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REVIEW

Perioperative, functional, and oncologic outcomes in patients undergoing robot-assisted radical prostatectomy previous transurethral resection of prostate: a systematic review and meta-analysis of comparative trials

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Abstract

The influence of robot-assisted radical prostatectomy (RARP) on patients who have previously undergone transurethral resection of the prostate (TURP) versus TURP-naive patients is still debatable. The present study aimed to compare perioperative, functional, and oncologic outcomes of RARP between TURP and Non-TURP groups. We systematically searched the databases such as Science, PubMed, Embase, Web of Science, and the Cochrane Library database to identify relevant studies published in English up to August 2022. Review Manager was used to compare various parameters. The study was registered with PROSPERO (CRD42022378126). Eight comparative trials with a total of 4186 participants were conducted. The TURP group had a longer operative time (WMD 22.22 min, 95% CI 8.48, 35.95; $p=0.002$), a longer catheterization time (WMD 1.32 day, 95% CI 0.37, 2.26; $p=0.006$), a higher estimated blood loss (WMD 23.86 mL, 95% CI 2.81, 44.90; $p=0.03$), and higher bladder neck reconstruction rate (OR 8.02, 95% CI 3.07, 20.93; $p<0.0001$). Moreover, the positive surgical margin (PSM) was higher in the TURP group (OR 1.49, 95% CI 1.12, 1.98 $p=0.007$). However, there was no difference between the two groups regarding the length of hospital stay, transfusion rates, nerve-sparing status, complication rates, long-term continence, potency rates and biochemical recurrence (BCR). Performing RARP on patients who have previously undergone TURP is a safe procedure. Furthermore, the current findings demonstrated that the TURP group had comparable oncologic and long-term functional outcomes to the Non-TURP group.

Keywords Prostate cancer · Robot-assisted radical prostatectomy · Transurethral resection of the prostate · Outcomes · Meta-analysis

Introduction

Increasing age is a risk factor for benign prostatic hyperplasia (BPH) and prostate cancer. It is common for older men with BPH to have a prostatectomy for prostate cancer [1]. Prostate cancer is found in 3–16% of transurethral resection of prostate (TURP) specimens [2, 3]. Furthermore, 4–6.4% of older men who have undergone TURP are diagnosed with prostate cancer within 7 years [4]. Due to inflammation, scarring, and fibrosis, previous surgery may influence perioperative, and functional, oncologic outcomes after radical prostatectomy [5]. Yang et al. [6] indicated that laparoscopic radical prostatectomy after TURP had higher rates of positive surgical margins, complications and bladder neck reconstruction than the Non-TURP group. In contrast,

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Fragkoulis et al. [7] revealed that operative time and blood loss were higher, and potency recovery was lower in the TURP group after open radical prostatectomy. However, no statistically significant difference in oncologic outcomes was demonstrated between the two groups of patients.

Robot-assisted radical prostatectomy (RARP) has become the standard method of performing radical prostatectomy [8]. It provides three-dimensional (3D) vision and amplification of the operative field, increases seven degrees of freedom versus four, and improves surgeon ergonomics [9]. Therefore, RARP in patients who have undergone TURP is critical, despite potential technical challenges. The perioperative and functional outcomes of robot-assisted, laparoscopic or open radical prostatectomy for the treatment of localized prostate cancer differ [10]. It is unclear whether prior transurethral prostate surgery affects the outcomes of RARP.

Therefore, we aimed to incorporate available clinical studies to systematically compare the perioperative, functional, and oncologic outcomes of RARP between TURP and Non-TURP groups and to provide clinicians with the latest evidence for clinical decision-making.

Methods

This meta-analysis was conducted according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement [11] and was registered in the PROSPERO (ID: CRD42022378126).

Literature search strategy, study selection and data collection

We conducted a comprehensive search of the PubMed, Embase, Web of Science, and Cochrane Library databases through August 2022 to identify eligible studies. The following terms were produced by combining intervention and patient-related search terms: [(Robotic surgical procedures OR Robotics OR Robot-assisted) AND (Prostatic neoplasms OR Prostatectomy) AND (Transurethral resection of prostate OR TURP)] Moreover, we manually searched and reviewed the relevant references to avoid any omissions. Only studies reported in English are included in the references.

The PICOS approach was used to define the inclusion criteria. (1) The patients were diagnosed with prostate cancer based on pathological findings; (2) in the experimental group, patients had a history of TURP and undergone RARP; (3) in the control group, patients had no previous TURP and were undergone RARP; (4) one or more of the following outcomes: perioperative, functional and oncologic outcomes; and (5) cohort studies, case–control studies or randomized controlled trials (RCTs). Following are the exclusion criteria: (1) non-comparative studies; (2) editorial comments, meeting abstracts, case reports, unpublished studies, or reviews; and (3) studies with unavailable data for analysis.

The Data were extracted independently by the two reviewers, which were as follows: (1) general information: first author, publication year and country; (2) population characteristics: number of patients, age, body mass index (BMI), prostate-specific antigen (PSA), follow-up time, pathological stage and outcomes; (3) perioperative outcomes: operative time, blood loss, transfusion rates, catheterization time, length of hospital stay, lymphadenectomy, positive lymph nodes, nerve-sparing status and bladder neck reconstruction rates; (4) minor complications (defined as Clavien grade 1–2), major complications (defined as Clavien grade ≥ 3); (5) functional outcomes: continence recovery (defined as the using no pad or one safety pad/day), potency recovery (defined as erections sufficient for sexual intercourse without phosphodiesterase 5 (PDE5) inhibitors); and (6) oncologic outcomes: positive surgical margins (PSM), and biochemical recurrence (BCR). Any discrepancies were resolved through consensus or consultation with the third reviewer.

Bias risk assessment

The quality of all included non-RCTs was assessed using the ROBINS-I [12], including bias due to (1) confounding; (2) participant selection; (3) exposure classification; (4) withdrawals from intended exposures; (5) missing data; (6) measurement of outcomes; and (7) selection of the reported result.

Statistical analysis

In the present study, the statistical analysis was performed using Review Manager V5.4 software (Cochrane Collaboration, Oxford, UK). The results were reported with 95% confidence intervals (CIs) and odds ratio (OR) for dichotomous variables, and weighted mean difference (WMD) for continuous variables. The Mantel–Haenszel method was used to pool meta-analyses of dichotomous variables, while the inverse variance method was used for continuous variables. Because of the predictable significance of between-trial heterogeneity, the random-effects model was used in all analyses. The I^2 statistic was used to calculate study heterogeneity [13]. $p < 0.05$ was considered statistically significant.

Sensitivity analysis

We used the leave-one-out method to exclude studies from the pooled effect one at a time to assess the robustness of the estimates. Furthermore, we evaluated the robustness based on the study cohort size (excluding studies with < 100

patients), which may contribute to heterogeneity. However, we cannot perform sensitivity analyses comparing three or fewer studies.

Publication bias

The test power was inadequate when ten or fewer studies were included. Therefore, we could not perform the publication bias [14, 15].

Results

Baseline characteristics

A total of 156 studies were preliminarily searched, with 35 remaining after duplicates were removed. We excluded 20 studies after reviewing titles and abstracts and seven articles after reading and screening the full texts. Finally, eight studies (non-RCTs) involving 4186 patients (446 TURP vs. 3740 Non-TURP) were included in the present study [16–23] (Fig. 1). The eight studies were all retrospective comparisons. These studies were conducted in various countries, including the United States of America (USA), India, China and Germany. The follow-up time for the included studies ranged from 12 to 24 months.

Furthermore, the RARP has performed a minimum of 12 weeks after TURP and 6 weeks after biopsy in the included studies. Table 1 summarizes the baseline characteristics and the preoperative variables of included patients (sample size, age, BMI, PSA and pathologic outcomes). Moreover, the preoperative demographics were comparable in terms of age, BMI, baseline, and tumor stage. Tables 2 and 3 summarize surgical, complication, functional and oncologic outcomes.

Assessment of quality

These studies conducted comparative analysis and were published between 2008 and 2022. The eight non-RCTs included had a moderate risk of bias (Table 4; the details are in Table S1).

Outcome analysis

Perioperative outcomes

A meta-analysis of the length of hospital stay revealed no statistically significant difference between the TURP and

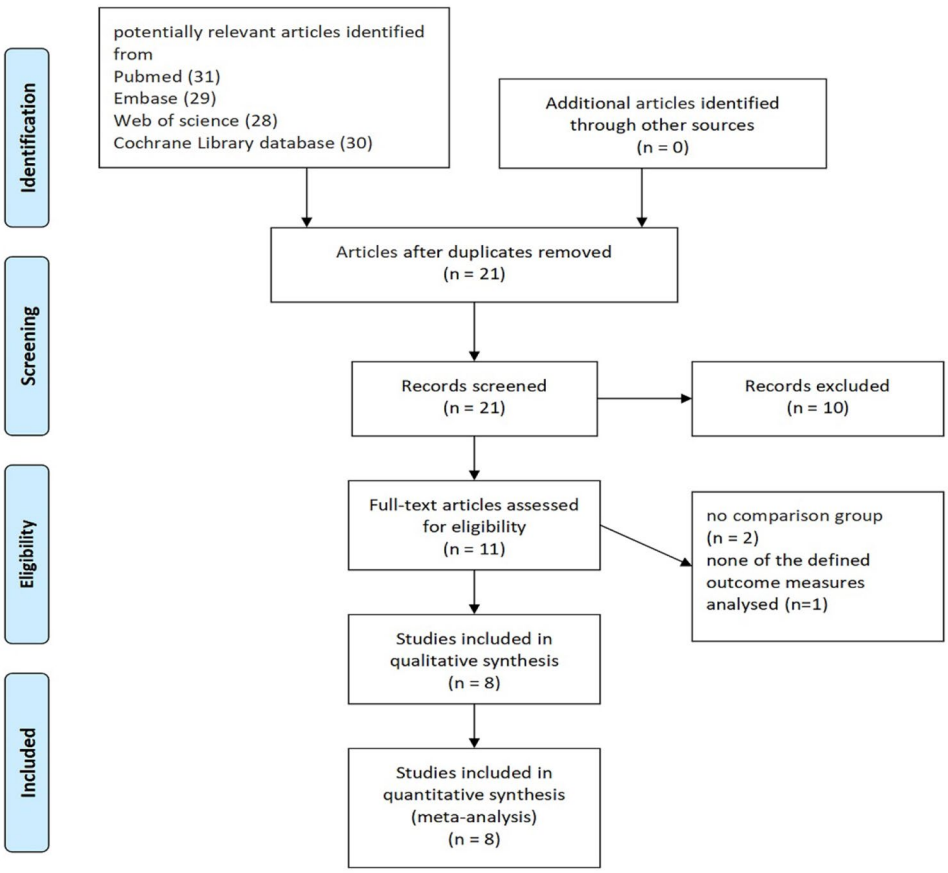

Fig. 1 PRISMA flow diagram for the systematic review

Table 1 Main baseline patient for the studies included

References	Bajpai 2022		Garg 2022		Carbin 2021		Su 2015		Hung 2014		Zugor 2012		Gupta 2011	
	TURP	Non-TURP	TURP	Non-TURP	TURP	Non-TURP	TURP	Non-TURP	TURP	Non-TURP	TURP	Non-TURP	TURP	Non-TURP
Country	USA		India		India		USA		China		Germany		India	
Number of patients, *n*	150	450	38	76	36	72	49	2644	16	184	80	80	26	132
Age, years	59.8 (5)	59.8 (5.4)	65.3 (6.1)	64.7 (5.9)	66.9 (7.2)	67.3 (6.5)	63.65	59.77	67.5(7.4)	64.8 (6.9)	67.5 (6.75)	66.1 (6.5)	66.6	63.4
BMI, kg/m^2	24.9 (2.7)	25.1 (2.9)	NA	NA	25.9 (5.6)	26 (4)	28.04	23.92	25.2(3.5)	24.5 (2.8)	26.8 (5)	24.6 (2.25)	25.61	26.1
PSA, ng/mL	5.9 (1.7)	6.2 (1.6)	8 (6.81)	9.1 (5.85)	16.4 (20.6)	19.9 (26.9)	6.91	5.91	26.44(29.59)	17.85 (20.27)	9.5 (19.15)	9.2 (12.05)	13.2	19.6
Follow-up time	9 mo		2 years		1 year		1 year		1 year		13.5 (3–48), mo		1 year	
Pathologic														
ISUP grade group														
Grade group 1	67	198	16	42	2	15	NA		NA		NA		NA	
Grade group 2	31	83	16	25	11	24								
Grade group 3	31	115	3	2	12	16								
Grade group 4	18	44	1	1	7	12								
Grade group 5	3	10	1	2	4	5								
Gleason score	NA		NA		NA		6.49	6.56	6.63 (1.02)	6.59 (1.08)	< 7 (*n*): 42; = 7 (*n*): 30; > 7 (*n*): 8	< 7 (*n*): 56; = 7(*n*): 23; > 7(*n*): 1	6.36	6.1
Pathological stage, *n*														
< pT3	129	409	31	64	15	34	NA		4	74	NA		10	40
≥ pT3	21	41	7	12	21	38			12	110			16	92

TURP transurethral resection of the prostate, *ISUP* International society of urological pathology, *SD* Mean

Table 2 Perioperative outcomes

References	Bajpai 2022		Garg 2022		Carbin 2021		Su 2015		Hung 2014		Zugor 2012		Gupta 2011		Hampton 2008	
	TURP	Non-TURP	TURP	Non-TURP	TURP	Non-TURP	TURP	Non-TURP	TURP	Non-TURP	TURP	Non-TURP	TURP	Non-TURP	TURP	Non-TURP
Perioperative outcomes																
Operative/Console time (min)	70(6.67)	60 (8.89)	203.7 (44.7)	179.9 (54.3)	184.6 (42.6)	171.9 (42.1)	NA		3.16 (1.74) (h)	2.95 (0.78) (h)	189 (112.5)	149 (65)	NA		NA	
Estimated blood loss (ml)	110 (14.82)	90 (29.63)	325 (222.2)	225 (203.7)	176.38 (103.8)	142 (71.3)	128.13	115.94	145 (161.4)	183.2 (18.06)	165 (50)	144 (237.5)	NA		NA	
Transfusion	0	0	NA		0	0	NA		0	7	1	0	3	9	NA	
Catheterization time (day)	10	10	16 (4.2)	14 (3.2)	10	8	NA		9.31 (2.82)	9 (2.57)	6.8 (5.25)	5.2 (0.25)	NA	NA	NA	NA
Length of hospital stay (day)	1	1	5.5 (3.5)	5.7 (3.3)	2 (4)	2.1 (0.6)	NA		4.19 (2.01)	3.77 (2.26)						
Lymphadenectomy, *n*	83	253	NA		NA		NA		14	153	59	59	NA		NA	
Positive lymph nodes, *n*	NA		NA		10	17	NA		1	12	2	0	NA		NA	

Table 2 (continued)

References	Bajpai 2022		Garg 2022		Carbin 2021		Su 2015		Hung 2014		Zugor 2012		Gupta 2011		Hampton 2008	
	TURP	Non-TURP	TURP	Non-TURP	TURP	Non-TURP	TURP	Non-TURP	TURP	Non-TURP	TURP	Non-TURP	TURP	Non-TURP	TURP	Non-TURP
Nerve sparing status																
Bilateral sparing, *n*	123	378	NA		7	15	NA		2	48	42	54	NA		NA	
Unilateral sparing, *n*	12	61			19	42			0	17	NA					
Total, *n*	135	439			26	57			2	65						
Bladder neck reconstruction, n	12	8	8	5	21	21	NA		15	28	47	2	7	13	NA	

TURP transurethral resection of the prostate, *SD* Mean

Non-TURP groups (three studies pooled; $p=0.76$) [17, 18, 20]. The TURP group was associated with longer operative time than the Non-TURP group (WMD 22.22 min, 95% CI 8.48, 35.95; $p=0.002$), including four studies [16–18, 21]. More catheterization time was also observed in the TURP group (WMD 1.32 days, 95% CI 0.37, 2.26; $p=0.006$), including three studies [17, 20, 21]. Furthermore, a pooled analysis of five studies revealed that the TURP group had greater estimated blood loss than the Non-TURP group (WMD 23.86 mL, 95% CI 2.81, 44.90; $p=0.03$) [16–18, 20, 21]. However, leave-one-out sensitivity analysis demonstrated no significant difference between the two groups with the removal of two studies ($p=0.17$, $p=0.18$) [16, 18]. There was no significant difference in the transfusion rates between the TURP and Non-TURP groups (five studies pooled; $p=0.40$) [16, 18, 20–22]. The statistical significance of the transfusion rates did not change after we performed the leave-one-out test (Fig. 2).

The cumulative analysis showed no significant difference in the prevalence of unilateral nerve sparing (three studies; $p=0.06$) [16, 18, 20] and bilateral nerve sparing (four studies; $p=0.07$) between TURP and Non-TURP groups [16, 18, 20, 21]. However, the TURP group had lower overall nerve-sparing rates (OR 0.26, 95% CI 0.13, 0.53 $p=0.007$), including three studies [16, 18, 20]. In contrast, the TURP group was associated with a higher rate of bladder neck reconstruction (OR 8.02, 95% CI 3.07, 20.93 $p<0.0001$) [16–22]. We identified no statistically significant difference between the two groups after eliminating studies with < 100 patients and performing the leave-one-out analysis (Fig. 3).

Complications

Minor complications rates (Clavien grade 1–2) were 11.9% (38 out of 320 cases) in the TURP group and 8.35% (72 of 862 cases) in the Non-TURP group. A meta-analysis of minor complication rates revealed no statistically significant difference between the TURP and Non-TURP groups (five studies; $p=0.52$) [16–18, 20, 21]. The major complication (Clavien grade ≥ 3) rates were 5.3% (17 out of 329 cases) and 3.01% (26 of 863 cases) in the TURP and Non-TURP groups, respectively. Similarly, there is no statistical significance in major complications between the TURP and Non-TURP groups (five studies; $p=0.10$) [16–18, 20, 21]. The statistical significance of minor and major complications remained unchanged in the leave-one-out analysis (Fig. 4).

Functional outcomes

The pooled results revealed that there was no difference in urinary continence at 1 month (four studies; $p=0.25$) [16–18, 20], 3 months (six studies; $p=0.10$) [16–21] and 12 months (six studies; $p=0.07$) [16–21]. Furthermore,

Table 3 The complications, functional and oncologic outcomes

Reference	Bajpai 2022		Garg 2022		Carbin 2021		Su 2015		Hung 2014		Zugor 2012		Gupta 2011		Hampton 2008	
	TURP	Non-TURP	TURP	Non-TURP	TURP	Non-TURP	TURP	Non-TURP	TURP	Non-TURP	TURP	Non-TURP	TURP	Non-TURP	TURP	Non-TURP
Postoperative complications																
Minor complications	12	31	3	12	2	3	NA		1	18	20	8	NA		NA	
Major complications	9	19	3	2	0	2			3	2	2	1				
Functional outcomes																
Continence	1 month: 28 3 months: 133 6 months: 145 9 months: 146	1 month: 72 3 months: 384 6 month: 448 9 months: NA	1 month: 7 3 months: 15 6 months: 25 12 months: 32 24 months: 32	1 month: 43 3 month: 66 6 month: 74 12 month: 73 24 month: 74	1 month: 3 3 months: 10 6 months: 19 12 months: 27	1 month: 10 3 months: 25 6 months: 43 12 months: 59	3 months: 30 12 months: 40	3 months: 1722 12 months: 2109	1 month: 9 3 months: 14 6 months: 15 12 months: 15	1 month: 114 3 months: 172 6 months: 179 12 months: 180	3 month: 35 6 months: 54 12 months: 70	3 months: 46 6 months: 66 12 months: 73	6 months: 3/21 12 months: 3/14	6 months: 12/102 12 months: 7/85	NA	
Potency	NA		12 months: 3 24 months: 3	12 months: 3 24 months: 3	NA		NA		12 months: 2	12 months: 65	6 months: 23 12 months: 38	6 months: 46 12 months: 58	NA		NA	
Oncologic outcomes																
Biochemical recurrent	3	9	2	14	22	35	NA		3	21	NA		4/15	9/85	NA	
Positive surgical mar	21	53	6	11	11	18	15	554	7	74	6	4	5	17	18	18

TURP transurethral resection of the prostate, *ISUP* International society of urological pathology, *SD* Mean

Table 4 The risk of bias (Non-RCTs)-ROBINS-I

Bias domain	Bajpai 2022	Garg 2022	Carbin 2021	Su 2015	Hung 2014	Zugor 2012	Gupta 2011	Hampton 2008
Bias due to confounding	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate
Bias in selection of participants into the study	Low	Low	Low	Low	Low	Low	Low	Low
Bias in classification of interventions	Low	Low	Low	Low	Low	Low	Low	Low
Bias due to deviations from intended interventions	Low	Low	Moderate	Moderate	Low	Moderate	Low	Moderate
Bias due to missing data	Moderate	Moderate	Low	Low	Moderate	Low	Low	Low
Bias in measurement of outcomes	Low	Low	Moderate	Low	Moderate	Low	Moderate	Low
Bias in selection of the reported result	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate
Overall bias	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate

excluding smaller studies and findings of leave-one-out sensitivity analysis also demonstrated no significant differences between the two groups at one, three and 12 months. However, the absolute risk of urinary continence was 80.9% (276 of 341 cases) and 93.4% (900 of 964 cases) at 6 months in the TURP and Non-TURP groups, respectively. In addition, the meta-analysis indicated that the TURP group had lower urinary continence than the Non-TURP group (OR 0.35, 95% CI 0.16, 0.75 $p = 0.008$) [16–21]. A leave-one-out sensitivity analysis revealed that the statistical significance of urinary continence outcomes at 6 months remained unchanged. There was also no statistical significance between the TURP and Non-TURP groups regarding potency recovery. The follow-up time was 1 year (three studies; $p = 0.19$) [17, 20, 21] (Fig. 5).

Oncologic outcomes

The meta-analysis revealed that the TURP group had higher rates of positive surgical margins (PSM) than the Non-TURP group (OR 1.49, 95% CI 1.12, 1.98 $p = 0.007$) [16–23]. However, when we one study is removed from the pooled effect, there is no statistical significance in PSM between the two groups ($p = 0.05$) [23]. In terms of BCR, three studies defined PSA levels > 0.2 ng/mL as BCR, while the definitions of other studies are unclear. Three studies detected BCR at 12 months [16, 18, 20] while one detected it at 18 months [17]. However, the time point of one study is unknown [22]. The cumulative analysis revealed no significant difference in BCR between the TURP and the Non-TURP groups (five studies; $p = 0.50$). Moreover, there was no statistically significant change in the difference in BCR when the leave-one-out test was performed (Fig. 6).

Heterogeneity

Most of the outcomes had moderate to low heterogeneity. High heterogeneity was only observed in bladder neck reconstruction rates and urinary continence (3 months). Many factors contributed to the heterogeneity, such as the surgeon's experience and different follow-up times. Therefore, we must be cautious in interpreting this outcome; more research must confirm it. However, the low or moderate heterogeneity of these results may be misleading because I^2 is highly biased in a small number of studies [24].

Discussion

Some significant findings in perioperative, complications, functional, and oncologic outcomes of the present study warrant in-depth discussion.

Perioperative outcomes

The main perioperative parameters of the two groups were the length of hospital stay, operative time, catheterization time, estimated blood loss and transfusion rates. Notably, no significant length of hospital stay differences was found between the TURP and the Non-TURP groups. In one of the studies included, all patients were discharged on the second postoperative day [16]. The surgeon's experience and institutional volume have consistently been shown to be important factors influencing surgical outcomes [25]. For example, in the USA, patients are typically discharged two days after RARP [26], whereas patients in Asia may have a longer hospital stay, typically around 1 week [27, 28]. Therefore, we should pay attention to these differences. Three studies reported total operative time, whereas one only reported console time. Consequently, we performed a subgroup analysis

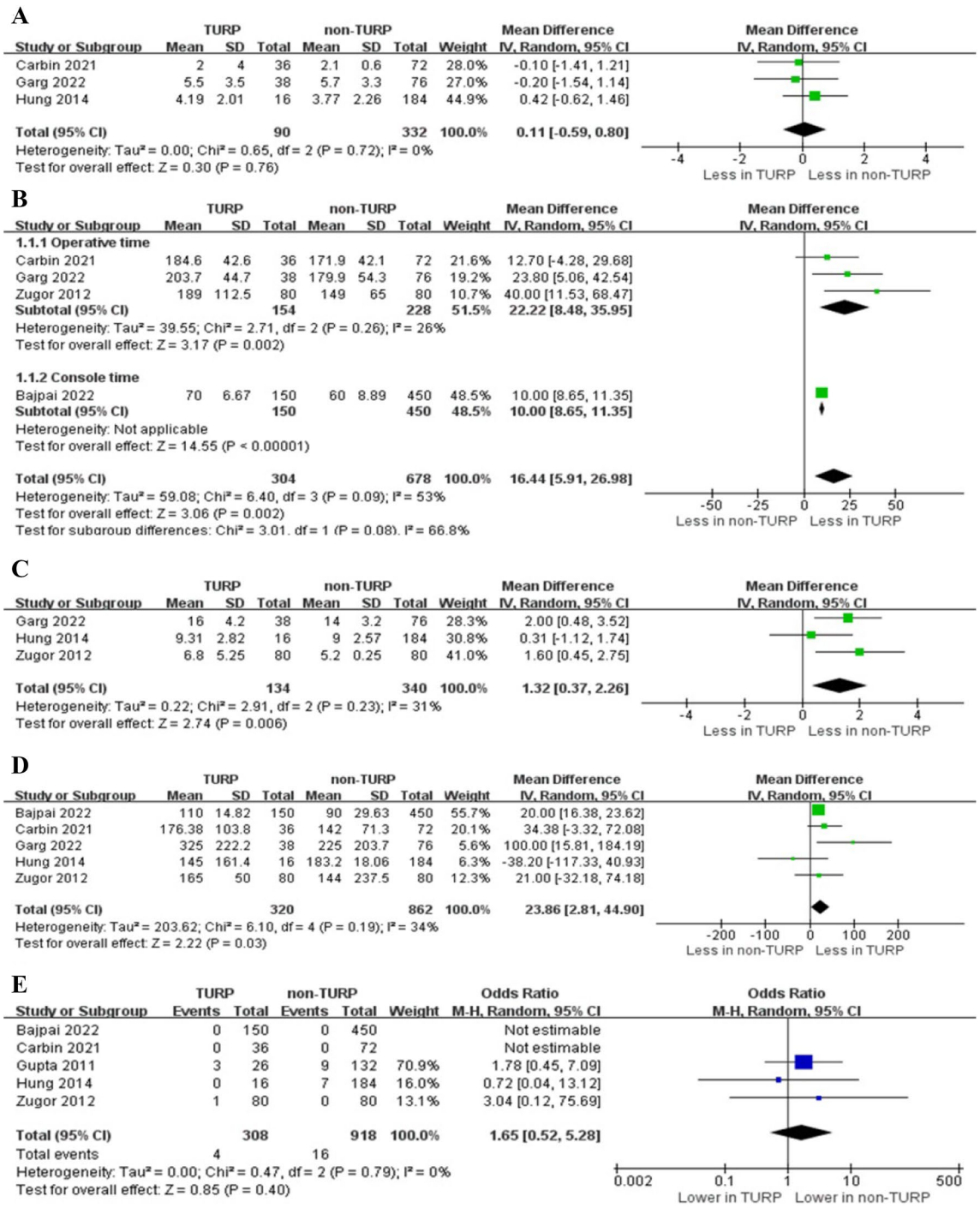

Fig. 2 Forest plots of perioperative outcomes. **A** length of hospital stay **B** operative time **C** catheterization time **D** estimated blood loss **E** transfusion rates

based on the count time. The meta-analysis revealed that the TURP group was associated with more operative time in every pool. Teber et al. [29] indicated that laparoscopic radical prostatectomy (LRP) after TURP had more operative time than the Non-TURP group. In contrast, a previous study also reported that open radical prostatectomy (ORP) after transurethral resection would increase the operative time [7]. This can be explained by the following reasons. Firstly, transurethral prostate surgery results in fluid extravasation and capsular perforation. Fibrosis and periprostatic adhesions contributed to preserving sufficient urethral length to perform a challenging anastomosis [30]. Second, the present

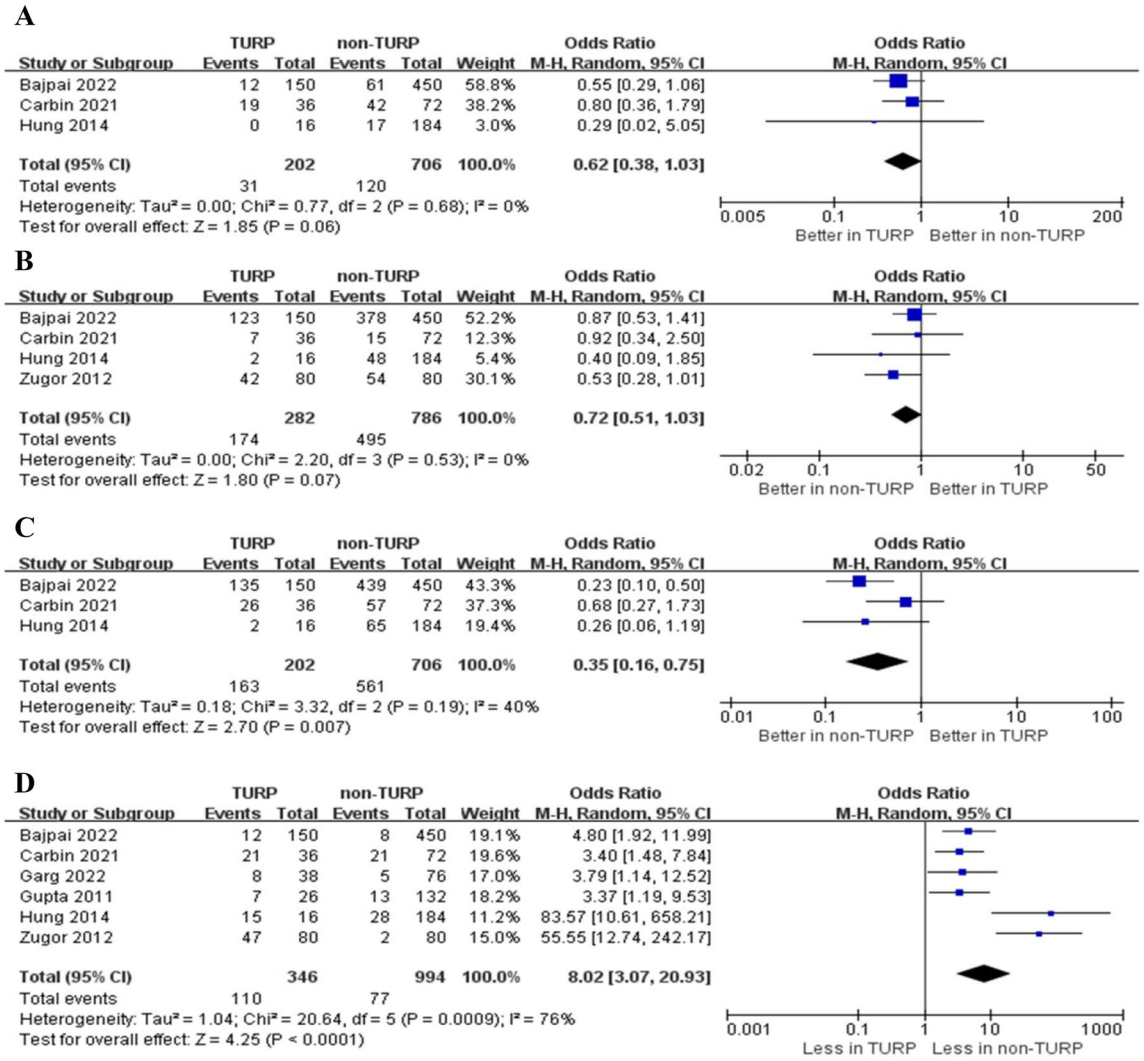

Fig. 3 Forest plots of perioperative outcomes. **A** Nerve sparing status (Unilateral) **B** Nerve sparing status (Bilateral) **C** Nerve sparing status (Overall) **D** Bladder neck reconstruction

study indicated that the TURP group had a higher rate of bladder neck reconstruction than the Non-TURP group. Therefore, the incidence of bladder neck reconstruction may increase the operative time. In addition, the operative time was affected by each surgeon's different levels of experience. In other words, the "learning curve" effect should be considered because the outcomes were influenced by the different levels of expertise that each surgeon possessed. Therefore, this conclusion must be supported by high-quality research. Longer catheterization time was observed in the TURP group than in the Non-TURP group. Most patients experience 6–15 days of catheterization time after surgery. Furthermore, in one of the included studies (two groups), the average catheterization time is ten days [16]. However, most patients were discharged with Foley catheters removed during outpatient follow-up visits. Therefore, the catheterization time may not be an important indicator for evaluating perioperative outcomes. We found that the TURP group had more estimated blood loss than the Non-TURP group. Because the previous TURP complicated posterior dissection, and bladder neck dissection, the procedures would result in more blood loss [31]. However, when two studies were removed from the sensitivity analysis, there was no significant difference between the two groups. It demonstrated that the estimates were not robust. Therefore, we must be cautious when estimating blood loss and more high-quality studies are required to validate this conclusion. However, there was no significant difference between the two groups regarding the transfusion rates.

Previous TURP would result in a fibrotic post-inflammatory reaction, leading to more difficult surgical procedures and plane distortion [32]. Therefore, these factors

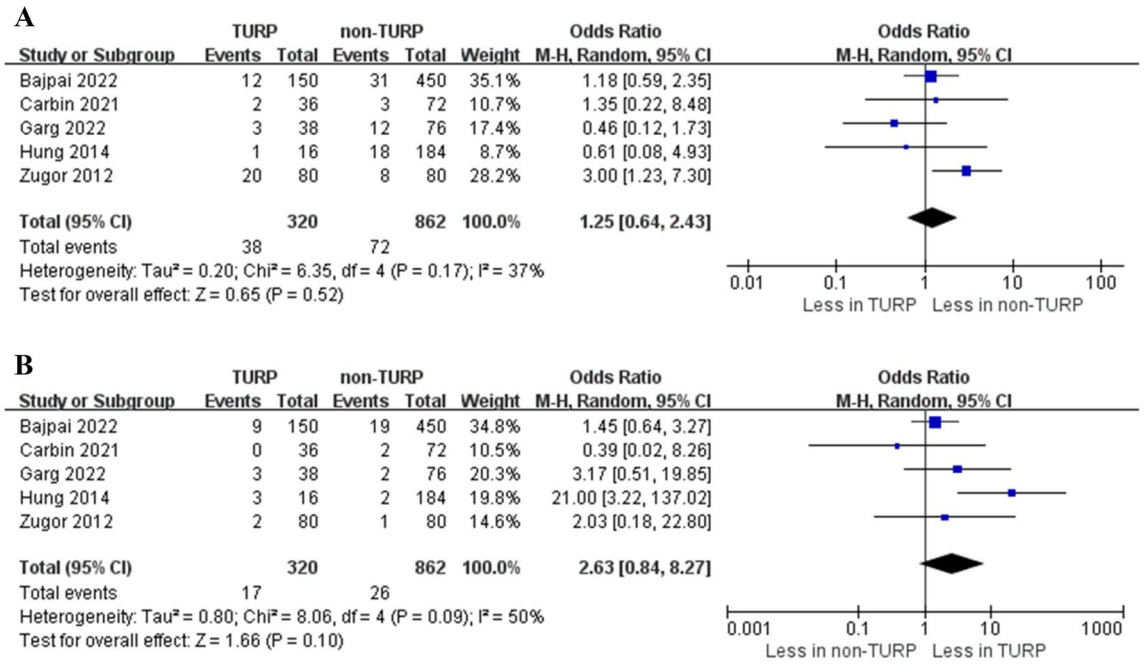

Fig. 4 Forest plots of complication. **A** Minor complications **B** Major complications

may reduce the nerve sparing rate in patients undergoing radical prostatectomy after TURP. According to previous research, the TURP group had a lower nerve-sparing rate when compared to the Non-TURP group who underwent LRP and ORP [6, 33]. However, there was no significant difference between the two groups in unilateral and bilateral nerve-sparing. The surgical robots provided 3D vision and amplification of the operative field, which was shown to help the surgeon in challenging dissections. These advantages may increase the nerve sparing rate in patients undergoing radical prostatectomy after TURP compared with LRP and ORP. However, we need more high-level evidence to substantiate our findings. In terms of bladder neck reconstruction, the present study indicated that the TURP group had higher bladder neck reconstruction rates. The bladder neck becomes twisted and floppy after previous TURP, making identifying the prostate junction and ureteric orifice difficult. In addition, because of the wider bladder neck and associated distortion, bladder neck reconstruction is frequently required [34].

Complications

There was no statistically significant difference in the rates of minor and major complications between the two groups. In contrast, Liao et al. identified that the TURP group had more complications than the Non-TURP group [35]. They utilized various surgical approaches, including LRP, ORP and RARP. The different surgical approaches would result in heterogeneity. The introduction of surgical robots, with high-resolution 3D optics, enhanced dexterity, and improved ergonomics that enable precise movements. The robotic platform would reduce invasiveness compared to laparoscopic and open surgery [36]. Therefore, the prior TURP may not affect RARP complication rates, but it still needs to be validated in high-quality, multicenter studies.

Functional outcomes

The continence recovery was defined as using no or one safety pad per day. No significant difference in continence was found between the TURP and Non-TURP groups at one, three and 12 months. In contrast, the previous study revealed that the Non-TURP group had lower urinary continence in early cases after LRP [6]. The possible explanations include scarring, a deficient internal sphincter mechanism, and the risk of external sphincter injury during the previous TURP, which would result in incontinence. Based on our findings, the two groups had similar outcomes after RARP. We hypothesized that the robotic platform could subtly separate periprostatic inflammation and fibrosis, leading to better results. However, high-quality studies are required to validate our findings. At 1 year, potency recovery, was not statistically significant between the TURP and Non-TURP groups. However, some critical issues must be addressed before discussing the functional results. Firstly, nerve-sparing technique, preoperative function and pelvic lymphadenectomy may impact the continence and potency

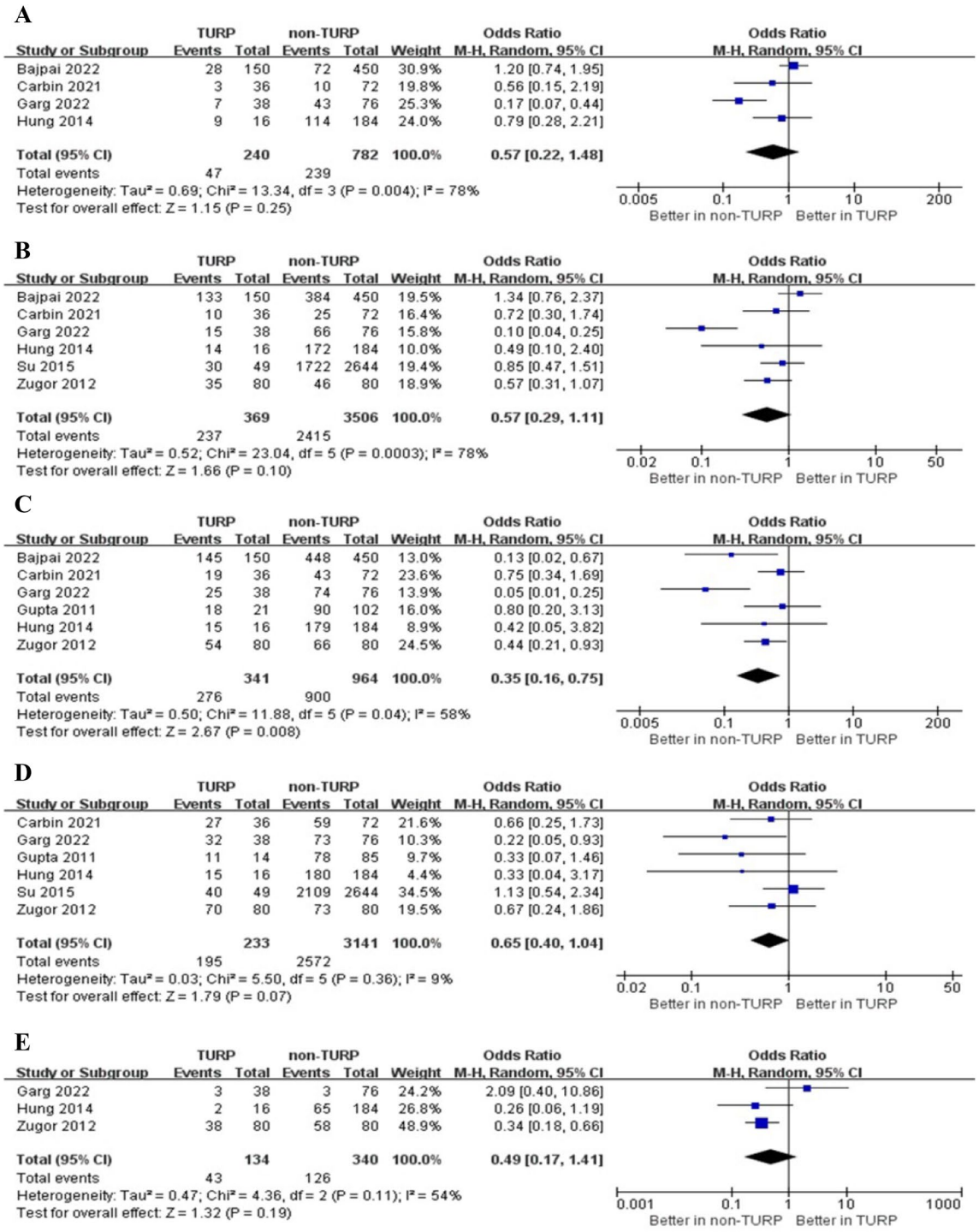

Fig. 5 Forest plots of functional outcomes. **A** Continence recovery (1 month) **B** Continence recovery (3 months) **C**. Continence recovery (6 months) **D**. Continence recovery (12 months) **E** Potency recovery (12 months)

recovery [37]. Second, in one of the included studies [16], potency recovery was defined as penetrative intercourse with/without PDE5 inhibitors > 50% of the time. In contrast, other studies defined it as erections sufficient for sexual intercourse without PDE5. In the future, we hope to use standard definitions for potency evaluation to ensure that the conclusions of the present study are clinically relevant. Therefore, we must be cautious when evaluating the functional outcome of two groups after RARP.

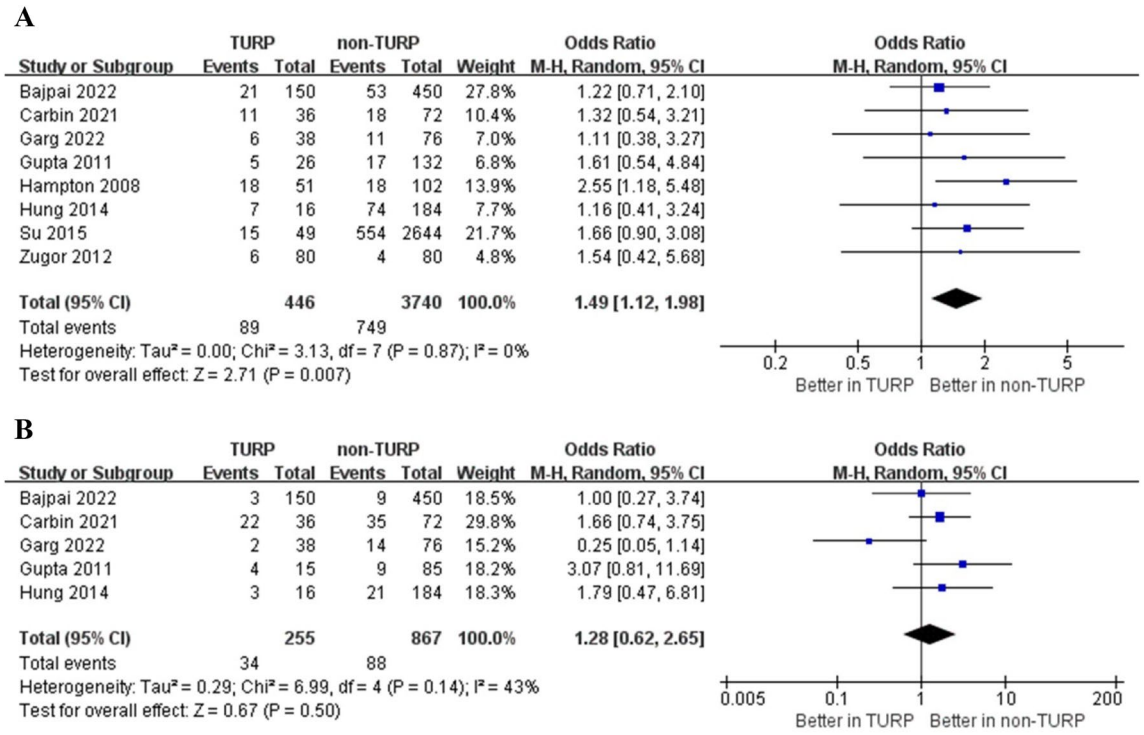

Fig. 6 Forest plots of oncologic outcomes. **A** Positive surgical margins **B** Biochemical recurrence

Oncologic outcomes

The oncological outcome is an important outcome metric. The pooled results demonstrated that the TURP group had higher positive surgical margin rates. The post-inflammatory fibrotic response post-TURP, difficult bladder neck anatomy and distorted bladder neck anatomy may attribute to high PSM. However, Liao et al. [35] indicated no difference in PSM between the two groups after LRP. Therefore, some key issues should be focused on comparing the PSM results between the two groups. First, Nyberg et al. [38] reported large and statistically significant differences in oncological outcomes among individual surgeons. When one study was removed from the pooled effect, there was no statistical significance in PSM between the two groups, demonstrating that the estimates were not robust. In other words, when the earlier study [23] is excluded, there is no statistical significance between the two groups. We believe that as each surgeon gain more experience with the robot, the PSM of the TURP group after RARP will reduce. Second, PSA level and tumor stage are two important factors that influence PSM [39]. Although the preoperative demographics in PSA and tumor stage were comparable between the two groups, there were some differences between the included studies. It still needs to be validated in high-quality, multicenter studies. In terms of BCR, there was no statistical difference between the TURP and the None-TURP groups. Although prostate volume and follow-up time were important factors in predicting BCR incidence [40], most included studies did not report the prostate volume. On the other hand, we did not compare BCR in different tumor stages, and the follow-up time of the three studies was short (the follow-up time was 12 months) [16, 18, 20]. Notably, the timeframe of one study is unknown [17]. Therefore, more studies on different tumor stages, prostate volume and long-term follow-up would be required to verify the outcomes.

Our study has the advantage of including many recent matched cohort analyses and then analyzing most of the parameters related to the perioperative, functional, and oncologic outcomes of the two groups. Another strength of the present study is that we performed a more in-depth analysis that systematically compared the TURP group with Non-TURP group after RARP for the first time. Furthermore, we also prepared reports based on the time of follow-up. Another point worth discussing is how various newer TURP modifications, such as laser ablation or enucleation, may affect the outcome of radical prostatectomy differently. Suardi et al. [41] investigated the feasibility and safety of nerve-sparing radical retropubic prostatectomy for localized prostate cancer following holmium laser enucleation of the prostate (HoLEP). They demonstrated that radical prostatectomy is a feasible procedure in patients with prostate cancer who have previously undergone HoLEP for BPH. However,

further research is required to determine whether previous laser ablation or enucleation affects radical prostatectomy.

The present study has some limitations that should be noted before interpreting results. First, the included studies are non- RCTs of intermediate quality. They may have been influenced by potential misclassification bias, raising the risk of selection bias. Second, the included studies were conducted in different hospitals and countries. Therefore, the outcomes may have been influenced by different surgeons or institutions. Third, some outcomes used data from only three or four studies, making the outcome less reliable. Fourth, the short-term follow-up and different definitions make comparing functional outcomes between two groups difficult. Finally, we could not assess publication bias due to the scarcity of included studies.

Conclusions

Performing RARP for prostate cancer in TURP patients is a technically demanding procedure. Compared to the Non-TURP group, the TURP group had significantly more operative time, estimated blood loss and, higher bladder-neck reconstruction rates. However, the present study suggested that the safety, oncologic and long-term functional outcomes were comparable between TURP and Non-TURP groups after RARP. In patients who have had prior TURP, RARP may be considered a better treatment for prostate cancer.

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Declarations

Conflict of interest The authors have no relevant financial or non-financial interests to disclose.

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