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ORIGINAL ARTICLE

Risk factors for ileus after hip and knee arthroplasty

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Abstract

Purpose Postoperative ileus (POI) is one of the complications that can occur after every surgical procedure including arthroplasty. It can have detrimental consequences for the patient and portrays an economic burden on health care systems. The risk factors for POI after arthroplasty described in the literature are scarce and include hip arthroplasty, male gender and previous abdominal surgery. The purpose of the study was to determine the risk factors for POI after hip and knee arthroplasty.

Methods A retrospective review of 2760 patients undergoing primary hip and knee arthroplasty was performed. An in-depth analysis of patient history and physical operative and postoperative course was reviewed and statistically analyzed in a univariate and multivariate setting.

Results Overall incidence of POI was 0.54%. History of myocardial infarction and chronic kidney disease were statistically significant risk factors for developing POI after arthroplasty with values of $p = 0.023$ and $p = 0.004$, respectively. Other risk factors included previous abdominal surgery ($p < 0.001$) and hip arthroplasty ($p = 0.026$). Age or gender correlations were not observed.

Conclusions Although postoperative ileus is an uncommon complication after joint arthroplasty, in addition to the known risk factors of male age, hip arthroplasty, and previous abdominal surgery, this study describes two previously unknown risk factors: chronic kidney disease and history of myocardial infarction. Patients with these risk factors should be monitored closely for developing postoperative ileus.

Keywords Ileus · Complications · Arthroplasty · Myocardial infarction · Chronic kidney disease

Introduction

Total joint arthroplasty (TJA) is the standard therapy for advanced osteoarthritis of both the hip and the knee. These operations are very successful [1, 2] even though complications do occur [3].

Postoperative ileus (POI) is one of the complications that can occur after every surgical procedure [4] and even though it is more common after abdominal surgery [5], it also occurs after joint arthroplasty with a reported incidence between 0.3% and 4% [6–10].

Ileus is defined as an accumulation of gas and secretion that results from a hypomotility of the gastrointestinal tract [11]. The complications of POI can have detrimental effects, causing an additional adverse effect in 60% of patients [12] and can cause mortality in 1% of patients [12]. POI has also been reported as the most common reason for readmission after TJA [13]. It poses a very significant economic burden on the health care system [14]. Development of POI during hospital stay can double the cost of the in-hospital treatment [15] and the costs of readmission due to POI can be as high as 15-fold compared to the original treatment [13]. Due to an increasing trend towards fast-track surgery [16] and arthroplasty [17] it will be essential to define all of the risk factors for POI.

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Even though treatment options exist [18], there is still controversy regarding risk factors for POI after joint arthroplasty due to the paucity of literature to date. One study found older age, male sex, hip arthroplasty, and prior history of abdominal surgery to be associated with a higher risk of POI [7]. A previous study, however, described younger, male patients in the postoperative period, and especially patients undergoing bilateral total knee arthroplasty (TKA) to be at higher risk for developing POI after TJA [6].

The purpose of this study was to identify risk factors for POI after primary TJA using detailed patients' medical history and operative data.

Material and methods

Study design

A consecutive series of 2760 patients who underwent primary total knee or total hip arthroplasty at the first author's primary affiliation from January 2010 to December 2014 were included in the study and retrospectively reviewed. Extensive medical history, in-hospital stay as well as postoperative phase have been reviewed for each patient. Postoperative ileus was the only dependent variable. Our institutions' ethics board reviewed the study and approved it. Ethical approval was received prior to commencement of the data collection (F2015/010).

Postoperative ileus diagnosis criteria and classification system

Postoperative ileus was defined as ≥ 2 of the 5 following criteria [19]: nausea or vomiting over the preceding 12 h; inability to tolerate a solid or semisolid oral diet over the preceding two mealtimes; abdominal distension; absence of flatus and stool over the preceding 24 h; and radiological evidence of ileus on abdominal plain film or CT over the preceding 24 h. Patients fulfilling any two criteria except the CT criteria were presented to an abdominal surgeon on call who evaluated the X-rays, ordered a CT scan, if deemed necessary, and set the treatment plan for the patient. In case surgery was necessary, the patients were transferred to the abdominal surgery department, based on the abdominal surgeon's assessment. Reassessments by the department of abdominal surgery were undertaken daily.

The severity of POI was classified according to the classification proposed by Venara et al. [20]: Grade A – no consequence of POI apart from an increase in the length of stay; Grade B – need for symptomatic measures or diagnostic examinations (medical treatment); Grade C – need for nasogastric tube intake or hospital re-admission after discharge; Grade D: severe consequences of POI; D1 – general complications, D2 – need for intensive care unit or further surgery; Grade E – death.

Preoperative phase—demographic and medical history data

The surgeons' and the anesthesiologists' assessments were performed separately. The notes of both of these physicians are in digital form and have been reviewed for all of the patients. The collected and assessed patient data can be found in Table 1. All surgeries were performed in a teaching hospital by or with one of the senior surgeons. Body mass index (BMI) was calculated using the height and weight. Arterial hypertension was defined as systemic hypertension needing medical treatment [21]. Use of all anticoagulants was documented, regardless of the medication type or indication [22]. History of myocardial infarction was defined as a medical report in the patient's history stating a ST or non-ST elevating infarction, regardless of coronary angioplasty [23]. Coronary artery disease (CAD) was deemed positive if the patient was being treated according to the guidelines [24]. Diabetes was defined as chronic hyperglycemia needing treatment [25]. Patients' estimated glomerular filtration rate (eGFR) was calculated using the Cockroft-Gault formula [26] and was diagnosed as chronic kidney disease (CKD) if eGFR was < 90 [27]. The American Association of Anesthesiologists' (ASA) score was determined by the preoperative anesthesiologist.

Operative phase—anesthesiological and surgical data

Prophylaxis for infection (cefazolin 1.5 g) was administered 30 min prior to the incision. Both total anesthesia as well as regional anesthesia has been used. Total anesthesia was routinely performed using weight-adjusted doses of propofol, remifentanyl, and rocuronium. Regional anesthesia was routinely performed using bupivacaine. A number of patients received an adductor canal catheter which was removed at day 2. The type of anesthesia was recorded.

Surgery was performed with the patient in supine position. Hip arthroplasty utilized an anterolateral approach or a direct anterior approach and knee arthroplasty was performed using medial parapatellar arthrotomy. Tourniquet was used only for cementing in knee arthroplasty. Drainages were routinely used and removed after 48 h. Surgical time was recorded for each patient and subsequently analyzed. Bilateral arthroplasty was not performed in our institution. The collected data from the operative phase is shown in Table 1.

Postoperative protocols

Thromboembolism prophylaxis (enoxaparine 40 mg for 6 weeks) was administered for all the patients according to our standard protocol unless contraindicated in which case it

Table 1 Data collected

Parameter	No of cases/mean ± standard deviation [min, max]
Preoperative phase	
Age at surgery	69.5 ± 9.8 [23, 94] years
Gender Female	1672
Male	1088
BMI	28.8 ± 5.3 [15.9, 63.6]
Previous arthroplasty	565
Previous abdominal surgery	127
Arterial hypertension	1936
Anticoagulants	630
History of myocardial infarction	167
Chronic coronary heart disease	507
Diabetes I and II	421
Chronic kidney disease	498
ASA I	170
ASA II	1812
ASA III	771
ASA IV	7
Operative phase	
Total hip arthroplasty	1418
Total knee arthroplasty	1342
General anesthesia	1003
Regional/spinal anesthesia	1757
Surgery time	63.06 ± 18.40 [25, 150]
Total cases	2760

BMI body mass index, *ASA* American Society of Anesthesiologists' score

was replaced according to the guideline for that particular condition.

Routine analgesia was performed using three daily doses of 400 mg ibuprofen and two daily doses of a combination of 10 mg oxycodone/5 mg naloxone, administered orally. Supplemental analgesia was provided if necessary using an increased dose of 20 mg oxycodone/10 mg naloxone (20 mg twice daily) and additionally with 10 mg morphium up to twice daily. Patients with diagnosed CKD were given celecoxib 200 mg twice daily. Patient-controlled analgesia is not used in our institution.

Patients were seen by a physical therapist on the day of surgery (if operation was in the morning) or on postoperative day and the first mobilization occurred at that time. Drainages were removed after 48 h. The knee arthroplasty patients were placed in a continuous passive motion machine on the first day and were encouraged to remain in the continuous passive motion machine as much as possible throughout their stay in the hospital. Patients were evaluated by the physical therapist for their potential for stair climbing on postoperative day 3. Patients were sent home or to a skilled facility depending on their ambulation status and home circumstances.

Statistical analysis

Univariate and multivariate logistic regression analyses were used to determine factors that influence POI. These included preoperative factors (age at surgery, gender, BMI, previous arthroplasty, previous abdominal surgery, arterial hypertension, anticoagulants, history of myocardial infarction, coronary artery disease, diabetes, chronic kidney disease, ASA score) and surgery-related factors (operated joint, surgical time, and anesthesia type). For the model development, a univariate analysis was carried out first. Normality tests were performed before using parametric tests. The chi-square test was used to compare the variable of interest for qualitative parameters and Student's t test for quantitative parameters. All variables that had a significant relationship in the univariate analysis were then included in the multivariate analysis. A multiple binomial logistic regression analysis was performed to identify significant independent predictors of POI that could be either continuous or categorical. The dependent variable was the occurrence of POI. Odds ratios (OR) and the corresponding 95% confidence intervals for each of these independent variables and their impact on POI were determined. The model variance was assessed using the Nagelkerke R^2. Finally, a correlation analysis using Pearson or Spearman correlation between the statistically significant risk factors of POI and all other factors was performed. Statistical tests were carried out with SPSS Statistics software (version 24, SPSS Inc., Chicago, IL, USA). The significance threshold was set at < 0.05.

Results

Occurrence of postoperative ileus

A total of 15 patients were diagnosed with POI, giving an incidence of 0.54%. Ileus occurred on average 3.7 days after primary surgery (range 0–7). According to the classification, 7 patients were grade C and 8 patients underwent surgical treatment, grade D2. Conservative treatment of POI included lactulose, metoclopramide, and in some instances an enema. Patients treated conservatively were routinely treated with a nasogastric tube, putting all conservatively treated patients at grade C. None of the patients primarily treated conservatively (grades A–C) needed surgery (grade D2). Grade E, death, was not observed in this cohort.

Factor analysis

Results of the two-step regression analysis are shown in Table 2. At the univariate analysis, there were four statistically significant factors for development of POI: previous abdominal surgery ($p < 0.001$), history of myocardial infarction ($p =$

Table 2 Results of statistical analysis

Parameter	univariate analysis *p* value	Multivariate analysis *p* value	OR (95%CI)
Preoperative phase			
Age at surgery	0.085		
Gender	0.963		
BMI	0.551		
Previous arthroplasty	0.551		
Previous abdominal surgery	< 0.001*	< 0.001*	13.3 (4.6–38.7)
Arterial hypertension	0.161		
Anticoagulants	0.112		
History of myocardial infarction	0.023*	0.070	3.4 (0.9–12.9)
Chronic coronary heart disease	0.168		
Diabetes I and II	0.354		
Chronic kidney disease	0.004*	0.014*	3.7 (1.3–10.7)
ASA	0.210		
Operative phase			
Total hip/knee arthroplasty	0.026*	0.040*	0.3 (0.1–0.9)
Type of anesthesia	0.633		
Surgery time	0.923		

BMI body mass index, *ASA* American Society of Anesthesiologists' score

0.023), chronic kidney disease ($p = 0.004$), and hip arthroplasty ($p = 0.026$). All other factors showed no statistical significance at first step regression (Table 2). The multivariate analysis reduced the statistical significance of history of myocardial infarction ($p = 0.07$) within the predictive model. The Nagelkerke R^2 for the predictive model was 0.172.

Table 3 shows the correlation analysis of all of the factors analyzed with the statistically significant factors.

Discussion

This study shows a correlation of previous abdominal surgery, history of myocardial infarction, chronic kidney disease and hip arthroplasty to the development of postoperative ileus after joint arthroplasty. The surgeon should be aware of the correlation and monitor these patients more closely for developing postoperative ileus.

Not many studies have researched the risk factors for POI specifically after joint arthroplasty and these studies report conflicting results. Bederman et al. reported that younger, male patients, and bilateral TKAs are risk factors for POI [6]. A study by Parvizi et al. [7] found older age, male sex, hip arthroplasty, and prior history of abdominal surgery were risk factors for POI after arthroplasty. Our findings confirm the risk factors described in the latter study, but the gender and age correlation were not

Table 3 Results of the correlation coefficient analysis of statistically significant preoperative and operative factors to all other factors

		Ileus	Previous abdominal surgery	History of myocardial infarction	Chronic kidney disease	Operated joint	BMI	Age at surgery	Gender	Arterial hypertension	Anticoagulants	Chronic coronary heart disease	Diabetes	ASA
Ileus	*R*	1	.124**	.043*	.055**	−.042*	−.011	.033	.001	.027	.030	.003	−.018	.024
	p													
Previous abdominal surgery	*R*	.124**	1	.009	.012	−.033	.097**	−.040*	.067**	.006	.010	.019	.016	.020
	p													
History of myocardial infarction	*R*	.043*	.009	1	.106**	.009	−.009	.094**	.112**	.166**	.380**	.433**	.028	.254**
	p													
Chronic kidney disease	*R*	.055*	.012	.106**	1	.026	.060**	.239**	−.020	.222**	.171**	.252**	.089**	.237**
	p													
Operated joint	*R*	−.042*	−.033	.009	.026	1	.188**	.062**	−.062**	.049*	.017	−.037	.059**	.044*
	p													

BMI body mass index, *ASA* American Society of Anesthesiologists' score

**Correlation is significant at the 0.01 level (2-tailed)

*Correlation is significant at the 0.05 level (2-tailed)

observed. In fact, previous abdominal surgery had a stronger predictive value within the model than all other factors combined. A clear trend is difficult to establish based on only three studies with different cohorts, bilateral procedures and not all studies examining exactly the same risk factors.

Contradictory to these findings, prior history of abdominal surgery has been reported as a protective factor after spinal surgery. Al Maaieh et al. [28] investigated risk factors for POI after lateral lumbar interbody fusion in 596 patients. They found a higher incidence of POI at 7%. None of the risk factors observed in this or other studies for POI in arthroplasty were observed in that study. The most controversial finding was that previous abdominal surgery was a protective factor. The authors do not provide an explanation of this phenomenon. Firstly, this procedure is performed in a prone position of the patient, has a longer average time and most importantly, has a demographically different cohort. Controlling for the confounding factors would in our opinion change the results of this study. An analysis of multiple approaches in spinal surgery, performed by Fineberg et al. [29], did not observe this phenomenon.

The correlation with hip arthroplasty has been described to be a risk factor due to the vicinity of the operated joint to the abdomen, the pressure of the limb on the bowel during the surgical procedure, and the leaning of the assistant on the abdomen during hip arthroplasty [7]. Bederman [6] reports an incidence of 0.32% for hips and knees, without a difference between procedures, whereas Parvizi reports an incidence of 0.7%, with a stronger correlation for hips. A study on bilateral TKAs reports an incidence of POI at 0.5% [30] and since Bederman only reports a higher incidence in bilateral TKAs [6], we believe that total hip arthroplasty is a stronger factor for developing POI..

The mechanisms in which chronic kidney disease decreases bowel motility are complex and have not been elucidated completely [31]. One of the mechanisms described is that uremic retention forms a uremic disbalance in the intestine to favor uremic bacteria that are not protective for the flora [32]. In this setting, the bacteria can move to other parts of the intestine [33]. This all leads to a loss of the protective barrier [32]. A recent study suggests that chronic kidney disease triggers an inflammation response with increased concentrations of tumor necrosis factor (TNF)-α, interleukin (IL)-6, and IL-10 in the ileum tissue [31].

The second risk factor found in this study, history of myocardial infarction, has to be observed in the larger setting of the known correlation of CAD and intestine. Patients with CAD have a systemic inflammatory response [34]. Wall thickness occurs as well as change in the bacterial flora [35]. Similarly to the patients with CKD, bacterial migration occurs in CAD, which emphasizes the systemic inflammation [36]. The disbalance in floral bacteria has been observed in these patients as well [37]. All of this suggests similar mechanisms in both of these risk factors. However, patients with CAD were not at risk of developing ileus in this study, only patients with history of myocardial infarction were. Myocardial infarction is the second worst complication of CAD behind death [24], suggesting that these patients' compensatory mechanisms are weaker compared to CAD patients without a history of myocardial infarction.

With ileus being a very rare complication after arthroplasty, these results have to be kept in the perspective of risk of ileus after arthroplasty. A recent study of risk factors for POI after colorectal resection, where incidence is 15.9%, found only male sex to have a higher correlation with POI [38]. Although uncommon, orthopedic surgeons have to be aware of this complication and carefully screen patients for risk factors, especially in the context of fast-track surgery. In practice, we recommend informing these patients before the surgery to educate them on this rare issue.

There are a few limitations that need to be stated. The opioid use was not controlled for in detail but was limited to orally administered oxycodone twice daily and morphine if the level 1 therapy was not sufficient. However, the amount of narcotic used has been shown not to have a correlation to development of POI after joint arthroplasty [6]. On the contrary, narcotics misuse preoperatively is associated other with risks after orthopedic surgery [39]. Our predictive model has an R^2 value of 0.172, which cannot be classified as strong. The multimodality of risk factors for POI after joint arthroplasty limits the development of a model with a stronger predictive value. Finally, as Venara et al. state in the limitations of their classification of POI [20], the management of POI is very subjective. In our instance, the abdominal surgeons in the department had routinely placed a nasogastric tube in all patients, making them grade C, where one has to assume that some could have been treated only with medication. POI prevention measures, such as the use of a nasointestinal tube [40] and nicotine gum [41] were not being utilized at the time of the data collection of this study. It remains unclear if implementing these measures in risk patients after TJA would have affected the incidence of POI.

Conclusion

Although postoperative ileus is an uncommon complication after joint arthroplasty, in addition to the known risk factors of male age, hip arthroplasty, and previous abdominal surgery, this study describes two previously unknown risk factors, chronic kidney disease, and history of myocardial infarction. Patients with these risk factors should be monitored closely for developing postoperative ileus.

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Author contributions AK conceived the study and did the data collection. AK, FA, and GM drafted the manuscript. AK and TN performed the statistical analysis. PD revised the manuscript. TH and TN supervised the study and did the final revision of the manuscript. All authors read and approved the final manuscript.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

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