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Effects of dexamethasone on postoperative urinary retention after laparoscopic inguinal hernia repair

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Abstract

Background Postoperative urinary retention (POUR) is a complication of laparoscopic inguinal hernia repair (LIHR). Previous research has identified predictive factors of POUR, such as age and history of benign prostatic hyperplasia (BPH). There is currently limited work on preventative measures. We hypothesize dexamethasone, a steroid, reduces POUR rates following LIHR due to its mechanism.

Methods Consecutive patients ($n=979$) undergoing LIHR from 2009 to 2017 at a single institution were selected from a prospectively managed database. All procedures were performed by four general surgeons. Only male patients were selected, as the majority of POUR occurs in males. Patients were retroactively chart reviewed and divided into two groups, dexamethasone use ($n=623$) and no dexamethasone use ($n=356$). Perioperative factors were compared between groups with Chi-square and independent samples t tests. Univariable and multivariable logistic regression analysis was used to assess whether dexamethasone use was associated with POUR. A subgroup analysis was performed on the dexamethasone group to determine any dose-dependent effects.

Results We found a significant difference in POUR between the dexamethasone group and no dexamethasone group (3.7% vs. 9.8%, $p=0.0001$). Patients in the dexamethasone group had a shorter length of stay, and were less likely to have BPH or a Foley placed (all $p<0.05$). Age and BMI were similar between groups. Multivariable analysis showed that the use of dexamethasone was associated with a reduced risk of POUR (OR 0.52, 95% CI 0.2–0.97, $p=0.0386$), while controlling for factors such as age and BPH. A subgroup analysis examined the effect of dexamethasone per unit (mg) increase. There was no significant association between dexamethasone dose and POUR rates (OR 1.07, 95% CI 0.82–1.38, $p=0.6241$).

Conclusions Patients who received dexamethasone showed a lower rate of POUR regardless of dose. These results suggest dexamethasone can be administered to reduce POUR in males undergoing LIHR.

Keywords Urinary retention · Hernia · Dexamethasone

Inguinal hernia repair is one of the most common surgical procedures in the world, with over 500,000 cases per year in the US alone [1]. Postoperative urinary retention (POUR) is one of the most frequent complications following these procedures, with varying rates of 1–25% reported [2–7]. POUR can be a very painful and uncomfortable complication, which reduces the quality of patients' recoveries. Additional procedures, such as catheterization, are required and often result in a prolonged postoperative length of stay. Incidence of POUR therefore leads to increased medical costs [8].

Previous studies have identified several demographic risk factors for development of POUR. These include age [3, 5, 6] and presence of benign prostatic hyperplasia [3]. POUR occurs more frequently in males, with some studies reporting no females developing the complication [4, 5, 7].

There is limited evidence identifying controllable, intraoperative factors related to POUR, such as operative time and perioperative fluid intake. The findings on operative time are conflicting, with some indicating longer operative time is predictive of POUR [3, 5, 9, 10] while others have

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found no relationship [2]. Additionally, there is evidence for increased fluid consumption postoperatively leading to increased urinary retention rates [11]. However, this may be confounded with development of POUR as patients having difficulty urinating in the postoperative period are given more fluids in an attempt to help them void. Intraoperative fluid intake has not been shown to be a predictor for development of POUR [2, 3]. Overall, the evidence for either operative time or perioperative fluid consumption contributing to POUR is debatable.

There have been few studies identifying preventive measures for POUR. Several studies have examined the potential of prophylactic alpha blockers in preventing POUR development, although these results are inconclusive [12–14]. Currently, there is a need for other preventive options for POUR.

In this study, we examine the effects of dexamethasone, a corticosteroid, on incidence of POUR. We expect POUR is caused by inflammation around the bladder due to trauma from inguinal hernia repair. Previous studies have demonstrated intraoperative administration of dexamethasone is effective in reducing inflammation due to surgery [15]. We therefore hypothesize dexamethasone will decrease rates of POUR following laparoscopic inguinal hernia repair.

Methods

Consecutive patients in a prospectively managed IRB-approved hernia database undergoing LIHR from January 2009-–August 2017 were selected for further review. Data extraction for demographics and perioperative factors was conducted in accordance with the IRB-approved protocol. All procedures were performed by four board-certified general surgeons at NorthShore University HealthSystem. Female patients were excluded as the vast majority of urinary retention complications occur in males. Patients undergoing a simultaneous umbilical or ventral hernia repair were also excluded.

The remaining patients ($n=979$) were divided into two groups, those who received dexamethasone intraoperatively ($n=623$) and those who did not ($n=356$). Perioperative factors such as BMI, age, and presence of benign prostatic hyperplasia (BPH), as well as combined preoperative and intraoperative fluid intake, were compared between groups with Chi-square and independent samples *t* tests. Univariable logistic regression analysis was used on all patients to identify factors associated with POUR, including dexamethasone use as a binary predictor. Factors with $p<.10$ on univariable analysis were entered into a multivariable model. A subgroup analysis was performed on the dexamethasone group, to determine if there was a dose-dependent effect. Dexamethasone was analyzed per milligram increase in the subgroup analysis. All statistical analysis was performed using SAS 9.3 (SAS Institute, Cary, NC). Statistical significance was set at the $p<0.05$ level.

All patients received general anesthesia. Following institution protocol, all patients were required to spontaneously void prior to entering the OR. Dexamethasone administration was at the discretion of the anesthesia team. Dexamethasone was typically given just prior to the start of the procedure, in doses of 4 or 8 mg, with a range of 2–12 mg. POUR was defined as the inability to spontaneously void requiring catheter placement or a return visit to the ED for failure to void.

Results

All 979 patients selected for analysis were included. Mean age of the patient population was 56.8 ± 15.8 years and mean BMI was 26.1 ± 3.8. The majority of patients ($n=960$) underwent a totally extraperitoneal (TEP) repair with the rest ($n=19$) undergoing a transabdominal preperitoneal repair. Overall, 58 patients developed urinary retention requiring catheterization for a rate of 5.9%.

Patient and surgical characteristics of the two groups, dexamethasone use and no dexamethasone use, are included in Table 1. Mean age and BMI were not different between the dexamethasone and no dexamethasone groups. The group without dexamethasone had a higher percentage (22.5 vs. 16.7%, $p=0.026$) of patients with BPH and intraoperative indwelling catheter use (5.9 vs. 1.0%, $p<0.001$) compared to the dexamethasone group. The rate of alpha blocker usage between the dexamethasone and no dexamethasone group is similar (5.8 vs. 4.2%, $p=0.29$). The dexamethasone group received more mean fluids during the preoperative and intraoperative periods combined than the no dexamethasone group ($p=0.002$). This group also underwent more TEP procedures compared to the no dexamethasone group ($p=0.003$), but operative time did not differ ($p=0.465$). The dexamethasone group had a lower rate of surgical site infections compared to the no dexamethasone group (0.2 vs. 1.7%, $p=0.011$). All infections were trocar site infections.

The dexamethasone group had a lower rate of POUR compared to the no dexamethasone group (3.7 vs. 9.8%, $p<0.001$).The relationship between dexamethasone use and rate of POUR is shown in Fig. 1. There was a higher rate of POUR among those that received 0 mg dexamethasone compared to those that received doses of 4 mg or more ($p=0.002$). There was no difference in POUR rates between the 4, 6, and 8 mg doses ($p=0.799$).

Logistic regression analysis for urinary retention in all patients was conducted with results shown in Table 2. In univariable analysis, dexamethasone use showed a protective effect (OR 0.35, 95% CI 0.21–0.61, $p<0.001$), while age (OR 1.07, 95% CI 1.04–1.09, $p<0.001$) and BPH (OR 4.24,

Table 1 Patient and surgical characteristics, by dexamethasone use

	No dexamethasone use ($N=356$) Mean ± SD	Dexamethasone use ($N=623$) Mean ± SD	p value
Age (years)	57.4 ± 16.3	56.4 ± 15.5	0.361
BMI	26.2 ± 3.6	26.0 ± 3.9	0.594
Fluids	878 ± 417	973 ± 287	0.002
Dexamethasone dose	0 ± 0	6.9 ± 1.8	< 0.001
OR time (min)	40.8 ± 16.7	39.7 ± 14.9	0.465
LOS (h)	8.8 ± 5.7	7.3 ± 4.5	< 0.001
	N (%)	*N* (%)	
BPH	80 (22.5)	104 (16.7)	0.026
Foley	21 (5.9)	6 (1.0)	< 0.001
Hernia laterality			< 0.001
Bilateral	75 (21.1)	213 (34.2)	
Left	114 (32.0)	179 (28.7)	
Right	167 (46.9)	231 (37.1)	
TEP repair type	343 (96.4)	617 (99.0)	0.003
Postoperative outcomes			
Infection	6 (1.7)	1 (0.2)	0.011
Seroma	34 (9.6)	49 (7.9)	0.363
Hematoma	23 (6.5)	5 (0.8)	< 0.001
Urinary retention	35 (9.8)	23 (3.7)	< 0.001
Recurrence	12 (3.4)	10 (1.6)	0.073

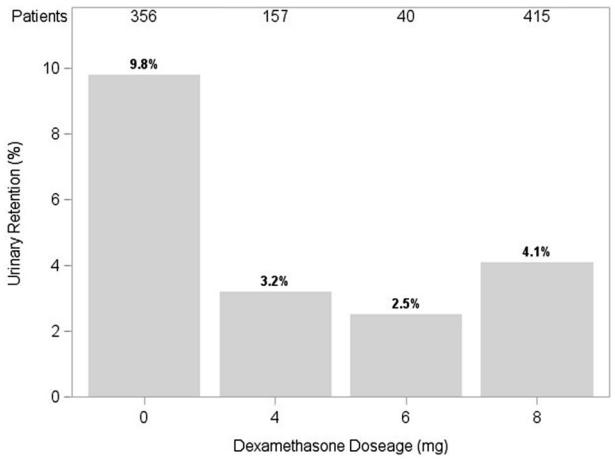

Fig. 1 Rate of urinary retention by dexamethasone dose. Percentage of patients with urinary retention in each dexamethasone dosage, from 0 to 8 mg. the number of patients in each group is listed across the top of the figure. Only the three largest dosage groups are depicted. Doses > 8 mg were not included in this figure due to the small number of patients in that group ($n=11$)

95% CI 2.47–7.28, $p<0.001$) were associated with POUR. In multivariable analysis, dexamethasone use (OR 0.42, 95% CI 0.23–0.75, $p=0.004$) and age (OR 1.05, 95% CI 1.03–1.08, $p<0.001$) were independent predictors of POUR. We could not include BPH in the multivariable analysis due to lack of power. However, we did examine an interaction between BPH and dexamethasone use, which we found to be insignificant ($p=0.8381$).

A subgroup analysis was conducted examining predictive factors of urinary retention for the dexamethasone group only. This was to determine a dosage effect, if any. Age was the only multivariable predictor of urinary retention (OR 1.08, 95% CI 1.04–1.12, $p<0.001$) for dexamethasone users (Table 3). Dexamethasone dosage was not a significant factor (OR 0.99, 95% CI 0.78–1.27, $p=0.972$), indicating no dosage effect (Table 3).

Discussion

POUR is common following laparoscopic inguinal hernia repair. It is a painful and uncomfortable complication for patients. POUR leads to increased medical costs as it requires additional procedures and often results in a prolonged postoperative length of stay or further ED visit [8, 16]. A preventative measure for this complication is still lacking among surgical practices. Our current study found an overall POUR rate of 5.9% and reduced rates of POUR among patients who received an intraoperative dose of

Table 2 Logistic regression analysis for urinary retention, all patients

Predictors	Univariable		Multivariable	
	OR (95% CI)	*p* value	OR (95% CI)	*p* value
Dexamethasone use, yes vs. no	0.35 (0.21–0.61)	< 0.001	0.42 (0.23–0.75)	0.004
Age, per year increase	1.07 (1.04–1.09)	< 0.001	1.05 (1.03–1.08)	< 0.001
BMI, per unit increase	0.94 (0.87–1.01)	0.071	0.94 (0.86–1.03)	0.184
Fluids, per 100 ml increase	0.97 (0.90–1.05)	0.452	–	–
BPH, yes vs. no	4.24 (2.47–7.28)	< 0.001	1.76 (0.94–3.30)	0.077
Foley, yes vs. no	2.31 (0.71–7.46)	0.162	–	–
Hernia laterality, bilateral vs. unilateral	1.64 (0.95–2.81)	0.074	1.44 (0.78–2.63)	0.241
TEP repair type	2.53 (0.14–45.67)	0.530	–	–

Table 3 Logistic regression analysis for urinary retention, dexamethasone users only

Predictors	Univariable		Multivariable	
	OR (95% CI)	*p* value	OR (95% CI)	*p* value
Dexamethasone dose, per mg increase	1.04 (0.82–1.32)	0.738	0.99 (0.78–1.27)	0.972
Age, per year increase	1.09 (1.05–1.13)	< 0.001	1.08 (1.04–1.12)	< 0.001
BMI, per unit increase	0.97 (0.87–1.08)	0.588	–	–
Fluids, per 100 ml increase	1.05 (0.91–1.20)	0.515	–	–
BPH, yes vs. no	4.17 (1.80–9.64)	< 0.001	1.54 (0.61–3.88)	0.361
Foley, yes vs. no	1.95 (0.09–44.70)	0.677	–	–
Hernia laterality, bilateral vs. unilateral	2.16 (0.95–4.89)	0.067	1.68 (0.71–3.97)	0.240
TEP repair type	0.51 (0.02–11.80)	0.677	–	–

dexamethasone. This effect is seen at doses of dexamethasone from 4 to 8 mg and is not dose dependent.

One widely accepted mechanism for POUR involves the relaxing effect of general anesthesia on the detrusor muscle, as described by Baldini et al. and Darrah et al. [4, 8]. As a result, the detrusor is unable to contract and complete micturition. We did not find a difference in operative time between the dexamethasone and no dexamethasone groups. Both groups were exposed to general anesthesia for similar amounts of time, indicating similar risk for development of POUR. The consequences of a weakened bladder muscle are exacerbated by increased flow resistance in the urinary tract found in older patients or patients with BPH, resulting in higher rates of POUR seen in these groups [16]. We found age to be a predictor of POUR, even among patients given dexamethasone, supporting increased flow resistance as a mechanism of POUR.

Inguinal hernia repair itself may lead to an increase in flow resistance. It is well known that inguinal hernia repair can lead to adrenergic agitation of the bladder neck and prostate [14]. This agitation increases resistance to the flow of urine, making micturition completion more difficult [17]. We hypothesize a potential mechanism of dexamethasone in which it acts on glucocorticoid receptors, a dexamethasone target that is highly expressed in the prostate. There is evidence for dexamethasone facilitating smooth muscle relaxation in animal models [18, 19]. Through a similar mechanism, dexamethasone administration could result in a relaxing effect combating the agitation, reducing resistance to the flow of urine and facilitating the completion of micturition. In the postoperative period, this would prevent POUR.

Several previous studies have examined the effects of a prophylactic alpha blockade to combat agitation of the bladder neck and prostate. Clancy et al., among others, have found reduced rates of POUR [12, 14]. Alpha blockers relax the bladder neck muscles, allowing for completion of micturition. This mechanism is similar to our hypothetical mechanism for dexamethasone, providing further support for the efficacy of smooth muscle relaxation preventing development of POUR. However, there have been cautions against overestimating the effect of alpha blockers and questions regarding the efficacy of bladder neck relaxation for POUR prevention [13]. Taking this into account, we think it is possible dexamethasone could act through a different mechanism to reduce incidence of POUR.

Inflammatory responses in the bladder neck and prostate due to surgery could also cause flow resistance and lead to urinary retention. Sacco et al. have previously found postoperative dexamethasone reduces the rates of POUR following transperineal prostate brachytherapy, a procedure that results in significant prostatic edema and inflammation in the postoperative period [20]. They administered a 2-week course of dexamethasone, while our study found efficacy with only a

one-time, intraoperative dose. This is likely because inguinal hernia repair causes less direct prostate trauma compared to brachytherapy. Additionally, the timing of intraoperative administration of dexamethasone may be more efficacious, as it allows for impediment of inflammatory processes as they are developing. Murphy et al. have demonstrated intraoperative dexamethasone hinders progression of inflammatory processes due to surgery in several procedure types [20, 21]. Therefore, it is possible POUR is reduced through an anti-inflammatory mechanism of dexamethasone.

There are few drawbacks to dexamethasone use in the intraoperative period. Murphy et al. have established dexamethasone is safe to administer in patients undergoing a range of procedures, from laparoscopic cholecystectomy to cardiac surgery [15, 21, 22]. The dosage in our study has been established as safe for diabetic patients with few negative effects on blood glucose levels [22]. As a steroid, dexamethasone has the potential to interfere with postoperative healing processes, which could lead to higher rates of infection and recurrence. Interestingly, however, we found a decreased rate of infection in patients who received dexamethasone. We additionally found no difference in the recurrence rate between groups, although there was a trend towards more recurrences in the no dexamethasone group. This further supports evidence that dexamethasone is safe to administer intraoperatively with few adverse effects.

There is conflicting evidence that fluid intake is a factor in the incidence of POUR. Some studies have found evidence that larger bladder volume upon entry to the PACU is predictive of POUR [5]. However, others have found perioperative fluid intake is not a predictor of POUR [2, 3]. Others have found that postoperative fluid intake is predictive of POUR [6]. We believe postoperative fluid intake could be confounded with POUR, as patients could be administered more fluid in an attempt to get them to void. We did examine the combined fluid intake of the pre and intraoperative periods. We found no effect of the combined fluid intake and POUR, suggesting fluid intake is not a predictor of POUR. Moreover, the dexamethasone group had a higher mean intake of fluid during the pre and intraoperative periods combined. This suggests dexamethasone has a strong protective effect. While other general surgery pelvic procedures have found fluid intake is a predictive factor for development of POUR [23], we believe it is not a factor in inguinal hernia procedures given the inconclusive literature specific to inguinal hernias and the results of our study.

While intraoperative indwelling catheter use was different between the dexamethasone and no dexamethasone groups, it was not associated with POUR in the univariable analysis, indicating intraoperative catheter use in not predictive of POUR. Blair et al. [7] have previously found no association between intraoperative catheter placement and POUR. We concur with that assessment based on our findings.

Although we found BPH was predictive of POUR in the univariable analysis, BPH was not an independent predictor in the multivariable analysis due to lack of power. The interaction between BPH and dexamethasone was also insignificant, indicating dexamethasone likely had a similar effect on patients with and without BPH. We therefore conclude the difference in POUR rates between the two are due to dexamethasone, and not the difference in BPH rates.

There are limitations to our current study. Its retrospective nature necessarily restricts the strength of our conclusions. A randomized, controlled trial is needed to confirm our findings. Additionally, dexamethasone use at our institution has increased over time due to findings in the anesthesia department's research. It is possible that there are other factors coinciding with this increase in dexamethasone use contributing to the reduced rates of POUR that we have unknowingly attributed to the dexamethasone. However, our multivariable analysis did account for many previously identified factors that could have affected POUR rates. We therefore recommend a dose of 4–8 mg of dexamethasone intraoperatively to protect against development of POUR in patients undergoing laparoscopic inguinal hernia repair.

Compliance with ethical standards

Disclosures Merritt Denham, Kara Donovan, Nicole Wetoska, Kristine Kuchta, JoAnn Carbray, and Drs. Michael Ujiki, John G. Linn, Woody Denham, Stephen P. Haggerty, and Raymond Joehl have no conflicts of interest or financial ties to disclose.

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