associated with increased risk of complication and increased healthcare resource utilization.⁹

Given that the prevalence of depression within the United States is roughly 20 million Americans according to the World Health Organization¹⁰ and the existence of prior literature showing unfavorable clinical outcomes in patients with preoperative diagnosis of depression,¹¹⁻¹³ there remains a need to study this topic in patients with hip fractures. The purpose for this investigation was to analyze the effects a preoperative diagnosis of depression on complications following hip fracture fixation in the geriatric population using a large national insurance claims database. We hypothesized that patients with a preoperative diagnosis of depression would have increased complication rates post operatively.

Methods

Data Source and Cohort Selection

In the current study, we performed a retrospective cohort analysis of patients who underwent open reduction internal fixation (ORIF) or intramedullary nail (IMN) fixation of an intertrochanteric, peritrochanteric or subtrochanteric femur fracture from January 1, 2009 and December 31, 2019. Patients were obtained by searching the Truven MarketScan Commercial Claims and Medicare database (Truven Health, Ann Arbor, MI). This database is a nationwide archive that compiles the medical records of approximately 250 million patients, allowing for the analysis of patient healthcare utilization, surgical procedures, and follow-up care. This database has been used for various clinical and epidemiological studies, specifically in the field of orthopedics.^{14,15}

The database was queried for patients who underwent either ORIF or IMN of an intertrochanteric, peritrochanteric or subtrochanteric femur fracture using the Current Procedural Terminology (CPT) codes 27244 and 27245 (Table 1). Patients were excluded based on several criteria including (1) 6-month noncontinuous preoperative enrollment (ie, patients who were not continuously enrolled in the database for the 6-month period preceding surgery), (2) 12-month noncontinuous post-operative enrollment, (3) open fracture, and (4) those aged less than 65 years. This was performed to accurately capture those

Table 1. Intertrochanteric Femur Fracture ORIF and IMN CPT Codes.

CPT Code	Description
27244	Treatment of intertrochanteric, peritrochanteric, or subtrochanteric femoral fracture; with plate/screw type implant, with or without cerclage
27245	Treatment of intertrochanteric, peritrochanteric, or subtrochanteric femoral fracture; with intramedullary implant, with or without interlocking screws and/or cerclage

ORIF: Open Reduction Internal Fixation; IMN: Intramedullary Nail; CPT: Current Procedural Terminology

with a preexisting depression diagnosis as well as to provide long enough follow up to monitor for potential complications in geriatric hip fracture patients.

Baseline Patient Data

Once the patients were queried, the baseline characteristics and comorbidities of the patients were collected. These included demographics (age and sex), obesity (defined as a body mass index (BMI) of ≥ 30), osteoporosis, chronic kidney disease, alcohol use disorders, tobacco use, hypertension, hyperlipidemia, coronary artery disease, congestive heart failure, diabetes, rheumatic disease, anxiety, lower back pain, and fibromyalgia.

Next the patients were then divided into 1 of 2 separate cohorts based on the presence or absence of a preoperative diagnosis of depression and then further separated into cohort based on type of operative fixation (ORIF or IMN). Patients were defined as having depression if their medical record consisted of at least 1 international classification of disease (ICD) code associated with depression and allocated to the depression group. Patients without an associated code were allocated to the "no depression" cohort. A list of all the ICD codes that were used to identify those with depression are include in (Table 2).

Postoperative Outcomes

The main outcome of interest for the current study was examining common postoperative complications that occur after hip fracture surgery. The complications included for analysis were a return to the emergency department for treatment of post-operative pain, development of sepsis, pneumonia, stroke, non-union, deep vein thrombosis and/or pulmonary embolism (DVT/PE), hardware complications (defined as hardware irritation and/or failure), wound complications (defined as wound dehiscence, seroma, and/or hematoma formation), surgical site infection, 30-day readmission, and 90-day readmission. All the complications listed were obtained from the medical record utilizing ICD codes that were new to the patient record during the post-operative period. All complications occurred within 1 year after surgery.

Table 2. ICD 9 and 10 Codes Used to Identify Patients with Depression.

ICD Code	Description
3004	Dysthymic disorder
30112	Chronic depressive personality disorder
3090	Adjustment disorder with depressed mood
3091	Prolonged depressive reaction
311	Depressive disorder, not elsewhere classified
29682	Atypical depressive disorder
29620	Major depressive affective disorder, single episode, unspecified
29621	Major depressive affective disorder, single episode, mild
29622	Major depressive affective disorder, single episode, moderate
29623	Major depressive affective disorder, single episode, severe, without mention of psychotic behavior
29624	Major depressive affective disorder, single episode, severe, specified as with psychotic behavior
29625	Major depressive affective disorder, single episode, in partial or unspecified remission
29626	Major depressive affective disorder, single episode, in full remission
29630	Major depressive affective disorder, recurrent episode, unspecified
29631	Major depressive affective disorder, recurrent episode, mild
29632	Major depressive affective disorder, recurrent episode, moderate
29633	Major depressive affective disorder, recurrent episode, severe, without mention of psychotic behavior
29634	Major depressive affective disorder, recurrent episode, severe, specified as with psychotic behavior
29635	Major depressive affective disorder, recurrent episode, in partial or unspecified remission
29636	Major depressive affective disorder, recurrent episode, in full remission
F32	Major depressive disorder, single episode
F33	Major depressive disorder, recurrent
F341	Dysthymic disorder
F432	Adjustment disorder with depressed mood

ICD: International Classification of Diseases

Statistical Analysis

Univariate analyses were performed to look for any differences within the baseline characteristics and comorbidities of the 2 cohorts (depression and no depression) and this was performed twice, once for the ORIF group and then for the IMN group (ie. there are 4 cohorts in total; depression/no depression in ORIF and depression/no depression in IMN). Student t-tests were used for continuous variables and chi square analysis was utilized for categorical variables (e.g. sex). Univariate analysis was then performed to investigate difference in complications between cohorts. This was followed by binomial multivariate logistic regression that was used to examine for independent complications associated with preoperative depression, while controlling for the baseline demographic and comorbidity data described above. For this analysis, we compared the preoperative depression diagnosis group to the no depression cohort as

Table 3. Baseline Patient Characteristics and Comorbidities (ORIF and IMN)

	No Depression	Depression	P-Value
Total, n (%)	68,553 (87.4)	9,882 (12.6)	
Age, avg (SD)	79.4 (7.2)	81.9 (6.7)	<0.001
Sex, n (%)			
Male	14,924 (21.8)	2,483 (25.1)	<0.001
Female	53,629 (78.2)	7,399 (74.9)	
Fixation			
ORIF	43,689 (63.7)	6,214 (62.9)	0.417
IMN	24,864 (36.3)	3,668 (37.1)	
Comorbidities, n (%)			
Obesity	13,532 (19.7)	2,315 (23.4)	<0.001
Osteoporosis	19,990 (29.2)	3,352 (33.9)	<0.001
Renal Disease	2,427 (3.5)	528 (5.3)	0.029
Alcohol Abuse	2,146 (3.1)	806 (8.2)	<0.001
Hyperlipidemia	35,496 (51.8)	5,627 (56.9)	0.031
Tobacco Use	4,764 (6.9)	973 (9.8)	<0.001
Hypertension	25,995 (37.9)	4,114 (41.6)	<0.001
Coronary Artery Disease	47,391 (69.1)	6,560 (66.4)	<0.001
Congestive Heart Failure	1,604 (2.3)	268 (2.7)	0.032
Rheumatic Disease	1,488 (2.2)	261 (2.6)	0.041
Diabetes	18,139 (26.4)	3,176 (32.1)	<0.001
Anxiety	1,947 (2.8)	1,322 (13.4)	<0.001
Low Back Pain	4,682 (6.8)	1,160 (11.7)	<0.001
Fibromyalgia	4,401 (6.4)	853 (8.6)	<0.001

n: number; %: percentage; avg: average; SD: standard deviation; ORIF: Open reduction internal fixation; IMN: Intramedullary nail

the reference. Results are reported as odds ratios (OR) with 95% confidence intervals (CI). A p-value of <0.05 was considered significant in this study. All statistical analysis was performed using R (R Core Team 2020) software.

Results

Patient Demographics and Comorbidities

In total 78,435 patients who underwent ORIF or IMN of an intertrochanteric, peritrochanteric or subtrochanteric femur fracture were included in the study. The majority (87.4%) of patients did not have a diagnosis of preoperative depression, while 12.6% had at least 1 ICD code associated with preoperative depression (Table 3). These were further subdivided into either an ORIF and IMN group, as described above, with the results shown in Table 4 and Table 5, respectively.

For the ORIF group, univariate analysis revealed multiple differences in baseline demographics and comorbidities between the 2 cohorts (Table 4). There was a significant difference between cohorts in most of the comorbidities evaluated. Of note, patients with a preoperative diagnosis of depression were more likely to also have obesity (26.9% vs. 18.2%, $p < 0.001$); osteoporosis (29.1% vs. 24.7%, $p < 0.001$); hypertension (44.8% vs. 39.5%, $p < 0.001$); diabetes mellitus (30.9% vs. 24.1%, $p < 0.001$).

For the IMN group, univariate analysis revealed similar patterns as was seen in the ORIF group above. A full view of the baseline characteristics and comorbidities can be seen in Table 5.

Table 4. Baseline Patient Characteristics and Comorbidities (ORIF).

	No Depression	Depression	P-Value
Total, n (%)	43,689 (87.5)	6,214 (12.5)	
Age, avg (SD)	80.9 (8.3)	82.8 (5.9)	<0.001
Sex, n (%)			
Male	8,401 (19.2)	1,347 (21.7)	<0.001
Female	35,288 (80.8)	4,867 (78.3)	
Comorbidities, n (%)			
Obesity	7,965 (18.2)	1,672 (26.9)	<0.001
Osteoporosis	10,774 (24.7)	1,808 (29.1)	<0.001
Renal Disease	1,608 (3.7)	362 (5.8)	<0.001
Alcohol Abuse	1,673 (3.8)	443 (7.1)	<0.001
Hyperlipidemia	20,918 (47.9)	3,432 (55.2)	<0.001
Tobacco Use	2,713 (6.2)	570 (9.2)	<0.001
Hypertension	17,266 (39.5)	2,786 (44.8)	<0.001
Coronary Artery Disease	27,834 (63.7)	4,096 (65.9)	0.031
Congestive Heart Failure	1,175 (2.7)	177 (2.7)	0.471
Rheumatic Disease	1,101 (2.5)	168 (2.7)	0.282
Diabetes	10,520 (24.1)	1,921 (30.9)	<0.001
Anxiety	1,446 (3.3)	987 (15.9)	<0.001
Low Back Pain	3,281 (7.5)	803 (12.9)	<0.001
Fibromyalgia	2,329 (5.3)	528 (8.5)	<0.001

n: number; %: percentage; avg: average; SD: standard deviation; ORIF: Open reduction internal fixation;

Table 5. Baseline Patient Characteristics and Comorbidities (IMN).

	No Depression	Depression	P-Value
Total, n (%)	24,864 (87.1)	3,668 (12.9)	
Age, avg (SD)	76.3 (6.5)	78.6 (7.1)	<0.001
Sex, n (%)			
Male	6,523 (26.2)	1,136 (31.0)	<0.001
Female	18,341 (73.8)	2,532 (69.0)	
Comorbidities, n (%)			
Obesity	5,567 (22.4)	643 (17.5)	<0.001
Osteoporosis	9,216 (37.1)	1,544 (42.1)	<0.001
Renal Disease	819 (3.3)	166 (4.5)	0.296
Alcohol Abuse	473 (1.9)	363 (9.9)	<0.001
Hyperlipidemia	14,578 (58.6)	2,195 (59.8)	0.317
Tobacco Use	2,051 (8.2)	403 (11.0)	<0.001
Hypertension	8,729 (35.1)	1,328 (36.2)	<0.001
Coronary Artery Disease	19,557 (78.7)	2,464 (67.2)	<0.001
Congestive Heart Failure	429 (1.7)	91 (2.5)	<0.001
Rheumatic Disease	387 (1.6)	93 (2.5)	<0.001
Diabetes	7,619 (30.6)	1,255 (34.2)	<0.001
Anxiety	501 (2.0)	335 (9.1)	<0.001
Low Back Pain	1,401 (5.6)	357 (9.7)	<0.001
Fibromyalgia	2,072 (8.3)	325 (8.9)	0.024

n: number; %: percentage; avg: average; SD: standard deviation; IMN: Intramedullary nail

Analysis of Preoperative Depression and Postoperative Complications

Univariate analysis of the complications in the ORIF group revealed that compared to the no depression group, the preoperative depression cohort had a higher proportion of patients with multiple complications, some of which included ED visits related to pain control (14.1% vs. 10.8%, $p < 0.001$); surgical

Table 6. Univariate Analysis of Depression and Patient Complications (ORIF).

Complications, n (%)	No Depression	Depression	P-Value
ED Visit Pain	4,727 (10.8)	878 (14.1)	<0.001
Sepsis	1,123 (2.6)	274 (4.4)	<0.001
DVT/ PE	4,028 (9.2)	613 (9.9)	<0.001
Pneumonia	1,691 (3.9)	417 (6.7)	<0.001
Stroke	1,010 (2.3)	154 (2.5)	0.039
Nonunion	577 (1.3)	197 (3.2)	<0.001
Hardware Complication	970 (2.2)	256 (4.1)	<0.001
Wound Complication	2,394 (5.5)	547 (8.8)	<0.001
Surgical Site Infection	2,001 (4.6)	439 (7.1)	<0.001
30-Day Readmission	8,262 (18.9)	1,403 (22.6)	<0.001
90-Day Readmission	9,686 (22.2)	1,442 (23.2)	0.263

n: number; %: percentage; ED: emergency department; DVT/PE: deep vein thrombosis and/or pulmonary embolism; ORIF: Open reduction internal fixation

site infection (7.1% vs 4.6%, $p < 0.001$); wound complication (8.8% vs. 5.5%, $p < 0.001$); 30-day readmission (22.6% vs. 18.9%, $p < 0.001$); nonunion (3.2% vs 1.3%, $p < 0.001$) Table 6. Univariate analysis of the complications in the IMN group revealed that compared to the no depression group, the preoperative depression cohort had a higher proportion of patients with multiple complications like the ORIF group. These included ED visits related to pain control (12.7% vs. 8.2%, $p < 0.001$); surgical site infection (4.8% vs 2.9%, $p < 0.001$); wound complication (5.9% vs. 3.2%, $p < 0.001$); 30-day readmission (19.5% vs. 16.1%, $p < 0.02$); nonunion (2.3% vs 0.9%, $p < 0.001$) Table 7.

Subsequent multivariate analysis was performed on both the ORIF and IMN groups to determine the complications independently associated with preoperative depression. Most complications maintained a significant association with preoperative depression in the multivariate analysis of both groups. For the ORIF group this included surgical site infection (OR 1.32, CI 1.23 -1.44), sepsis (OR 1.09, CI 1.02 -1.18), DVT/PE (OR 1.05, CI 1.01 -1.17), pneumonia (OR 1.19, CI 1.08 -1.30), hardware complication (OR 1.23, CI 1.11 -1.27), emergency department visits for pain control (OR 1.27, CI 1.16 -1.39), wound complication (OR 1.26, CI 1.14 -1.35), 30-day readmission (OR 1.11, CI 1.03 -1.29), and nonunion (OR 1.25, CI 1.17 -1.33) (Table 8). For the IMN group this also included surgical site infection (OR 1.37, CI 1.31 -1.45), sepsis (OR 1.07, CI 1.01 -1.18), DVT/PE (OR 1.09, CI 1.04 -1.16), pneumonia (OR 1.22, CI 1.10 -1.31), emergency department visits for pain control (OR 1.31, CI 1.19 -1.44), wound complication (OR 1.23, CI 1.10 -1.39), 30-day readmission (OR 1.14, CI 1.02 -1.32), 90-day readmission (OR 1.11, CI 1.03 -1.27), and nonunion (OR 1.18, CI 1.06 -1.30) Table 9.

Discussion

Depression continues to rank within the top 5 leading causes of worldwide morbidity according to The World Health

Table 7. Univariate Analysis of Depression and Patient Complications (IMN).

Complications, n (%)	No Depression	Depression	P-Value
ED Visit Pain	2,044 (8.2)	467 (12.7)	<0.001
Sepsis	465 (1.9)	140 (3.8)	<0.001
DVT/ PE	1,512 (6.1)	296 (8.1)	<0.001
Pneumonia	1,474 (5.9)	278 (7.6)	<0.001
Stroke	763 (3.1)	133 (3.6)	0.041
Nonunion	231 (0.9)	85 (2.3)	<0.001
Hardware Complication	306 (1.2)	55 (1.5)	0.037
Wound Complication	791 (3.2)	217 (5.9)	<0.001
Surgical Site Infection	714 (2.9)	175 (4.8)	<0.001
30-Day Readmission	4,008 (16.1)	716 (19.5)	0.019
90-Day Readmission	4,592 (18.5)	780 (21.3)	0.028

n: number; %: percentage; ED: emergency department; DVT/PE: deep vein thrombosis and/or pulmonary embolism; IMN: intramedullary nail

Table 8. Multivariate Analysis of Depression and Patient Complications (ORIF)*.

Complications	OR	95% CI	P-Value
ED Visit Pain	1.27	1.16 -1.39	<0.001
Sepsis	1.09	1.02 -1.18	0.027
DVT/PE	1.05	1.01 -1.17	0.012
Pneumonia	1.19	1.08 -1.30	<0.001
Stroke	1.02	0.93 -1.17	0.392
Nonunion	1.25	1.17 -1.33	<0.001
Hardware Complication	1.23	1.11 -1.37	<0.001
Wound Complication	1.26	1.14 -1.35	<0.001
Surgical Site Infection	1.32	1.23 -1.44	<0.001
30-Day Readmission	1.11	1.03 -1.29	0.022

*Model controlled for all demographic variables listed in Table 4. Reference group: no depression. OR: odds ratio. CI: confidence interval. ED: emergency department. DVT/PE: deep vein thrombosis and/or pulmonary embolism. ORIF: Open reduction internal fixation

Table 9. Multivariate Analysis of Depression and Patient Complications (IMN)*.

Complications	OR	95% CI	P-Value
ED Visit Pain	1.31	1.19 -1.44	<0.001
Sepsis	1.07	1.01 -1.18	0.041
DVT/PE	1.09	1.04 -1.16	0.019
Pneumonia	1.22	1.10 -1.31	<0.001
Stroke	1.05	0.91 -1.19	0.233
Nonunion	1.18	1.06 -1.30	<0.001
Hardware Complication	1.12	0.88 -1.33	0.304
Wound Complication	1.23	1.10 -1.39	<0.001
Surgical Site Infection	1.37	1.31 -1.45	<0.001
30-Day Readmission	1.14	1.02 -1.32	0.030
90-Day Readmission	1.11	1.03 -1.27	0.039

*Model controlled for all demographic variables listed in Table 5. Reference group: no depression. OR: odds ratio. CI: confidence interval. ED: emergency department. DVT/PE: deep vein thrombosis and/or pulmonary embolism. IMN: Intramedullary nail

Organization¹⁶ and projects that by 2030, it will be the second leading cause.¹⁷ In addition to reduced overall quality of life, depressed patients also have increased physical morbidity and mortality.^{18,19} As hip fractures are some of the most common fractures seen the elderly, this population represents a large proportion of the patients potentially affected by the effects of depression. Prior research has shown inferior outcomes in depressed patients, but these efforts have focused mainly on other areas of orthopedics (mainly arthroplasty) as well as general surgery.^{12,20,21} To our knowledge, no study has assessed preoperative depressive disorders and its associated postoperative complications in patients undergoing hip fracture fixation. The purpose of this study was to further understand the effects of pre-operative depression in patients who undergo intertrochanteric fracture fixation.

The major findings of this study showed an increase in sepsis, DVT/PE, Pneumonia, nonunion, hardware complications, wound complications, and surgical site infections in patients undergoing ORIF for intertrochanteric fractures (Table 8). In patients undergoing IMN fixation for intertrochanteric fracture, similar increases in complications were seen with the exception risk of hardware complication (Table 9). In addition to the increased complications, patients with preoperative diagnoses of depressive disorders were also found to have increased pain related ED visits, and readmission rates. The positive association persisted after controlling for patient sex, age, and medical comorbidities in our multivariate analysis.

This study confirms findings from prior studies showing inferior outcomes in patients with preoperative depressive disorders. Patients with preoperative depression who underwent a coronary artery bypass grafting (CABG) were found to have increased postoperative delirium, unplanned hospital admissions, increased cardiac events, and return of angina.^{22,23} Furthermore, Doering et al also found that depressive symptoms were also associated with increased infection, impaired wound healing, and poor physical recovery.²⁴ In the general surgery literature, patients with depression undergoing bariatric surgery were found to have less weight loss at 2 and 3 years.²⁵ In spine surgery, depression has been found to be an independent predictor of less 2 year improvement in disability after revision surgery for adjacent segment disease, pseudoarthrosis, and recurrent stenosis. Lastly in arthroplasty, Guild et al. found that after revision hip and knee arthroplasty, preoperative depression was associated with extended length of stay, non-home discharge, 90-day readmission, 90-day emergency department visit, prosthetic joint infection, revision surgery, and increased costs.⁹

Several theories have been postulated to explain the increased complications seen with depression. The most common theory suggest that psychological stress in humans can induce an inflammatory state via release of proinflammatory cytokines.²⁶ Furthermore, depression may lead to a shift in T-cell phenotype, leading to susceptibility to infection when combined with the proinflammatory cytokines.²⁷ This theory may explain our findings of increased sepsis, DVT/PE, Pneumonia,

and wound complications. Prior literature also documented that individuals with depressive disorders are at increased risk for frequent use of emergency department services and resources, potentially due to a heightened pain response which was also shown in our study.²⁸ Although orthopedic interventions and the postsurgical state in general is a risk factor for DVT and PE formation, depression has been linked with blood stasis and a generalized state of hypercoagulability which further exacerbates the underlying risk for DVT, PE, and stroke.²⁹⁻³² Depression has also been reported as a risk factor for delaying home disposition and prolonging hospital admission.^{33,34}

The findings in this study are important because in addition to diabetes, chronic kidney disease, operative delay, male gender, older age, and ASA classification, etc. we now have knowledge of an additional risk factor that contributes to inferior outcomes after hip fracture surgery. This raises the question as to whether this may be a modifiable risk factor that orthopedic surgeons can target to potentially improve outcomes and can be an important focus for future studies evaluating orthopedic trauma patients. Based on our findings, we recommend a collaborative effort be made between surgeons and patients to ensure that their depression is being adequately treated during the perioperative period.

The current investigation has several limitations. This retrospective database study relies on the accurate input of patient risk factors and outcomes, such as the proper documentation of preoperative depression and intertrochanteric open reduction internal fixation (ORIF) or intramedullary nailing (IMN). Additionally, our study was limited to patients that were at least 65 years old, failing to capture younger patients who may have a preoperative diagnosis of depression and experienced intertrochanteric fracture. Furthermore, details like fracture subtype, mechanism of injury, length of surgery, and the damage to the soft tissue could not be determined using a large database query. Additionally, other coexisting injuries at the time of hip fracture were unaccounted for such as abdominal and chest trauma (ie. rib fractures, solid organ injuries, etc.) as well as potential concurrent myocardial infarction or stroke, which could have been an indirect cause of the hip fracture (eg. falling after stroke) and thus lead to potential confounding. With regards to the diagnosis of depression, limitations were also encountered due to the use of a database. For example, the extent of the patient's depression or whether the patient was being treated successfully was not assessed. Patients who did not have their depression clinically documented were not included in the current study's sample size. Lastly, the patients in this study were also limited to those who had private health insurance, creating a bias that may not fully represent the entire population which includes individuals who are either uninsured or have Medicaid.

Conclusion

The findings of this investigation suggest a preoperative diagnosis of depression is correlated with increased rates of postoperative complications following treatment of intertrochanteric hip

fractures. As the incidence of both depression and hip fractures continues to rise, this study can aid clinicians in recognizing patients who are at higher risk for postsurgical complications due to their underlying depressive illness. Additional studies should be conducted to studying the modifiability of depression as a risk factor for poor outcomes after operative intervention for intertrochanteric hip fractures.


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