Original Article

Efficacy and safety of single port robotic radical prostatectomy and multiport robotic radical prostatectomy: a systematic review and meta-analysis

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Background: The purpose of this study is to compare the clinical efficacy and safety of single port (SP) robot radical prostatectomy and multiport (MP) robot radical prostatectomy.

Methods: Using the China National Knowledge database, EMBASE, Cochrane library, PubMed, and other databases to obtain relevant research, SP robot radical prostatectomy and MP robot radical prostatectomy were comprehensively evaluated. The software used to evaluate the impact of the results in the selected articles was Review Manager 5.2. Deviation analysis, forest plot analysis, and sensitivity analysis were carried out for the collected data.

Results: A total of 7 related studies that met the criteria were finally included. The data showed that the operation time of MP in the control group was significantly longer than that in the SP group [mean difference (MD) =−13.29; 95% confidence interval (CI): (−17.35, −9.23); P<0.00001; I^2=50%]. The duration of intensive care unit (ICU) stay for SP surgery was shorter than that for MP surgery [MD =−18.30; 95% CI: (−29.17, −7.42); P=0.0010; I^2=94%]. The blood loss of SP surgery was less than that of MP surgery [MD =−15.54; 95% CI: (−28.37, −2.71); the total effective rate was 0.02; I^2=0%]. There was no significant difference in the incidence of postoperative complications between SP and MP surgery [risk ratio (RR) =0.95; 95% CI: (0.55, 1.63); P=0.85; I^2=0%]. At the same time, the sensitivity analysis and funnel plot showed that this study was robust and publication bias was limited.

Discussion: Our results show that SP robotic radical prostatectomy is superior to MP robotic radical prostatectomy in terms of efficacy and safety. SP robot radical prostatectomy is worthy of wide promotion.

Keywords: Single port robotic radical prostatectomy (SP robotic radical prostatectomy); multiport robotic radical prostatectomy (MP robotic radical prostatectomy); meta-analysis

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Introduction

Radical prostatectomy is an effective treatment for patients with prostate cancer (1,2). At present, it provides the best long-term cancer control for patients with localized prostate cancer (3,4). In recent years, robot-assisted laparoscopic radical prostatectomy (RALP) has become a common choice for the treatment of localized prostate cancer (5,6). Many studies have shown that RALP has the advantages of reducing blood loss, reducing perioperative complications, shortening hospital stay, and producing a good tumor prognosis (7,8).

Urologists have long accepted the use of robotic surgery, from the earliest robot-guided transurethral resection of the prostate (TURP) tested in the 1980s, to various iterations of the Da Vinci multiport (MP) system (Intuitive Surgical, Sunnyvale, CA, USA) at the London Guy's Hospital (9,10). These two systems have been widely used in the fields of adult and pediatric urology (11,12). Single port (SP) robotic radical prostatectomy is a new technology which uses a robotic trocar and a flexible multi-joint instrument, while the previous Da Vinci model used multiple trocars and rigid laparoscopic instruments with joint wrists (13,14). The SP platform was approved by the FDA for urology applications in 2018 (15,16). Some case series have demonstrated its application in major urological surgery, including transvesical surgery, ureteral reimplantation, and prostatectomy (17,18). The challenges of adapting to this new platform are poorly understood by surgeons and operating room staff (19-21). Compared with the MP platform, the workload and task domain in the SP platform have increased, indicating that surgeons need more attention and awareness when using SP to perform surgery when learning new functions of the platform. Interestingly, SP reduces the area of frustration. This may reflect the ability of SP to perform operations, such as camera connection function that MP does not have, and improve the visualization of potentially challenging areas, such as during the anatomy of neurovascular bundles (19). In addition, SP makes surgeons more independent and reduces dependence on bedside surgical assistants to help with surgery, contributing to this finding. Although it is more challenging to perform SP tasks, SP cases' average active console time is shorter than that of MP. The amount of workflow interruption is the same, resulting in a reduction in the total operation time (21,22).

With the progress of the past 20 years, robotic surgery has become the mainstream of urology (22,23). Reducing the size and number of incisions in laparoscopic or robotic surgery has been a secondary objective, which aims to reduce the incidence of adverse events and to provide complex surgery with minimal invasiveness (24-26). Robotic surgery has developed to a single entry point and even beyond the traditional robotic methods (27,28). Previous attempts to apply a robotic surgical platform to single incision surgery, which was not designed for this purpose, have been limited.

The purpose of this meta-analysis was to compare the efficacy of SP robotic radical prostatectomy and MP robotic radical prostatectomy. We conduct this research to update the topic and used four typical indicators to comprehensively analyze the problem. We present the following article in accordance with the PRISMA reporting checklist (available at https://dx.doi.org/10.21037/tau-21-850).

Methods

Literature search strategy

We searched for relevant articles published between January 2000 and March 2021. PubMed, Cochrane library, EMBASE, and China National Knowledge database were searched with the following keywords: (I) single hole robot assisted; (I) multi hole robot assisted; (III) radical prostatectomy. To obtain relevant articles containing two or more words used in the search, we used the "and" Boolean operator to combine these words. Literature retrieval was not limited by publishing language. To obtain data from other relevant publications, we used a manual cross-search to retrieve literature to improve the sensitivity of the search strategy.

Study selection

After preliminary screening, publications meeting the following inclusion criteria were reviewed and included in the study: (I) a comparative study was conducted between SP robot radical prostatectomy and MP robot radical prostatectomy; (II) patients undergoing radical prostatectomy; (III) the effectiveness and safety of SP and MP surgery were evaluated. Publications were excluded according to the following criteria: (I) studies of other diseases except for bladder surgery, ureteral reimplantation, and prostatectomy; (II) patients underwent operations other than bladder surgery, ureteral reimplantation, and prostatectomy; (III) lack of texts available to analyze data.

Data extraction and quality assessment

According to PRISMA guidelines, two researchers

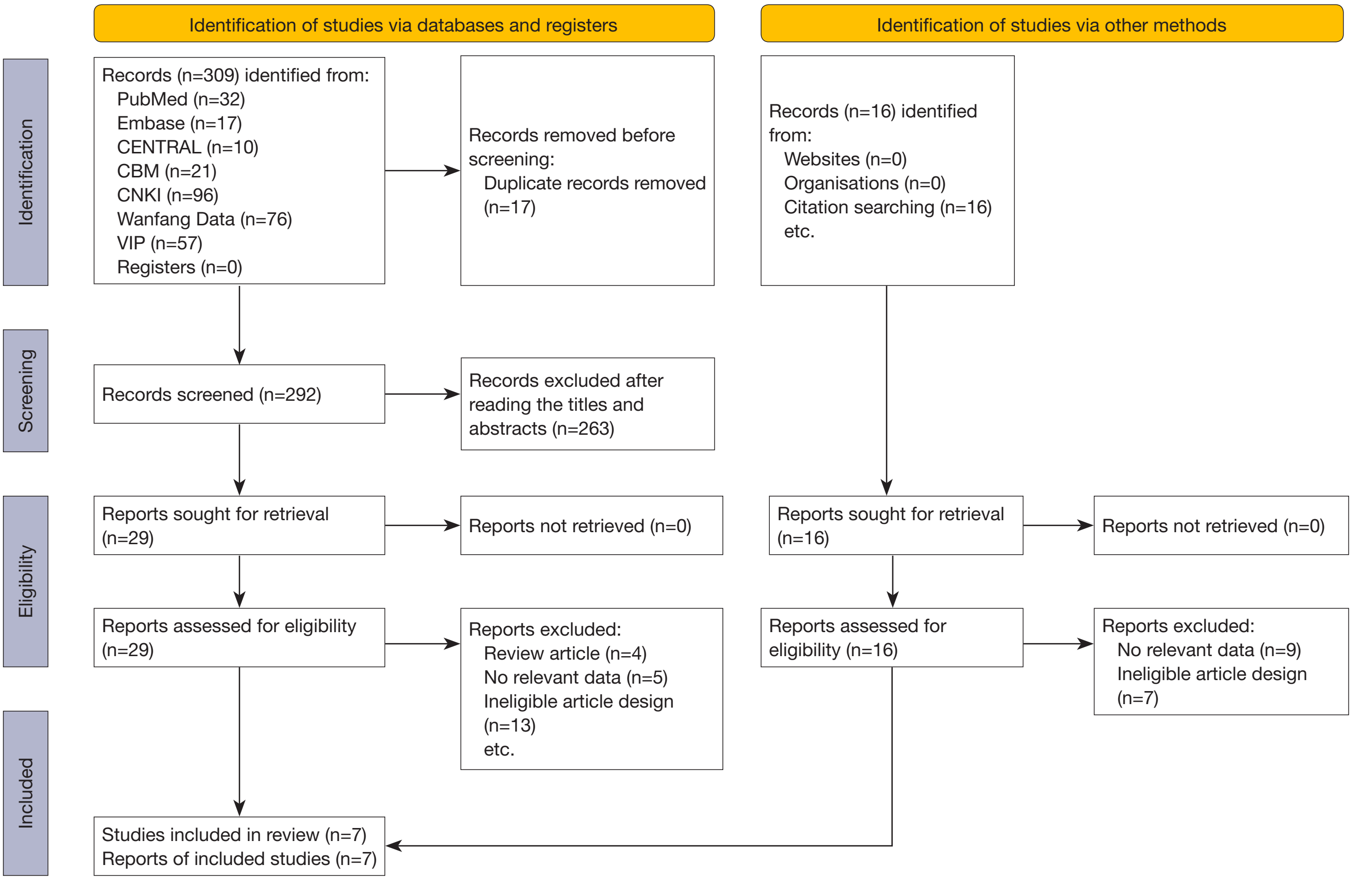

Figure 1 Flowchart of the selection of the included literature.

independently checked the eligibility of each full-text report. The extracted data of the eligible studies were as follows: the country of origin of the first author, the year of publication, and the age and number of patients, among others. The methodological quality of the included publications was assessed using the Cochrane risk of bias tool.

Statistical analysis

We used Review Manager (version 5.2, Cochrane Collaboration, 2011) to evaluate the impact of the results in the articles and conduct the heterogeneity test. The mean difference (MD) was used for continuous variables, and risk ratio (RR) was used for discontinuous variables. Heterogeneity between studies was measured using I^2 statistics (a quantitative measure of inconsistencies between research data). The results were considered as low heterogeneity with I^2 25% to 50%, results were considered to be moderately heterogeneous with I^2 50% to 75%, and I^2>75% indicated that the results were highly heterogeneous. If I^2>50%, one study per round was omitted through sensitivity analysis by removing one most impact article in order to investigate the impact of each study on the pooled analysis and to test the potential source of heterogeneity.

Results

Search process

A total of 292 articles were obtained through electronic retrieval. Of these, 29 papers reached the preliminary standard after careful reading and screening. In the further screening, 22 articles were excluded due to insufficient data, article types, and failure of research design. Finally, 7 papers were included in the analysis (29-35). *Figure 1* is a flowchart that reflects the identification, inclusion, and elimination of publications in the search process.

Table 1 Characteristics of the studies included in the meta-analysis

Study	Year	Type of study	Language	Country	Intervention	N	Mean age (years)	Years of onset
Kishimoto	2016	RCT	English	Japan	SP-RALP	58	67±5.5	December 2012 to November 2015
					MP-RALP	7	67.5±5.8	
Lenfant	2021	RCT	English	USA	SP-RALP	78	63.9±6.21	December 2018 to November 2019
					MP-RALP	97	62±5.8	
Lenfant2	2021	RCT	English	USA	SP-RALP	110	53.7±10	December 2019 to November 2020
					MP-RALP	100	60.2±5.2	
Lenfant3	2021	RCT	English	USA	SP-RALP	26	67±5.7	December 2018 to November 2020
					MP-RALP	86	67.5±5.10	
Moschovas	2021	RCT	English	USA	SP-RALP	71	59±21.4	December 2019 to November 2020
					MP-RALP	875	63±23.7	
Talamini	2021	RCT	English	USA	SP-RALP	20	64.4±2.2	December 2018 to November 2019
					MP-RALP	20	65.1±1.5	
Vigneswaran	2020	RCT	English	USA	SP-RALP	50	63±5.5	December 2018 to November 2019
					MP-RALP	113	62±5.8	

RCT, randomized control trial; SP, single port; MP, multiport; RALP, robot-assisted laparoscopic radical prostatectomy.

Characteristics of the included studies

Table 1 summarizes the total number of patients involved in each group and the types of reported studies. The contents include country, year of publication, author, age, sample size, grouping, and recruitment time. A total of 1,711 patients were included in the analysis.

Results of quality assessment

The risk of bias in patient selection in 7 clinical trials (29-35) was assessed using the Cochrane bias risk assessment tool. One study showed problems with reporting bias, and one study showed problems of other biases. Overall, 2 trials were at risk of bias while the other 5 trials were not (*Figures 2,3*).

Results of the heterogeneity test

Heterogeneity analysis of operation time between SP and MP surgery

A total of 4 studies performed a comparison of the operation time between SP and MP surgery, as presented in *Figure 4*. The results showed that the operation time of SP was significantly shorter than that of MP [MD =−13.29; 95% confidence interval (CI): (−17.35, −9.23); P<0.00001; I^2=50%].

Heterogeneity comparison of the length of stay (h) in the intensive care unit (ICU) between SP and MP surgery

The length of ICU stay between SP and MP surgery was assessed. The heterogeneity of the length of ICU stay between SP and MP surgery is presented in *Figure 5*. The results showed that the length of ICU stay between SP and MP surgery was significantly different [MD =−18.30; 95% CI: (−29.17, −7.42); P=0.0010; I^2=94%], and the hospitalization time of SP was shorter than that of MP (*Figure 5*).

Heterogeneity comparison of complications between SP and MP surgery

The heterogeneity of complications was evaluated according to the fixed effects model. Insignificant heterogeneity was observed in these studies. The results showed that there was no difference in the evaluation of complications between the SP group and the MP group [RR =0.95; 95% CI: (0.55, 1.63); P value of total efficacy was 0.85], as shown in *Figure 6*.

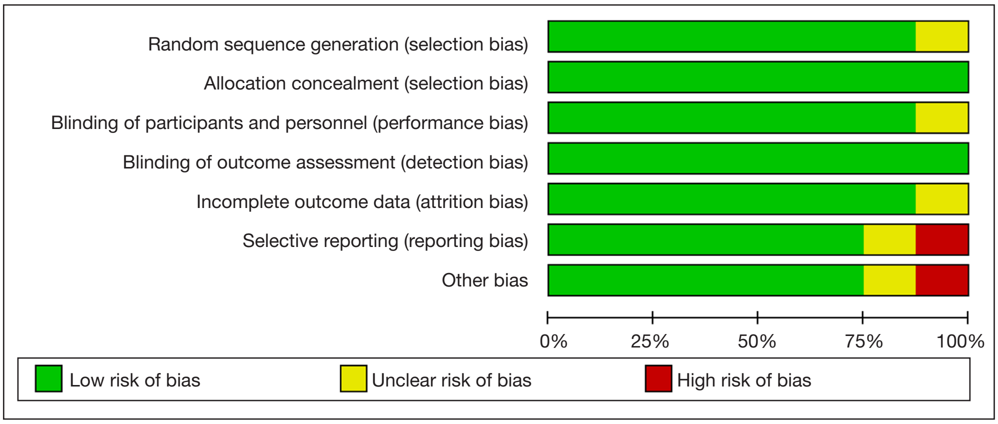

Figure 2 Study quality assessment: risk (red hexagon), high deviation and ambiguous deviation risk (yellow hexagon), low deviation risk (green hexagon).

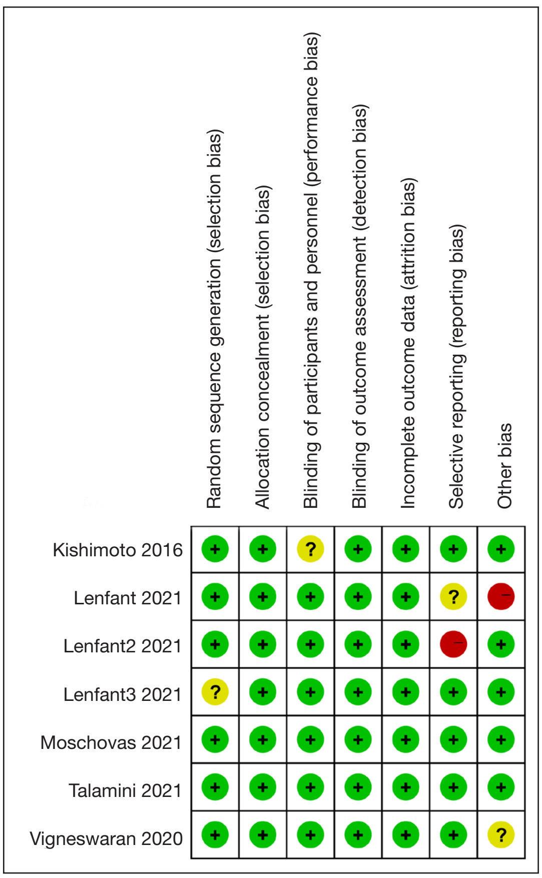

Figure 3 Quality assessment of the included studies.

Heterogeneity comparison of blood loss (mL) between SP and MP surgery

Blood loss between SP and MP surgery was analyzed. The heterogeneity test results showed that there were differences between SP and MP surgery in the analysis [MD =−15.54; 95% CI: (−28.37, −2.71); the total effective rate was 0.02; I^2=0%], and the blood loss of SP was less than that of MP (*Figure 7*).

Publication bias and sensitivity analysis results

Sensitivity analysis was performed to test the stability of the results. The relative outliers needed to be excluded. The results showed that in the heterogeneity section, the sensitivity of blood loss did not change, but its P value changed from 0.76 to 0.78. The results also showed that the formation of heterogeneity was mainly due to the research of Moschovas *et al.* (30) in 2021. Moschovas *et al.* (30) were not included in the forest plot for 2021, as shown in *Figure 8*.

A funnel plot was used to analyze blood loss, which included 5 studies. No publication bias was shown, as indicated by the good symmetry of the funnel plot (*Figure 9*).

Discussion

After screening, 7 studies met the inclusion criteria to evaluate the efficacy and safety of SP and MP surgery. The meta-analysis of these studies showed that there were differences in operation time, and the time of SP robot-assisted surgery was shorter than that of MP robot-assisted surgery. The postoperative ICU stay time of patients with MP robot-assisted surgery was longer than that of patients with SP robot-assisted surgery. There was no difference in the complications of SP between the experimental group

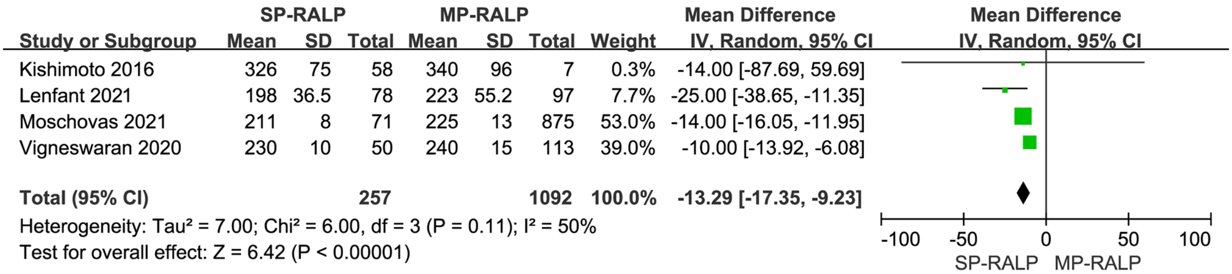

Figure 4 Forest plot of surgical time between the SP and MP groups. SP, single port; MP, multiport; RALP, robot-assisted laparoscopic radical prostatectomy.

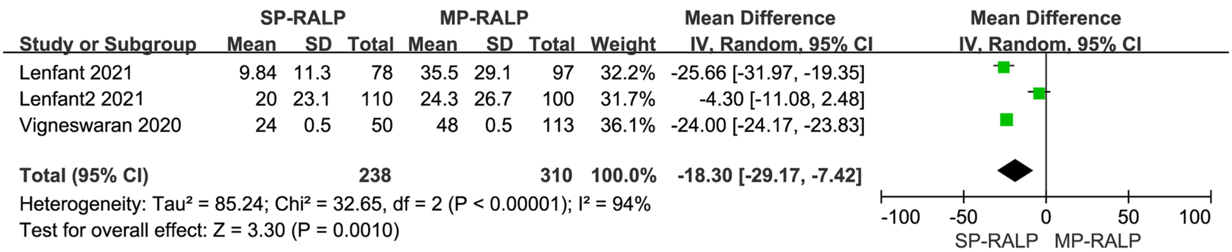

Figure 5 Forest plot of hospital stay between the SP and MP groups. SP, single port; MP, multiport; RALP, robot-assisted laparoscopic radical prostatectomy.

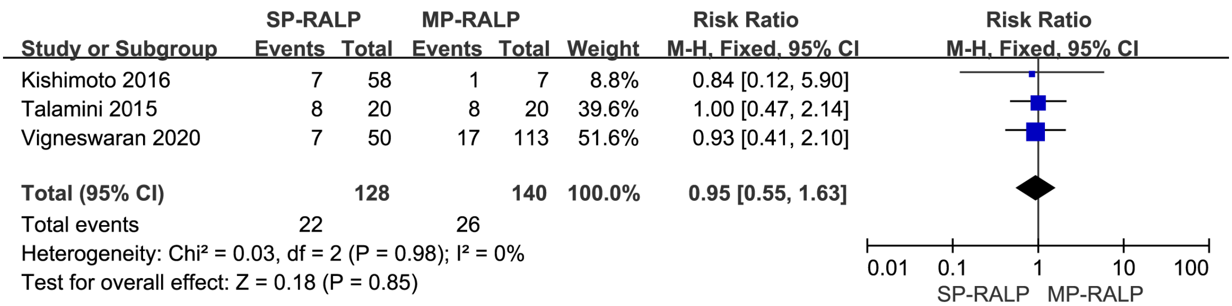

Figure 6 Forest plot of postoperative complications between the SP and MP groups. SP, single port; MP, multiport; RALP, robot-assisted laparoscopic radical prostatectomy.

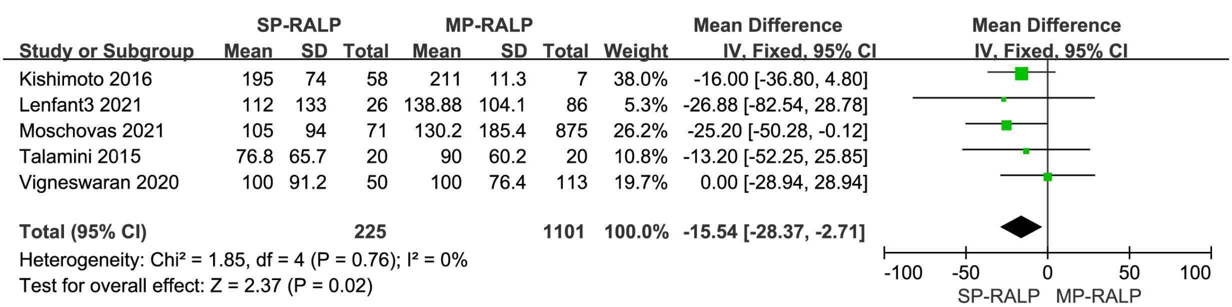

Figure 7 Forest plot of blood loss between the SP and MP groups. SP, single port; MP, multiport; RALP, robot-assisted laparoscopic radical prostatectomy.

Study or Subgroup	SP-RALP Mean	SP-RALP SD	SP-RALP Total	MP-RALP Mean	MP-RALP SD	MP-RALP Total	Weight	Mean Difference IV, Fixed, 95% CI
Kishimoto 2016	195	74	58	211	11.3	7	51.5%	-16.00 [-36.80, 4.80]
Lenfant3 2021	112	133	26	138.88	104.1	86	7.2%	-26.88 [-82.54, 28.78]
Talamini 2015	76.8	65.7	20	90	60.2	20	14.6%	-13.20 [-52.25, 25.85]
Vigneswaran 2020	100	91.2	50	100	76.4	113	26.6%	0.00 [-28.94, 28.94]
Total (95% CI)			**154**			**226**	**100.0%**	**-12.11 [-27.05, 2.82]**
Heterogeneity: Chi² = 1.08, df = 3 (P = 0.78); I² = 0%								
Test for overall effect: Z = 1.59 (P = 0.11)								

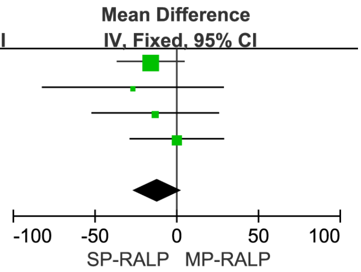

Figure 8 Sensitivity analysis of blood loss between the SP and MP groups. SP, single port; MP, multiport; RALP, robot-assisted laparoscopic radical prostatectomy.

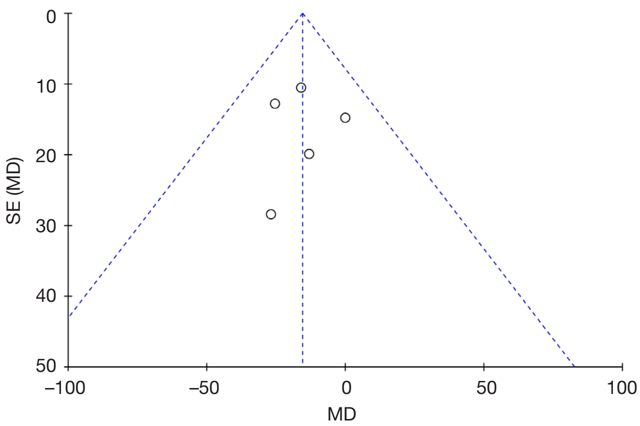

Figure 9 Funnel plot.

and the control group. The blood loss of patients with MP robot-assisted surgery was more than that of patients with SP robot-assisted surgery.

Prostate cancer is the most common cancer all over the world. RALP has the advantages of less bleeding and faster recovery than open or laparoscopic radical prostatectomy, and has become the first choice for radical prostatectomy (36-40). The SP laparoscopic technique combined with the transvesical approach is technically feasible in the treatment of benign prostatic hyperplasia or prostate cancer, which has the advantages of small trauma, rapid recovery, and improved urinary control (41-43).

At present, SP robotic radical prostatectomy seems to be a safe and feasible method for prostatectomy, but there is no study which has compared SP-RALP with the MP platform (44-46). Lowres *et al.* reported (47) a comparison between SP-RALP and MP-RALP patients. The operation time of SP surgery was less than that of MP surgery, and SP surgery could shorten the length of hospital stay. These results are consistent with the results of this meta-analysis. These results suggest that the learning time of SP-RALP is relatively short for surgeons who often operate robotic surgery, which may help to better control pain and shorten hospital stay (48,49).

However, compared with the MP platform, the workload and task domain in the SP platform have increased, indicating that surgeons need more attention and awareness when using SP to perform surgery when learning new functions of the platform. Interestingly, SP reduces the area of frustration (50). This may reflect the ability of SP to perform operations, such as camera connection function that MP does not have, and improve the visualization of potentially challenging areas, such as during the anatomy of neurovascular bundles. In addition, SP makes surgeons more independent and reduces dependence on bedside surgical assistants to help with surgery, contributing to this finding. Although it is more challenging to perform SP tasks, SP cases' average active console time is shorter than MP. The amount of workflow interruption is the same, resulting in a reduction in the total operation time (51).

Similar to our results, Achard *et al.* reported (50) that there was no difference in the incidence of complications between SP and MP surgery. SP robotic surgery is designed for robotic urology, which can shorten the operation time and reduce postoperative pain. SP-RALP can be safely used in most urological operations without increasing complications or readmission (51).

In conclusion, the operation time, blood loss, and ICU stay time of SP robot radical prostatectomy were better than those of MP robot radical prostatectomy, but there was no difference in complications between the two. We supported that SP robotic surgery using a robot specially designed for this application is feasible for most common urological surgery and can shorten LOS and reduce postoperative pain. Daytime surgery can safely use most SP urological surgery without increasing complications or readmission.

In addition, there are some limitations in this paper. First, there was no subgroup analysis by region, which can be further studied in the future. Secondly, the details of the complications were not evaluated, but will be analyzed in our future study.

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Footnote

Reporting Checklist: The authors have completed the PRISMA reporting checklist. Available at https://dx.doi.org/10.21037/tau-21-850

Conflicts of Interest: All authors have completed the ICMJE uniform disclosure form (available at https://dx.doi.org/10.21037/tau-21-850). The authors have no conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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