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REVIEW

Controversies in Post-Prostatectomy Incontinence Management: Role of Urodynamics Testing and Sequence of Continence Surgery with Salvage Radiation Therapy

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Abstract

Purpose of Review This paper evaluates the current evidence on the role of urodynamics in prostatectomy incontinence (PPI) and should male sling (MS) or artificial urinary sphincter (AUS) surgery be performed before or after patients receiving radiation therapy in terms of continence outcomes.

Recent Findings The prevalence of PPI is more common in patients undergoing radical prostatectomy than benign prostatic surgery, and the presence of postoperatively de novo overactive bladder and urge incontinence is not common even without the addition of radiation therapy. Hence, the question arises whether patients presenting with PPI should undergo formal urodynamics testing to exclude detrusor overactivity prior to continence surgery. There is a consensus that the spontaneous recovery of continence is less likely in the setting of salvage radiation therapy. The decision to undertake surgery is likely dictated by patient preference and the urgency for salvage radiation therapy. While the exact choice of MS or AUS, and the sequence of continence surgery in relation to salvage radiation therapy are debatable, irradiated patients are considered a high-risk group with substantially higher risks of postoperative complications.

Summary Urodynamics should be organized in non-classic SUI or mixed incontinence symptoms with PPI and those who had radiation therapy since it can provide useful information in counselling patients regarding continence outcomes and postoperative expectations. It is important to place greater emphasis on preoperative evaluation and surgical vigilance in irradiated patients with PPI.

Keywords Prostatectomy incontinence · Urodynamics · Radiation · Surgical outcomes

Introduction

Stress urinary incontinence (SUI) can occur following prostate surgery, whether for benign prostatic enlargement or prostate cancer if the underlying external urethral sphincter complex is damaged [1••, 2, 3]. The prevalence of prostatectomy incontinence (PPI) is more common in patients undergoing radical prostatectomy and published literature shows that innovations in robotic techniques and judicious adherence to pelvic floor physiotherapy can improve the continence outcomes in patients undergoing radical prostatectomy for prostate cancer [4, 5]. There is a consensus that progressive recovery of continence rates during the postoperative period can be expected up to 12 months with an estimated 10% of patients living with PPI in the long term [3, 6]. Although the presence of postoperatively de novo overactive bladder and urge incontinence is not common even without the addition of radiation therapy [7, 8], the question arises whether patients presenting with PPI should undergo formal urodynamics to exclude detrusor overactivity prior to continence surgery. While it is not established what duration of recovery time must be allowed to elapse to determine the final (irrecoverable) continence outcome, it is likely that the severity of PPI coupled with the presence of other equally important factors such as postoperative radiation therapy means spontaneous recovery of continence is

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less likely and there is a need to consider an earlier surgical intervention for persisting incontinence.

The AMS 800™ (Boston Scientific, previously the American Medical Systems, Minnetonka, MN, USA) artificial urinary sphincter (AUS) is widely acknowledged as the standard of care to treat males with moderate to severe stress urinary incontinence (SUI), following radiation-induced SUI and as a salvage option in those who failed male sling surgery [1••, 9•, 10•]. While it has been five decades since the landmark paper on the first modern AUS prototype was published [11], continued scientific advances in both device technology and surgical techniques have significantly improved its clinical efficacy, mechanical durability, and safety profile [12•, 13–16]. On the other hand, the modern synthetic male sling (MS) was developed in the early 2000s but has gained considerable recognition as an effective and less invasive surgical alternative to the AUS, and the patient is able to void spontaneously postoperatively [12•]. The modern MS can be categorized as an adjustable or non-adjustable sling. Despite the theoretical advantage of adjustable MS over non-adjustable MS with the ability to revise the sling tension in the event of persistent and/or recurrent incontinence, adjustable MS had higher complication and explant rates with each revision surgery [17, 18].

The most recent systematic review and network meta-analysis of various surgical treatments for PPI [19] showed that pooled overall odds ratios of patients achieving urinary continence compared with no treatment was 3.31 (95% credible interval, CrI: 0.749, 15.710) in AUS, 2.97 (95% CrI: 0.412, 16.000) in adjustable sling, and 2.33 (95% CrI: 0.559, 8.290) in nonadjustable sling based on 11 analyzed studies, with AUS ranked first in terms of continence rate, pad weight, and pad use count for under the cumulative ranking curve values of ranking probabilities for each treatment performance. Nonetheless, the unique noninferiority randomized MASTER trial reported that MS provides similar continence rates as an AUS (difference 3.6% [95% CI − 11.6 to 4.6, $P_{NI} = 0.003$]) in terms of improvement in incontinence symptoms [20•] although post hoc secondary outcome measures analysis found the AMS 800 device to deliver superior clinical outcomes in terms of postoperative continence, overall satisfaction, and complication rates. Therefore, whether MS is indeed superior to AMS 800 device to treat PPI is a difficult question to answer (or prove) since both therapeutic devices are designed to treat different degrees of PPI. Equally, pertinent questions on whether urodynamics can assist or predict the success rate of MS or AUS in PPI, and if the sequence of continence surgery in relation to the timing of radiation therapy will alter the continence outcomes, require further research and critical discussion. This paper aims to evaluate the current evidence on the role of urodynamics in PPI and should MS or AUS surgery be performed before or after patients receiving radiation therapy in terms of continence outcomes.

Methods and Materials

Relevant English-published literature pertaining to PPI, MS, and AUS between January 1, 2000 and June 1, 2023 were undertaken and the following terms "artificial urinary sphincter," "stress incontinence," "postprostatectomy," "male sling," "recurrent incontinence," and "complications" were searched in MEDLINE and EMBASE databases. The specific emphasis is placed on the task to address two important questions, namely: (1) Should urodynamics be performed prior to MS or AUS surgery?; (2) Should MS or AUS surgery be done in a patient prior to, or after salvage radiation for a biochemical recurrence?

Given there are very few prospective and almost non-existent randomized-controlled trials between MS and AUS surgery have been published, a full Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) protocol was not adopted for this article; instead, a narrative approach was taken. A detailed analysis of all relevant studies including a full surgical description is not the goal of this paper although a brief discussion of the potential clinical challenges and surgical strategies to mitigate them will be provided in this narrative review.

Should Urodynamics be Performed Prior to MS or AUS Surgery?

Published international guidelines recommended that urodynamics may be performed to facilitate the diagnosis of incontinence and/or aid in patient counselling [1••, 7, 9•, 10•, 16]. Urodynamics provides a valuable diagnostic tool in determining the extent of true SUI in patients presenting with non-classic PPI or in a mixed urinary incontinence setting. Not all PPI is due to genuine SUI since de novo overactive bladder is estimated to occur in up to a third of male patients following radical prostatectomy [21, 22]. Furthermore, secondary detrusor overactivity can occur in patients who have poor preoperative bladder capacity or developed subsequent bladder outlet obstruction in the settings of bladder neck contracture or urethral stricture following surgery or radiation therapy [23–25]. For patients with non-classic SUI or mixed incontinence symptoms, urodynamics plays an important role in assessing underlying bladder (storage) dysfunction and detrusor contractility to exclude bladder outlet obstruction. Another study found that intrinsic sphincter deficiency (ISD) can be demonstrated in 54 patients (90%) out of 60 patients with PPI, although 27 patients (45%) patients were diagnosed with underlying bladder dysfunction and 16 (27%) of SUI cases were related to bladder dysfunction (rather than isolated ISD) [26].

The diagnosis of true ISD is based on the measurement of leak point pressure during the Valsalva manoeuvre (VLPP). The predictive value of VLPP in determining the success of MS has been reported in the literature, especially during the intraoperative setting of adjusting the optimal sling tension in adjustable MS cases [27–29]. However, it is important to note that a negative VLPP does not always exclude complete urinary continence since the measurement of VLPP in the presence of a urethral catheter may create some degree of urethral obstruction resulting in a false reading [30]. Hence, it has been recommended that VLPP should be repeated without a urethral catheter in situ [31, 32]. Furthermore, in some patients with severe PPI with complete sphincteric damage, it is not possible to fill the bladder to a sufficient volume to fully assess its storage pressures since it is not possible to achieve a steady state of filling, and use of foley catheter balloon or penile clamp may be necessary.

On the other hand, urodynamics-proven DO is thought to be quite common, especially in patients with mixed incontinence symptoms, and decreased bladder compliance can be observed in up to two-fifths of patients with PPI [33]. The presence of preoperative DO, bladder compliance, and capacity have been reported as adverse predictive factors in successful outcomes for male slings [34–36] and AUS outcomes [37, 38]. Adequate bladder contractility is a pre-requisite for MS since most MS cause some degree of urethral obstruction [39], whereas this would be less of a concern in the setting of an AUS where the circumferential urethral occlusion is released during micturition.

While the role of urodynamics can be useful in non-classic SUI or mixed incontinence symptoms with PPI, the more critical question to evaluate is whether the urodynamics findings will significantly alter the decision-making process in deciding whether to proceed with a continence surgery or not. These urodynamics parameters while not necessarily contraindicating a specific type of surgery, do provide useful information to counsel patients regarding postoperative expectations and the extent of continence (or voiding) outcomes. It is important to consider that many of these so-called de novo (or secondary) overactive bladder problems are often minor, may not be of clinical significance in the overall PPI presentation, and can be addressed effectively following continence surgery. Hence, international guidelines recommend the use of urodynamics in selected PPI cases such as those with a history of neurological disorder, pre-existing symptoms prior to postprostatectomy, or worsening incontinence following radiation therapy [1••, 9•, 10•, 40–42].

Should MS or AUS Surgery be Done in a Patient Prior to, or After Salvage Radiation for a Biochemical Recurrence?

Given that it is estimated around 10% of patients who underwent radical prostatectomy will end up with PPI at 12 months despite strict adherence to pelvic floor exercise therapy [3, 5, 6], and that radiation is shown to worsen PPI [1••, 6, 43], the question arises whether these PPI patients should undergo a continence surgery prior to radiation therapy or to wait and see if their incontinence rates get worse following radiation therapy.

Radiation can cause endarteritis and chronic vascular changes which invariably lead to decreased blood flow, thereby increasing the urethral tissue vulnerability and may result in higher complication rates; hence, it is generally agreed that patients who received radiation therapy constitute a group of high-risk patients with substantially higher risks of urethral stricture, atrophy, and device-related erosion [44–46]. The poor urethral tissue may also increase prosthetic-related infection risk [47, 48].

The rationales for proceeding with continence surgery in patients with PPI who will need salvage radiation therapy later include earlier restoration of continence and quality-of-life domains, potentially safeguarding against worsening SUI following radiation, and minimizing the theoretical risks of higher complication rates when operating in irradiated patients [49–51]. Furthermore, some of the patients with PPI may be able to choose from MS since it is considered a relatively contra-indication for radiated patients to receive MS due to lower continence outcomes and the perceived higher risk of sling erosion in irradiated urethra [52–54]. The hypothetical benefits for MS in PPI prior to radiation therapy are patients will be able to achieve continence and potentially safeguard this outcome with radiation therapy can "fix" the sling in place through radiation-induced tissue fibrosis [55].

On the other hand, given that radiation therapy may worsen PPI, perhaps it is best to wait until after salvage radiation therapy to determine the true extent of incontinence given the first continence surgery often offers the most effective therapeutic intervention. The decision to undertake surgery is likely dictated by patient preference and the urgency for salvage radiation therapy. Data pertaining to continence outcomes following AUS surgery in irradiated patients are mixed [49, 50, 56], although most literature shows that AUS patients with a prior history of radiation have higher rates of revisions given the higher rates of urethral erosion and atrophy [49, 57, 58]. The reasons for the poorer outcomes may be related to urethra atrophy or erosion [59, 60•] or perhaps secondary to other non-SUI lower urinary tract symptoms such as subsequent development of de-novo overactive bladder or (overflow) incontinence with stricture diseases which can occur over time [37, 51, 61].

The AUS is considered the superior option to salvage MS failure rather than a secondary MS surgery [9•, 10•, 62, 63]. Surgical strategies to manage recurrent incontinence in AUS patients with subsequent urethral atrophy include downsizing the cuff size, repositioning the cuff to a new urethral position, placing tandem (double) cuffs, increasing reservoir pressure, and performing transcorporal cuff placement or interposition of a biologic graft material between the cuff and urethra [60•, 64–66]. For irradiated patients, it is generally recommended that performing transcorporal cuff placement is a better and safer option to minimize the risk of cuff erosion in the fragile urethra [9•, 10•, 60•].

Conclusions

Both AUS and MS are effective surgical treatments for PPI. Urodynamics should be organized in non-classic SUI or mixed incontinence symptoms with PPI and those who had radiation therapy since it can provide useful information in counselling patients regarding continence outcomes and postoperative expectations. While the exact choice of MS or AUS, and the sequence of continence surgery in relation to salvage radiation therapy are debatable, irradiated patients are considered a high-risk group with substantially higher risks of postoperative complications. Hence, it is important to place greater emphasis on preoperative evaluation and surgical vigilance in irradiated patients with PPI.

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Declarations

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References

Papers of particular interest, published recently, have been highlighted as:
- • Of importance
- •• Of major importance

1.•• Sandhu JS, Breyer B, Comiter C, Eastham JA, Gomez C, Kirages DJ et al. Incontinence after prostate treatment: AUA/SUFU guideline. J Urol. 2019;202(2):369–378. **This paper combines the position statements from both AUA and SUFU in managing patients with incontinence after prostate treatment.**
2. Huang SW, Tsai CY, Tseng CS, Shih MC, Chien KL, Pu YS, et al. Comparative efficacy and safety of new surgical treatments for benign prostatic hyperplasia: systematic review and network meta-analysis. BMJ. 2019;367:15919.
3. Ficarra V, Novara G, Rosen RC, Artibani W, Carroll PR, Costello A, et al. Systematic review and meta-analysis of studies reporting urinary continence recovery after robot-assisted radical prostatectomy. Eur Urol. 2012;62(3):405–17.
4. Wu ML, Wang CS, Xiao Q, Peng CH, Zeng TY. The therapeutic effect of pelvic floor muscle exercise on urinary incontinence after radical prostatectomy: a meta-analysis. Asian J Androl. 2019;21(2):170–6.
5. Dovey ZS, Tewari AK. Anatomical robotic prostatectomy: technical factors to achieve superb continence and erectile function. Transl Androl Urol. 2020;9(2):8887–97.
6. Wallis CJD, Glaser A, Hu JC, Huland H, Lawrentschuk N, Moon D, et al. Survival and complications following surgery and radiation for localized prostate cancer: an international collaborative review. Eur Urol. 2018;73(1):11–20.
7. Uberoi P, Smith CA, Lucioni A. Management of lower urinary tract symptoms after prostate radiation. Curr Urol Rep. 2021;22(7):37.
8. Biers S, Sievert KD, Thiruchelvam N. Overactive bladder syndrome and lower urinary tract symptoms after prostate cancer treatment. Curr Opin Urol. 2017;27(3):307–13.
9.• Chung E, Liao L, Kim JH, Wang Z, Kitta T, Lin ATL et al. The Asia-Pacific AMS800 artificial urinary sphincter consensus statement. Int J Urol. 2023;30(2):128–138. **This paper serves as a clinical guideline in the various roles of the AMS 800 artificial urinary sphincter device.**
10.• Biardeau X, Aharony S, the AUS Consensus Group, Campeau L, Corcos J. Artificial urinary sphincter: report of the 2015 Consensus Conference. Neurourol Urodyn. 2016;35 Suppl 2:S6–22. **This paper provides a nice summary of the artificial urinary sphincter surgery.**

11. Scott FB, Bradley WE, Timm GW. Treatment of urinary incontinence by implantable prosthetic sphincter. Urology. 1973;1:252–6.
12.• Chung E. Contemporary surgical devices for male stress urinary incontinence: a review of technological advances in current continence surgery. Trans Androl Urol. 2017;6(Suppl 2):S112-S121. **This paper provides a comprehensive review of the current surgical treatments for stress incontinence surgery in male patients.**
13. Silva LA, Andriolo RB, Atallah AN, da Silva EM. Surgery for stress urinary incontinence due to presumed sphincter deficiency after prostate surgery. Cochrane Database Syst Rev. 2014;(9):CD008306
14. Chung E. A state of art review on the evolution of the urinary sphincter devices for the treatment of post-prostatectomy urinary incontinence: past, present and future innovations. J Med Eng Technol. 2014;38(6):328–32.
15. Crivellaro S, Morlacco A, Bodo G, et al. Systematic review of surgical treatment of post radical prostatectomy stress urinary incontinence. Neurourol Urodyn. 2016;35(8):875–81.
16. Van der Aa F, Drake MJ, Kasyan GR, Petrolekas A, Cornu JN, Young Academic Urologists Functional Urology Group. The artificial urinary sphincter after a quarter of a century: a critical systematic review of its use in male non-neurogenic incontinence. Eur Urol. 2013;63(4):681–689
17. Meisterhofer K, Herzog S, Strini K, Sebastianelli L, Bauer R, Dalpiaz O. Male slings for postprostatectomy incontinence: a systematic review and meta-analysis. Eur Urol Focus. 2020;6(3):575–92.
18. Chung E, Smith P, Malone G, Cartmill R. Adjustable versus nonadjustable male sling for post-prostatectomy urinary incontinence: a prospective clinical trial comparing patient choice, clinical outcomes and satisfaction rate with a minimum follow up of 24 months. Neurourol Urodyn. 2016;35(4):482–6.
19. Park JJ, Hong Y, Kwon A, Shim SR, Kim JH. Efficacy of surgical treatment for post-prostatectomy urinary incontinence: a systematic review and network meta-analysis. Int K Surg. 2023;109(3):401–11.
20.• Abrams P, Constable LD, Cooper D et al. Outcomes of a noninferiority randomised controlled trial of surgery for men with urodynamic stress incontinence after prostate surgery (MASTER). Eur Urol. 2021;79(6):812–823. **This paper is the first randomized controlled study comparing male sling and artificial urinary sphincter surgery in patients with postprostatectomy stress incontinence.**
21. Hosier GW, Tennankore KK, Himmelman JG, Gajewski J, Cox AR. Overactive bladder and storage lower urinary tract symptoms following radical prostatectomy. Urology. 2016;94:193–7.
22. Matsukawa Y, Yoshino Y, Ishida S, Fujita T, Majima T, Funahashi Y, et al. De Novo overactive bladder after robotic-assisted laparoscopic radical prostatectomy. Neurourol Urodyn. 2018;37(6):2008–14.
23. Watanabe K, Otsuka A, Sano A, Sato R, Matsushita Y, Watanabe H, et al. Predictive factors of de novo overactive bladder in clinically localized prostate cancer patients after robot-assisted radical prostatectomy. Int J Urol. 2023;30(1):57–61.
24. Ko KJ, Lee CU, Kim TH, Suh YS, Lee KS. Predictive factors of de novo overactive bladder after artificial urinary sphincter implantation in men with postprostatectomy incontinence. Urology. 2018;113:215–9.
25. Kan KM, Tin AL, Stearns GL, Eastham JA, Sjoberg DD, Sandhu JS. De novo urinary storage symptoms are common after radical prostatectomy: incidence, natural history and predictors. J Urol. 2022;207(3):601–8.
26. Ficazzola MA, Nitti VW. The etiology of post-radical prostatectomy incontinence and correlation of symptoms with urodynamic findings. J Urol. 1998;160(4):1317–20.
27. Barnard J, van Rij S, Westenberg AM. A Valsalva leak-point pressure of >100 cmH2O is associated with greater success in AdVance sling placement for the treatment of post-prostatectomy urinary incontinence. BJU Int. 2014;114(Suppl 1):34–7.
28. Loertzer H, Huesch T, Kirschner-Hermanns R, et al. Retropubic vs transobturator Argus adjustable male sling: results from a multicentre study. Neurourol Urodyn. 2020;39(3):987–93.
29. Comiter CV, Sullivan MP, Yalla SV. Correlation among maximal urethral closure pressure, retrograde leak point pressure, and abdominal leak point pressure in men with postprostatectomy stress incontinence. Urology. 2003;62:75–8.
30. Smith AL, Ferlise VJ, Wein AJ, Ramchandani P, Rovner ES. Effect of A 7-F transurethral catheter on abdominal leak point pressure measurement in men with post-prostatectomy incontinence. Urology. 2011;77(5):1188–93.
31. Huckabay C, Twiss C, Berger A, Nitti VW. A urodynamics protocol to optimally assess men with post-prostatectomy incontinence. Neurourol Urodyn. 2005;24(7):622–6.
32. Drake MJ, Doumouchtsis SK, Hashim H, Gammie A. Fundamentals of urodynamic practice, based on International Continence Society good urodynamic practices recommendations. Neurourol Urodyn. 2018;37:S50–60.
33. Porena M, Mearini E, Mearini L, Vianello A, Giannantoni A. Voiding dysfunction after radical retropubic prostatectomy: more than external urethral sphincter deficiency. Eur Urol. 2007;52(1):38–45.
34. Toia B, Leung LY, Saigal R, Solomon E, Malde S, Taylor C, et al. Is pre-operative urodynamic bladder function the true predictor of outcome of male sling for post prostatectomy incontinence? World J Urol. 2021;39(4):1227–32.
35. Habashy D, Losco G, Tse V, Collins R, Chan L. Mid-term outcomes of a male retro-urethral, transobturator synthetic sling for treatment of post-prostatectomy incontinence: impact of radiotherapy and storage dysfunction. Neurourol Urodyn. 2017;36(4):1147–50.
36. Virseda-Chamorro M, Ruiz S, Garcia G, Queissert F, Salinas J, Arance I, et al. Do voiding urodynamic parameters predict the success of adjustable transobturator male system (ATOMS) to treat postprostatectomy urinary incontinence? Neurourol Urodyn. 2020;39(6):1746–52.
37. Thiel DD, Young PR, Broderick GA, Heckman MG, Wehle MJ, Igel TC, et al. Do clinical or urodynamic parameters predict artificial urinary sphincter outcome in post-radical prostatectomy incontinence? Urology. 2007;69(2):315–9.
38. Lai HH, Hsu EI, Boone TB. Urodynamic testing in evaluation of postradical prostatectomy incontinence before artificial urinary sphincter implantation. Urology. 2009;73(6):1264–9.
39. Elliott CS, Comiter CV. Maximum isometric detrusor pressure to measure bladder strength in men with postprostatectomy incontinence. Urology. 2012;80(5):1111–5.
40. Gammie A, Clarkson B, Constantinou C, Damaser M, Drinnan M, Geleijne G, et al. International Continence Society Guidelines on urodynamic equipment performance. Neurouro Urodyn. 2014;33(4):370–9.

41. Braga A, Serati M, Illiano E, Manassero F, Milanesi M, Natale F et a. When should we use urodynamic testing? Recommendations of the Italian Society of Urodynamics (SIUD). Part 2 – Male and neurological population. Minerva Urol Nefrol. 2020;72(2):187–99
42. Drake MJ, Doumouchtsis SK, Hashim H, Gammie A. Fundamentals of urodynamic practice, based on International Continence Society good urodynamic practices recommendations. Neurourol Urodyn. 2018;37(S6):S50–60.
43. Lee TK, Breau RH, Mallick R, Eapen L. A systematic review of expanded prostate cancer index composite (EPIC) quality of life after surgery or radiation treatment. Can J Urol. 2015;22(1):7599–606.
44. Mayer EN, Tward JD, Bassett M, Lenherr SM, Hotaling JM, Brant WO, et al. Management of Radiation Therapy Oncology Group grade 4 urinary adverse events after radiotherapy for prostate cancer. BJU Int. 2017;119(5):700–8.
45. Matta R, Chapple CR, Fisch M, Heidenreich A, Herschorn S, et al. Pelvic complications after prostate cancer radiation therapy and their management: an international collaborative narrative review. Eur Urol. 2019;75(3):464–76.
46. Martin JM, Richardson M, Siva S, Cardoso M, Handmer M, Sidhorn M. Mechanisms, mitigation, and management of urinary toxicity from prostate radiotherapy. Lancet Oncol. 2022;23(12):e534-543.
47. Swanson G, Hammonds K. Long-term effects of radiation on lymphocytes and risk of opportunistic infections. Cureus. 2022;14(7):e26887.
48. Swanson G, Hammonds K, Jhavar S. Short-term haematogical effects of androgen deprivation and radiotherapy in prostate cancer patients. Open J Urol. 2021;11:103–11.
49. Ravier E, Fassi-Fehri H, Crouzet S, Gelet A, Abid N, Martin X. Complications after artificial urinary sphincter implantation in patients with or without prior radiotherapy. BJU Int. 2015;115:300–7.
50. Jhavar S, Swanson G, Deb N, Littlejohn L, Pruszynski J, Machen G, et al. Durability of artificial urinary sphincter with prior radiation therapy. Clin Genitourin Cancer. 2017;15:e175–80.
51. Suardi N, Gallina A, Lista G, Gandaglia G, Abdollah F, Capitanio U, et al. Impact of adjuvant radiation therapy on urinary continence recovery after radical prostatectomy. Eur Urol. 2014;65:546–51.
52. Wright HC, McGeagh K, Richter LA, Hwang JJ, Venkatesan K, Pysher A, et al. Transobturator sling for post-prostatectomy incontinence: radiation's effect on efficacy/satisfaction. Can J Urol. 2017;24(5):8998–9002.
53. Sturm RM, Guralnick ML, Stone AR, Bales GT, Dangle OO, O'Connor RC. Comparison of clinical outcomes between "ideal" and "nonideal" transobturator male sling patients for treatment of postprostatectomy incontinence. Urology. 2014;83(5):1186–8.
54. Torrey R, Rajeshuni N, Ruel N, Muldrew S, Chan K. Radiation history affects continence outcomes after advance transobturator sling placement in patients with post-prostatectomy incontinence. Urology. 2013;82(3):713–7.
55. Stone HB, Coleman CN, Anscher MS, McBride WH. Effects of radiation on normal tissue: consequences and mechanisms. Lancet Oncol. 2003;4(9):529–36.
56. Bates AS, Martin RM, Terry TR. Complications following artificial urinary sphincter placement after radical prostatectomy and radiotherapy: a meta-analysis. BJU Int. 2015;116(4):623–33.
57. Simhan J, Morey AF, Singla N, et al. 3.5 cm artificial urinary sphincter cuff erosion occurs predominantly in irradiated patients. J Urol. 2015;193(2):593–597
58. Walsh IK, Williams SG, Mahendra V, Nambirajan T, Stone AR. Artificial urinary sphincter implantation in the irradiated patient: safety, efficacy and satisfaction. BJU Int. 2002;89(4):364–8.
59. Khouri RK Jr, Ortiz NM, Dropkin BM, et al. Artificial urinary sphincter complications: risk factors, workup and clinical approach. Curr Urol Rep. 2021;22(5):30.
60.• Chung E. Artificial urinary sphincter surgery in the special populations: neurological, revision, concurrent penile prosthesis and female stress urinary incontinence groups. Asian J Androl. 2020;22(1):45–50. **This paper provides practical considerations in AUS surgery for specific subpopulations and surgical strategies for managing these complex patients.**
61. Chung E and Cartmill R. Diagnostic challenges in the evaluation of persistent or recurrent urinary incontinence after artificial urinary sphincter (AUS) implantation in patients after prostatectomy. BJU Int. 2013;112(Suppl 2):32–35
62. Ajay D, Zhang H, Gupta S, Selph JP, Belsante MJ, Lentz AC, et al. The artificial urinary sphincter is superior to a secondary transobturator male sling in cases of a primary sling failure. J Urol. 2015;194(4):1038–42.
63. Martinez EJ, Zuckerman JM, Henderson K, Edwards B, McCammon K. Evaluation of salvage male transobturator sling placement following recurrent stress urinary incontinence after failed transobturator sling. Urology. 2015;85(2):478–82.
64. Saffarian A, Walsh K, Walsh IK, Stone AR. Urethral atrophy after artificial urinary sphincter placement: is cuff downsizing effective? J Urol. 2003;169:567–9.
65. DiMarco DS, Elliott DS. Tandem cuff artificial urinary sphincter as a salvage procedure following failed primary sphincter placement for the treatment of postprostatectomy incontinence. J Urol. 2003;170:1252–4.
66. Guralnick ML, Miller E, Toh KL, Webster GD. Transcorporal artificial urinary sphincter cuff placement in cases requiring revision for erosion and urethral atrophy. J Urol. 2002;167:2075–8.