

Review Article

Early catheter removal adds no significant morbidity following transurethral resection of the prostate: a systematic review and meta-analysis

Jia-Jun Yu^{1*}, Qiang Li^{2*}, Peng Zhang³, Bo Shu¹

¹Department of Urology, Wuhan Central Hospital Affiliated to The Tongji Medical College, Huazhong Science and Technology University, Wuhan 430050, Hubei Province, P.R. China; ²Department of Urology, The People's Hospital of Bortala Mongol Autonomous Prefecture, Xin Jiang, P.R. China; ³Department of Urology, Zhongnan Hospital, Wuhan University, Wuhan 430071, Hubei, P.R. China. *Equal contributors.

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Abstract: *Background and Objective:* Delayed catheter removal is a conventional procedure following transurethral resection of the prostate (TURP) but it remains controversial. The aim of our study was to identify whether delayed catheter removal was necessary following TURP. *Materials and Methods:* Electronic databases including PubMed, Embase, the Cochrane Library and the Science Citation Index were searched for relevant randomized controlled trials (RCTs). Two reviewers independently screened the search records from the electronic databases to identify the studies that met the inclusion criteria, evaluated the quality of the studies and abstracted the data. The pooled analyses of the outcome data were conducted with Review Manager 5.3 software. *Results:* Seven RCTs with 864 patients who underwent TURP were ultimately included in the meta-analysis. The early catheter removal after the surgery did not significantly add to the risk of re-catheterization [relative risk (RR) 1.12, 95% confidence interval (CI) 0.73 to 1.72] and secondary haemorrhage (RR 1.07, 95% CI 0.54 to 2.13) compared with the conventional delayed catheter removal following TURP. Nevertheless, the delayed catheter removal was associated with urinary tract infections (RR 0.46, 95% CI 0.24 to 0.91) and longer hospital stays (SMD -1.33, 95% CI -2.22 to -0.44). *Conclusion:* Early catheter removal does not significantly increase the risk of re-catheterization and haemorrhage while it reduces incidences of UTI and shortens hospital stays.

Keywords: Catheter removal, transurethral resection, prostate

Introduction

Low urinary tract symptoms secondary to benign prostatic hyperplasia (BPH) are common in older men and there is a more than 50% chance that men aged more than 60 years will be affected [1]. Transurethral resection of the prostate (TURP) is defined as the “gold standard” surgical treatment for BPH by the American Urological Association’s (AUA) Guideline [2]. TURP including monopolar and bipolar techniques is minimally invasive surgery [3]. Three-way catheter indwelling and continued bladder irrigation have been routine procedure for preventing haemorrhage and clot retention following TURP [4]. Urologists usually choose to remove the catheter and conduct a trial of voiding for patients when they are discharged

[5]. Long-term indwelling catheter is associated with higher rates of urinary tract infection (UTI), longer hospital stays and higher cost of treatment [6, 7]. Early catheter removal and discharge from hospital also benefit the patients [8].

The time to remove the three-way catheter is based on conventional experience and varies considerably. The Foley haemostatic catheter was introduced in the 1940 s, and the original protocol for catheter management was documented as ‘fifteen minute post-operative bladder irrigations and the catheter left in situ for three days’ [9]. Many derivative techniques have emerged since then. In Australia and the UK, continuous saline bladder irrigation for 24 hours and catheter removal on the second day

Table 1. Search strategies

Electronic database	Methods for searching
PubMed	1# AND 2# AND 3# AND 4# (any field)
Web of science	1# AND 2# AND 3# AND 4# (Title/Key words/Abstract)
Cochrane library	1# AND 2# AND 3# AND 4# (Title/Key words/Abstract)
Embase	1# AND 2# AND 3# AND 4# (any field)

1#: prostate; 2#: resection; 3#: catheter; 4#: removal.

after the operation are the conventional protocols [10]. In Singapore and Pakistan, the standard time until three-way catheter removal is 4 to 5 days [8, 11]. Some studies showed a quite high rate of re-catheterization and clot retention in patients who had early catheter removal. Tatsuo *et al* suggested that the early catheter removal was cost-effective and that it improved the patients' quality of life in a study of 431 patients [12]. Irani *et al* conducted a prospective randomized analysis of 213 patients and found no significant differences between the early and delayed catheter removal groups in postoperative complications [13].

We conducted a systematic review and meta-analysis to confirm whether early three-way catheter removal added risk of relative complications following TURP.

Material and methods

Our systematic review and meta-analysis was conducted according to the methodology recommended by the Cochrane Collaboration and the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) statement [14].

Eligibility criteria

Studies were included once they met the following eligibility criteria: (1) the study participants were patients who underwent TURP for BPH; (2) the study design was RCT; (3) the intervention and control groups in the trials were early and delayed catheter removal, respectively; (4) the rates of re-catheterization or/and secondary haemorrhage or/and urinary tract infection or/and other outcomes were reported in the study.

Search strategy

PubMed (1966 to May 2017), Embase (1974 to May 2017), the Cochrane Library (issue11, May 2017) and the Science Citation Index

(1974 to May 2017) were searched to obtain relevant RCTs. The details on the searching process are summarized in **Table 1**. The reference lists of the included studies were checked manually and we also screened the titles and abstracts of conference papers

and unpublished articles. No language was restricted in the search process.

Study selection and data extraction

Two reviewers independently screened the titles and abstracts from the electronic databases and supplemental sources. The titles and abstracts were evaluated independently by the two reviewers to identify whether they met the inclusion criteria. The same authors independently abstracted the data according to standard data extraction forms including title, publication time, sample size, participant, intervention, control, and other relative characteristics. Disagreements were resolved through consultation with an arbitrator. We also contacted authors by E-mail to request missing information when it was necessary. Furthermore, missing standard deviations in the original articles were calculated using the *p* value or were imputed from other trials in the meta-analysis using the formula

$$SD_{\text{pooled}} = \sqrt{\frac{\sum (n_i - 1) SD_i^2}{\sum (n_i - 1)}} \quad [15, 16] \text{ when the authors did not respond.}$$

Methodological quality assessment

The Cochrane Collaboration tool for assessing risk of bias was applied to evaluate the methodological quality of the included RCTs [17]. Selection bias was evaluated by "random sequence generation" and "allocation concealment". Performance bias, detection bias, attrition bias and reporting bias were assessed according to "blinding of participants and personnel", "blinding of outcome assessment", "incomplete outcome data" and "selective reporting", respectively [18]. Furthermore, other sources of bias in the included studies were assessed as well. Every item was classified as low risk of bias, "unclear" (unable to judge the bias due to missing information) and

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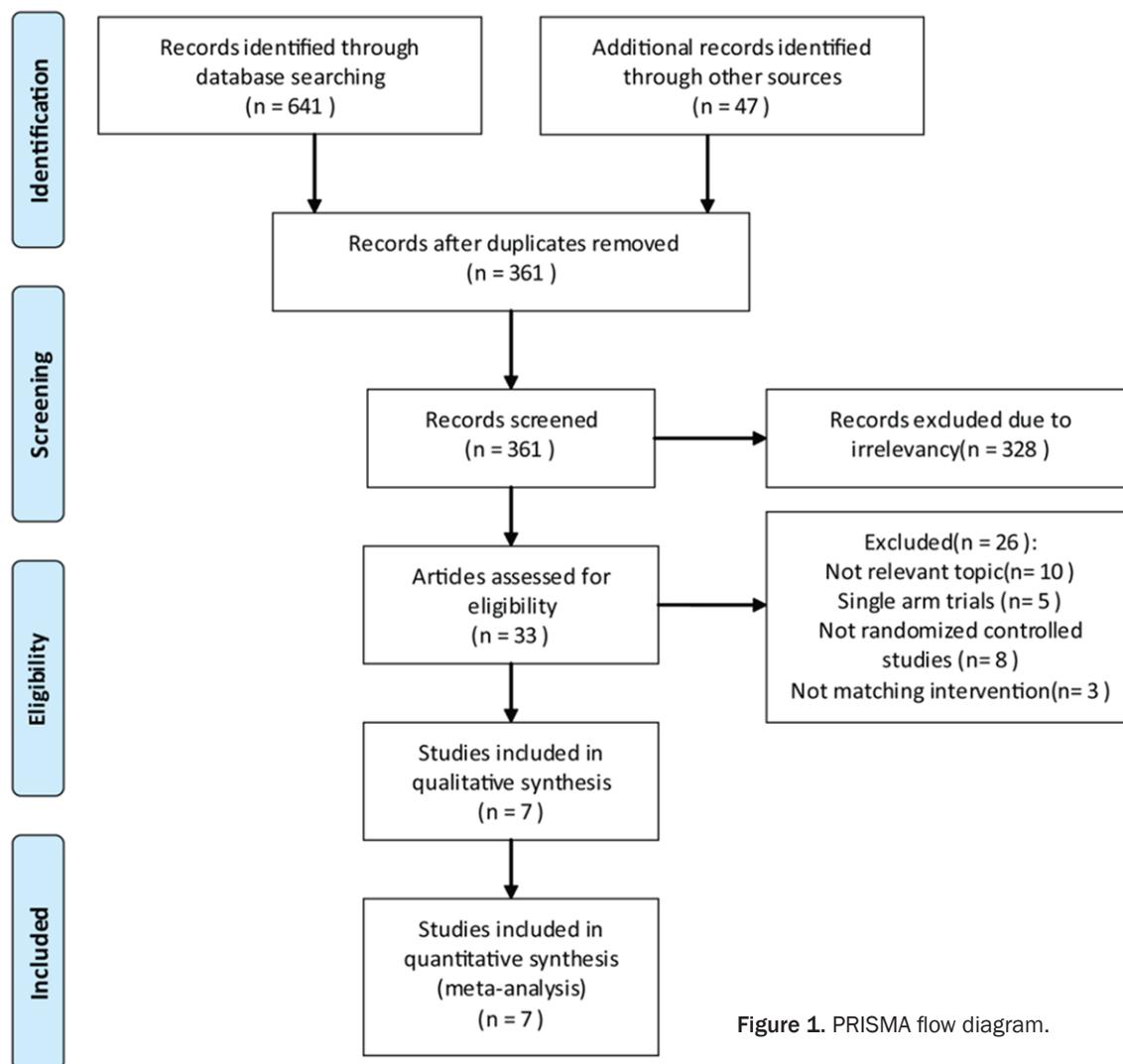


Figure 1. PRISMA flow diagram.

high risk of bias under the guidance of the Cochrane Handbook [18].

Data synthesis and analysis

Our pooled data analyses were performed with Review Manager 5.3 software under the PRISMA guidelines. Heterogeneity was evaluated by examining the clinical characteristics of the included studies as well as by formal statistical testing with χ^2 and I^2 . For binary outcomes, we applied Mantel-Haenszel estimates with a fixed-effect analytical model to calculate relative risks (RRs) and their 95% confidence intervals (CIs). If significant between-trial heterogeneity had been discovered according to the clinical characteristics of these studies, a random effects statistical model would be used [18]. For continuous outcomes, we used inverse

variance estimates with a random-effects model to calculate standard mean differences (SMDs) and their 95% CIs when there were considerable clinical differences among studies [18]. An I^2 value of more than 40% was regarded as indicating significant between-trial heterogeneity [18]. When ten or more studies were included, the funnel plot methods of Begg or Egger were applied to detect publication bias [19]. Sensitivity and subgroup analyses were performed when necessary.

Results

Characteristics of the included studies

A total of 688 records from our preliminary strategy were screened, and seven RCTs [10, 11, 13, 20-23] that met the inclusion criteria

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Table 2. Basic characteristic of included studies

Study ID	Year	Country	Sample size	Age, yr	Postoperative catheter removal, intervention/control group	Catheters types	Irrigation	Specimen weight, g	Surgery	Outcomes
Koh, KBH [20]	1994	UK	29/30	68.8/73.0	The first post-operative morning/ the second post-operative morning	NA	Mostly no irrigation	17.1/19.6	TURP	RC, SH, UTI, LHT
Dodds, L [10]	1995	Australia	50/50	70.6/71.4	Catheter removed at < 24 h/36-48 h after surgery	Bardex catheter, 22F	Normal saline	22/27	TURP	RC, LHT
Irani, J [13]	1995	France	54/55	70	48 h after surgery/usual criteria of the surgeon	3-way latex catheter, 20F	Normal saline	23/20	TURP	RC, SH
Toscano, IL [21]	2001	Brazil	54/50	67.4/69.6	The first postoperative day/the second postoperative day	3-way catheter, 22F	Normal saline	NA	TURP	RC, SH
Sahin, CB [22]	2011	Turkey	22/22	62.5/61.5	The first post-operative/the second post-operative	3-way foley catheter, 22F	Normal saline	NA	TURP	RC, SH
Durrani, SN [11]	2014	Pakistan	157/163	71.3	First day/Delayed removal	3-way haemostatic catheter, 22 F	Normal saline	45.22/46.67	TURP	RC, SH, UTI, LHT
Li SX [23]	2014	China	64/64	56-92	First-second day/Delayed removal	3-way foley catheter, 22F	Normal saline	NA	PKRP	RC, UTI, LHT

NA: not available; TURP: transurethral resection of the prostate; PKRP: plasmakinetic resection of the prostate; RC: re-catheterization; SH: secondary haemorrhage; UTI: urinary tract infection; LHT: length of hospital stay.

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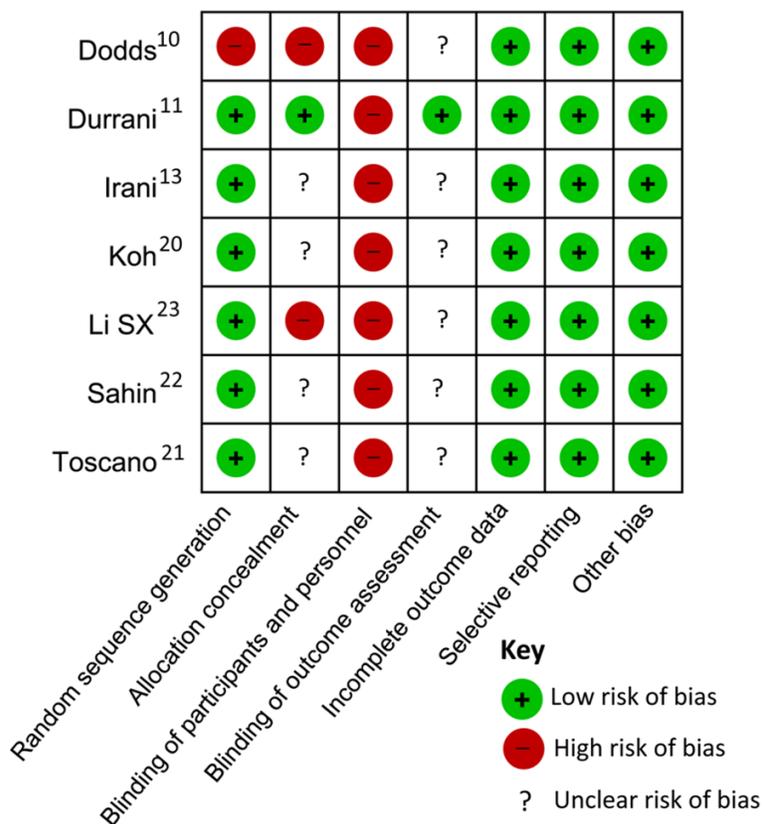


Figure 2. Risk of bias assessment for the included RCTs.

were ultimately included (**Figure 1**). A total of 864 patients who were TURP for BPH (there were postoperative positive results of specimen for prostate cancer in a few patients) were enrolled for the pooled analyses. In the included studies, the catheters were mostly removed at the first postoperative day in the early catheter removal group. In the delayed catheter removal group, timing of catheter removal was the conventional time (the second postoperative day or later) according to local experiences. Most patients were undergoing TURP, although in one trial [23] by Li SX et al, the operation was plasmakinetic resection of the prostate (PKRP). This study was also included in the meta-analysis due to the parallel clinical characteristics. Some studies excluded the patients with large post-void urine volume, unstable complications (such as capsular or bladder perforation, severe haemorrhage during or immediately after surgery) and co-morbidity (such as uncontrolled diabetes mellitus, spinal cord problems, cerebro-vascular accidents). **Table 2** shows the main details of the included studies; there are

comparable baseline characteristics among the studies in terms of the objective of our meta-analysis.

Risk of bias

Only one [11] study assessed all items completely based on available data. No study was judged to be of low risk of bias in all items. A prospective study that had 100 consecutive patients [10] was judged to be of high risk of bias in “Random sequence generation”, “Allocation concealment” and “Blinding of participants and personnel”. The item “Blinding of participants and personnel” was judged to have a high risk bias in all included trials. One study [11] and three studies [10, 11, 23] provided available data for us to assess the items “Blinding of outcome assessment” and “Allocation concealment”, respectively. For the remaining

items, most studies were judged to have a low risk of bias (**Figure 2**).

Re-catheterization

All included studies [10, 11, 13, 20-23] reported rates of re-catheterization. After the catheters were removed, the patients with clot retention or haemorrhage or failure to urinate had a catheter re-inserted again. The re-catheterization events were recorded. There was no significant difference in the rate of re-catheterization between the early and delayed catheter removal groups (RR 1.12, 95% CI 0.73 to 1.72). No significant between-trial heterogeneity in statistics was found ($I^2=0\%$; **Figure 3**). These data denoted that early catheter removal did not increase the risk of re-catheterization following TURP.

Secondary haemorrhage

Incidence of secondary haemorrhage following three-way catheter removal was reported in five studies [11, 13, 20-22]. There were no signifi-

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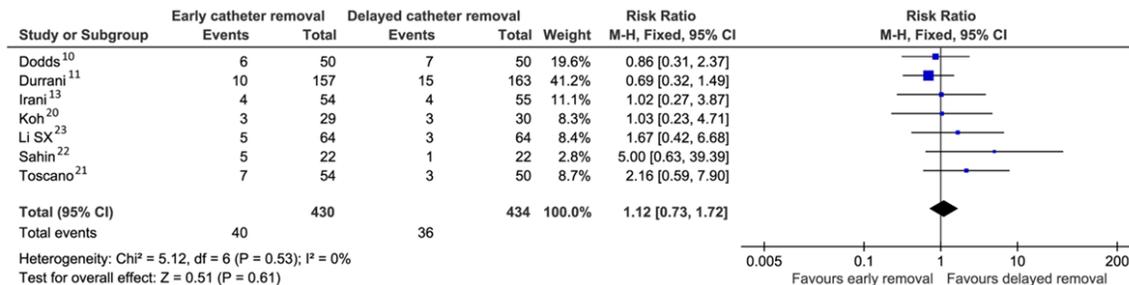


Figure 3. Forest plot for re-catheterization (RR relative risk, CI confidence interval).

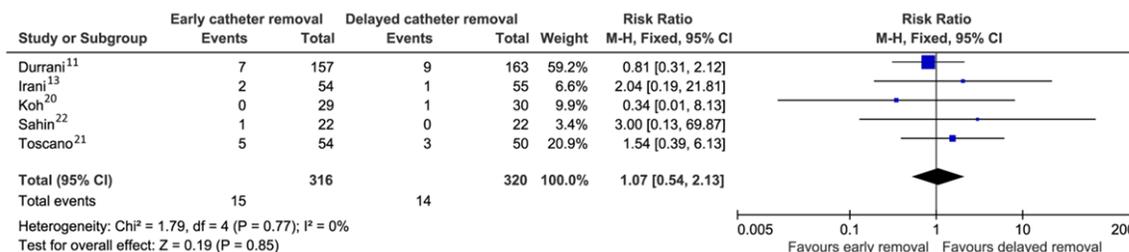


Figure 4. Forest plot for secondary haemorrhage (RR relative risk, CI confidence interval).

cant differences in the rate of secondary haemorrhage between the early and delayed catheter removal groups (RR 1.07, 95% CI 0.54 to 2.13). An *I*² value of 0% suggested no statistically significant heterogeneity between the trials (Figure 4). These data indicated that early catheter removal did not increase the risk of secondary haemorrhage following TURP.

Urinary tract infection (UTI)

Patients with a positive urine culture were diagnosed as having a UTI. Only three studies [11, 20, 23] reported UTI events after catheter removal. There were significant differences in the incidence of UTI between the early and delayed catheter removal groups (RR 0.46, 95% CI 0.24 to 0.91). An *I*² value of 0% suggested no statistically significant heterogeneity between the trials (Figure 5). The results suggested that delayed catheter removal increased the risk of UTI following TURP.

Hospital stay

In five studies [10, 11, 13, 20, 23], time of hospital stay was reported. However, the data were not suitable for pooled analysis in one study [13] because there were 24 patients in the study whose hospitalization was prolonged for social reasons. The conservative estimates

(SMD -1.33, 95% CI -2.22 to -0.44) showed a significant difference in the length of hospital stay in favour of the early catheter removal group compared with the delayed catheter removal group (Figure 6).

Publication bias and other analyses

Because only seven studies were analyzed, we did not perform a Begg or Egger funnel plot to explore potential publication bias. In the absence of obvious between-trial heterogeneity in the statistics or the clinic, we did not conduct subgroup and sensitivity analyses.

Discussion

To the best of our knowledge, this is the first meta-analysis and systematic review of the safety of patients with early catheter removal following TURP. We found no significant differences in the risk of re-catheterization and secondary haemorrhage between the early and delayed catheter removal groups following TURP. Additionally, standard catheter removal significantly increased the incidence of UTI and the length of hospital stay after surgery compared with early catheter removal. This finding suggested that our results were credible with regard to the comparable baseline characteristics among the included studies, the high

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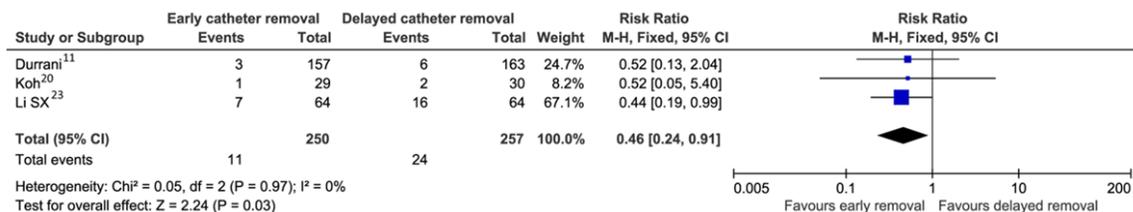


Figure 5. Forest plot for urinary tract infection (RR relative risk, CI confidence interval).

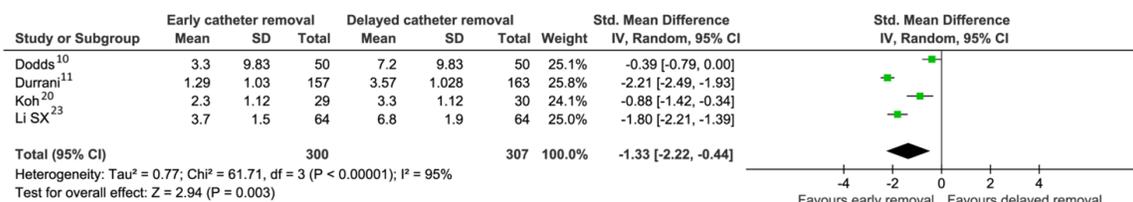


Figure 6. Forest plot for length of hospital stay (SMD standard mean differences, CI confidence interval).

quality of the included RCTs and the low between-trial heterogeneity in the pooled analyses of main outcomes.

As part of nursing care after anaesthesia, an indwelling catheter is usually used to prevent urinary retention and keep patients from moving around as their wounds heal after surgery. An additional reason for catheterization following TURP has been to prevent haemorrhage and blood clots. It was confirmed that catheter traction and bladder irrigation could be beneficial in preventing post-TURP bleeding [24] but timing of indwelling catheter drainage following TURP varied amongst surgeons. Large numbers of urologists routinely left the catheter in the palace until the second day or much later after surgery even when there were no unstable perioperative complications. Indeed, there were differences in the timing of catheter removal in different regions, and even at different hospitals in the same region [8, 10, 11]. Time of indwelling catheter and length of hospital stay after TURP declined significantly during the last decade. The standard concern was that early catheter removal would be unsafe due to potential urinary retention, clot retention, and secondary haemorrhage. Mueller *et al* found in their study that the complication rates were 5% and 6.6% in the early catheter removal group and the control group, respectively [25]. Tatsuo *et al* reported a rate of 7% of secondary bleeding in patients with short-term indwelling catheters [25]. Nevertheless, early catheter removal could reduce the length of hospital

stays and cost of treatment. It was reported that patients aged less than and over age 70 saved, respectively, 829 dollars and 1406 dollars when their catheters were removed early [26]. Starkman *et al* noted savings of 1, 200 dollars per patient as a result of early catheter removal following TURP [4]. Delayed catheter removal also increased the rate of catheter-associated urinary tract infection (CAUTI) [27].

In this present meta-analysis, recatheterization and secondary haemorrhage rates seemed to be not direct linked to the early catheter removal indeed. Some other reasons possibly caused the recatheterization. On one hand, persisting large amounts of residual urine secondary to BPH could result in bladder detrusor dysfunction [28]. For the patients with bladder detrusor dysfunction, postoperative urinary retention was likely to occur. Prolonged catheterization in the patients was necessary to recover their bladder function. On the other hand, catheters were also possibly prolonged by surgery accidents such as capsular defects, bladder neck incision and much lower resection weight [8]. Incidences of these events were relatively lower compared with bladder detrusor dysfunction [28, 29]. Some of included studies excluded above mentioned cases due to their high risks in postoperative complications [11, 20, 22].

Secondary haemorrhage was likely to mainly attribute to these problems on surgical technique and the patients themselves, such as

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poor bleeding control, surgery incidents, large sized prostate and co-morbidity. Even though risks of these events were quite low, and urologists also should pay more attention on them to improve their technical levels [29].

CAUTI is the second most common cause of hospital-acquired infection worldwide [30], and long-term indwelling catheters have a higher risk of UTI than do short-term indwelling catheters. A urinary catheter in the bladder is a foreign body in a moist environment. This recruits colonization of biofilm microorganisms (A biofilm microorganism is any group of microorganisms in which cells stick to each other on a surface). Biofilm microorganisms have the ability to withstand antimicrobial agents as well as drying and ultraviolet radiation [31], which means that an indwelling urinary catheter cannot usually be cleared of a pathogenic biofilm without removing the catheter. As long as the colonized catheter remains in place, biofilm-associated organisms can seed the urine with bacteria [31]. More importantly, the included studies were RCTs, and they excluded the bias due to UTIs caused by preoperative bacteria, because of longer duration of the procedure (>70 min), preoperative stay longer than two days and other reasons [32]. Our meta-analysis also excluded these confounding factors but suggested that delayed catheter removal in patients who underwent TURP increased the risk of UTI.

We explained how early catheter removal shortened hospital stays following TURP. Firstly, in the 4 RCTs involving shorter length of hospital stay, catheter removal was necessary for the uneventful patients to be discharged. Patients with requirement of prolonged catheterization could be discharged with catheter as well. Secondly, early catheter removal did not significantly increase the risk of secondary haemorrhage and recatheterization according to this present meta-analysis. Thirdly, included RCTs suggested all patients had similar risk of prolonged hospital stays caused by incidents during the procedure and social factors related to the patients because the patients in the two groups were random allocated and operators did not know which group their patients belongs to during the surgery. Fourthly, incidences of short-term complications of TURP were significantly low and catheterization in a few patients was prolonged for these complications. For

instance, Koh et al reported incidence of secondary hemorrhage were 0% and 3.3% in early and delayed catheter removal groups, respectively. Incidences of re-catheterization were 10.3% and 10% in the two groups respectively. Incidences of deep vein thrombosis were 3% and 0% in the two groups, respectively [20]. Furthermore, cases such as bladder detrusor dysfunction, capsular defects and bladder neck incision were excluded from some of included studies [11, 20, 22]. Even if these cases were included [10], they had little effects on the mean of hospital stay due to their low incidence. Fifthly, prolonged hospital stays due to social factors were not recorded in the studies [10, 20]. Overall, following early catheter removal, most of patients would be uneventful and could be discharged sooner because TURP was safe, effective and minimally invasive surgery. It also suggested urologists should do better in their operation techniques and post-operative care to reduce related complications. Conversely, delayed catheter removal by surgeon preference resulted in patients without requirement of prolonged catheterization spending more time on hospital to wait for their catheter removal. Of course, we did not include other discharge criteria. For instance, during day-surgery TURP, the patients were discharged with urinary catheters within hours after surgery, but 78% of the patients felt the procedure was acceptable although they had to bear the physical and social inconvenience of catheter care [5].

We tried our best to search the relevant studies following our search strategy, and we included seven RCTs. This sample size was larger than that in any of the previous studies that we analyzed for our meta-analysis. Methodological quality of all included RCTs was evaluated by the Cochrane collaboration's tool for assessing risk of bias and the low-quality studies were distinguished.

There were limitations in our review: (1) We were missing information from original article studies but we were unable to obtain these details even when we attempted to contact the authors of the original article studies; (2) Hospital stays might be affected by different discharge criteria; (3) long-term complications such as urethral strictures and bladder neck contractures were not explored; (4) urodynamic parameters should be conducted to deter-

mine the probability of the need for re-catheterization in future studies; (5) our sample was small.

Conclusion

In summary, early catheter removal was not associated with increased risk of re-catheterization or secondary haemorrhage but it reduced the incidence of UTI and length of hospital stay following TURP. Nevertheless, early catheter removal did take place, and surgeons who perform early catheter removal should consider particular cases in which catheter drainage following the surgery is necessary.

Disclosure of conflict of interest

None.

Address correspondence to: Bo Shu, Department of Urology, Wuhan Central Hospital Affiliated to The Tongji Medical College, Huazhong Science and Technology University, 26 Shengli Street, Wuhan 430014, Hubei, P.R. China. Tel: 027-82211488; Fax: 027-82811446; E-mail: zhangnanurology@hotmail.com

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