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Preservation of continence in radical prostatectomy patients: a laparoscopic surgeon's perspective

Piotr Kania[1], Piotr Wośkowiak[2], Maciej Salagierski[2]

[1]Mazovian Regional Hospital, Department of Urology, Siedlce, Poland
[2]Faculty of Medicine and Health Sciences, University Hospital, Department of Urology, Zielona Góra, Poland

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Corresponding author
Maciej Salagierski
Faculty of Medicine
and Health Sciences
University Hospital
Department of Urology
26 Zyty Street
65-046 Zielona Góra, Poland
m.salagierski@wlnz.uz.zgora. pl

Introduction Preserving continence in patients who underwent radical prostatectomy is of utmost importance. Therefore, modification of surgical technique that would contribute to the regaining of continence with a shortest possible delay after the procedure and adequate evaluation of chances of continence recovery should be considered.

Material and methods A PubMed database search was performed to review the current literature concerning the physiology and anatomy of sphincter mechanisms, perioperative risk factors, the effects of surgical techniques on post-prostatectomy continence and post-operative management.

Results Modifications of surgical approach with an aim to minimize damage to the sphincter complex, maintenance of maximal urethral length to enable safe anastomosis, and the reconstruction of the urethral support system appears necessary. The patient should also be informed about the chances of regaining continence after surgery.

Conclusions There is a need to develop a predictive model to stratify patients according to risk of incontinence and implement adequate action to minimize those risks including preoperative pelvic floor muscle training and/or surgical technique modification.

Key Words: membranous urethra ‹› preservation ‹› prostate cancer ‹› radical prostatectomy ‹› urinary incontinence

INTRODUCTION

Prostate cancer is one of the most common cancers diagnosed in men. The majority of cases are organ confined at the time of diagnosis and radical prostatectomy (RP) is the method of choice for many patients. The increasing number of RP is a major cause of stress urinary incontinence (SUI). An overwhelming number of patients will gradually regain continence in one year [1] and even more will be continent two years after surgery [2].

Urinary incontinence after RP is the most debilitating complication significantly affecting quality of life and may have a potential impact on choosing RP as a treatment option. Due to improvements in surgical techniques, continence rates are much better in contemporary patient series, however, post-prostatectomy incontinence (PPI) remains permanent in approximately 15% of patients. Therefore, the time to recovery of continence or to final continence status is very important for patients and their surgeons. Less invasive surgery with magnification and more precise instruments and better access to pelvic structures gives a potential opportunity to preserve key structures for maintaining continence. The results of classical laparoscopic prostatectomy (LRP) are similar to open radical retropubic prostatectomy (RRP) with recovery of continence after 12 months ranging from 66% to 95% and results of robot-assisted radical prostatectomy (RARP) appear superior in referral centers reaching from 84% to 97% of patients regaining continence after one year [1].

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It is not an easy task to compare the presented results due to different definitions of continence, various data acquisition methods and incomparable patient cohorts but noteworthy is the gradual improvement of incontinence rates reaching nowadays a high plateau. This is an outcome of improved surgical technique and better understanding of pelvic anatomy [3, 4] and incontinence pathophysiology.

The precise etiology of post-prostatectomy incontinence (PPI) has not been completely explained, but awareness of all known risk factors can help patients and their urologists in adequate counseling about the individualized risk of PPI, should provide them with realistic expectations and can be helpful in choosing the most appropriate treatment option. Since there is evidence that treatment with radiotherapy and RP lead to a similarly poor prognosis of regaining continence after RP, this can make a patient opt for other treatment methods or it can prompt adequate surgery modification and motivate to intensified physiotherapy.

Our review aims at discussing the most important issues related to the preservation of continence during a pre-, peri- and postoperative period in order to make an adequate patient recommendation.

Preoperative consideration

Numerous factors were taken into account to help predict urinary incontinence (UI) after radical prostatectomy (RP) (Table 1). Most studies have shown that patients who recovered their continence in one year after prostatectomy were significantly younger [5]. Higher BMI (Body Mass Index) and physical inactivity is considered to be an independent predictor of worse continence after surgery [6]. Furthermore, RP in patients with large prostate will cause excision of a longer part of the urethra thus having a negative impact on functional outcome of RP. Some authors reported a negative influence of the intravesical prostatic protrusion on continence status [7], most probably due to damage of the internal smooth muscle layer in the bladder neck by difficult dissection or protruding prostate causing atrophy of this part of the sphincteric complex. On the basis of anatomical concept of urethral sphincter complex the theoretical thesis of predictive value of membranous urethral length (MUL) on PPI seems justified. MUL was usually assessed by magnetic resonance imaging (MRI) prior to RP and its value on functional outcome of RP was summarized by meta-analysis [8]. Addition of MUL to the predictive model constructed by Matsushita [5] significantly improved its accuracy. Retrospective analysis also confirmed a negative impact of comorbidities assessed generally in American Society of Anesthesiologists (ASA) score, or separately mainly metabolic syndrome or diabetes mellitus [9]. There are opposing outcomes of analyses if transurethral resection of prostate (TURP) before RP can influence PPI, but the suggestion of delaying RP for about four months after TURP seems reasonable [10]. Preoperative imaging studies should also assess MUL and the information about configuration of apical part of the urethra as a significant portion of sphincteric urethra can be covered by apical tissues [11]. On the basis of the highlighted risk factors, a urologist can improve patient counseling about the individualized risk of PPI to help select the best treatment options in order to identify patients who should intensify perioperative pelvic floor muscles exercises and to select patients in whom special efforts should be undertaken during surgery.

Modification of surgical technique

The surgical treatment itself appears a much more important factor than other preoperative issues but on the other hand the sentence of Patrick Walsh: "The surgery could go badly and patient not leak. The surgery could go very well and he leaks" shows that there is still not enough knowledge about the ways to improve surgical technique to achieve best results in terms of continence. The common idea of most modifications is to preserve integrity and maximal length of the urethral sphincter complex and preserve or restore its supportive system in the pelvis.

Surgeon's experience

The studies evaluating functional outcomes revealed that the results of high-volume surgeons are excellent regardless of the surgical approach [12]. In RARP cohorts the surgical learning curve of continence recovery does not reach a plateau even after 100 cases [13].

LRP requires an even longer learning curve of several hundred cases [14]. Both approaches with all known advantages including magnification and better visualization deep in the pelvis offer better conditions to achieve a watertight urethrovesical anastomosis. It is believed that urine leak through the anastomosis may lead to more pronounced scarring and fibrosis around the urethra leading to worse functional results or even permanent incontinence [10]. Extensive fibrosis around an anastomosis can be depicted in MRI [15] and such an outcome may help identify patients in whom further physiotherapy and waiting will bring no improvement in continence. As it was shown in anatomical and urodynamic studies, the highest closure pressure is located in the bladder neck where the lissosphincter (LS) predominates and a middle part of membranous urethra with thinnest urethral wall and action of both RS and LS. This is the rationale of bladder neck preservation technique that in many studies proved its positive impact on continence after LRP [16] and it was advocated to preserve bladder neck during LRP in all cases except for patients with an enlarged medial lobe where bladder neck reconstruction should be performed [17].

Preservation of the membranous urethral length

Many authors believe that membranous urethral length (MUL) is a significant preoperative factor helping to predict the postoperative continence, but it seems obvious that an even more important factor is postoperative MUL. It depends on both the length before operation and the quality of the dissection. MRI is increasingly used in preoperative assessment, but it is not a standard examination in postoperative follow-up probably because of its cost and availability. Hence, the postoperatively measured in MRI MUL as well as MUL loss ratio was not often analyzed [8]. In the meta-analysis done by Mugovan et al., MRI measurement of MUL is recommended prior to RP. Smooth muscle sphincter as an internal layer of sphincteric complex extends from the vesical orifice to the level of perineal membrane and is coated with the striated layer from the prostatic apex caudally. Due to anatomical variability of the prostatic apex, 10 to 40% of the functional urethra is covered by prostatic apex tissue [11]. Thus, a simple measurement of the distance from prostatic apex to the perineal membrane in MRI does not always give a thorough answer on the functional urethral length that can be spared in meticulous apical dissection. The principals of full functional-length urethral sphincter preservation proposed by Schlomm et al. [11] include, among others, dissecting the urethra cranially to the seminal colliculus thus sparing the longest possible membranous urethra length. Not only dissecting part of the operation can significantly change the sphincter action, but also it is believed that during anastomosis too deep passage of the needle will lead to atrophy of a clinched portion of urethra and excessive fibrosis in the anastomosis. Creating the anastomosis under tension can have the same deteriorating effect (Table 2).

Preservation of the neurovascular supply

Pudendal nerves supply the rhabdosphincter with somatic neural fibers and due to its extrapelvic course direct damage in well-performed RP seems unlikely. Preserved rhabdosphincter function and innervations after surgery may be confirmed by movement of the proximal urethra towards the symphysis pubis during voluntary contraction of sphincter and pelvic floor muscles that can be observed in ultrasonography and cystoscopy. Nevertheless, some authors indicate that one of the a PPI cause may be temporary deterioration in neural supply function – neuropraxia. That is why it is recommended in many studies to avoid tension on the rhabdosphincter and neurovascular bundle (NVB) to diminish neural component damage [18]. It has been confirmed by anatomical and neurophysiological studies that part of the somatic fibers run along with the autonomic nerve in the NVB [19] and there are many interconnections between these two neural components. However, it is still a matter of debate whether saving NVB's influence leads to a faster return of continence, or is it just a result of more precise dissection. Authors of the 6th International Consultation on Incontinence stated that sphincter and bladder dysfunction coexist in at least one-third of incontinent patients [20]. It is believed that the concept of musculofascial posterior reconstruction (PR) of rhabdosphincter proposed by Rocco over 15 years ago helps with restoration of support of the urethra deep in the pelvis and also give the possibility to approximate the structures involved in the anastomosis without tension and prevent from urethral stump recession [10]. PR was applied by open, laparoscopic and robotic surgeons all over the world resulting in significant improvement in MUL and faster continence recovery [21]. In light of the aforementioned anatomical studies, the Rocco stitch approximates not only fascial or tendinous structures but also smooth muscle tissue and elastic fibers of medial dorsal raphe and rectourethralis muscle and thanks to the Bayllis effect, provide active support for the proximal urethra. These structures are also densely innervated, thus a surgeon performing RP should not place stitches too deep in order to diminish potential neural damage. PPI in patients with lack of posterior support for the urethra and its hypermobility and appropriate sphincter function is the basis of an idea analogous to the hammock theory for women proposed by DeLancey. This is a theoretical concept for postoperative non-obstructive sling procedures to reposition the proximal urethra and give additional posterior support. There are also concepts of intraoperative autologous sling placement to support the anastomosis [22] but this concept did not go beyond the experimental phase. Anterior support consisting of pubourethral ligament can be preserved or it can be reconstructed after apical dissection. As with the Rocco stitch this is still under debate whether anterior urethra anchoring to the symphysis pubis improves the functional outcome after RP by mimicking pubourethral ligaments and giving better fixation of urethra or if it merely lowers the tension and improves mucosal coaptation in anastomosis [10].

Reconstruction of urethral and urethrovesical support

There are many modifications of reconstruction of urethral and urethrovesical support. Some surgeons create and improve only posterior reconstruction, some others report better functional outcome after anterior and posterior repair. Relatively new ideas emerging from the field of RARP were proposed by Dal Moro et al. with CORPUS – complete reconstruction of posterior urethral support [23] and Student et al. with advanced reconstruction of vesicourethral support (ARVUS) [24] and the basis of those concepts in brief is to approximate bilaterally, a portion of puborectalis muscle in addition to Denonvilier'a fascia, rectourethralis muscle and median dorsal raphe to create a hammock like strong support for the membranous urethra. Interestingly, preliminary reports suggest significant improvement in immediate and very early continence after catheter removal (Table 2).

Neurovascular bundles sparing surgery

Many reports have linked neurovascular bundles sparing modification of prostatectomy or attempts to spare NVB with overall continence status and time to final continence level. The limitation of this method is that NVB sparing surgery can be recommended only for patients with low risk of extracapsular disease [25]. The bias of continence results of cohorts treated with nerve-sparing is that this treatment option is indicated mainly for younger, potent patients. However, various studies come to conflicting conclusions. Nevertheless in a recent study, Michl et al. concluded that the nerve-sparing technique, not the preservation of the neurovascular bundles leads to improved continence rates indicating again that meticulous and gentle dissection is of utmost importance for continence [26]. The Retzius-sparing technique that was initially proposed by Galfano and colleagues is one of the most recent ideas that originates from surgeons utilizing the robotic platform. This is a thoroughly new approach with initial posterior access to seminal vesicles through the Douglas space like in laparoscopic Montsouris technique and further anterior part of dissection that avoids and leaves intact all important, in terms of continence, structures located within the Retzius space [27].

Posterior robot-assisted radical prostatectomy

The continence status after posterior or Retzius-sparing RARP is significantly better than in anterior RARP with 71% of patients continent in 1 week in comparison to 48% after anterior approach. Posterior RARP achieves one of the highest observed levels of continence recovery with only 2 days median time after catheter removal as reported in a recent paper from Vattikuti Urology Institute [28]. In reference to those results, Antonio Galfano stated that although a huge number of surgical innovations have passed like meteors in the urological sky, Retzius-sparing prostatectomy (RSP) is transforming from passing meteor into a new shining star [29]. One more message can be drawn from the outstanding results after posterior RARP, that preservation of anterior supporting structures integrity and attachment to the bladder wall give far better results than anterior reconstruction by merely anchoring the urethro-vesical anastomosis to the pubic symphysis. As the robotic platform is not accessible in many urology departments offering open or laparoscopic radical prostatectomy, possibly these modifications might be adopted for applying in other approaches.

Postoperative period

Length of catheterisation

The data on the influence of catheter removal time after RP on continence recovery are sparse. Depending on the anastomosis quality this time can be shorter and it significantly improves quality of life if the patient is discharged without a catheter [30]. There are also data showing that early catheter removal can lead to increased rate of early urinary retention and can predispose to anastomotic scarring and stricture formation [31]. The optimal length of catheterisation has not been established and it should be based on surgeon's experience, quality and integrity of anastomosis and in doubtful cases tightening of anastomosis should be confirmed by cystography.

Pelvic floor muscle training

The state of pelvic floor musculature can influence time to continence recovery after RP. Pelvic floor muscle training (PFMT), especially when applied soon after catheter removal and supervised by a physiotherapist with manual, ultrasonographic or electromyographic biofeedback proved its effectiveness in many studies. PFMT can influence continence mainly by strengthening an active component of sphincteric mechanism, that is RS and levator ani

Table 1. *Patient's related risk factors of urinary incontinence after radical prostatectomy*

Urinary incontinence risk factor	Features
Higher prostate volume	Greater adenoma development causes atrophy of striated muscles around the bladder neck
	Reduces the possibility of saving the bladder neck
	Reduces the chances of maintaining a long membranous urethra
Large central lobe	More damage to the sphincter apparatus around the bladder neck
	Difficulty in the preparation of the bladder neck
	Inevitability of a reconstruction
Biological age and comorbidities	Worse quality of a tissue and collagen in the sphincteric apparatus
	Neuropathies of various origin
BMI	Reduced operative capabilities
	Worse tissue quality

BMI – Body Mass Index

Table 2. *Intraoperative approach to prevent urinary incontinence after radical prostatectomy*

The element of the intervention	Features
Maintenance of the sphincter apparatus	Preservation of the longest possible part of the membranous urethra
	Sparing the bladder neck
Maintenance of the urethra supporting complex	Allows the proper action of the urethral sphincter, in particular, the striated part of the complex

muscle, improving maximal urethral closure pressure during voluntary contraction. Many various modifications and schedules of PFMT were published finding positive effects but due to a lot of bias, their results should be interpreted cautiously [32]. Conservative management of PPI was summarised in the 6th International Consultation on Incontinence [20] showing that benefits from PFMT are most pronounced at 3 months post RP with almost no difference in rate of continence after 12 months. The same conclusion can be drawn from recent meta-analysis [33] of influence of preoperative PFMT. The benefit from a preoperative guided training due to obvious short time before operation (in some studies training begun one day before RP) may merely increase awareness of the pelvic floor muscles rather than significantly improve urethral support. The impact on PFMT on postoperative non-sphincteric lower urinary tract symptoms especially overactive bladder is not well recognised.

Management of detrusor instability

It is estimated that about a third of men after prostatectomy have mixed incontinence due to bladder and sphincter dysfunction [20]. Probably immediately after surgery, the proportion of patients with symptoms of detrusor overactivity (DO) is even greater. In a randomized placebo-controlled study, 5mg solifenacin once daily was given as an effective and well tolerated treatment significantly lowering rate of DO episodes [34]. Duloxetin, a serotonin and noradrenaline reuptake inhibitor, through an increased concentration of serotonin in lower spinal segments can increase urethral resistance. While this drug is not approved in many countries it can be used as a treatment option in patients with PPI but compliance rate is rather small due to side effects [20].

Postoperative membranous urethral length assessment

On the basis of postoperative dynamic imaging studies of membranous urethral length (MUL), fibrosis intensity in the anastomosis and movement of the proximal urethra during cough and voluntary contraction can help in distinguishing a group of patients who are less likely to achieve continence recovery quickly. Those patients then could be appropriately counseled about additional options like increased intensity in PFMT, guided PFMT, sling procedure or even early qualification to artificial sphincter implantation. MUL in most studies was measured in MRI but this examination is not a standard option for post-prostatectomy evaluation and does not give possibilities to assess dynamic function of pelvic floor. There are attempts to depict in ultrasonography sphincteric structures as well as post-prostatectomy changes in male pelvic anatomy and function [35, 36]. Other studies highlight a bigger importance of the intrinsic, lisosphincter layer. The pressure component of intrinsic sphincter was measured in urethral profilometry by Pfister et al. [37], showing that most continent patients post-prostatectomy have significant intrinsic factor pressure in contrary to incontinent cases. This can also explain paradoxical incontinence in patients after appropriate PFMT program (Table 2).

CONCLUSIONS

Post-prostatectomy continence rate and a time to achieve a final continence status may be influenced by many factors thus prediction of PPI is not easy. Efforts in assessing those risks will help patients and urologists in the decision-making process before surgery, and lead to the implementation of additional modifications during surgery or intensification of the post-prostatectomy PFMT program. Currently available RP modifications lead to better results in earlier continence recovery with not very significant long-term improvement.

CONFLICTS OF INTEREST

The authors declare no conflicts of interest.

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