Systematic Review and Meta-analysis of Studies Reporting Urinary Continence Recovery After Robot-assisted Radical Prostatectomy

Vincenzo Ficarra, Giacomo Novara, Raymond C. Rosen, Walter Artibani, Peter R. Carroll, Anthony Costello, Mani Menon, Francesco Montorsi, Vipul R. Patel, Jens-Uwe Stolzenburg, Henk Van der Poel, Timothy G. Wilson, Filiberto Zattoni, Alexandre Mottrie

A University of Padua, Padua, Italy; b O.L.V. Clinic, Aalst, Belgium; c New England Research Institutes, Inc., Watertown, MA, USA; d University of Verona, Verona, Italy; e University of California, San Francisco, CA, USA; f Royal Melbourne Hospital, Melbourne, Australia; g Henry Ford Hospital, Detroit, MI, USA; h Vita-Salute San Raffaele University, Milan, Italy; i Global Robotic Institute, Florida Hospital Celebration Health, Orlando, FL, USA; j University of Leipzig, Leipzig, Germany; k Netherlands Cancer Institute, Amsterdam, The Netherlands; l City of Hope Cancer Center, Duarte, CA, USA

Abstract

Context: Robot-assisted radical prostatectomy (RARP) was proposed to improve functional outcomes in comparison with retropubic radical prostatectomy (RRP) or laparoscopic radical prostatectomy (LRP). In the initial RARP series, 12-mo urinary continence recovery rates ranged from 84% to 97%. However, the few available studies comparing RARP with RRP or LRP published before 2008 did not permit any definitive conclusions about the superiority of any one of these techniques in terms of urinary continence recovery.

Objective: The aims of this systematic review were (1) to evaluate the prevalence and risk factors for urinary incontinence after RARP, (2) to identify surgical techniques able to improve urinary continence recovery after RARP, and (3) to perform a cumulative analysis of all available studies comparing RARP versus RRP or LRP in terms of the urinary continence recovery rate.

Evidence acquisition: A literature search was performed in August 2011 using the Medline, Embase, and Web of Science databases. The Medline search included only a free-text protocol using the term radical prostatectomy across the title and abstract fields of the records. The following limits were used: humans; gender (male); and publication date from January 1, 2008. Searches of the Embase and Web of Science databases used the same free-text protocol, keywords, and search period. Only comparative studies or clinical series including >100 cases reporting urinary continence outcomes were included in this review. Cumulative analysis was conducted using the Review Manager v.4.2 software designed for composing Cochrane Reviews (Cochrane Collaboration, Oxford, UK).

Evidence synthesis: We analyzed 51 articles reporting urinary continence rates after RARP: 17 case series, 17 studies comparing different techniques in the context of RARP, 9 studies comparing RARP with RRP, and 8 studies comparing RARP with LRP. The 12-mo urinary incontinence rates ranged from 4% to 31%, with a mean value of 16% using a no pad definition. Considering a no pad or safety pad definition, the incidence ranged from 8% to 11%, with a mean value of 9%. Age, body mass index, comorbidity index, lower urinary tract symptoms, and prostate volume were the most relevant preoperative risk factors.

Keywords:
Prostatic neoplasms
Prostatectomy
Laparoscopy
Robotics

0302-2838/$ – see back matter © 2012 Published by Elsevier B.V. on behalf of European Association of Urology.
http://dx.doi.org/10.1016/j.eururo.2012.05.045
1. Introduction

Postoperative urinary incontinence has a relevant negative effect on the satisfaction and health-related quality of life of patients who undergo radical prostatectomy for prostate cancer.

Historically, significant updates in the surgical techniques used in anatomic retropubic radical prostatectomy (RRP) derived from improvements in the knowledge of the anatomy of the dorsal venous complex [1,2], the puboprostatic ligaments [3], prostate shape, urinary sphincter [2], and posterior rhabdosphincter [4] as well as the description of the intrapelvic branch of the pudendal nerve and putative continence enabling intrapelvic branches of the pelvic plexus [5]. The most important recent RRP series showed a 12-mo urinary continence recovery rate ranging from 60% to 93% according to the different methods used to evaluate this parameter [6].

Since 1999, some surgeons have proposed using the laparoscopic approach [7] with the intent of minimizing damage to the anatomic structure involved in the urinary continence mechanism. Mature laparoscopic radical prostatectomy (LRP) series showed 12-mo urinary continence recovery ranging from 66% to 95%, and a cumulative analysis of available comparative studies showed overlapping results in comparison with RRP [6].

Robotic technology combining optical magnification, three-dimensional vision, and instruments with 7 degrees of freedom allows surgeons to perform meticulous, precise, and accurate movements that are fundamental to preserve the key anatomic structures for urinary continence and potency and to minimize perioperative complications. In a previous systematic review of the literature, the 12-mo urinary recovery after RARP in referral centers ranged from 84% to 97%. However, the few comparative studies between RARP and other approaches (RRP and LRP) published before 2008 did not permit any definitive conclusion about the superiority of one of these techniques in terms of urinary continence recovery [6].

The aims of this systematic review were to evaluate the prevalence of and the risk factors for urinary incontinence after RARP, to identify surgical techniques able to improve urinary continence recovery after RARP, and to perform a cumulative analysis of all studies comparing RARP versus RRP or LRP in terms of urinary continence recovery.

2. Evidence acquisition

To update our previous systematic reviews [6,8], a literature search was performed in August 2011 using the Medline, Embase, and Web of Science databases. The Medline search included only a free-text protocol using the term radical prostatectomy across the title and abstract fields of the records. The following limits were used: humans; gender (male); and publications dating from January 1, 2008. The searches of the Embase and Web of Science databases used the same free-text protocol, keywords, and publication dates.

Two authors (G.N. and V.F.) separately reviewed the records to select the studies comparing RARP series as well as studies comparing RARP with RRP or LRP, with any discrepancy resolved by open discussion. Other significant studies cited in the reference lists of the selected papers were evaluated, as were relevant studies published after the systematic search. All the noncomparative studies reporting the outcome of RALP on >100 cases were collected. In the present review, we included only studies reporting the urinary continence outcomes. Studies published only as abstracts and reports from meetings as well as population-based studies were not included in the review. From each comparative or noncomparative study we extracted the number of analyzed patients; the study design; the continence definition; the data collection methods; and, when available, the 3-, 6-, 12-, and 24-mo urinary continence rates.

All of the data retrieved from the selected studies were recorded in an electronic database. Quality control of the electronic data recording was performed on a random sample of papers (accounting for about 15% of the articles).

All the papers were distinguished according to the 2011 level of evidence for therapy studies: systematic review of randomized trials or n-of-1 trials (level 1); randomized trials or observational studies with dramatic effects (level 2); nonrandomized controlled cohort/follow-up studies (level 3); case series, case-control studies, or historically controlled studies (level 4); and mechanism-based reasoning (level 5) [9].
2.1. Statistical analysis

Cumulative analysis was conducted using the Review Manager v.4.2 software designed for composing Cochrane Reviews (Cochrane Collaboration, Oxford, UK). Statistical heterogeneity was tested using the $\chi^2$ test. A $p$ value $<0.10$ was used to indicate heterogeneity. In case of a lack of heterogeneity, fixed effects models were used for the cumulative analysis. Random effects models were used in case of heterogeneity. The results were expressed as weighted mean differences and standard deviations (SDs) for continuous outcomes and as odd ratios (ORs) and 95% confidence intervals (CIs) for dichotomous variables. Due to the limitations of the Cochrane software, only studies presenting continuous data as means and SDs were included in the cumulative analysis. For all statistical analyses, a two-sided $p < 0.05$ was considered statistically significant.

3. Evidence synthesis

3.1. Quality of the studies and level of evidence

Figure 1 shows the flowchart of this systematic review of the literature (Fig. 1). We selected 76 records reporting urinary continence rates after RARP. One further randomized controlled trial (RCT) comparing different techniques in the context of RARP published after the search period [10] and a prospective nonrandomized study comparing RARP and RRP [11] and one retrospective study comparing RARP and LRP [12] published before the search period were also included in the present analyses. Twenty-four abstracts or meeting reports and three clinical series reporting data coming from the same institution were excluded. The remaining studies were 17 case series (33.3%) (level 4); 16 studies comparing different techniques in the context of RARP (5 studies, level 2; 7 studies, level 3; 4 studies, level 4); 8 studies comparing RARP with RRP (4 studies, level 3; 4 studies, level 4), and 8 studies comparing RARP with LRP (1 study, level 2; 7 studies, level 4).

3.2. Incidence and predictors of urinary incontinence after robot-assisted radical prostatectomy

Table 1 summarizes the prevalence of urinary continence recovery reported in the surgical series published between 2008 and 2011. According to the continence definition of no pad, 12-mo urinary incontinence rates ranged from 4% to 31%, with a mean value of 16%. Considering studies using no pad or safety pad as the continence definition, 12-mo urinary incontinence rates ranged from 8% to 11%, with a mean value of 9%. A single paper reported a 24-mo urinary incontinence rate of 12% using the no pad definition [19]. Murphy et al. reported a 36-mo urinary incontinence rate of 5%, using the no pad or safety pad definition [23].

Table 2 reports the prevalence of urinary continence recovery in some difficult cases or according to different surgeon experiences. Prostate volume [21], body mass index (BMI) $>30$ [13,26], and surgeon experiences [24,27] could affect the probability of recovering urinary continence after
RARP. Patient age [13–16,28,29], comorbidities [15], severity of lower urinary tract symptoms (LUTS), and preoperative erectile function [13,16] represent other significant preoperative predictors of urinary incontinence in patients who underwent RARP.

### 3.3. Surgical aspects influencing urinary continence recovery after robot-assisted radical prostatectomy

A retrospective comparative study using a historical control series showed overlapping results in terms of 3-, 6-, and
12-mo urinary continence recovery after the extraperitoneal or transperitoneal approach (level 4) [30].

Bladder neck preservation was associated with significantly better continence rates 3 mo and 12 mo after RARP in comparison with bladder neck resection and reconstruction. Such a difference was not reconfirmed at 24-mo follow-up (level 3) [31]. In a prospective comparative study, Finley et al. reported significantly better early urinary continence rates in patients who performed a hypothermic nerve-sparing dissection using cold irrigation and an endorectal cooling balloon cycled with 4°C saline in comparison with those receiving a standard procedure (level 3) [13].

Concerning the different techniques to perform the dorsal venous complex (DVC) section, in a prospective nonrandomized comparative study, in 2011 Lei et al. reported significantly better 6-mo urinary continence rates in patients who underwent the athermal DVC division followed by selective suture ligation prior to RARP anastomosis in comparison with those receiving suture ligation before athermal DVC division prior to bladder neck dissection. This advantage was not present at 12-mo follow-up (level 3) [31]. Table 3 summarizes the results reported in the previous studies.

A consistent number of comparative studies evaluated the potential role of posterior and/or anterior reconstruction during RARP. Table 4 reports the results of seven studies comparing the posterior reconstruction versus the standard technique. Only one study reported data in a format not suitable for cumulative analysis. Specifically, in a nonrandomized prospective comparative study (level 3), Woo et al. reported a mean time to reach continence that was significantly inferior in patients who received the posterior reconstruction (90 d vs 150 d) [36]. Looking at 1-mo urinary continence recovery, the best available evidence is represented by the nonrandomized prospective

<table>
<thead>
<tr>
<th>First author</th>
<th>Cases, n</th>
<th>Study design</th>
<th>Continence definition</th>
<th>Data collection</th>
<th>Urinary continence rates, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Freire, 2009 [32]</td>
<td>Extraperitoneal, 155</td>
<td>Prospective comparative</td>
<td>0 pad</td>
<td>Validated questionnaire</td>
<td>66</td>
</tr>
<tr>
<td>Lei, 2011 [31]</td>
<td>Cooling, 114 Standard, 141</td>
<td>Prospective comparative</td>
<td>0 pad</td>
<td>Validated questionnaire</td>
<td>84</td>
</tr>
<tr>
<td>Sammon, 2011 [33]</td>
<td>Selective suturing DVC, 240 Standard, 303</td>
<td>Prospective comparative</td>
<td>0 pad</td>
<td>Validated questionnaire</td>
<td>51</td>
</tr>
</tbody>
</table>

DVC = dorsal venous complex; RCT = randomized controlled trial.

<table>
<thead>
<tr>
<th>First author</th>
<th>Cases, n</th>
<th>Study design</th>
<th>Continence definition</th>
<th>Data collection</th>
<th>Urinary continence rates, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Krane, 2009 [34]</td>
<td>PR, 42 Standard, 42</td>
<td>Retrospective comparative (historical series)</td>
<td>0–1 safety pad</td>
<td>Interview</td>
<td>85</td>
</tr>
<tr>
<td>Kim, 2009 [35]</td>
<td>PR, 30 Standard, 30</td>
<td>Retrospective comparative</td>
<td>Not reported</td>
<td>Not reported</td>
<td>49</td>
</tr>
<tr>
<td>Woo, 2009 [36]</td>
<td>PR, 69 Standard, 63</td>
<td>Prospective comparative</td>
<td>0–1 safety pad</td>
<td>Validated questionnaire</td>
<td>Mean time to continence: 90 d</td>
</tr>
<tr>
<td>Joshi, 2010 [37]</td>
<td>PR, 53 Standard, 54</td>
<td>Prospective comparative</td>
<td>0 pad</td>
<td>Validated questionnaire</td>
<td>–</td>
</tr>
<tr>
<td>Kim, 2010 [38]</td>
<td>PR, 25 Standard, 25</td>
<td>Prospective comparative</td>
<td>0 pad</td>
<td>Validated questionnaire</td>
<td>72</td>
</tr>
<tr>
<td>Coelho, 2011 [39]</td>
<td>PR, 473 Standard, 330</td>
<td>Prospective comparative</td>
<td>0 pad</td>
<td>Validated questionnaire</td>
<td>51</td>
</tr>
<tr>
<td>Sutherland, 2011 [40]</td>
<td>PR, 47 Standard, 47</td>
<td>RCT</td>
<td>0–1 safety pad</td>
<td>Validated questionnaire</td>
<td>–</td>
</tr>
</tbody>
</table>

PR = posterior reconstruction; RCT = randomized controlled trial.
Fig. 2 – Cumulative analyses of robot-assisted radical prostatectomy studies comparing posterior reconstruction of rhabdosphincter versus standard technique in terms of (a) 1-mo, (b) 3-mo, and (c) 6-mo urinary continence recovery. CI = confidence interval; OR = odds ratio; Post. reconstruction = posterior reconstruction; RARP = robot-assisted radical prostatectomy.
comparative study recently published by Coelho et al. to evaluate the influence of a modified posterior reconstruction on early urinary continence recovery (level 3) [39]. A total of 473 patients receiving posterior reconstruction showed higher urinary continence rates 1 wk and 4 wk after RARP in comparison with 330 patients receiving a standard procedure. Data at a longer follow-up showed overlapping results between the two techniques [39]. Cumulative analysis of available comparative studies reporting data 1 mo after surgery showed a small advantage in favor of posterior reconstruction (OR: 0.76; 95% CI, 0.59–0.98; \( p = 0.04 \)). Conversely, cumulative analyses evaluating the effect of posterior reconstruction at 3 mo (OR: 1.11; 95% CI, 0.78–1.57; \( p = 0.57 \)) and 6 mo (OR: 0.95; 95% CI, 0.54–1.68; \( p = 0.86 \)) after RARP showed overlapping results between the two techniques (Fig. 2a–2c).

Table 5 summarizes the data of five studies comparing anterior and posterior reconstruction (total reconstruction) versus the standard procedure. The three available RCTs (level 2) showed conflicting results 1 mo after surgery [10,41–43]. One study showed similar results in patients who received a total reconstruction and those who had neither anterior or posterior reconstruction [41,42]. In contrast, the other two RCTs showed statistically significant advantages in favor of complete reconstruction [10,43]. Moreover, the nonrandomized comparative study including the higher number of cases showed a statistically significant advantage in favor of total reconstruction (level 3) [28]. The cumulative analysis of all available comparative studies showed a small statistically significant difference in favor of total reconstruction 1 mo after the RARP (OR: 0.40; 95% CI, 0.16–0.96; \( p = 0.04 \)) (Fig. 3).

One RCT (level 2) [10] and one nonrandomized prospective comparative study (level 3) [28] evaluated the effect of complete reconstruction at a longer follow-up. The cumulative analyses of previous studies showed a statistically significant advantage in favor of total reconstruction 3 mo after RARP (OR: 0.13; 95% CI, 0.06–0.27; \( p < 0.0001 \)) and overlapping results 6 mo later (OR: 0.23; 95% CI, 0.03–1.811; \( p = 0.16 \)).

An RCT comparing barbed versus standard monofilament suture for urethrovesical anastomosis demonstrated overlapping results in terms of 1-mo urinary continence recovery (level 2) [33].
3.4. Cumulative analysis of studies comparing robot-assisted radical prostatectomy with retropubic radical prostatectomy or laparoscopic radical prostatectomy

Table 6 shows the characteristics of studies comparing RARP and RRP in terms of urinary continence recovery. Four are nonrandomized prospective comparative studies (level 3); five are retrospective comparisons with contemporary series or a historical control (level 4). Before 2008, only one study compared RARP and RRP in terms of urinary continence recovery [11]. That study and the one published by Kim et al. in 2011 [46] reported data as median time to continence and thus were not included in the cumulative analysis. In 2003 Tewari et al. reported a statistically significant reduction in the days needed to reach continence in patients who underwent RARP in comparison with those who received RRP (44 d vs 160 d) (level 3) [11]. Kim et al. reported overlapping results between the two techniques [46]. However, when the authors excluded the first 132 cases performed from the analysis, the median time to continence in RARP patients was 1.6 mo, significantly lower in comparison with the value of 4.3 mo reported in the RRP patients (p < 0.001) (level 3). Five studies were included in the cumulative analysis evaluating the 12-mo urinary continence recovery after RARP or RRP [44,45,47,48,50]. The absolute risk of urinary incontinence was 11.3% after RRP (105 of 923 cases) and 7.5% after RARP (38 of 509 cases). Therefore, the absolute risk reduction was 3.8%. The cumulative analysis showed a statistically significant advantage in favor of RARP (OR: 1.53; 95% CI, 1.04–2.25; p = 0.03) (Fig. 4).

Table 7 reports the results of eight studies comparing RARP and LRP. One study was an RCT (level 2), and the remaining seven were retrospective comparisons with contemporary series or a historical control (level 4). The available RCT showed statistically significant advantages in favor of RARP in terms of 12-mo urinary continence recovery (level 2) [51].

Five studies were included in the cumulative analysis evaluating the 12-mo urinary continence recovery after RARP or RRP [51,53–56]. The absolute risk of urinary incontinence was 9.6% after LRP (29 of 302 cases) and 5% after RARP (22 of 436 cases). Therefore, the absolute risk reduction was 4.6%. The cumulative analysis showed a statistically significant advantage in favor of RARP (OR: 2.39; 95% CI, 1.29–4.45; p = 0.006) (Fig. 5).

Table 6 – Studies comparing urinary continence recovery after robot-assisted radical prostatectomy or retropubic radical prostatectomy

<table>
<thead>
<tr>
<th>First author</th>
<th>Cases, n</th>
<th>Study design</th>
<th>Continence definition</th>
<th>Data collection</th>
<th>Urinary continence recovery, %</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>6 mo</td>
<td>12 mo</td>
<td></td>
</tr>
<tr>
<td>Tewari, 2003</td>
<td>RRP, 100</td>
<td>Prospective comparison</td>
<td>0 pad Interview</td>
<td>Median: 160 d</td>
<td>RARP, 200</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Median: 44 d</td>
<td></td>
</tr>
<tr>
<td>Ficarra, 2009</td>
<td>RRP, 105</td>
<td>Prospective comparison</td>
<td>0 pad Validated</td>
<td>–</td>
<td>RARP, 103</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>–</td>
<td></td>
</tr>
<tr>
<td>Di Pierro, 2011</td>
<td>RRP, 75</td>
<td>Prospective comparison</td>
<td>0 pad Institutional questionnaire</td>
<td>–</td>
<td>RARP, 75</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>–</td>
<td></td>
</tr>
<tr>
<td></td>
<td>RRP, 235</td>
<td>Prospective comparison</td>
<td>0 pad Validated</td>
<td>Median: 4.3 mo</td>
<td>RARP, 528</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Median: 3.7 mo</td>
<td></td>
</tr>
<tr>
<td>Krambeck, 2008</td>
<td>RRP, 564</td>
<td>Retrospective,</td>
<td>0 pad Institution</td>
<td>–</td>
<td>RARP, 286</td>
</tr>
<tr>
<td></td>
<td></td>
<td>contemporary series</td>
<td></td>
<td>93.1</td>
<td></td>
</tr>
<tr>
<td>Ou, 2010</td>
<td>RRP, 30</td>
<td>Retrospective</td>
<td>0 pad Unspecified</td>
<td>83</td>
<td>RARP, 30</td>
</tr>
<tr>
<td>Caballero, 2008</td>
<td>RRP, 62</td>
<td>Historical control</td>
<td>0 pad Unspecified</td>
<td>97</td>
<td>RARP, 60</td>
</tr>
<tr>
<td>Rocco, 2009</td>
<td>RRP, 240</td>
<td>Historical control</td>
<td>0–1 safety pad Interview</td>
<td>84</td>
<td>RARP, 120</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>93</td>
<td></td>
</tr>
</tbody>
</table>

RARP = robot-assisted radical prostatectomy; RRP = retropubic radical prostatectomy.

![Fig. 4 – Cumulative analysis of studies comparing robot-assisted radical prostatectomy versus retropubic radical prostatectomy in terms of 12-mo urinary continence recovery. CI = confidence interval; OR = odds ratio; RARP = robot-assisted radical prostatectomy; RRP = retropubic radical prostatectomy.](image-url)
4. Discussion

The prevalence of urinary incontinence after RARP is influenced by preoperative patient characteristics, surgeon experience, surgical techniques, and methodological aspects such as continence definitions, tools used for data collection, and different follow-up intervals. Specifically, 12-mo urinary incontinence rates ranged from 4% to 31% of cases using a no pad definition and from 8% to 11% when also including as successful those patients using a safety pad. Currently, few data are available at longer follow-up with urinary incontinence rates from 5% to 12% after 24–36 mo. Data coming from recent RARP case series cannot be indirectly compared with historical results reported in the main RRP or LRP case series due to potential confounding factors represented by different patient characteristics, study designs, continence definitions, and, above all, data collection methods.

Studies evaluating the potential predictors showed that patient age \([15,16,28,29]\) is a relevant factor influencing urinary continence recovery, together with BMI \([13,26]\), comorbidity index \([15]\), LUTS \([13,16]\), and prostate volume \([21,25,57]\). Although different values were used in the literature to define a large prostate, a cut-off value between 70 and 80 cm\(^3\) could be correlated with a significant risk of urinary incontinence after RARP \([21,57]\). No data evaluated the potential impact of median lobe or previous transurethral resection of the prostate (TURP) on urinary continence recovery. Therefore, the identified predictors of urinary incontinence after RARP can be considered similar to those previously investigated in RRP or LRP series. Prospective studies comparing the different RP approaches in the special setting of difficult cases such as elderly patients, obese patients, large prostate, median lobe, and previous TURP are needed for more realistic evaluation of the potential advantages of robotic technology in comparison with RRP or LRP \([58]\). More controversial is the impact of surgeon experience and learning curve on the prevalence of urinary incontinence after RARP. Two prospective studies showed a significant increase of the continence rate after 500 cases \([24,27]\). Conversely, excellent results were also reported in several clinical series including <500 cases \([14,15,17,22,23]\).

Puboprostatic-sparing techniques, bladder neck preservation, selective DVC division, nerve-sparing technique, and posterior musculofascial reconstruction as well as anterior

### Table 7 – Studies comparing urinary continence recovery after robot-assisted radical prostatectomy or laparoscopic radical prostatectomy

<table>
<thead>
<tr>
<th>First author</th>
<th>Cases, n</th>
<th>Study design</th>
<th>Continence definition</th>
<th>Data collection</th>
<th>Urinary continence recovery, %</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>6 mo</td>
</tr>
<tr>
<td></td>
<td>RARP, 52</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Joseph, 2005 [12]</td>
<td>LRP, 50</td>
<td>Historical control</td>
<td>0 pad</td>
<td>Interview</td>
<td>92</td>
</tr>
<tr>
<td></td>
<td>RARP, 50</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lee, 2009 [52]</td>
<td>LRP, 31</td>
<td>Retrospective, contemporary series</td>
<td>0–1 safety pad</td>
<td>Institutional questionnaire</td>
<td>81</td>
</tr>
<tr>
<td></td>
<td>RARP, 21</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>RARP, 62</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>RARP, 44</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Park, 2011 [53]</td>
<td>LRP, 70</td>
<td>Historical control</td>
<td>0 pad</td>
<td>Interview</td>
<td>76</td>
</tr>
<tr>
<td></td>
<td>RARP, 60</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Caballero, 2008 [49]</td>
<td>LRP, 70</td>
<td>Historical control</td>
<td>0 pad</td>
<td>Interview</td>
<td>64</td>
</tr>
<tr>
<td></td>
<td>RARP, 60</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cho, 2009 [54]</td>
<td>LRP, 60</td>
<td>Historical control</td>
<td>0–1 safety pad</td>
<td>Interview</td>
<td>71</td>
</tr>
<tr>
<td></td>
<td>RARP, 60</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hakimi, 2009 [55]</td>
<td>LRP, 75</td>
<td>Historical control</td>
<td>0 pad</td>
<td>Interview</td>
<td>93</td>
</tr>
<tr>
<td></td>
<td>RARP, 75</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trabulsi, 2010 [56]</td>
<td>LRP, 45</td>
<td>Historical control</td>
<td>0–1 safety pad</td>
<td>Interview</td>
<td>71</td>
</tr>
<tr>
<td></td>
<td>RARP, 205</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

LRP = laparoscopic radical prostatectomy; RARP = robot-assisted radical prostatectomy; RCT = randomized controlled trial.

![Fig. 5](image-url) – Cumulative analysis of the studies comparing robot-assisted radical prostatectomy versus laparoscopic radical prostatectomy in terms of 12-mo urinary continence recovery. CI = confidence interval; LRP = laparoscopic radical prostatectomy; OR = odds ratio; RARP = robot-assisted radical prostatectomy.
restoration of the pelvis space were advocated as surgical aspects potentially able to reduce the risk of urinary incontinence after RARP. However, only a few comparative studies analyzed the impact of some of these surgical aspects on urinary continence recovery. Interesting results were reported by Finley et al. with the use of hypothermic nerve-sparing dissection [13]. The authors reported a statistically significant advantage in terms of 3- and 12-mo urinary continence recovery in the subgroup of patients using cold irrigation and an endorectal cooling balloon cycled with 4 °C saline. However, these data need to be externally validated in a multicenter setting of patients. Considering the cost of the device, a more detailed, cost-effective evaluation is awaited.

Looking at the reconstructive steps of the RARP, the role of posterior and/or anterior reconstruction on early urinary continence recovery remains one of the most investigated surgical aspects. In the original description of posterior rhabdosphincter reconstruction, two interrupted 3-0 Vicryl sutures were used to approximate the cut end of the Denonvilliers’ fascia to the rhabdosphincter/median fibrous raphe on either side of the midline. This reconstructed plane was fixed to the posterior bladder wall, 2 cm cranial to the bladder neck [4]. The aim of this maneuver is to restore the length of the urethrophincteric complex, to prevent its caudal retraction, to avoid undue tension on the subsequent vesicourethral anastomosis, and to provide a posterior buttress to the urethrophincteric complex to facilitate its effective contraction. A previous review of the literature showed inconclusive results in terms of early urinary continence recovery mainly due to the lack of a uniform surgical technique, continence definitions, and methods used in the few analyzed studies comparing posterior reconstruction with the standard technique [59]. However, in that review of the literature, the authors also included in the analysis some clinical series in which the posterior reconstruction was associated with an anterior restoration of the pelvis [41,60]. In our systematic review, we selected seven studies comparing only patients receiving RARP with posterior reconstruction versus the standard technique (Table 4). Specifically, our analyses showed a small statistical advantage in favor of posterior reconstruction only after 1 mo (Fig. 2a). However, the observed 95% CI of this cumulative analysis raised questions about the real clinical benefit of this difference. Conversely, current evidence clearly showed that posterior reconstruction did not influence 3- and 6-mo urinary continence recovery. Although the impact of posterior musculofascial reconstruction on early continence is possibly less accentuated than initially thought, the technique is simple and reproducible, with a very limited increase in operative time and with only a slight risk of potential harm to the patient. Moreover, it could improve hemostasis and provide greater support for a delicate anastomosis.

Steiner described the ventral fixation of the rhabdosphincter involving the puboprostatic ligaments bilaterally and comprising a median suspensory system of the subpubic arch [3]. Considering these anatomic assumptions, different anterior reconstruction techniques were described. In 2008, Tewari et al. described the total reconstruction of the vesicourethral junction technique combining the posterior reconstruction to the reattachment of the arcus tendineus and puboprostatic plate to the bladder neck once anastomosis is completed [60]. In the same year, Menon et al. described the double-layer (with periprostatic tissue reconstruction) urethrovaginal anastomosis [41]. In 2009, Patel described the anterior reconstruction using the perurethral suspension stitch [61]. This technique was associated with significantly better urinary continence recovery at 1 mo and 3 mo in comparison with the standard technique. Therefore, a potential limit of our cumulative analyses can be represented by the different reconstructive techniques used in the analyzed studies. Indeed, the concept of anterior perurethral suspension proposed by Patel et al. seems to be quite different from the total reconstruction of vesicourethral anastomosis described by Tewari et al. [41,60,61].

Our cumulative analyses showed a small advantage in favor of total reconstruction at both 1 mo and 3 mo after RARP. No differences were noted after a longer follow-up. Therefore, the anterior reconstruction combined with the posterior reconstruction of the rhabdosphincter seems to offer some advantages to improve urinary continence recovery.

The use of barbed suture was recently proposed with the aim of reducing the time needed to perform the reconstructive steps of the RARP procedure. The RCT published by Sammon et al. in 2011 showed that the use of barbed monofilament suture was associated with overlapping urinary continence recovery in comparison with the standard monofilament [33].

Concerning the comparison between RARP and other approaches, a previous systematic review was not able to reach any definitive conclusion about the superiority of one of these techniques in terms of urinary continence recovery due to the few available comparative studies [6]. Until 2008, only one study compared RARP and RRP [11] and only one compared RARP and LRP [12]. The current update of the previous systematic review allowed us to add nine studies comparing RARP and RRP and seven others comparing RARP and LRP (Tables 6 and 7). For the first time, the present cumulative analysis showed significant advantages for RARP in comparison with RRP in terms of 12-mo urinary continence rates. This result does not seem to be influenced by data coming from referral high-volume centers, considering that most of the available comparative studies included in the cumulative analysis come from low- to intermediate-volume centers. However, it is possible that other potential confounding factors were not adequately evaluated and could have influenced the reported outcomes.

Another important open question was represented by the potential advantages of RARP in comparison with LRP. This update of previous systematic reviews showed a statistically significant advantage in favor of RARP in terms of 12-mo urinary continence recovery. The result of our cumulative analysis is supported by the results reported by the only available RCT comparing the two techniques [51].
Although the conclusion of this systematic review represents the best piece of evidence available in the literature, some potential drawbacks must be taken into consideration. First, the most critical issue remains the impossibility of controlling for surgical skill and individual surgeon factors in determining outcomes of RP surgery. Similarly to open and laparoscopic surgeons, robotic surgeons do not all have the same level of surgical ability, regardless of their experience. Therefore, the time required to complete the learning curve is a highly individual factor and is difficult to generalize. In the context of comparative studies, in many instances RRPCs were performed by multiple surgeons with varying levels of expertise. Conversely, laparoscopic or robotic procedures were usually performed by a small number of dedicated urologists. Further complications are evident in evaluating impact of the surgical technique on the prevalence of urinary incontinence. Various surgical steps of the procedure can influence the recovery of urinary continence, and, very frequently, the reported outcomes represent the evolution of surgical techniques. The same surgical step can be performed using different techniques by various surgeons. Unfortunately, many studies fail to provide adequate information concerning relevant aspects of the surgical procedure.

From a methodological point of view, potential limitations concern the quality of the available studies, the definition of continence from one study to another, and the methods used for data collection. Only four RCTs were retrieved in this systematic review. However, each of these studies randomized a limited number of cases. Therefore, most of the studies included in the present systematic review are level of evidence 3 or 4. Concerning a continence definition, the most relevant confounding factor was the acceptance of the safety pad. As recently proposed by Ficarra et al, a standardized classification distinguishing patients not using pads (C0) from those using a safety pad (C1) or multiple pads (C2) should be strongly considered in future studies [62]. Although the majority of the studies included in this systematic review were based on a validated questionnaire to evaluate urinary continence status, 41% of the studies failed to include validated instruments for this purpose. Moreover, very frequently, preoperative urinary continence status is not reported, and continence recovery is not evaluated in all treated cases because some patients are lost at follow-up.

Data coming from population-based studies were not included in our cumulative analysis because these studies were based on incontinence coding and did not use standardized outcomes definitions. Moreover, population-based studies suffer from the lack of essential preoperative standardized outcomes definitions. Further complications are evident in evaluating impact of the surgical technique on the prevalence of urinary incontinence. Various surgical steps of the procedure can influence the recovery of urinary continence, and, very frequently, the reported outcomes represent the evolution of surgical techniques. The same surgical step can be performed using different techniques by various surgeons. Unfortunately, many studies fail to provide adequate information concerning relevant aspects of the surgical procedure.

From a methodological point of view, potential limitations concern the quality of the available studies, the definition of continence from one study to another, and the methods used for data collection. Only four RCTs were retrieved in this systematic review. However, each of these studies randomized a limited number of cases. Therefore, most of the studies included in the present systematic review are level of evidence 3 or 4. Concerning a continence definition, the most relevant confounding factor was the acceptance of the safety pad. As recently proposed by Ficarra et al, a standardized classification distinguishing patients not using pads (C0) from those using a safety pad (C1) or multiple pads (C2) should be strongly considered in future studies [62]. Although the majority of the studies included in this systematic review were based on a validated questionnaire to evaluate urinary continence status, 41% of the studies failed to include validated instruments for this purpose. Moreover, very frequently, preoperative urinary continence status is not reported, and continence recovery is not evaluated in all treated cases because some patients are lost at follow-up.

5. Conclusions

The prevalence of urinary incontinence after RARP ranged from 4% to 31%. These outcomes can be influenced by preoperative patient characteristics, surgeon experience, surgical technique, and methods used to collect and report data. Similar to RRP and LRP, increasing age, the presence of comorbidities, high BMI, and the presence of LUTS also seem to be correlated with a higher risk of urinary incontinence in patients who underwent RARP. Only a few comparative studies have evaluated the impact of different surgical techniques on urinary continence recovery after RARP. Posterior reconstruction, with or without anterior reconstruction, seems to be associated with a small advantage in urinary continence recovery 1 mo after the procedure. For the first time, our cumulative analyses showed a statistically significant advantage in favor of RARP in comparison with both RRP and LRP in terms of 12-mo urinary continence recovery. However, multiple design and methodological factors need to be considered in interpreting these outcomes.

Author contributions: Vincenzo Ficarra had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

Study concept and design: Novara, Ficarra, Montorsi.
Acquisition of data: Novara.
Analysis and interpretation of data: Novara, Ficarra.
Drafting of the manuscript: Ficarra.
Critical revision of the manuscript for important intellectual content: Ficarra, Novara, Rosen, Artibani, Carroll, Costello, Menon, Montorsi, Patel, Stolzenburg, Van der Poel, Wilson, Zattoni, Mottrie.
Statistical analysis: Novara.
Obtaining funding: None.
Administrative, technical, or material support: Wilson, Rosen.
Other (specify): None.
Financial disclosures: Vincenzo Ficarra certifies that all conflicts of interest, including specific financial interests and relationships and affiliations relevant to the subject matter or materials discussed in the manuscript (eg, employment/affiliation, grants or funding, consultancies, honoraria, stock ownership or options, expert testimony, royalties, or patents filed, received, or pending), are the following: Vincenzo Ficarra was speaker for Intuitive Surgical, Sunnyvale, CA, USA. Giacomo Novara was lecturer/advisory board member for Astellas, Eli Lilly, Pierre Fabre, Provenge, Recordati Int., Takeda. Walter Artibani was lecturer for Astellas, Ipsen, Zambon. Francesco Montorsi and Alexandre Mottrie acknowledge receiving research grants from Intuitive Surgical, Sunnyvale, CA, USA.

Funding/Support and role of the sponsor: None.

References


