Anatomical, surgical and technical factors influencing continence after radical prostatectomy

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Carlos Arroyo, Alberto Martini, Joanna Wang and Ashutosh K. Tewari

Abstract: Radical prostatectomy (RP) is the most frequent treatment with curative intent performed for prostate cancer to date. Different surgical approaches (perineal, transperitoneal, and extraperitoneal) and techniques (laparoscopic and robot assisted) have been described to increase the efficiency and potentially diminish the postoperative complications of this procedure.
The aim of this narrative review is to investigate and define the factors that influence postprostatectomy urinary continence. We highlighted the anatomical landmarks and the modifications of surgical techniques aimed at improving the continence rates and thus, patient quality of life.
After RP, the long-term continence rates range from 84% to 97%. In order to achieve good continence rates, a careful dissection along with meticulous anatomical reconstruction is required. To this end, a detailed knowledge of the periprostatic anatomy is mandatory.

Keywords: radical prostatectomy, laparoscopic radical prostatectomy, robot assisted radical prostatectomy, secondary incontinence, radical prostatectomy complications

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Introduction

Radical prostatectomy (RP) remains the most frequent treatment with curative intent performed for prostate cancer to date. Different surgical approaches (perineal, transperitoneal, and extraperitoneal) and techniques (laparoscopic and robot assisted) are considered to increase the efficiency and potentially diminish the postoperative complications of this procedure. While the main objective of RP is the oncological control, the ideal pentafecta management (negative biochemical recurrence, negative surgical margins, total continence, adequate erectile function, and absence of perioperative complications[1]) is vital to strive for as well. Thanks to a deeper understanding of prostatic anatomy, modifications of the surgical approach, and technical advances over the last decade, RP has been increasingly successful in achieving these outcomes.

Continence and micturition are complex processes involving intricate interactions between the autonomic sympathetic and parasympathetic nervous systems. Coordinated neuromuscular activity is necessary to allow for urethral sphincter contraction and bladder detrusor relaxation during the filling phase, and the same applies for the micturition process.

One of the main issues after RP is urinary incontinence (UI). After surgery, the components essential for continence are invariably affected, with different extent. These encompass the muscular component (bladder neck, internal and external rhabdosphincter, membranous urethra, puboperinealis, and pelvic floor muscles), support structures of the sphincteric complex (*arcus tendinosus*, puboprostatic ligament, detrusor apron, *Denonvilliers' fascia* (DF), pelvic bones, and pelvic floor levator ani muscle), and the ligaments that support the bladder and urethra toward the anterior abdominal wall and pelvis. The incidence of UI is reported to vary from 8 to 87% in the relatively short term after RP, but usually diminishes to 3–10% in the first 2 years after RP. However, the incontinence

Correspondence to:
Carlos Arroyo
Department of Urology, Hospital Ángeles Puebla, Universidad Anahuac, School of Medicine, Puebla, c.p.72820, Puebla, Mexico
jcakurologia@yahoo.com.mx

Alberto Martini
Joanna Wang
Ashutosh K. Tewari
Department of Urology, Icahn School of Medicine at Mount Sinai, New York, USA

rates have been shown to rise up to 17% 15 years after RP.[2]

Despite the complex nature of UI, it has been schematically divided into UI of urethral or detrusor origin. The urethral component results from sphincteric incompetence, which may be a result of short urethral stump length, loss of neural innervations, muscle damage and loss of the surrounding support tissue. The detrusor elements involve *de novo* bladder instability, detrusor overactivity or hypocontractility due to neural damage or diminished bladder compliance.[3]

Preservation of post-RP continence and fluctuations in UI rates, therefore, is multifactorial. These factors encompass not only anatomical and surgical aspects, but patient characteristics also. Specifically, a patient's age (<65) and lower preoperative International Prostate Symptom Score are directly associated with better continence rates.[4] While some patient features, including body mass index, preoperative continence level, large prostatic volume, and narrow bone pelvis, increase the difficulty of the procedure, they have not demonstrated influencing overall continence outcomes.

The aim of this narrative review is to investigate and define the factors that influence the preservation of postprostatectomy continence. The present article will span from the description of anatomical landmarks to the modifications of surgical techniques designed to improve the continence rates and thus, patient quality of life.

Anatomical considerations

In addition to long-term oncologic control, one of the main patient concerns after RP is the recovery of urinary continence, as it bears a significant impact on quality of life. It has been shown that bilateral nerve-sparing procedures preserve the motor innervation of the urethral sphincter and thus, result in improved postoperative continence rates.[5] Therefore, particular attention to nerve preservation is currently performed; not only to protect erectile function, but also urinary continence. Prominent anatomical structures involved in urinary continence to be discussed in detail include the bladder neck and urethral sphincters, the levator ani muscle, the puboprostatic ligament, the detrusor apron extension, the endopelvic fascia, and the neurovascular bundle (NVB), Table 1.

In his 1982 article, Walsh described in detail the first nerve-sparing RP in which the crucial periprostatic tissues were identified and preserved.[6] The inferior hypogastric plexus, as he described, is formed by sympathetic (T11 to L2) fibers and parasympathetic (S2 to S4) fibers that provide autonomic innervation to the pelvic organs and external genitalia. Situated retroperitoneally along the rectum, this plexus travels along the posterolateral aspect of the prostate and descends posterolaterally to the urethra before penetrating the urogenital diaphragm where it continues posterior to the dorsal penile artery. Intraoperatively, these nerves can be recognized along the endopelvic fascia, traveling outside of the prostatic capsule and DF until it sends capsular perforations to innervate the prostate.[6]

A network of neural fibers around the prostate and seminal vesicles distributed in a hammock or fan-like trizonal pattern has been described, composed of the proximal neurovascular plate, predominant NVB, and accessory neural pathways distributed around the prostate.[7] The periprostatic fascia has traditionally been divided into two layers for practical surgical landmarks. The nerve-sparing procedure is, therefore, termed interfascial if done between the lateral and medial layers, or intrafascial if done close to the prostatic capsule below the fascia. Histologically, however, there is evidence that the periprostatic fascia has actually a multilayered structure, which may have an impact on how the nerve-sparing technique is performed in the future.[8]

The lateral aspect of the prostate involves the tendinous arch of the pelvic fascia, which lies in close contact to the prostatic capsule. Though its thickness varies between individuals, it is not directly attached to the prostatic capsule. Rather, it consists of loose connective tissue that can be dissected away from the prostate to free up and preserve the NVB without damage.[9]

A more recent focus has been oriented toward the detrusor apron, which is an extension of the anterior wall of the bladder that is in direct continuity with the pubis and spreads around the prostate. Nearby, the musculotendinous sheet of the pubococcygeus contributes to the visceral endopelvic fascia, which crosses anterior to the detrusor apron and fixes to the pubis. Initially described by Santorini in 1724, the detrusor fibers were said to extend past the bladder neck, spread around the prostate, and collect at the pubis. Subsequent

Table 1. Anatomical structures involved in continence.

- Nerves
  - Pudendal nerves
  - Pelvic nerves:
    1. Somatic nerves
    2. Autonomic inferior hypogastric neural plexus:
       - Sympathetic nerves:
         - T-11 to L-2 ganglia
       - Parasympathetic nerves:
         - S-2 to S-4 spinal nerves
- Muscles
  - Bladder neck and membranous urethra:
    1. Inner lissosphincter:
       - Longitudinal fibers
       - Circular fibers
    2. External rhabdosphincter
  - Puboperinealis
  - *Levator ani*
- Fibrous structures
  1. Anterior:
     - Retzius fibrous attachments
     - Detrusor apron:
       (a) Anterior musculotendinous with three layers:
         - Anterior to the decussated pubococcygeal fibers
         - Middle layer to the dorsal vascular complex
         - Posterior layer to the dorsal vascular complex and prostate

       (b) Puboprostatic ligament
  2. Posterior:
     - Urethropelvic ligament
     - *Denonvilliers' fascia*
  3. Lateral:
     - Periprostatic fascia:
       - Multilayer
     - Endopelvic fascia:
       - Derived from pubococcygeous ligament
     - *Archus tendinosus*
  4. Pubic bone

studies have confirmed and expanded on this description. Anterior to the prostate, the detrusor apron splits into an anterior, middle, and posterior layer. The anterior layer passes posteriorly to the decussated pubococcygeal fibers, defuses antero-inferiorly, and anchors onto the posterior surface of the pubic bone. The middle layer is loose and joins with the fascial sheath of the dorsal venous complex (DVC). Lastly, the posterior layer encloses and extends into the prostate to form the anterior fibromuscular stroma (AFMS) of the prostate.[10]

The detrusor apron has since been considered a key part of the AFMS, a thick sheet of tissue obscuring the entire anterior external surface of the prostate. Completely devoid of glandular tissue, this structure is instead comprised of fibrous and smooth muscle elements continuous with the detrusor fibers of the anterior bladder wall. Distally, it is shown to end proximal to the beginning of the striated urethral sphincter.[11]

Another significant anatomical structure whose preservation is essential for continence is the urethra. In general, the preservation of a long urethral stump with its lateral supporting tissue is of paramount importance to reduce the risk of postoperative incontinence. It has been shown that the membranous urethra retracts proximally immediately after RP while the urethral stump retracts toward the bladder after the urethrovesical anastomosis. These processes can negatively impact the urethral sphincter function and the urethral closure pressure, cumulatively causing UI. Over time, however, these changes can return to their preoperative location, recovering the urethral closure pressure and re-establishing urinary

Table 2. Strategies used to increase continence rates.

- Preservation
  - Retzius space
  - Bladder neck
  - Seminal vesicles (not routinely recommended)
  - Nerve bundle(s)
  - Puboprostatic ligaments
  - Maximal urethral length
  - Endopelvic fascia
  - Detrusor apron
- Reconsctruction
  1. Posterior urethral support:
     - *Denonvilliers' fascia*, pubourethralis ligament, endpelvic fascia, *levator ani, arcus tendinosus fascia*
  2. Anterior puboprostatic support:
     - Puboprostatic ligament, detrusor apron
  3. Combined or total
  4. Bladder neck
- Surgical modifications from traditional techniques
  - Continuous suture
  - Barbed sutures
  - Suprapubic catheter

continence.[12] By leaving a long residual urethral stump, there is reduced migration of the membranous urethra and thus, earlier continence rates after RP.

It is important to note that the urethral sphincter complex consists not only of the external rhabdosphincter (skeletal muscles fibers from the perineal membrane to the prostatic apex) and the inner lissosphincter (a complete cylinder of circular and longitudinal muscle fibers around the urethra),[13] but also of the membranous urethra and its surrounding support structures. These include the pelvic diaphragm, rhabdosphincter and supporting fascia. In fact, the pelvic diaphragm length has been shown associated with the functional urethral length, which is further related to the functional sphincteric role and the return to continence. Thus, it may be more crucial to preserve the distal portion of the membranous urethra rather than the full length, given the location of its surrounding tissue of the pelvic diaphragm.[14] Magnetic resonance imaging studies further support that a longer membranous urethral length and a close relation between the *levator ani* muscle and the membranous urethra have a beneficial impact on continence recovery.[15]

With the goal of optimizing the membranous urethral stump length, a synchronous, posterior-to-anterior urethral transection approach to the apical dissection has been proposed. Using a 30° upward-facing lens, there is improved visualization and transection at the transition between the prostatic apex and membranous urethra. Additional benefits of this approach include precise dissection of the apical neural scaffold and control of the DVC. This proposed synchronous approach, therefore, allows for optimal membranous urethral preservation without compromising the surgical margins, a set up for maximizing chances of early return of continence.[16]

In summary, preservation of the aforementioned anatomical structures (the endopelvic fascia, the detrusor apron, the neural preservation *via* an intrafascial dissection, and the length of the membranous urethra) allow an adequate support system to remain. This helps to keep the urethral sphincter function as intact as possible to provide an earlier return of continence.

Surgical technique modifications

In addition to the aforementioned anatomical considerations, there are modifications of the surgical technique that can contribute to maintaining urinary continence after surgery. RPs have evolved significantly over the past several decades. One of the most important advances is represented by the surgical platforms available, evolving from open to laparoscopic to, most recently, robot assisted. This latest modality consists of the same surgical steps, yet it offers better visualization (three-dimensional video and augmented image) and maneuverability (endowrist technology). Surgical strategies aimed at improving continence are listed in Table 2.

Retzius space preservation

When the transperitoneal rather than the total extraperitoneal approach is adopted, a larger working surgical space and clearer recognition of anatomical structures is allowed.

Traditionally, RPs are done by opening the Retzius space in order to gain access to the prostate. The Retzius-sparing technique resembles the older open radical perineal approach and implies opening the peritoneum over the *vas deferens* and seminal vesicles with its dissection.

It has been reported that the Retzius-sparing robotic-assisted laparoscopic prostatectomy (RALP) provides equivocal oncologic control to those of conventional RALP, as well as superb continence rates with 70% of patients completely dry and 92% with no pad use at 1 month.[17] Similarly, other studies comment on the early recovery rates of continence with the Retzius-sparing approach, reporting postoperative continence of 20% *versus* 8% within the first month after Retzius-sparing *versus* conventional RALP, respectively.[18]

These recovery differences could be the result of keeping the bladder attachments intact, as the pubovesical complex, detrusor apron, *levator ani, arcus tendinosus*, pubourethral ligaments, accessory pudendal arteries, and anterior fixation of the bladder to the abdominal wall are all left untouched with this technique. Collectively, these structures create an important suspensory mechanism that prevents the prolapse of the pelvic structures and urethral hypermobility while also preserving the vesicoprostatic junction angle.[19] As seen on postoperative cystograms, preservation of this angle translates into decreased bladder neck descent, a phenomenon which could be responsible for the immediate continence reported in patients.[20] Of note, some studies report no significant differences in urinary continence 1-year post-RALP, regardless of which approach is used.[21]

Bladder neck preservation

It is possible to individualize the bladder neck dissection, which is done by gentle separation of the muscle fibers of the superficial bladder wall. Under the guidance of optical magnification, the fiber patterns can be identified and a space laterally to the bladder neck can be created. This step allows the urethral mobilization and dissection of the *vas deferens* and seminal vesicles in order to gain access to DF. This dissection also frees the seminal vesicles and bladder neck away from the distal urethra and prostate, allowing for the urethral cut to be completed with cold scissors with the maximal length preserved and under visualization. Others have cut the fibers of the detrusor muscle at the insertion of the ventral aspect of the base of the prostate to allow maximal length of preservation of the internal sphincter.[22]

A variation in the bladder neck preservation technique is *via* a lateral approach, which requires precise identification of the detrusor muscle fibers at the junction of the lateral bladder neck and prostate base. It requires preserving the circular muscle fibers of the bladder neck until the proximal urethral mucosa is identified in order to create a space from the side of the bladder neck up to the seminal vesicles. Once the mucosa is dissected circumferentially, it is cut under direct vision. This modification provides a surgical margin rate similar to that of the anterior approach, but it includes the added benefit of continence recovery to 80% at 1 week and 92% at 4 weeks after surgery.[23]

It is important to consider that efforts to preserve the bladder neck could compromise oncologic control, especially in patients with advanced disease. Bladder neck preservation has been reported with 7–29% positive surgical margins,[24] although a meta-analysis reported that there is no significant increased risk of positive surgical margins nor biochemical failure. Even though there are papers that do not find a significant difference in continence rates with and without bladder neck preservation,[25] there are several studies that show that early continence rates are better with this technique and could even diminish the risk of bladder neck contracture or stenosis.[26] However, there are also other articles that show no difference in long-term continence rates with patients that had bladder neck reconstruction instead of preservation.[27]

Seminal vesicle preservation

Several papers describe the preservation of the tips of the seminal vesicle during the dissection of the bladder neck and NVB. Sectioning the seminal vesicles near the tip would create a larger margin away from the nearby pelvic nerves and theoretically improve continence.[28] Similarly, another study hypothesized that this modification would diminish damage to the NVB, and found superior preservation of continence (95% *versus* 28%), erectile function (drop of 5 *versus* 14.5 points on the International Index for Erectile Function (IIEF-5) score), and quality of orgasms (90% *versus* 62%) compared with the control group.[29]

Some argue that the remaining seminal vesicle tissue produces prostate-specific antigen (PSA) and can compromise the validity of post-RP oncologic follow up. However, further investigations have shown that the low PSA-expression levels can only be detected on molecular biological and immunohistochemical techniques, but not at the serum PSA level. Thus, any rise in serum PSA detected on follow up should still be attributed to residual prostatic tissue or metastasis.[30]

This procedure is not currently accepted nor recommended for standard practice. With the recent use of magnetic resonance to predict the location and size of the prostate cancer prior to RP, there have been several experimental procedures tailored to treat only the index prostatic lesion. In the same manner, perhaps there will be a role for seminal vesicle preservation in future cases considered optimal for this modification.

Intra and interfascial nerve preservation

There are three major groups of nerves crucial for the sphincteric mechanism: (a) the pudendal nerve that supplies the external striated rhabdosphincter; (b) a dense autonomic nerve supply to the internal sphincter; and (c) the cavernosal nerves of the NVB that innervate the membranous urethra.[31] Looking closer at the NVB, these cavernosal nerves travel with the prostatic supply and descend along the posterolateral surface of the prostate. Nearby, the supply to the rectum travels in the posterior and posterolateral sections, while the supply to the levator is found within the lateral pelvic fascia.[32]

A current strategy to preserve the neurovascular hammock involves an anatomical, trizonal, traction-free, athermal and risk-stratified technique.[33] This intrafascial dissection starts in the medial avascular compartment and heads towards DF to develop a retroprostatic space. Once established, the retroprostatic space is extended distally to expose the prostato-urethral junction. By carefully dissecting laterally, the predominant NVB is brought away from the posterolateral surface of the prostate. This is continued until a plane is created between the neurovascular hammock and the lateral edge of the prostate and repeated on the contralateral side. With the entire posterior aspect of the hammock freed, the hammock is now only adhered to the prostate at the anterolateral edges bilaterally. It is here that the fascial compartments fuse with the endopelvic fascia and the AFMS.

This nerve-preserving technique has been referred to as the ‘veil of Aphrodite,’ ‘curtain dissection,’ or ‘high anterior release’ technique. Current descriptions advocate for the intrafascial dissection that releases the NVB under the prostatic fascia, one layer closer to the prostatic surface, and the interfascial approach in the avascular plane between the prostate capsule and the prostatic fascia.[34]

According to the multilayer structure of the LPF, different grades of nerve-sparing have been described: grade I: where the incision of the DF and the lateral pelvic fascia (LPF) is made just external to prostatic capsule; grade II: where the incision of the DF and LPF is made just external to the layer of veins of the capsule; and grade III: where the incision is made through the outer compartment of the LPF, and all layers of the DF are excised.[33] It is remarkable that a careful patient selection for NVB preservation is required.[35]

The intrafascial technique has proven to be superior to the interfascial technique in a meta-analysis, likely due to lesser nerve damage.[36] The preservation of the NVB not only influences the degree of erectile function after surgery, but also the rate of urinary continence. These effects may be attributable to the conservation of the motor innervation of the urethral sphincter through special branches originating from the dorsal nerve of the penis, which lies in close proximity to the prostatic apex. It has also been mentioned that damage to the afferent autonomic innervation of the membranous urethra results in impaired urethral sensitivity with UI, as well as diminishing urethral vascular microcirculation.[37] In fact, it has been reported that the resection of the NVB even just unilaterally significantly reduces the return of postoperatory continence,[5] with a 1.8-fold higher chance of recovering full continence when a bilateral rather than unilateral nerve preservation is performed.[38] Finally, by undertaking an intrafascial nerve-sparing procedure, there is preservation of the periprostatic supporting structures that are essential for the recovery of continence.[39]

Preservation of the deep venous complex and puboprostatic ligament

In open RP, the preservation of the Santorini complex was achieved by passing forceps with a suture into the space between the Santorini plexus and the urethra to ligate and anchor the DVC to the pubic symphysis. The Santorini plexus was then sharply transected over the lower half of the prostate and dissected toward the apex.[40] This has also been done laparoscopically and has been described as a complete periprostatic anatomic preservation or a DVC-preserving technique for intrafascial nerve-sparing laparoscopic RP and puboprostatic ligament preservation. All of the above modifications involve the preservation of the puboprostatic ligament, with the placement of a suture for hemostasis of the DVC and the AFMS. Superior continence rates (57%, 77%, 95%) have been documented with this surgical technique compared with both the conventional, non-DVC preserving procedure (37%, 63%, and 90%) and no-nerve-sparing technique (23%, 57% and 82%) at 1, 3, and 12 months post-RP, respectively. All three techniques yielded similar positive surgical margins rates (11%).[41]

There are other descriptions of partial preservation of the puboprostatic ligament, such as that put forth by the Vattikuti Institute. Their current technique avoids bulk ligation of the DVC and cuts the puboprostatic ligament up to the apical prostatic notch. This method avoids skeletonizing the urethra in order to maintain the fibrovascular support of the urethra. In select patients with low-volume disease, preservation of the AFMS has been pursued as well.[42]

Distal urethral preservation

The preservation of the membranous urethra and its supporting structures increases the likelihood of continence after RP. Blunt dissection of the urethra distal to the prostatic apex should ideally be carried out, given no unexpected intraoperative findings. The verumontanum has been proposed as the anatomical landmark for the dissection, as this would allow for adequate preservation of the external striated sphincter and its autonomic innervations that lie just distally. Dissection in this location also creates a margin between the inflammation that occurs during the postoperative scarring process and the sphincteric structures. Overall, this technique allows for earlier return of continence, with the caveat that continence rates is reportedly equaled by 1 year in patients who do not undergo distal urethral preservation.[43]

Bladder neck reconstruction

Bladder neck reconstruction is performed in cases for which a large bladder opening was necessary due to either the prostate volume, a large median lobe, or individual patient characteristics. While no significant differences in early continence rates were measured between the anterior and posterior reconstruction cohorts, the rates were inferior to that of the bladder neck-sparing group.[44,45]

When a posterior bladder neck reconstruction is performed, a running suture is used beginning distally and close to the trigonal aspect of the bladder neck and then toward the superior end of the bladder neck. The final morphology resembles a reversed tennis racquet, with the bladder opening diameter similar to that of the urethra. The vesicourethral anastomosis (VUA) is then completed after the reconstruction.[44]

Posterior Denonvilliers' reconstruction

Since its original description, there have been several modifications to the posterior reconstruction. The main purpose of this surgical step is to minimize urethrosphincteric sliding after RP, to provide support to the VUA, to descend the bladder neck close to the urethral stump, and to provide an adequate fulcrum of contraction for the rhabdosphincter.

The posterior reconstruction involves placing a suture approximating the cephalad portion of DF to the edge of the paraurethral remnant and the posterior portion of the bladder near the bladder neck a couple of centimeters away from its luminal edge. Some modifications entail reinforcing the bladder neck by constructing a thick muscle plane, created by suturing the lateral detrusor flaps in the posterior midline and avoiding dissection of the structures surrounding the urethra.[46]

A three-layer modification involves placing a suture from the posterior peritoneum between the bladder and rectum through the transected musculofascial plate of the posterior urethra. The needle is then passed through the retrotrigonal layer close to the bladder neck.[47] This reconstruction is associated with higher continence rates, lower rates of cystographic leaks, and overall improved patient-reported quality of life.[48] When this procedure is completed in conjunction with an anterior suspension suture from the VUA to the puboprostatic ligament, a narrower anterior and posterior vesicourethral angle has been demonstrated on cystography. This narrowed angle could support the observation of earlier recovery of urinary function.[49]

Three meta-analyses have concluded that the posterior reconstruction of the rhabdosphincter leads to earlier continence recovery and reduction of anastomotic urinary leakage.[50] When comparing patient outcomes with the posterior reconstruction *versus* nonreconstruction, the urinary continence is 49% *versus* 24% at 3 months, and 92% *versus* 79% at 1-year post-RP.[51]

Anterior suspension

A proposed technique for anterior suspension is the bladder neck fixation to the pubis, either by placing a pubourethral stitch or by suspending the bladder neck along the VUA with or without the ligated DVC to the pubic symphysis. The reported results of continence recovery, however, remain controversial.

One technique for anterior suspension involves three sutures to suspend the VUA to the posterior part of the pubic arch.[52] The first suture is used to ligate Santorini's plexus by selectively passing the needle under the plexus from left to right. Once the plexus is ligated, the same needle is passed through the retropubic tissue from right to left, and a final knot is used to fix the urethra to the posterior pubic symphysis. The remaining two sutures are used for suspension and placed with the last two VUA stitches at the 11 and 1 o'clock positions. The VUA stitches placed at these positions further serve as suspension sutures and are fixed to the pubic arch lateral to the posterior pubic symphysis.

While some authors found that anterior suspension with this technique did not improve early post-RP continence, others report continence rates of 53%, 73%, and 100% at 1, 3 and 6 months, respectively, compared with the control group rates of 20%, 47%, and 83%, respectively.[52,53]

Complete reconstruction

This technique, alternatively named the total or complete pelvic reconstruction, involves two important concepts. The first is a posterior reconstruction of the musculofascial plate before the VUA by suturing the DF to the median dorsal raphe and the periphery of the bladder neck. The second is an anterior reconstruction of the detrusor apron, with preservation or reconstruction of the puboprostatic ligaments, which is stitched to the anterior aspect of the bladder after the VUA. In a meta-analysis, the use of this bimodal reconstruction not only increased urinary continence rates in the short term (defined as weeks 1 to 12), but also in the long-term period (up to a year after surgery). Furthermore, this reconstruction was completed without an observed increase in complications, including bleeding, positive margins, and prolonged surgical time.[54] This finding has been confirmed even in patients in whom a nerve-sparing technique is not pursued.[55]

Technical innovation

Suture technique for vesicourethral anastomosis

Among the complications after a RP, two are directly associated with the anastomotic step: urinary leakage, an early complication, and anastomotic strictures, a late complication. Key technical considerations during the VUA include making the anastomosis tension free, and ensuring precise alignment between the bladder neck and urethral stump such that the end product is both nonischemic and watertight.[56]

In a meta-analysis evaluating the type of suture used during the VUA, it was shown that the continuous is superior to the interrupted suture technique in several parameters. Overall, it showed a reduction in catheterization time, anastomotic time, and rate of urinary extravasation, all without compromising the rates of continence and stricture development.[57]

Barbed sutures

The introduction of unidirectional barbed sutures has facilitated continuous suturing in laparoscopic and robotic surgery. This self-anchoring suture allows for tension to be maintained along the joint tissues without losing a watertight anastomosis. The incorporation of these sutures has been proven safe and efficient in helping the surgeon to avoid suture slippage, eliminating the need for an additional grasper or bedside assistant to maintain the tension along the anastomotic stitch. The final knot tying is omitted as well.[58]

A meta-analysis of barbed *versus* nonbarbed sutures for the VUA demonstrates that its use shortens the anastomosis and posterior reconstruction times, and thereby the global surgical time. Furthermore, it has been statistically shown that its use diminishes postoperative leakage rate and time to catheter removal while increasing the continence rates after surgery.[59]

Catheter

Though the time to urinary catheter extraction varies between hospital practices and policies, some advocate for early removal to diminish patient discomfort after surgery. It has been shown that removal as early as 2 days postoperatively results in no urine leakage, on cystographic studies. However, premature removal of the catheter is associated with acute urinary retention, attributable to anastomotic edema, diminished bladder neck smooth muscle contraction, or pain. In addition to the risk of needing catheter replacement for this complication, hasty catheter removal may also increase early and 9-month incontinence rates.[60]

The placement of a suprapubic tube instead of a urethral catheter is a proposed alternative aimed at theoretically reducing pain, bladder discomfort, incontinence rates, emergency room visits, and stenosis rates associated with urethral catheter use. However, studies do not demonstrate any significant impact of suprapubic tube placement on these factors. Suprapubic tube placement, therefore, is not routinely recommended for urine drainage after a RP.[61]

Conclusion

After RP, the continence rates in the long term range from 84% to 97%. The reasons for incontinence are multifactorial. In order to achieve good continence rates, a careful dissection is required, along with meticulous anatomical reconstruction after the specimen removal. To this end, a detailed knowledge of the periprostatic anatomy is mandatory.

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Conflict of interest statement

The authors declare that there is no conflict of interest.

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