Improving Urinary Continence after Radical Prostatectomy: Review of Surgical Modifications

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Purpose: Urinary incontinence remains the most feared long-term complication following radical prostatectomy with potentially devastating psychosocial consequences. In recent years, several surgical techniques have been introduced during radical prostatectomy, both open and laparoscopic/robotic, in the hope of improving urinary continence outcomes. Herein, we review the various surgical modifications that have shown a benefit in minimizing post-prostatectomy urinary incontinence (PPI).

Materials and Methods: A comprehensive review of the current urologic literature was conducted to identify surgical techniques that have been correlated with improved continence following radical prostatectomy.

Results: Over the years, several surgical modifications have been incorporated into radical prostatectomy in order to minimize the risk of prolonged PPI. Most techniques emphasize the importance of restoring the "normal" pelvic anatomy after removal of the prostate gland. In addition, certain patient factors such as preoperative posterior urethral length and patient age appear to have an independent prognostic value in predicting PPI. Postoperatively, bladder neck contracture remains the most consistent complication leading to PPI.

Conclusions: The present findings suggest that the risk of PPI can be minimized, or even eliminated, through careful patient selection and surgical modifications during radical prostatectomy. **(Korean J Urol 2009;50:935-941)**

Key Words: Prostatectomy, Urinary incontinence, Prostatic neoplasms

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INTRODUCTION

Urinary incontinence remains a common complication following radical prostatectomy, with a current incidence ranging from 1% to 69% [1-4]. The wide variability in the reported rates of post-prostatectomy urinary incontinence (PPI) is largely due to inconsistent definitions of PPI by various investigators as well as differences in the methodology of data collection [5-8] and experience of surgeons [9]. Nevertheless, prolonged or permanent PPI is poorly tolerated by most patients, and quality of life is significantly compromised in these men [10,11].

The causes of urinary incontinence after radical prostatectomy are likely multi-factorial and include both functional and anatomical changes related to removal of the prostate gland and alterations in the pelvic floor musculature and the urinary sphincter complex [12-15]. In addition, patient's age at surgery, the status of nerve sparing, and bladder neck contracture have all been identified as independent predictors of significant PPI [16,17].

Several surgical modifications during radical prostatectomy are now available to potentially reduce the incidence and duration of PPI. Although the physiologic mechanism of male urinary continence after radical prostatectomy is poorly understood, most surgeons agree that meticulous hemostasis, precise anatomical dissection of the prostate apex, providing structural support to the posterior urethra, and creating a watertight vesicourethral anastomosis are the key surgical steps in ensuring

excellent continence outcomes [18,19]. Herein, we review the current and past surgical techniques aimed at improving urinary continence at the time of radical prostatectomy.

PERI-URETHRAL SUSPENSION

The concept of peri-urethral suspension is based on an observation that in the normal pelvic anatomy, the urethra is fixated, via the pubo-prostatic ligaments, to the posterior pubis [20]. It has been purported that anterior urethral fixation with peri-urethral suspension stitches reduces urethral hypermobility and aids in external sphincteric function after radical prostatectomy [21]. In a single institutional series, Campenni et al evaluated the impact of peri-urethral suspension in 50 consecutively treated men undergoing radical retropubic prostatectomy (RRP), with the first 25 men serving as controls. In their technique, two sutures of 2-0 Monocryl placed in the anterior vesico-urethral anastomosis are anchored to the lower portion of the pubic bone periosteum after completion of urinary continuity. At 6 months postoperatively, the rates of continence were 84% (suspension) and 64% (control), respectively [22]. No continence data were available for an earlier postoperative time point.

In a prospective, single-blind, randomized trial, Noguchi et al assessed the effect of their surgical modification of peri-urethral suspension. A total of 60 men who underwent an RRP by a single surgeon were randomly assigned to two groups. The suspension technique involved preservation of the pubo-prostatic ligaments as well as the anterior urethral ligamentous attachments, and anchoring of the anterior vesico-urethral anastomosis to the pubo-prostatic ligaments. The suspension technique resulted in significantly greater continence rates at 1, 3, and 6 months after RRP of 53% versus 20%, 73% versus 47%, and 100% versus 83%; the mean time to continence in the suspension group was 31 days versus 90 days in the control group. In the multivariate analyses, the suspension technique and age at surgery were the only two clinical parameters associated with a return of continence after radical prostatectomy [23]. The same investigators performed multi-channel urodynamics testing in men with and without peri-urethral suspension in an earlier study, and interestingly, there was no significant difference in urodynamics parameters between the two groups despite the higher continence rate in the suspension group [24].

Patel et al analyzed the continence outcomes of the peri-urethral suspension stitch incorporated during robotic-assisted laparoscopic radical prostatectomy (RALP) [25]; all RALP cases were performed transperitoneally by a single surgeon. In a prospective analysis of 331 consecutively treated patients, the suspension stitch was utilized in 237 men with the remaining men serving as the control group. Although robotically executed, the suspension technique in this study mirrored that of the open approach developed by Walsh in which a single suture was used to ligate the dorsal vein complex and secured to the periosteum of the pubic bone. At 1, 3, and 6 months of follow-up, 40%, 93%, and 98% of men with suspension were continent in contrast with 33%, 83%, and 95% of men in the control group; only the difference at 3 months was considered statistically significant [19]. In addition, there was no impact on the frequency of positive surgical margins by the introduction of the suspension stitch.

PRESERVATION OF LATERAL PROSTATIC FASCIA

Mixed innervation of the proximal urethra through the pudendal nerve and pelvic hypogastric plexus appears to be critical for proper external urethral sphincter function [26,27]. It has been postulated that urethral sphincter innervation is closely related to the prostate apex, and some of the key nerve branches modulating passive urethral closure enter the urethra from the anterolateral aspects of the lateral fascia [28]. Consequently, aggressive surgical dissection lateral to the posterior urethra may injure both pudendal and pelvic nerve branches responsible for urethral closure resulting in protracted PPI. Consistent with this theory, Menon et al recently published their experience with preservation of the lateral prostatic fascia (veil of Aphrodite) during RALP in which the bladder neck was transected without incising the endopelvic fascia. The dorsal vein complex was ligated only after dissection of the prostatic apex, thus minimizing any tissue disruption lateral to the membranous urethra [29]. In their series of 2,625 patients, complete continence information was obtained from 1,142 patients at a minimum follow-up of 12 months. Median duration to incontinence (use of one pad or less per day) was 4 weeks, and the continence rates at 3 and 12 months were 90% and 95.2%, respectively. The positive surgical margin rate was 13%, and the actuarial 5-year biochemical recurrence rate was 8.4%.

Most recently, van der Poel et al correlated their scoring system of lateral pelvic fascia preservation with the risk of post-prostatectomy incontinence in 151 men treated with RALP

by a single surgeon [30]. At 6 and 12 months postoperatively, 46% and 30% of men reported some degree of PPI (no further data provided). In their logistic regression analyses, preservation of the lateral aspects of the prostatic fascia reduced the risk of PPI at 6 months by 60% and was the most important clinical parameter in predicting post-prostatectomy continence. The authors did not offer any specific explanation in regard to the rather high incontinence rates in their patient cohort.

TECHNIQUES TO PRESERVE THE BLADDER NECK

In the male anatomy, passive urinary control is regulated by two dominant mechanisms: the striated urethral sphincter and the pre-prostatic sphincter/bladder neck [31,32]. With radical prostatectomy, the pre-prostatic sphincter/bladder neck is compromised, and it remains speculative whether functionality of the bladder neck continence can be recapitulated with surgical modifications [33]. To evaluate the effect of bladder neck preservation, Deliveliotis et al examined the continence outcomes of 149 men undergoing RRP by a single surgeon [34]. Based on the surgical techniques utilized, the men were stratified into three groups: bladder neck preservation (group 1), puboprostatic ligament sparing (group 2), and the combination technique (group 3). Although the overall continence rates at 1 year were similar among the groups, an earlier return of continence was observed in groups 1 and 3 compared with group 2, which was statistically significant. There was no disparity in regard to margin-positive rates among the groups. In contrast, Srougi et al observed no impact on continence rates in a randomized trial based on bladder neck preservation [35]. There was no statistical difference in the return of continence at 2 days, 2 months, and 6 months postoperatively. That trial was terminated early because of to a significantly higher rate of a positive bladder neck margin in the bladder neck preservation group (10% vs. 0%; p=0.08).

In a video-based analysis of their RRP experience, Walsh and Schke could not identify any consistent intraoperative factor, with respect to apical dissection and sphincter preservation, responsible for the earlier return of urinary control. Subsequently, they evaluated the continence outcomes after bladder neck reconstruction in the form of intussusception using buttressing sutures during radical retropubic prostatectomy in 45 men with clinically localized prostate cancer. At 3 months, 82% of these men were continent compared with 54% in their prior report [36]. Although the initial results were promising, the authors recommended longer follow-up before incorporating this technique in all patients undergoing RRP.

RECTUS FASCIAL SLING AT RADICAL PROSTATECTOMY

Fascial sling suspension of the bladder neck has long been used in the management of severe sphincter incompetence and neurogenic bladder [37,38]. The major drawbacks of the native facial sling procedure include increased morbidity and pain related to facial harvest, longer operative time, and the risk of postoperative retention. In a series of 30 men undergoing RRP, Jorion placed a rectus fascial sling after completion of the vesico-urethral junction [39]. These men were compared with 30 previous patients who underwent RRP without sling placement. At 1 month and 6 months postoperatively, the continence rates in the sling group were 60% and 93%, respectively, which were significantly higher than in the non-sling group (33% and 70%, respectively). There were 2 cases of urinary retention in the sling group, which resolved spontaneously over time. The author emphasized the importance of avoiding any tension when placing the sling. No data were provided with respect to operative time. In a more recent series, Altinova et al reported their experience with the anterior rectus fascial sling in 40 men undergoing RRP [40]. Compared with the non-sling patients, these men had a significantly higher rate of continence at 12 months (83% versus 57%). No information was provided with regard to operative time, postoperative retention, or other complications. In contrast with these two reports, Westney et al from The University of Texas M.D. Anderson Cancer Center found no significant difference in the incidence of PPI between the groups of high-risk men (prior TURP, morbid obesity, and prior radiotherapy) with and without the sling procedure at the time of RRP [41]. The overall social continence (0-1 pad per day) rates were 59% and 70% in men with and without the sling modification, respectively, at 6 months of follow-up. In addition, the urethral stricture rate was much greater in the sling group (35% versus 14%). Based on these observations, these authors did not support the routine use of a rectus sling at the time of radical prostatectomy in men at high risk of urinary incontinence after RRP.

POSTERIOR URETHRAL LENGTH AND PRESERVATION

For reasons not well understood, the time to reach final continence status varies greatly among all prostatectomy patients, including those with similar physical characteristics. One anatomical variation that exists among individuals is different lengths of the posterior urethra in relation to the prostate apex and pelvic floor musculature, which might explain discrepancies in time to urinary continence in these men [12-14]. In a series of 33 fresh cadaver dissections conducted by Myers, the length of the distal portion of the posterior urethra ranged from 1.3 to 2.8 cm [32]. Evidence from several studies suggests that urinary continence following radical prostatectomy is essentially a function of the extent to which the maximum possible urethral length is preserved. In all but one study reviewed [42], surgical procedures designed to preserve the maximum possible urethral length were associated with a reduced incidence of PPI [43,44].

The concept of a threshold membranous urethral length necessary for continence is further supported by a recent publication in which van Randenborgh et al reported improved urinary continence (89% vs. 76%) in patients whose posterior urethra was lengthened by freeing up the intra-prostatic portion of the urethra versus the control group who underwent a standard radical prostatectomy [45]. In another study, Coakley et al used an endorectal MRI to measure the length of the membranous urethra preoperatively and correlate that with PPI outcomes in 211 patients [46]. The results showed that a longer posterior urethra was associated with significantly more rapid recovery of urinary continence after RRP. These findings strongly suggest that attempting to secure as much membranous urethral length as possible appears to be a worthy goal during apical dissection.

ANTERIOR COLLAR AND POSTERIOR RHABDOSPHINCTER RECONSTRUCTION

As mentioned above, urethral shortening is a common event during radical prostatectomy, which leads to decreased urethral closing pressure and maximum urethral pressure [47]. Based on their open RRP experience, Rocco et al proposed that the primary cause of PPI is related to caudal retraction of the rhabdosphincter complex and disruption of the posterior median fibrous raphe during apical dissection. In response to this observation, these investigators subsequently developed a novel surgical technique of restoring the posterior infrastructure of the membranous urethra, in which the posterior fibrous tissues of the external sphincter complex are fixated to the proximal Denonvillier's fascia and the posterior bladder wall, prior to initiation of the vesico-urethral anastomosis [48]. In a recent publication, Rocco et al reported their early and long-term continence outcomes based on this technique [49]. Posterior reconstruction was performed in 250 men undergoing RRP, and another 50 men served as the control group. At 3 months, 85.2% of the study group achieved continence (0-1 pad per day) compared with only 46% in the control group; long-term continence results were similar between the two groups (94% vs. 90%). The authors surmised that posterior reconstruction leads to early continence without adverse effects.

In an attempt to improve continence outcomes following radical prostatectomy, Tewari et al conducted a detailed fresh-cadaver-based study and concluded that preservation of the entire puboprostatic musculoligamentous complex and reconstructing the arcus tendineus and pubo-prostatic complex - also known as anterior reconstruction - can further aid in early recovery of urinary continence after RALP [4]. His group evaluated the impact of posterior and anterior reconstructions during RALP in relation to urinary continence and further stratified the data according to patients' posterior urethral lengths measured by preoperative endorectal MRI [14]. At 6 months postoperatively, the continence rate in the shorter sphincteric group (less than 14 mm) was 47% for the control technique (no reconstruction), 81% for anterior reconstruction, and 90% for both anterior and posterior reconstruction. The continence results were further enhanced in the longer sphincter group (greater than 14 mm): 80%, 83%, and 99%, respectively.

With recent reports favoring anterior or posterior reconstruction or both, Menon et al recently completed a double-blinded randomized clinical trial comparing early continence rates in patients completing RALP with or without posterior reconstruction [50]. A total of 116 consecutively treated patients were enrolled and randomly assigned. In contrast with other studies, this group did not find any significant disparity in early continence rates (74% without and 80% with at 1 month) between the two groups. The authors concluded that the lack of meaningful difference between these groups was due to outstanding early

continence rates in both groups, which were not evident in other series. Because of the unique set-up in regard to RALP at the authors' institution (a high-volume, extensive RALP experience; a uniform surgical technique; etc), the authors correctly pointed out that the results of their single-center experience may not be applicable to all surgeons. Although posterior reconstruction did not correlate with improved early continence rates, there was a significantly lower anastomotic leak rate in this group compared with the control (3% vs. 10%).

MISCELLANEOUS

Controversy exists in regard to the role of nerve sparing and its contribution in preventing PPI. One of the more recent series examined the correlation of nerve-sparing status and return to baseline urinary function in men undergoing radical prostatectomy by all approaches (open, laparoscopic, and robotic) [51]. Multivariate analysis of 628 men who underwent a radical prostatectomy and were followed up to 36 months demonstrated that there was no correlation between type of nerve sparing, type of surgery, and postoperative urinary dysfunction. Although not statistically significant, the laparoscopic approach portended a poorer prognosis with respect to the longer time interval to continence.

John and Hauri investigated the relationship between seminal vesicle-sparing radical prostatectomy and early urinary continence [52]. In a pilot study of 20 patients, the continence rates in this group were 60% and 95% at 6 weeks and 6 months, respectively, compared with 18% and 82% in the control group. The authors surmised that there is less damage to the pelvic nerve plexus with this approach but that a well-conducted randomized trial will be required before this technique is routinely incorporated into radical prostatectomy.

CONCLUSIONS

Urinary incontinence represents a common morbidity following radical prostatectomy and can be associated with significant psychosocial stress and poor quality of life. Improved understanding of the pelvic anatomy and urinary sphincter complex has led to surgical modifications that can potentially overcome the anatomical shortcomings of the standard approach. Although these techniques may result in improved continence after radical prostatectomy, careful and judicious patient selection combined with meticulous surgical dissection and precise urinary reconstruction remain the cornerstone of successful surgical outcomes. Further research is needed to elucidate both anatomical and functional changes that are responsible for a proper return of urinary continence after radical prostatectomy.

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