Int J Clin Exp Med 2017;10(4):7105-7110
www.ijcem.com /ISSN:1940-5901/IJCEM0042868

Original Article

Clinical factors influencing postoperative urinary retention after lower limb arthroplasty

Min-Soo Choo[1], Seong-Ho Lee[1], Young-Goo Lee[2], Jun-Dong Chang[3], Jun-Hyun Han[1,4]

[1]Department of Urology, [3]Arthroplasty Center, Hallym University Dongtan Sacred Heart Hospital, 7, Keunjaebong-gil, Hwaseong-si, Gyeonggi-do 18450, Korea; [2]Department of Urology, Kangnam Sacred Heart Hospital, 1 Singil-ro, Yeongdeungpo-gu, Seoul 07441, Korea; [4]Research Institute for Complementary & Alternative Medicine, Hallym University, 7, Keunjaebong-gil, Hwaseong-si, Gyeonggi-do 18450, Korea

Received April 11, 2016; Accepted February 11, 2017; Epub April 15, 2017; Published April 30, 2017

Abstract: Acute postoperative urinary retention (POUR) is a common surgical complication. The estimated incidence of POUR after general surgery is 2.1% to 36.6%; the reported incidence after lower limb arthroplasty is 20 times higher than that after other procedures. The aim of the present study was to evaluate the incidence and predictive factors of POUR after lower limb arthroplasty. Between January 2013 and July 2014, 226 consecutive patients (mean age 72.2±12.5 years; 190 females [84.1%]) who underwent hip or knee arthroplasty performed by a single surgeon at our institution were enrolled in this study. POUR was defined as clinical evidence of a distended bladder with inability to void or incomplete bladder emptying despite a desire to void, accompanied by bladder pain or discomfort persisting at least 4 hours after urinary catheter removal. Sixty-two (27.4%) of the 226 patients were diagnosed with POUR. A significantly higher incidence of POUR was found among patients with older age or low body mass index among those who underwent hip surgery or general anesthesia, and among those who received a higher rate of fluid administration or transfusion. Multivariate analysis revealed that age ≥75 years and intraoperative fluid infusion ≥12 mL/min were independent risk factors for POUR. The optimal cutoff value for age as a predictor of POUR was 75 years (area under the receiver operating characteristic curve = 0.764).

Keywords: Urinary retention, arthroplasty, postoperative, risk factors, incidence, aged

Introduction

Acute postoperative urinary retention (POUR) is a common complication after surgery. Its overall incidence among general surgical patients is estimated to be 2.1% to 36.6% [1-3]. POUR has a variety of adverse implications that can affect surgical outcomes.

Bladder distention is the apparent cause of the discomfort or pain associated with POUR. Sympathetic stimulation caused by pain can result in hemodynamic effects, such as dysrhythmias and asystole [4]. Prolonged bladder ischemia from persistent over-distension can cause long-term bladder dysfunction and chronic kidney disease [5]. Indirect sequelae of POUR include iatrogenic urinary tract infection and delayed hospital discharge, both of which can result in higher hospital costs [6].

Although the pathophysiology of POUR is not well understood, the lower spinal level of sensory and motor blockade obtained with lumbar spinal anesthesia compared with thoracic spinal anesthesia may explain the increased time needed for recovery of bladder function after lower limb arthroplasty [7]. Furthermore, systemic opioid analgesia for pain management can result in delayed perception of the need to void [7].

Because of differences in diagnostic criteria, the reported incidence of POUR after lower limb arthroplasty varies widely, from 10.7% to 77.8% [8]. The reported incidence of POUR after lower limb arthroplasty is 20 times greater than that after other procedures [7]. Identifying patients who are likely to develop POUR will help to prevent associated complications. However, no previous studies have convincingly demonstrated the perioperative clinical factors that contribute to POUR. The aim of the present study was to determine the incidence and predictive factors of POUR after lower limb arthroplasty.

Table 1. Baseline and perioperative characteristics

		POUR(-)	POUR(+)	
N	226	164 (72.6%)	62 (27.4%)	*P*[a]
Age	72.2±12.5	69.3±12.1	79.7±10.0	<0.001*
Sex				0.114†
Male	36 (15.9%)	30 (83.3%)	6 (16.7%)	
Female	190 (84.1%)	134 (70.5%)	56 (29.5%)	
Body mass index	24.8±4.5	25.2±4.2	23.7±4.9	0.031*
Comorbidity				
Diabetes mellitus	53 (23.5%)	40 (24.4%)	13 (21.0%)	0.588†
Hypertension	145 (64.2%)	107 (65.2%)	38 (61.3%)	0.580†
Cerebrovascular accident	23 (10.2%)	16 (9.8%)	7 (11.3%)	0.734†
Hyperlipidemia	28 (12.4%)	9 (14.1%)	4 (15.4%)	0.872†
Previous operation	47 (20.8%)	34 (20.7%)	13 (21.0%)	0.969†
Arthroplasty				0.006†
Knee	99 (43.8%)	81 (81.8%)	18 (18.2%)	
Hip	127 (56.2%)	83 (65.4%)	44 (34.6%)	
Emergency operation (vs. elective)	7 (3.1%)	5 (3.0%)	2 (3.2%)	0.142†
ASA classification				0.004†
Physical status 1	27 (11.9%)	24 (14.6%)	3 (4.8%)	
Physical status 2	152 (67.3%)	114 (69.5%)	38 (61.3%)	
Physical status 3	47 (20.8%)	26 (15.9%)	21 (33.9%)	
Anesthesia method				0.076†
General	10 (4.4%)	7 (4.3%)	3 (4.8%)	
Spinal	44 (19.5%)	26 (15.9%)	18 (29.0%)	
Epidural	172 (76.1%)	131 (79.9%)	41 (66.1%)	
Operative duration	119.2±68.6	126.6±67.9	99.7±66.8	0.008*
Anesthetic duration	202.2±76.9	207.8±74.9	187.3±80.4	0.074*
Total EBL, mL	407.1±238.6	429.9±249.6	346.8±196.3	0.019*
EBL, mL/min	3.91±2.26	3.92±2.38	3.89±1.92	0.948*
Total intraoperative fluid administered (mL)	1,347.3±759.9	1,357.5±711.2	1,320.1±882.1	0.742*
Rate of intraoperative fluid administration (mL/min)	12.37±5.77	11.66±5.19	14.23±6.76	0.008*
Blood transfusion	111 (50.9%)	71 (43.3%)	40 (64.5%)	0.004†
PCA				0.249†
None	5 (2.2%)	4 (2.4%)	1 (1.6%)	
Intravenous	49 (21.7%)	31 (18.9%)	43 (69.4%)	
Epidural	172 (76.1%)	129 (78.7%)	18 (29.0%)	

Significant factors shown in bold. P<0.05 for POUR(-) vs. POUR(+). [a]ASA = American Society of Anesthesiologists, POUR = postoperative urinary retention, EBL = estimated blood loss, PCA = patient-controlled analgesia, *Student's *t* test, †Pearson's chi-squared test.

Methods

Between January 2013 and July 2014, 226 consecutive patients who underwent hip or knee arthroplasty performed by a single surgeon at Dongtan Sacred Heart Hospital, Hwaseong-si, Korea, were enrolled in the present study. Patients with Foley catheter *in situ* (five patients) or suprapubic cystostomy (two patients) preoperatively were excluded. In addition, patients with a history of urinary retention (two), urinary incontinence (one), or pelvic organ prolapse (one) were excluded. All patients with preoperative pyuria were treated with prophylactic antibiotics before surgery.

Patient demographics and perioperative data, including age, sex, body mass index, comorbidities, American Society of Anesthesiologists (ASA) classification of physical status, type of

Table 2. Significant predictive factors for acute postoperative urinary retention after lower limb arthroplasty according to Cox univariate and multivariate analyses

	Univariate			Multivariate		
	P	OR	95% CI	*P*	OR	95% CI
Age ≥75 yrs	<0.001	7.822	3.856-15.866	<0.001	5.559	2.419-12.774
Male sex	0.121	2.090	0.824-5.298	0.155	2.185	0.743-6.426
Body mass index ≥23 kg/m^2	0.020	0.923	0.863-0.987	0.825	0.912	0.406-2.053
Diabetes mellitus	0.588	1.216	0.599-2.468			
Cerebrovascular accident	0.758	1.154	0.464-2.867			
Hyperlipidemia	0.872	1.111	0.310-3.986			
Previous operation	0.969	1.014	0.494-2.081			
Hip lesion	0.007	2.386	1.273-4.470	0.415	1.596	0.519-4.910
Emergency operation	0.945	1.060	0.200-5.611			
ASA classification	0.006					
Physical status 2	0.126	2.667	0.760-9.355	0.803	1.190	0.302-4.681
Physical status 3	0.006	6.462	1.707-24.453	0.630	1.467	0.308-6.977
Anesthesia	0.081					
Spinal	0.659	1.369	0.339-5.538	0.812	1.239	0.212-7.253
General	0.025	2.212	1.103-4.436	0.588	0.637	0.125-3.258
Operative duration ≥120 min	0.018	0.444	0.227-0.870	0.705	0.802	0.255-2.521
Intraoperative fluid ≥1,200 mL	0.200	0.671	0.365-1.235			
Intraoperative fluid ≥12 mL/min	0.001	2.900	1.589-5.291	0.020	2.554	1.161-5.622
EBL ≥400 mL	0.008	0.447	0.246-0.814	0.116	0.505	0.215-1.184
EBL ≥4 mL/min	0.139	1.564	0.865-2.827			
Transfusion	0.005	2.382	1.300-4.361	0.109	1.967	0.859-4.501
PCA	0.254					
Epidural	0.799	1.333	0.145-12.256			
Intravenous	0.466	2.323	0.241-22.413			

Significant factors shown in bold. ASA = American Society of Anesthesiologists, CI = confidence interval, EBL = estimated blood loss, OR = odds ratio, PCA = patient-controlled analgesia.

surgery, estimated blood loss, operative duration, anesthetic duration, intraoperative intravenous fluid administration, transfusion volume, and timing of urinary catheter removal were retrospectively collected through careful review of electronic medical records, including anesthesiologists' notes. This study was approved by the institutional review board and local ethics committee.

A 16-Fr or 18-Fr Foley catheter was inserted in the operating room just before surgery. In most cases, the Foley catheter was kept indwelling for 3 days postoperatively. Patient-controlled analgesia consisting of fentanyl and ropivacaine was routinely provided to control postoperative pain. POUR was defined as clinical evidence of a distended bladder, with inability to void or incomplete emptying despite a desire to void, accompanied by bladder pain or discomfort persisting at least 4 hours after urinary catheter removal. In patients with no sensation of the need to void for 6 hours after Foley catheter removal, the residual urine volume was checked with bladder ultrasound and then, catheterization was performed if the residual urine volume was over 400 mL. These patients were also considered to have POUR.

Pearson's chi-squared test was performed to evaluate categorical variables. Analysis of continuous variables was performed with Student's *t* test. The associations between clinical factors and POUR were analyzed with a multivariate backward stepwise logistic regression model to adjust for other related covariates. Backward elimination was performed and variables with a *P* value >0.1 were removed. The goodness of fit of the regression model was evaluated with the Hosmer-Leme show test. Comparisons were two-sided; a *P* value of <0.05 was considered statistically significant. The optimal cutoff value

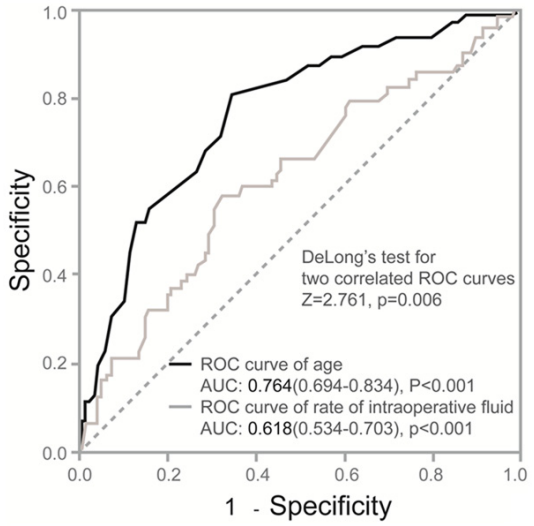

Figure 1. ROC curve for age and rate of intraoperative fluid in the prediction of acute postoperative urinary retention. The AUC value for age was 0.764 (95% CI 0.694-0.834); the AUC value for intraoperative fluid administration rate was 0.618 (95% CI 0.534-0.703). CI = confidence interval, ROC = receiver operating characteristic, AUC = area under the ROC curve.

for a risk factor was determined with receiver operating characteristic (ROC) analysis. Statistical analyses were conducted with IBM SPSS for Windows, Version 21.0 (IBM Inc., Armonk, NY, USA).

Results

The mean patient age was 72.2±12.5 years. Thirty-six of the patients (15.9%) were males and 190 (84.1%) were females. This study included 99 cases of knee and 127 cases of hip arthroplasty. Fifty-three patients had diabetes and 23 had cerebrovascular accidents. Baseline demographic data are shown in **Table 1**.

Of the 226 patients who underwent lower limb arthroplasty, 62 (27.4%) were diagnosed with POUR. The sex-specific incidence of POUR was 16.7% (6/36) among male patients and 29.5% (56/190) among female patients. There was no statistical difference in incidence according to sex (odds ratio [9] 2.185, 95% confidence interval [CI] 0.824-5.298).

Patients with POUR were significantly older than other patients, and POUR was more common after hip than after knee arthroplasty. The rate of intraoperative intravenous fluid infusion was significantly higher among patients with POUR than others. Patients with POUR were significantly more likely to have a higher ASA score. Univariate analysis revealed a significantly higher rate of POUR among patients with older age or lower body mass index, those who underwent hip surgery or general anesthesia, and those receiving a high rate of fluid infusion or a blood transfusion. After adjustment for the effects of covariates with multivariate logistic regression analysis, age ≥75 years (OR 5.559, 95% CI 2.419-12.774, P<0.001) and intraoperative fluid infusion ≥12 mL/min (OR 2.554, 95% CI 1.161-5.622, P = 0.020) were found to be independent risk factors for POUR (**Table 2**).

ROC curves for age and rate of intraoperative fluid administration were constructed to predict POUR. The area under the ROC curve (AUC) value for age was 0.764 (95% CI 0.694-0.834); the AUC value for rate of intraoperative fluid administration was 0.618 (95% CI 0.534-0.703). The optimal cutoff value for age as a predictor of POUR was 75 years. The sensitivity and specificity of this cutoff were 80.6% and 65.2%, respectively (**Figure 1**). The incidence of POUR among patients under 74 years of age was 10.1% (12/119); among those over 75 years, the incidence was 46.7% (50/107). After adjusting for the effects of other confounders, the risk of POUR was calculated to be 5.5 times higher in patients aged ≥75 years than in those aged <75 years.

Discussion

The purpose of this study was to evaluate the incidence and predictive factors of POUR after lower limb arthroplasty. We estimated the incidence of POUR after hip or knee arthroplasty to be approximately 27%. Our results suggest that older age and intraoperative volume overload are independent predictors of POUR.

POUR after lower limb arthroplasty involves a combination of various factors. Innervation of bone is provided by sympathetic and sensory nerve fibers [10], and the density of sympathetic nerve fibers is markedly higher in patients with osteoarthritis [11]. The sympathetic nerves in the bladder cause α-receptor-mediated contraction of the internal urethral sphincter. Furthermore, postoperative pain and discomfort after arthroplasty can cause sympathetic-

dominant nerve discharge, with α-receptor-mediated bladder-neck contraction resulting in functional bladder outlet obstruction. If the bladder detrusor cannot overcome the added resistance at the bladder neck, urinary retention can occur. Inability to sit or stand to void postoperatively may also contribute to urinary retention [12].

In this study, the incidence of POUR after lower limb arthroplasty was significantly higher among older patients than among younger patients. O'Riordan et al. [9] and Sarasin et al. [13] reported that older age is a statistically significant factor predicting the development of POUR. Detrusor contractility may decline with age because of age-related progressive neuronal degeneration in both sexes [14]. Bladder capacity also decreases with age, even in the absence of pathological conditions [15]. Delayed or decreased sensation of bladder filling with aging may also contribute to the higher incidence of POUR among older patients [16].

Our analysis suggests that the cutoff value for age as a predictor of POUR after lower limb arthroplasty is 75 years. Although older age is a well-known risk factor for POUR, precise determination of the threshold age for predicting POUR is difficult. Kotwak et al. [8] and Sarasin et al. [13] reported that age >70 years could be associated with increased risk for POUR after lower limb arthroplasty. Keita et al. [14] recommended systematic evaluation for POUR, especially in patients older than 50 years. Our results revealed that in patients 75 years or older, the risk of POUR increased continuously by a factor of 1.086 for every 1-year increase in age. In other studies, however, the risk of POUR did not increase continuously with advancing age [17, 18].

We found that excessive intraoperative fluid administration was an independent risk factor for POUR, which is consistent with the results of earlier studies that investigated POUR in general surgery [19] and in hip and knee replacement and reconstructive surgeries [20]. In the present study, the rate of intraoperative fluid administration, not total volume, was a significant predictive factor for POUR. This finding can be attributed to the variation in operative duration depending on the patient and the procedure. Interestingly, the operative duration of POUR patients was shorter than that of non-POUR patients in the present study, although operative duration was not identified as a significant factor in multivariate analysis. It has been reported that the type of intravenous fluid given perioperatively does not significantly affect the incidence of retention [12].

This study has limitations stemming from its being a retrospective, single-center, single-surgeon investigation and from its relatively small sample size. Specific information about preoperative voiding function was not available; however, patients with Foley or suprapubic cystostomy *in situ* were excluded from this study. Thus, no preoperative voiding problems were identified. Despite the consecutive nature of our study sample, a potential weakness is the relatively small number of male patients. However, this can also be viewed as an advantage, as the influence of benign prostatic hyperplasia on the incidence of POUR was minimized.

In conclusion, the incidence of POUR in the present study was 27.4%. Older age and intraoperative volume overload were identified as independent risk factors for the occurrence of POUR. Our data suggest that the age cutoff to predict the risk of POUR is 75 years. To prevent POUR after lower limb arthroplasty, the administration rate of intraoperative intravenous fluid, especially in older patients, should be closely monitored to avoid excessive fluid accumulation during surgery.

Acknowledgements

This research was supported by Hallym University Research Fund 2015 (HURF-2015-27).

Disclosure of conflict of interest

None.

Address correspondence to: Dr. Jun-Hyun Han, Department of Urology, Hallym University Dongtan Sacred Heart Hospital; Research Institute for Complementary & Alternative Medicine, Hallym University, 7, Keunjaebong-gil, Hwaseong-si, Gyeonggi-do 18450, Korea. Tel: 82-31-8086-2730; Fax: 82-31-8086-2728; E-mail: junuro@naver.com

References

[1] Baldini G, Bagry H, Aprikian A and Carli F. Postoperative urinary retention: anesthetic and perioperative considerations. Anesthesiology 2009; 110: 1139-1157.

[2] Wu AK, Auerbach AD and Aaronson DS. National incidence and outcomes of postoperative urinary retention in the surgical care improvement project. Am J Surg 2012; 204: 167-171.
[3] Lee KS, Lim KH, Kim SJ, Choi HJ, Noh DH, Lee HW and Cho MC. Predictors of successful trial without catheter for postoperative urinary retention following non-urological surgery. Int Neurourol J 2011; 15: 158-165.
[4] Kamphuis ET, Ionescu TI, Kuipers PW, de Gier J, van Venrooij GE and Boon TA. Recovery of storage and emptying functions of the urinary bladder after spinal anesthesia with lidocaine and with bupivacaine in men. Anesthesiology 1998; 88: 310-316.
[5] Buckley BS and Lapitan MC. Drugs for treatment of urinary retention after surgery in adults. Cochrane Database Syst Rev 2010; CD008023.
[6] Choi S and Awad I. Maintaining micturition in the perioperative period: strategies to avoid urinary retention. Curr Opin Anaesthesiol 2013; 26: 361-367.
[7] Balderi T and Carli F. Urinary retention after total hip and knee arthroplasty. Minerva Anestesiol 2010; 76: 120-130.
[8] Kotwal R, Hodgson P and Carpenter C. Urinary retention following lower limb arthroplasty: analysis of predictive factors and review of literature. Acta Orthop Belg 2008; 74: 332-336.
[9] O'Riordan JA, Hopkins PM, Ravenscroft A and Stevens JD. Patient-controlled analgesia and urinary retention following lower limb joint replacement: prospective audit and logistic regression analysis. Eur J Anaesthesiol 2000; 17: 431-435.
[10] Togari A. Adrenergic regulation of bone metabolism: possible involvement of sympathetic innervation of osteoblastic and osteoclastic cells. Microsc Res Tech 2002; 58: 77-84.
[11] Beckmann J, Knodl M, Bauser E, Tingart M, Grifka J and Straub RH. Loss of sympathetic nerve fibers in vital intertrochanteric bone cylinders lateral to osteonecrosis of the femoral head. Joint Bone Spine 2013; 80: 188-194.
[12] Petros JG, Rimm EB, Robillard RJ and Argy O. Factors influencing postoperative urinary retention in patients undergoing elective inguinal herniorrhaphy. Am J Surg 1991; 161: 431-433; discussion 434.
[13] Sarasin SM, Walton MJ, Singh HP and Clark DI. Can a urinary tract symptom score predict the development of postoperative urinary retention in patients undergoing lower limb arthroplasty under spinal anaesthesia? A prospective study. Ann R Coll Surg Engl 2006; 88: 394-398.
[14] Keita H, Diouf E, Tubach F, Brouwer T, Dahmani S, Mantz J and Desmonts JM. Predictive factors of early postoperative urinary retention in the postanesthesia care unit. Anesth Analg 2005; 101: 592-596; table of contents.
[15] Gomes CM, Arap S and Trigo-Rocha FE. Voiding dysfunction and urodynamic abnormalities in elderly patients. Rev Hosp Clin Fac Med Sao Paulo 2004; 59: 206-215.
[16] Kin C, Rhoads KF, Jalali M, Shelton AA and Welton ML. Predictors of postoperative urinary retention after colorectal surgery. Dis Colon Rectum 2013; 56: 738-746.
[17] Brander VA, Malhotra S, Jet J, Heinemann AW and Stulberg SD. Outcome of hip and knee arthroplasty in persons aged 80 years and older. Clin Orthop Relat Res 1997; 67-78.
[18] Belmar CJ, Barth P, Lonner JH and Lotke PA. Total knee arthroplasty in patients 90 years of age and older. J Arthroplasty 1999; 14: 911-914.
[19] Tammela T, Kontturi M and Lukkarinen O. Postoperative urinary retention. II. Micturition problems after the first catheterization. Scand J Urol Nephrol 1986; 20: 257-260.
[20] Wynd CA, Wallace M and Smith KM. Factors influencing postoperative urinary retention following orthopaedic surgical procedures. Orthop Nurs 1996; 15: 43-50.