Original Article

The comparison of transurethral versus suprapubic catheter after robot-assisted radical prostatectomy: a systematic review and meta-analysis

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Background: The transurethral catheter (TUC) or supra-pubic catheter is commonly used after robot-assisted radical prostatectomy (RARP). However, the best way of urine drainage after the operation is still controversial.

Methods: A comprehensive search of PubMed, Cochrane, Web of Science databases and the reference lists of relevant articles was performed up to July 2019. This systematic review and meta-analysis was performed based on all randomized controlled trials (RCTs) and retrospective studies assessing the two techniques.

Results: In total, nine studies (1,121 patients) were eligible, including three RCTs, one prospective and five retrospective studies. After RARP, postoperative pain was less in suprapubic catheter (SPC) group than TC group, both within 3 days [mean difference (MD): −0.70; 95% confidence interval (CI): −1.37 to −0.02; P=0.04] and 5 days after operation (MD: −0.96; 95% CI: −1.39 to −0.52; P<0.00001). There was no significant difference between SPC and TUC groups, in operation time (MD: 2.58; 95% CI: −5.82 to 10.97; P=0.55) and at rates of both catheterization-associated complication [odds ratio (OR): 1.05; 95% CI: 0.67 to 1.64; P=0.83] and long-term urinary incontinence (OR: 0.69; 95% CI: 0.42 to 1.12; P=0.13).

Conclusions: Patients in SPC group suffer from less postoperative pain compared with the TUC group. SPC can be a better alternate of TUC.

Keywords: Catheter; prostatectomy; robot-assisted; suprapubic; meta-analysis

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Introduction

Prostate cancer is the second most commonly diagnosed malignancy and the fifth leading cause of cancer death in men worldwide (1,2). Radical prostatectomy is a therapeutic approach to patients with low- and intermediate-risk prostate cancer.

Robot-assisted radical prostatectomy (RARP) has the advantages in terms of perioperative outcomes, postoperative complications and long-term continence (3,4). After the

operation, the transurethral catheter (TUC) is mostly used, which remains a major source of pain and discomfort (5).

To minimize postoperative pain, suprapubic catheter (SPC) has been used in cardiothoracic (6) and abdominal operation (7), which had indicated that SPC had less postoperative pain and discomfort compared to TUC. Furthermore, SPC is associated with a low incidence of urethral injury, urinary tract infection and other complications (7-10). SPC has been accepted by urologists since a custom-made SPC used after RARP by Tewari *et al.* in 2008 (11).

However, whether SPC is better than TUC after RARP remains unclear. The present study is to perform a systematic review and meta-analysis to evaluate the benefits of SPC compared with TUC after RARP.

Methods

A prospective protocol of literature-search strategies, inclusion and exclusion criteria, outcome measurements, quality assessment and methods of data analysis was prepared a priori according to the Preferred Reporting Items for Systematic Reviews and Meta-analysis and Meta-analysis of Observational Studies in Epidemiology recommendations for study reporting (12,13).

Literature search strategy

A literature search was performed in PubMed, Cochrane, Web of Science databases on July 25, 2019, and was restricted to the English language. The following MeSH terms and their combinations were searched in (Title/Abstract): catheter/catheterization, prostatectomy. The details of the search strategy were given in Appendix 1. The Related Articles function was also used to broaden the search, and the computer search was supplemented with manual searches of the reference lists of all related articles. When multiple reports describing the same population were published, the most recent or complete report was used.

Inclusion and exclusion criteria

All randomized controlled trials (RCTs) and observational comparative studies comparing TUC and SPC after RARP and had at least one of the quantitative outcomes were included. Single-arm series, editorials, comments, letters to the editor, review articles, case reports and experimental animal studies were excluded (*Table 1*).

Data extraction and outcomes of interest

Data from the included studies were extracted and summarized independently by two of the authors (Li Z and Li K). Any disagreement was resolved by the adjudicating senior authors (Huang H and Wang F).

The primary outcome was postoperative pain. It was divided into early postoperative pain [within postoperative day 3 (≤POD3)] and later postoperative pain (≥POD5). Postoperative pain was evaluated using a visual analog scale (VAS) or Numeric Rating Scale (NRS).

The secondary outcomes were long-term (>30 days) urinary incontinence (>1 pad per day), operation time and complications related to catheterization including urinary retention, catheter malfunction, bladder spasm, bladder neck contracture, urinary tract infection, and hematuria (*Table 1*, *Table S1*).

Quality assessment

Studies were rated for the level of evidence provided according to criteria by the Centre for Evidence-Based Medicine in Oxford, UK (14) .

The methodological quality of RCTs was assessed by the Cochrane risk of bias tool (15). The methodological quality of retrospective studies was assessed by the modified Newcastle-Ottawa scale (16,17). A score of 0–9 was allocated to each study except RCTs.

Statistical analysis

The meta-analyses were performed using Review Manager 5 (Cochrane Collaboration, Oxford, UK). The mean difference (MD) and odds ratio (OR) were used to compare continuous and dichotomous variables, respectively. All results were reported with 95% CI. For studies that presented continuous data as median, interquartile range or range values, the mean and standard deviations were calculated or estimated using the technique described by Hozo *et al.* or Wan *et al.* (18-20). The mean value of the data only reported in the studies would be removed.

Statistical heterogeneity between studies was assessed using the chi-square test with significance set at $P<0.10$, and heterogeneity was quantified using the I^2 statistic. The random-effects model was used if there was heterogeneity between studies; otherwise, the fixed-effects model was used (15).

Subgroup analyses were performed. The included

Table 1 study criteria for inclusion and exclusion in the review

Variables	Inclusion criteria	Exclusion criteria
Participants	The patients requiring robot-assisted radical prostatectomy (RARP)	The patents requiring open or laparoscopic prostatectomy or other surgery
Types of intervention	All studies evaluating suprapubic catheter (SPC) after RARP, defined as: (I) catheter was passed through the inferior incision above the symphysis pubis or through the wound for the robotic system's arms; (II) the patients requiring SPC without or with additional transurethral catheter after RARP for one day or several days	
	Compared with transurethral catheter (TUC) after RARP, defined as: the patients requiring catheter through the penis into bladder	
Types of outcome measures	All studies included one or more of the following	
	Primary outcomes [measured by visual analog scale (VAS) or other scale]	
	Early postoperative pain (< POD3)	
	Later postoperative pain (> POD5)	
	Secondary outcomes	
	Urinary incontinence (>1 pad per day)	
	Urinary tract infection	
	Hemateuresis	
	Complication related to catheter (i.e., clot retention, urinary retention, catheter malfunction, bladder spasm, bladder neck contracture, urinary tract infection, hematuria, skin irritation)	
	Duration time of operation	
Types of study	All comparative studies (i.e., randomized clinical trial) and nonrandomized comparative studies (i.e., Prospective collective data, retrospective studies)	Single-arm series, case reports, editorial or commentaries

studies were grouped into RCT group and Not RCT group which contain retrospective studies and prospective nonrandomized trials. Publication bias was assessed by funnel plot.

Results

Results of the search

Nine studies (11,21-28) including 1,121 patients (585 patients for SPC and 536 patients for TUC) fulfilled the predefined inclusion criteria and were included in the final analysis (*Figure 1*).

Risk of bias and methodological quality of included studies

Three RCTs of 9 studies were assessed by Cochrane risk of bias tool and the other six retrospective studies were assessed by the modified Newcastle-Ottawa scale (NOS). As shown in *Figure 2*, assessment of risk of bias indicated that all RCTs has low levels of potential bias. Comparatively, all of the retrospective studies adopted an appropriate protocol for treatment assignment and had high scores (≥7) assess by NOS (*Table S2*). Matching criteria between the groups were variable. All of the included studies mentioned the length of follow-up and most of them measured the outcomes at different time points during their trials.

Characteristics of included studies

The characteristics of the included studies were shown in *Table 2*. Three of the included article were RCTs (evident level 2b) (21-23), one was prospective nonrandomized trial (27) and five were retrospective studies declared prospective data collection (11,24-26,28). All of them had evidence level 3b. Baseline characteristics of patients in included studies are presented in *Table 3*.

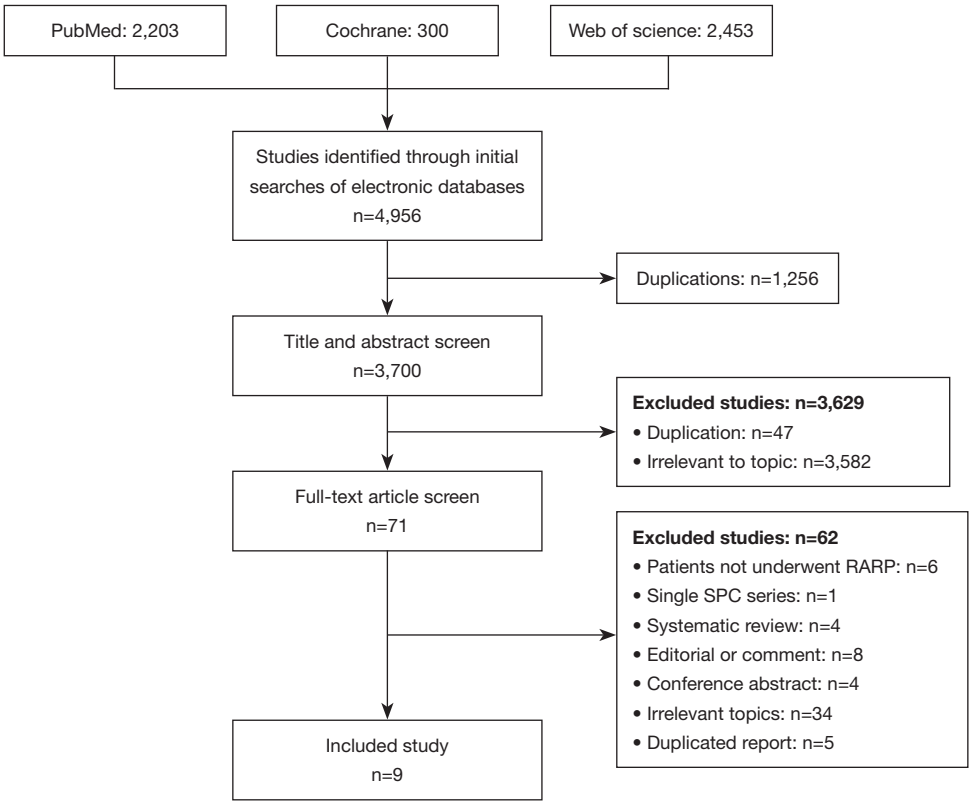

Figure 1 Flow diagram of studies identified included and excluded. SPC, suprapubic catheter; RARP, robot-assisted radical prostatectomy.

Outcomes

The outcome reported by each study was shown in *Table S1*. Most studies reported the score of postoperative pain at more time points. The studies that assess the postoperative pain by VAS or other 10-point scale were included in the meta-analysis (*Table 4*).

Early postoperative pain (≤ POD3)

Five studies (21-23,25,27) (523 patients) were included in the meta-analysis. Two of them (25,27) found the SPC decreased the early postoperative pain compared to TUC, while three RCTs (21-23) found no significant difference between the groups. A test for heterogeneity in Not RCTs subgroup (χ^2=0.74, P=0.39, I^2=0%) and RCTs subgroup (χ^2=2.13, P=0.35, I^2=6%) was not significant.

Pooling data of these five studies showed a small statistically significant difference in favor of SPC. A test for heterogeneity between the five studies was positive (χ^2=20.37, P=0.0004, I^2=80%), so a random-effect meta-analysis was performed between the groups (MD: −0.70; 95% CI: −1.37 to −0.02; P=0.04) (*Figure 3*).

Later postoperative pain(≥ POD5)

Differ from early postoperative pain, pooling data of five studies (22,23,25,27,28) that assessed later postoperative pain found a significant difference in favor of SPC while only one trial (21) found no difference between groups. A random-effects meta-analysis was performed due to the significant heterogeneity among these six studies (χ^2=15.04, P=0.01, I^2=67%). It was found that there was a statistically significant difference in favor of SPC (MD: −0.96; 95% CI: −1.39 to −0.52; P<0.00001) (*Figure 4*).

Long term urinary incontinence (>1 pad per day)

Seven studies (904 patients) (11,22-25,27,28) reported the numbers of patients who suffer from urinary incontinence in different time points (*Table S1*). All of them showed no

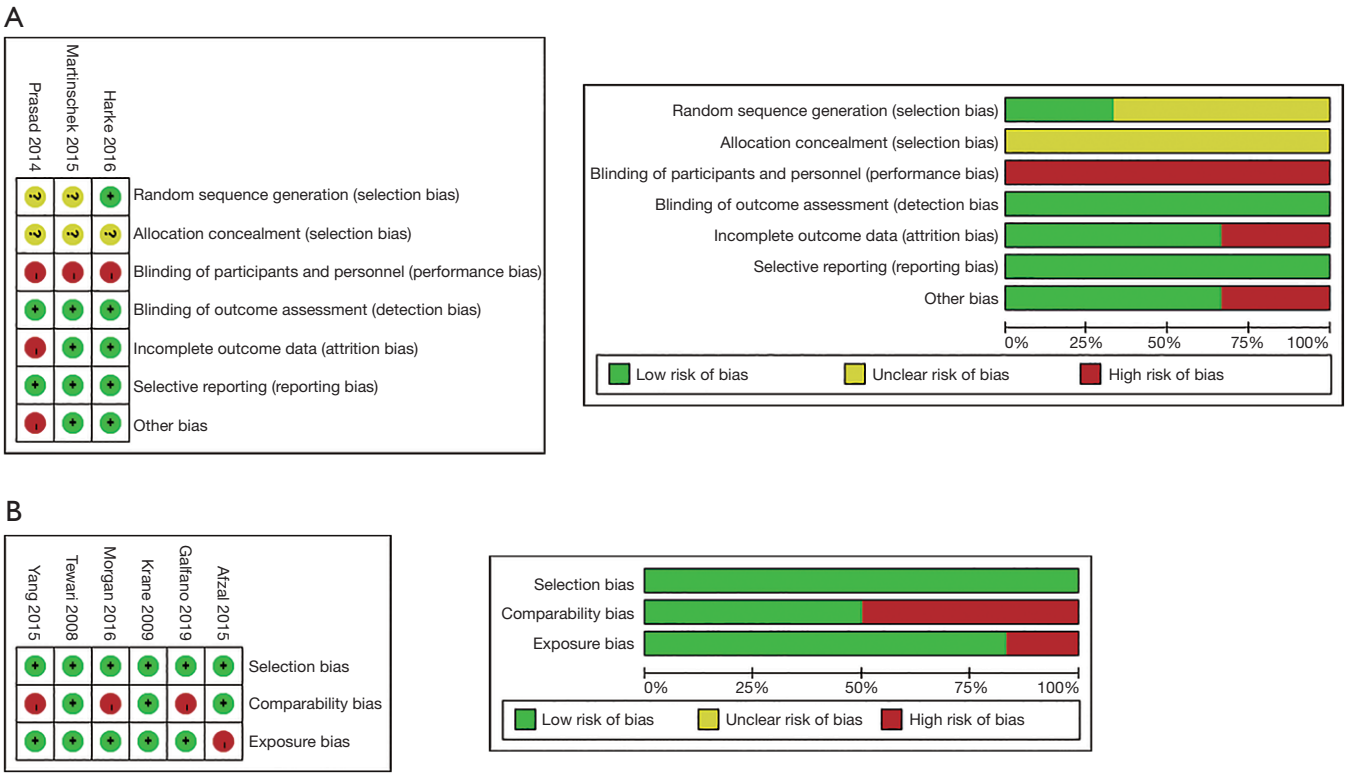

Figure 2 Risk of bias and quality of included studies. (A) The risk of bias graph and summary of three randomized controlled trials (RCTs) that were included. The risk of bias was assessed by the Cochrane risk of bias tool; (B) the methodological quality of five retrospective studies. The quality was assessed by the modified Newcastle-Ottawa scale (NOS).

Table 2 Characteristics of included studies

First author, year of reference	Sample size	Type of intervention	Type of comparison	Study design	Follow-up months, SPC/TUC	Time of indwelling catheter (day), SPC/TUC	Level of evidence	Quality score (NOS)
Tewari 2008	30	SPC	18F TUC	RP	6	7	3b	********
Krane 2009	252	14F SPT with POD1 TUC	TUC with POD1 SPT	RP	7	7	3b	********
Prasad 2014	58	14F SPT with POD1 20F TUC	20F TUC	RCT	13	7.1±0.4/7.2±0.8	2b	RCT
Yang 2015	20	10F PCD with POD3 18F TUC	18F TUC	P	6	7	3b	*******
Afzal 2015	225	14F or 16F SPC with POD1 12F TUC	12F TUC	RP	18	8±2.8/7.3±2.5	3b	*******
Martinschek 2015	62	12F SPT	18F TUC	RCT	12	6	2b	RCT
Morgan 2016	159	SPT with POD1 16F TUC	16F TUC	RP	13.7/3.6	7–10	3b	*******
Harke 2016	160	SPT with POD1 TUC	TUC	RCT	>24/22	NA	2b	RCT
Galfano 2019	191	14F SPT	18F TUC	RP	12	7	3b	*******

*, the quality score of included studies. SPC, suprapubic catheter; SPT, suprapubic tube; PCD, percutaneous cystostomy device; TUC, transurethral catheter; POD1, until postoperation day 1; RP, retrospective design, prospective data collection; P, prospective design, nonrandomized study; RCT, randomized controlled trial; NA, data not available.

Table 3 Baseline characteristics

First author, year of reference	Group	N	Mean age	Mean BMI (kg/m^2)	pre-op Mean PSA (ng/mL)	Gleason score (≤6/7/≥8)	Clinical stage (T1/T2/T3/T4)	Pre-IPSS	Weight of prostate (g)	Blood loss (mL)	Never sparing No.	Lymph node dissection No.
Tewari, 2008	TUC	20	60	27.3	5.5	14/6/0	17/3/0/0	NA	NA	155	NA	NA
	SPC	10	60.8	26.1	4.2	8/2/0	9/1/0/0	NA	NA	170	NA	NA
Krane, 2009	TUC	50	58	28*	5.35	13/27/10	0/28/22/0	5	49.9	NA	NA	NA
	SPC	202	60	27*	5	62/118/22	0/122/80/0	6	48.1	NA	NA	NA
Prasad, 2014	TUC	29	57.7	29	6.3	12/17†*	18/11‡	6.8	44.8	193.1	NA	25
	SPC	29	60	28.8	5.3	21/8†*	18/11‡	7.5	47.1	162.4	NA	26
Yang, 2015	TUC	10	64.6	25.16	18.42	NA	2/7/1/0	NA	NA	63	NA	NA
	SPC	10	68.5	23.83	16.69	NA	3/6/1/0	NA	NA	50.5	NA	NA
Afzal, 2015	TUC	174	63.7	29.6	6.1	71/88/14	118/48/8/0	NA	48.9	NA	NA	NA
	SPC	51	61.9	29.7	6.4	15/28/9	38/11/2/0	NA	48.1	NA	NA	NA
Martinschek, 2015	TUC	35	62.99	NA	6	NA	NA	7	49.9	NA	NA	NA
	SPC	27	64.97	NA	7.51	NA	NA	5	53.3	NA	NA	NA
Morgan, 2016	TUC	94	64	28	5.7	6/69/17	0/53/40/0*	NA	44	NA	82	92*
	SPC	65	62	27	5.4	10/47/6	0/48/15/0*	NA	44	NA	59	43*
Harke, 2016	TUC	80	63.1	26.2	7.2	27/39/12	0/43/34/1	NA	NA	NA	NA	NA
	SPC	80	62.3	25.6	7.6	25/25/9	0/33/26/0	NA	NA	NA	NA	NA
Galfano, 2019	TUC	56	65	NA	7.1	NA	NA	NA	44	200	56	NA
	SPC	135	68	NA	7.5	NA	NA	NA	50	200	135	NA

*, have significant differences between two groups; †, the study divide Gleason score into "6" and "≥7"; ‡, the study decide clinical stage into "≤T1c" and "≥T2a". pre-op, preoperation; TUC, transurethral catheter; SPC, suprapubic catheter; NA, data not available.

Table 4 primary and secondary outcomes comparing SPC with TUC

Outcomes or subgroup of interest	No. of studies	No. of patients (SPC/TUC)	MD/OR[§]	95% CI	P value	Study heterogeneity			
						χ^2	df	I^2, %	P value
Early postoperative pain (≤POD3)	5	325/198	−0.70	−1.37, −0.02	0.04	20.37	4	80	0.0004
Not RCT	2	212/60	−1.4	−1.77, −1.04	<0.00001	0.74	1	0	0.39
RCT	3	113/138	−0.22	−0.66, 0.21	0.32	2.13	2	6	0.35
Later postoperative pain (≥POD5)	6	460/254	−0.96	−1.39, −0.52	<0.00001	15.04	5	67	0.01
Not RCT	3	347/116	−1.21	−1.53, −0.89	<0.00001	1.66	2	0	0.44
RCT	3	113/138	−0.56	−1.40, 0.27	0.18	9.62	2	79	0.008
Long term urinary incontinence (>1 pad per day)	7	491/413	0.69[§]	0.42, 1.12	0.13	2.81	5	0	0.73
Not RCT	5	408/310	0.61[§]	0.36, 1.05	0.07	1.76	3	0	0.62
RCT	2	83/103	1.2[§]	0.36, 3.96	0.77	0.01	1	0	0.91
Complication related to catheter	9	585/536	1.05[§]	0.67, 1.64	0.83	8.69	7	19	0.28
Not RCT	6	473/404	1.26[§]	0.75, 2.13	0.39	6.00	4	33	0.2
RCT	3	112/132	0.64[§]	0.27, 1.55	0.33	1.29	2	0	0.53
Duration time of operation	6	268/228	2.58	−5.82, 10.97	0.55	10.61	5	53	0.06
Not RCT	3	155/86	−0.09	−9.25, 9.06	0.98	0.85	2	0	0.65
RCT	3	113/142	4.55	−13.21, 22.31	0.62	9.53	2	79	0.009

[§], odds ratio. SPC, suprapubic catheter; TUC, transurethral catheter; MD/OR, mean difference/odds ratio; df, degrees of freedom; CI, confidence interval.

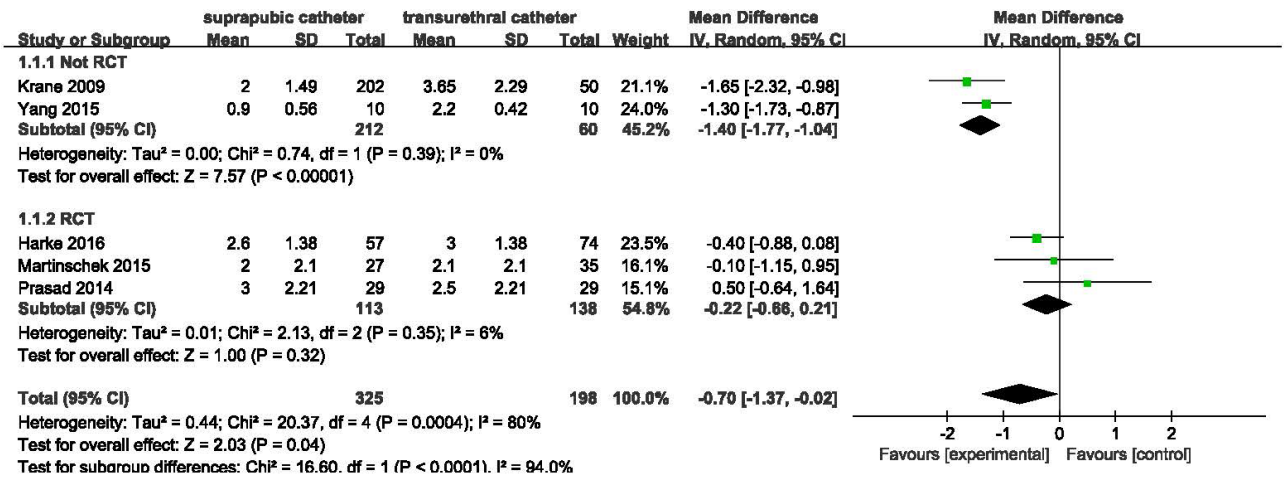

Figure 3 Forest plot and meta-analysis of early postoperative pain (≤ POD3).

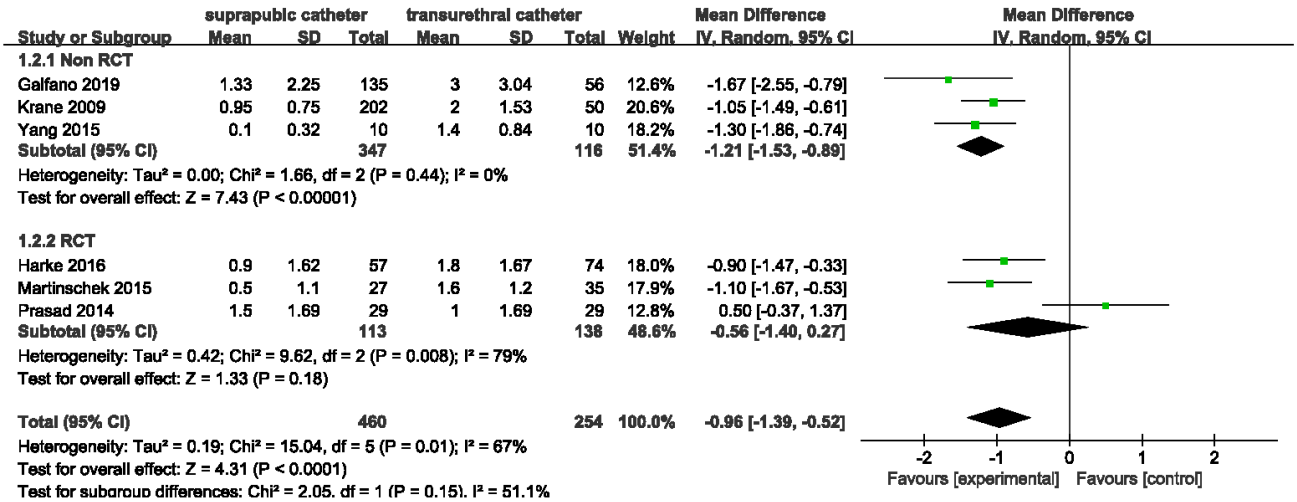

Figure 4 Forest plot and meta-analysis of later postoperative pain (≥ POD5).

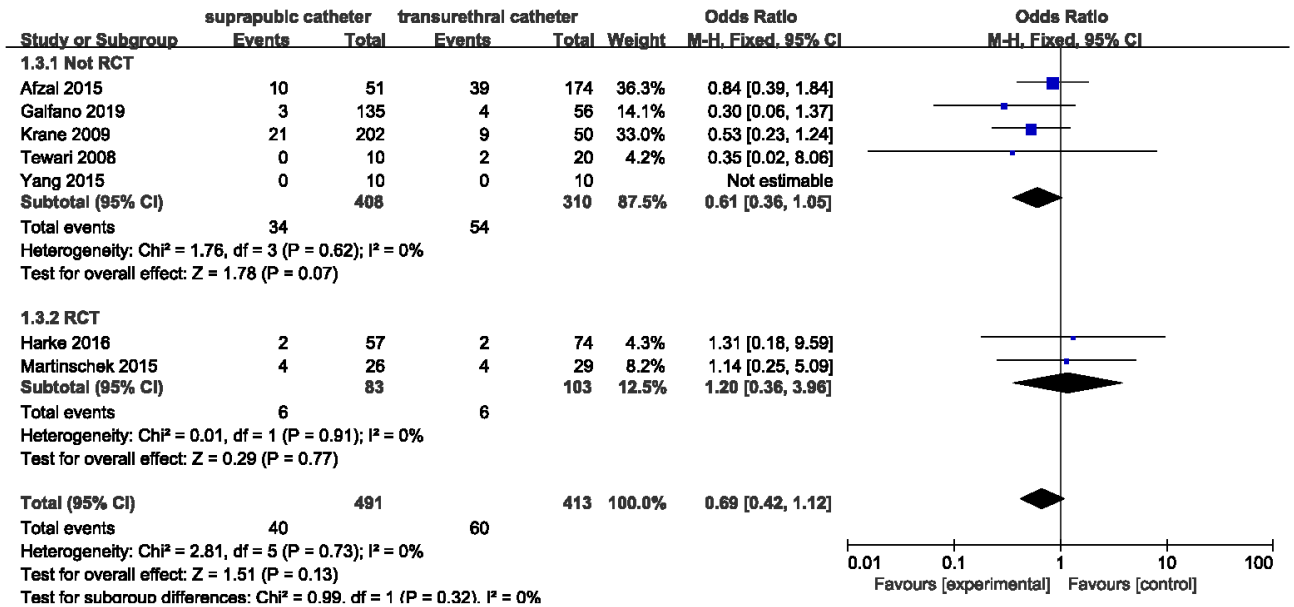

Figure 5 Forest plot and meta-analysis of long-term urinary incontinence rate (>1 pad per day).

significant difference between groups. *Figure 5* shows the number of long-term urinary incontinence from which a fix-effect analysis yields an OR of 0.69 (95% CI: 0.42 to 1.12; P=0.13) for SPC versus TUC.

Complications related to catheterization

Pooling data of nine studies (11,21-28) that assessed overall complications related to catheterization in 930 patients showed there is no statistically significant difference of overall complications related to catheterization in the SPC versus TUC groups (OR: 1.05; 95% CI: 0.67 to 1.64; P=0.83). The same result occurred in subgroups of RCTs and Not RCTs (*Figure 6*).

The single type of overall complications related to catheterization hasn't been analyzed since they were

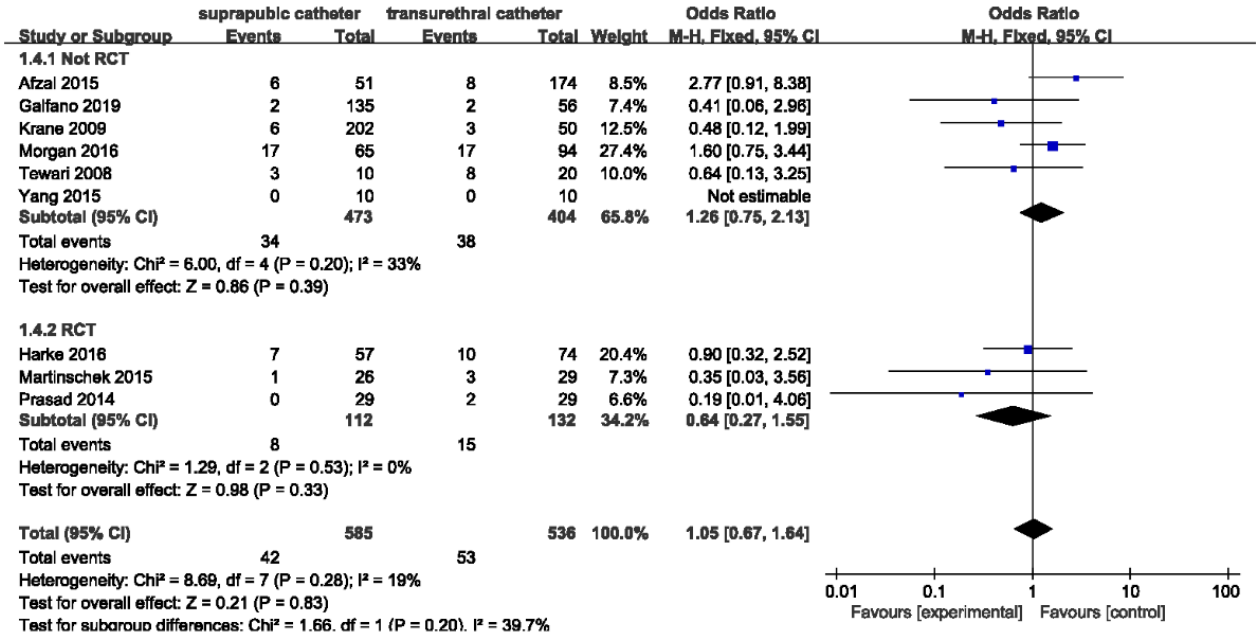

Figure 6 Forest plot and meta-analysis of complications related to catheterization (>1 pad per day).

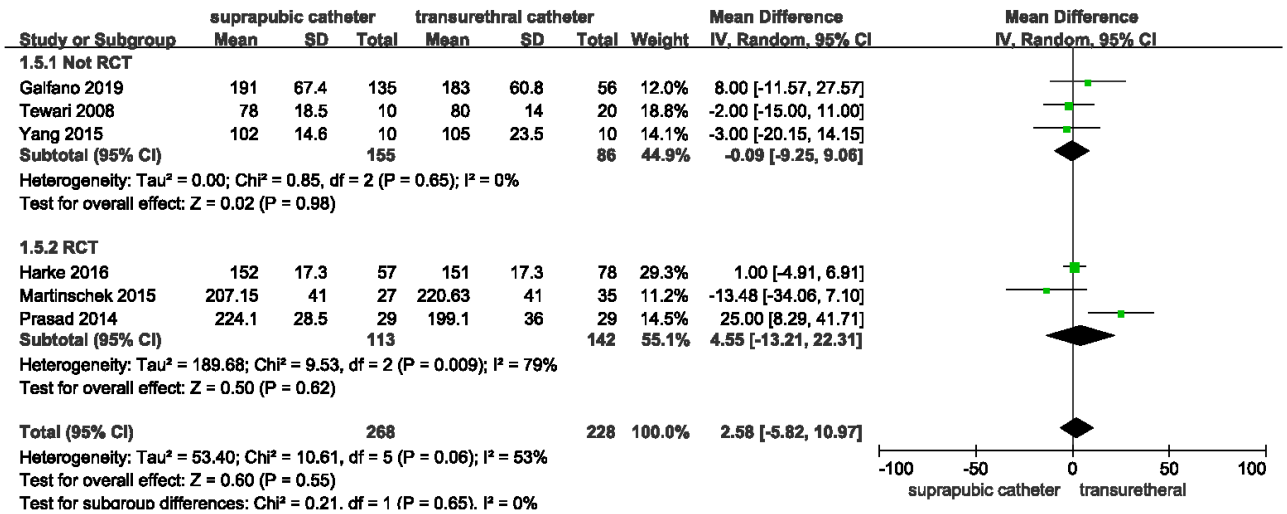

Figure 7 Forest plot and meta-analysis of the duration time of operation.

reported dispersedly in these studies (*Table S1*).

Duration of operation

Six studies (496 patients) (11,21-23,27,28) were included in the meta-analysis. A fix-effect meta-analysis was performed between these six studies and no statistically significant difference was found (MD: 2.58; 95% CI: −5.82 to 10.97; P=0.55) (*Figure 7*).

Subgroup analysis

The results of subgroup analysis were similar to those of total meta-analysis except the primary outcomes. We found no significant difference in postoperative pain either in early time or later period among three RCTs.

Table 5 Sensitivity analysis of three RCTs and one prospective nonrandomized study

Outcomes or subgroup of interest	No. of studies	No. of patients (SPC/TUC)	MD/OR[§]	95% CI	P value	study heterogeneity			
						χ^2	df	I^2, %	P value
Early postoperative pain (≤ POD3)	4	123/148	−0.44	−1.19, 0.30	0.24	14.33	3	79	0.002
Later postoperative pain (≥ POD5)	4	123/148	−0.77	−1.41, −0.13	0.02	12.40	3	76	0.006
Long term urinary incontinence (>1 pad per day)	3	93/113	1.20[§]	0.36, 3.96	0.77	0.01	1	0	0.91
complication related to catheter	4	122/142	0.64[§]	0.27, 1.55	0.33	1.29	2	0	0.53
Duration time of operation	4	123/152	2.85	−10.05, 15.76	0.66	9.89	3	70	0.02

SPC, suprapubic catheter; TUC, transurethral catheter; MD/OR, mean difference/odds ratio; df, degrees of freedom; CI, confidence interval; [§], odds ratio.

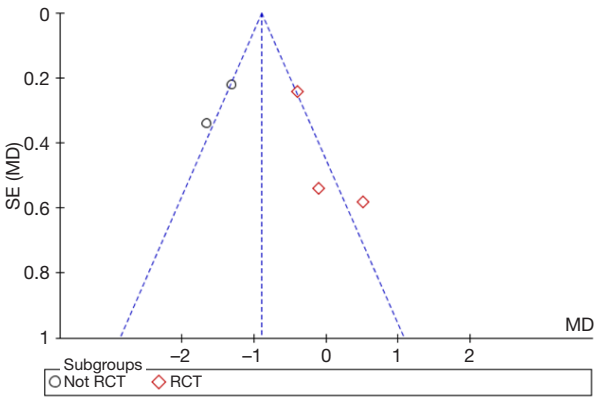

Figure 8 Funnel plots illustrating meta-analysis of early postoperative pain (≤ POD3). SE, standard error; MD, mean difference.

Sensitivity analysis and publication bias

Three RCTs (21-23) and one prospective nonrandomized studies (27) were included in the sensitivity analysis (*Table 5*). The degree of between-study heterogeneity decreased slightly for early postoperative pain but increased slightly for later postoperative pain and duration of the operation. There was no change in the significance of any of the outcomes except for early postoperative pain, which was shown no significant difference between SPC and TUC group (MD: −0.44; 95% CI: −1.19 to 0.30; P=0.24).

In comparison with TUC, a single statistical outlier was identified in the meta-analysis of operative time. Morgan et al have shown that the median operative time for TUC group was significantly shorter than the SPC group (177 *vs.* 230 minutes, P<0.0001). However, the authors of the trial considered the reason was not related to SPC placement alone, which took only 5 to 10 minutes (26). So, we remove the data to reduce the evidence of publication bias.

A funnel plot of the studies included in this meta-analysis that reported early postoperative pain was shown in *Figure 8*. All studies nearly lie inside the 95% CIs, with an even distribution around the vertical, indicating no obvious publication bias.

Discussion

This meta-analysis of three RCTs, one prospective nonrandomized trial and five retrospective studies including 1,121 patients comparing the efficacy of SPC and TUC showed that SPC would decrease the postoperative pain either in early time or the later period while without showing an increase in the rate of complications related to catheterization. This meta-analysis found no significant differences in long-term incontinence rate and duration time of operation.

The primary outcome was postoperative pain. Many authors have indicated that TUC can be removed within 3–5 days of prostatectomy (23). On one hand, Martinschek *et al.* (22) demonstrated less catheter-associated pain could be found in the SPT group in the later period, on the other hand, Harke *et al.* found catheter-associated pain had no significant difference between TUC and SPC group after POD 5 and drew a potential conclusion that the major benefit of supra-pubic catheter can be seen when the patient is fully mobilized (23). Therefore, we grouped the primary outcome into the early time and the later period.

In the most recently systematic review written by Jian *et al.* (29), they included only three studies and found that the postoperative pain had no statistic difference between

the TUC and SPC group by dividing the patients into two groups (with pain and without pain) according to VAS score of overall pain, which was not applicable to other studies (21-23,27). Another systematic review written by Li *et al.* (30), they indicated that the overall pain after radical prostatectomy has no significant difference between the SPT and UC groups. However, it included pains not related to catheterization. In our study, we used original and quantitative data presented by original trials and found that the SPC was more adopted by patients undergoing RARP than TUC which may limit daily activities both in early time and later period that was similar to other reviews (7,10). Furthermore, we included the data of the most recent study written by Galfano *et al.* (28) and compared the duration time of operation between SPC and TUC group, and found that there's no significant difference between SPC and TUC group which indicated that SPC would be a potential way for urinary drainage after RARP.

Interestingly, we pooling data of five studies which have shown SPC can decrease the early postoperative pain, but we found no significant difference in the subgroup of RCTs. Pain has both physical and psychological components. In the nonrandomized trials, patients who selected SPC subjectively might have tended to report lower scores. Differ to the result of early postoperative pain, all studies included in meta-analysis showed SPC was associated with lower pain compared to TUC in the later period after RARP except one (21). This finding may represent that the major benefit of SPC can only be seen on the later postoperative day after they fully adapt to it (23), although Prasad *et al.* considered the most severe pain from the catheter is due to bladder spams which would ease by the first day after operation (21).

The pooling data of long-term incontinence rate and overall postoperative complications suggested that SPC had no significant difference in these two parts compared to TUC while other reviews showed SPC could decrease complication relative to catheterization especially urinary tract infection in other operations (7,10). This finding may result from the particularity of using a catheter after RARP. The catheter is not only used as bladder drainage but also an important component of the healing process of the vesicourethral anastomosis and prevention of anastomotic stricture developed (21). Single type of complication was reported dispersedly in these studies. The further trials should record the number of patients who suffer from these complications respectively. The result of the duration of operation demonstrated that SPC group have no longer operative time compared to TUC group due to the fact that SPC placement only took 5 to 10 minutes (24,26).

The present meta-analysis has the following limitations that must be taken into account. The main limitation is that the limited number of RCTs prevented us from reaching any definitive conclusions. Inadequate random sequence generation and blinding tended to increase the risk of bias although there's no way to enforce blind to the patients. A future original trial should evaluate different complications separately and roundly.

Nevertheless, we applied multiple strategies to identify studies, strict criteria to include and evaluate the methodological quality of the studies, and subgroup and sensitivity analysis to minimize the heterogeneity.

Conclusions

The present systematic review and meta-analysis reveals SPC is an alternative way for bladder drainage after RARP and it can decrease the postoperative pain while the complications related to catheterization are similar to TUC. Future large-volume, well-designed RCTs are required.

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Footnote

Conflicts of Interest: The authors have no conflicts of interest to declare.

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Supplementary

Appendix 1 Detail of search strategy

PubMed: ((“catheters”[MeSH Terms] OR “catheterization”[MeSH Terms]) OR catheter[Title/Abstract]) AND (“prostatectomy”[MeSH Terms] OR prostatectomy[Title/Abstract])

Cochrane: prostatectomy and catheter(TI/Ab/KEY)

Web of Science: TS=(prostatectomy and catheter)

Table S1 Detail of outcomes

First author, year of reference	Early postoperative pain (≤ POD3)	Later postoperative pain (≥ POD5)	No. urinary incontinence (>1 pad per day)	Duration time of operation, mean (min)	No. of complications related to catheter							
					Postoperative retention	Catheter malfunction	Bladder spasm	Bladder neck contracture	Hematuria	Skin irritation	Bacteriuria	Overall
Tewari 2008	Number of patients suffered penile pain (18 *vs.* 2)		2 *vs.* 0 at 12 weeks postoperation	78 *vs.* 80	NR	NR	8 *vs.* 3	0 *vs.* 0	NR	NR	NR	8 *vs.* 3
Krane 2009	Median 4 *vs.* 2 measured overall pain by FPS-R at POD2	Median 2 *vs.* 0 measured overall pain by FPS-R at POD6	9 *vs.* 21 at 2 months postoperation	171 *vs.* 165	3 *vs.* 5	NR	0 *vs.* 1	NR	NR	NR	NR	3 *vs.* 6
Prasad 2014	Mean 2.5 *vs.* 3.0 measured overall pain by VAS at POD1	Mean 1.0 *vs.* 1.5 measured overall pain by VAS at POD7	NR	199.1 *vs.* 224.1	NR	0 *vs.* 2	NR	0 *vs.* 0	NR	NR	NR	0 *vs.* 2
Yang 2015	Mean 2.2 *vs.* 0.9 measured penile pain by VAS at POD3	Mean 1.4 *vs.* 0.1 measured penile pain by VAS at POD7	0 *vs.* 0 at 1 month postoperation	105 *vs.* 102	0 *vs.* 0	NR	NR	0 *vs.* 0	NR	NR	NR	0 *vs.* 0
Afzal 2015	Retrospective measured catheter bothered by a 10-points scaled at 28 weeks		39 *vs.* 10 at 6 weeks postoperation	NR	NR	NR	NR	NR	NR	NR	NR	8 *vs.* 6
Martinschek 2015	Mean 2.1 *vs.* 2 measured pain caused by catheter by VAS at POD1	Mean 1.6 *vs.* 0.5 measured pain caused by catheter by VAS at POD6	4 *vs.* 4 at 1 year postoperation	220.63 *vs.* 207.15	1 *vs.* 1	NR	NR	2 *vs.* 0	NR	NR	NR	3 *vs.* 1
Morgan 2016	Number of patients suffered penile pain		NR	177 *vs.* 230	0 *vs.* 3	13 *vs.* 10	2 *vs.* 2	NR	1 *vs.* 1	1 *vs.* 1	NR	17 *vs.* 17
Harke 2016	Mean 3 *vs.* 2.6 measured overall pain by NRS at POD1	Mean 1.8 *vs.* 0.9 measured overall pain by NRS at POD5	2 *vs.* 2 at 2 years postoperation	151 *vs.* 152	2 *vs.* 4	NR	NR	0 *vs.* 0	NR	NR	8 *vs.* 3	10 *vs.* 7
Galfano 2019	NR	Mean 3 *vs.* 1 measured pain for urinary drain by vas-nas at POD7	4 *vs.* 3 at 1 year postoperation	190 *vs.* 195	1 *vs.* 2	1 *vs.* 0	NR	NR	NR	NR	NR	2 *vs.* 2

POD, postoperation day; FPS-R, faces pain score-revised; VAS, visual analog scale; NRS, numeric rating scale; NR, no record.

Table S2 Risk of bias in retrospective studies using modified (Newcastle-Ottawa scale)

Study	Selection				Comparability		Exposure			Quality score
	Representativeness of the exposed cohort	Selection of the non-exposed cohort	Ascertainment of exposure	Outcome of interest was not present at start	Comparable for 1–4*	Comparable for 5–8*	Assessment of outcome	Follow-up long enough	Adequacy of follow up of cohorts	
Tewari 2008	Yes	Yes	Yes	Yes	1,2,3,4	5	Yes	Yes	Yes	********
Afzal 2015	Yes	Yes	Yes	Yes	1,2,3,4	5,7	Yes	Yes	No	*******
Krane 2009	Yes	Yes	Yes	Yes	1,2,3,4	5.6,7	Yes	Yes	Yes	********
Morgan 2016	Yes	Yes	Yes	Yes	1,2,3	5.7.8	Yes	Yes	Yes	*******
Yang 2015	Yes	Yes	Yes	Yes	1,2 ,4	5	Yes	Yes	Yes	*******
Galfano 2019	Yes	Yes	Yes	Yes	1,2	7,8	Yes	Yes	Yes	*******

Comparability variables: 1= age; 2= preoperative PSA; 3= Gleason score; 4= clinical stage; 5= BMI; 6= preoperative IPSS; 7= weight of prostate; 8= nerve sparing. *, if all characteristics were comparable, two stars; if preoperative PSA, Gleason score or Clinical stage wasn’t comparable, no star; otherwise, one star.