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Low incidence of postoperative urinary retention with the use of a nurse-led bladder scan protocol after hip and knee arthroplasty: a retrospective cohort study

N. P. Kort[1] · Y. Bemelmans[1] · R. Vos[2] · M. G. M. Schotanus[1]

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Abstract
Purpose Postoperative urinary retention (POUR), defined as the inability to empty the bladder voluntary after surgery, is a commonly reported complication. This study reports the incidence and possible risk factors for POUR after elective fast-track hip or knee arthroplasty when using a nurse-led bladder scan protocol.
Methods This retrospective cohort study included data from 803 patients who underwent unilateral hip or knee arthroplasty. Patients' digital clinical records were reviewed for eligibility. Patients with incomplete data registration, preoperative bladder volume >250 ml, preexisting bladder catheterization, and/or patients following the outpatient pathway were excluded. Bladder volumes were assessed at different moments pre- and postoperatively. The outcome was the incidence of POUR, defined as the inability to void spontaneously with a bladder volume >600 ml, treated with indwelling catheterization. Further analysis between POUR and non-POUR patients was performed to detect possible risk factors for POUR.
Results Six hundred and thirty-eight patients operated on primary unilateral hip or knee arthroplasty were analyzed. The incidence of POUR was 12.9% ($n = 82$, 95% CI 9.4–15.5). Gender, age, BMI, ASA classification, preoperative bladder volume, type of anesthesia, type of arthroplasty, and perioperative fluid administration were not significant different between POUR and non-POUR patients. Patients with a bladder volume of >200 ml at the recovery room were at higher risk (OR 5.049, 95% CI 2.815–9.054) for POUR.
Conclusions When using a nurse-led bladder scan protocol in fast-track hip and knee arthroplasty, the incidence of POUR was 12.9%, with a bladder volume of >200 ml at the recovery room as a risk factor for POUR.
Level of evidence A retrospective cohort study, Level III.

Keywords Postoperative urinary retention · POUR · Bladder scan · Hip arthroplasty · Knee arthroplasty

Introduction

Since the introduction of fast-track surgery pathways in orthopedic departments, peri- and postoperative indwelling bladder catheterization is no longer routinely performed [19, 22, 27]. Postoperative urinary retention (POUR), defined as the inability to empty the bladder voluntarily after anesthesia and surgery, is a commonly reported adverse event after elective total hip (THA) and knee arthroplasty (TKA) [1, 2, 4, 5]. The reported incidence of POUR after TKA and THA following a fast-track or conventional pathway ranges widely between 0 and 75% [1, 4–6, 16, 17, 27]. Many factors contribute to the risk of POUR, such as type of anesthesia, male gender, comorbidities, and perioperative fluid management [2–6, 13, 21]. An ultrasound bladder scan is introduced as a diagnostic tool to monitor bladder volume

✉ M. G. M. Schotanus
martijnschotanus@hotmail.com

N. P. Kort
n.kort@nannekort.eu

Y. Bemelmans
yo.bemelmans@zuyderland.nl

R. Vos
rein.vos@maastrichtuniversity.nl

[1] Department of Orthopaedic Surgery, Zuyderland Medical Centre, Sittard-Geleen, The Netherlands

[2] Department of Methodology and Statistics, Maastricht University Medical Center, Maastricht, The Netherlands

in the prevention of POUR [8, 9, 18]. General consensus on definition of POUR, cutoff values, time of measurement with a bladder scan, and treatment strategies (intermittent vs. indwelling catheterization) is lacking [4, 14, 29]. Most studies reported POUR as the inability to void spontaneously after surgery with a high bladder volume, ranging between 400 and 800 ml [2, 5, 6]. As other studies defined POUR as the need for postoperative urologic consultation [26] or the postoperative inability to void spontaneously without monitoring bladder volume [21, 27]. Based on physiological knowledge, exceeding 600 ml of bladder volume is considered to be pathophysiological [29]. The potential risk of POUR is overdistension of the bladder, which can cause urologic adverse events [3]. Indications for postoperative catheterization after THA and TKA in fast-track surgery are based on the bladder volume and are widely diverse in the literature [1–3, 5, 6] ranging from 400 to 800 ml. Early detection and treatment of POUR is paramount in prevention of bladder overdistension and thereby urologic adverse events [23]. Treatment of POUR consists of intermittent or indwelling catheterization, which both is often associated with an increased risk of urinary tract infection, morbidity and prolonged hospital stay [7, 25, 29]. With the use of an ultrasound-guided bladder scan protocol, elective bladder catheterization is unnecessary in patients undergoing THA and TKA [2]. However, there is limited evidence regarding a standardized pre-, peri-, and postoperative bladder scan protocol with general applicable cutoff values and strategies regarding the treatment of high bladder volumes to prevent for POUR [2, 5, 14, 18]. This study reports the incidence and the potential risk factors for POUR, after elective fast-track hip and knee arthroplasty, when using a nurse-led bladder scan protocol.

Materials and methods

This retrospective analysis included all patients who underwent elective unilateral primary total hip (THA), total knee (TKA), or unicompartmental knee (UKA) arthroplasty in a fast-track pathway between June 2014 and May 2015 in the Zuyderland Medical Center (Sittard-Geleen, the Netherlands). Patients were excluded from analysis in case of incomplete data registration, preoperative bladder volume >250 ml, and therefore placement of an indwelling catheter prior to surgery, preexisting usage of bladder catheterization, and/or patients who underwent arthroplasty surgery in an outpatient pathway. A total of 638 patients were analyzed after application of the exclusion criteria (Fig. 1).

A urinary bladder management protocol was used for the prevention of POUR by using an ultrasound bladder scanner (BladderScan® BVI 9400; Verathon Medical Europe BV, the Netherlands), based on the available literature [2, 3, 14, 18, 28] and the expert opinion of the hospital urologists (Fig. 2).

Pre-, peri-, and postoperative treatment

Bladder volumes were monitored preoperatively after voiding to detect a possible urinary retention >250 ml, which has been found as a risk factor for POUR [3]. In case of >250 ml of urinary retention preoperative after spontaneous voiding, indwelling catheter was placed prior to surgery [27]. When indwelling catheter was used, it was removed the next day. All nurses were trained in using the bladder scanner and were familiar with the online available bladder scan protocol (Fig. 2).

All surgeries were performed by seven experienced arthroplasty surgeons. Patients were operated under spinal or general anesthesia with intravenous fluid restriction (max. 1000 ml). Local infiltration analgesia (LIA) was used intraoperative in knee arthroplasty [24]. In order to prevent PONV, intravenous dexamethasone (single shot, 8 mg) was administrated during the surgery. Oral tranexamic acid (1 g if weight <100 kg, 1.5 g if weight >100 kg) was provided preoperatively. At wound closure, the same doses were given intravenous for prevention of blood loss. No wound drains were used. An opioid-sparing pain protocol was provided (Table 1). In case of inadequate pain control, tramadol was

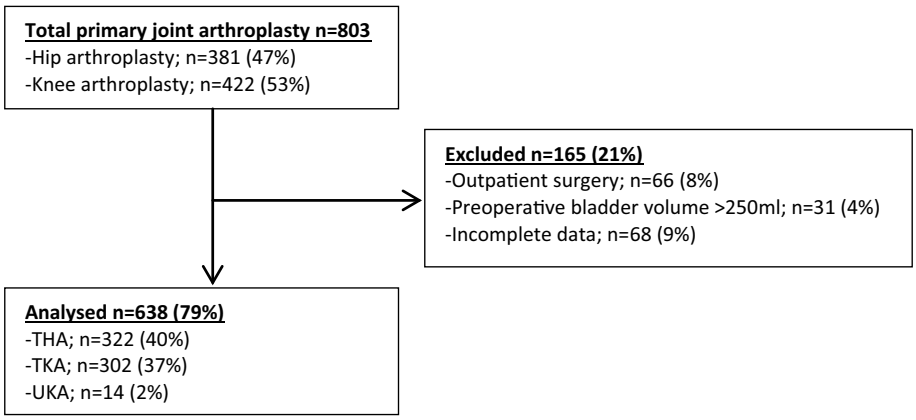

Fig. 1 Selection of patients

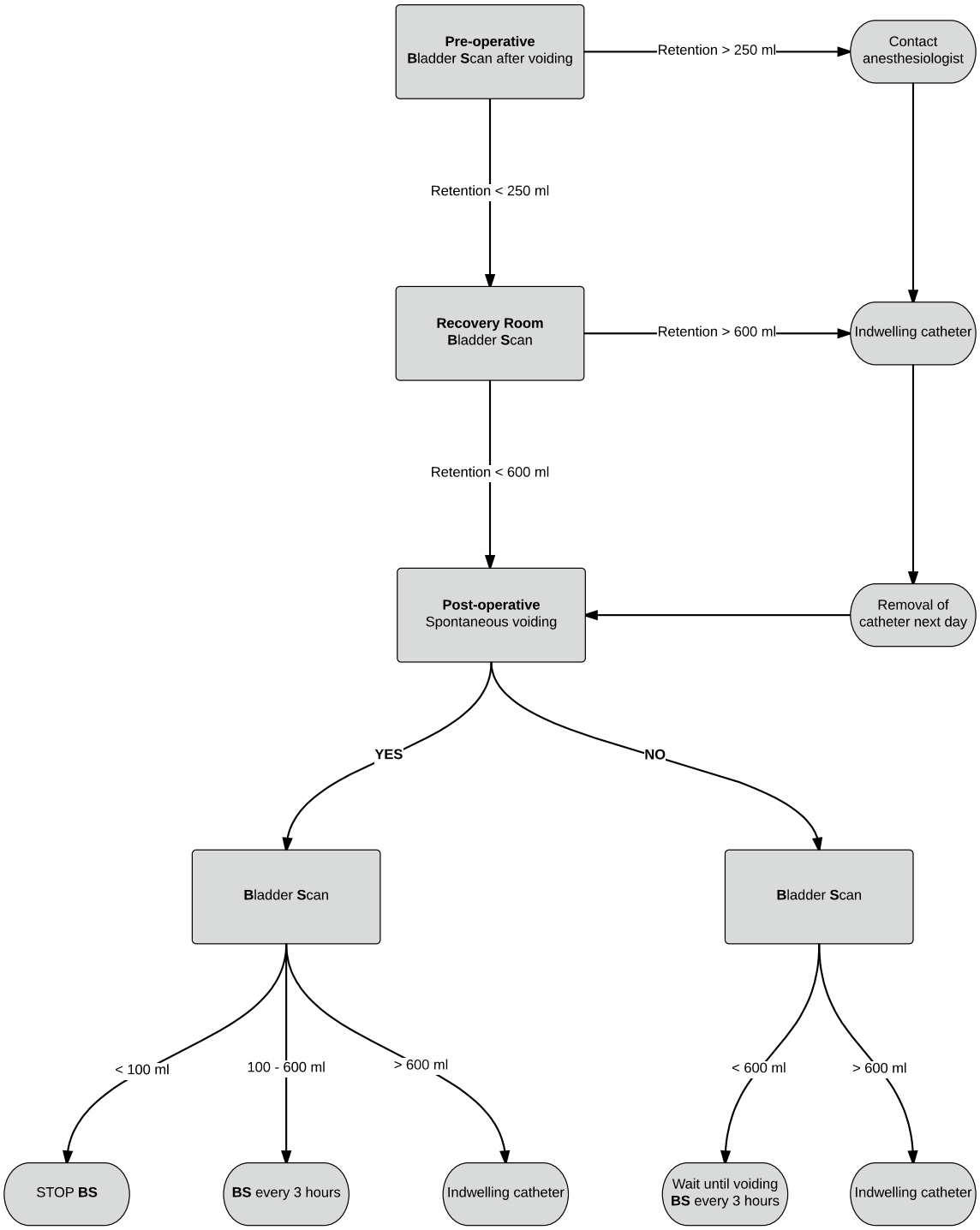

Fig. 2 Pre- and postoperative bladder scan (BS) protocol for the prevention of POUR used by the nursing staff

used with a maximum of two times 50 mg per day, and occasional oxycodone was used when the patient experienced side effects from tramadol.

After surgery, patients were observed in the recovery room until their cardiorespiratory status was stable and pain control was adequate before transferring them to the orthopedic ward. Directly postoperative at the recovery room and every 3 h at the orthopedic ward, bladder volume was monitored until spontaneous voiding (Fig. 2). If the bladder volume exceeded more than 600 ml, with the inability to void spontaneously, catheterization was performed with an indwelling catheter to cope with a possible overdistension

Table 1 Pain protocol

	Preoperative	Postoperative			
	2 h	4 h	8 h	First day	Day 2–14
Meloxicam (mg)	15			15	15
Paracetamol (g)	1	1	1	1	1
Gabapentine (mg)	600	300		300	
Pantoprazol (mg)	40			40	40

of the bladder [23]. In case of catheterization, the catheter was removed the next day. If the patient was able to void spontaneously, with a bladder volume <100 ml, monitoring was discontinued.

Within 6 h postoperative, the patient was mobilized under supervision of a physiotherapist after recovery from anesthesia. After the first mobilization, patients were transferred to the restroom under guidance of a nurse in case of urge to void. Patients were discharged from the hospital if they met the discharge criteria: overall general well-being, spontaneous voiding with bladder volume <100 ml, a dry wound, adequate pain control, individual and safe mobilization with transfer into and out of bed and chair, walk independently with a walking aid, and if necessary walking stairs with crutches.

Outcome

The primary outcome of this study was the incidence of POUR defined as the inability to void spontaneously with a bladder volume >600 ml, detected with a bladder scan, requiring indwelling catheterization. Secondary, to detect potential risk factors: gender, age, body mass index (BMI), ASA classification, preoperative bladder volume, type of anesthesia, type of arthroplasty, perioperative fluid administration, and bladder volume at the recovery room were analyzed between POUR and non-POUR patients. All outcomes were recorded in the patients' digital clinical record.

This study was performed in compliance with the Declaration of Helsinki 1975, as revised in 2000, and the study was approved by the IRB (METC Zuyderland, Heerlen, the Netherlands, IRB Nr. 15-N-136) and conducted in accordance with the guidelines for Good Clinical Practice (GCP).

Statistics

All data collected for this study was entered into an Excel database (Microsoft Office 2003) and analyzed using the SPSS 17.0 (SPSS Inc. Chicago, IL) statistical program. A descriptive analysis of the sample was done using rates for categorical variables and the mean (SD) for continuous variables. The collected data were tested for normality with use of the Shapiro–Wilk test. Since data were not normally distributed, differences between the POUR and non-POUR group were tested with the use of Mann–Whitney *U* test. A p value ≤ 0.05 was considered to be statistically significant. If there was a significant difference for one of the secondary outcomes measures, the odds ratio (OR) with 95% confidence interval (CI) was calculated to determine possible risk factors for POUR. To create a cutoff point, median values of the total group were used. Results are presented as either frequencies (%) or mean (SD).

Results

The incidence of POUR was 12.9% (n = 82; 95% CI 9.4–15.5%). There were no significant differences for patient demographics and pre- and perioperative outcome measures between POUR and non-POUR patients (Table 2). None of the patients underwent re-catheterization after treatment of POUR.

Median bladder volume at the recovery room for the total group was 200 ml. When using this as a cutoff value, bladder volume of >200 ml at the recovery room was a risk factor for POUR (OR 5.049, 95% CI 2.815–9.054) (Table 3).

Table 2 Baseline demographics are presented as frequencies (%) or mean (SD) with p value

	POUR (n = 82)	Non-POUR (n = 556)	p value
Patient demographics			
Male/female (%)	29/53 (35/65)	200/365 (36/64)	0.915
Age in years (SD)	68.64 (11.04)	69.42 (8.72)	0.827
BMI in kg/m^2 (SD)	28.63 (4.39)	28.94 (5.97)	0.742
ASA classification I/II/III	7/43/5	35/332/20	0.312
Spinal/general anesthesia (%)	59/23 (72/28)	398/158 (72/28)	1.000
THA/TKA (%)	51/31 (62/38)	272/284 (49/51)	0.059
Fluid administration in ml, mean (SD)	941.89 (367.80)	881.49 (343.33)	0.231

Table 3 Pre- and postoperative bladder volume outcomes are presented as mean (SD) with *p* value

	POUR ($n = 82$)	Non-POUR ($n = 556$)	*p* value
Preoperative			
Preoperative bladder volume in ml (SD)	47.78 (61.69)	37.99 (53.68)	0.131
Postoperative			
Bladder volume at recovery room in ml, mean (SD)	468.21 (257.67)	215.47 (139.59)	**0.000**

Discussion

The most important finding of the present study was that with the use of a nurse-led bladder scan protocol combined with pre-, peri-, and postoperative optimizations (e.g., fluid restriction, opioid-sparing pain protocol), the incidence of POUR after arthroplasty patients following a fast-track pathway was 12.9%, with >200 ml of bladder volume at the recovery room as a risk factor for POUR.

The first large-scale and multicenter prospective study on POUR after arthroplasty showed an incidence of approximately 40% [5]. Later series found an incidence of 13–32% depending on the used cutoff value for bladder volume, respectively, 800 and 500 ml [6]. Balderi et al. [2] reported an incidence of 25% in arthroplasty patients and concluded that the use of a bladder scan algorithm can reduce the incidence of POUR. An even lower incidence of POUR after hip and knee arthroplasty was found by Tischler et al. [27]. They performed only bladder scans on patients with symptomatic bladder distention and could therefore underrate the incidence of POUR. Compared to these studies, the presented incidence of POUR in this study was low.

A possible explanation for the low incidence of POUR could be the selection prior to surgery. Since it is known that a preoperative bladder volume of >270 ml is a risk factor for POUR [3], the present study created a safe cutoff value for preoperative urinary retention (>250 ml) and excluded these patients from analysis. In case of preoperative urinary retention, patients were treated with indwelling catheterization prior to surgery [29]. Another explanation could be the wide range of bladder volume as cutoff values (400–800 ml) in the literature [2, 5, 6, 29]. These cutoff values can affect a valid comparison between the study results.

Frequent monitoring with the use of a bladder scan decreases the incidence of POUR [8, 9, 18] and should be performed 6–8 h after the start of anesthesia [15]. In the current study, monitoring continued directly postoperative at the recovery room and was repeated every 3 h at the orthopedic ward until spontaneous voiding. As far as we know, this is the first study showing that >200 ml of bladder volume on the recovery room is a risk factor (OR 5.049) for POUR after hip or knee arthroplasty. Previously, Keita et al. [20] found >270 ml at the post anesthesia care unit as a predictive factor for POUR (OR 4.8), but these results were found after surgeries of different specialties (e.g., orthopedic, abdominal, urologic). Bladder volume monitoring should be performed directly postoperative to detect an early development of POUR [14]. For patients who exceed >200 ml of bladder volume at the recovery room, a more stringent follow-up, in terms of frequent bladder scan monitoring at the orthopedic ward, should be considered.

Treatment strategies in case of POUR (intermittent vs. indwelling catheterization) and duration of catheterization remain controversial [3]. Zhang et al. [29] found that indwelling catheterization was superior to intermittent catheterization in the prevention of POUR after the routine use of indwelling catheterization for all patients undergoing THA or TKA. They found comparable risk of urinary tract infection. The superior treatment of POUR, without the routine use of preoperative indwelling catheterization, remains questionable. In case of POUR and treatment with indwelling catheterization in the postoperative phase, the present study found no recurrent POUR as seen after intermittent catheterization [5, 6, 12].

Literature on anesthesia technique as a risk factor for POUR is divided. Several studies found that the use of spinal anesthesia increased the risk of POUR [5, 6, 15, 22], as other studies concluded that type of anesthesia did not influence the incidence of POUR [1, 21, 26]. Based on the negative influence on detrusor activity, which can lead to a subsequent atonic bladder, postoperative epidural anesthetics can increase POUR [2, 21]. Patient-controlled analgesia [15] and intrathecal morphine use [10, 11, 27, 28] were also found to be risk factors and should be avoided in the pain management to prevent for POUR. Higher amounts of perioperative fluid administration are related to increased risk of POUR [3, 13]. Unfortunately, a precise cutoff value is unknown. When using a restrictive protocol (max. 1000 ml), perioperative fluid administration did not increase the risk of POUR in the present study.

Several studies reported male gender as a risk factor for POUR [1–3, 11, 13, 15, 21, 26]. Bjerregaard et al. [5] did not find gender to be a risk factor, but an increased International Prostate Symptom Score (IPSS) was related to POUR. In a retrospective analysis on 376 male THA patients, Hollman et al. [15] could not confirm these results since they found no relation between POUR and prostate pathology. Nevertheless, a high incidence (39.9%) of POUR after THA in men was reported [15].

This study has several limitations. Firstly, the presented study examined a general applicable protocol for hip and knee arthroplasty patients following a fast-track pathway,

without consideration of the patients' specific comorbidity (e.g., IPSS, urologic or renal comorbidities), which could have led to confounding results. Secondly, there is no consensus on cutoff value's for bladder volume. Therefore, the presented incidence of POUR, when using a cutoff value of more than 600 ml, could be underrated. Randomized controlled trials on the bladder scan protocol are needed to confirm the presented results and should focus on cutoff value's at different steps in the bladder scan protocol. Furthermore, selection criteria are needed to detect high-risk patients. To ensure patient's safety, these patients should be treated with indwelling catheterization prior to surgery. When using a nurse-led bladder scan protocol, this study showed a low incidence of POUR after fast-track hip and knee arthroplasty in comparison with recent literature.

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Compliance with ethical standards

Conflict of interest One author (NK) is a paid consultant for Zimmer Biomet, Europe. One other author (PP) is currently a paid employee of Zimmer Biomet. This was not the case when the study was set up. The other authors certify that they have no commercial associations (e.g., consultancies, stock ownership, equity interest, patent/licensing arrangements) that might pose a conflict of interest in connection with the submitted manuscript. The other authors declare that they have no conflict of interest. No financial support was received for this study.

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