

Comparison of functional outcomes after retropubic, laparoscopic and robot-assisted radical prostatectomy: A meta-analysis

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Abstract

AIM: To assess the 6-mo and 12-mo functional outcomes after retropubic, laparoscopic and robot-assisted laparoscopic radical prostatectomy (RRP) laparoscopic radical prostatectomy (LRP); robot-assisted laparoscopic prostatectomy (RARP).

METHODS: A literature search was conducted using the PubMed, EMBASE, The Cochrane Library and the Web of Knowledge databases updated to March, 2014 for relevant published studies. After data extraction and quality assessment *via* the Newcastle-Ottawa Scale or the Cochrane collaboration's tool for assessing risk of

bias, meta-analysis was performed using RevMan 5.1. Either a random-effects model or a fixed-effects model was used. Potential publication bias was assessed using visual inspection of the funnel plots, and verified by the Egger linear regression test.

RESULTS: Thirty-seven studies were identified in total: 14 articles comparing LRP with RRP, 12 articles comparing RARP with RRP, and 11 articles comparing RARP with LRP. For urinary continence, a statistically significant advantage was observed in RARP compared with LRP or RRP both at 6 mo [odds ratio (OR) = 1.93; $P < 0.01$, OR = 2.23; $P < 0.05$, respectively] and 12 mo (OR = 1.47; $P < 0.01$, OR = 2.93; $P < 0.01$, respectively) postoperatively. The continence recovery rates after LRP and RRP, with obvious heterogeneity (6-mo: $I^2 = 74\%$; 12-mo: $I^2 = 75\%$), were equivalent (6-mo: $P = 0.52$; 12-mo: $P = 0.75$). In terms of potency recovery, for the first time, we ranked the three surgical approaches into a superiority level: RARP > LRP > RRP, with a statistically significant difference at 12 mo [RARP *vs* LRP (OR = 1.99; $P < 0.01$); RARP *vs* RRP (OR = 2.66; $P < 0.01$); LRP *vs* RRP (OR = 1.34; $P < 0.05$)], respectively. Meta-regression and subgroup analyses according to adjustment of the age, body mass index, prostate volume, Gleason score or prostate-specific antigen did not vary significantly.

CONCLUSION: Current evidence suggests that minimally invasive approaches (RARP or LRP) are effective procedures for functional recovery. However, more high-quality randomized control trials investigating the long-term functional outcomes are needed.

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Key words: Prostate cancer; Radical prostatectomy; Urinary continence; Potency; Meta-analysis

Core tip: This review directly compared the functional

outcomes after retropubic, laparoscopic and robot-assisted radical prostatectomy, both at 6-mo and 12-mo follow-up. Compared with the previous meta-analysis which reported a comparable potency recovery of robot-assisted laparoscopic prostatectomy (RARP) *vs* laparoscopic radical prostatectomy (LRP), our review obviously included more studies and ranked the three techniques into a superiority level: RARP > LRP > RRP (retropubic radical prostatectomy). In addition, we performed a quality assessment of the studies, separated evaluation of randomized control trials (RCTs) and non-RCTs, and subgroup analyses or meta-regression as a supplement, thus the risk of methodological bias was reduced considerably.

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INTRODUCTION

Prostate cancer (PCa) is now recognized as one of the most important medical problems in the male population. PCa accounted for almost 28% (238590) of all newly diagnosed cancer cases and it is the second cause of male cancer death (after lung cancer) in the United States, while in Europe, data show an incidence rate of 22.8% and a mortality of 9.5%^[1,2]. With combined application of prostate-specific antigen (PSA) test and prostate biopsy, the percentage of early diagnosed PCa cases has increased.

Radical prostatectomy (RP) is one of the recommended standard treatments for clinically localized prostate cancer (cT1-cT2) patients with a life expectancy of more than 10 years^[3]. The retropubic radical prostatectomy (RRP), since its first introduction by Walsh *et al*^[4] in 1982, soon became the gold standard and the most widely used treatment for patients with localized PCa^[5]. Recently, we have witnessed the emergence of laparoscopic radical prostatectomy (LRP) and robot-assisted laparoscopic prostatectomy (RARP). Facing all these surgical options, both patients and surgeons hesitate when a best treatment choice should be made. Although several experts have demonstrated that when compared with RRP, LRP and RARP have obvious advantages such as lower blood loss, less need for transfusion and shorter hospital-stay^[6,7], but the lack of high-quality evidence and randomized control trials (RCTs) available precluded us from proving the superiority of any surgical approaches in terms of postoperative functional outcomes.

The increase in life expectancy in patients with localized PCa has made the post-treatment quality of life a key issue for PCa survivors, but some negative functional outcomes such as urinary incontinence and erectile dys-

function make the health-related quality of life worse. Relevant comparative studies showed 12-mo urinary continence recovery rates ranging from 47% to 96%, 48% to 97% and 88% to 97% after RRP, LRP and RARP, respectively. The previously published surgical series showed 12-mo potency recovery rates ranging from 39% to 72%, 41% to 81% and 61% to 87% after RRP, LRP and RARP, respectively. This apparent difference can be attributed to multiple definitions of urinary continence and potency, variations in population baseline, differences among surgical techniques and diverged data collection as well. In comparison with the only two meta-analyses evaluating functional outcomes after different surgical approaches, reported by the same author Ficarra *et al*^[8,9] in August 2011, obviously our review included more studies and excluded two studies^[10,11] which appeared to be ineligible since the presence of preoperative adjuvant hormonal therapy. Moreover, powerful quality assessment tools were utilized in this initial comparison of three key techniques (RRP, LRP and RARP) both at 6-mo and 12-mo follow-up.

MATERIALS AND METHODS

Literature search

A literature search of the following databases was performed: the PubMed, EMBASE, The Cochrane Library and the Web of Knowledge databases up to March, 2014. We used the following limits: humans, gender (male), and no restriction for languages. For each database, the same search terms “radical prostatectomy”, “urinary continence”, “incontinence”, “potency” and “erectile function” were used. Although we also paid attention to two unpublished studies (gray literature) with relevant outcomes reported on the website “Clinical Trials.gov” and tried to contact the experts by e-mail, there has been no response so far, and therefore in this review only published papers were included.

Study selection

Our study followed the preferred reporting items for meta-analyses of observational studies in epidemiology (MOOSE) statement^[12]. The inclusion criteria were as follows: (1) patient characteristics: localized PCa (cT1-cT2); comparable baseline demographics; preoperatively potent and continent; no obvious comorbidities; (2) surgical techniques: only pure RRP/RARP/LRP with or without modification; (3) methodologically: all studies comparing the postoperative outcomes as RRP/LRP, RRP/RARP or LRP/RARP and including at least one of the functional results; clear definition of urinary continence and potency; and (4) population-based studies, duplicated publications and meeting abstracts were excluded.

Data extraction

All eligible records were extracted independently by two reviewers and selected according to the inclusion criteria. We extracted the details of authors and publishing date;

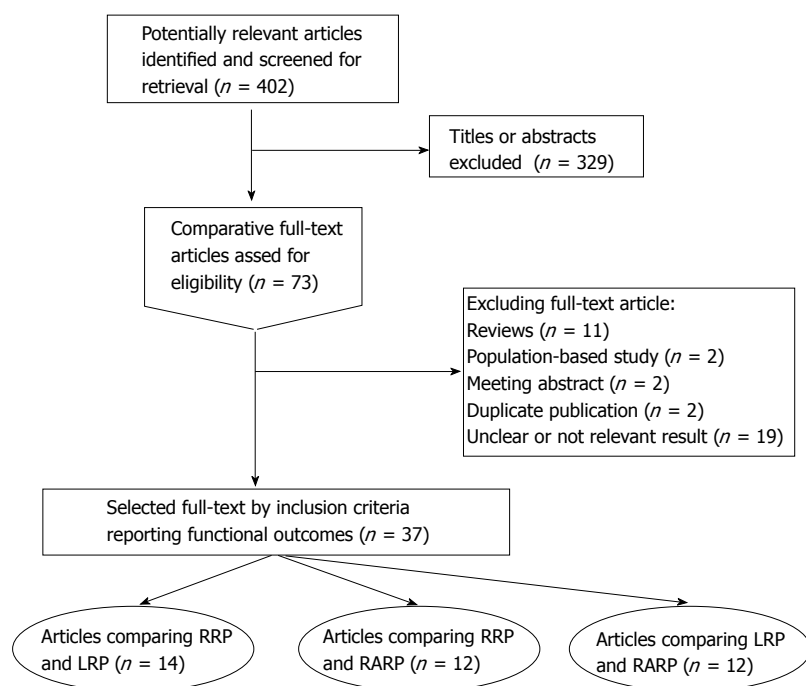


Figure 1 Flow diagram of the systematic review. RRP: Retropubic radical prostatectomy; LRP: Laparoscopic radical prostatectomy; RARP: Robot-assisted radical prostatectomy.

surgical techniques and number of patients; study design; baseline mean age; BMI value; prostate volume; PSA level; urinary continence and potency definition; and 6- and 12-mo recovery rates of urinary continence and potency. Any uncertainties or discrepancies between the two reviewers were resolved by open discussion or consultation with the third reviewer.

Methodological quality assessment

The quality of cohort and case-control studies was assessed using the Newcastle-Ottawa quality scale (NOS) proposed by Wells *et al.*^[13]. This tool can be used either as a checklist or as a scale. The NOS scales were separately developed for cohort and case-control studies. Briefly, a star system was used for quality assessment of studies, and the NOS ranges from zero up to nine stars; studies were evaluated using items from three broad perspectives: selection of study groups (0-4 stars), comparability between groups (0-2 stars), and ascertainment of either the exposure or the outcome of interest (0-3 stars) for case-control or cohort studies, respectively.

The quality of each RCT was assessed using the Cochrane collaboration's tool for assessing risk of bias^[14], which utilizes seven aspects: (1) details of randomization method; (2) allocation concealment; (3) blinding of participants and personnel; (4) blinding of outcome assessment; (5) incomplete outcome data; (6) selective outcome reporting; and (7) other sources of bias, to provide a qualification of risk of bias.

Statistical analysis

Statistical analyses were performed using the Cochrane Review Manager (RevMan) Version 5.1 software. Odds ratios (ORs) with 95% confidence intervals (CIs) for dichotomous variables were computed as summary statistics. According to the Higgins' I^2 statistic, a statistical

heterogeneity of < 25, 25-50, and > 50% was defined as low, moderate, and high, respectively^[15]. If no heterogeneity was found, a fixed-effects model using the Mantel-Haenszel method would be used^[16,17]. If statistically significant heterogeneity was revealed, a random-effects model would be used^[18]. The sensitivity analysis was also performed by two methods: (1) subgroup analysis, and (2) exclusion of the study accounting for the largest proportion; if no difference was detected then it could be confirmed that the outcomes were stable and reliable. The meta-regression analyses were performed by modeling on binary continence and potency outcomes, adjusting the age, BMI, prostate volume, mean Gleason score, and PSA level by using the STATA SE 12.0. For all statistical analyses, a P -value < 0.05 was set as the level of significance. The publication bias was examined using the funnel plot, the results of which were further verified by Egger's test^[19].

RESULTS

Study identification

Figure 1 shows the flowchart of this review and summarizes the number of potential citations (Figure 1). The authors selected 73 full-text articles after a comprehensive review of 402 potential relevant citations. Among these, 14 articles compared RRP with LRP, consisting of seven prospective and seven retrospective studies^[20-33]; 12 articles compared RRP with RARP, which consisted of six prospective and six retrospective studies^[10,11,34-43]; 12 articles compared LRP with RARP, including two RCTs, one prospective and nine retrospective studies^[39,44-54].

Quality of studies

Totally, there were 14 prospective studies and 21 retrospective studies included in this review. According to the

Table 1 Comparative studies evaluating urinary continence recovery after retropubic radical prostatectomy or laparoscopic radical prostatectomy

Quality	Case, n	Ref.	Country	Age (yr)	BMI (kg/m ²)	Prostate volume (mL, g)	Gleason score (biopsy)	PSA (ng/mL)	Study design	Continence definition	Data collection	Loss of follow-up (N/Y, %)	Urinary continence recovery, %(n)	
													6 mo	12 mo
3/2/2(H)	RRP, 70	Anastasiadis <i>et al</i> ^[20] , 2003	France	64.8 ± 6.4	-	-	6.1 ± 1.1	11.2 ± 9.7	Prospective	0 pad	Nonvalidated questionnaire	Y, > 20%	43.3 (16/37)	77.7 (26/33)
	LRP, 230			64.1 ± 6.4	-	-	5.8 ± 1.2	10.7 ± 8.8					59.2 ^a (67/113)	89.0 (94/106)
2/2/3(H)	RRP, 77	Roumeguere <i>et al</i> ^[21] , 2003	Belgium	63.9 ± 5.5	-	42.0 ± 20.4	5.4 ± 1.5	10.5 ± 11.5	Prospective	0 pad	Interview	Y, > 20%	62.5 (40/64)	83.9 (47/56)
	LRP, 85			62.5 ± 6.0	-	37.3 ± 15.6	5.4 ± 1.5	8.6 ± 5.2					50.6 (37/73)	80.7 (42/52)
3/1/3(H)	RRP, 41	Remzi <i>et al</i> ^[22] , 2005	Austria	60 ± 14	-	44 ± 18	4.7 ± 1.5	6.9 ± 4.4	Prospective	0 pad	Physician	N	-	80.3 (33/41)
	(a)LRP, 39			61 ± 11	-	37 ± 16	5.1 ± 1.2	5.5 ± 3.7					-	84.6 (33/39)
	(b)LRP, 41			59 ± 12	-	32 ± 14	5.5 ± 1.3	8.1 ± 6.1					-	87.8 (36/41)
3/2/3(H)	RRP, 75	Wagner <i>et al</i> ^[23] , 2007	United States	59 ± 6.9	29 ± 4.5	-	-	8.1 ± 6.27	Prospective	0 pad	EPIC	Y, < 20%	-	47.0 (31/66)
	LRP, 75			58 ± 6.9	27 ± 3.0	-	-	6.2 ± 4.22					-	64.0 ^a (43/67)
3/2/2(H)	RRP, 222	Touijer <i>et al</i> ^[24] , 2008	United States	59 (54, 64)	-	-	-	5.3 (4.1, 7.3)	Prospective	0-1 safety pad	Institutional	N	-	75.0 ^a (167/222)
	LRP, 193			60 (55, 65)	-	-	-	5.3 (4.0, 7.5)			questionnaire		48.0 (93/193)	
3/2/3(H)	RRP, 150	Greco <i>et al</i> ^[25] , 2009	Italy	61.5 (49-74)	29 (25-33)	-	5 (3-7)	6.95 (3.4-10)	Prospective	0 pad	Validated questionnaire	N	76.0 (114/150)	91.0 (137/150)
	LRP, 150			60.5 (45-76)	32 (26-38)	-	5 (3-7)	6.3 (2.4-10)			questionnaire		89.3 (134/150)	97.0 (146/150)
3/2/2(H)	RRP, 102	Dahl <i>et al</i> ^[26] , 2009	United States	59.9	-	-	-	-	Prospective	0 pad	Validated questionnaire	Y, > 20%	49.0 (38/78)	49.0 (35/72)
	LRP, 104			59.5	-	-	-	-			questionnaire		42.0 (31/74)	53.0 (41/78)
2/2/2(M)	RRP, 49	Egawa <i>et al</i> ^[27] , 2003	Japan	67.0 ± 0.7	-	-	6.0 ± 0.2	8.3 ± 1.4	Retrospective	0 pad	Interview	Y, > 20%	84.1 ^a (37/44)	92.9 ^a (39/42)
	LRP, 34			68.0 ± 0.9	-	-	5.0 ± 0.2	6.6 ± 0.6					46.9 (15/32)	60.0 (12/20)
3/1/2(M)	RRP, 50	Artibani <i>et al</i> ^[28] , 2003	Italy	64.28 ± 6.6	-	-	5.7 ± 1.2	11 ± 9	Retrospective	0 pad	Nonvalidated questionnaire	Y, > 20%	-	64.0 (9/14)
	LRP, 71			63.14 ± 5.8	-	-	5.8 ± 1.3	15.7 ± 17			questionnaire		40.0 (8/20)	40.0 (8/20)
4/2/2(H)	RRP, 70	Ghavamian <i>et al</i> ^[29] , 2006	United States	57.8 ± 7.3	28.1	53.2 (19-135)	6.7 ± 1.3	9.9 ± 7.1	Retrospective	0 pad	Physician	Y, < 20%	71.4 (50/70)	87.6 (57/65)
	LRP, 70			60.8 ± 6.1	27.5	40.8 (20-114)	6.4 ± 0.8	7.6 ± 8.0					70.0 (49/70)	90.0 (63/70)
4/2/2(H)	RRP, 37	Takenaka <i>et al</i> ^[30] , 2008	Japan	67.1 ± 6.0	23.5 ± 3.0	30.1 ± 26.9	6.9 ± 1.0	14.7 ± 11.9	Retrospective	0 pad	Nonvalidated questionnaire	N	77.0 (28/37)	91.0 (34/37)
	LRP, 109			66.1 ± 6.3	23.8 ± 2.5	32.2 ± 16.5	6.6 ± 0.7	11.0 ± 8.4			questionnaire		65.0 (71/109)	77.0 (84/109)
2/2/3(H)	RRP, 188	Simforoosh <i>et al</i> ^[31] , 2009	Iran	62.1 (45-74)	-	-	-	13.6	Retrospective	0 pad	Physician	N	91.5 (172/188)	95.2 (179/188)
	LRP, 136			62.5 (45-76)	-	-	-	12.7					89.0 (121/136)	96.3 (131/136)
2/1/1(M)	RRP, 128	Springer <i>et al</i> ^[32] , 2013	Germany	57.2 ± 7.4	28.3 ± 2.6	-	-	3.1 ± 1.7	Retrospective	0 pad	Validated questionnaire	N	73.4 (94/128)	86.4 (111/128)
	LRP, 125			56.8 ± 6.7	27.7 ± 3.8	-	-	3.2 ± 1.4			questionnaire		86.4 (108/125) ^a	96.8 ^a (121/125)
3/2/2(H)	RRP, 168	Magheli <i>et al</i> ^[33] , 2014	Germany	62.6 ± 5.4	-	58 ± 22	-	10.1 ± 11.9	Retrospective	0-1 safety pad	Validated questionnaire	Y, > 20%	-	83.2 (99/119)
	LRP, 171			62.3 ± 5.7	-	53 ± 20	-	9.2 ± 6.9			questionnaire		-	82.8 (96/116)

^a *p* < 0.05. RRP: Retropubic radical prostatectomy; LRP: Laparoscopic radical prostatectomy; (a)LRP: Transperitoneal laparoscopic radical; EPIC: Expanded prostate cancer index composite.

NOS scale (case-control studies) used for quality evaluation of the retrospective studies, 12 studies were in the high level (7-9 stars)^[29-31,33,41-43,48,50-52,54], one study was in the low level (0-3 stars)^[11], and the remaining eight studies were in the middle level (4-6 stars). As for the quality of the prospective studies, the NOS scale (cohort studies) was used, and 12 studies were in the high level (7-9 stars)^[21-26,34-36,38,46], one study was in the middle level (4-6 stars)^[37], and one study was in the low level (0-3 stars)^[10].

The only available two RCIs were considered high quality by using the Cochrane collaboration's tool for assessing risk of bias.

Characteristics of included studies and meta-analyses on urinary continence recovery

Table 1 summarizes the results of urinary continence recovery rate between LRP and RRP. Among the 12 studies^[20-33], 1427 patients treated with RRP and 1633 patients treated with LRP were included. Most of the selected studies had a very strict urinary continence definition as no pad. Only seven studies^[25-27,29-32] provided the 6-mo urinary continence

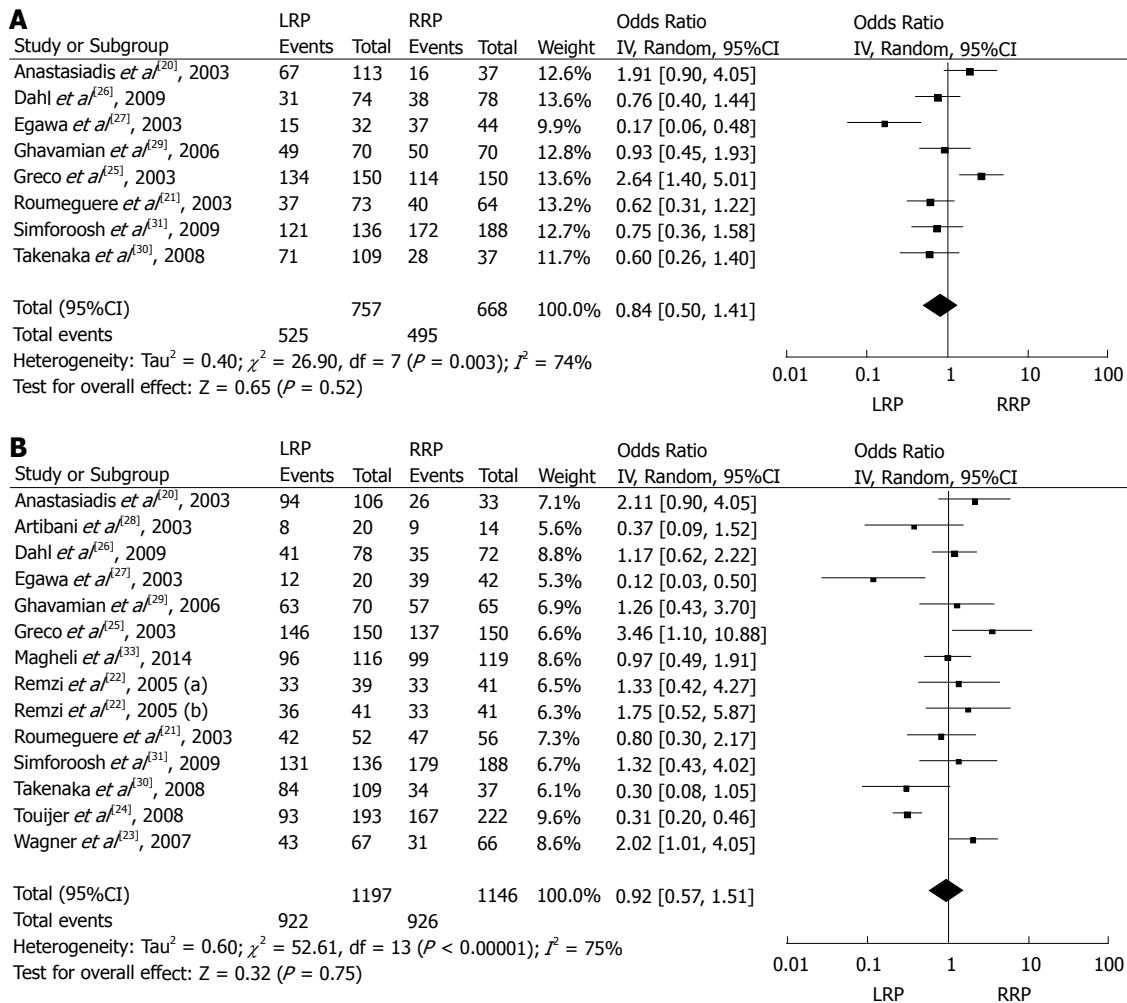


Figure 2 Forest plots and meta-analyses of laparoscopic radical prostatectomy and retropubic radical prostatectomy. A: 6-mo continence recovery; B: 12-mo continence recovery. RRP: Retropubic radical prostatectomy; LRP: Laparoscopic radical prostatectomy.

rate. The 12-mo loss to follow-up rate was $> 20\%$ in six studies^[20-21,26-28,33]. Although Springer *et al*^[32] reported demonstrated a significant better outcome of LRP than ORP (96.8% *vs* 86.4%, $P < 0.05$), we did not include it in because of the preoperatively performed transurethral resection of the prostate in that report, which could potentially be an inconsistent factor among the groups. The mean urinary continence recovery rates at 6 and 12 mo were 56.6% (42.0%-70.0%) and 84.3% (48.0%-96.3%) after LRP; and 64.9% (43.3%-84.1%) and 77.8% (47.0%-95.2%) after RRP, respectively.

Six-month continence recovery after LRP and RRP: Statistically high heterogeneity ($I^2 = 74\%$, $P < 0.05$) was observed among the eight studies^[20-21,25-27,29-31] included. The meta-analysis with a random-effects model showed no significant difference between LRP and RRP (OR = 0.84; 95%CI: 0.50-1.41; $P = 0.52$) (Figure 2).

Twelve-month continence recovery after LRP and RRP: Fourteen studies were included in the meta-analysis^[20-31,33], and there was a statistical heterogeneity ($I^2 = 75\%$, $P < 0.05$). No significant difference was found

between LRP and RRP by using a random-effects model (OR = 0.92; 95%CI: 0.57-1.51; $P = 0.75$) (Figure 2).

Table 2 summarizes the results of urinary continence recovery rate between RARP and RRP. A total of 1942 patients who received RRP and 1882 patients who received RARP were included. Half of the included studies had a very strict urinary continence definition as no pad. Only two studies^[37,40] had a high loss to follow-up rate ($> 20\%$) at 12 mo. Tewari *et al*^[34] reported that the median urinary continence recovery was significantly better after RARP compared with after RRP (44 d *vs* 160 d, $P < 0.05$), and Kim *et al*^[10] drew the same conclusion, while Krambeck *et al*^[11] presented an opposite result in the comparison of RARP and RRP (91.8% *vs* 93.7%, respectively). However, compared with the previous meta-analysis^[8], Kim *et al*^[10] and Krambeck *et al*^[11] results were excluded in our review because of their preoperative adjuvant hormonal therapy, which would undoubtedly cause difference.

Six-month continence recovery after RARP and RRP: Statistically significant heterogeneity was observed among the eight included studies ($I^2 = 73\%$, $P < 0.05$)^[36-43],

Table 2 Comparative studies evaluating urinary continence recovery after retropubic radical prostatectomy or robot-assisted radical prostatectomy

Quality	Case, n	Ref.	Country	Age (yr)	BMI (kg/m ²)	Prostate volume (mL, g)	Gleason score (biopsy)	Study design	Continence definition	Data collection	Loss of follow-up (N/Y,%)	Urinary continence recovery, % (n)
3/2/3(H)	RRP, 100	Tewari <i>et al</i> ^[64] , 2003	United States	63.1 (42.8-72)	27.6 (17-41)	48.4 (24.2-70)	-	Prospective	0-1 safety pad	Interview	-	Median: 160 d Median: 44 d ^a
3/2/2(H)	RRP, 200	Ficarra <i>et al</i>	Italy	59.9 (40-72)	27.7 (19-38)	58.8 (18-140)	-	Prospective	0 pad	ICIQ-UI	N	88.0 (92/105)
3/2/2(H)	RRP, 105	Ficarra <i>et al</i>	Italy	65 (61-69)	26 (24-28)	40 (30-47)	-	Prospective	0 pad	Validated questionnaire	N	97.0 ^a (100/103)
3/2/3(H)	RRP, 103	Ham <i>et al</i> ^[65] , 2008	South Korea	61 (57-67)	26 (24-28)	37.5 (30-48)	-	Prospective	0 pad	Validated questionnaire	N	81.8 (90/110)
3/2/3(H)	RRP, 110	Ham <i>et al</i> ^[65] , 2008	South Korea	66.9 ± 6.0	23.6 ± 1.8	-	-	Prospective	0 pad	Institutional questionnaire	Y, > 20%	92.0 ^a (173/188)
3/2/3(H)	RRP, 188	Di Pierro <i>et al</i> ^[67] , 2010	Switzerland	67.3 ± 6.2	23.6 ± 2.3	-	-	Prospective	0 pad	Validated questionnaire	-	80.0 (60/75)
3/1/2(M)	RRP, 75	Kim <i>et al</i> ^[68] , 2013	South Korea	64.3 (59.1-68.0)	-	-	-	Prospective	0 pad	Validated questionnaire	-	89 ^a (40/45)
1/1/1(L)	RRP, 235	Geraerts <i>et al</i> ^[69] , 2013	Belgium	62.8 (58.4-67.0)	-	18.2 ± 23.4	-	Prospective	24h pad test	questionnaire	Y, < 20%	Median: 4.3 mo
4/2/3(H)	RRP, 528	Geraerts <i>et al</i> ^[69] , 2013	Belgium	66.5 ± 5.7	-	15.2 ± 20.2	-	Retrospective	0 pad	questionnaire	Y, < 20%	Median: 3.7 mo
2/1/2(M)	RRP, 61	Caballero <i>et al</i> ^[70] , 2008	Spain	62.22 ± 6.12	-	-	-	Retrospective	0 pad	questionnaire	Y, < 20%	96.0 (105/109)
2/1/2(M)	RRP, 60	Caballero <i>et al</i> ^[70] , 2008	Spain	61.48 ± 6.08	-	41 (30.15-52)	-	Retrospective	0 pad	questionnaire	Y, < 20%	97.0 (59/61)
2/0/1(L)	RRP, 588	Krambeck <i>et al</i> ^[71] , 2008	United States	66.5 (62-69)	-	29.5 (23-40)	-	Retrospective	0 pad	Unspecified	Y, < 20%	-
3/1/2(M)	RRP, 294	Rocco <i>et al</i> ^[72] , 2009	Italy	56 (56-65.25)	-	-	-	Retrospective	0 pad	Institutional questionnaire	Y, < 20%	93.7 (446/476)
3/1/2(M)	RRP, 240	Rocco <i>et al</i> ^[72] , 2009	Italy	61.0 (41.0-77.0)	-	-	-	Retrospective	0-1 safety pad	questionnaire	Y, > 20%	91.8 (224/244)
3/1/3(H)	RRP, 120	Ou <i>et al</i> ^[41] , 2009	United States	63 (46-77)	-	6 (4-9)	-	Retrospective	0-1 safety pad	Interview	Y, > 20%	88.0 (191/217)
3/2/3(H)	RRP, 30	Choo <i>et al</i> ^[42] , 2013	South Korea	63 (47-76)	24.09 ± 3.28	15.89 ± 14.15	6.22 ± 1.62	Retrospective	0-1 safety pad	Unspecified	N	93.0 ^a (102/110)
3/2/3(H)	RRP, 176	Choo <i>et al</i> ^[42] , 2013	South Korea	67.27 ± 6.21	24.22 ± 3.16	16.45 ± 18.80	6.13 ± 0.9	Retrospective	0-1 safety pad	Validated questionnaire	N	83.3 (25/30)
3/1/3(H)	RRP, 112	Son <i>et al</i> ^[83] , 2013	South Korea	67 ± 6.25	24 ± 2.73	42 ± 18.82	-	Retrospective	0-1 safety pad	Validated questionnaire	N	96.6 (29/30)
3/1/3(H)	RRP, 146	Son <i>et al</i> ^[83] , 2013	South Korea	66 ± 7.75	24 ± 2.55	41 ± 15.77	-	Retrospective	0 pad	Validated questionnaire	Y, < 20%	100.0 (30/30)
				65.0 ± 6.1	24.3 ± 2.4	41.3 ± 30.0	-	Retrospective	0 pad	Validated questionnaire	Y, < 20%	96.0 (169/176)
				65.5 ± 6.7	24.5 ± 2.5	45.9 ± 16.3	-	Retrospective	0 pad	Validated questionnaire	Y, < 20%	94.0 (72/77)
												70.7 (66/94)
												87.5 ^a (107/122)
												94.5 ^a (115/122)

^a $P < 0.05$. RRP: Retropubic radical prostatectomy; RARP: Robot-assisted radical prostatectomy; ICIQ-UI: International consultation of incontinence questionnaire-urinary incontinence.

and the meta-analysis with a random-effects model showed a significant advantage after RARP than after RRP (OR = 2.23; 95%CI: 1.20-4.14; $P < 0.05$) (Figure 3).

Twelve-month continence recovery after RARP and RRP: Totally, eight studies were included to compare RARP and RRP^[35,38,40-43]. No evidence of statistical heterogeneity was observed ($I^2 = 49\%$, $P = 0.06$) and pooled analysis with a fixed-effects model demonstrated a statistically significant advantage in favor of RARP (OR = 2.93; 95%CI: 1.99-4.32; $P < 0.01$) (Figure 3).

Table 3 summarizes the results of urinary continence recovery rate between LRP and RARP. A total of 2195 patients treated with LRP and 1940 patients treated with RARP were included. Both of the only two RCTs (high quality) revealed that the urinary continence recovery rates were significantly higher at 6 and 12 mo after RARP, in comparison with those after LRP ($P < 0.05$)^[44,45]. The evidence with the largest sample size, reported by Ploussard *et al*^[46], was the only prospective study of high quality (7 stars) and showed similar results with the two RCTs. Almost all of the remaining retrospective studies also indicated better outcomes after RARP. Only one study^[52] had a high loss to follow-up rate (> 20%) at 12 mo. The most crucial difference between our pooled-analysis and the previous meta-analysis^[8] was that the RCTs were evaluated separately with non-RCTs (NRCITs) in this review, since they had totally different data types.

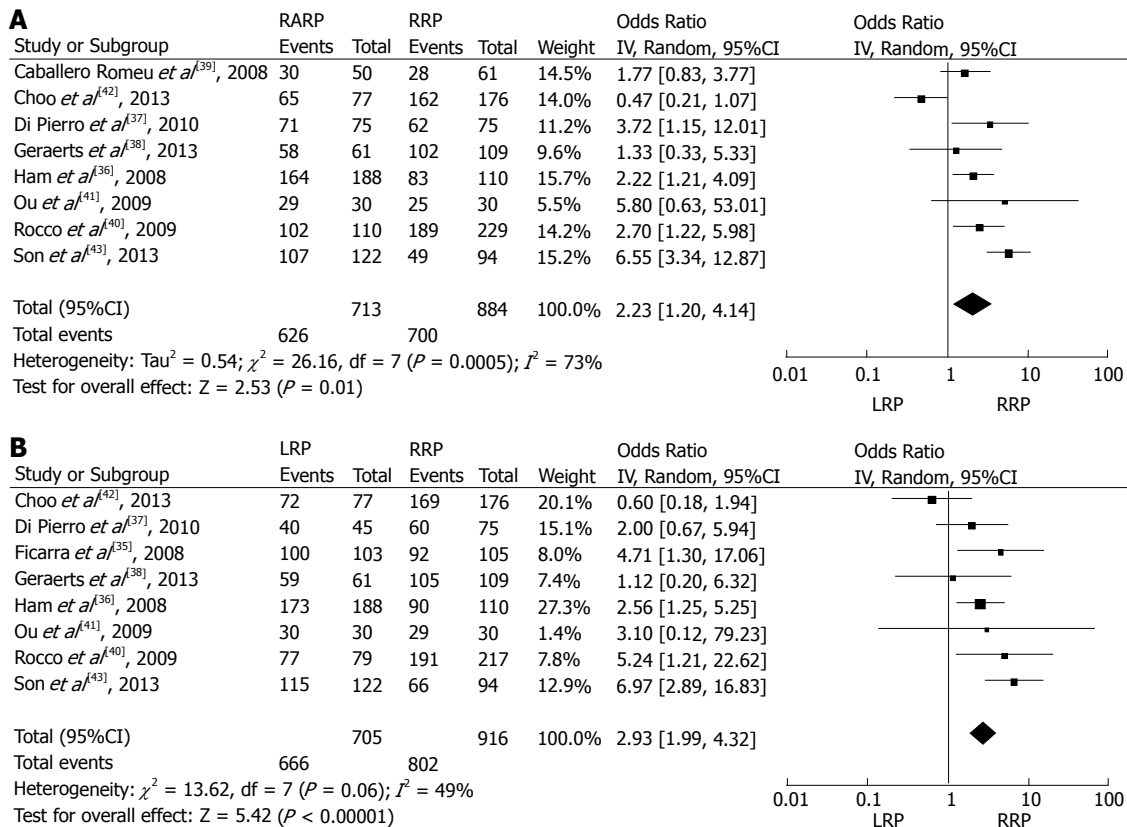


Figure 3 Forest plots and meta-analyses of robot-assisted radical prostatectomy and retropubic radical prostatectomy. A: 6-mo continence recovery; B: 12-mo continence recovery. RRP: Retropubic radical prostatectomy; RARP: Robot-assisted radical prostatectomy.

Six-month continence recovery after RARP and LRP: The two RCTs^[44,45] showed no heterogeneity ($I^2 = 0\%$, $P = 0.92$), and supported the advantage after RARP with a fixed-effects model (OR = 2.66; 95%CI: 1.31-5.40; $P < 0.01$) (Figure 4). In the cumulative analysis of 10 NRCTs^[39,46-54], no heterogeneity was found ($I^2 = 38\%$, $P = 0.11$), so a fixed-effects model was performed. The result also demonstrated a statistically significant advantage in favor of RARP (OR = 1.93; 95%CI: 1.67-2.23; $P < 0.01$) (Figure 4).

Twelve-month continence recovery after RARP and LRP: No evidence of statistical heterogeneity was observed in both of the two RCTs ($I^2 = 0\%$, $P = 0.88$) or the seven NRCTs ($I^2 = 0\%$, $P = 0.44$), and the pooled analyses with a fixed-effects model either for the RCTs or the NRCTs showed a statistically significant advantage in favor of RARP [(OR = 3.52; 95%CI: 1.36-9.13; $P < 0.05$); (OR = 1.47; 95%CI: 1.25-1.74; $P < 0.01$), respectively] (Figure 4).

Characteristics of included studies and meta-analyses on potency recovery

Table 4 summarizes the results of potency recovery rate between LRP and RRP. Among the 10 studies, 907 patients treated with RRP and 1004 patients treated with LRP were included. Eight of them had a very strict potency definition as erection sufficient for intercourse

(ESI). The 12-mo loss to follow-up rate was $> 20\%$ in three studies^[20,26,33]. Springer *et al.*^[32] report was not included in the meta-analysis because of its preoperative surgery. The nerve sparing (NS) procedures were not clearly mentioned in two studies^[24,26], and the remaining studies either used the bilateral or unilateral nerve sparing measures. The mean potency recovery rates at 6 and 12 mo were 30.6% (23.0%-38.1%) and 45.8% (32.0%-54.5%) after RRP; and 42.5% (37%-48%) and 55% (41%-66%) after LRP, respectively.

Six-month potency recovery after LRP and RRP: No statistical heterogeneity was observed ($I^2 = 0\%$, $P = 0.67$) in the included four studies^[21,26,28,29]. The meta-analysis evaluating potency with a fixed-effects model suggested no statistically significant difference between LRP and RRP (OR = 1.48; 95%CI: 0.94-2.34; $P = 0.09$) (Figure 5).

Twelve-month potency recovery after LRP and RRP: Eight studies were included^[20-21,23-26,29,33] and no statistical heterogeneity was observed ($I^2 = 0\%$, $P = 0.50$). The pooled analysis with a fixed-effects model showed a statistically significant advantage in favor of LRP (OR = 1.34; 95%CI: 1.05-1.70; $P < 0.05$) (Figure 5).

Table 5 summarizes the results of potency recovery rate after RARP and RRP. A total of 1278 patients treated with RRP and 1309 patients treated with RARP were included. In half of them, the NS procedures were not

Table 3 Comparative studies evaluating urinary continence recovery after laparoscopic radical prostatectomy or robot-assisted radical prostatectomy

Quality	Case, n	Author, yr	Country	Age (yr)	BMI (kg/m ²)	Prostate volume (mL/g)	Gleason score (biopsy)	PSA (ng/mL)	Study design	Continence definition	Data collection	Loss of follow-up (N/Y, %)	Urinary continence recovery, %(n)	
													6 mo	12 mo
High	LRP, 60	Asimakopoulos <i>et al</i> ^[44] , 2011	Italy	61.1 ± 5.1	26.3 ± 2.2	-	-	7.37 (1.5-9.15)	RCT	0 pad	ICS-MSF	N	75.0 (45/60)	83.0 (50/60)
	RARP, 52			59.6 ± 5.4	25.8 ± 2.6	-	-	8.9 (5.8-9.2)					88.0 (46/52)	94.0 (49/52)
High	LRP, 60	Porpiglia <i>et al</i> ^[45] , 2012	Italy	64.7 ± 5.9	26.8 ± 2.9	37.7 ± 14.1	-	8.3 ± 6.5	RCT	0-1 pad	EPIC	N	73.3 (44/60)	83.3 (50/60)
	RARP, 60			63.9 ± 6.7	26.2 ± 2.5	36.2 ± 12.6	-	6.9 ± 4.2					88.3a (53/60)	95.0 ^a (57/60)
3/1/3(H)	LRP, 1377	Ploussard <i>et al</i> ^[46] , 2012	France	62.7	26.6	-	-	9.8	Prospective	0 pad	Validated questionnaire	N	58.9 (811/1377)	68.5 (943/1377)
	RARP, 1009			62.7	26.5	-	-	9.2					72.0 ^a (726/1009)	75.4 (761/1009)
2/1/2(M)	LRP, 50	Joseph <i>et al</i> ^[47] , 2005	United Kingdom	61.8 ± 1.6	-	-	6 ± 0.14	6.0 ± 0.83	Retrospective	0 pad	Interview	N	92.0 (46/50)	-
	RARP, 50			59.6 ± 1.6	-	-	6 ± 0.15	7.3 ± 1.2					90.0 (45/50)	-
2/1/2(M)	LRP, 70	Caballero <i>et al</i> ^[48] , 2008	Spain	66.5 (62-69)	-	41 (30.15-52)	-	9.66 (7-16.6)	Retrospective	0 pad	Unspecified	Y, < 20%	36.4 (24/66)	-
	RARP, 60			56 (56-65.25)	-	29.5 (23-40)	-	7 (5.7-10)					60.0 (30/50)	-
3/1/3(H)	LRP, 31	Lee <i>et al</i> ^[48] , 2009	South Korea	63.0 ± 8.52	25.2 ± 2.59	37.4 ± 13.05	6.5 ± 1.23	11.7 ± 13.72	Retrospective	0-1 safety pad	Institutional questionnaire	N	80.6 (25/31)	-
	RARP, 21			64.6 ± 6.79	25.5 ± 2.64	39.9 ± 15.54	6.6 ± 0.97	8.1 ± 7.01					81.0 (17/21)	-
3/1/2(M)	LRP, 60	Cho <i>et al</i> ^[49] , 2009	South Korea	66.5 (57-75)	23.65 (18.1-28.4)	39.7 (19-72)	6.81 (5-9)	11.04 (2.72-36.6)	Retrospective	0-1 safety pad	Interview	N	71.7 (43/60)	100.0 (60/60)
	RARP, 60			66.3 (50-77)	24.61 (19.9-26.3)	36.6 (22-92.8)	6.83 (5-8)	9.98 (2.91-26.3)					93.3 (56/60)	100.0 (60/60)
4/2/3(H)	LRP, 75	Hakimi <i>et al</i> ^[50] , 2009	United States	59.6 (43-72)	-	-	-	7.5	Retrospective	0 pad	IPSS	N	65.3 (49/75)	89.3 (67/75)
	RARP, 75			59.8 (42-71)	-	-	-	8.4					74.7 (56/75)	93.3 (70/75)
4/2/2(H)	LRP, 45	Trabulsi <i>et al</i> ^[51] , 2010	United States	58.1 (43-74)	-	-	-	6.2	Retrospective	0-1 safety pad	Validated questionnaire	N	71.0 (32/45)	82.0 (37/45)
	RARP, 205			59.9 (42-76)	-	-	-	6.4					91.0 ^a (187/205)	94.0 ^a (193/205)
3/2/2(H)	LRP, 161	Willis <i>et al</i> ^[52] , 2011	United States	58.0 ± 6.7	27.0 ± 3.4	35.2 ± 10.1	-	5.7 ± 2.9	Retrospective	0 pad	Validated questionnaire	Y, > 20%	55.0 (64/117)	72.0 (84/116)
	RARP, 121			58.1 ± 6.3	26.7 ± 3.3	41.5 ± 15.2	-	5.0 ± 2.2					66.0 (50/76)	75.0 (33/44)
3/1/2(M)	LRP, 62	Park <i>et al</i> ^[53] , 2011	South Korea	65.7 (38-77)	24.6 (19.4-31.4)	30.1 (12.0-56.0)	-	9.14 (2.65-30.77)	Retrospective	0-1 safety pad	Interview	N	76.3 (47/62)	95.0 (59/62)
	RARP, 44			62.7 (46-71)	26.0 (19.7-39.4)	32.9 (15.5-66.8)	-	6.32 (1.86-29.5)					93.5 (41/44)	94.4 (42/44)
3/2/3(H)	LRP, 144	Park <i>et al</i> ^[54] , 2013	South Korea	67 (38-77)	24.2 (17.2-31.4)	28.8 (12.0-74.0)	-	5.84 (0.08-41.26)	Retrospective	0 pad	Interview	N	65.5 (94/144)	78.1 (112/144)
	RARP, 183			63 (44-75)	24.7 (16.4-39.4)	30.3 (15.5-82.8)	-	4.98 (0.05-51.46)					83.5 ^a (153/183)	87.4 (160/183)

^a $P < 0.05$. LRP: Laparoscopic radical prostatectomy; RARP: Robot-assisted radical prostatectomy; RCT: Randomized controlled trial; IPSS: International prostate symptom score; EPIC: Expanded prostate cancer index composite; ICS-MSF: International continence society-male short form questionnaire.

clearly mentioned. Three studies^[11,37,40] had a high loss to follow-up rate ($> 20\%$) at 12 mo. Tewari *et al*^[34] reported that the median potency recovery was significantly better after RARP than after RRP (180 d *vs* 440 d, $P < 0.05$). The mean 12-mo potency recovery rate ranged from 40% to 50% after RRP and from 54% to 87.5% after RARP.

Six-month potency recovery after RARP and RRP: A statistically significant heterogeneity was observed among the three included studies ($I^2 = 68\%$, $P = 0.05$)^[37,40,42], and the pooled analysis with a random-effects model suggested a statistically significance in favor of RARP (OR = 2.77; 95%CI: 1.23-6.21; $P < 0.05$) (Figure 6).

Twelve-month potency recovery after RARP and RRP: Six studies were included^[15,37,40-42] and no statistical heterogeneity was observed ($I^2 = 0\%$, $P = 0.61$). The cumulative analysis with a fixed-effects model showed a statistically significant advantage in favor of RARP (OR = 2.66; 95%CI: 1.96-3.60; $P < 0.01$) (Figure 6).

Table 6 summarizes the results of potency recovery rate after RARP with LRP. Among these eight studies^[44-46,49,50,52-54], 1322 patients who received LRP and 1203 patients who received RARP were included, and all these studies performed the NS techniques (bilateral or unilateral) except the one by Asimakopoulos *et al*^[41]. Most of the studies

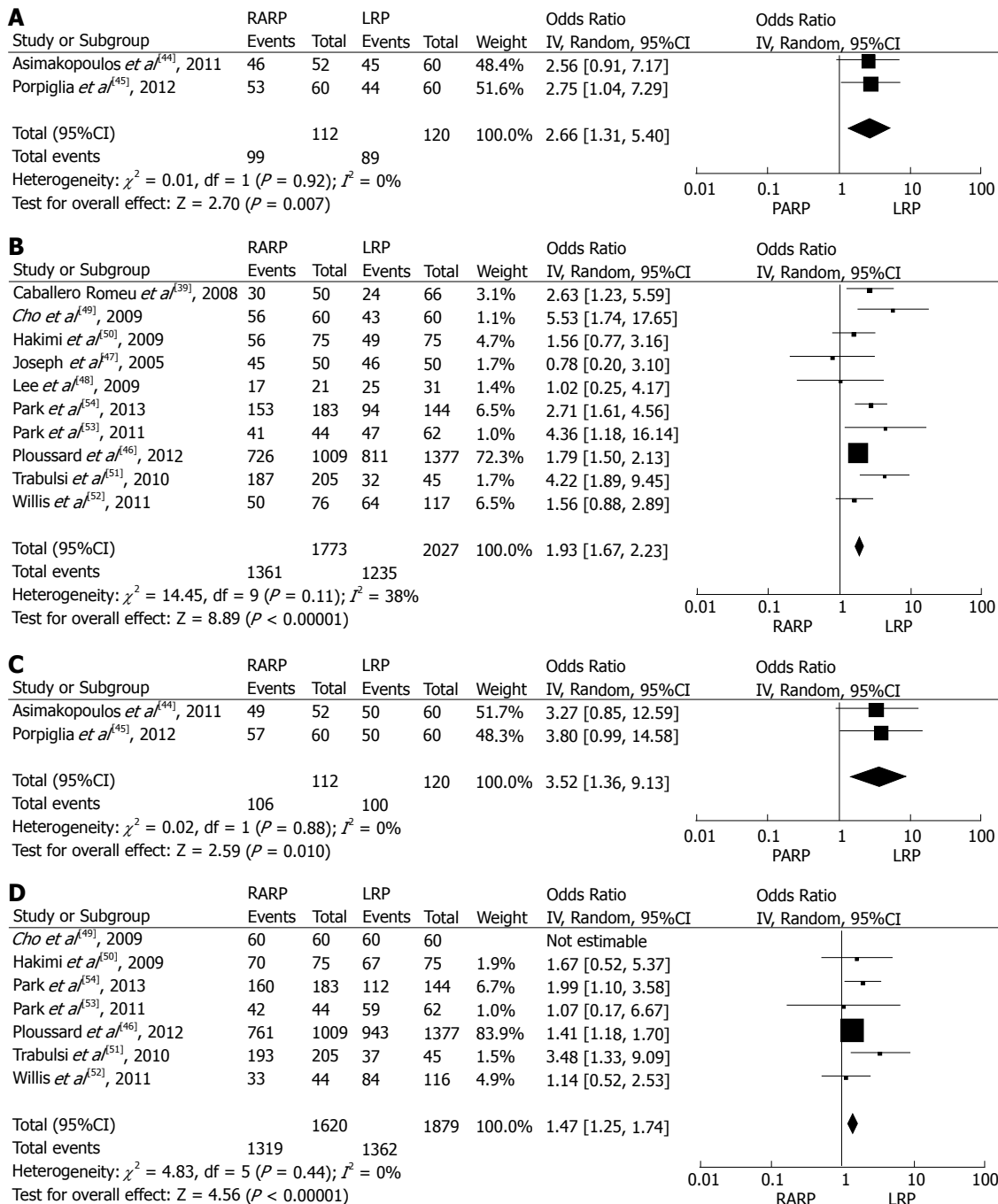


Figure 4 Forest plots and meta-analyses of robot-assisted radical prostatectomy and laparoscopic radical prostatectomy. A: 6-mo continence recovery based on randomized control trials (RCTs); B: 6-mo continence recovery based on non-randomized control trials (NRCTs); C: 12-mo continence recovery based on RCTs; D: 12-mo continence recovery based on NRCTs. RRP: Retropubic radical prostatectomy; LRP: Laparoscopic radical prostatectomy.

used a strict potency definition as ESI. In addition, two retrospective studies^[52,53] had a high loss to follow-up rate ($> 20\%$) at 12 mo. The RCTs were evaluated separately with NRCTs. For NRCTs, the mean potency recovery rates at 6 and 12 mo were 33.8% (20.4%-48.5%) and 43.2% (31.6%-65.5%) after LRP; and 55.5% (31.1%-75%) and 65.1% (36.5%-80.0%) after RARP.

Six-month potency recovery after RARP and LRP: The two RCTs^[44,45] showed a statistical heterogeneity ($I^2 = 84\%$, $P < 0.05$), and demonstrated comparable result be-

tween RARP and LRP with a random-effects model (OR = 4.75; 95%CI: 0.92-24.54; $P = 0.06$) (Figure 7). In the cumulative analysis of five NRCTs^[46,49-50,52,54], no heterogeneity was found ($I^2 = 0\%$, $P = 0.50$), so a fixed-effects model was utilized. The result demonstrated a statistically significant advantage in favor of RARP (OR = 2.56; 95%CI: 2.11-3.10; $P < 0.01$) (Figure 7).

Twelve-month potency recovery after RARP and LRP: No evidence of statistical heterogeneity was observed in the two RCTs ($I^2 = 17\%$, $P = 0.27$) and

Table 4 Comparative studies evaluating potency recovery after retropubic radical prostatectomy or laparoscopic radical prostatectomy

Quality	Case, n	Author, yr	Country	Age (yr)	BMI (kg/m ²)	Prostate volume (mL, g)	Gleason score (biopsy)	PSA (ng/mL)	Study design	Potency definition	Data collection	Loss of follow-up (N/Y, %)	Potency recovery (UNS/BNS), % (n)		
													6 mo	12 mo	12 mo
3/2/2(H)	RRP, 70	Anastasiadis <i>et al.</i> ^[20] , 2003	France	64.8 ± 6.4	-	-	6.1 ± 1.1	11.2 ± 9.7	Prospective	ESI	Nonvalidated questionnaire	Y ₁ > 20%	-	71.0 (23/33)	30.0 (10/33)
2/2/3(H)	RRP, 230	Roumeguere <i>et al.</i> ^[21] , 2003	Belgium	64.1 ± 6.4	-	-	5.8 ± 1.2	10.7 ± 8.8	Prospective	ESI	IIIEF-5	N	33.3 (11/33)	98.0 (104/106)	41.0 (43/106)
3/2/3(H)	RRP, 26	Wagner <i>et al.</i> ^[22] , 2007	United States	62.5 ± 6.0	29 ± 4.5	-	5.4 ± 1.5	10.5 ± 11.5	Prospective	ESI	EPIC	N	34.6 (9/26)	54.5 (18/33)	-
3/2/2(H)	RRP, 164	Touijer <i>et al.</i> ^[23] , 2008	United States	59 ± 6.9	27 ± 3.0	-	5.4 ± 1.5	8.1 ± 6.27	Prospective	ESI	Institutional questionnaire	N	-	65.3 (17/26)	-
3/2/3(H)	RRP, 132	Greco <i>et al.</i> ^[24] , 2009	Italy	58 ± 6.9	-	-	-	6.2 ± 4.22	Prospective	ESI	Validated questionnaire	Y ₁ > 20%	-	44.0 (11/25)	-
3/2/2(H)	RRP, 102	Dahl <i>et al.</i> ^[25] , 2009	United States	59.9	-	-	-	5.3 (4.1, 7.3)	Prospective	ESI	Validated questionnaire	Y ₁ > 20%	-	41.0 (15/37)	-
3/2/2(H)	RRP, 150	Artibani <i>et al.</i> ^[26] , 2003	Italy	61.5 (49-74)	29 (25-33)	-	5 (3-7)	5.3 (4.0, 7.5)	Retrospective	ESI	IIIEF-5	N	-	51.0 (77/150)	58.5 (96/164)
3/2/2(H)	RRP, 104	Artibani <i>et al.</i> ^[27] , 2003	Italy	60.5 (45-76)	32 (26-38)	-	5 (3-7)	6.95 (3.4-10)	Retrospective	ESI	Validated questionnaire	Y ₁ > 20%	-	66.0 (99/150)	56.2 (73/130)
3/1/2(M)	RRP, 50	Artibani <i>et al.</i> ^[28] , 2003	Italy	64.28 ± 6.6	-	-	5.7 ± 1.2	11 ± 9	Retrospective	ESI	Nonvalidated questionnaire	Y ₁ > 20%	-	23.0 (18/77)	32.0 (23/73)
4/2/2(H)	RRP, 42	Chaverman <i>et al.</i> ^[29] , 2006	United States	63.14 ± 5.8	28.1	53.2 (19-135)	5.8 ± 1.3	15.7 ± 17	Retrospective	ESI	IIIEF-5	N	-	37.0 (28/75)	43.0 (33/77)
2/1/1(M)	RRP, 128	Springer <i>et al.</i> ^[30] , 2013	Germany	57.8 ± 7.3	27.5	40.8 (20-114)	6.7 ± 1.3	9.9 ± 7.1	Retrospective	ESI	IIIEF-5	N	38.1 (16/42)	52.5 (21/40)	-
3/2/2(H)	RRP, 125	Magheii <i>et al.</i> ^[31] , 2014	Germany	60.8 ± 6.1	28.3 ± 2.6	-	7.6 ± 8.0	3.1 ± 1.7	Retrospective	IIIEF-5 > 22	Validated questionnaire	Y ₁ > 20%	-	48.0 (24/50)	64.0 (32/50)
3/2/2(H)	RRP, 143	Magheii <i>et al.</i> ^[32] , 2014	Germany	57.2 ± 7.4	27.7 ± 3.8	-	6.4 ± 0.8	3.2 ± 1.4	Retrospective	IIIEF-5 > 17	Validated questionnaire	Y ₁ > 20%	-	53.1 (68/128)	-
3/2/2(H)	RRP, 79	Magheii <i>et al.</i> ^[33] , 2014	Germany	56.8 ± 6.7	-	58 ± 22	-	10.1 ± 11.9	Retrospective	IIIEF-5 > 17	Validated questionnaire	Y ₁ > 20%	-	74.4 (93/125)	-
3/2/2(H)	RRP, 143	Magheii <i>et al.</i> ^[34] , 2014	Germany	62.6 ± 5.4	-	53 ± 20	-	9.2 ± 6.9	Retrospective	IIIEF-5 > 17	Validated questionnaire	Y ₁ > 20%	-	29.0 (18/62)	-
3/2/2(H)	RRP, 79	Magheii <i>et al.</i> ^[35] , 2014	Germany	62.3 ± 5.7	-	-	-	-	Retrospective	IIIEF-5 > 17	Validated questionnaire	Y ₁ > 20%	-	28.0 (7/25)	-

*P < 0.05. RRP: Retropubic radical prostatectomy; LRP: Laparoscopic radical prostatectomy; ESI: Erection sufficient for intercourse; IIIEF: International index of erectile function; EPIC: Expanded prostate cancer index composite; UNS: Unilateral nerve sparing; PSA: Prostate-specific antigen; BNS: Bilateral nerve sparing.

the pooled analyses with a fixed-effects model showed a statistically significant advantage in favor of RARP (OR = 5.35; 95%CI: 2.77-10.31; $P < 0.01$) (Figure 7). In the six NRCTs^[46,49-50,52-54], a statistical heterogeneity ($I^2 = 52\%$, $P = 0.27$) was found, and the cumulative analysis also demonstrated a statistically significant advantage in favor of RARP by using a random-effects model (OR = 1.99; 95%CI: 1.35-2.93; $P < 0.01$) (Figure 7).

Sensitivity analysis and meta-regression analysis

Sensitivity analysis was performed to verify the reliability and stability of the evidence when a statistical heterogeneity existed. The subgroup analyses of the 6- or 12-mo urinary continence recovery following LRP and RRP did not vary significantly by source of country ($P > 0.05$), continence definition ($P > 0.05$), study design ($P > 0.05$) and loss of follow-up rate ($P > 0.05$) (Tables 7 and 8). While in the subgroup analyses of 6-mo urinary continence recovery following RARP and RRP, the results were unstable, with Western country and strict definition indicating better outcomes in favor of RARP (OR = 2.32; 95%CI: 1.47-3.67; $P < 0.01$ and OR = 3.09; 95%CI: 1.65-5.80; $P < 0.01$, respectively) (Table 9). Table 10 independently evaluates the most important factors (NS procedures) for 12-mo potency recovery among different techniques. Since all the included studies comparing RARP and LRP had taken unilateral or bilateral NS procedures, only the subgroups comparing LRP/RRP and RARP/RRP were analyzed. Our results again

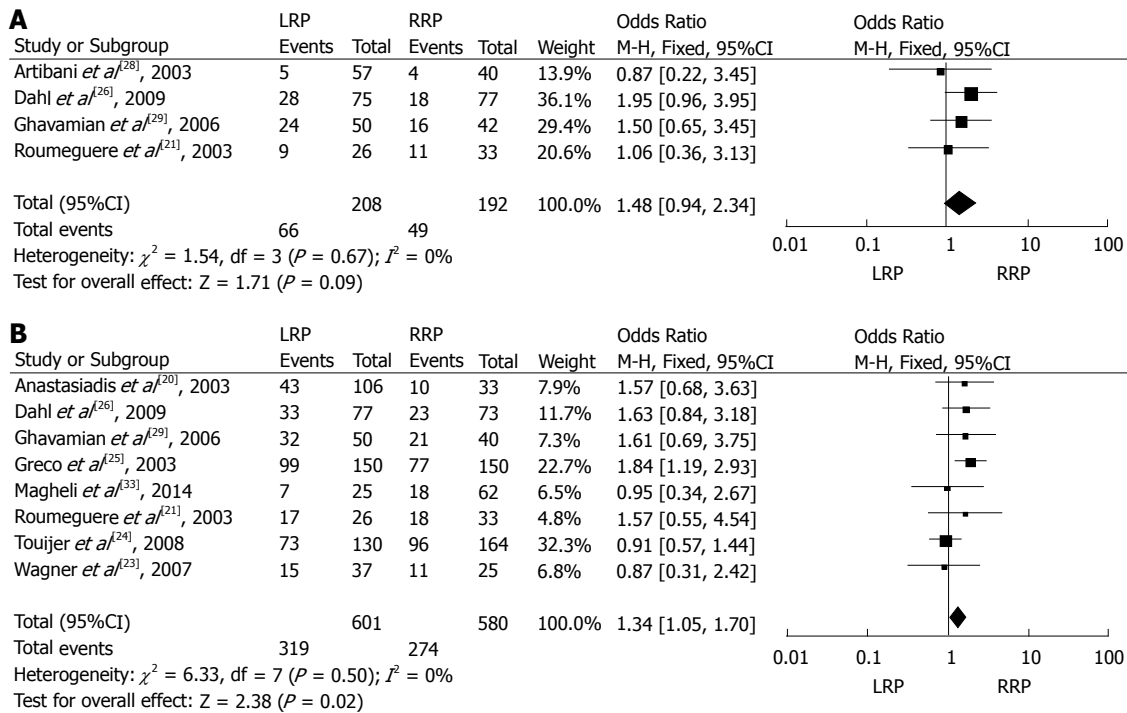


Figure 5 Forest plots and meta-analyses of laparoscopic radical prostatectomy and retropubic radical prostatectomy. A: 6-mo potency recovery; B: 12-mo potency recovery. RRP: Retropubic radical prostatectomy; LRP: Laparoscopic radical prostatectomy.

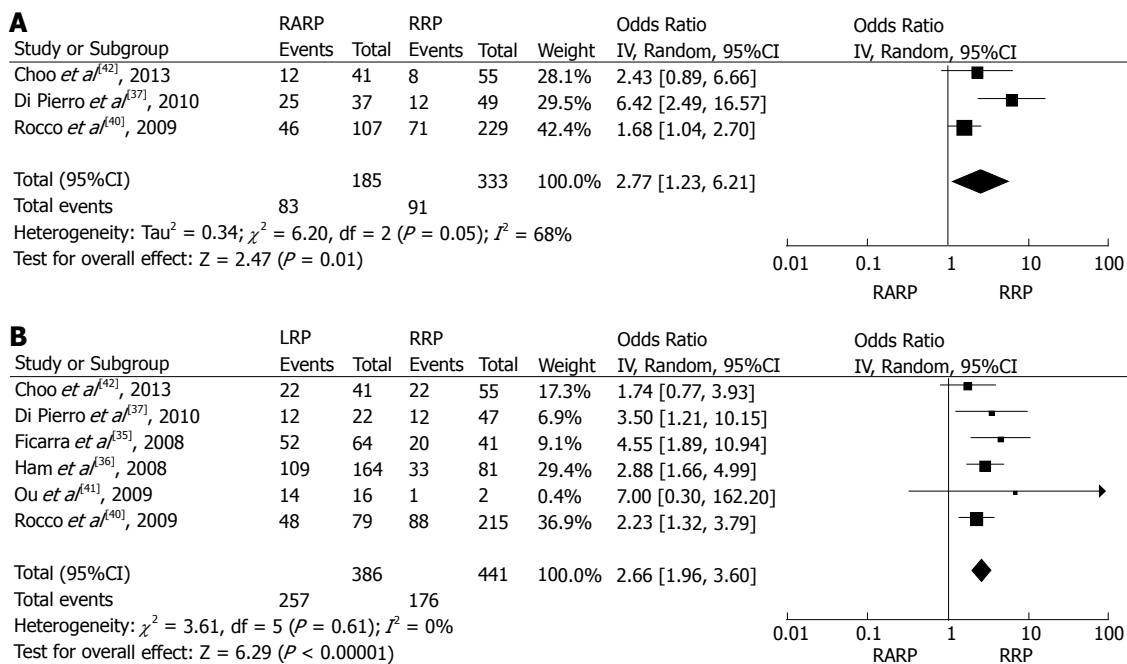


Figure 6 Forest plots and meta-analyses of robot-assisted radical prostatectomy and retropubic radical prostatectomy. A: 6-mo potency recovery; B: 12-mo potency recovery. RRP: Retropubic radical prostatectomy; RARP: Robot-assisted radical prostatectomy.

confirmed that the NS measures were advantageous factors to potency recovery ($P < 0.05$). All of the other remaining outcomes were proved to be stable and reliable by either using model conversion or exclusion of the study with the largest proportion.

Regrettably, in our meta-regression analyses, none of the adjustments such as age, BMI, prostate volume,

Gleason score or PSA, achieved a statistical significance ($P < 0.05$) (Tables 11 and 12); however, the l'Abbé graphs showed an overall trend either as a positive correlation or a negative correlation between those potential factors and different surgical techniques. The older age, lower BMI and lower PSA level were associated with lower odds of different technical groups (Figure 8). The prostate vol-

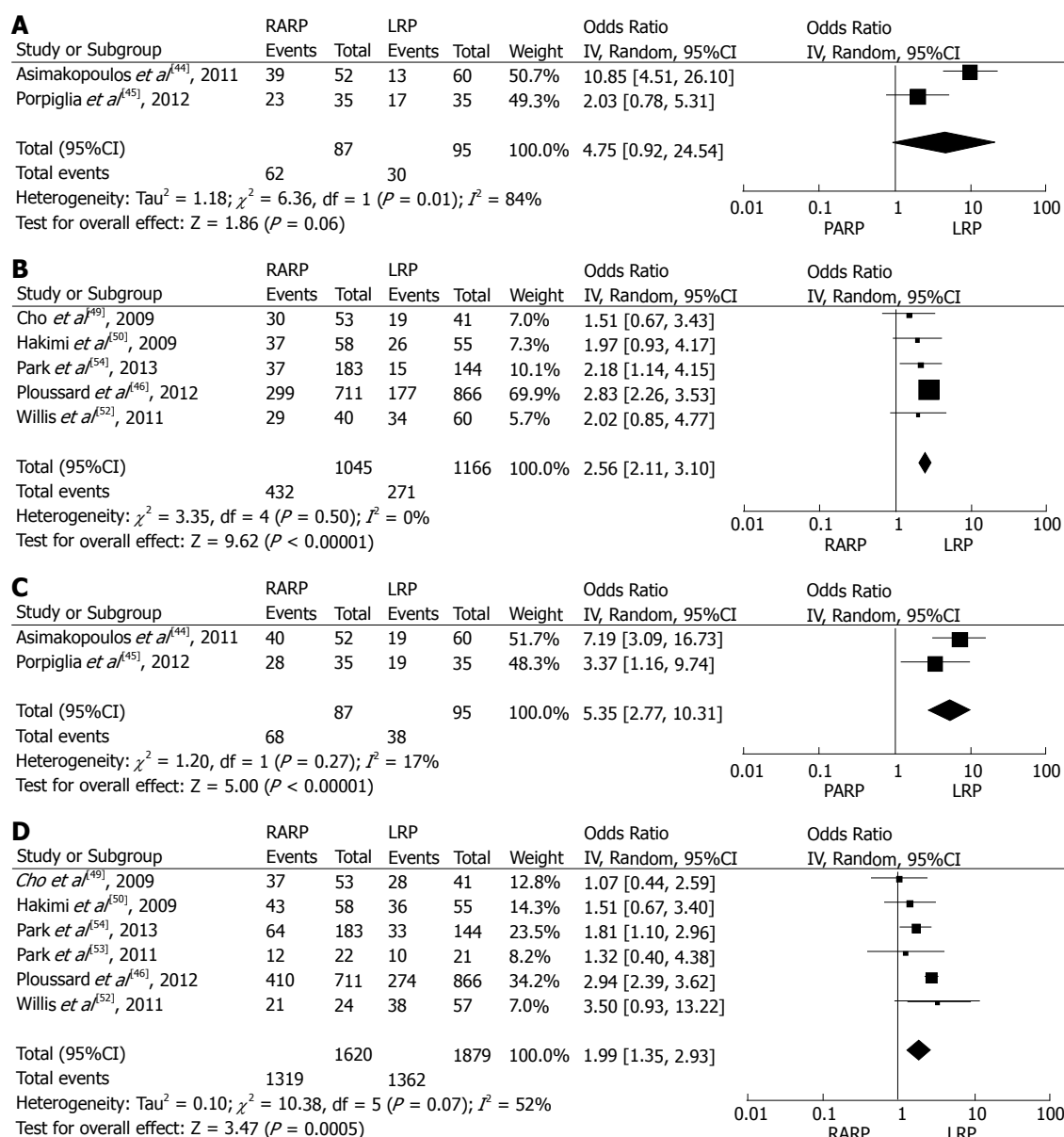


Figure 7 Forest plots and meta-analyses of robot-assisted radical prostatectomy and laparoscopic radical prostatectomy. A: 6-mo potency recovery based on randomized control trials (RCTs); B: 6-mo potency recovery based on non-randomized control trials (NRCTs); C: 12-mo potency recovery based on RCTs; D: 12-mo potency recovery based on NRCTs. LRP: Laparoscopic radical prostatectomy; RARP: Robot-assisted radical prostatectomy.

ume and Gleason score did not demonstrate any trend between the different methods of surgery (Figure 8).

Publication bias

The funnel plots of two comparative results (6-mo potency recovery after LRP/RRP and after RARP/LRP) were asymmetrical (Figure 9), indicating the existence of publication bias; this was also confirmed by Egger linear regression test ($P = 0.024$ and $P = 0.013$, respectively). All the other comparisons demonstrated symmetrical funnel plots and found no statistical significance ($P > 0.05$) by using the Egger's test, indicating no publication bias.

DISCUSSION

This meta-analysis was designed in accordance with the

MOOSE reporting guidelines^[10]. In 2011, Ficarra *et al*^[8,9] had performed two meta-analyses which tried to compare the superiority of techniques concerning RARP *vs* RRP and RARP *vs* LRP. However, a deep investigation focusing on the deficiencies of these two studies made them possibly inconvincible: (1) limited number of studies included; (2) the lack of credible quality assessment tool for the included studies; (3) as for the comparison between RARP and LRP, it did not correspond with the methodological rules of a meta-analysis to integrate the RCT with the NRCT studies to analyze the outcomes, as they were totally two different level of evidences; (4) in the few included studies, Kim *et al*^[10] and Krambeck *et al*^[11] results were not available for the comparison between RARP and RRP; and (5) though all the outcomes of these two studies were apparently heterogeneous, the

Table 5 Comparative studies evaluating potency recovery after retropubic radical prostatectomy or robot-assisted radical prostatectomy

Quality	Case, n	Author, yr	Country	Age (y)	BMI (kg/m ²)	Prostate volume (mL, g)	Gleason score (biopsy)	PSA (ng/mL)	Study design	Potency definition	Data collection	Loss of follow-up (N/Y, %)	Potency recovery (UNS/BNS), % (n)		Potency recovery (unclear NS), % (n)	
													6 mo	12 mo	6 mo	12 mo
3/2/3(H)	RRP, 100	Tewari <i>et al.</i> ^[94]	United States	63.1 (42.8-72)	27.6 (17-41)	48.4 (24.2-70)	-	7.3 (1.9-35)	Prospective	Presence of erection	Interview	-	Median: 440 d	-	Median: 440 d	-
	RRP, 200	Ficarra <i>et al.</i> ^[95]	Italy	59.9 (40-72)	27.7 (19-38)	58.8 (18-140)	-	6.4 (0.6-41)	Prospective	IIIEF-5 > 17	IIIEF-5	N	Median: 180 d ^a	-	Median: 180 d ^a	-
3/2/2(H)	RRP, 41	Ficarra <i>et al.</i> ^[95]	Italy	65 (61-69)	26 (24-28)	40 (30-47)	-	6 (5-10)	Prospective	IIIEF-5 > 17	IIIEF-5	N	49.0 (20/41)	-	-	-
	RRP, 64	Ham <i>et al.</i> ^[96]	South Korea	61 (57-67)	26 (24-28)	37.5 (30-48)	-	6.4 (4.6-9)	Prospective	ESI	IIIEF-5	N	81.0 ^a (52/64)	-	-	-
3/2/3(H)	RRP, 81	Ham <i>et al.</i> ^[96]	South Korea	66.9 ± 6.0	23.6 ± 1.8	-	-	55.2 ± 23.7	Prospective	ESI	IIIEF-5	N	40.7 (33/81)	-	-	-
	RRP, 164	Di Pierro <i>et al.</i> ^[97]	Switzerland	67.3 ± 6.2	23.6 ± 2.3	-	-	22.3 ± 34.3	Prospective	ESI	Institutional questionnaire	Y, > 20%	66.5 (109/164)	-	-	-
3/1/2(M)	RRP, 49	Kim <i>et al.</i> ^[98]	South Korea	64.3 (59.1-68.0)	-	-	-	7.57 (5.1-10.4)	Prospective	ESI	Validated	N	-	-	25.0 (12/49)	26.0 (12/47)
	RRP, 37	Kim <i>et al.</i> ^[98]	South Korea	62.8 (58.4-67.0)	-	-	-	7.72 (5.6-12.1)	Prospective	ESI	Validated	N	-	-	68.0 (25/37)	55.0 (12/22)
1/1/1(L)	RRP, 122	Kim <i>et al.</i> ^[99]	South Korea	66.5 ± 5.7	-	18.2 ± 23.4	-	14.6 ± 22.1	Prospective	ESI	questionnaire	N	-	-	6.7 (8/122)	28.1
	RRP, 373	Krambeck <i>et al.</i> ^[100]	United States	64.2 ± 7.3	15.2 ± 20.2	-	-	10.4 ± 16.0	Retrospective	ESI	Institutional questionnaire	Y, > 20%	-	-	33.0 (123/373)	57.1
2/0/1(L)	RRP, 588	Rocco <i>et al.</i> ^[101]	Italy	61.0 (41.0-77.0)	-	-	-	5.0 (0.6-39.7)	Retrospective	ESI	questionnaire	Y, > 20%	-	-	-	62.8
	RRP, 294	Rocco <i>et al.</i> ^[101]	Italy	61.0 (38.0-76.0)	-	-	-	4.9 (0.5-33.5)	Retrospective	ESI	questionnaire	Y, > 20%	-	-	-	70.0
3/1/2(M)	RRP, 240	Choo <i>et al.</i> ^[102]	South Korea	63 (46-77)	-	-	-	6.7 (0.7-22.0)	Retrospective	ESI	Interview	Y, > 20%	-	-	31.0	41.0
	RRP, 120	Choo <i>et al.</i> ^[102]	South Korea	63 (47-76)	-	-	-	6.9 (0.4-23.0)	Retrospective	ESI	Interview	Y, > 20%	-	-	71.0 (229)	88.0 (215)
3/1/3(H)	RRP, 2	Ou <i>et al.</i> ^[103]	United States	70.03 ± 6.10	24.09 ± 3.28	15.89 ± 14.15	6.22 ± 1.62	-	Retrospective	Presence of erection	Unspecified	N	-	-	-	-
	RRP, 16	Choo <i>et al.</i> ^[102]	South Korea	67.27 ± 6.21	24.22 ± 3.16	16.45 ± 18.80	6.13 ± 0.9	-	Retrospective	ESI	IIIEF-5	N	15.0 (8/55)	40.0 (22/55)	-	-
3/2/3(H)	RRP, 55	Choo <i>et al.</i> ^[102]	South Korea	67 ± 6.25	24 ± 2.73	42 ± 18.82	-	7.6 ± 19.33	Retrospective	ESI	IIIEF-5	N	29.0 (12/41)	54.0 (22/41)	-	-
	RRP, 41	Choo <i>et al.</i> ^[102]	South Korea	66 ± 7.75	24 ± 2.55	41 ± 15.77	-	7.2 ± 13.19	Retrospective	ESI	IIIEF-5	N	-	-	-	-

^a $P < 0.05$. RRP: Retropubic radical prostatectomy; RARP: Robot-assisted radical prostatectomy; ESI: Erection sufficient for intercourse; IIIEF-5: International index of erectile function; UNS: Unilateral nerve sparing; BNS: Bilateral nerve sparing.

authors did not use any sensitivity analysis or subgroup analysis to explain the source of heterogeneity.

In contrast, our meta-analysis directly compared these three surgical approaches for the 6- and the 12-mo functional outcomes following radical prostatectomy (RP). In 2009, Ficarra *et al.*^[6] conducted a meta-analysis including only 6 studies and reported the 12-mo continence recovery following LRP and RRP, whose result was consistent with ours (OR = 0.87; 95%CI: 0.54-1.39; $P = 0.56$ and OR = 0.92; 95%CI: 0.57-1.51; $P = 0.75$, respectively). However, in our meta-analysis, the study by Rassweiler *et al.*^[55] was excluded because of its preoperative surgery and neo-adjuvant therapy and 13 eligible studies were included. Moreover, we evaluated the 6-mo continence recovery (OR, 0.84; 95%CI: 0.50-1.41; $P = 0.52$), so this result would be more convincing and complete. Compared with the previous meta-analysis by Ficarra *et al.*^[6], whose results for 12-mo urinary continence recovery based on a pooled analysis of 5 studies comparing RARP vs RRP, and 5 studies comparing RARP vs LRP identified the advantage in favor of RARP (OR = 1.53; 95%CI: 1.04-2.25; $P < 0.05$ and OR = 2.39; 95%CI: 1.29-4.45; $P < 0.01$, respectively), our meta-analyses identified the similar advantage in favor of RARP both at 6-mo and 12-mo follow-up. A critical review by Coelho *et al.*^[7] also indicated better outcomes after RARP compared with RRP (92% vs 80%) or with LRP (92% vs 84%). Obviously,

Table 6 Comparative studies evaluating potency recovery after laparoscopic radical prostatectomy or robot-assisted radical prostatectomy

Quality	Case, n	Author, yr	Country	Age (yr)	BMI (kg/m ²)	Prostate Volume (mL/g)	Gleason score (biopsy)	PSA (ng/mL)	Study design	Potency definition	Data collection	Loss of follow-up (N/Y, %)	Potency recovery (UNS/ BNS), % (n)	Potency recovery (unclear NS), % (n)	6 mo	12 mo	6 mo	12 mo
High	LRP, 60	Asimakopoulou	Italy	61.1 ± 5.1	26.3 ± 2.2	-	-	7.37 (1.5-9.15)	RCT	ESI	IIIEF-6	N	-	-	22.0 (13/60)	32.0 (19/60)	-	-
	RARP, 52	<i>et al</i> ^[41] , 2011		59.6 ± 5.4	25.8 ± 2.6	-	-	8.9 (5.8-9.2)							75.0 ^a (39/52)	77.0 ^a (40/52)	-	-
High	LRP, 35	Porpiglia <i>et al</i> ^[45] , 2012	Italy	64.7 ± 5.9	26.8 ± 2.9	37.7 ± 14.1	-	8.3 ± 6.5	RCT	IIIEF-5 > 17	IIIEF-5	N	48.5 (17/35)	-	54.2 (19/35)	-	-	-
	RARP, 35			63.9 ± 6.7	26.2 ± 2.5	36.2 ± 12.6	-	6.9 ± 4.2					65.7 (23/35)	80.0 ^a	-	-	-	-
3/1/3(H)	LRP, 866	Ploussard <i>et al</i> ^[46] , 2012	France	62.7	26.6	-	-	9.8	Prospective	ESI	IIIEF-5	N	20.4 (177/866)	-	31.6 (274/866)	-	-	-
	RARP, 711			62.7	26.5	-	-	9.2					42.1 (299/711)	-	57.7 (410/711)	-	-	-
3/1/2(M)	LRP, 41	Cho <i>et al</i> ^[49]	South Korea	66.5 (57-75)	23.65 (18.1-28.4)	39.7 (19-72)	6.81 (5-9)	11.04 (2.72-36.6)	Retrospective	ESI	Interview	N	46.3 (19/41)	-	68.3 (28/41)	-	-	-
	RARP, 53			66.3 (50-77)	24.61 (19.9-26.3)	36.6 (22-92.8)	6.83 (5-8)	9.98 (2.91-26.3)					56.6 (30/53)	-	69.8 (37/53)	-	-	-
4/2/3(H)	LRP, 55	Hakimi <i>et al</i> ^[50] , 2009	United States	59.6 (43-72)	-	-	-	7.5	Retrospective	Presence of Erection	IIIEF-5	N	47.3 (26/55)	-	65.5 (36/55)	-	-	-
	RARP, 58			59.8 (42-71)	-	-	-	8.4					63.8 (37/58)	-	74.1 (43/58)	-	-	-
3/2/2(H)	LRP, 86	Willis <i>et al</i> ^[53] , 2011	United States	58.0 ± 6.7	27.0 ± 3.4	35.2 ± 10.1	-	5.7 ± 2.9	Retrospective	ESI	Validated	Y, > 20%	57.0 (34/60)	-	67.0 (38/57)	-	-	-
	RARP, 74			58.1 ± 6.3	26.7 ± 3.3	41.5 ± 15.2	-	5.0 ± 2.2			questionnaire		73.0 (29/40)	-	88.0 (21/24)	-	-	-
3/1/2(M)	LRP, 35	Park <i>et al</i> ^[53] , 2011	South Korea	65.7 (38-77)	24.6 (19.4-31.4)	30.1 (12.0-56.0)	-	9.14 (2.65-30.77)	Retrospective	ESI	Interview	Y, > 20%	-	-	47.6 (10/21)	-	-	-
	RARP, 37			62.7 (46-71)	26.0 (19.7-39.4)	32.9 (15.5-66.8)	-	6.32 (1.86-29.5)					54.5 (12/22)	-	54.5 (12/22)	-	-	-
3/2/3(H)	LRP, 144	Park <i>et al</i> ^[54] , 2013	South Korea	67 (38-77)	24.2 (17.2-31.4)	28.8 (12.0-74.0)	-	5.84 (0.08-41.26)	Retrospective	ESI	Interview	N	30.8 (26/83)	-	32.7 (27/83)	-	-	-
	RARP, 183			63 (44-75)	24.7 (16.4-39.4)	30.3 (15.5-82.8)	-	4.98 (0.05-51.46)					31.1 (49/156)	-	36.5 (57/156)	-	-	-

^aP < 0.05. LRP: Laparoscopic radical prostatectomy; RARP: Robot-assisted radical prostatectomy; RCT: Randomized controlled trial; ESI: Erection sufficient for intercourse; IIIEF: International index of erectile function. EPIC: Expanded prostate cancer index composite; SHIM: Sexual health inventory for men; UNS: Unilateral nerve sparing; PSA: Prostate-specific antigen; BNS: Bilateral nerve sparing.

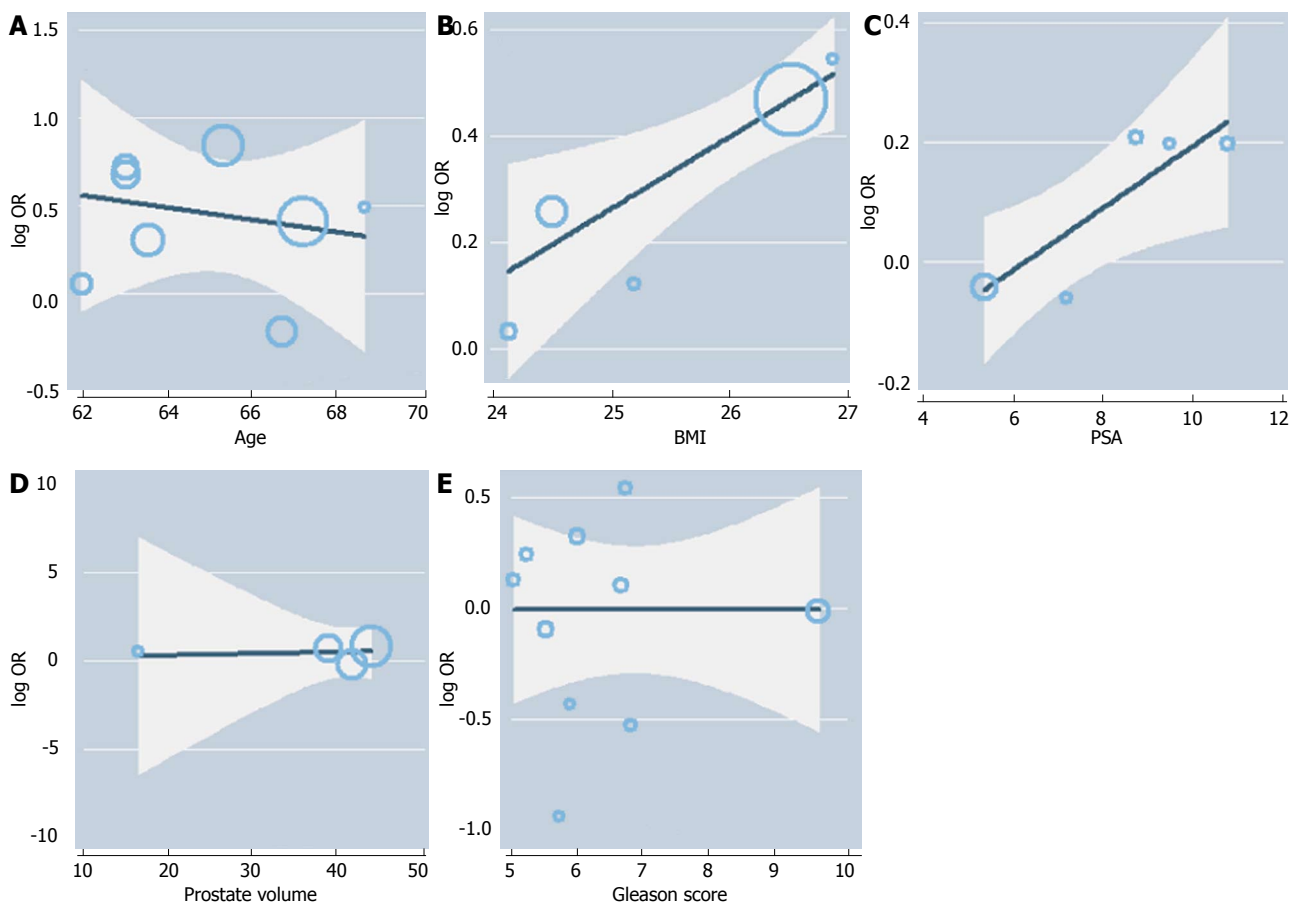
except the inclusion of more studies and the exclusion of two studies^[10,11], our meta-analyses separated the RCT from the NRCT studies to analyze the outcomes, therefore, the result was subjected to fewer confounding and biases of study design.

In terms of potency recovery, for the first time, with 8 studies included, our meta-analysis supported the superiority of LRP than RRP at 12-mo follow-up (OR = 1.34; 95%CI: 1.05-1.70; P < 0.05). Compared with the previous meta-analysis by Ficarra *et al*^[9], whose results for 12-mo potency recovery based on pooled 6 studies comparing RARP vs RRP, and 4 studies comparing RARP vs LRP demonstrated a better outcome in favor of RARP against RRP (OR = 2.84; 95%CI: 1.48-5.43; P < 0.01) and a non-statistically significant trend between RARP and LRP (OR = 1.89; 95%CI: 0.70-5.05; P = 0.21), our meta-analyses showed a statistically significant advantage in favor of RARP vs RRP (6-mo: P < 0.05 and 12-mo: P < 0.01, respectively) and also showed a better result in favor of RARP vs LRP (6-mo: P < 0.01 and 12-mo: P < 0.01, respectively). In ad-

Table 7 Subgroup analyses of 6-mo urinary continence recovery after laparoscopic radical prostatectomy or retropubic radical prostatectomy

Subgroup	Study	Sample size	Heterogeneity I^2 (%)	P -value	Meta-analysis	
					OR	95%CI
Country	Asia	553	63	0.06	0.45	0.20-1.04
	America	346	0	0.45	0.83	0.51-1.34
	Europe	763	80	0.40	1.46	0.60-3.55
Continence definition	0 pad	1662	74	0.52	0.84	0.50-1.41
	0-1 pad	0	-	-	-	-
Study design	prospective	968	77	0.55	1.24	0.61-2.50
	retrospective	694	59	0.08	0.56	0.29-1.07
Loss of follow-up	≤ 20%	911	71	0.87	1.06	0.53-2.09
	> 20%	751	78	0.32	0.66	0.29-1.51

OR: Odds ratio; CI: Confidence

**Figure 8** Representative l'Abbé plots show the overall trend. A: 12-mo continence of robot-assisted radical prostatectomy (RARP) and retropubic radical prostatectomy (RRP); B: 12-mo potency of RARP and laparoscopic radical prostatectomy (LRP); C: 12-mo potency of LRP and RRP; D: 12-mo continence of RARP and RRP; E: 12-mo continence of LRP and RRP. PSA: Prostate-specific antigen; BMI: Body mass index.

dition, there were some potential biases in Ficarra *et al*^[9] meta-analysis which included only 6 studies, and two of them^[10,11] were considered ineligible. While in our meta-analyses, the increased study number and the separation of the RCT and the NRCT studies, would be helpful to minimize the confounding of study design. Briefly, we supported a dramatic grading by superiority level for different comparisons of potency: RARP > LRP > RRP.

In this review, statistically significant heterogeneity

was observed for several comparisons. So the subgroup analyses were added according to adjustment for country, continence or potency definition, study design and the NS procedures. We found that Western country and strict definition indicated better outcomes in favor of RARP against RRP ($P < 0.01$) for 6-mo urinary continence recovery. This difference may be explained by the popularity of robotic technique in Western countries. As the classic NS technique was repeatedly proved to be a sig-

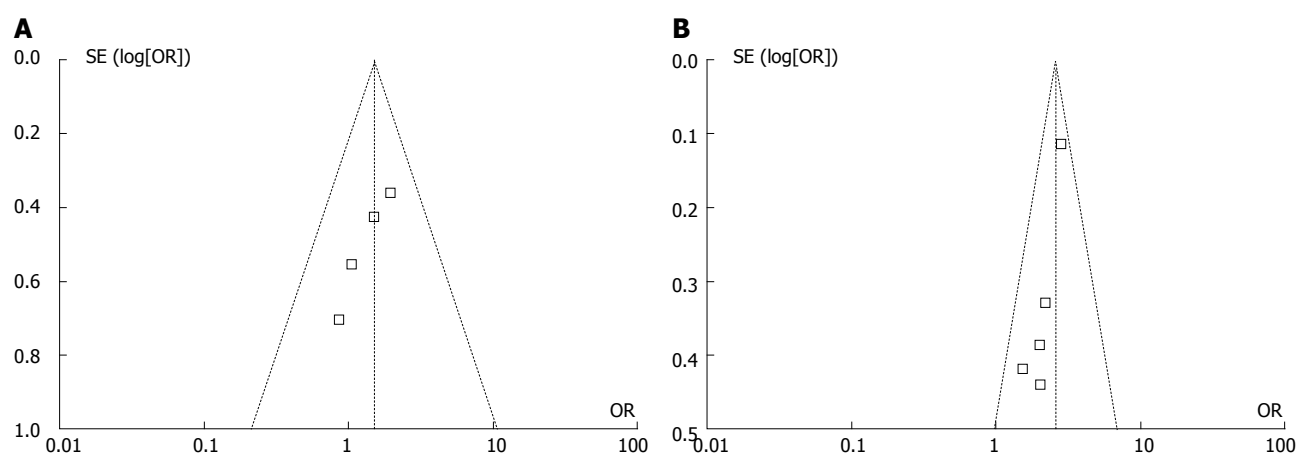


Figure 9 Funnel plots for 6-mo potency recovery. A: Comparison of laparoscopic radical prostatectomy (LRP) and retropubic radical prostatectomy (RRP); B: Comparison of robot-assisted radical prostatectomy (RARP) and LRP based on non-randomized control trials (NRCTs).

Table 8 Subgroup analyses of 12-mo urinary continence recovery after laparoscopic radical prostatectomy or retropubic radical prostatectomy

Subgroup	Study	Sample size	Heterogeneity I^2 (%)	P-value	Meta-analysis	
					OR	95%CI
Country	Asia	553	72	0.18	0.38	0.09-1.54
	America	911	89	0.91	0.95	0.35-2.55
	Europe	1343	29	0.33	1.26	0.79-2.02
Continence definition	0 pad	908	55	0.75	1.08	0.68-1.69
	0-1 pad	754	88	0.27	0.53	0.17-1.63
Study design	prospective	509	83	0.51	1.26	0.63-2.53
	retrospective	1153	57	0.15	0.60	0.30-1.20
Loss of follow-up	≤ 20%	451	82	0.82	1.09	0.51-2.33
	> 20%	1211	59	0.45	0.79	0.43-1.46

OR: Odds ratio; CI: Confidence interval.

Table 9 Subgroup analyses of 6-mo urinary continence recovery after robot-assisted radical prostatectomy or retropubic radical prostatectomy

Subgroup	Study	Sample size	Heterogeneity I^2 (%)	P-value	Meta-analysis	
					OR	95%CI
Country	Asia	809	92	0.35	1.93	0.48-7.70
	Europe/America	862	0	< 0.01	2.32	1.47-3.67
Continence definition	0 pad	828	63	< 0.01	3.09	1.65-5.80
	0-1 pad	673	82	0.52	1.62	0.37-7.06
Study design	prospective	448	0	< 0.01	2.48	1.44-4.26
	retrospective	1223	80	0.1	2.07	0.87-4.95
Loss of follow-up	≤ 20%	1161	80	0.1	2.00	0.88-4.53
	> 20%	510	0	< 0.01	2.99	1.55-5.77

OR: Odds ratio; CI: Confidence interval.

nificant predictor of return of potency by Coelho *et al*^[7], by Ayyathurai *et al*^[56] and by Briganti *et al*^[57], this review independently evaluated it for 12-mo potency recovery between different techniques, and we confirmed again that the NS measures were advantageous factors to potency recovery ($P < 0.05$). Furthermore, the other factors such as age, BMI, prostate volume, Gleason score or PSA could also be a source of heterogeneity. Stanford *et al*^[58] found that urinary function varied with age and sexual

function with age and race. Shikanov *et al*^[59] emphasized other factors influencing continence and potency, such as baseline status, surgical technique, extent of NS and adjuvant therapy. In this review, we performed meta-regression analyses to explore the correlation between these factors and different techniques. Though no obviously statistical significance was found, the P-Abbé graphs predicted the trends that better functional outcomes were more easily achieved in patients with younger age, larger

Table 10 Subgroup analyses of 12-mo potency recovery after nerve sparing procedures

Techniques	Subgroup	Sample size	Heterogeneity I^2 (%)	P-value	Meta-analysis	
					OR	95%CI
LRP <i>vs</i> RRP	uni/bilateral NS	735	0	< 0.05	1.52	1.09-2.13
	unclear NS	802	22	0.37	1.17	0.83-1.65
RARP <i>vs</i> RRP	uni/bilateral NS	464	0	< 0.01	2.83	1.90-4.22
	unclear NS	446	0	< 0.01	2.43	1.52-3.90

RRP: Retropubic radical prostatectomy; LRP: Laparoscopic radical prostatectomy; RARP: Robot-assisted radical prostatectomy; OR: Odds ratio; CI: Confidence interval; NS: Nerve sparing.

Table 11 Meta-regression of 12-mo continence recovery

Techniques	Factors	Sample, <i>n</i>	Coefficient	P value	95%CI	
					Lower CI	Upper CI
LRP <i>vs</i> RRP	Age	14	-0.0422414	0.480	-0.1685084	0.0840256
	Prostate Volume	7	0.0004602	0.976	-0.0367033	0.0376237
	Gleason Score	10	-0.0002758	0.998	-0.2325786	0.2320269
	PSA	11	0.0381884	0.508	-0.0871645	0.1635414
RARP <i>vs</i> RRP	Age	8	-0.0347693	0.763	-0.3038441	0.2343054
	BMI	5	0.178217	0.604	-0.8030416	1.159476
	Prostate Volume	4	0.0076432	0.912	-0.2556839	0.2709703
	PSA	5	0.0028508	0.882	-0.053367	0.0590685
RARP <i>vs</i> LRP	Age	6	-0.0026949	0.968	-0.1735327	0.1789224
	BMI	4	0.0709043	0.680	-0.7088789	0.5670703
	PSA	6	0.0275948	0.661	-0.1898594	0.1346698

RRP: Retropubic radical prostatectomy; LRP: Laparoscopic radical prostatectomy; RARP: Robot-assisted radical prostatectomy; CI: Confidence interval; PSA: Prostate-specific antigen; BMI: Body mass index.

Table 12 Meta-regression of 12-mo potency recovery

Techniques	Factors	Sample, <i>n</i>	Coefficient	P value	95%CI	
					Lower CI	Upper CI
LRP <i>vs</i> RRP	Age	8	-0.0334222	0.682	-0.156947	0.2237914
	Gleason Score	5	-0.0059256	0.732	-0.5614423	0.4429304
	PSA	5	0.0509797	0.558	-0.1961242	0.2980837
RARP <i>vs</i> RRP	Age	6	-0.006352	0.939	-0.2221039	0.2093999
	PSA	5	0.0018209	0.892	-0.0373331	0.0409749
RARP <i>vs</i> LRP	Age	6	-0.0437647	0.535	-0.2229024	0.1353731
	BMI	5	0.1340739	0.315	-0.220684	0.4888318
	Prostate Volume	4	-0.0080152	0.894	-0.2365214	0.2204911
	PSA	6	0.0350044	0.588	-0.1301063	0.2001150

RRP: Retropubic radical prostatectomy; LRP: Laparoscopic radical prostatectomy; RARP: Robot-assisted radical prostatectomy; CI: Confidence interval; PSA: Prostate-specific antigen; BMI: Body mass index.

BMI or higher PSA level in the RARP group than the other two groups (LRP or RRP), while it was difficult to judge the superiority of any technique in patients with different prostate volumes and Gleason scores.

Some potential limitations should be noted. First, moderate heterogeneity was found in several comparisons. Except the potential confounding factors controlled by the inclusion criteria and analyzed with subgroup stratification as described above, surgeon's experience and the means of modification varied from one to another, which could also influence the functional outcomes and were difficult to control. Second, contrary to expectation, due to the inclusion of few eligible studies for each

comparison and the lack of data in available studies, all the meta-regression analyses presented non-statistically significant differences, which limited us to reach an exact correlation between those potential factors and the three techniques, this result still needs to be identified by further research. Third, the quality of eligible studies could potentially be another confounding factor. RCTs are powerful tools, which provide the highest level of evidence; however, because many patients refuse to participate in the randomization and the blinding degree is less, surgical RCTs are difficult to conduct. Only two RCTs were included for the comparison between RARP and LRP, and the remaining studies were all observational

comparative studies. In addition, the NOS tool itself has imperfections^[60]. Finally, publication bias still existed. The failed acquisition of gray literature may contribute to this publication bias.

The superiority of a certain surgical approach in terms of functional outcomes is always a pivotal controversy. These outcomes were influenced by multiple factors including patient characteristics, surgical techniques and methodology used for data collection. In summary, concerning the urinary continence recovery, only RARP showed an advantage when compared with LRP or with RRP, and the result was comparable between LRP and RRP. In terms of potency recovery, for the first time, we ranked the three surgical approaches into a superiority level: RARP > LRP > RRP, which showed a statistically significant advantage both at 6 and 12 mo postoperatively. However, the limitation of this meta-analysis and potential factors should be taken into consideration and our results also need to be validated by further high quality multi-center RCTs with strict design and large sample size.

COMMENTS

Background

Radical prostatectomy (RP) is one of the recommended standard treatments for clinically localized prostate cancer (cT1-cT2) patients. The retropubic radical prostatectomy (RRP) was considered as the gold standard and the most widely used treatment for patients with localized prostate cancer (PCa). Recently, the authors have witnessed the emergence of laparoscopic radical prostatectomy (LRP) and robot-assisted laparoscopic prostatectomy (RARP).

Research frontiers

Several experts have demonstrated that when compared with RRP, LRP and RARP have obvious advantages such as lower blood loss, less need for transfusion and shorter hospital-stay, but the lack of high-quality evidence and RCTs available precluded us from proving the superiority of any surgical option in terms of postoperative functional outcomes.

Innovations and breakthroughs

In terms of potency recovery, for the first time, we ranked the three surgical approaches into a superiority level: RARP > LRP > RRP, which showed a statistically significant advantage both at 6 and 12 mo postoperatively.

Applications

Current evidence suggests that minimally invasive approaches (RARP or LRP) are effective procedures for functional recovery. However, more high-quality randomized, controlled trials investigating the long-term functional outcomes are required to determine the advantages of RARP.

Terminology

RARP means robot-assisted laparoscopic prostatectomy. LRP means laparoscopic radical prostatectomy. RRP means retropubic radical prostatectomy. The principal postoperative functional outcomes for patients with prostatectomy are urinary continence and potency recovery.

Peer review

This manuscript compared the functional outcomes among three radical prostatectomy procedures. The project design and analyses of the data are acceptable. The figures and tables well summarize the existing data. Overall the manuscript is well written.

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