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REVIEW

- 1 Post-operative urinary retention: Review of literature
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Post-operative urinary retention: Review of literature

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Abstract

Postoperative urinary retention (POUR) is one of the postoperative complications which is often underestimated and often gets missed and causes lot of discomfort to the patient. POUR is essentially the inability to void despite a full bladder in the postoperative period. The reported incidence varies for the wide range of 5%-70%. Multiple factors and etiology have been reported for occurrence of POUR and these depend on the type of anaesthesia, type and duration of surgery, underlying comorbidities, and drugs used in perioperative period. Untreated POUR can lead to significant morbidities such as prolongation of the hospital stay, urinary tract infection, detrusor muscle dysfunction, delirium, cardiac arrhythmias etc. This has led to an increasing focus on early detection of POUR. This review of literature aims at understanding the normal physiology of micturition, POUR and its predisposing factors, complications, diagnosis and management with special emphasis on the role of ultrasound in POUR.

Key words: Postoperative urinary retention; Urinary retention; Postoperative bladder dysfunction; Urinary retention and anaesthesia; Prevention postoperative urinary retention

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Core tip: Postoperative urinary retention is considerable concern inpatients after the surgical intervention. It not only dissatisfies the patient but also confounds many serious concerns in immediate postoperative period. It is reported variably with many etiological factors. Its understanding, recognition using suitable assessment/tools and suitable timely management remains paramount and can avoid many untoward outcomes.

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INTRODUCTION

Postoperative period is a critical period which can witness numerous complications including pain, respiratory and/or haemodynamic disturbances, nausea, and vomiting *etc.* Postoperative urinary retention (POUR) is another such complication which is often underestimated and often gets missed. POUR refers to patients' inability to void urine in spite of full bladder after the surgical intervention in the postoperative period. The reported incidence varies for the wide range of 5%-70%. This wide range may be due to absence of a uniformly accepted definition for POUR along with its multifactorial etiology^[1-3]. Occurrence of POUR may depend on the various reasons like the type of anaesthesia, type and duration of surgery, underlying comorbidities, and drugs used in perioperative period. Untreated POUR can lead to significant morbidities such as prolongation of the hospital stay, urinary tract infection, detrusor muscle dysfunction, delirium, cardiac arrhythmias *etc.*^[4,5]. This has led to an increasing focus on early detection of POUR. The use of ultrasonography to diagnose POUR has gained popularity in recent years. The various advantages of ultrasound as a diagnostic tool include its non-invasive technique, high accuracy, and absence of any risk of trauma or infection. This review aims at understanding the normal physiology of micturition, POUR and its predisposing factors, complications, diagnosis and management with special emphasis on the role of ultrasound in POUR.

This review is being written with an objective to summarize the literature related to POUR. The literature search was done from various search engines including PubMed, Cochrane Library, and Google Scholar. The search words included "postoperative urinary retention", "urinary retention", "postoperative bladder dysfunction", "micturition physiology", "risk factors", "urinary retention and anaesthesia", "postoperative voiding dysfunction", "complications urinary retention", "diagnosis postoperative urinary retention", "catheterization complications", "ultrasound urinary retention", "three-diameter ultrasound", and "prevention postoperative urinary retention".

The published literature related to POUR has been included and all study designs including systematic reviews and editorials were studied. During the search, any published literature not related to POUR were excluded. The literature published till June 2018 were included in this review.

MECHANISM OF MICTURITION

Normal physiology

Bladder is supplied with sympathetic, parasympathetic and efferent somatic fibres. Visceral afferent fibres, also called stretch receptors, arise from bladder wall. Micturition is a complex process which can be divided into two phases viz storage phase and voiding phase. Storage phase is mediated through sympathetic innervation whereas voiding phase by parasympathetic fibres. Overall, micturition is a spinal reflex which is further governed by brainstem centres. The bladder wall is a compliant muscular organ and can accommodate increasing volume of urine without much increase in pressure till a particular volume. The capacity of the normal bladder is 400-600 mL. The first urge to void occurs when the bladder volume is approximately 150 mL whereas the sensation of fullness occurs at 300 mL. The pelvic splanchnic nerves carry the reflex from the stretch receptors to the brainstem through afferent fibres when the bladder contains urine more than 300 mL. This activates the voiding phase and the parasympathetic fibres conduct the efferent pathway. Detrusor muscle contraction by parasympathetic fibres and removal of inhibition of motor cortex is required for voiding of urine. As soon as urine enters the posterior urethra this motor cortex inhibition is removed by pudendal afferents which results in relaxation of pelvic floor, descent of levator ani muscle and voiding of urine^[1,6].

Alterations in physiology in perioperative period

The perioperative period can potentially affect the normal physiology of micturition. This can be attributed to the effects of anaesthesia, the surgical procedure performed,

the intraoperative physiologic stressors, drugs, pain, anxiety *etc.* Many drugs used in perioperative period such as sedatives, analgesics and anaesthetic agents are known to interfere with the micturition pathway^[5,7].

Opioids, commonly used for both intraoperative and postoperative analgesia, are known to cause urinary retention by blunting the sensation of bladder fullness (due to parasympathetic inhibition) along with increasing the sphincter tone (due to augmented sympathetic activity). Neuraxial opioids have been reported to have greater incidence of urinary retention as compared to intravenous administration. General anaesthetics also predispose to urinary retention as they cause relaxation of smooth muscle and hence decrease bladder contractility. In addition, they may also cause autonomic dys-regulation of the bladder tone.

Neuraxial local anaesthetics increase the propensity for POUR by interfering with both the afferent and efferent pathways of micturition. The longer acting agents entail higher risk for causing bladder dysfunction due to prolonged over-distention^[5,7,8].

Risk factors

Various authors have studied the perioperative factors which can potentially influence the occurrence of urinary retention in the postoperative period (Table 1)^[9-14]. Some of these factors are well proven for causing POUR while certain other factors are less proven and need further trials to implicate their role in POUR.

Age

The incidence of POUR increases with increasing age. This possibly is related to deterioration of the neurologic pathway responsible for urination with advancing age. Increased incidence of prostatomegaly in older males could also be a contributory factor for POUR^[1,3,5,9,10].

Gender

Though majority of the studies and reviews report higher incidence of POUR in males^[1,3,9,15], but Toyonaga *et al*^[7] found female gender to be an independent predictor of POUR.

Pre-existing neurologic abnormality

Patients with pre-existing neurologic disorders like stroke, cerebral palsy, multiple sclerosis, diabetic and alcohol neuropathy, poliomyelitis are at higher risk for urinary retention in the postoperative period^[1,9].

Preoperative urinary tract pathology

The evidence on pre-existing urinary tract pathology as a potential risk factor for POUR remains equivocal. Tammela *et al*^[9] studied 5220 surgical patients and reported that almost 80% of the patients who developed POUR had some form of previous voiding difficulty. Toyonaga *et al*^[7] reported various factors responsible for POUR after surgical interventions like anorectal diseases. They observed that presence of pre-existing urinary tract symptoms such as frequent urination, nocturia *etc.* to be an independent predictor for POUR. However, many authors have found contradictory results where pre-existing urinary tract abnormalities did not predispose the patients to develop urinary retention postoperatively^[16,17].

Bladder volume on entry to post anaesthesia care unit

The bladder volume after the surgical intervention has been related with occurrence of POUR. A prospective study conducted to determine the risk factors for predicting early POUR reported the presence of bladder volume of more than 270 mL after the surgery remain an independent predictor of POUR^[3].

Surgical procedure

Certain surgical procedures entail a higher risk of POUR than other surgeries^[5]. Owing to multiple reasons, anorectal, colorectal, and urogynaecological surgeries have been observed to have a significantly higher risk of POUR^[5,11,12].

Anaesthetic technique

Literature remains equivocal on the effect of the anaesthetic technique on the incidence of POUR. A review of the perioperative factors responsible for POUR evaluated 190 studies and found that the overall incidence of POUR was higher with regional anaesthesia as compared to general anaesthesia (GA)^[1]. However, when clinical diagnostic criteria (patient discomfort, distended and palpable bladder, inability to void after a defined time postoperatively) were used, the incidence was higher with GA. The authors attributed this difference to the wide variation in the clinical criteria used in the different studies. Also, the retrospective nature of the

Table 1 Various risk factors for urinary retention in the postoperative period

Definitive	Equivocal	Unrelated
Age ^[1,3,5,9,10] ; Pre-existing neurologic abnormality (stroke, cerebral palsy, multiple sclerosis, diabetic and alcohol neuropathy, poliomyelitis) ^[1,9] ; Bladder volume on entry to PACU ^[3] ; Surgical procedure (anorectal, colorectal, urogynaecological) ^[5,7,11,12] ; Intraoperative aggressive fluid administration ^[1,3,5,6,11,13] ; Postoperative pain and need for postoperative analgesia ^[5,7,9,11,14] ; Postoperative opioid use ^[1,5,11]	Gender ^[1,3,7,9,15] ; Preoperative urinary tract pathology ^[5,7,9,16,17] ; Anaesthetic technique (general anaesthesia <i>vs</i> neuraxial anaesthesia) ^[1,2,6,9,10,12,17] ; Duration of surgery ^[1,3,5-7,18]	American Society of Anaesthesiologists physical status ^[18] ; Presence of pelvic drain ^[18] ; Pelvic infection ^[18]

PACU: Post anaesthesia care unit.

analysis; majority of the data being taken from the clinical records may have contributed to this discrepancy^[1]. The reported incidence of POUR has been observed to be higher in patients undergoing surgery under subarachnoid block (SAB)^[2,6,10,12]. Contradictory, few other studies negate the effect of type of anaesthesia on occurrence of POUR^[9,17].

Intraoperative fluid administration

The volume of fluids administered intraoperatively can have a significant impact on the occurrence of POUR. The aggressive fluid management can lead to over distension of the urinary bladder and more possibility of POUR^[1,5,9]. However, there is no clear consensus as to the cut-off limit for volume of intraoperative fluids with various authors using different values *e.g.*, 750 mL^[3,7], 1000 mL^[13], and 1200 mL^[11].

Duration of surgery

Longer duration of surgery can be a contributing factor for POUR; possibly due to more fluid administered and higher amount of opioids used^[1,6]. Various studies have confirmed this association^[3,5-7,18].

Postoperative pain

Postoperative pain can cause higher incidence of POUR by causing inhibition of the micturition reflex due to increased sympathetic discharge^[5,9]. Many authors have documented a higher incidence of POUR in patients experiencing more postoperative pain^[7,11,14].

Postoperative opioids

Despite the fact that increased pain and need for postoperative analgesia are known predisposing factors for POUR; use of postoperative opioids can itself lead to a higher incidence of POUR^[1,5,11].

Concerns related to POUR

Pour can have multiple impacts on the patients in the postoperative period. Urinary retention in the postoperative period can potentially delay the discharge from hospital leading to increase in the health costs^[9,19]. Apart from causing prolonged hospitalization, POUR is also a source of significant discomfort and morbidity to the patient. An over-distended bladder can cause severe suprapubic pain, nausea and vomiting. Bladder distension and the resulting pain can result in sympathetic over-activity leading to haemodynamic disturbances such as hypertension, cardiac dysrhythmias *etc*^[20].

Incomplete emptying of the bladder due to retention of urine also predisposes the patient to urinary tract infections (UTI) in the postoperative period. Urethral catheterization itself, done for the management of POUR, can also increase the risk for UTI^[1]. Even a single brief catheterization has the propensity to introduce infection into the urinary tract^[21].

Over-distension of the bladder, especially if prolonged, can cause long-term changes in bladder contractility and elasticity due to detrusor muscle dysfunction. Even a transient over-distension of the urinary bladder can have deleterious effects on the detrusor muscle and bladder wall^[22]. Lamonerie *et al*^[6] reported that incidence of bladder distension to be 44% in 177 adult patients after a variety of elective surgical procedures. Stretching of bladder beyond its maximum capacity of 400-600 mL has potential to cause ischemic damage and irreversible insult to the contractile elements of the detrusor muscle and the associated motor end-plates^[23,24]. This can lead to long-term micturition difficulties, higher post-voiding residual volumes and thereby further increased predisposition to UTIs.

Diagnosis of POUR

POUR usually is a transient complication which gets relieved spontaneously in majority of the patients. However, in some cases, especially in those with high risk factors, prolonged retention can cause significant morbidity. Screening of high-risk patients and aiming for an early diagnosis of POUR are critical in averting the detrimental effects of over-distension on bladder morphology and function subsequently. Diagnosis of POUR has been done by three basic methods viz clinical signs and symptoms, bladder catheterization and ultrasound assessment (Table 2)^[25-51].

Clinical signs and symptoms

The traditional technique for identification of urinary retention and bladder distension after surgery was by assessing the patient for suprapubic pain and discomfort, difficulty or inability to void, presence of suprapubic dullness, and palpable bladder^[11,13,25,26]. However, clinical assessment by patients, nurses or physicians is fraught with inaccuracies. Pavlin *et al*^[12] assessed 334 patients undergoing different types of day-care surgeries for occurrence of POUR by clinical assessment and by ultrasound. They reported that clinical estimation of postoperative bladder volume was incorrect in 54% and 46% cases when done by patients and nurses respectively. Additionally, manual estimation of bladder size may be difficult in patients with obesity or having previous abdominal surgery; often resulting in failure to recognize a distended bladder^[27].

Bladder catheterization

Catheterization of bladder can be used both as a diagnostic as well as therapeutic measure for POUR. The need to catheterize after a stipulated period of time postoperatively and/or volume of urine voided by catheterization has been employed as the diagnostic criteria for POUR in many studies^[7,10,14,38,39]. However, catheterization, being an invasive procedure, itself carries many risks such as urethral trauma, discomfort, and urinary tract infection. Also, the use of catheterization for diagnosis may lead to unnecessary catheterizations, further increasing the patient morbidity^[1,21].

Role of ultrasonographic assessment

Applications of ultrasound in the field of anaesthesiology have already been established in many areas and they continue to expand even now. Its role in the diagnosis of POUR has received recognition in the last decade. The appeal of bedside ultrasound as a diagnostic modality for POUR lies in its high accuracy and inter-observer reliability; even in children^[9] and obese^[27]. In addition, being a non-invasive method, it carries no risk of trauma, discomfort or infection^[52]. The other diagnostic methods for POUR; as elucidated previously; either lack precision or carry risk of infection and trauma. The use of ultrasound for prediction and diagnosis of POUR can help avoid unnecessary catheterizations while also preventing potential complications of bladder over-distension in high-risk patients.

Many authors have employed ultrasound for measurement of bladder volume and have established its role as a diagnostic tool for POUR. While most studies have focussed on its use in the post anaesthesia care unit (PACU), few authors have also evaluated its use in screening patients preoperatively in order to prevent development of postoperative bladder distension^[2,48,49].

Grieg *et al*^[27] compared manual examination of bladder volume with ultrasound and found that ultrasound was superior in identifying patients with bladder over-distension. Pavlin *et al*^[12] also observed that use of ultrasound as screening tool for POUR is beneficial by avoiding unnecessary urinary catheterization. When comparing the bladder volumes measured by bladder catheterization and by portable ultrasound, ultrasound showed good accuracy and correlation with volume emptied by catheterization^[50,53].

Determination of bladder volume by ultrasonography has traditionally been done by measurement of three diameters viz transverse, supero-inferior and antero-posterior^[49,54]. The accuracy of a single diameter measurement was assessed by Daurat *et al*^[4] measured the largest transverse bladder diameter in 100 orthopaedic patients with at least one risk factor for POUR in the PACU and evaluated its correlation with the bladder volume (estimated by automated bladder USG and by bladder catheterization). These authors reported that bladder measurement of largest transverse diameter of ≤ 9.7 cm does not require catheterization. However, patients with bladder diameter of > 10.7 cm should be catheterized. They concluded that a single measurement of the largest transverse diameter is a technically simpler method for assessment of bladder volume and can be used for prediction of POUR with good inter-observer reliability.

Widespread use of ultrasound for diagnosis of POUR however remains limited by the fact that there is no clear consensus on the bladder volume at which

Table 2 Diagnostic modalities for postoperative urinary retention

Method of diagnosis	Ref.	Objective	Sample population	Results
Clinical examination				
Palpable bladder distension	Bailey <i>et al</i> ^[25] (1976)	To study effect of fluid restriction on incidence of POUR	500 patients undergoing anorectal surgeries	Significant reduction in POUR with fluid restriction
Palpable bladder or patient discomfort	Petros <i>et al</i> ^[11] (1991)	To determine incidence of and factors influencing POUR after herniorrhaphy	295 patients who had undergone herniorrhaphy	Factors affecting POUR included age, fluid restriction, type of anaesthesia
Palpable/distended bladder or patient discomfort	Petros <i>et al</i> ^[13] (1990)	To determine factors affecting POUR after surgery for benign anorectal diseases	111 patients who had undergone surgery for benign anorectal diseases under spinal anaesthesia	Using long-acting local anaesthetic (bupivacaine) and use of > 1000 mL fluid increased risk of POUR
	Waterhouse <i>et al</i> ^[26] (1987)	To identify patients at risk of POUR	103 patients undergoing total hip replacement	At-risk patients included those with inability to pass urine into bottle while lying supine, with history of voiding difficulty, and with urinary peak flow rate suggestive of obstruction
Clinical assessment by patient or nurses	Pavlin <i>et al</i> ^[12] (1999)	To compare patient outcome after ambulatory surgery with or without USG monitoring of bladder volume	334 patients undergoing outpatient surgeries	USG monitoring was beneficial in patients at high-risk for POUR
Manual palpation and percussion of bladder	Greig <i>et al</i> ^[27] (1995)	To compare bladder volume by manual and USG examination	90 patients undergoing laparoscopic surgery	Manual assessment of bladder failed to detect urinary retention especially in obese patients
Painful urinary retention or manual palpation of bladder	Stallard <i>et al</i> ^[28] (1998)	To measure incidence of POUR	280 patients undergoing general surgical operations	Incidence of POUR was 6% and was attributed to decreased awareness of bladder sensation
Failure to void till 8 h postoperatively and distended bladder/patient discomfort	Cataldo <i>et al</i> ^[29] (1991)	To study role of prazosin for prevention of POUR after anorectal surgeries	51 patients undergoing elective anorectal procedures	Prophylactic use of prazosin did not decrease incidence of POUR
Failure to void postoperatively	Pawlowski <i>et al</i> ^[30] (2000)	To compare the time for discharge after use of two doses of mepivacaine in ambulatory SAB	60 patients undergoing ambulatory surgery for anterior cruciate ligament tear under spinal anaesthesia	None of the patient in either group had difficulty in voiding
Distended bladder	Esmaoglu <i>et al</i> ^[31] (2004)	To compare time for hospital discharge for knee arthroscopies under unilateral <i>vs</i> bilateral SAB	70 patients undergoing elective outpatient knee arthroscopy	Urinary retention was present in bilateral SAB group with longer time to discharge
Distended/palpable bladder and failure to void postoperatively	Evron <i>et al</i> ^[32] (1985)	To assess urinary retention after epidural methadone and morphine	120 females scheduled for caesarean section under epidural anaesthesia	Lower incidence of urinary complications with use of epidural methadone
Failure to void spontaneously within 8 h of removal of urinary catheter	Paulsen <i>et al</i> ^[33] (2001)	To compare postoperative recovery after bowel resection with thoracic epidural <i>vs</i> patient-controlled analgesia	49 patients undergoing elective bowel resection	Patients with thoracic epidural had lower pain scores but higher incidence of POUR and other complications
Urinary retention graded as: 0 = none; 1 = mild hesitancy; 2 = straight catheter required; and 3 = Foley catheter required	Baron <i>et al</i> ^[34] (1996)	To evaluate effect of addition of epinephrine on postoperative requirement of epidural fentanyl	38 patients undergoing elective posterolateral thoracotomy	Addition of epidural epinephrine decreased fentanyl requirement with no significant change in POUR incidence
Delayed spontaneous micturition	Lanz <i>et al</i> ^[35] (1982)	To study effect of epidural morphine on postoperative analgesia	174 patients receiving lumbar epidural anaesthesia orthopaedic procedures	Better postoperative analgesia but higher incidence of POUR with epidural morphine
Failure to void till 12 h postoperatively	Dobbs <i>et al</i> ^[36] (1997)	To compare postoperative outcomes in continuous bladder drainage <i>vs</i> in-out catheterization during total abdominal hysterectomy	100 females scheduled for total abdominal hysterectomy for non-malignant cause	Significantly higher incidence of POUR after in-out bladder catheterization

Failure to void postoperatively along with patient discomfort/palpable bladder	Kumar <i>et al</i> ^[37] (2006)	To evaluate the occurrence of POUR after total knee arthroplasty and role of indwelling bladder catheterization	142 patients undergoing total knee arthroplasty	19.7% patients had POUR. Authors recommended use of indwelling catheter for management of POUR
Bladder catheterization				
Requirement of bladder catheterization	Lau <i>et al</i> ^[10] (2004)	To ascertain optimal management of POUR (in-out catheterization <i>vs</i> indwelling catheter)	1448 patients undergoing elective inpatient general surgery	In-out catheterization recommended for POUR over indwelling catheter
Need for catheterization within 24 h postoperatively	Toyonaga <i>et al</i> ^[7] (2006)	Incidence and risk factors for POUR after surgery for benign anorectal diseases	2011 patients who underwent surgery for benign anorectal diseases under SAB	Incidence of POUR was 16.7%. Perioperative pain and excessive fluid administration were found to be risk factors
Need for urinary qcatheter (indwelling and/or temporary) within 24 h after surgery	Zaheer <i>et al</i> ^[14] (1998)	Incidence and risk factors for POUR after surgery for benign anorectal diseases	1026 patients who underwent surgery for benign anorectal diseases	Incidence of POUR was more after haemorrhoidectomy than other anorectal procedures.
Requirement of catheterization (with resulting urinary volume > 400 mL)	Faas <i>et al</i> ^[38] (2002)	Effect of SAB <i>vs</i> epidural anaesthesia on pain, urinary retention and ambulation in patients scheduled for inguinal herniorrhaphy	144 patients scheduled for elective inguinal herniorrhaphy	SAB resulted in more incidence of POUR and delayed ambulation
Need for catheterization (with residual volume > 500 mL)	Olofsson <i>et al</i> ^[39] (1996)	To compare post-partum urinary retention after epidural labour analgesia with bupivacaine and adrenaline <i>vs</i> bupivacaine and sufentanil	1000 antenatal females scheduled for epidural labour analgesia	Epidural anaesthesia led to higher risk for post-partum urinary retention
Need for catheterization	Lingaraj <i>et al</i> ^[40] (2007)	Incidence and risk factors for POUR after total knee arthroplasty	125 patients who underwent total knee arthroplasty	Incidence of POUR was 8%; predisposing factors being male gender and epidural anaesthesia
Need for catheterization	O'Riordan <i>et al</i> ^[41] (2000)	Risk factors for POUR after lower limb joint replacements	116 patients undergoing lower limb replacements	Increasing age, male gender, and use of patient-controlled analgesia (PCA) were risk factors
Need for catheterization	Jellish <i>et al</i> ^[42] (1996)	To compare perioperative outcomes after SAB <i>vs</i> GA for lumbar disc and laminectomy procedures	122 patients undergoing lumbar laminectomy or disc surgery	Incidence of POUR was similar in both groups
Need for catheterization	Fernandes MCBC <i>et al</i> ^[43] (2007)	To determine incidence of POUR in patients using postoperative opioid analgesics (PCA or epidural)	1316 patients undergoing elective surgery and using opioids for postoperative analgesia	Incidence of POUR was 22% ; with higher incidence in patients using continuous epidural analgesia
Need for catheterization	Matthews <i>et al</i> ^[44] (1989)	To compare efficacy of epidural <i>vs</i> paravertebral bupivacaine infusion for post-thoracotomy analgesia	20 patients scheduled for thoracotomy and pulmonary resection	Analgesia was comparable in both groups. Incidence of urinary retention was lower in paravertebral group
Need for catheterization	Peiper <i>et al</i> ^[45] (1994)	To compare perioperative outcomes after LA <i>vs</i> GA for inguinal hernia repair	607 patients operated for inguinal hernia repair	Patients in LA group had lower intensity of pain and had fewer complications <i>e.g.</i> POUR
Need for catheterization within 48 h postoperatively	Fletcher <i>et al</i> ^[46] (1997)	To study postoperative analgesia with iv paracetamol and ketoprofen after lumbar disc surgery	64 adults undergoing surgery for lumbar disc herniation	Postoperative analgesia was better in patients receiving both paracetamol and ketoprofen; with no difference in incidence of POUR
Ultrasonographic assessment				
Inability to void with residual volume ≥ 600 mL	Pavlin <i>et al</i> ^[12] (1999)	To evaluate the effect of ultrasonographic monitoring of bladder volume postoperatively after ambulatory surgery	334 patients scheduled for outpatient surgeries	USG assessment helped in evaluating the need for catheterization in patients at high risk for POUR
Inability to void with bladder volume ≥ 600 mL	Daurat <i>et al</i> ^[4] (2015)	To determine the reliability of diagnosis of POUR by a simplified USG measurement of largest transverse bladder diameter	100 patients undergoing orthopaedic surgery	Measurement of largest transverse bladder diameter using USG facilitated in diagnosing POUR

Inability to void with bladder volume > 600 mL	Lamonerie <i>et al</i> ^[46] (2004)	To determine the prevalence and risk factors for POUR using USG	177 patients undergoing a variety of surgical procedures	44% patients had bladder distension as measured by USG. Risk factors for POUR were increasing age, SAB, and surgical duration > 2 h
Inability to void with bladder volume > estimated bladder capacity [(30 mL/age in years) + 30 mL]	Rosseland <i>et al</i> ^[47] (2005)	To assess reliability of postoperative USG monitoring of bladder volume in children	48 children of 0-15 years who had undergone surgical procedure under GA	Reliability of USG monitoring was good in children above 3 years age
Inability to void with bladder volume ≥ 500 mL	Joelsson-Alm <i>et al</i> ^[48] (2012)	To evaluate the efficacy of preoperative USG monitoring in decreasing POUR	281 patients scheduled for emergency orthopaedic surgery	Preoperative scanning of bladder helped in decreasing incidence of POUR
Inability to void with residual volume ≥ 600 mL	Ozturk <i>et al</i> ^[49] (2016)	To evaluate efficacy of preoperative and postoperative bladder scanning to decrease incidence of POUR	80 patients receiving SAB for arthroscopic knee surgery	Postoperative USG monitoring can reduce incidence of POUR
Inability to void with residual volume > 500 mL	Rosseland <i>et al</i> ^[50] (2002)	To compare bladder volume measured by USG with that measured after catheterization	36 patients undergoing surgical procedure under SAB	Good correlation was found between volume estimated by USG and that measured after catheterization
Inability to void within 30 min with bladder volume > 600 mL	Keita <i>et al</i> ^[3] (2005)	To determine risk factors for POUR	313 patients scheduled for elective surgery	Risk factors for POUR included intraoperative fluids > 750 mL, increasing age and bladder volume > 270 mL in PACU
Inability to void with bladder volume ≥ 500 mL	Gupta <i>et al</i> ^[51] (2003)	To compare outcome with two doses of bupivacaine (along with fentanyl) for SAB for inguinal herniorrhaphy	40 patients scheduled for outpatient inguinal herniorrhaphy	Bupivacaine 7.5 mg provide better analgesia than 6mg but led to more urinary retention and longer hospital stay

GA: General anaesthesia; LA: Local anaesthesia; POUR: Postoperative urinary retention; SAB: Subarachnoid block.

catheterization should be done. Bladder volumes ranging from 300-600 mL have been used as the criteria for diagnosing POUR and for catheterizing the bladder^[1,6,12,27,50]. In addition, accuracy and reliability of ultrasonographic bladder scanning may be limited in conditions such as pregnancy, severe abdominal scars, abdominal herniation, co-existing abdominal pathology *etc*^[52].

Prevention

Patients who are at high risk for POUR should be counselled preoperatively about the condition. Intraoperative preventive strategies primarily involve judicious fluid management and reduction of blood loss^[3,55]. Bailey and Ferguson evaluated 500 patients after anorectal procedures and reported that patients who received less than 250 mL fluid perioperatively had significantly lower incidence of POUR^[25].

Optimal management of postoperative pain also plays an important role in preventing POUR. Sympathetic stimulation secondary to pain results in decreased detrusor contraction and increased outflow resistance; thus leading to difficulty in voiding^[5].

Various pharmacological methods have also been attempted for prevention of POUR. Several authors used phenoxybenzamine, an alpha adrenergic blocker, and found favourable results. Alpha-adrenergic antagonists aid micturition by increasing intravesical pressure and decreasing outflow resistance. However, phenoxybenzamine is no longer used due to its carcinogenic potential^[5,56,57]. Tamsulosin, a newer alpha-adrenergic antagonist, has also been found to be effective in reducing the incidence of POUR^[58,59].

MANAGEMENT

Management of POUR involves measures for decompression of the bladder. Since the degree of detrusor dysfunction is directly proportional to the duration of urinary retention and bladder over-distension, therefore early decompression should be the priority; especially in high-risk patients^[6,23,60].

Patients who are at high-risk for POUR can be encouraged to void spontaneously by providing a comfortable environment for the same^[23,60]. In patients who are unable to void on their own, emptying of the bladder by urethral catheterization remains the primary modality of treatment. At present, there is no clear consensus for the criteria

for determining the timing for catheterization^[1,6,61].

Urethral catheterization can be done by two basic approaches viz single in-and-out catheterization or use of indwelling catheter^[5,55]. However, the guidelines for the most appropriate approach remain equivocal^[1,5,10]. A single in-and-out catheterization or clean-intermittent-catheterization has often been preferred due to its lower risk of UTIs^[10,62]. Few authors have, however, reported a higher incidence of bladder distension with this approach^[17,63]. Though an indwelling urethral catheter can prevent the bladder dysfunction resulting from over-distension; but catheterization itself can be a source of significant discomfort and morbidity to the patient^[1,64]. In fact, catheterization-associated UTI are one of the most common causes of nosocomial infections which may deteriorate to cause sepsis and even death. The incidence of UTI increases by 5%-7% for each day the urethral catheter is *in situ*^[65].

Thus, the decision of which patients to catheterize, when to catheterize, and by which approach to catheterize remains at the discretion of the attending physician and is usually taken according to the hospital protocols. Considering the wide variability in literature regarding the diagnostic criteria for POUR, this review cannot advise definite guidelines for the same. Further large studies need to be undertaken for definite conclusion for thresholds and ultrasound based assessment of volume at which catheterization should be done.

CONCLUSION

POUR is a fairly common but an often ignored perioperative complication. Various factors such as age, type and duration of surgery, anaesthetic technique, intra-operative fluid administration can affect the occurrence of POUR. If not diagnosed and managed optimally, it can prolong hospital stay and cause significant morbidity to the patient due to pain, vomiting, UTI, and even permanent bladder dysfunction. Various methods have been used for diagnosing POUR including clinical assessment and bladder catheterization. Use of ultrasound for detection of POUR is gaining popularity in view of its ease of application, accuracy and reliability.

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