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Risk factors for urinary retention after laparoscopic inguinal hernia repairs

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Abstract
Background Postoperative urinary retention (POUR) is a common entity following surgery, particularly after laparoscopic inguinal hernia repair. Here the intent is to investigate the incidence of POUR in all comers at a single institution following laparoscopic inguinal hernia repair.
Methods A retrospective chart review of all patients who underwent laparoscopic hernia repair at our institution from January 2010 through December 2013 was performed. POUR was defined as the inability to spontaneously urinate following surgery, requiring straight catheterization or placement of a Foley catheter. Perioperative data including narcotic use, operative time, type of mesh, and intraoperative fluid use were also recorded for each patient.
Results A total of 346 patients underwent laparoscopic inguinal hernia repair in the specified time period, 340 patients were included in this study. The incidence of POUR after laparoscopic inguinal hernia repair at our institution was 8.2 % ($n = 28$) with the most common presentation of POUR being failure to void ($n = 23$). Postoperative narcotic use of 6.5 mg or greater of morphine or morphine equivalent was associated with higher risk of POUR via ROC analysis (OR 2.5, 95 % CI 1.2–5.6, $p = 0.025$). In univariate analysis, age greater than 50 years was also a risk factor for developing POUR (OR 2.8, 95 % CI 1.2–6.4, $p = 0.02$). Factors not found to be significant included intraoperative IV fluids, history of BPH, unilateral versus bilateral repair, and preoperative void time in relation to surgery start.
Conclusions Minimizing postoperative narcotic medications may reduce the risk of developing POUR after laparoscopic inguinal hernia repairs. If possible surgeons should consider non-steroidal anti-inflammatory drugs, acetaminophen, or regional anesthetic blocks to minimize postoperative narcotic requirements.

Keyword Hernia · Laparoscopy · Urinary retention

Postoperative urinary retention (POUR) is a well-known complication after procedures in many different surgical disciplines [1]. In general surgery, the incidence of POUR is low among those who undergo open inguinal hernia repairs, ranging between 0.4 and 3 % [2]. However, the incidence of POUR after laparoscopic inguinal hernia repairs is higher, ranging between 1 and 22 % [3, 4]. Patients diagnosed with POUR require urethral catheterization for decompression and relief, which causes significant discomfort, increased risk for urethral trauma, catheter-related infections, and detrusor muscle damage, as well as increased healthcare costs [5]. Risk factors associated with POUR after laparoscopic inguinal hernia

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repairs have been studied but with mixed results. Risk factors considered include advanced age, history of benign prostatic hypertrophy (BPH), long operating room times, and high intraoperative intravenous fluid (IVF) administration [3, 6, 7]. One risk factor that has not been evaluated is the effect of postoperative narcotic use after inguinal hernia repair on POUR. The aim of this study was to report the incidence of POUR at our institution as well as to determine if the total postoperative narcotic use and other risk factors are associated with POUR after laparoscopic inguinal hernia repair.

Materials and methods

An IRB approved retrospective chart review was conducted involving all patients, 18 years of age and above, who underwent a laparoscopic inguinal hernia repair between January 2010 and December 2013. The procedures were performed by 16 board-certified surgeons at the Walter Reed National Military Medical Center (WRNMMC), Bethesda, Maryland. Mesh type and the quantity and positioning of tacks, if used, were at the discretion of the attending surgeon performing the hernia repair. Totally extraperitoneal (TEP) and transabdominal preperitoneal (TAPP) hernia repairs were not separated as the records did not consistently discern between these two types of laparoscopic inguinal hernia repair techniques.

Postoperative urinary retention was defined as the inability to spontaneously void, requiring in-and-out straight urethral catheterization or Foley catheter placement. At our institution, each patient was required to void within 8 h of completion of surgery. Symptoms of urinary retention prior this time limit, including palpable bladder, urgency, and suprapubic pain prompted further evaluation by bladder scan or direct intervention by catheterization. In all cases, it was a physician authorized decision to intervene, and the choice between in-and-out and Foley catheter placement was determined on an individual basis. All patients were required to void spontaneously prior to discharge, or they were discharged with the urethral catheter and close follow-up with a urologist. Demographic data including age, gender, and pertinent past medical history such as BPH were collected in concordance with the IRB protocol. Perioperative data including laterality, mesh type, preoperative void, operative time, intraoperative Foley catheter placement, and intraoperative fluid use were collected from the electronic medical record. At our institution, preoperative void was defined as a voiding within 30 min of entering the operating room as recorded by the operating room nursing staff. Finally, postoperative narcotic use was recorded by specific narcotic type, including fentanyl, hydromorphone, and morphine. Data regarding pre-catheterization bladder scans were not included in this report due to the inconsistent reporting of this information in the electronic medical record. To standardize the postoperative intravenous narcotics given during recovery, the intravenous morphine equivalence for each patient was calculated using the Hopkins Opioid Program algorithm [8].

Continuous data are presented as the median and interquartile range (IQR) and are compared between groups using the Wilcoxon rank sum test. Categorical data are presented as counts with proportions and compared between groups using Fisher's exact test. For the examination of the effect of BPH, only men were included in the analysis. Receiver operating characteristic (ROC) analysis was used to determine the threshold for postoperative narcotic use that was most highly associated with POUR: The threshold was chosen based on the level of narcotic use that maximized the Youden index. Multivariate analysis of factors associated with POUR was examined using logistic regression: The model was generated using the purposeful selection algorithm recommended by Hosmer and Lemeshow, and initially included those variables that had a p value <0.25 in the univariate analysis [9]. Variables with a p value <0.05 were retained in the final model. Odds ratios (OR) are presented together with the 95 % confidence interval (95 % CI) for the OR. Data were examined using IBM/SPSS Statistics (version 21, IBM/SPSS, Chicago, IL).

Results

Of the 346 patients who underwent a laparoscopic inguinal hernia repair, 340 patients were included. Patients who left the operating room with a urinary catheter ($n = 4$) and those with conversion to the open procedure ($n = 2$) were excluded. All patients received general anesthesia. Fifty-five percent of the patients were younger than 51 years, and 93 % of the cohort was male. Of the men, there were 29 reports (9.2 %) of a past medical history of BPH. Table 1 presents demographic information and clinical characteristics.

The incidence of POUR after laparoscopic inguinal hernia repair at our institution was 8.2 % ($n = 28$). The most common indication for urethral catheterization was failure to void within 8 h ($n = 23$). The remaining patients had complaints of a palpable bladder, urgency, and pubic pain. The median amount of urine collected on postoperative catheterization was 550 mL. Twenty-one patients received a straight catheterization, 6 patients received a Foley catheter, and 1 patient underwent in-and-out straight catheterization followed by Foley catheter placement after failing to void after two voiding trials.

In univariate analysis, age greater than 50 years was a risk factor for developing POUR (OR 2.8, 95 % CI 1.2–6.4,

Table 1 Demographic and clinical characteristics

	All subjects (*n*, %) $n = 340$	POUR (*n*, %) $n = 28$	No POUR (*n*, %) $n = 312$	*p* value
Age category				
18–50 years	187 (55)	9 (32)	178 (57)	0.02
51+ years	153 (45)	19 (68)	134 (43)	
Gender				
Male	315 (93)	25 (89)	290 (93)	0.45
Female	25 (7)	3 (11)	22 (7)	
Benign prostatic hypertrophy				
Yes	29 (9)	4 (16)	25 (9)	0.27
No	286 (91)	21 (84)	265 (91)	
Laterality				
Unilateral	179 (53)	10 (36)	169 (54)	0.08
Bilateral	161 (47)	18 (64)	143 (46)	
Mesh type				
Polyester	198 (59)	13 (46)	185 (60)	0.17
Polypropylene	138 (41)	15 (54)	123 (40)	
Preoperative void				
Yes	158 (49)	15 (63)	143 (48)	0.21
No	164 (51)	9 (37)	155 (52)	
Intraoperative foley				
Present	127 (37)	11 (39)	116 (37)	0.84
Absent	213 (63)	17 (61)	196 (63)	
Operative time (min)				
Median (IQR)	90 (65–117)	93 (67–120)	90 (65–116)	0.73
Intraoperative fluids (mL)				
Median (IQR)	1,100 (900–1,500)	1,000 (850–1,700)	1,100 (925–1,500)	0.79
Intraoperative fluids <1,000 mL				
<1,000 mL	87 (26)	8 (29)	79 (25)	0.66
1,000 + mL	253 (74)	20 (71)	233 (75)	
Narcotic use				
Total postoperative hydromorphone (mg)				
Median (IQR)	0 (0–0.4)	0.2 (0–1.0)	0 (0–0.4)	0.03
Postoperative hydromorphone use				
Yes	129 (38)	14 (50)	115 (37)	0.22
No	211 (62)	14 (50)	197 (63)	
Total postoperative fentanyl (mg)				
Median (IQR)	25 (0–75)	50 (0–100)	25 (0–75)	0.25
Postoperative fentanyl use				
Yes	184 (54)	17 (61)	167 (54)	0.55
No	156 (46)	11 (39)	145 (46)	
Postoperative morphine use[b]				
Yes	15 (4)	3 (11)	12 (4)	0.12
No	325 (96)	25 (89)	300 (96)	
Total postoperative narcotic (mg)[a]				
Median (IQR)	5.0 (0–10.1)	7.7 (1.3–15.1)	4.0 (0–10.0)	0.03
Postoperative narcotic use				
Yes	203 (60)	21 (75)	182 (58)	0.11
No	137 (40)	7 (25)	130 (42)	

Data are presented as the count and percent or the median (interquartile range)

POUR postoperative urinary retention, *IQR* interquartile range

[a] Recorded as intravenous morphine equivalence based on doses of morphine, hydromorphone, and fentanyl

[b] Median and interquartile data for morphine use are all equal to 0 mg, as <5 % of all subjects received morphine

$p = 0.02$). The prevalence of any use of postoperative intravenous narcotics was higher in the POUR group (OR 2.1, 95 % CI 0.9–5.2), but this association was not statistically significant in univariate analysis ($p = 0.11$). However, the total amount of postoperative intravenous narcotics used by patients who developed POUR was significantly higher (median 7.7 mg) compared to patients who did not develop POUR (median 4.0 mg). Using ROC analysis to explore a possible threshold for risk of POUR, a cumulative morphine equivalent dose of 6.5 mg or more was associated with a higher risk of POUR (OR 2.5, 95 % CI 1.2–5.6, $p = 0.025$).

Patients with bilateral hernia repairs appeared to be more likely to have POUR (OR 2.1, 95 % CI 0.95–4.8), but this association was not statistically significant ($p = 0.08$) in univariate analysis. Also not statistically significant was the type of mesh used for repair (OR 1.7, 95 % CI 0.8–3.8, $p = 0.17$). The median values for operative time and intraoperative IVF were very similar between the two groups, and therefore no relationship could be determined.

The effect of age, unilateral versus bilateral repairs, preoperative void, and postoperative narcotic use were examined in a multivariate logistic regression model. Both age greater than 50 years (adjusted OR 3.0, 95 % CI 1.3–6.9) and postoperative narcotic use of 6.5 mg or more (adjusted OR 2.7, 95 % CI 1.2–6.1) were associated with developing POUR (Table 2; Fig. 1).

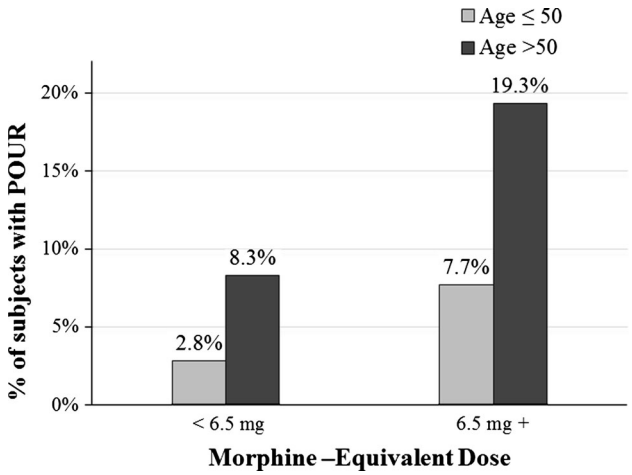

Fig. 1 Association of age and intravenous morphine equivalent dose with POUR

Discussion

POUR as a complication not only causes a great deal of discomfort and stress to patients but can also increase hospital costs by prolonging hospitalization, and by increasing the need for outpatient follow-up appointments after an elective, same-day surgical procedure. Furthermore, the infectious risk of urinary catheterization in today's practice is not reimbursed. Detecting risk factors to reduce the incidence of POUR after one of the most commonly performed procedures by general surgeons could help reduce that burden. In this retrospective review, patients older than 50 years and patients who received an intravenous morphine equivalent dose more than 6.5 mg were independent risk factors for developing POUR after laparoscopic inguinal hernia repairs.

This report is the first study to utilize a narcotic equivalence to detect a relationship between postoperative narcotic use and the risk for POUR. Narcotic analgesics are known to increase patients' risk for urinary retention by reducing parasympathetic bladder tone, detrusor tone, and causing detrusor-sphincter dysfunction [10]. Narcotic use was not statistically significant when defined as a simple 'Yes/No' outcome. However, using the Hopkins Opioid Program algorithm, we were able to demonstrate that postoperative intravenous narcotic use is associated with an increased risk for POUR in patients who receive over an equivalent intravenous morphine dose of 6.5 mg postoperatively (OR 2.5, 95 % CI 1.2–5.6, $p = 0.03$) [8]. According to the algorithm, this is equivalent to 1 mg of intravenous hydromorphone or 65 μg of intravenous fentanyl. In our cohort, 19.3 % of patients older than 50 who received greater than 6.5 mg of a morphine equivalent dose experienced POUR, compared to 2.8 % of patients who were younger than 50 received more than 6.5 mg of morphine equivalence (Fig. 1).

In addition to the significant finding relating postoperative narcotic use, the results here agree with the literature in that older age confers an increased risk for POUR (greater than 50 years, OR 2.8, 95 % CI 1.2–6.4). Multiple studies have shown that the elderly have an increased risk of POUR after open hernia, orthopedic, and anorectal procedures [11–13]. In endoscopic surgery, the data are

Table 2 Logistic regression analysis of factors associated with development of POUR

Risk factor (referent group is listed first)	Adjusted odds ratio (95 % CI)	*p* value
Age (≤51 vs. >50 years)	3.0 (1.3–6.9)	0.01
Postop narcotic use (<6.5 vs. 6.5+ mg)	2.7 (1.2–6.1)	0.01

mixed with the present studying agreeing with work by Sivasankaran et al. [7]. Koch et al. although showed age is not related to POUR following laparoscopic hernia repair [3]. Changes with advancing age that could account for an increase in risk for POUR include impaired detrusor muscle contractility, delayed anesthetic agent metabolism, or BPH [1].

The incidence of BPH in the general population increases with age, with point estimates ranging from 8 % for men in their thirties to 88 % for those over the age of 80 [14]. The overall incidence of BPH in our cohort was 9.2 % ($n = 29$) and 14 % ($n = 4$) among those who experienced POUR. In one study that demonstrated BPH to be a risk factor, the incidence of BPH in their case group was 41 % [7]. In a nested case–control study that did not demonstrate a significant association, the incidence of BPH in the POUR group was 26 % [3]. Because the incidence of BPH increases with advancing age and that 55 % of our cohort was under the age of 50, we may not have been able to detect a true difference based on our patient population, which are primarily young, active duty service members. These results reveal the disparity between the studied patient populations who present at different facilities and thus influence the relationship of the variable. Further analysis needs to be completed with a larger number of BPH cases in order to validate the results from any of these studies.

Here, no significance was found relating POUR following general surgery procedures to intraoperative and postoperative fluid administration, past work has shown mixed results [3, 6, 7, 11]. No study was able to show significance with intraoperative fluid restriction during endoscopic inguinal hernia repairs. Koch demonstrated that postoperative fluids more than 500 mL, not intraoperative fluids more than 1,000 mL, increased the risk for POUR in open inguinal hernia repairs [3]. However, it was unknown if these patients had an increase in their rate of fluids when their due to void was not met, which would require a standardized postoperative management plan to determine the causal relationship. Possibly this difference was missed due to the relatively low power of this study combined with the relatively low incidence of this problem. Of the studies that recorded the amount of intraoperative fluids, including this study, the means between the case and control groups are very similar, due to the low incidence of cases with intraoperative fluid restriction [6]. Here the difference between groups was only 70 mL, possibly leading to the failure to determine a difference. The American Society of Colon and Rectal Surgeons currently recommend that perioperative fluids be limited to reduce the risk for POUR after anorectal surgery. No such definitive guidelines exist for laparoscopic hernia surgery and current literature documents risk factors with variability in their significance [15]. Future studies should be conducted with larger sample sizes for both exposure and control groups such that the mean fluids administered are significantly different.

Furthermore, it is known that general anesthesia can cause bladder atony [16]. A definitive relationship between the duration of anesthesia and urinary retention has not been established. Of the previous reports on operative or anesthesia duration, only one study demonstrated an increased risk for POUR after a prolonged anesthesia time but not operative time for laparoscopic inguinal hernia repairs [7]. Other studies on gynecologic and orthopedic procedures did not demonstrate such a relationship [13, 17, 18]. In our study, we were not able to demonstrate an effect, which could be contributed to having similar operative times between those who developed POUR and those who did not.

Finally, preoperative voiding and intraoperative Foley catheter placement have been implicated as possible risk factors of POUR. The preoperative void is thought to help avoid bladder over distension in combination with receiving general anesthetics [19]. In a study by Joelsson-Alm et al., orthopedic and general surgery patients had a bladder volume greater than 300 mL prior to anesthesia induction, already increasing their risk for POUR [19]. Intraoperative Foley catheter placement can cause detrusor muscle injury subjecting patients to urinary retention. However, we were not able to detect an effect secondary to either of these factors.

This study demonstrated a trend, although not significant, toward a higher risk for POUR in patients who had bilateral inguinal hernia repairs compared to unilateral repairs (OR 2.1, 95 % CI 0.95–4.8). A true relationship may require a larger sample size to detect a statistically significant difference. This study produced results close to significance when compared to others investigating similar questions [3, 6, 7]. A possible explanation for the increased incidence is bilateral mesh placement creates a more intense inflammatory reaction disrupting bladder tone that can cause urinary retention; however, this needs to be tested and validated in larger prospective studies.

There are limitations to this study. First, because patients can receive different types of opioids that have different side effect and strength profiles, a mean to analyze their effects in a standardized way is necessary. This could lead to better postoperative pain control decisions. This relationship needs to be validated in a larger study or in a randomized control study. Second, this study consists of a low number of cases from a single institution. As a result, trends that could be associated with developing POUR but were not able to reach statistical significance to draw any definitive conclusions in factors that are considered significant in other studies. It also limited the ability to examine more than two predictors in a multivariate model.

Further studies with a larger number of cases are required to validate our results or detect significant associations.

Conclusion

This study is the first to quantify a patient's postoperative narcotic use in relation to other risk factors for POUR. Minimizing postoperative narcotic medications may reduce the risk of developing POUR after laparoscopic inguinal hernia repairs. Surgeons should utilize adjuncts, such as non-steroidal anti-inflammatory drugs, acetaminophen, or regional anesthetic blocks to minimize postoperative narcotic requirements. This study also confirms that increased age is a risk factor for developing postoperative urinary retention after laparoscopic inguinal hernia repairs.

Disclosures Drs. Patel, Kaufman, Rodriguez, Jessie and R. Howard have no conflicts of interest or financial ties to disclose.

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