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ORIGINAL SCIENTIFIC REPORT

Postoperative Urinary Retention After Laparoscopic Colorectal Resection with Early Catheter Removal: A Prospective Observational Study

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Abstract

Background Early catheter removal is essential to enhance postoperative mobilization and recovery, but may carry a risk of urinary retention. This study aimed to evaluate a standardized regimen for early postoperative catheter removal and re-catheterization in patients undergoing elective laparoscopic colorectal cancer surgery within an optimal ERAS setting.

Methods This was a single-center prospective study of patients undergoing elective minimally invasive colorectal resection and postoperative catheter removal within 24 h, with a re-catheterization threshold of 800 ml bladder volume. The primary outcome was postoperative urinary retention rate, and the secondary outcomes were time of catheter removal and length of stay with a special focus on differences between colon and rectal resections.

Results A total of 113 patients were included in the study, and 87 patients were eligible for the final analysis. Rectal resection was performed in 22 of 87 patients, and all operations were performed with minimally invasive technique. The conversion rate was 3.5%, and 30-day mortality was 0%. More than 95% of the patients had their catheter removed within 24 h with no difference between rectal and colonic resections. Postoperative urinary retention was observed in 9% of all patients (rectum 18% vs. colon 6%, $p = 0.11$). One patient had an indwelling catheter at discharge, but all patients had free voluntary micturition at 30-day follow-up. Median length of stay was 3 days (1–13 days).

Conclusions Catheter removal within 24 h of surgery using a re-catheterization threshold of 800 ml is safe and reduces unnecessary re-catheterizations following minimally invasive colorectal resection.

Introduction

Postoperative urinary retention (POUR) is defined as an inability to empty a full urinary bladder following surgery. It occurs with varying incidences depending on the type of surgery, surgical technique and time of postoperative catheter removal [1–4]. Current practice for postoperative catheter use and removal following laparoscopic colorectal surgery is mainly based on traditions and limited evidence. International guidelines for *Enhanced Recovery After Surgery* (ERAS) recommend catheter removal within 24–48 h after elective colonic and rectal resections with a low estimated risk of POUR and within 48 h following mid- and low rectal resection [5–7]. Long-lasting indwelling urinary catheters and unnecessary bladder instrumentations conflict with modern ERAS principles and should be avoided, to minimize urinary tract infections, sepsis and prolonged hospital stay [8]. Thus, the optimal time of

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catheter removal is not established, as well as the most favorable threshold for re-catheterization is unknown, and both may affect the incidence of POUR and need for re-catheterization [9].

The aim of the study was to evaluate a standardized regimen for early postoperative catheter removal and re-catheterization in patients undergoing laparoscopic colorectal cancer surgery within an optimal ERAS setting.

Materials and methods

Study design

The study was performed as part of a prospective single-center ERAS cohort study in a high-volume colorectal cancer unit. From September 2016 to July 2017, patients aged 18 years or above, scheduled for an elective minimally invasive oncologic colorectal resection, were enrolled in the study. The standardized regimen for catheter removal and re-catheterization was one of many issues incorporated in the study, and besides measurements and collection of catheter-related data, daily data collection included orthostatic intolerance test, heart variability measurement, blood samples, fulfilling questionnaires and others. Patients were included by the study nurse immediately after the weekly 'patient school.' Between two and ten patients participate in the patient school weekly, but no more than four patients could be included per week to ensure high data quality, as data collection was performed by only one study nurse. Patient selection was unbiased and without reference to the type of surgery, tumor location or patient-related factors. If more than four patients were eligible at the patient school, the first four patients were included. If less than four patients were eligible, all these patients were included. Patients planned for abdominoperineal resections, total colectomies and palliative resections and patients with peritoneal carcinomatosis were not included or were excluded postoperatively. Furthermore, patients having chronic urinary catheters or using clean intermittent catheterization (CIC) and patients undergoing conversion to open surgery, receiving epidural analgesia or having a reoperation in general anesthesia for any reason were also excluded from data analysis. Oral and written informed consent was obtained from all participants, and the study has been approved by the Danish Data protection agency (REG-044-2018).

All data were prospectively collected and documented in individual CRFs by the colorectal study nurse. Postoperative opioid consumption was calculated as oral morphine equivalent dose (OMEQ). Opioid consumption at the day of surgery (postoperative day 0, POD 0) was calculated from patient arrival in the post-anesthesia care unit (PACU) until 23.59 P.M.

Urinary function was measured using the ICIQ-UI Short Form for females [10] and the DAN-PSS for males [11]. A urine strip examination was performed preoperatively and at discharge, and if positive for leukocytes and/or nitrite, a urine culture was performed. Asymptomatic bacteriuria was defined as a positive urine culture ($>10^5$ bacteria/ml) without clinical symptoms of urinary tract infection (UTI). All patients were routinely bladder scanned after micturition preoperatively, after the first postoperative voluntary micturition and at discharge, as an estimate of residual urine volume.

The primary outcome parameter was POUR rate, and the secondary outcome parameters were compliance with catheter removal regimen and length of stay (LOS).

Perioperative care program

All patients followed a standard perioperative care program including pre-, intra- and postoperative ERAS elements to reduce surgical stress and improve outcome [12].

In the PACU, patients received acetaminophen routinely (4 g daily) and opioids only on demand. NSAIDs were not used. Nausea was treated with oral Ondansetron on demand. Drains were not routinely used, and patients were allowed to drink and eat solid food immediately. All patients were mobilized at arrival to the ward according to a standard mobilization protocol and discharged according to standard ERAS criteria. Follow-up included a phone call from the study nurse 2 days after discharge, a visit in the outpatient clinic at POD 12–14 and a nurse phone call at POD 30.

Urinary catheter and re-catheterization regimen

A transurethral indwelling urinary catheter was placed after the patient was anesthetized, and postoperative catheter removal was planned within 24 h postoperatively for all patients. A standard algorithm for management of POUR and voiding difficulties [9] was followed for all patients as shown in Fig. 1. After catheter removal, patients were observed for 4–6 h for free micturition to occur. If the patients were unable to urinate, a bladder scan was performed every 2 h. If bladder volume exceeded 800 ml, the patient was encouraged to void, and if unsuccessful, a clean intermittent catheterization (CIC) was performed. If CIC was necessary more than twice, an indwelling catheter was inserted and removed after a maximum of 24 h. Patients unable to void voluntarily and presenting with abdominal pain or discomfort without any other obvious reason were catheterized using CIC no matter what the bladder scan showed.

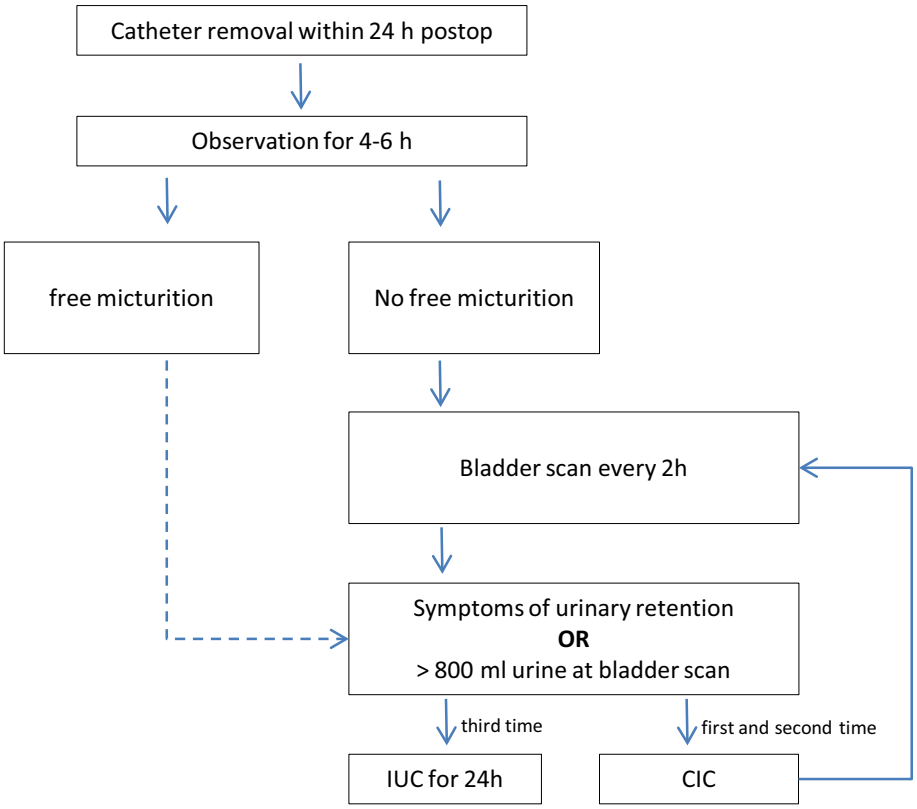

Fig. 1 Flowchart and algorithm for postoperative observation, diagnosis and treatment of urinary retention

Statistics

No formal power calculation was performed due to the confirmatory nature of a quality insurance study. Statistical analysis was performed using IBM SPSS version 21 software (IBM Corp., Armonk, NY, USA). All data are presented as medians (range), if not stated otherwise. A p value < 0.05 was considered significant. All continuous variables were tested using the nonparametric Mann–Whitney test. Categorical data were analyzed using the Chi-square test or Fisher's exact test when appropriate.

Results

A total of 113 patients were included in the study, and 87 patients were eligible for the final analysis (Fig. 2). Patient characteristics with relevant comorbidity and operative data are shown in Table 1. No patients were prescribed α-blockers or other medication for prostate hypertrophy pre- or postoperatively. All operations were performed with minimally invasive technique, the conversion rate was 3.5%, and the 30-day mortality rate was 0%. Rectal resection was performed in 22 of 87 patients (25%).

Urinary catheters were removed in the PACU in 33% of the patients, 71% of the patients had their catheter removed during POD 0, and 96% had their catheter removed within 24 h postoperatively. There was no difference in time of catheter removal between colonic and rectal resections (Fig. 3). The overall incidence of POUR was 9%, and the highest following rectal resection compared with colonic resection (18% vs. 6%, $p = 0.11$), as shown in Table 2. Seven out of eight patients with POUR had their catheter removed on POD 0 and one patient on POD 1. POUR was treated with CIC in seven patients and CIC and IUC in one patient. The indications for CIC were symptoms (pain/discomfort) in four patients and a bladder volume > 800 ml at bladder scan in four patients. The POUR rate for males was 14% and for females 3% ($p = 0.13$) as shown in Table 3.

There were no differences in urinary function between patients undergoing colonic versus rectal resections (Table 2) or with or without POUR (Table 3). We found no difference in residual urine volume at any time between patients undergoing colonic and rectal resections (Table 2), but patients with POUR had significantly higher residual urine volume after the first voluntary micturition compared with non-POUR patients (389 ml vs. 87 ml, $p = 0.004$, Table 3).

Asymptomatic bacteriuria was found in six (6.8%) patients preoperatively and in one patient (1.3%) at discharge. No patients had urinary tract infection (UTI) or

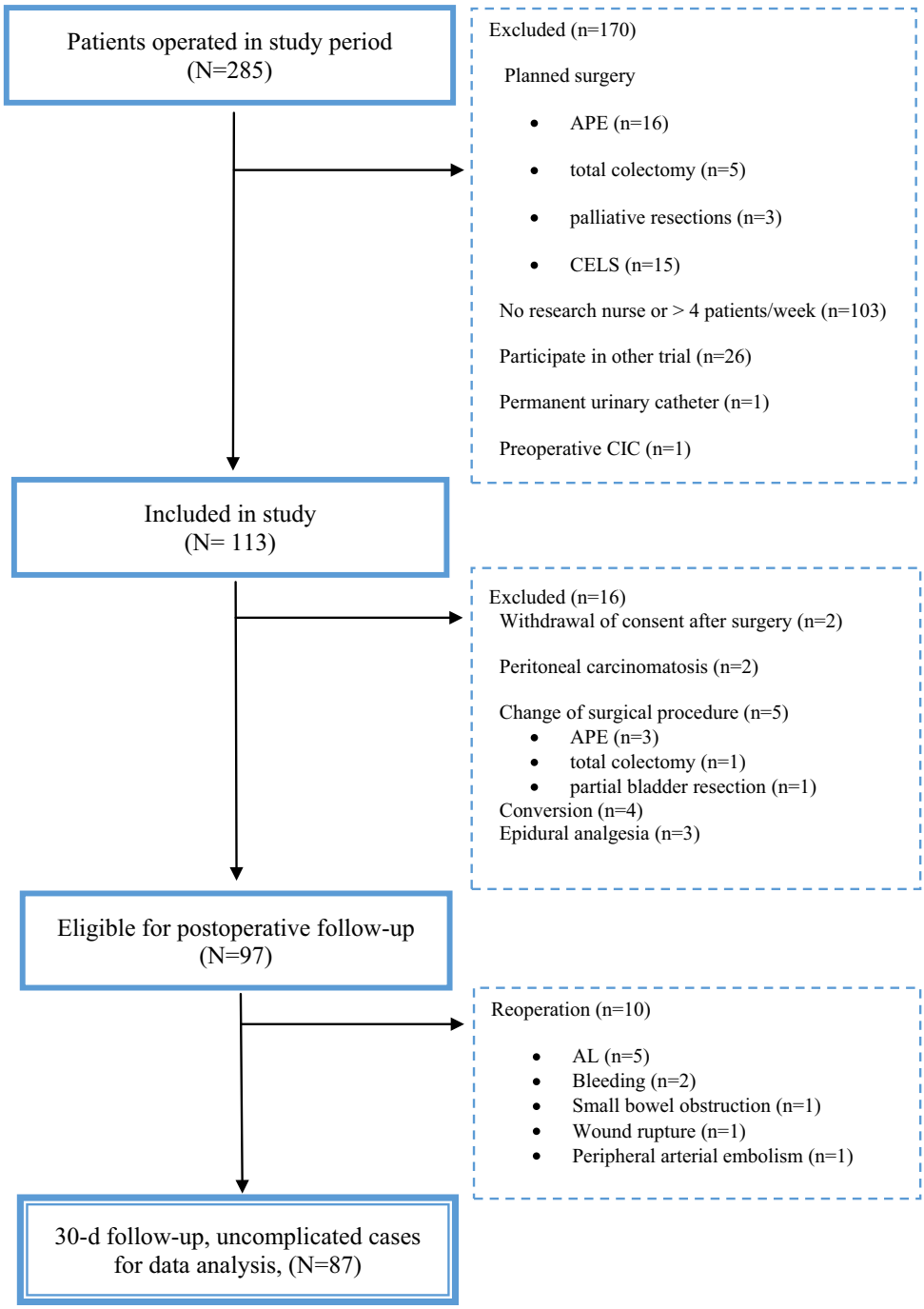

Fig. 2 Flowchart of patients in the study. *APE* abdominoperineal excision, *CELS* combined endoscopic–laparoscopic surgery, *CIC* clean intermittent catheterization and *AL* anastomotic leakage

symptoms of UTI preoperatively or at discharge, but one patient was treated for symptomatic UTI after discharge.

We found no difference in pre- or postoperative pain scores between patients undergoing colonic and rectal resections (data not shown) or between patients with or without POUR (Table 3). Opioid consumption in the PACU on POD 0 and total opioid use from PACU to POD 1 were significantly higher for patients with POUR compared with patients without POUR (Table 3). Three patients received a peripheral nerve block postoperatively, all following colonic resections, as shown in Table 3.

The median LOS for all patients was 3 days with no difference between colonic and rectal resections [3 (1–12) vs. 3 (1–13) days, $p = 0.18$], but patients with POUR had a longer median hospital stay compared with patients without POUR [4 (2–5) vs. 3 (1–13) days, $p = 0.03$].

We found alcohol consumption >14 units per week, higher residual urine volume after the first micturition,

Table 1 Patient characteristics and operative data

	Total $n = 87$	Colon $n = 65$	Rectum $n = 22$	p
Gender				0.19
Male [n (%)]	49 (56)	34 (52)	15 (68)	
Female [n (%)]	38 (44)	31 (48)	7 (32)	
Age (years)	70 (54–83)	72 (56–83)	67 (54–83)	0.005
Body mass index (kg/m^2)	27 (17–40)	26 (19–40)	27 (17–39)	0.82
Performance score [n (%)]				0.22
0	81 (93)	61 (94)	20 (91)	
1	5 (6)	4 (6)	1 (4.5)	
≥2	1 (1)	0	1 (4.5)	
ASA [n (%)]				0.20
1	32 (37)	21 (32)	11 (50)	
2	42 (48)	35 (54)	7 (32)	
≥3	13 (15)	9 (14)	4 (18)	
Former urinary retention [n (%)]	3 (3)	2 (3)	1 (5)	1
Former pelvic surgery [n (%)]	11 (13)	9 (14)	2 (9)	0.72
Bilateral salpingo-oophorectomy (BSO)	2 (2)	2 (3)	0	
Hysterectomy	6 (7)	5 (8)	1 (5)	
Hysterectomy + BSO	2 (2)	2 (3)	0	
Endometriosis	1 (1)	0	1 (5)	
Comorbidity [n (%)]				
Parkinson	1 (1)	1 (2)	0	1
Former stroke	2 (2)	2 (3)	0	1
Diabetes	12 (14)	7 (11)	5 (23)	0.16
Use of diuretics [n (%)]	12 (14)	10 (15)	2 (9)	0.72
Alcohol consumption > 14 units/week [n (%)]	24 (28)	16 (25)	8 (36)	0.29
Active smokers [n (%)]	15 (17)	12 (18)	3 (14)	0.75
Surgical procedure [n (%)]				–
Right hemicolectomy[a]		29 (45)	–	
Left hemicolectomy		9 (14)	–	
Sigmoid		27 (41)	–	
PME		–	13 (59)	
TME with diverting loop ileostomy[b]		–	9 (41)	
Surgical access [n (%)]				0.86
Laparoscopic	68 (78)	49 (75)	17 (77)	
Robotic	21 (22)	16 (25)	5 (23)	

[a]Including extended right hemicolectomy ($n = 3$) and transverse colon resection ($n = 2$)

[b]Including TaTME ($n = 2$)

preoperative *P*-creatinine and opioid use, associated with POUR in the univariate analysis (Table 3). Due to the small dataset, a multivariate regression analysis was not performed.

Discussion

The present prospective single-center study demonstrates the feasibility, safety and positive effects of a standardized program for early postoperative catheter removal and re-catheterization, following standard minimally invasive colorectal surgery without reoperation and conversion. Overall, we found a high compliance rate of 96% catheters

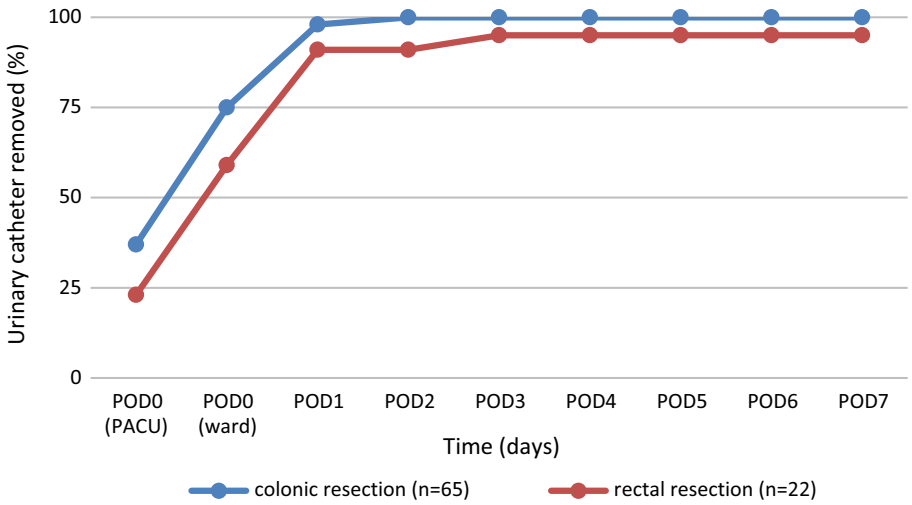

Fig. 3 Percentage of patients having their urinary catheter removed in the postoperative period after colonic or rectal resections

Table 2 POUR and urinary function according to resection type

	Total $n = 87$	Colon $n = 65$	Rectum $n = 22$	p
POUR [n (%)]	8 (9)	4 (6)	4 (18)	0.11
Treated with CIC[a]	8 (9)	4 (6)	4 (18)	0.11
Treated with IUC[b]	1 (2)[c]	0	1 (5)	0.25
CIC at discharge (n)	0	0	0	–
IUC at discharge (n)	1	0	1	0.25
Free micturition POD 30 [n (%)]	87 (100)	65 (100)	22 (100)	–
Residual urine (ml)				
Preoperative	0 (0–248)	0 (0–248)	0 (0–172)	0.64
After first voluntary micturition	105 (0–600)	117 (0–586)	96 (0–600)	0.81
At discharge	0 (0–737)	0 (0–737)	13 (0–305)	0.83
Urinary function (score)				
DAN-PSS preoperatively	1	1 (0–12)	0 (0–7)	0.77
DAN-PSS POD 30	1	0 (0–22)	1 (0–25)	0.28
ICIQ-UI preoperatively	0	0 (0–16)	3 (0–6)	0.12
ICIQ-UI POD 30	0	0 (0–9)	0 (0–5)	0.99
LOS	3 (1–13)	3 (1–12)	3 (1–13)	0.18

[a]*CIC* clean intermittent catheterization

[b]*IUC* indwelling urinary catheter

[c]One patient had an indwelling urinary catheter after CIC × 2

removed within 24 h, an overall POUR rate of 9% and an overall median length of stay of 3 days.

The difference in POUR between patients undergoing colonic and rectal resections (6 vs. 18%) in our study did not reach statistical significance, which may be due to the small sample size (type 2 error). In general, patients undergoing rectal resection have a higher risk of POUR compared with colonic resections [1, 13].

Two randomized trials comparing early versus late catheter removal following open colorectal resection have been published [14, 15]. Benoist et al. [15] compared early (POD 1) versus late (POD 5) catheter removal in 126 patients undergoing open rectal resection. Early catheter removal was associated with a higher POUR rate (25% vs. 10%, $p < 0.05$) but also a lower UTI rate (20% vs. 42%, $p < 0.01$), compared with late removal. In the other randomized trial by Zmora et al., 118 patients were

Table 3 Possible predictive parameters for POUR

	−POUR $n = 79$	+POUR $n = 8$	p
Gender [*n* (%)]			0.13
Male	42 (86)	7 (14)	
Female	37 (97)	1 (3)	
Age (years)	70 (54–83)	72 (58–77)	0.91
Performance score [*n* (%)]			0.72
0	73 (92)	8 (100)	
≥1	6 (8)	0	
ASA class [*n* (%)]			0.42
1	28 (35)	4 (50)	
2	38 (48)	4 (50)	
≥3	13 (17)	0	
BMI (kg/m^2)	27 (17–40)	25 (22–34)	0.36
Former urinary retention (*n*)	3 (4)	0	1
Former pelvic surgery (*n*)	11 (14)	0	0.59
Diabetes (*n*)	11 (14)	1 (13)	1
Use of diuretics (*n*)	12 (15)	0	0.59
Alcohol > 14 units/week (*n*)	19 (24)	5 (63)	0.03
Active smoker (*n*)	14 (18)	1 (13)	1
Resection type [*n* (%)]			0.11
Rectal	18 (82)	4 (18)	
Colonic	61 (94)	4 (6)	
Blood loss (ml)	20 (0–1500)	23 (10–100)	0.61
Anesthetic time (min)	213 (140–543)	242 (167–464)	0.23
Operative time (min)	159 (76–430)	184 (135–321)	0.19
IUC removal (POD)	0 (0–3)	0 (0–1)	0.28
ICIQ score, preoperatively	0 (0–16)	0 (0–0)	0.70
DAN-PSS score, preoperatively	1 (0–12)	1 (0–6)	0.76
Residual urine (ml)			
Preoperatively	0 (0–248)	0 (0–98)	0.33
After first micturition	87 (0–517)	389 (79–600)	0.004
At discharge	0 (0–737)	118 (0–625)	0.09
Preoperative *P*-creatinine (μmol/l)	74 (34–130)	96 (68–136)	0.006
I.v fluid OR + PACU (ml)	2074 (818–4941)	2090 (2019–3410)	0.40
Opioid consumption [OMEQ dose (mg)]			
PACU	13 (0–88)	32 (0–84)	0.04
POD 0	31 (0–156)	59 (25–94)	0.05
POD 1	10 (0–100)	10 (0–240)	0.69
PACU to POD 1 (total)	41 (0–231)	88 (28–298)	0.05
Nerve block PACU [*n* (%)]	1 (1.3)	0	1
Nerve block POD 1 [*n* (%)]			
Pain score (VAS 0–10)	2 (2.5)	0	1
PACU	1 (0–9)	3 (0–3)	0.17
POD1 rest	3 (0–10)	5 (1–7)	0.39
POD1 activity	4 (0–8)	3 (3–3)	1
LOS (days)	3 (1–13)	4 (2–5)	0.03

randomized for catheter removal on POD 1, 3 or 5, following open rectal resection. The overall POUR rate was 10% with no significant differences between the three groups, and no difference in LOS was observed between patients with or without POUR (14 vs. 9.7 days, $p = 0.13$) [14].

The literature is sparse on data regarding urinary catheter-related outcomes following laparoscopic colorectal resection. Consequently, guidelines and recommendations are mainly based on data from open surgery and may not stick to modern ERAS principles and perioperative patient care. Essential ERAS elements as minimally invasive surgical technique, opioid-sparing analgesic treatment and early mobilization and oral feeding may in itself facilitate an uncomplicated postoperative urinary function. On the other hand, adherence to recommendations on early catheter removal may significantly improve postoperative mobilization and facilitate reduced LOS and risk of UTI [16, 17]. We found no value of urine strip analysis preoperatively or at discharge to predict UTI or POUR, and it should not be performed routinely.

Compliance rates for catheter removal according to ERAS recommendations are disappointingly low and range from 47 to 68% after colonic resection and from 34 to 70% following rectal resection [17, 18]. In comparison, we demonstrated a compliance rate of more than 95% due to a completely multi-disciplinary implementation and understanding of the importance of each single step in the ERAS pathway [19], including a specific focus on catheter removal in the PACU.

We did not include abdominoperineal resections in our study, as we have no standard protocol for catheter removal in this subgroup of colorectal patients. In a recent randomized trial by Patel et al., comparing early versus late catheter removal (1 vs. 3 POD) in patients undergoing APEs, early catheter removal after APE was safe with no increase in POUR rate and a significant reduction in urinary tract infections [20].

The incidences of POUR reported in the literature after colorectal surgery range from 1.8 to 25% [1, 14, 15, 21] and reflect the lack of consensus of a definition of POUR and patient heterogeneity. More than 15 different definitions of POUR have been used in the published literature [22]. We have chosen a composite definition including both subjective (symptoms: pain/discomfort with no other obvious cause) and objective (bladder volume of 800 ml) parameters as the most clinically relevant definition, based upon the only available RCT [9]. Furthermore, information about when, how and for how long re-catheterization should be maintained is rarely published and it makes interpretation and reproducibility difficult.

A relevant concern in relation to increased threshold for re-catheterization is the risk of bladder distension and permanent injury. The normal capacity of the urinary bladder is 400–600 ml, but a temporary bladder volume of 500–1000 ml has no adverse effect on subsequent bladder function if treated within 1–2 h [22]. This was confirmed in a recent randomized study on hip and knee arthroplasty patients comparing a 500-ml vs. 800-ml threshold for re-catheterization with CIC [9]. The authors found a significantly reduced re-catheterization rate in the 800-ml group (13% vs. 32% in the 500-ml group, $p < 0.0001$, relative risk 0.4, 95% CI 0.3–0.6) without any adverse effects on late postoperative urinary function or infections [9]. In a prospective observational study of 143 patients undergoing colorectal resections, by both open and laparoscopic approaches, patients with POUR had an average bladder volume measured by bladder scan or catheterization of 537 ml [21].

Our results raise the important question of whether urinary bladder catheterization is indicated at all, during colorectal procedures lasting less than 2–3 h in selected patients. This has not been investigated earlier, but a recent retrospective study of 131 patients undergoing colorectal resections compared whether the presence or absence of an indwelling urinary catheter on leaving the operating theater had any effect on postoperative fluid administration, morbidity and length of stay The authors reported that the absence of a catheter was associated with a reduction in length of stay and intravenous fluid administration [23].

We were not able to predict POUR based on preoperative urinary residual volume or urinary function scores, but we found a significantly higher residual volume after the first micturition in patients with POUR compared to patients without POUR (median 389 ml vs. 87 ml, $p = 0.004$).

This study has some limitations with respect to generalizability as we excluded abdominoperineal excision, patients undergoing a reoperation or conversion to open surgery and patients receiving epidural analgesia. Furthermore, the patient cohort is small and less than half of the potentially eligible patients were included in the study. This increases the risk of type 2 errors in the data analysis, but on the other hand, the complete and prospective data collection strengthens our results in conjunction with a high ERAS compliance.

Conclusion

Evidence to support prolonged catheterization after minimally invasive colorectal resection is poor. Urinary catheter removal within 24 h postoperatively and a re-catheterization threshold of 800 ml using clean intermittent catheterization are safe within an ERAS program for both

colonic and rectal resections with a low re-catheterization rate.

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Compliance with ethical standards

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

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