Review

Radical prostatectomy: a focus on urinary continence

Practice Points

- Radical prostatectomy is the most commonly recommended treatment for patients diagnosed with localized prostate cancer who have a long life expectancy.
- Radical prostatectomy has three major goals: cancer control, urinary continence and erectile function preservation.
- A number of a priori patient characteristics cannot be modified and may eventually have an impact on urinary continence recovery.
- However, physicians must make every effort to promote the best possible urinary continence recovery rates and quality by making changes and improvements to all editable elements, such as conservative surgical techniques, pelvic floor exercises and drug therapies.

Radical prostatectomy is the most commonly recommended treatment for patients diagnosed with localized prostate cancer and a sufficiently long life expectancy. Radical prostatectomy has three major aims: cancer control, urinary continence and erectile function preservation. Some a priori patient characteristics, such as age, prostate volume and tumor extension, cannot be modified, with a potential negative impact on urinary continence recovery. However, physicians must make every effort to promote the best possible urinary continence recovery rates and quality by modifying and improving all editable elements, such as conservative surgical techniques (i.e. nerve-sparing techniques, urethral length preservation), pelvic floor exercises and drug therapies.

Keywords: bladder neck preservation and reconstruction • nerve sparing • radical prostatectomy • urethral length preservation • urinary continence • urinary incontinence

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Introduction

Radical prostatectomy (RP) is the most commonly recommended treatment for patients diagnosed with localized prostate cancer (PCa), who have a life expectancy of at least of 10 years [1]. The concept of TRIFECTA, concerning the goals that RP should endeavor to promote, has long been debated [2]; among them cancer control, urinary continence (UC) and erectile function (EF) preservation/recovery; the latter two being mainly obtained with the intraoperative preservation of the neurovascular bundles (NVB) [3]. There is no doubt that cancer control – and patient survival – should be considered the first post-surgical aim. Nevertheless, the increasing number of younger patients diagnosed with PCa must be taken into consideration, and supports the need for both UC and EF postoperative preservation. Accordingly, the preservation of UC after RP has been garnering much interest and attention within the scientific community given that it represents one of the most feared complications for men, potentially even more than erectile dysfunction (ED) [4–6]. Waller and Pattison, for instance, carried out a com-

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pelling survey aimed at understanding patients' personal feelings regarding UC aspects after surgery [6]. They reported that regaining urinary control was the first aim following catheter removal for those individuals. Even when urinary incontinence (UI) occurring immediately after catheter removal was perceived as part of the healing process and not as something going wrong, UI *per se* brings these gentlemen feelings of shame, despair, embarrassment and abnormality. Hence, all possible efforts must be made to preserve UC while taking into account the fact that UC recovery is usually achieved within 12 months of RP. Almost 10% of patients, however, will not recover UC within this time span, thus eventually necessitating definitive treatment for UI [7,8].

A controversial aspect of UC is its own definition. Indeed, in the 1990s, UC was typically described as 0–1 pads 1 year after RP. Many reports continue to define UC as using no pads throughout the day, thus not considering a security pad (0–1 pad), although UC is currently defined as no pad at all by most centers [9]. This lack of homogeneity regarding both the definition of UC and the methodology to evaluate UI can explain the wide range of prevalence of post-RP UI rates reported across the literature and the discrepancies in the perception of UI between doctors and patients. In this context, only 14.7% of patients considered continent by their doctors considered themselves to be continent, thus suggesting: 1) the nonuse of pads is likely not equivalent to obtaining complete UC; and 2) the number of pads used per day is not a reliable measure of UC status [10,11].

We sought to paint a clearer, more realistic picture of the different aspects of UI after RP, paying specific attention to a number of preventative aspects. A literature search for English-language original and review articles either published or e-published up to April 2014 was performed using Google and the National library of Medicine's PubMed database. Keywords included: radical prostatectomy, nerve sparing, urinary continence and urinary incontinence. Of all manuscripts, 93 were considered; among them, studies carried out with the largest cohorts of patients, those with the statistical analyses of the highest quality and the potential for greater impact in clinical terms were preferred. The retrieved articles were gathered and examined. Reference lists of retrieved articles in addition to relevant review articles were also studied.

Evidence synthesis

Patient-related factors that may impact *a priori* on post-RP UC

The first characteristic which should be taken into consideration as an a priori feature with a potential impact on postoperative recovery of UC is the patient's age. Jeong *et al.* recently showed that age at surgery is one of the significant elements for UC recovery at 1, 3 and 12 months after RP, along with membranous urethral length (MUL) and the surgical technique itself (robot-assisted RP [RARP] vs open surgery) [12]. Similarly, Becker *et al.* compared biochemical recurrence and functional results between men aged <50 years and older patients (for a total cohort of 13,268 patients) who underwent RP at the same center and observed UC to be more favorable in younger men, resulting in continence rates of 97.4% versus 91.6% for patients aged <50 versus >50 years, respectively [13].

Conflicting opinions emerge from the literature regarding the impact of prostate volume (PV) on postoperative UC recovery. Many studies have reported an absence of any significant association between PV and final UC status [14]. Choo *et al.* considered 253 patients who underwent RP (77 of them were operated on with the RARP technique and 176 with open RP) and were segregated into two subgroups according to their PV as measured by transrectal ultrasound, more specifically into PV <40 g or ≥40 g [15]. The authors reported no statistically significant differences between the groups at the 2-year follow-up assessment, although patients with larger PV who had undergone RARP were less likely to recover UC compared with those who underwent open RP within the same cohort. On the other hand, a few investigators have reported that larger prostate glands are significantly associated with a delay in UC recovery [16,17]. In this context, both a possible voiding dysfunction at baseline [16] or a more prominent dissection at the bladder neck [17] have been suggested as potential explanations for the negative influence of PV on UC recovery in men with larger prostates.

Body Mass Index (BMI) is a further feature to be taken into consideration since it has been reported that high BMI values are associated with symptom aggravation at the 3-month postoperative assessment in patients with mild preoperative lower urinary tract symptoms (LUTS). Likewise, obesity was shown to be negatively associated with improvement in storage symptoms at 12 months post-RP. On the whole, LUTS and involuntary detrusor contractions may negatively impact UC recovery in men with a deficient urethral sphincter [18].

Additional factors that may adversely affect UC recovery over the postoperative period are shorter urethral length, low surgical volume, vesico–urethral anastomosis located below the pubic symphysis and a previous prostate surgery [18–20].

How to prevent urinary incontinence & optimize the recovery of urinary function

Nerve-sparing technique

The urethral rhabdosphincter, which is fundamental for male continence, is innervated by nerve fibers coming

from the pelvic nerve and by a dual innervation from the intrapelvic and perineal branches of the pudendal nerve. Although the use of a NVB-sparing technique has been largely proven as an independent predictor of postoperative potency preservation and erectile function (EF) recovery [3], data suggest that a rigorous NVB approach could also be important for UC preservation [21]. The role of the preservation of nerve fibers around prostate, bladder and urethra, however, still requires better clarification in terms of a greater post-RP UC [21–23].

Pick *et al.* evaluated the association between baseline characteristics, NS status and UC return in 592 patients who underwent RARP [24]. They found that continence rates at 12 months post-RP were 89.2, 88.9 and 84.8% for bilateral NS, unilateral NS and non-NS surgery, respectively (p = 0.56). At multivariable analyses, age, the International Index of Erectile Function-5 score and BMI emerged as independent predictors of UC. Therefore, Pick et *al.* concluded that baseline factors, but not the physical preservation of the cavernosal nerves, could predict overall return to continence [24]. Conversely, Marien and Lepor considered 1100 men undergoing radical retropubic prostatectomy (RRP) and observed that men undergoing bilateral versus unilateral NS procedures reported the same rates of UC [25]. This was also true for potent versus impotent men at a 24-mo assessment, leading the authors to deduce that NS status is not associated with better continence [25].

Conversely, Choi *et al.* analyzed data from a cohort of 602 patients undergoing RARP and showed that both urinary function (62.8 vs 42.4, p < 0.001) and UC rates (47.2 vs 26.7%, p = 0.043) were better for men submitted to bilateral versus non-NS procedures at the 4-month follow-up [26]. Urinary function scores remained higher in men undergoing bilateral NS both after 12 and 24 months, although UC rates were similar [26]. Considering data from 1299 patients operated by the same large case-load surgeon, Ko *et al.* showed that the likelihood of postoperative urinary control was significantly higher in younger patients and after a NS procedure [27]. Suardi *et al.* showed that bilateral NS was an independent predictor associated with continence recovery in a cohort of 1249 men undergoing RRP at the same center [23]. Moreover, patients in this series treated with bilateral NSRRP had a 1.8-fold higher chance of full UC recovery [23]. In addition, Kaye *et al.* analyzed data from 102 men who underwent laparoscopic or robotic RP and observed that the quality of NS significantly influenced patient-defined urinary functional convalescence [28]. In fact, completely sparing at least one NVB along with its supportive tissue has a dramatic effect on the recovery of UC and quality of life (QoL) in preoperatively potent men [28]. Similarly, using data from a cohort of 2536 preoperatively continent and potent patients who underwent RARP, Tewari *et al.* showed that a better NS grade is a significant independent predictor of UC at ≥12-month follow up [29]. Finally, Sammon *et al.* confirmed not only that the degree of NS is predictive of long-term continence rates 12 months after surgery but also demonstrated that better NVB preservation would promote higher rates of immediate continence after catheter removal [30,31]. On the whole, even though published data are not conclusive in suggesting a positive impact of NS technique in terms of UC preservation and recovery, most data supported the concept that intraoperative NS preservation is compulsory to promote EF maintenance and recovery, along with a major positive effect in terms of UC preservation. As a clinical consequence, these authors would clinically recommend to promote a NS technique every time it is technically feasible and oncologically possible.

Bladder neck preservation & reconstruction

The bladder neck (BN) acts as an internal sphincter composed by three muscular layers – the inner longitudinal, the middle circular and the outer longitudinal layer. Some fibers from the outer longitudinal layer contribute to the pubovescical muscle and have therefore been advocated to potentially aid in BN opening during micturition. Likewise, some fibers of the outer layer intersect posteriorly with deep trigonal fibers and may contribute to BN closure [32]. As a whole, these anatomical observations seem to support the idea that BN preservation at surgery, or at least its adequate reconstruction, may potentially contribute to an earlier and easier return of postoperative UC.

Freire *et al.* conducted a retrospective comparison between 348 men who underwent RARP along with bladder neck preservation and 271 patients who underwent a standard RARP technique and observed overall better urinary function in the first group at both the 4-month and 24-month assessment (64.6 vs 57.2%; p = 0.037, and 94.1 vs 86.8%; p < 0.001, respectively) [33]. Similarly, UC showed improvements after 4 months (65.6 vs 26.5%; p < 0.001). No significant differences in terms of positive margin rates were observed between the two groups (1.4 vs 2.2%; p = 0.547), thus supporting the concept that cancer control was not affected by the chosen technique [33]. More recently, You *et al.* confirmed that BN preservation leads to early postoperative UC recovery while not affecting the final rate of positive surgical margins [34]. Moreover Friedlander *et al.* showed that BN sparing is associated with fewer urinary leak complications, shorter hospital stays and better post-RP UC, all without compromising cancer control, as compared with techniques which

did not preserve the bladder neck [35]. Nyarangi-Dix *et al.* carried out a prospective, randomized, controlled, single-blind trial to investigate the influence of BN preservation on UC, QoL and surgical margins after RP; 208 men who presented for RP were randomized to be submitted to either complete BN preservation with subsequent urethro-urethral anastomosis or have been treated without preservation being considered as controls. At 0, 3, 6 and 12 months, mean urine loss in the control versus BN preservation group was 713.3 versus 237.0, 49.6 versus 15.6, 44.4 versus 5.5, and 25.4 versus 3.1 grams, respectively (all $p<0.001$). At 3, 6, and 12 months the social continence rate was 55.3% versus 84.2% ($p < 0.001$), 74.8% versus 89.5% ($p = 0.05$) and 81.4% versus 94.7% ($p = 0.027$), and the QoL score was estimated in 80.4 versus 90.3 ($p < 0.001$), 85.4 versus 91.7 ($p = 0.016$), and 86.0 versus 93.8 ($p < 0.001$) in the control versus the preservation group, respectively. The authors observed significantly less urine loss, higher objective and social continence rates, and higher QoL scores after complete BN preservation at all follow-up points. In multivariable logistic regression analyses, complete BN preservation emerged as an independent positive predictor of UC. No significant difference was found in surgical margin status between the two groups (12.5 vs 14.7%, $p = 0.65$) [36]. Finally, analyses conducted over a cohort of 599 patients who underwent RARP by a single surgeon interestingly showed that robot-assisted BN preservation is a graded, rather than an all-or-none outcome, with increasing degrees of BN preservation being associated with an earlier return to UC, without compromising oncologic outcomes [37].

When BN preservation is not possible, BN reconstruction techniques may represent the best choice for improving UC preservation and recovery. Lin *et al.*, for instance, performed a plication of the BN in 74 men for whom a robot-assisted BN preservation at RARP was not possible for varying reasons [38]. Of these men, 12.7% resumed pad-free continence immediately after catheter removal. Short-term postoperative pad-free continence rates at 1, 3, 6 and 12 months were 29.8, 91.8, 97.3 and 97.3%, respectively [38]. Similarly, Lee *et al.* compared 159 men who underwent RARP with BN plication (after completion of the vesicourethral anastomosis, a single suture was used to plicate the distal BN) with 175 patients submitted to standard RARP, and demonstrated that the bladder plication stitch is a simple technical modification that is effective at reducing the length of post-RARP UC recovery [39].

Urethral length preservation

The anatomical study of 64 gross specimens confirmed that the external striated urethral sphincter extends as a single unit from the proximal penile urethra to the bladder base. Its configuration was variable and related to the shape of the apical prostate. Two basic prostatic shapes were recognized, distinguished by the presence or absence of an anterior apical notch. Whether a notch existed depended upon the degree of lateral lobe development and the position of its anterior commissure. In RP, knowledge of variation in the shape of the prostatic apex can help the surgeon achieve optimal urethral transection with maximal preservation of the external striated urethral sphincter and other tissues of the continence mechanism [40]. Hence, the striated urogenital sphincter muscle functionally acts from the prostate apex to the bulb, while the internal component of the distal sphincter mechanism extends up to the verumontanum [41]. Thus, in order to obtain full and early UC, the importance of preserving not only the striated sphincter but also the intraprostatic portion of the membranous urethra has been suggested [42]. Accordingly, the most difficult aspect of this procedure would be to precisely identify the junction between the prostatic apex and the proximal urethra in order to spare the maximal urethral length without compromising the apical margin status [42]. Hakimi *et al.* studied preoperative and intraoperative urethral length and its effect on postoperative UC and QoL in 75 men undergoing RARP [41]. They found no relationship between preoperative MRI urethral length and postoperative continence. However, at multivariable analysis, both stretched and cut urethral length correlated with decreased time to UC ($p = 0.03$ and $p = 0.04$, respectively) [41]. This means that RARP techniques aimed at preserving urethral length as well as avoiding disturbance of the levator muscles can hasten UC. Similarly, considering 329 patients who underwent open RP, Sfoungaristos *et al.* showed that those whose urethra was preserved up to the level of the verumontanum had statistically lower incidence rates of UC, urgency and nocturia at the 1-month assessment compared with those who received standard RRP [43]. Moreover, there was a statistically significant difference in the number of pads/day in favour of the first group at 1, 3, and 6 months postoperatively, without significant differences between the two groups in terms of either positive surgical margins or biochemical relapse [43]. Schlomm *et al.* analysed 691 consecutive patients who underwent RP over a 12-month period; of whom, 285 were operated without and 406 with a full functional urethra length preservation technique, which consists of an individualized apical preparation strictly along anatomic landmarks, respecting the individual length of the intraprostatically located proportion of the urethral sphincter. Anatomic fixation of the sphincter was reached by a thorough preservation of the pelvic floor

and anatomic restoration of the Mueller's ligaments. Continence rates were 50.1 and 30.9% 1 week after catheter removal ($p < 0.0001$) and 96.9 and 94.7% ($p = 0.59$) at 12-month assessment after surgery in patients operated with the full functional urethra length technique versus those who did not receive that approach, respectively. In multivariate regression analyses, only the surgical technique was significantly associated with continence status. Neither the overall positive surgical margin rates nor the number of positive margins at the urethral resection border differed significantly between the two technical approaches (13.6 and 0.5% vs 14.9 and 1.3%, respectively) [44].

In order to help surgeons be as precise as possible, Hung *et al.* recently showed a robotically manipulated transrectal ultrasound system which can be used during RARP to help identify the membranous urethra, thus maximally preserving urethral length [45].

Periurethral suspension stitch

Walsh described the reversal of the dorsal venous complex suture through the symphysis pubis perichondrium to control venous bleeding and to provide support to the rhabdosphincter in the RRP technique [46]. Subsequently, this periurethral suspension stitch (PSS) was found to improve continence recovery. For instance, Patel *et al.* [47] used this technique in a cohort of RARP patients and showed that UC was significantly improved 3 months after the operation in those submitted to RARP with PSS [47]. Conversely, UC at 1-, 6- and 12-month assessments was similar. Therefore, it could be considered that PSS can hasten UC recovery without affecting long-term UC.

Posterior reconstruction of the rhabdosphincter

The musculofascial plate – composed by the posterior median raphe with the connected rhabdosphincter – the dorsal prostate and Denonvilliers' fascia (DF) represent a dynamic support system for the prostatic–membranous urethra [48]. This support system extends from the pouch of Douglas peritoneum to the perineal membrane and the central tendon of the perineum [49,50]. A consequence of prostate removal at RP is the anatomic and functional ruin of this support system resulting from the separation of the urethral sphincter complex from the prostatic apex and DF. This can lead to a postoperative loss of UC. The reconstruction of this support system – which consists of the repositioning of the posterior semicircumference of the rhabdosphincter to the cut edge of the residual DF – aims to re-establish the anatomical and functional deficiency created by the surgery itself, thus providing anatomical support in the posterior aspect of the urethral sphincter complex by fixing it again in the natural position. Similarly, it allows for the avoidance of caudal retraction of the urethra–sphincteric complex before the vesicourethral anastomosis is completed [48–50]. This posterior rhabdosphincter reconstruction technique was first introduced by Rocco *et al.* as a modification to ameliorate urinary incontinence after retropubic RP [50]. Termed Rocco's stitch, it can also decrease the mechanical tension over anastomosis and anastomotic leakage by creating an additional strength layer [51]. In a recent systematic review of the literature Rocco *et al.* showed that posterior reconstruction improves the early return of UC within the first 30 days after RP ($p = 0.004$), whereas continence rates 90 days after surgery seemed not to be affected [52]. The role of posterior musculofascial plate reconstruction in terms of earlier UC recovery is encouraging, though still controversial [52]. Indeed, Coelho *et al.* [53] and Brien *et al.* [54] separately showed better UC rates at 1- and 3-months follow-up, respectively, without differences in long-term UC. Conversely, other groups reported no advantages in terms of absolute UC rates and rates of UC recovery after implementing the posterior reconstruction technique. Joshi *et al.*, for instance, showed that the posterior reconstruction of the musculofascial complex did not promote early UC amelioration after RARP [55]. Moreover, Menon *et al.* reported no advantages in continence rates with either this technique or with PSS [50]. Hence, posterior reconstruction can be useful to improve postoperative urinary leakage as well as to facilitate the vesicourethral anastomosis, thus attenuating tension during RARP. However, there is not sufficient information to prove its effectiveness in ameliorating final postoperative UC.

Combined anterior & posterior reconstruction

Yet a further surgical option has been reported involving the combination of both an anterior and a posterior reconstruction by performing a PSS along with a posterior reconstruction. Studies comparing combined anterior and posterior reconstruction and standard anastomosis have been carried out with nonunique findings. Menon *et al.* [50] and Summon *et al.* [54] observed no significant differences in early or late UC recovery in the two groups. Koliakos *et al.* [56] and Hurtes *et al.* [57] found improved UC rates at 7 weeks, 1 and 3 months following RARP, respectively, in patients undergoing both combined techniques. Conversely, no significant differences in UC were observed 6 months from surgery.

Anterior preservation

Several reports underline that nerve and vascular fibers are not only at 5 and 7 o'clock around the prostate –

as has been traditionally considered – but completely surround the gland over its whole circumference [58]. Accordingly, Asimakopoulos *et al.* hypothesized that due to the continuity of the puboprostatic ligaments to the detrusor apron, it is virtually impossible to preserve the puboprostatic support elements if the whole pubovesical complex (i.e., dorsal vein complex, puboprostatic ligaments and detrusor apron) is kept intact [59]. Therefore, these authors implemented this technical concept in 30 men, eventually observing that 80% of the entire cohort was continent at catheter removal, with the whole cohort being continent at the 3-month assessment [59]. More recently, Galfano *et al.* developed a novel approach for RARP which avoids all the Retzius structures involved in continence and potency preservation while passing through the pouch of Douglas, with more than 90% of their patients experiencing immediate continence after surgery [60].

Pelvic floor muscle exercise

Different opinions have been reported throughout the literature regarding the usefulness and effectiveness of pelvic floor muscle exercise (PFME) carried out before and after RP to preserve and improve UC. In a cohort of 118 patients randomized either to start PFME preoperatively, which was then continued postoperatively (group A; n = 59), or to start PFME postoperatively (group B; n = 59), Centemero *et al.* showed that after 1 month 44.1 and 20.3% of patients were continent in the two groups (p = 0.018), respectively [61]. Moreover, 59.3 and 37.3% of patients were continent in the two groups at 3-months follow-up (p = 0.028), respectively. The International Continence Society male short form mean score showed better results for patients in group A than group B at both follow-up assessment dates (p = 0.002) [61]. Terzoni *et al.* compared PFME with no treatment in patients submitted to retropubic RP [62]; at 3-months post-RP assessment they found that PFME carried out after the operation was able to reduce the International Prostate Symptom Score compared with patients who did not receive any PFME course. Conversely, no difference was observed between the two groups 6 months after surgery [62].

Patel *et al.* conducted a retrospective analysis in a cohort of men who underwent RRP, the first group had received physiotherapist-guided PFM training (PFMT) starting 4 weeks before surgery; in contrast, the control group was provided only with verbal instructions on PFME by the surgeon [63]. Postoperatively, all patients had received physiotherapist-guided PFMT. They showed that a physiotherapist-guided PFMT program, started 4 weeks prior to surgery, significantly reduced the duration and severity of early UI at 6-weeks follow-up, while no significant differences were found between the two groups 3 months after surgery [63].

Conversely, other studies have shown that PFME is not so effective at UC preservation and recovery. Dijkstra-Eshuis *et al.* showed that there were no significant differences in UC recovery rates between men who underwent PFME once a week for 4 weeks prior to laparoscopic RP and patients who received standard care [64]. *Mungovan et al.* demonstrated that – despite the fact that higher physical activity levels are continence-protective in non-prostate cancer populations – there was no relationship between perioperative physical activity levels (PFME and physical activity prescription) and post-RP UI rates and severity [65].

Phosphodiesterase type 5 inhibitors & penile vibratory stimulation

Phosphodiesterase type 5 inhibitors (PDE5Is), either in a daily or as an on demand fashion, have been advocated as a first line treatment to promote erectile function recovery following RP [3,66]. In this context, data have also suggested that PDE5, cGMP and the cGMP-dependent protein kinase-1 are expressed in the human lower urinary tract, including the prostate, bladder and urethra [67–70]. PDE5 is particularly expressed within smooth muscle fibers of supplying arteries of pelvic organs [68–70]. Based on these considerations, Gacci *et al.* carried out a study to assess the role of vardenafil in continence recovery after BNS-RP. The considered 39 patients with prostate cancer: after BNS-RP, patients were double-blinded assigned to three arms: vardenafil on demand; vardenafil nightly; and placebo. Validated questionnaires concerning urinary function were assessed preoperatively and at 1, 3, 6, 9, 10 and 12 months. They demonstrated that vardenafil can improve continence recovery after BNS-RP as compared with placebo. Daily use of vardenafil seemed to provide better continence rates, although it did not seem to influence the timing needed to achieve full continence [71]. More recently, Gandaglia *et al.* investigated the effect of different schedules of PDE5I administration in terms of UC recovery in a cohort of 341 patients treated with retropubic BNS-RP at a single high-volume center [72]. UC recovery was defined as being completely pad free over a period of 24 h. Patients were stratified according to postoperative daily (n = 58; 17%), on-demand (n = 112; 32.8%), and no (n = 171; 50.1%) PDE5Is use. As a whole, 288 patients (84.5%) recovered UC after BNS-RP at a 36.4-month postoperative mean follow-up. Patients who did not use PDE5Is after surgery showed lower rates of UC recovery at both 1- and 2-year follow-ups compared with those taking PDE5Is (67.1 vs 86.7% and 76

vs 94.4%, respectively; p < 0.001). After adjusting for all potential confounds, multivariable analysis showed that PDE5I use, with any schedule, had a significant positive impact on UC recovery (p = 0.03). Thus, the authors concluded that patients taking PDE5Is have higher UC recovery rates compared with patients left untreated after BNS-RP [72]. An improvement in sphincteric and pelvic floor blood supply might be responsible for this beneficial effect associated with the use of PDE5Is.

On the other hand, the use of penile vibratory stimulation (PVS) did not show ameliorative effects on UC recovery. To this aim, Fode *et al.* considered a cohort of patients submitted to NSRP and compared a PVS group (PVS was started at least one week before surgery and was maintained until 6 weeks after catheter removal) to a control group [73]. The authors observed no significant differences in terms of proportions of continent patients between the two groups at 3-, 6- or 12-month evaluations.

Comparison among continence results using different surgical radical prostatectomy techniques

Open RP is still a relatively common treatment for PCa. UC rates and quality, as assessed with dedicated and validated psychometric instruments, have been reported to worsen immediately after surgery and then improve throughout the following months up to 2 years after RP [74–79]. According to the most recent data regarding functional results after open RP, UC recovery rate ranges between 60 and 93% 12 months after surgery [80]. There are very few studies concerning UC over the 2 years after open RP; available data seem to show that after this period continence mostly tends to either decay or reach a stationary framework [81–84], while almost 23% of men reported improvements in their UC quality from 2 to 4 years after RRP [81]. In this context, Prabhu *et al.* carried out a study to elucidate the long-term progression of UC after open RP [85]. They considered 1788 men undergoing retropubic RP who were followed for 120 months after surgery. Postoperative UC rates at 2, 8 and 10 years after RP were 95.5, 93.1 and 91.1%, respectively. Moreover, the authors reported slight decreases in mean scores of the University of California, Los-Angeles-Prostate Cancer Index urinary function score from 2 to 8 years and marginal, but significant, decreases from 8 to 10 years after open RP. In fact, men younger than 60 years of age had better long-term outcomes. Overall, these results provided a realistic picture in terms of long–term UC expectations for patients undergoing open RP [85]. Even better results are obtained when an open NSRP is carried out; Budäus *et al.* described their technique, key elements of which are a selective ligation of the dorsal vein complex and an early release of the NVB using a high anterior tension- and energy-free intrafascial technique. During dissection of the urethra, its posterior insertion at DF is preserved. DF is left *in situ*, and it is selectively opened above the seminal vesicles, which are completely removed inside the DF; five muscle-sparing interrupted sutures are used to make the anastomosis. The authors showed that age and extent of NS approach were associated with postoperative UC and EF outcomes. Considering UC, rates of 1-year postoperative complete UC were 97.4 and 84.1% in men <60 years and >70 years of age, respectively. In patients with organ-confined cancers, recurrence-free survival, and cancer-specific survival 10 years after open RP were 87 and 98.3%, respectively. These findings supported the idea that that open intrafascial NSRP may promote excellent long-term cancer control rates along with superior functional outcome and a low morbidity [86].

Considering laparoscopic RP (LRP), Verze *et al.* recently showed data from a cohort of 778 patients who underwent LRP with a 5-year follow-up [87]. Complete postoperative UC rates were 39 and 92% after 1 and 2 months, respectively. A further UC increase from 92 to 98.4% was then observed at the 24-month follow-up evaluation [87]. Wang *et al.* retrospectively considered 49 patients treated with LRP more than 10 years earlier and compared overall QoL and UC rates with those of an age- and region-matched control group [88]. In total, 86 and 88% of patients reported having no urinary leakage, respectively, with a prevalence of complete UC eventually being similar between groups. Data also suggested that QoL scores were comparable, despite a higher frequency of anxiety in LRP patients [88].

Lastly, taking into account the RARP technique, Ficarra *et al.* [89] recently reported the findings of a study considering preoperatively continent patients submitted to RARP with a 5-yr minimum follow-up [89]. In line with the specific aim of the study, patients were classified as using no pad (C0), using one pad for security (C1), and using ≥1 pad per day (C2). At follow-up assessment, 146 men (79.8%) were fully continent, 20 (10.9%) still used a safety pad (C1), and 17 (9.3%) were incontinent using ≥1 pad (C2). Specifically, UC rates were 39, 73, 87, 91% at 1-, 3-, 6, and 12-month follow-ups, respectively. Median time to reach UC was 2 months (range 1–3 months). As a whole, these data confirmed the excellent results in terms of UC recovery in patients submitted to RARP [87]. Likewise, Ficarra *et al.* recently showed a better 12-month UC recovery after RARP than after both open RP (OR: 1.53; p = 0.03) and LRP (OR: 2.39; p = 0.006) [74].

How to assess urinary function after prostatectomy

As comprehensively analysed throughout this review, successful treatment of locally confined PCa is firstly characterized by postoperative cancer control; then, and certainly not less importantly, by UC and potency preservation. Hence, it is important to identify the least invasive but most effective method to assess functional outcomes. As in most of the fields of clinical evaluation of functional outcomes, even for the UC (both for postoperative UC preservation and for UC recovery), the use of psychometric instruments is essential for a proper and objective assessment, even though these are certainly far from perfect. Likewise, a pad- est should be always combined with psychometric investigation, though it is still difficult get an unambiguous definition of what should be considered as a normal and/or negative pad tests. Accordingly, the use of psychometric questionnaires, which can be easily completed at fixed time periods (i.e. at 3, 6, 9, 12 months after the operation), has emerged as the most effective option. For example, the Expanded Prostate Cancer Index Composite (EPIC) is a broad-domain health-related QoL (HRQOL) instrument specifically developed for patients undergoing treatments for localized PCa; EPIC evaluates 4 main areas related to bowel, urinary, sexual and hormonal function in PCa survivors and can be effectively applied to longitudinally track recovery rates of functional HRQOL domains over time [89,90]. Interestingly, each domain can be evaluated both from the functional and the bothering point of view; higher scores in all domains indicate better function and less bother. The EPIC-short form contains 26 questions related to all domains. Of these, EPIC-short form includes five questions related to urinary incontinence, three on urinary function and two related to urinary bother. Moreover, the EPIC-sexual inventory (EPIC-S) includes 5 questions related to sexual functioning and 1 item related to sexual function bother. On the whole, the EPIC-urinary inventory and the EPIC-S short form tally scores up to 100. Ellison *et al.* [91] showed that EPIC-urinary inventory and EPIC-S scores at 3-months assessment after RP were useful to predict 12-month functional outcomes. These would underline that HRQOL instruments should be applied in the immediate postoperative period as a precious aid in counseling patients over the UC recovery process.

Conclusion

Radical prostatectomy is the most commonly recommended treatment for patients diagnosed with localized PCa who have a sufficiently long life expectancy. On the whole, RP can be considered in need for improvements in postoperative UC and EF preservation and recovery. In terms of UC expectations, a number of a priori patient characteristics must be carefully considered, including patient age, BMI and prostate volume. Hence, despite numerous aspects which cannot be modified or even adequately ameliorated, others, such as those which can be handled differently during surgery (i.e., conservative and precise surgical techniques), pelvic floor exercises and adequate drug support, must be taken into careful consideration as they can lead to significant differences in terms of postoperative UC preservation. Future translational research should be aimed at suggesting a formal common definition of postoperative UC, in order to provide patients with more realistic expectations and to better define those patients who might actually benefit from medical therapy, although off-label, or specific surgery.

Future perspective

Despite surgical improvements over the last three decades, including minimally invasive techniques such as robotically-assisted RP, a significant improvement of the functional outcome of patients undergoing curative surgery for PCa remains an essential requirement. Therefore, we believe that in the coming 5–10 years, more and more attention towards UC and sexual functioning preservation will be paid, both with further surgical developments, more personalized surgery and novel drug development towards specific patient tailoring.

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