REVIEW

Management of Urinary Incontinence Following Radical Prostatectomy: Challenges and Solutions

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Abstract: Urinary incontinence is a common and debilitating problem in patients undergoing radical prostatectomy. Current methods developed to treat urinary incontinence include conservative treatments, such as lifestyle education, pelvic muscle floor training, pharmacotherapy, and surgical treatments, such as bulking agents use, artificial urinary sphincter implants, retrourethral transobturator slings, and adjustable male sling system. Pelvic floor muscle exercise is the most common management to improve the strength of striated muscles of the pelvic floor to try to recover the sphincter weakness. Antimuscarinic drugs, phosphodiesterase inhibitors, duloxetine, and a-adrenergic drugs have been proposed as medical treatments for urinary incontinence after radical prostatectomy. Development of new surgical techniques, new surgical tools and materials, such as male slings, has provided an improvement of outcomes after UI surgery. Such improvement is still ongoing, and the uptake of new devices might lead to even better outcomes after UI surgery.

Keywords: urinary incontinence, radical prostatectomy, pelvic muscle floor exercise, artificial urinary sphincter, male slings, anticholinergic agents, PDE5 inhibitors, duloxetine

Introduction

Prostate cancer (PCa) is the most common male cancer and one of the major causes of cancer-related death. The earlier diagnosis and the development of new effective treatments have improved PCa prognosis.[1]

Radical prostatectomy (RP) and radiotherapy are the first-line treatment for localized PCa, with nearby active surveillance in specific patients.[2,3]

Most studies have shown similar oncological and functional outcomes after open versus RARP.[4,5] However, RARP warrants 3D vision of operation field allowing performance of precise and accurate surgery. Consequently, a better preservation of anatomical structure is possible, alongside a lower risk of complications.[6] Unfortunately, even after RARP, up to 31% of patients might suffer UI.[6]

Causes of postoperative urinary incontinence (UI) are extensive dissection during surgery with injuries to the internal sphincter, to the external rhabdosphincter, to the supporting structures of the urethra,[7] or to the neurovascular bundle,[8] and even the development of post-operative fibrosis.

Conservative and surgical treatments were developed for UI treatment. Conservative strategies include lifestyle education, pelvic muscle floor training (PMFT), and pharmacotherapy. Surgical treatments include bulking agents use, artificial urinary sphincter implants, retrourethral transobturator slings, and adjustable male sling systems.[9,10]

We aim to provide an overview of current evidence about male UI treatments after prostatectomy.

Pathophysiology and Diagnosis

The International Continence Society (ICS) defines UI as a condition that occurs when there is involuntary loss of urine,[11] so demonstrable as to create a hygienic or social problem. Always ICS defines overactive bladder (OAB) as a symptomatic

diagnosis characterized by urinary urgency, increased daytime frequency and/or nocturia, with or without urinary incontinence, in the absence of urinary tract infection or other detectable disease.[12] Detrusor overactivity (DO) is an urodynamic diagnosis in patients with lower urinary tract symptoms when detrusor muscle contracts during filling cystometry.[12] Almost 30% of OAB do not have DO at urodynamic study.[13]

Continence is normally determined by the combination of the detrusor muscle, the intrinsic sphincter, the rhabdosphincter, and the pubourethral ligaments.[14,15] For normal urinary function, the autonomic and voluntary nervous systems must be intact, and urinary tract muscle must be functional. RP involves the removal of the proximal urethral sphincter and pubourethral suspensory ligaments. Consequently, the rhabdosphincter becomes the main structure responsible for the urinary continence.[16] In addition, damage to the neurovascular bundle of the rhabdosphincter might affect continence recovery.[17] Such considerations might explain occurrence of SUI after RP.

Intrinsic sphincter deficiency (ISD) is the most commonly urodynamic finding observed after radical prostatectomy (67–92.4%).[18] Meanwhile DO is the second most common with a range from 33.7% to 40%.[18] From the clinical aspect, ISD is associated with SUI as a result of iatrogenic damage of the muscle fibers, while OAB and DO, characterized by urge urinary incontinence (UUI), might be the result of the iatrogenic pelvic nerve injury.[18,19] Alongside that, up to 40% patients after RP might have detrusor underactivity.[20]

The membranous urethral length (MUL) and the preoperative and postoperative urethral sphincter function are important factors contributing to post RP incontinence.[21] A longer preoperative MUL is associated with an increase in continence rates after RP.[22] According to the current guidelines, basic tests to diagnose UI must include urinalysis and bladder ultrasound with postvoid residual urine. For more information, voiding diaries and standardized questionnaires should be used, especially for spotting voiding and storage bladder disorder.[23]

After the diagnosis of urinary incontinence, the first approach should be a conservative treatment.[24] If this first-line therapy fails, more invasive tests are needed to start a surgical treatment: urethrocystoscopy to detect potential urethral disease such as bladder neck stenosis or urethral stricture, and urodynamic tests in patients with OAB symptoms or neurogenic disorders.[23] A correct diagnosis allows to identify any comorbidities and complicating factors that could affect the effectiveness of the surgical treatment.

Urinary Continence Prevalence and Surgical Approaches

Prevalence of male stress urinary incontinence (SUI) after robot-assisted radical prostatectomy (RARP) is related to patient characteristics, surgeon's experience, surgical techniques adopted, and eventually tools used for follow-up.[9]

UI prevalence following RP is from 2.5% to 90%[25] according to SUI definition.

Reported incontinence rates are deeply influenced by incontinence definition. Indeed, fully continent patients (no pad utilization) represent up to 70% of all patients at 12 months. However, if the use of one safety pad is admitted continence rates rise to 90% at 12 months. At longer follow-up, studies showed continence rates about 89%.[26]

Surgical techniques have evolved through time in order to reduce UI rates. The introduction of RARP seems to offer a serious advantage on open radical prostatectomy (ORP), due to the better anatomical structure preservation. However, a recent meta-analysis showed no significant difference of UI from open surgery and RARP.[4]

Several different surgical approaches were proposed to preserve urethral length and external rhabdosphincter. Ficarra et al[27] reported that the approach with posterior reconstruction versus standard procedure has a small advantage in terms of continence at 1 month (odds ratio: 0.76; p=0.04). Differently, Patel et al[28] described the anterior reconstruction with a suspension point, with continence rate of 92.8% at 3 months. Rocco et al deeply studied the anatomy of the rhabdosphincter[29] and described new techniques for preservation and restoration of the posterior structure of the rhabdosphincter: the reconstruction of the posterior musculofascial plate and the suspension of the urethral sphincteric complex from the bladder.[30] The authors showed that these surgical skills reduced continence recovery times after radical retropubic prostatectomy[31] and transperitoneal laparoscopic radical prostatectomy.[32]

In 2010, Bocciardi and co-workers proposed a new approach for RARP without dissection of the anterior compartment, the Retzius space, following an intrafascial plane through the Douglas space.[33] This technique allows to preserve anterior structures involved in continence and potency, such as pubovesical and pubourethral ligaments, puboprostatic fascia, neurovascular bundles, and the Santorini plexus.[33] After incising the parietal peritoneum at the level of seminal

vesicles and dissecting the vasa deferentia and the seminal vesicles, the antegrade dissection of the prostate is performed, without incising the Santorini plexus.[33] The posterolateral prostate surface is separated from the Denonvilliers fascia up to the prostatic apex. Thereafter, the section of the bladder neck and the section of the urethra complete the prostate dissection.[33] In a randomized controlled trial, Dalela et al demonstrated an earlier return to continence with the Retzius-sparing technique than with the anterior one.[34] Also, a recently systematic review compared the Bocciardi approach with standard technique and showed a statistically significant advantage for Retzius-sparing RARP in terms of continence recovery at 1 month (OR 2.54; 95% CI 1.16, 5.53; p=0.02), as well as at 3 months (OR 3.86; 95% CI 2.23, 6.68; p<0.001), 6 months (OR 3.61; 95% CI 1.88, 6.91; p=0.001), and 12 months (OR 7.29; 95% CI 1.89, 28.13; p=0.004).[35]

In a systematic review, Kim et al evaluated the effect of bladder neck preservation (BNP) on 2607 patients who underwent on RARP (1880 with BNP vs 727 without BNP).[36] With BPN approach, the surgeon tried to save the internal sphincter. The results showed that BNP technique was associated with greater urinary continence rates at 3–4 months (OR, 2.88; 95% CI, 1.52–5.48; p=0.001), 12 months (OR, 2.03; 95% CI, 1.10–3.74; p=0.02), and 24 months (OR, 3.23; 95% CI, 1.13–9.20; p=0.03) after RARP.[36]

Another point of controversy is the importance of surgeon experience and the relative learning curve: some studies confirmed better continence rates after >500 cases.[37,38] However, such a cut-off has been questioned by others.[39,40]

It should be noticed that probably the described variability among series is only partially explained by different surgical techniques. Indeed, several other predictors of urinary continence recovery were identified: older age,[41,42] BMI,[43,44] pre-existing LUTS,[42,43] prostate volume,[37,45,46] functional bladder changes, and lower motor unit lesion.[21] More recently, Tutolo et al presented a preoperative model to predict incontinence before RP.[47] Authors introduced in the nomogram: patient age, EAU risk classification, adjuvant-RT, preoperative questionnaire of ICIQ-UI-SF and EORTC QLQ-C30 QoL, and higher sum scores were associated with higher presence of urinary incontinence.[47] Furthermore, they presented another nomogram to predict the postoperative possibility of additional surgery for UI or a severe pelvic floor muscle training protocol.[47]

Conservative Therapy

There are still controversies regarding functional outcomes in conservative treatment of patients after RP.[48] Pelvic floor muscles (PFM) include elevator ani muscles (puborectalis, pubococcygeus, and iliococcygeus muscles) and coccygeus muscle. They support the pelvic organs, and their contraction contributes to voluntary urination.

Pelvic floor muscle exercise (PFME) aims to improve the strength of pelvic floor muscles to recover sphincter weakness.[48] Repeated exercises with voluntary contraction of pelvic floor muscles enhance pelvic floor muscle strength with benefits for striated urethral rhabdosphincter, bulbocavernosus, and elevator ani muscles.[49] Normally PFME is recommended in the postoperative setting, with verbal indication. Unfortunately this information, although supported by written instructions, could lead to wrongly performed exercise.[50] The main drawbacks are the need to perform exercises for a long time to maintain good results and the possibility of patients executing them incorrectly.

Kegel exercises (KE) are the most popular and used among the PFME. Currently, there is not a standardized protocol, so KE are usually custom-made with different numbers of contractions, durations of holding time, and training regimens among patients.[51] The fundamental rules include identification of the appropriate muscles which stop or slow the urination, contraction of the muscles in the correct manner, and repetition of the cycle for several times.[51] In a meta-analysis, Wu et al[52] showed how therapist-led PFME could lead to faster recovery in patients with UI after RARP. Authors showed how the need of a professional figure was correlated with a better performance for patients who have undergone this therapy.[52] Moreover, there is the possibility to perform the PMFE with biofeedback device or to use transabdominal real-time ultrasound to visualize the muscle structures.[52] Biofeedback is a technique that provides biological information to patients in real time, beyond the normal and intrinsic feedback originating from sensory receptors.[53] Before the start of PFME, the therapist could explain the anatomy and the function of pelvic floor muscles, in order to ensure a correct understanding of how to contract the muscles.[52] Still, controversies exist. Ribeiro et al showed that PFME is effective for a faster recovery after RARP.[54] Burgio et al, in another study, reported how preoperative training could improve the strength and the skill of the patients, reducing the time to continence.[55]

In recent trial, Milos et al randomized 97 men who underwent RP, into a control group (n=47) and an intervention group (n=50) that started PFM training 5 weeks prior to surgery and continued 12 weeks after RP. The authors demonstrated a faster return to urinary continence (74% vs 43% at 12 weeks) in the intervention group compared to the control one.[56]

However, other authors showed no significant differences between trained and control group: Glazener et al considered patients with incontinence 6 weeks after radical prostatectomy and transurethral resection of prostate (TURP) and showed that the rates of urinary incontinence at 12 months were not significantly different in both groups.[57] Bales et al described how preoperative biofeedback PFME did not significantly improve the overall continence or urinary control return after RARP.[58] Chang et al[59] concluded, in their meta-analysis, that preoperative PMFE improved early recovery rates but not long-term continence rates.

All these studies should be interpreted with caution due to the limited number of cases and the lack of a standardized program, with several bias. For example, simple definition of continence is often different, such as the acceptance of a safety pad or not, or the presence of leakage or not, and the standardization of training regimen.

Pharmacologic Therapy

Antimuscarinics

After behavioral therapy, anticholinergic agents are the mainstay of treatment for OAB. Several formulations are available, with no significant differences in effect or side effects reported between different antimuscarinic compounds.[60,61]

After RP, de novo voiding dysfunction due to reduced bladder compliance has been found in 50% of patients.[62] In this scenario, such consideration might justify antimuscarinic agent use. Indeed, the beneficial effect on lower urinary tract symptoms (LUTS) might shorten the time to continence gain. Few studies investigated solifenacin use in post-RP incontinence.

In a multicenter, randomized, double-blind study,[63] 640 patients were treated with solifenacin 5 mg daily versus placebo for 12 weeks. Continence was defined as no pad use for at least 3 days. Overall, 29% vs 21% of patients in treatment vs placebo group, respectively, achieved continence.[63] Most common adverse events were dry mouth and constipation.

Liss et al[64] evaluated the safety and efficacy of solifenacin: in a group of 40 men, 26 reported side effects, and 18 continued medication for 3 months; 2 reached continence, defined as zero pads per day. Shim et al,[65] in a prospective, randomized trial, reported that solifenacin (5 mg once daily) might reduce the leakage amount and LUTS symptoms, compared to midodrine. Unfortunately, no evidence is available about other substances in post-prostatectomy UI.

5-Phosphodiesterase Inhibitors

5-Phosphodiesterase (5-PDE) isoenzymes are present and biologically active in bladder.[66,67]

Morelli et al reported that 5-PDE inhibitors (5-PDEi) increase bladder tissue oxygenation after tadalafil administration.[67] Indeed, 5-PDEi increase the level of cyclic guanosine monophosphate (cGMP) or cyclic adenosine monophosphate (cAMP), producing relaxation of smooth muscle fibers in the pelvic arteries,[68] and blood supply in the urethral sphincter, bladder, and pelvic floor improves.[69,70]

In a retrospective study by Gandaglia et al,[69] 393 men with incontinence after RP received tadalafil 20 mg, vardenafil 20 mg, or sildenafil 100 mg on demand, tadalafil daily, or no medication. Three-year continence rates (no pad use) were reported to be 95.8% among those treated with 5-PDEi versus 79.7% in untreated patients. No significant difference was observed between the daily treatment group and the on-demand group.

In a randomized study 112 patients received tadalafil 20 mg three times weekly, 20 mg on demand, or no treatment. No differences between the two treatment groups and the control group have been reported.[71] In conclusion, studies on PDE5 inhibitors reported controversial results, and none of them assessed the amount of leakage.

Duloxetine

Duloxetine is a serotonin and norepinephrine reuptake inhibitor that has its effect on the spinal cord Onuf's nucleus. It works by stimulating the pudendal nerve, thereby increasing tension in the urethral sphincter and relaxing the detrusor muscle[72,73] and has effect in patients who have undergone nerve-sparing prostatectomy.

46

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Therapeutics and Clinical Risk Management 2023:19

In a prospective, randomized, double-blind study, Cornu et al[74,75] compared duloxetine versus placebo in 31 patients. Percentage of reduced incontinence episode frequency was significantly higher in the duloxetine group (−52.2 ± 38.6%) compared with the placebo group (19.0 ± 43.5%). Treatment with duloxetine 80 mg was superior to placebo, with the limitation due to the small number of patients included (31 patients). Most common side effects were fatigue, dry mouth, nausea, and constipation.

Also, for duloxetine there is lack of evidence, and more studies were needed before it could be used as a standard treatment.

Surgical Therapy

Surgical treatments should be considered after conservative treatment failure. Surgical treatments include artificial urinary sphincter, sling application, compressive devices, bulking agents.

Compressive Devices

Compressive devices are classified as circumferential and non-circumferential ones.

In the first group, we have the artificial urinary sphincter (AUS): a three-component device with a pump, a reservoir, and urethral cuff. This circumferential device works with a mechanical compression to the urethra with a hydraulic mechanism.[76] The perineal AUS are considered, nowadays, the gold standard of post-RP moderate-to-severe incontinence.[23]

After compressive devices implants, high continence rates (61% to 100%) have been reported.[77] Dupuis et al, in a recent large multicenter study,[78] showed that AUS efficacy, defined as continence at 3 months, was 79% after radical prostatectomy.

Continence definition after AUS implants is not universally accepted. Indeed, some authors define as continent also those reporting a minimum residual leakage after surgery. A direct correlation between dryness and QoL is known.[79] However, Abrams et al demonstrated that satisfaction was more than 90% despite a residual incontinence with leakage, variable in time from one to several times a week.[80]

All these studies usually excluded cases with patients who underwent radiotherapy, because irradiation history is associated with potential bias.[81] Possible complications after AUS surgery are site infection or urethral erosion, mechanical failure, urethral atrophy, and urinary retention, and a reintervention rate of about 26% has been reported. These data are variable depending on surgeon experience and the surgical approaches (perineal/penoscrotal), which, however, are increasingly standardized.[79,82] Future research and consensus trying to define continence after implants procedure are warranted, as such definition is fundamental to comparison of different series. The main characteristics of currently available AUS are summarized in Table 1.

Table 1 Characteristics of Available Compressive Devices

Study (Year)	Compressive Devices	Type	Success Rate	Post-Operative Complications
Van der Aa et al (2013)[77]	AMS 800 (Boston Scientific, USA)	Circumferential	43.5%	Urethral erosion/infection, urethral atrophy, mechanical failure, explantation, reintervention
Giammò et al (2021)[88]	VICTO (Promedon, Argentina)	Circumferential	76.4%	Urethral erosion/infection, mechanical failure, cuff refill
Knight et al (2006)[87]	FlowSecure (Barloworld Scientific, Staffordshire, UK)	Circumferential	Not significant	Explantation
Staerman et al (2013)[85] Llorens et al (2017)[86]	ZSI 375 (Zephyr Surgical Implants, Switzerland)	Circumferential	73%	Urethral erosion/infection, mechanical failure
Crivellaro et al (2008)[89] Gregori et al (2010)[91] Venturino et al (2015)[92]	PROACT (Uromedica, USA)	Non circumferential	4.5–68%	Device migration, urethral erosion, transient urinary retention

The AMS 800 (Boston Scientific, Marlborough, MA, USA, formerly AMS, USA) is the most used and studied device: in different studies the dry rates varied in a range from 4.3%[83] to 85.7%.[84] Van der Aa et al reported a combined dry rate of 43.5%.[77] The most important complications after single-cuff AMS 800 implant were: urethral erosion/ infection (8.5%), urethral atrophy (7.9%), mechanical failure (6.2%), and reintervention (26%).[77]

Besides the AMS 800 there are other alternatives available, but with lower evidence and small case numbers. The ZSI 375 (Zephyr Surgical Implants, Geneva, Switzerland) is a preconnected device that does not require abdominal access for intraperitoneal implantation of a reservoir balloon. Staerman et al reported urinary continence in 73% at 6 months' follow-up in 36 patients after implant of ZSI 375. The device was removed in four patients for erosion and infection.[85] In their recent retrospective study, Llorens et al showed continence rates in 73% of patients after 5 years and 72% of patients after 7 years of ZSI 375 implantation. The most important adverse events were urethral erosion (13.33%) and infections (2.2%). Mechanical failure with a revision occurred in 6.67%.[86]

The FlowSecure device (Barloworld Scientific, Staffordshire, UK) consists of one silicone piece prefilled with 30 mL physiological solution and a stress-release balloon to contrast the intra-abdominal pressure. Knight et al demonstrated a reduction of mean daily leakage at 12 months post RP and reduction of pad usage from 3.3 to 1.6 pads per day. No major complications were detected in the first 12 postoperative months.[87]

VICTO (Victo; Promedon, Argentina) is a preconnected device consisting of an occluding urethral cuff, a pressure-regulating balloon, and a self-sealing port for pressure adjustment. VICTOplus offers an additional stress-balloon that transmits intra-abdominal pressure to the occluding cuff. In a recent trial Giammò et al implanted 17 devices: 8 VICTO and 9 VICTOplus. They reported a dry rate of 76.4% and a continence rate about 94%. The postoperative complication rate was 17.6%.[88]

The non-circumferential device available is the ProACT (Uromedica, USA) consisting of two balloons, which are positioned on the sides of the proximal urethra.[89] Crivellaro et al reported success rates of 62–68%, with a presence of erosion in 3.2–10.9% and dislocation in 4–6%.[90] Gregori et al reported a dry rate of 66%, with postoperative complications such as device migration in 3.8%, urethral erosion in 2.5%, and transient urinary retention in 1.2%.[91] In a recent study Venturino et al analyzed long-term outcomes in 22 patients. Only one patient (4.5%) was immediately dry, but the other 95.5% needed at least one balloon adjustment. Dry rate increased temporarily to 18% but decreased again to 4.5% after 57 months postoperatively. Revision and explantation rates of 73% and 55%, respectively, led the authors to conclude that the ProACT system does not offer satisfactory results in the long-term follow-up.[92]

Indeed, the EAU guidelines do not report recommendation for this type of implant because of the limited evidence.[24]

Male Slings

Male slings emerged as a non-inferior minimally invasive alternative treatment to AUS.[80] Slings aim to reposition the bulbar urethra, moving it to a proximal position.[93,94] In the past, the male sling worked on retropubic placement and bone fixation, while contemporary devices were projected with fixing or adjustable mesh.[95] The most familiar are: AdVance and AdVance XP (Boston Scientific, USA), Virtue (Coloplast, Denmark), and I-stop TOMS (Cl Medical, France) (Table 2).

Among the retrourethral transobturator slings, the most frequently used and studied are AdVance and its second-generation AdVance XP, introduced in 2010. AdVance consists of a mesh placed under the membranous urethra through a transobturator approach. It relocates the dislocated sphincter and posterior urethra into their original position, increasing the venous sealing effect and the functional urethral length. Cornel et al reported a success rate of only 9% (no pad and <2 g urine loss in a 24-h pad test). The most frequently reported adverse events were transient urinary retention and transient perineal pain, and explantations are rare.[96] AdVance XP includes several innovations such as anchors at the sling arms to reduce early postoperative dislocations, a shape that facilitates implantation in obese patients, increased sling arm length, and protection sheaths on the sling arms. Cornu et al observed a success rate (no pad or one safety pad) of about 59% after 16 months and a transient urinary retention rate of 2%.[97] In another study, Bauer et al reported a higher success rate of 65% (no pad or one safety pad) after 25 months postoperative and a persistent residual urine rate about 5%.[98]

Table 2 Characteristics of Available Male Slings

Study (Year)	Male Slings	Approach	Adjustable Mesh	Success Rate	Post-Operative Complications
Cornel et al (2010)[96]	AdVance (Boston Scientific, USA)	Transobturator	Fixed	9%	Urinary retention and transient perineal pain, explantations
Cornu et al (2014)[97] Bauer et al (2017)[98]	AdVance XP (Boston Scientific, USA)	Transobturator	Fixed	59–65%	Transient urinary retention, persistent residual urine
Ferro et al (2017)[100]	Virtue (Coloplast, Denmark)	Transobturator and prepubic	Fixed	58%	Scrotal pain
Grise et al (2012)[99]	I-STOP TOMS (CL Medical, France)	Transobturator	Fixed	87%	–
Hübner et al (2011)[106]	Argus (Promedon, Argentina)	Retropubic	Adjustable	79%	Urethral erosion/infection, explantation,
Bauer et al (2015)[107]	ArgusT (Promedon, Argentina)	Transobturator	Adjustable	79%	Pelvic pain
Sousa-Escandòn et al (2007)[108]	ReMeex (Neomedic, Spain)	Retropubic	Adjustable	65%	System rupture during adjustment, explantation
Esquinas et al (2019)[109] Meisterhofer et al (2020)[101]	ATOMS (A.M.I. Surgical, Austria)	Transobturator	Adjustable	17–92%	Urethral infection, explantation

The I-STOP TOMS is a monofilament polypropylene non-extensible 4-arm large sling with a central part placed over the urethra. Grise et al analyzed 103 patients after implantation of I-STOP TOMS with a 12-month follow-up. They reported a decrement of mean daily pad use from 2.4 to 0.6. The continence improved in about 87% of patients (59.4% completely dry, 20.3% 1 pad/d, 7.3% >1 pad/d).[99]

The Virtue is a quadratic transobturator sling with two inferior (transobturator) extensions and two superior (prepubic) extensions that provides bidirectional support and compression for bulbar urethra. In their study, Ferro et al followed 29 consecutive patients treated with the Virtue sling. They observed a significant improvement in 24-h pad test and number of pads per day after 12 months of follow-up, with stable outcomes at 36 months.[100]

A recent meta-analysis reported success rates between 8% and 87%, with a lower rate of complication events: most common were pelvic pain and urinary retention.[101] In their study, Inouye et al[102] evidenced the benefit deriving from an accurate selection of the patients and optimal placement, offering this procedure only in cases that have low 24-hour pad weights, high Valsalva leak point pressure, and no history of pelvic radiation. Non-invasive tests include bladder diary, pad weight, and urine analysis; while invasive tests are cystoscopy and urodynamics to ascertain bladder pathology.

History of pelvic radiotherapy is a relative contraindication due to high failure rate, up to 50%,[81,103] and the higher risk of complication in irradiated patients compared to non-irradiated.[75,104]

Adjustable slings offer the chance to modify the correction or the compression to urethra, applying more tension or filling a cushion localized under urethra.[105] Currently available are Argus classic and ArgusT (Promedon, Argentina) with a retropubic and a transobturator implant approach, respectively; Remeex (Neomedic, Spain) with retropubic types; and ATOMS (A.M.I. Surgical, Austria) with transobturator approach (Table 2).

The Argus classic and ArgusT consist of a radiopaque silicone foam pad attached to two silicone sling arms. Hübner et al analyzed the outcomes of 101 patients after implantation of Argus classic. About 79% of patients were considered dry (pad test of 0–1 g) in median follow-up of 24 months. Adjustment was necessary in about 38%. The sling had to be removed in about 16% due to urethral erosion or infection.[106] The ArgusT was studied in one prospective study by Bauer et al. After a mean follow-up of 28 months, the success rate (defined by 0–5 g in 24-h pad test) was about 62%. Authors

reported a lesser risk of intraoperative complications compared to Argus classic, but a higher persistent perineal pain >3 months (16.7%).[107]

The Remeex, a retropubic male sling, is formed by a mesh placed under the urethra, connected to a suprapubic mechanical regulator via two bilateral monofilament fibers. Sousa-Escandòn et al in their multicenter study enrolled 51 patients. After a mean follow-up of 32 months the reported success rate (1 pad per day) was 64.7%. Postoperative complication rates were low, but with possible system breakdown during the adjustment. The authors reported an explantation rate of 6%.[108]

The ATOMS adjustable male sling system consists of a radiopaque silicone cushion attached to bilateral monofilament polypropylene mesh arms. In a recent meta-analysis with more than 1300 patients, ATOMS reported a success rate (no pad or only one safety pad per day) of 67% with perception of improvements of UI in 90%.[109] Complications were encountered in 16% of patients, with an explantation rate of about 6%. In other analysis, including the different devices, was reported a success rate between 17% and 92%; most common complications were pelvic pain with infection and subsequent removal, but only in 1.5%.[101]

Bulking Agents

In patients unfit for invasive options and with mild incontinence, bulking agents may be an attractive alternative.[110] In the last decades, the most widely used agents were Bovine collagen and polytetrafluoroethylene (Teflon) according to Medicare beneficiary data.[111] The principal limitations that occurred were migration, embolization, absorption, and fibrotic and allergic reaction; however, new materials have been introduced in the last decade.[111] These products are Macroplastique (polydimethylsiloxane elastomer), Opsys (polyacrylate polyalcohol copolymer), Durasphere (carbon-coated zirconium), and Urolastic (vinyl dimethyl-terminated polydimethylsiloxane polymer) (Table 3).

Heterogeneous literature data were produced on the newer agents, but evidence is scarce due to the lack of standardized technique or agreement on the amount/position of injection. Tola et al recently reviewed the use of bulking agents in males after RP with minimal SUI, and 80% were dry at 48 months' follow-up. In other series, Colombo et al[112]

Table 3 Available Urethral Bulking Agents

Urethral Bulking Agents	Trade Name
Bovine collagen	Contigen
Porcine dermal collagen	Permacol
Silicone particles	Macroplastique
Calcium hydroxylapatite	Coaptite
Carbon-coated beads	Durasphere
Dextranomer-hyaluronic acid compound	Zuidex
Polytetrafluoroethylene	Polytef
Ethylene vinyl alcohol	Uryx or tegress
Autologous fat	

Abbreviations: 5-PDE, 5-phosphodiesterase; 5-PDEi, 5-PDE inhibitors; AUS, artificial urinary sphincter; BMI, body mass index; BNP, bladder neck preservation; CI, confidence interval; EAU, European Association of Urology; ICS, International Continence Society; ICIQ-UI SF, International Consultation on Incontinence Questionnaire-Urinary Incontinence Short Form; ISD, intrinsic sphincter deficiency; KE, Kegel exercises; LUTS, lower urinary tract symptoms; MUL, membranous urethral length; OAB, overactive bladder; OR, odds ratio; ORP, open radical prostatectomy; PCa, prostate cancer; PFM, pelvic floor muscle; PFME, pelvic floor muscle exercise; PMFT, pelvic muscle floor training; QoL, quality of life; RALP, robot-assisted laparoscopic prostatectomy; RARP, robot-assisted radical prostatectomy; RP, radical prostatectomy; SUI, stress urinary incontinence; TURP, transurethral resection of prostate; UI, urinary incontinence; UUI, urge urinary incontinence.

reported dry continence in 83% of patients at 15 months after macroplastique injections, with a 38% rate of re-treatment. Other study[113] showed a subjective dry result of 32% after 2 procedures with 80% of patients who received 2 treatments.

It is widely accepted that repeat injections might be required, but authors report minimal data on the reinjection technique and less is standardized about the optimal number of repeat treatments. Most reported postoperative complications were retention, lower urinary tract infections, and hematuria, while the migration risk remains under investigation. Van Uhm et al[114] utilized MRI to investigate, and they found no correlation between the volume measured and the injected, speculating that paraurethral collagen after RP could be less supportive.

In conclusion, periurethral bulking agents should be restricted to selected cases, awaiting major recommendation and more standardized injection technique.

Challenges and Solutions

Urinary incontinence after RARP is the main result of urethral sphincter deficiency or detrusor overactivity,[115] and it represents a very important clinical and social problem. Many men are afraid of urinary leakage post-operation, and sometimes may decide to not undergo surgery. The identification of the key factors (age, race, height and weight, lifestyle) that predict presentation of UI and recovery of urinary control after RP could be a very useful tool in clinical practice.[47,116] In this sense the development of easy-to-use nomograms allows the urologists to create a better therapeutic pathway for the continence recovery after RP.[47,116]

Different therapeutic approaches are available for treatments of UI, and this includes conservative treatment, pharmacological therapy, and lastly surgical therapy.[117]

The pelvic muscle floor training (PMFT) is the first treatment to offer to patients with UI after RP.[23] However, a standardized regimen is not yet available. Various studies observed significant differences among the PMFT regimen adopted: number and duration of contractions, session frequency per day, and the presence or absence of therapist. Manassero et al used 15 contractions repeated 3 times per day,[118] whereas Patel et al proposed 10 contractions lasting 10 sec.[115] Filocamo et al used 10 contractions lasting 5 sec with 10 sec of muscular relaxation 3 times a day.[119] Nilssen et[120] al and Overgard et al[121] used 10 contractions lasting 6–8 sec followed by 3–4 fast contractions. A specific procedure for PFME after radical prostatectomy is needed because this would reduce the heterogeneity of the data.

The pharmacological therapy is not yet considered as first-choice therapy due to limited evidence. Their use is limited to reducing temporally the symptoms linked to OAB and urgency.[23]

Regarding surgical treatments, more and more evidence is available, and many new devices can be found in commerce. In addition, the selection of the ideal patient is fundamental to minimize possible postoperative complications. The AUS is the most studied implantable device, and the reported complication rate is the highest compared to other available devices, probably due to the longest follow-up.[23,77] Nevertheless, AUS seems to have good efficacy even in patients with complete intrinsic sphincter insufficiency, complete incontinence, and high level of suffering.[23,77] The ProACT system can count on a surgical implantation technique, changed over time that reduced invasiveness. The efficacy rate and complication rate are acceptable. It might be offered to patients with mild-to-moderate SUI and/or previous urethral manipulation, but with no previous history of radiation therapy.[89,91,92] The male slings, in the available studies, have demonstrated good efficacy and complication rate, in patients with mild-to-moderate SUI, able to interrupt urine stream and store urine capacity. Furthermore, previous radiotherapy does not seem to be a negative predictor factor.[75,98,106,107]

About bulking agents, there is not enough evidence in the literature, also due to high initial failure rates and decreasing success rates over time. Only elderly patients with mild-to-moderate SUI, not fit for surgery, might find benefit from bulking agents.[110,114]

RARP and LRP demonstrated 12-month continence rates ranging from 60% to 93% and from 66% to 95%, respectively.[27] However, about 30% may develop UI after RP.[6] Treatment of these patients should be initially as non-invasive as possible: start with conservative therapy, associated or not with pharmacological treatment, and, in case of failure of the latter, it would be necessary to resort to more invasive treatment.[24]

Conclusion

Stress urinary incontinence is a common complication for patients undergoing radical prostatectomy, and it reduces considerably their quality of life. Many studies focused on treatments for urinary continence recovery after radical prostatectomy are available. The conservative treatments remain the first-line therapy, with PFME as the best choice for its easy accessibility and the shortened recovery time. Among the pharmacologic treatments, duloxetine is still an off-label drug, offered only for a temporary improvement of symptoms. Patients with additional urinary urgency symptoms might find benefit from antimuscarinic drugs.

Regarding invasive management of this type of urinary incontinence, the AMS 800 remains the first choice for moderate-to-severe forms. New types of AUS are increasingly studied to provide an alternative, but evidence is still too scarce to reach reliable conclusions or offer valid recommendations. The development of new therapeutic choices such as male sling has allowed for more acceptable management of less severe forms of urinary incontinence after radical prostatectomy. The efficacy of these new devices seems to be comparable, but the frequency and mostly the kind of complications vary significantly.

The therapeutic decisions and the treatment options must be individualized for each patient according to clinical and social factors. With this perspective, the technological improvements and the emergence of new dedicated treatments and devices have created a continuously positive evolution of clinical outcomes in these patients.

Disclosure

The authors report no conflicts of interest in this work.

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