Risk Factors for Postoperative Ileus following Primary Total Hip Arthroplasty

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Abstract

Postoperative ileus (POI) is a feared complication following surgery. The purpose of this study was to (1) compare patient demographics between patients who developed and did not develop POI following primary total hip arthroplasty (THA), (2) compare in-hospital lengths of stay (LOS), and (3) identify patient-related risk factors associated with developing POI after primary THA. Using the 100% Medicare Standard Analytical Files from the PearlDiver from 2005 to 2014, patients developing POI within 3 days following primary THA were identified as the study cohort, whereas patients not developing POI served as the comparison cohort. Primary endpoints of the study included comparing patient demographics, in-hospital LOS, and identifying patient-related risk factors. A multivariate binomial logistic regression analysis was used to identify patient-related risk factors by calculating odds ratio (OR) for the risk of developing POI. A *p*-value less than 0.001 was considered to be statistically significant. The query yielded 335 patients (0.03%) who developed POI following their primary THA procedure. The study group was significantly different compared with controls with respect to age ($p < 0.0001$), sex ($p < 0.0001$), and prevalence of comorbid conditions. Patients who developed POI had longer in-hospital LOS (5 vs. 3 days, $p < 0.0001$). Risk factors associated with POI included electrolyte and fluid imbalance (OR: 3.06, $p < 0.0001$), male sex (OR: 2.86, $p < 0.0001$), and obesity (OR: 1.89, $p < 0.0001$). The study found significant differences among patients who did and did not develop POI following primary THA and several associated risk factors for the complication. Identification and adequate preoperative optimization of modifiable risk factors could potentially reduce the incidence of POI.

Keywords

- total hip arthroplasty
- postoperative ileus
- Medicare
- risk factors

While orthopaedic surgeons continue to stay observant of medical complications such as cerebrovascular accidents, myocardial infarctions, venous thromboemboli, and infections, one important adverse event that is often overlooked is the development of postoperative ileus (POI)—defined as developing ileus within 3 days following the index procedure, as initially described by Livingston and Pasarro.[1] POI is a relatively common complication after abdominal surgery with a reported incidence rate of up to 30% following the procedure.[1–3] However, the literature has shown POI to occur less commonly after orthopaedic procedures, with an incidence rate ranging from 0.27 to 8.4%, with patients undergoing spine surgery at the highest risk for this complication.[4–7]

With respect to following total joint arthroplasty (TJA), Parvizi et al identified older male patients undergoing bilateral total knee arthroplasty (TKA) being the leading

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risk factors for developing POI.[8] In contrast, Bederman et al found that younger patients were at greatest risk of developing POI following primary TJA.[9] However, Klasan et al showed no significant association between age or gender on developing POI.[10] While these were single institution studies with varying demographics and time frames, the inconsistency of these findings within the literature necessitates the need for additional research on POI following primary total hip arthroplasty (THA).

With the expected rise in primary THA procedures being performed worldwide, the purpose of this study was to investigate the association of POI following primary THA.[11] Specifically, this investigation aimed to compare (1) patient demographic profiles between patients developing and not developing POI following primary THA, (2) in-hospital length of stay (LOS), and (3) identify patient-related risk factors associated with developing POI following primary THA. Based on prior investigations, we hypothesize that male sex, electrolyte and fluid derangements, and obesity will be associated with an increased risk of developing POI.

Methods

A retrospective analysis from January 1, 2005 to March 31, 2014 was performed using the 100% Medicare Standard Analytical Files from the PearlDiver (PearlDiver Technologies, Fort Wayne, IN). The supercomputer houses the records of over 100 million patients and has been used to investigate outcomes, trends, and economic impact in the field of various orthopaedic subspecialties.[12–14] Information provided by the database is reliant on International Classification of Disease (ICD) and Current Procedural Terminology (CPT) coding and is downloaded as a comma separated value (.csv) spreadsheet. Data provided on this csv spreadsheet includes complications, procedures, costs, reimbursements, discharge disposition, and other metrics. Since the database contains deidentified patient information, our study was exempt from our institution's Institutional Review Board approval.

The inclusion criteria for the study group consisted of all patients in the database undergoing primary THA and developed POI within 3 days following the index procedure. Three days was chosen as the threshold, as the time frame initially used to define POI by Livingston and Passaro.[1] All patients not developing POI following their primary THA represented the control cohort. The database was initially queried for all patients undergoing primary THA, using CPT and ICD-9 procedural codes 27,130 and 81.51, respectively. Patients developing POI were identified using ICD-9 diagnosis code 560.1.

Primary endpoints of this study were to compare patient demographics between the two cohorts, in-hospital LOS, and identify patient-related risk factors for developing POI. Patient demographics analyzed included age, sex, and prevalence of medical comorbidities that are found within the Elixhauser comorbidity index (ECI) and Charlson comorbidity index.[15,16] The following medical comorbidities were used to compare patient demographics: alcohol use disorder, acquired immunodeficiency syndrome (AIDS), arrhythmia, blood loss anemia, congestive heart failure, coagulopathies, depression, diabetes mellitus, hypertension, hypothyroidism, iron deficiency anemia (IDA), liver failure, metastatic cancer, neurological deficits, obesity, psychoses, peptic ulcer disease, peripheral vascular disease, renal failure, rheumatoid arthritis, tumor, valvular disorders, and pathologic weight loss.

Data Analyses

Statistical analyses were performed using the open programming language R (R, Foundation for Computational Statistics; Vienna, Austria). Patient demographics between the study and control cohort were compared using Pearson's χ^2. Multivariate binomial logistic regression analysis was used to calculate odds ratio (OR) and 95% confidence intervals (95% CI) on the odds of certain patient-related risk factors and developing POI following primary THA. For age, patients younger than the age of 65 were used as the reference group, and for sex, females were used as the reference category. Variables entered into the regression analysis were those comorbid conditions used to compare patient demographics as previously mentioned. Since inputs in the regression model can be entered in any order, a backward elimination process was utilized to ensure remaining variables were risk factors associated with the development of POI following primary THA that were statistically significant.[17–22] Welch's *t*-test were used to compare mean ECI and in-hospital LOS between the cohorts. Due to the large number of comparisons being performed within the study, a Bonferroni-adjusted correction was performed to reduce the probability of a type I error. Thus, a *p*-value less than 0.001 was considered statistically significant.

Results

The study identified 335 (0.03%) patients developing POI during the study time interval, out of 1,108,499 patients undergoing primary THA. In-hospital LOS between study group patients was significantly longer compared with controls (5- vs. 3 days, $p < 0.0001$). Linear regression analysis demonstrated mean in-hospital LOS of patients developing POI increased 1.96 days during the study interval ($p < 0.0001$).

Study group patients developing POI were generally older than the age of 75 and of male sex (60.90 vs. 38.70%). With respect to medical comorbidities, the study found POI patients had significantly higher weighted mean ECI scores (8 vs. 6, $p < 0.0001$) compared with controls (►**Table 1**). Study group patients were found to have a higher prevalence of hypertension (91.94 vs. 85.14%, $p = 0.0006$), electrolyte and fluid imbalance (74.33 vs. 46.51%, $p < 0.0001$), IDA (67.16 vs. 51.04%, $p < 0.0001$), arrhythmias (50.45 vs. 37.24%, $p < 0.0001$), and other medical comorbidities (►**Table 1**).

Multivariate binomial logistic regression analysis demonstrated that the following were the greatest risk factors associated with developing POI following primary THA: male sex (OR: 2.86, 95% CI: 2.26–3.63, $p < 0.0001$), electrolyte and fluid imbalance (OR: 3.06, 95% CI: 2.34–4.06,

Table 1 Prevalence of comorbidities based on the ECI among patients developing and not developing postoperative ileus following primary total hip arthroplasty

Demographics	Ileus		Control		*p*-Value
	n	%	*n*	%	
Total	335	0.03%	1,108,164	99.97%	
Age (years)					< 0.0001
< 64	33	9.85	112,938	10.19	
65–69	70	20.90	278,462	25.13	
70–74	68	20.30	243,877	22.01	
75–79	75	22.39	218,461	19.71	
80–84	58	17.31	158,231	14.28	
85+	31	9.25	96,195	8.68	
Sex					< 0.0001
Female	131	39.10	679,349	61.30	
Male	204	60.90	428,815	38.70	
Comorbidities					
AIDS	[a]	N/A	4,086	0.37	0.811
Alcohol use disorder	21	6.27	53,155	4.80	0.257
Arrhythmias	169	50.45	412,682	37.24	< 0.0001
Blood loss anemia	26	7.76	84,091	7.59	0.987
Congestive heart failure	96	28.66	249,138	22.48	0.006
Coagulopathies	64	19.10	154,988	13.99	0.008
Depression	99	29.55	296,783	26.78	0.278
Diabetes mellitus	136	40.60	345,459	31.17	0.0002
Drug use	16	4.78	39,087	3.53	0.275
Electrolyte/fluid imbalance	249	74.33	515,396	46.51	< 0.0001
Hypertension	308	91.94	943,436	85.14	0.0006
Hypothyroidism	99	29.55	334,648	30.20	0.843
Iron deficiency anemia	225	67.16	565,594	51.04	< 0.0001
Liver failure	33	9.85	62,668	5.66	0.001
Metastatic cancer	12	3.58	54,273	4.90	0.322
Neurological	35	10.45	114,660	10.35	1
Obesity	64	19.36	90,758	8.19	< 0.0001
Psychoses	39	11.64	120,764	10.90	0.726
Peptic ulcer disease	36	10.75	83,535	7.54	0.033
Pulmonary circulatory disorders	35	10.45	90,290	8.15	0.153
Pulmonary disease	138	41.19	401,940	36.27	0.069
Peripheral vascular disease	116	34.63	278,822	25.16	< 0.0001
Renal failure	24	7.16	56,152	5.07	0.104
Rheumatoid arthritis	60	17.91	157,576	14.22	0.063
Tumor	117	34.93	343,969	31.04	0.139
Valvular disorders	100	29.85	255,845	23.09	0.004
Weight loss	61	18.21	85,098	7.68	< 0.0001
ECI score	8		6		< 0.0001

Abbreviations: AIDS, acquired immunodeficiency syndrome; ECI, Elixhauser comorbidity index; N/A, nonapplicable.
[a]less than 11 patients.

Table 2 Multivariate logistic regression analysis on risk factors associated with developing postoperative ileus following primary total hip arthroplasty

Variable	OR	95% CI	*p*-Value
Sex			
Male	2.86	2.26–3.63	< 0.0001
Comorbidities			
Electrolyte/fluid imbalance	3.06	2.34–4.06	< 0.0001
Body mass index 30–39 kg/m^2	1.89	1.39–2.53	< 0.0001
Pathologic weight loss	1.83	1.35–2.45	< 0.0001
Iron deficiency anemia	1.46	1.14–1.89	0.0001

Abbreviations: CI, confidence interval; OR, odds ratio.

$p < 0.0001$), obesity (OR: 1.89, 95% CI: 1.39–2.53, $p < 0.0001$), pathologic weight loss (OR: 1.83, 95% CI: 1.35–2.45, $p < 0.0001$), and IDA (OR: 1.46, 95% CI: 1.14–1.89, $p = 0.0001$) (►**Table 2**). The regression analysis also found patients with AIDS (OR: 1.05, $p = 0.945$), arrhythmias (OR: 1.16, $p = 0.201$), depression (OR: 1.05, $p = 0.705$), peptic ulcer disease (OR: 1.09, $p = 0.631$), and peripheral vascular disease (OR: 1.11, $p = 0.383$) had increased odds of POI, but these variables did not reach statistical significance.

Discussion

As the incidence of primary THA continues to increase worldwide, identifying patient-related risk factors associated with worse outcomes and increasing the costs of care are pivotal.[8] Studies investigating the impact of POI following primary THA have been limited to small sample sizes with questionable power, not thoroughly investigating risk factors by looking at multiple comorbid conditions, or the results of the study were not generalizable to patients undergoing primary THA within the United States. As such, we decided to investigate risk factors of POI in a large well-powered study by comparing patient demographics, in-hospital LOS, and identifying risk-factors associated with the condition following primary THA. Our study demonstrated patients developing POI were significantly different with respect to patient demographics of age, sex, and prevalence of medical comorbidities. Additionally, we found male sex, having electrolyte/fluid imbalance, being obese, having pathologic weight loss, or IDA were the greatest risk factors for developing POI within 3 days following primary THA.

The results of our study coincide with the results of other published studies in the literature in both adult reconstruction and other orthopaedic subspecialties. We found patients who developed POI had significantly longer in-hospital LOS. Utilizing their institution's own database, Parvizi et al found patients who developed POI after TJA had nearly twice as long of in-hospital LOS compared with controls (6.5 vs. 3.4 days, $p = 0.001$).[8] These results were also similar to those by Bederman et al who found POI patients undergoing primary TJA had an in-hospital LOS of 4.6 days ($p < 0.0001$), which was significantly longer compared with patients not developing POI.[9] With respect to other orthopaedic subspecialties and the influence of POI and in-hospital LOS, Fineberg et al utilized the Nationwide Inpatient Sample (NIS) database and demonstrated patients developing ileus following either anterior (6.1 vs. 3.8 days, $p < 0.001$), posterior (6.9 vs. 4.1 days, $p < 0.001$), or circumferential lumbar fusion (7.3 vs. 4.9 days, $p < 0.001$) had significantly longer in-hospital LOS.[7]

In addition to the prolonged in-hospital LOS, we found the greatest risk factors for developing POI were male sex (OR: 2.86), electrolyte/fluid imbalance (OR: 3.06), and body mass index (BMI) greater than 30 kg/m^2 (OR: 1.89). These risk factors align with findings from a retrospective study from 1988 to 1997 by Bederman et al who analyzed 21,589 patients undergoing primary TJA and found the incidence of POI to be 0.32%, with 46% of patients having POI lasting greater than 3 days.[9] The study found male patients had nearly fivefold increased risk of developing POI following primary TJA. Parvizi et al analyzed their own institution's database of patients undergoing primary TJA and found the incidence of POI to be greater than our study (0.7%) and demonstrated that the greatest risk factors associated with POI in their population were also male sex ($p < 0.005$) and older patients ($p = 0.035$), with majority of the patients developing POI approximately 2.5 days following the index procedure.[8] The decreased incidence of POI in our study can be attributed to several factors such as different patient populations, varying postoperative management, and decreased identification of POI. Our results are also shared with other orthopaedic subspecialties. In another level III case–control study utilizing the NIS database, Fineberg et al found the greatest risk factors for POI following spine surgery were weight loss (OR: 3.1), electrolyte/fluid imbalance (OR: 3.1), male sex (OR: 1.9), and IDA (OR: 1.7).[7] While these studies coincide with similar results to our study, major limitations to these studies include not stratifying the results between THA or TKA or using a comprehensive list of patient-related risk factors to identify the association between comorbid conditions and developing POI.[23]

In addition to male sex, we found electrolyte/fluid imbalance and obesity increased the risk of POI. Wang et al found electrolyte/fluid imbalance to be a large contributor to POI in patients undergoing surgery within their institution.[24] When stratifying the prevalence of electrolyte abnormalities in patients developing POI, Wang et al found hypokalemia

was the leading electrolyte abnormality associated with developing POI (33.3%), followed by hypocalcemia (31.4%), and lastly hyponatremia (15.7%).[24] Furthermore, our study showed obesity increased the risk of developing POI following primary THA. Recent studies have shown patients with increased central adiposity are more prone to developing intestinal motility problems as the visceral adipose predisposes improper intestinal contraction.[25] While the literature of obesity and POI following orthopaedic procedures is limited, these results do coincide with other surgical subspecialties. In their analysis of 283 patients undergoing radical cystectomy, Svatek et al found patients with a BMI greater than 30 kg/m^2 to be a significant risk factor for POI in their study population.[26] These results also coincide with Parker et al who found the incidence of POI to be 15% in patients who were obese compared with normal BMI patients who underwent a laparoscopic surgical procedure.[27] These studies could corroborate the claim that electrolyte abnormalities and obesity are risk factors associated with the development of POI following primary THA. Given that POI is associated with significantly longer hospital stays, it is critical to adopt methods of reducing POI in these high-risk individuals.

Ways of reducing POI and augmented quality improvement for patients can include administering laxatives, reducing the number of narcotics provided to patients postoperatively, recommending earlier ambulation, or a simple cost-effective way can be to provide chewing gum.[28–31] In their prospective randomized control trial, Topcu and Oztekin showed chewing gum up to three times per day led to quicker defecation times and significantly shorter in-hospital LOS compared with their counterparts.[29] These results were also reproducible in another randomized control trial by Liu et al who showed chewing gum to be associated with a significantly lower odds of developing POI (OR: 0.41, 95% CI: 0.23–0.73, $p = 0.003$).[28]

The current study is not without limitations, most of which are inherent through the use of a large administrative database. Since age and BMI are provided from the database as categorical variables, we were unable to ascertain a proper understanding of the demographic profiles of the cohorts. Additionally, since our study utilized ICD-9 and CPT coding, the study is reliant on accurate diagnostic and procedural coding, and it is currently estimated that there are up to 1.3% of coding errors within the Medicare administrative database.[32] Furthermore, while we compared demographic profiles of patients with various comorbid conditions, we were unable to determine the duration or severity of these conditions, which could potentially impact the results of our study. The PearlDiver database is also limited to the data provided. Furthermore, while our study found electrolyte/fluid imbalance and IDA as risk factors associated with the development of POI following primary THA, we were unable to ascertain laboratory markers and values associated with developing POI; but this can certainly be used as the basis for future studies. To the best of our knowledge, this is the first study to investigate POI by comparing in-hospital LOS, patient demographics, and identifying patient-related risk factors exclusive in patients undergoing primary THA.

Our study aimed at comparing in-hospital LOS, patient demographics, and identifying patient-related risk factors for the development of POI following primary THA. We found longer in-hospital LOS, differences in baseline patient demographics, and patient-related risk factors associated with developing POI, most notably male sex, electrolyte/fluid imbalance, and BMI greater than 30 kg/m^2. This study can be used by orthopaedic surgeons to identify high-risk patients and adequately educate them of this potential complication that may occur following their procedure, which may extend their LOS. This has a negative impact on patient well-being and impacts cost of care as well, rendering it a complication that needs to be addressed and further studied. To further investigate these risk factors, large prospective studies would be necessary to conclude a causal relationship between specific patient-related risk factors and the development of POI.

Conflict of Interest
None declared.

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