World Journal of Urology (2019) 37:2715–2719
https://doi.org/10.1007/s00345-019-02737-3

ORIGINAL ARTICLE

The risk factors of urinary tract infection after transurethral resection of bladder tumors

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Received: 5 December 2018 / Accepted: 20 March 2019 / Published online: 26 March 2019

Abstract

Purpose Few studies mention the necessity of antimicrobial prophylaxis (AMP) for transurethral resection of bladder tumor (TURBT) and the risk factors for postoperative urinary tract infections (UTIs) after TURBT. To evaluate the necessity of AMP and to detect the risk of UTIs, we examined the perioperative clinical factors.

Methods 687 patients who underwent TURBT between 2006 and 2017 at Hiroshima Prefectural Hospital were examined retrospectively. We defined the postoperative UTIs as febrile UTIs (≥ 38 °C). The AMP for the TURBT that we used was mostly cephalosporin generation 1. The association between the perioperative clinical/pathological factors and postoperative UTIs was assessed by logistic regression retrospectively.

Results 21 patients (3.1%) suffered from postoperative UTIs, and almost all of them were successfully treated with the immediate administration of antibiotics. Univariate analysis showed that past pelvic radiotherapy ($p = 0.024$, odds ratio (OR) 6.00), tumor size (≥ 2cm) ($p = 0.008$, OR 3.38), age (≥ 75 years) ($p = 0.036$, OR 2.65), preoperative hospital stay (≥ 5 days) ($p = 0.017$, OR 3.76), asymptomatic pyuria ($p = 0.038$, OR 2.54) and bacteriuria ($p = 0.044$, OR 2.97) were all associated with postoperative UTIs.

Conclusions We demonstrated that AMP was effective for patients who underwent TURBT, and history of pelvic radiotherapy, high age, preoperative hospital stay and a certain tumor size were the risk factors as well as pyuria and bacteriuria of postoperative UTIs.

Keywords Transurethral resection of bladder tumors · Urinary tract infections · Antimicrobial prophylaxis · Surgical site infection

Abbreviations

TURBT	Transurethral resection of bladder tumors
AMP	Antimicrobial prophylaxis
UTIs	Urinary tract infections

Introduction

Transurethral resection of bladder tumor (TURBT) is one of the most frequently performed endourological surgeries. The risk of postoperative urinary tract infections (UTIs) after TURBT is a highly controversial topic. Because TURBT is associated with increased incidence of postoperative UTIs [1], some studies have recommended the use of antimicrobial prophylaxis (AMP) for TURBT [2–8]. On the other hand, there are other studies that show AMP for TURBT is not necessary because the incidence of postoperative UTIs is quite low and there is no advantage of preoperative AMP for TURBT [9–13].

Published guidelines note options for using AMP for TURBT. The American Urological Association (AUA) and Japanese Urological Association (JUA) guidelines recommend the use of AMP for TURBT for all cases [14]. However, JUA guidelines also note that it is not necessary for low-risk cases of UTIs [15]. The European Association of Urology (EAU) guidelines note that AMP is not necessary for TURBT except patients who have a risk of UTIs and have large tumors requiring a prolonged operation time or necrotic tumors. Although all guidelines describe the general risk factors of infection for urological surgeries, there are few references about the risk factors of postoperative UTIs after TURBT [16].

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In this study, we aimed to evaluate the role of AMP and detect the risk of infection through perioperative clinical outcomes.

Materials and methods

The medical records of patients who underwent TURBT at Hiroshima Prefectural Hospital from April 2006 to March 2017 were reviewed retrospectively. In all patients, the urine culture was proven prior to TURBT. Patients who took immunosuppressive agents or had indwelling catheters were excluded. In addition, patients who did not have preoperative blood tests and urinalysis were also excluded. Using these criteria, we evaluated a total of 687 patients in this study.

We obtained the relevant clinicopathological data from medical records, such as age, gender, the American Society of Anesthesiologists physical status (ASA-PS), past pelvic radiotherapy, preoperative hospital stay, Hemoglobin A1c, serum albumin, bacteriuria, pyuria, history of TURBT, multiple site biopsy, length of operation, duration of antimicrobial prophylaxis, number of tumors, size of tumor, clinical T stage, and histological grade. We defined the postoperative UTIs as febrile UTIs (≥ 38 °C) after TURBT and bacteriuria as a single bacterial growth of 10^5 colony forming units per ml in a urine culture on a clean catch urine sample. The AMP for the TUR-BT was mostly cephalosporin generation 1.

All continuous variables were shown as median values and interquartile ranges (IQRs). Associations between clinicopathological parameters and postoperative UTIs were assessed in univariate models using logistic regression retrospectively. All statistical analyses were conducted using the JMP 10.0.0 (SAS Institute Inc., Cary, NC, USA) with a value of $p < 0.05$ was considered to be statistically significant for each comparison.

Results

Table 1 lists the clinical characteristics of patients in our cohort. Postoperative UTIs occurred in 21 patients (3.1%) in our institution. In these patients, pyelonephritis occurred in 15 patients (71.4%), prostatitis occurred in 4 patients (19.0%), epididymitis occurred in 1 (4.8%), and peritonitis after bladder perforation occurred in another one (4.8%) (Table 2). The main causative bacteria of the postoperative UTIs were *Escherichia coli* (23.8%) and *Pseudomonas aeruginosa* (14.3%). Drug-resistant bacteria such as extended-spectrum *b*-lactamase-producing (ESBL)-producing *Escherichia coli* (9.5%), or methicillin-resistant *Staphylococcus aureus* (MRSA) (9.5%) were detected in some cases. In the preoperative urine culture, ESBL-producing *Escherichia*

Table 1 Baseline characteristics

Variables	All patients $n = 687$
Age; mean (IQR)	74 (68–80)
Gender, *n* (%)	
Male	553 (80.5)
Female	134 (19.5)
ASA-PS, *n* (%)	
1	38 (5.5)
2	606 (88.2)
3	43 (62.3)
Past pelvic radiotherapy, *n* (%)	
None	666 (96.9)
Had	21 (3.1)
Preoperative hospital stay, *n* (%)	
< 5 days	658 (95.8)
≥ 5 days	29 (4.2)
Hemoglobin A1c (%); mean (IQR)	5.9 (5.5–6.4)
Serum albumin (ng/dl); mean (IQR)	4.1 (3.9–4.3)
Bacteriuria, *n* (%)	
None	602 (87.6)
Had	85 (12.4)
Pyuria, *n* (%)	
None	475 (69.1)
Had	212 (30.9)
Hystory of TURBT, *n* (%)	
None	302 (44.0)
One or more	385 (56.0)
Multiple site biopsy, *n* (%)	
None	627 (91.3)
Had	60 (8.7)
Length of operation (min); mean (IQR)	30 (19–47)
Duration of anitimicrobial prophylaxis, *n* (%)	
≤ 24 h	589 (85.7)
≥ 24 h	98 (14.3)
Number of tumors, *n* (%)	
Single	371 (54.0)
Multiple	316 (46.0)
Tumor size, *n* (%)	
< 2cm	536 (78.0)
≥ 2cm	151 (22.0)
Clinical T stage, *n* (%)	
cTa or no malignancy	459 (66.8)
≥ cT1	228 (33.2)
Histological grade, *n* (%)	
G1, G2	378 (55.0)
G3	309 (45.0)
Postoperative UTIs, *n* (%)	
None	666 (96.9)
Had	21 (3.1)

IQR interquartile range, *ASA-PS* American Society of Anesthesiologists physical status, *UTIs* urinary tract infections

Table 2 Postoperative infections of patients undergoing TURBT

Infection site	*n* (%)	Causative organism	*n*
Pyelonephritis	15 (71.4)	*Escherichia coli*	4
		Pseudomonas aeruginosa	3
		Enterococcus faecalis	2
		Klebsiella pneumoniae	1
		Coagulase-negative *staphylococci*	1
		Methicillin-resistant *Staphylococcus aureus*	1
		Unknown	3
Prostatitis	4 (19.0)	Extended-spectrum *b*-lactamase-producing *Escherichia coli*	2
		Escherichia coli	1
		Serratia marcescens	1
Epididymitis	1 (4.8)	*Bacteroides fragilis*	1
Peritonitis	1 (4.8)	Methicillin-resistant *Staphylococcus aureus*	1

coli was detected in six cases and MRSA was detected in five cases. In these cases, two cases of ESBL-producing *Escherichia coli* carrier were developed for postoperative UTIs, while there were no postoperative UTIs in the MRSA group. All patients who suffered from postoperative UTIs were successfully treated with the immediate administration of antibiotics, except one patient who died of multiple organ failure as a result of peritonitis after bladder perforation. The case of peritonitis after bladder perforation was 88-year-old man. He was diagnosed as bladder perforation immediately during TURBT, and performed open bladder repair for the perforation. However, he had high-grade fever and abdominal pain at postoperative day 3. He took antibiotic treatment by dripenem, but got disuse atrophy and finally died.

To evaluate the risk of the postoperative UTIs of TURBT, we examined the perioperative clinical outcomes by univariate and multivariate analysis (Table 3). Univariate analysis showed that past pelvic radiotherapy ($p=0.024$, odds ratio (OR) 6.00), tumor size (≥2cm) ($p=0.008$, OR 3.38), age (≥75 years) ($p=0.036$, OR 2.65), preoperative hospital stay (≥5 days) ($p=0.017$, OR 3.76), pyuria ($p=0.038$, OR 2.54) and bacteriuria ($p=0.044$, OR 2.97) were all associated with postoperative UTIs.

Discussion

In this study, we demonstrated that past pelvic radiotherapy, age, preoperative hospital stay and tumor size were risk factors as well as pyuria and bacteriuria of postoperative UTIs of TURBT. To our knowledge, this is the first report that notes the risk factors of postoperative UTIs of TURBT.

The incidence of postoperative UTIs of TURBT was 3.1%, which was the same incidence as previous studies that recommended both AMP and no AMP [4, 10, 11, 13]. Table 4 shows the comparison of previous studies about AMP for TURBT only. Since there have been only a few

Table 3 Risk factors predicting postoperative urinary tract infections after TURBT

Predictors	Postoperative UTIs	
	Univariate analysis	
	OR (95% CI)	*p* value
Age (≥75 years vs. <75 years)	2.65 (1.06–7.52)	0.036
Gender (female vs. male)	0.77 (0.29–2.38)	0.621
ASA-PS (3 vs. 1/2)	2.61 (0.59–8.12)	0.179
Past pelvic radiotherapy (positive vs. negative)	6.00 (1.32–19.8)	0.024
Preoperative hospital stay (≥5days vs. <5days)	3.76 (1.30–9.62)	0.017
Hemoglobin A1c (≥6.5% vs. <6.5%)	2.74 (0.78–17.3)	0.126
Hypoalbuminemia (≤3.7 ng/ml vs. >3.7 ng/ml)	2.73 (0.95–6.93)	0.060
Bacteriuria (positive vs. negative)	2.97 (1.04–7.55)	0.044
Pyuria (positive vs. negative)	2.54 (1.06–6.20)	0.038
History of TURBT (one or more vs. none)	0.71 (0.29–1.70)	0.432
Length of operation (≥40 min vs. <40 min)	2.23 (0.93–5.43)	0.073
Multiple site biopsy (had vs. none)	0.51 (0.03–2.54)	0.514
Duration of antimicrobial prophylaxis (≤24 h vs. >24h)	0.52 (0.20–1.62)	0.238
Number of tumors (multiple vs. single)	1.95 (0.81–4.98)	0.137
Tumor size (≥2cm vs. <2cm)	3.38 (1.38–8.19)	0.008
Clinical T stage (≥cT1 vs. pTa or no malignancy)	1.53 (0.62–3.67)	0.349
Histological grade (G3 vs. G1/2)	2.03 (0.84–5.19)	0.114

UTIs urinary tract infections, *OR* odds ratio, *CI* confidence interval, *TURBT* transurethral resection of bladder tumor, *ASA-PSs* American Society of Anesthesiologists physical status

Table 4 Comparison of literature studies about antibiotic prophylaxis for TURBT

Study or subgroup	Perioperative AMPs	Antibiotic group			Control group		
		Total *n*	Postoperative bacteriuria *n* (%)	Postoperative UTIs (≥ 38 °C) *n* (%)	Total *n*	Postoperative bacteriuria *n* (%)	Postoperative UTIs (≥ 38 °C) *n* (%)
MacDermott 1988 [4]	Cephradine	91	3 (3.3)	–	98	16 (16.3)	–
Upton 1986 [10]	Carbenicillin	16	1 (6.3)	1 (6.3)	14	0 (0.0)	0 (0.0)
Delavierre 1993 [11]	Pefloxacin	32	3 (9.4)	0 (0.0)	29	7 (24.1)	0 (0.0)
Yokoyama 2009 [13]	Levofloxacin	44	1 (2.3)	1 (2.3)	118	4 (3.4)	2 (1.7)

AMP antimicrobial prophylaxis, *UTIs* urinary tract infections, *TURBT* transurethral resection of bladder tumor

studies about perioperative AMP for TURBT, the guidelines should have been created on the basis of the studies of transurethral resection of prostate (TURP) [17, 18]. To define accurate directions for perioperative AMP for TURBT, more studies are necessary.

The overall postoperative UTIs rate in our study was low, and almost all patients having postoperative UTIs were easily treated with antibiotics. This result suggested that AMP was effective in patients with low/intermediate risk of infection and postoperative UTIs were controllable by immediate antibiotic treatment. In this study, all patients had AMP regardless of the risk of infection. As described above, the incidence of postoperative UTIs of TURBT is extremely low, so AMP for low/intermediate risk cases may not be necessary. This result coincides with the EAU and JUA guidelines recommendation [15, 16].

This study showed that there were several risk factors for UTIs after TURBT. The past pelvic radiotherapy was a risk factor of postoperative UTIs after TURBT. Previous studies revealed that cancer patients treated with pelvic radiotherapy have an increased risk of urinary infections, depending on the type of cancer and radiation techniques [19–23]. Past radiotherapy techniques had given actinic irreversible damage to the bladder mucosa and detrusor muscle and induced chronic inflammation and urinary discomfort. This process is why past pelvic radiotherapy is the risk factor for infection in our study. EAU guidelines describe that there is little evidence for any benefit of AMP for TURBT to small bladder tumors, but large tumors requiring a prolonged operation time or necrotic tumors are risks for UTIs and recommend using AMP [16]. Previous studies did not distinguish between simple fulguration and large or multiple tumors, the presence of necrotic material or not, and the definition of the large tumor was not defined. In this study, a large tumor, that we defined to ≥ 2 cm, was also an independent risk factor of postoperative UTIs of TURBT, as well as the EAU guidelines recommendation. TURBT for large tumors generally needs a longer operation time because of the need for extensive and deep resection. A previous study described that an increased operation time is associated with serious postoperative complications [24]. Although, operation time was not an independent risk factor in this cohort, tumor size induced the risk of postoperative UTIs. Age and preoperative hospital stay were also associated with postoperative UTIs. These factors are recognized as the risk factors of infections, which were noted by published guidelines [14–16] and recognized as the risk factors of surgical site infections in other surgical procedures [25, 26]. Pyuria and bacteriuria were also detected as the risk factors of postoperative UTIs that previous studies presented [27, 28]. Drug-resistant bacteriuria is not negligible as a risk factor for postoperative UTIs after TURBT. Not all drug-resistant bacteriuria develops into postoperative UTIs, but it is rational to treat bacteriuria with AMP if the sensitivity has been detected before TURBT.

There are some limitations in our study. First, these results were analyzed retrospectively, and unknown bias might exist when it comes to the interpretation of findings. In addition, a report from only a single institution may reduce its validity. Second, the observation period of this study was relatively long, so that any treatment of comorbidity progressed and not all cases were treated equally. Third, because of the small incidence of postoperative UTIs, multivariate analysis would be inappropriate for this study. Further validation and feasibility studies are required before the results of this study can be generalized and used in routine practice.

In conclusion, the evaluation of preoperative risks is necessary for appropriate use of AMP for TURBT. AMP may not always be necessary for patients with low/intermediate risk of infection. However, it should be necessary for patients with the risk factors, such as the history of pelvic radiotherapy, high age, longer preoperative hospital stay and a certain tumor size that are major risk factors for postoperative UTIs of TURBT.

Author contributions YK: protocol/project development, data management, data analysis, and manuscript writing. AG: manuscript editing. KY: data collection. SO: manuscript editing. MK: protocol/project development.

Compliance with ethical standards

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

Ethical approval For this type of study formal consent is not required. This article does not contain any studies with animals performed by any of the authors.

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