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Damage Control Considerations During IPP Surgery

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Abstract
Purpose of Review This review summarizes the latest reports in inflatable penile prosthesis (IPP) complication management.
Recent Findings IPP complications are rare, and reports are limited to retrospective studies. However, recent multi-institutional studies and use of national databases have provided further insight into risk factors for complications. Guidance on complication management is largely limited to techniques recommended by experts within the field.
Summary American Urological Association guidelines place IPP implantation as a first line erectile dysfunction treatment. However, the majority of cases are performed by low-volume (≤ 4 cases/year) surgeons. Herein, we summarize the IPP literature and our personal experience to provide guidance on managing IPP complications.

Keywords Complications · Inflatable penile prosthesis · Erectile dysfunction · Outcomes

Introduction

Inflatable penile prosthesis (IPP) is a reliable treatment for erectile dysfunction (ED) with the high patient satisfaction rates [1]. While IPP surgical volume is known to correlate with improved surgical outcomes and patient satisfaction, low-volume surgeons (≤ 4 cases/year) perform more than 75% of the cases in the USA, with andrology subspecialists performing only 10% of the cases [1–3]. With the update on the AUA ED guidelines, surgical correction of ED is now considered first line without having to compel patients to fail less invasive but less reliable options such as intracavernosal injections and PDE5 inhibitors [4••]. Therefore, as IPP surgery is likely to continue to play a prominent role in a urologist's armamentarium, we write this article to help prevent and provide guidance in prevention and damage control of intraoperative and postoperative IPP complications.

This article is part of the Topical Collection on *Surgery*

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Intraoperative Complications

As Benjamin Franklin once said, an ounce of prevention is worth a pound of cure. This is true for all surgery, but is essential in IPP surgery where complications result in significant morbidity and cost. In the following sections, we will present multiple vignettes of intraoperative and postoperative complications that can be encountered during IPP surgery. We will provide tips on how to best avoid them, and when necessary the appropriate steps to provide damage control.

Cylinder Complications

Crossover

At many points following dilation, crossover can be identified. You may be clued in when there is discrepancy in corporal measurements, you have difficulty placing the second cylinder proximally, or upon cycling the device, you find one side of the penis is unevenly large whereas the contralateral side is thin. All of these are intraoperative findings associated with proximal or distal crossover; however, even still, these findings can be subtle, and you may find yourself seeing a patient in follow-up with continued penile pain and de novo curvature.

Distal crossover is more likely to occur when the penis is not on stretch and the dilator or Furlow passer is not guided in a posterolateral direction. While each cylinder head is palpated on the correct side, more often than not, a crossover injury involves the cylinder crossing over the septum to the contralateral side and then back to the ipsilateral side. Often, crossover occurs at the point of initial Furlow insertion tool use prior to directing the instrument laterally. Fortunately, when diagnosed intraoperatively, correction of this is relatively easy [5]. The cylinders should be removed. A Hegar dilator should be placed on the side where both cylinders had previously occupied. Once done, the contralateral side should be redilated and the cylinder is placed using the Furlow passer. Lastly, the Hegar dilator is removed and last cylinder is placed per standard protocol.

In a rare case where a patient presents to the clinic with obvious crossover, the easiest and most practical approach to repairing this would require revision through an infrapubic or penoscrotal approach. While this approach may be more comfortable to the everyday urologist as it does not require any additional learned techniques, Antonini and colleagues [6•] provide an alternative method for managing distal crossover and impending lateral extrusion. Performing a distal anchoring stitch begins with a lateral subcoronal incision made on the side where the cylinder has crossed over. Dissection is performed through the tunica of the corpora where the distal cylinder is delivered. The corpora is then dilated in the correct trajectory, and the cylinder is passed using the Furlow passer and a new 4-0 PDS suture through the distal cylinder hole. Unlike uncomplicated IPP placement where the suture is removed following appropriate cylinder placement, a cruciate incision is made on the glans allowing the distal suture to be tied down as a buried stitch, anchoring the cylinder in the appropriate position.

Proximal crossover occurs due to improper dilation and leads to inability to place both cylinders proximally. This is often associated with narrow fibrotic proximal corpora. Following dilation, we recommend performing the "field goal test" that can identify both proximal crossover and proximal perforation [5]. If found, repeat dilation should be performed in a similar fashion as recommended above for distal perforation. If there are still difficulties placing the second cylinder, consider placing a narrow device that will more easily fit in the true dilation tract.

Distal Perforation/Urethral Meatus Injury

After dilating the corpora, you see blood emanating from the urethral meatus. Irrigation is injected into the corporotomy, and rather than seeing the corporotomy balloon with irrigation backflowing through the contralateral corporotomy, irrigation leaks around the catheter, or more subtly, the glans swells.

Distal perforation or urethral meatus injury occurs in the setting of aggressive dilation, placing a cylinder too large for the corporal cavity, chronic pressure from the cylinder, or during modeling for Peyronie's disease [7]. The tunica albuginea of the corpora is thinnest at the distal end. When dilating a fibrotic corpora (e.g., in the setting of ischemic priapism), the physician pushes harder, and when the resistance yields, the momentum pushes the dilator into the urethra. If severe, this can present intraoperatively as seen above; however, if it is perforation excluding the urethra, this can present intraoperatively as swelling glans on irrigating the corpora or delayed as new onset hematuria, urethral extrusion, or impending lateral of distal glans extrusion.

Avoiding a distal perforation requires a deft touch, and repetition. While some surgeons use the Hegar dilator for IPP placement, we prefer to use the Brooks dilator. In our experience, the bullet-shaped Brooks dilator places all of the resistance at the tip where dilation occurs rather than along the entire length of the cylinder. This allows the surgeon to have a better feel and control of the force needed to dilate even the most fibrotic corpora. Protecting the urethra during dilation by applying pressure to the glans and a posterolateral angulation of the dilator are necessary to dilate safely.

Severe fibrosis often may require additional maneuvers such as serial dilation, use of special cavernotomes, scissors, or even corporal excavation [8, 9, 10•]. These special instruments may not be a part of the everyday urologist's surgical equipment, and therefore in patients who you expect to encounter severe fibrosis, the patient may benefit from referral. However, even in "straightforward" cases, over a quarter of these will require special instruments or techniques, and therefore, it is important for the general urologist to have tricks up his or her sleeve to complete the case [10•]. Distal injury can always be avoided by serially extending the corporotomy distally (with placement of additional stay sutures) when resistance to distal dilation is attempted, even all the way to the glans, like opening up the belly of a trout.

When treating a patient with expected corporal fibrosis, first, consider use of either preoperative penile traction or vacuum-assisted device to potentially stretch/soften the corpora prior to surgery [11–13]. Then, you must know the minimal dilation size required for placing an IPP. For Coloplast's Titan cylinders, they recommend dilation to 11 mm proximally and 9 mm distally. For Boston Scientific's CX and LGX, corpora need to be dilated to 10 mm proximally and 9 mm distally. For each company's downsized cylinders, the Coloplast NB and Boston Scientific CXR, proximal and distal dilation needs to be at least 9 mm. Last, when dilating distally, rather than placing extra force to get the maximum length of dilation, in our experience, we have found that slightly under dilating and then oversizing the device will allow the pressure from device cycling and patient use to properly seat the cylinder within the corpora. With the use of these steps and avoiding aggressive

dilation in the setting of fibrosis, you can save yourself from future pain.

Unfortunately, even in the best of hands, distal perforation and urethral injury can happen. When identified, only the most experienced prosthetic surgeon should consider urethral repair and continuing on with implantation. While there are reports of using a suprapubic tube or creation of a proximal hypospadias to salvage the case, we would advocate a more conservative approach [14, 15].

Classically, the teaching for distal urethral injuries is to abort the case and live to fight another day. After a period of healing, at least 3 months, it is then safe to perform an implantation. For small injuries, the urethra does not need to be closed and we recommend temporary catheter drainage of no more than a week. Previously, Mulcahy [16] reported that the urinary stream pulls fluid into the urethra rather than allowing urinary extravasation into the corporal space. For larger defects that are amenable for closure, a two-layer closure should be attempted. After the urethral defect has been addressed, you have the option of leaving a unilateral cylinder in the uninjured corpora. This may provide enough rigidity and girth for some patients for satisfactory use [17]; however, we caution doing this in the setting of modeling as the trauma that led to the perforation potentially places the contralateral corpora at risk. For urethral injuries unrelated to dilating or away from tips of the cylinder (e.g., during initial dissection), an argument can be made for two-layer urethral repair and continuing with the implantation.

In the delayed setting, the patient may present with penile pain, a palpable/visible cylinder tip under the foreskin or urethral mucosa, or exposed through the skin. If the prosthesis is not exposed and there are no signs of inflammation or infection, the cylinder can be repositioned within the corpora as described above for crossover with a lateral corporotomy [6•, 16]. If the prosthesis is exposed without signs of infection, the single cylinder can be removed with the tubing capped leaving a unilateral working prosthesis. If clinically infected (e.g., red, purulent drainage), the entire prosthesis should be removed as described later in this review.

Proximal Perforation

When dilating proximally, you reach a shelf or trampoline of tissue without feeling the inferior pubic rami. It is important to dilate to the bone, and therefore you push a little harder or you use a smaller dilator and all of a sudden you feel a give. Now dilation is easy but goes on indefinitely.

Proximal perforation is relatively easy to do; fortunately, new techniques provide simple solutions [18]. Prior to discussing these, we will provide a few tips on prevention. Dilation should be smooth without sudden movement. Use of preplaced corporotomy sutures allows counter tension for dilation, and when dilating, the natural curvature of the corpora should be considered. Therefore, when you reach the trampoline of tissue, rather than pushing harder, the dilator should be deflected slightly lateral to make the final bend. In cases of fibrotic corpora, the tendency is to use a thinner dilator. While sequential dilation may be necessary, the smaller the dilator, the greater the force administered on the tip, and therefore the easier it is to perforate [19].

Nevertheless, with enough IPP cases, proximal perforation will eventually happen and therefore understanding techniques to repair this is important as failure to do so can lead to proximal migration of the cylinders postoperatively. Previously, the standard repair techniques included placing the patient in lithotomy to perform a perineal dissection and formal closure of the corpora. This was overly cumbersome and added morbidity to the surgery. To avoid closure, a graft windsock was developed to be fixed to the corpora [20]. However, this led to an exceedingly high infection rate likely due to the avascular region between prosthesis and graft. Alternatively, some have advocated for tube fixation to lock the prosthesis in place [7].

In 2010, Wilson [21] presented his rear tip sling that created a hammock similar to the windsock technique without adding any graft material. A 00 prolene suture is placed through one side of the corporotomy, through the rear tip of the cylinder or rear tip extender, and then passed through the opposite side of the corporotomy. With the sling in place, the cylinder is inserted into the corpora. The glans sutures are held on tension to ensure the cylinder is seated distally. The cylinder is then inflated, and the suture sling is tied. Once tied, the tension from the sling prevents proximal migration of the cylinder. Postoperatively, the patient should reframe from using the device for 6 weeks to allow the corpora to scar over.

Cylinder Herniation/Aneurysm

Your patient returns in follow-up with the complaint that, when using his device, he feels a bulge on the side of his penis. You evaluate and determine that the cylinder or corpora has developed a herniation or aneurysm.

Cylinder herniation or aneurysm can occur in the setting of either a weakened corpora or cylinder aneurysm associated with wear and tear. Unfortunately, there is not much that can be done to protect from this complication beyond ensuring appropriate sizing of cylinders and promoting regular and early activation to avoid buckling caused from capsule formation [22]. When identified, the device should be revised. You have the option of resecting the diseased corpora with primary or graft closure. However, whether or not this is done, the revised prosthesis should be an AMS CX to utilize the safety of controlled expansion, although device aneurysm with the CX has been reported [23]. The use of a Coloplast device's potential infinite girth expansion or the AMS LGX could lead to repeat herniation.

Glans Necrosis

You are seeing your patient on postoperative day 1, and you notice the glans is dusky with blistering.

While glans necrosis is an infrequent complication, once identified, the surgeon should have no hesitation towards device explantation. Previous reports have identified risk factors for glans ischemia to include peripheral vascular disease, diabetes, smoking, radiation, subcoronal incision, sliding technique, and compressive dressing [24•]. Deflating the device and removal of any compressive dressing may improve distal blood flow. However, in every case of explantation, the glans recovered to allow future implantation. In settings where the urologist elected to observe, glans necrosis occurred in over 80%.

Reservoir Complications

When placing the abdominal reservoir, the ideal location is a place that can be safely and reliably accessed without applying excessive pressure on the reservoir [25]. The traditional position for reservoir placement is through the external inguinal ring and into the retropubic space or space of retzius. We recommend having the lock out valve or neck of the reservoir peeping out of the external ring for easier future retrieval. With the advent of robotic surgery, the peritoneal veil is violated during prostatectomy and not reestablished increasing the risk of complication in the retropubic space (small bowel obstruction, fistula, etc.) Therefore, a new ectopic location in the high submuscular position behind the rectus muscles is increasingly used [26, 27]. Below, we describe several reservoir complications that a urologist may face.

Bladder Injury

Bladder injury is a rare complication. Intraoperatively, this presents as hematuria. However, postoperative device erosion into the bladder may present as pain, recurrent UTIs, dysuria, or an infected device.

While rare, several basic steps can help avoid intraoperative bladder injury during orthotopic reservoir placement. First, the bladder must be decompressed with a catheter. Henry et al. [28•] demonstrated in cadaveric models that when the bladder is filled to 200 cc, the bladder was 2.4 cm from the external ring in comparison with 6.4 cm when decompressed. Different surgeons have used various instruments to perforate into the space of retzius (Metzenbaum, Jorgenson, or nasal speculum) [29–31]. All of these different techniques are to help avoid intraabdominal injury. We favor the use of the surgeon's index finger to burrow through the layers of the posterior fascia, as we feel this is least likely to result in injury.

Alternatively, in the setting of a fluid leak, the reservoir capsule can contract. During revision, if the in situ reservoir is reused or new reservoir is placed within the same capsule, reservoir inflation may cause capsule rupture and subsequent bladder laceration [32]. While it is safe to use a previous reservoir space during revision surgery (without fluid leak with similar size reservoir), copious irrigation and careful reservoir filling is recommended.

In the setting of an intraoperative bladder injury, the bladder should be repaired and the reservoir placed in the contralateral space or in an ectopic location. If identified in a delayed fashion or due to erosion into the bladder, the device should be treated similar to an eroded cylinder [33]. If clinically infected, the device should be explanted. If there are no signs of infection, bladder repair with replacement of a new reservoir in either the contralateral space or ectopic location is appropriate.

Vascular Complication

After perforating through the external ring, the Metzenbaum scissors pierce deep and laterally. The patient is experiencing significant hemorrhage.

What some have described as "bleeding you can hear," vascular injury is a significant complication that requires aggressive repair. If it is a small venous branch, a combination of pressure and fibrinogenic products should be able to stop the bleeding. However, if the major vessels are injured, quick exposure of the pelvis (midline incision), consultation of a vascular surgeon, immediate resuscitation with type and cross, and notification of anesthesia for potential significant hemorrhage are imperative.

As mentioned above, we use the surgeon's finger to enter the space of retzius to avoid reservoir complications. In our hands, if a finger cannot break through the fascia, we elect for an ectopic placement. If instruments are used to perforate through transversalis fascia, Trendelenburg should be used to increase the space between the external ring and the pelvic vessels [28•].

Postoperatively, the patient develops unilateral lower extremity swelling and pain ipsilateral to his retropubic reservoir. Duplex ultrasound diagnoses a DVT.

While venous thromboembolism can occur following any urologic surgery, venous compression from the pelvic reservoir leading to DVT has been described [34]. Once diagnosed, previous reports have utilized an IVC filter prior to reservoir repositioning [35]. This rare complication highlights the need to avoid overfilling the reservoir to prevent unnecessary compression of the pelvic vasculature or bladder.

During removal of a reservoir placed by an outside urologist, cautery is used to chase the tubing deep into the pelvis. Growing somewhat frustrated, you decide to pull a little bit harder on the reservoir tubing, and out it comes, with a piece of adherent iliac vessel and a torrent of blood.

In many instances, removal of reservoirs can be more dangerous than primary placement. We do not hesitate to use a drain and retain strategy when we have not placed the original reservoir in a noninfected setting [36]. In an infected setting, greater attempts to retrieve the reservoir should be undertaken. However, if the patient is too sick, it also can be left behind and pursued at another time. We also would recommend considering preoperative imaging for operative planning and identifying the location of the reservoir. As seen in Fig. 1, reservoirs may migrate to unexpected locations, and removal may require a separate incision and/or help from colorectal colleagues.

A patient calls in 3 days post prosthesis complaining of new onset severe scrotal swelling, pain, and partial breakdown of the incision. The patient is asked to come to the office and a large hematoma with blue and yellow discoloration all the way up to the umbilicus is found. The pump is nonpalpable and the patient tender.

Scrotal hematoma after IPP probably occurs in 1–5% of patients. Known strategies to prevent hematoma include immediate partial inflation of the cylinders, scrotal pressure dressing, and closed suction drainage (which has not been shown to increase risk of infection) [37, 38•]. In fact, some implanters leave a closed suction drain in place for a planned 3 days post procedure to minimize hematoma. The vast majority of hematomas can be observed, with some requiring up to 3 months to completely resolve. Small hematomas can surround the pump often prolonging the time to patient use.

Hematoma exploration and evacuation should be performed urgently in instances where old black blood is visible and draining out of the wound. The hematoma is a two-way street and provides an excellent culture medium for infection. Hematoma exploration can be performed for nondraining hematomas at the surgeon's discretion in instances where they want to facilitate earlier device use. We recommend waiting at least 10 days in this instance to let the clot consolidate.

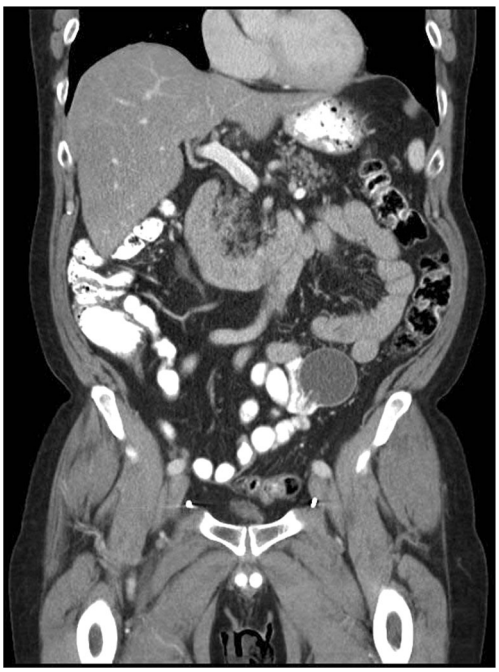

Fig. 1 Preoperative CT scan demonstrating intraperitoneal reservoir

Infectious Complications

You receive a call from the patient. He is having new worsening pain, his penis and scrotum are swollen, and he is having intermittent fevers.

With the advent of antibiotic-coated penile prosthesis, device infection has become much less common [39]. Signs of infection can be obvious as noted in the vignette, but infection with less virulent skin organisms may present with mild symptoms including prolonged pain, pump, or tubing that has become adherent to the skin, wound breakdown, or serous wound drainage.

Device infection ultimately results from intraoperative contamination. Multiple factors can be adopted to improve sterile technique including use of chlorhexidine-alcohol-based site prep, copious antibiotic irrigation during surgery, antibiotic-coated prosthesis, no-touch technique, and surgical efficiency [2, 40–42]. However, when faced with an infected prosthesis, certain steps need to be made to salvage future function.

In patients who present as described above with obvious infectious symptoms (i.e., erythema, fever, leukocytosis, and purulent drainage), the device is likely infected with a virulent organism such as *E. coli*, Pseudomonas, or yeast. In this setting, aggressive IV antibiotics should be initiated and the device removed urgently. These patients are not the ones that warrant heroic salvage reimplantation, as it likely would result in further infection. The infection should be allowed to convalesce with staged reimplantation. In the interim, use of a vacuum erection device may reduce penile length loss associated with infection and make future dilation easier. Additionally, given the expected severe fibrosis and risk for infection with repeat implantation, referral to a high-volume center is recommended.

However, if the patient presents with more localized symptoms such as pump adherence to the skin, clear drainage from the wound, or visible components without purulence, salvage therapy is potentially warranted. While the majority of cases are explanted without replacing the cylinders, salvage surgery should be considered to maintain implanted status and prevent penile shortening [43, 44•]. When salvaging the implanted state, the patient should be treated with IV antibiotics for at least 48 h to destroy any periprosthetic bacteria. The entire device is removed, and all spaces are copiously irrigated with a series of antibiotic and antiseptic fluids [45]. With this technique, Dr. Mulcahy has reported salvaging over 80% of

Table 1 Tips and tricks of complicated intraoperative IPP surgery

Damage scenarios	Etiology/rationale	Solutions
Urethral/spongiosal injury on initial dissection	No urethral catheter, previous scrotal surgery	Close injury in 2 layers, leave catheter 3–5 days, continue with implant
Difficulty with corporal dilation	Wrong surgical plane, fibrosis, worse distal from priapism and proximal from previous infection or vascular insufficiency	Deepen incision into corporotomies, extend corporotomy length, use depth and angle of already dilated corporal side if available
Proximal corporal perforation	Vigorous dilation with small caliber dilators, fibrosis from prior case, incorrect dilation angle (typically too medial)	Avoid by lateral dilation at crura, account for patient positioning (Trendelenburg etc.), rear tip extender sling and continue
Urethral perforation from dilation	Vigorous dilation with small caliber dilator medially	Abort case, may leave one cylinder in place if already present
Urethral injury from modeling	Glans not protected, modeling multiple times, oversized cylinder	Abort case, may leave one cylinder in place if already present but assess for injury with nasal speculum in urethra as force may cause bilateral injury
Difficulty with placement of cylinders	Unrecognized proximal cross over, corporal fibrosis from previous surgery, patient anatomy	Repeat field goal test, leave dilator in one corpora with placement of other, use narrow device if unable to dilate to > 10
Erection is uneven in girth	Unrecognized distal cross over	Leave dilator in one corpora while performing repeat dilation. Furlow should be passed with dilator in uninjured side.
Bladder injury	Reservoir placement with full bladder, removal of old reservoir	Remove reservoir and repair bladder, place reservoir on opposite side
Vigorous bleeding from reservoir site	Occult pelvic vessel injury from reservoir placement, removal of adherent old reservoir	Equanimity, inform anesthesia and vascular surgery, pressure, hemostatic agents, consider counter incision

locally infected prostheses. More recently, Gross et al. [46•] report even higher success rates using primarily malleable implants as they are less likely to get reinfected considering they lack the increased surface area of the pump, tubing, and reservoir.

Tips for the Second Urologist

Invariably, if you see enough IPP patients, you will come to revise an IPP placed elsewhere. You expect certain prosthetic anatomy, but you find an exorbitant amount of rear tips; the protective tube coating on the AMS is adhered to the scrotal contents, and after you remove the reservoir, small bowel starts coming through the ring.

When attempting to revise an IPP placed elsewhere, constant vigilance is necessary to prevent external sabotage. Preoperatively, it is imperative to obtain the outside operative report, and if unavailable, the manufacturer should be contacted to know what size device and number of rear tips used. Failure to identify a retained rear tip extender intraoperatively may make cylinder placement more difficult or leads to infection from retained biofilm. As stated earlier, pelvic and abdominal imaging prior to revision may be beneficial.

During dissection to remove the cylinder, the tubing can be cut and each individual cylinder inflated to guide the corporotomy and prevent going too lateral or spiraling along the corpora. This is important, as then finding the true corpora for closure is imperative in preventing cylinder herniation. We also recommend visualization of the distal seating of the device with test inflation as often the second surgeon is left wondering if they caused a new distal abnormality.

Lastly, we recommend having specialized instruments, narrow cylinders, and multiple rear tip extenders available. A small narrow device with multiple rear tips beats aborting the case due to failure to progress.

Conclusion

Implanting an IPP device is a rewarding yet humbling experience. With any surgery, there are risks of complications, and a frank discussion of appropriate expectations with surgery is paramount in getting any patient and their family through the unexpected. Herein, we reviewed multiple intraoperative and postoperative complications the prosthetic surgeon may experience and have provided tips on how to avoid and repair complications when they occur (Table 1). We hope that our experiences and the humbling reports from fellow urologists may provide you with the necessary tools to face any challenge during IPP surgery.

Compliance with Ethical Standards

Conflict of Interest David Y. Yang declares no potential conflicts of interest.

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References

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

1. Capogrosso P, Pescatori E, Caraceni E, et al. Satisfaction rate at 1-year follow-up in patients treated with penile implants: data from the multicentre prospective registry INSIST-ED. BJU Int. 2018.
2. Henry GD, Kansal NS, Callaway M, Grigsby T, Henderson J, Noble J, et al. Centers of excellence concept and penile prostheses: an outcome analysis. J Urol. 2009;181:1264–8.
3. Oberlin DT, Matulewicz RS, Bachrach L, Hofer MD, Brannigan RE, Flury SC. National practice patterns of treatment of erectile dysfunction with penile prosthesis implantation. J Urol. 2015;193:2040–4.
4. •• Burnett AL, Nehra A, Breau RH, et al. Erectile dysfunction: AUA guideline. J Urol. 2018; **Having a strong knowledge of current guideline recommendations is essential for appropriate patient workup, couseling and management**.
5. Karpman E. Management of distal & proximal penile prosthesis crossover. J Sex Med. 2016;13:1008–12.
6. • Antonini G, Busetto GM, Del Giudice F, et al. Distal corporal anchoring stitch: a technique to address distal corporal crossovers and impending lateral extrusions of a penile prosthesis. J Sex Med. 2017;14:767 **This article describes a reproducable technique for managing impending lateral extrusion and distal corporal crossover**.
7. Stember DS, Kohler TS, Morey AF. Management of perforation injuries during and following penile prosthesis surgery. J Sex Med. 2015;12(Suppl 7):456.
8. Trost L, Patil M, Kramer A. Critical appraisal and review of management strategies for severe fibrosis during penile implant surgery. J Sex Med. 2015;12(Suppl 7):439.
9. Garber BB, Lim C. Inflatable penile prosthesis insertion in men with severe intracorporal fibrosis. Curr Urol. 2017;10:92.
10. • Brant W, Köhler T, Henry G, Karpman E, Kansas B, Jones L, et al. "Unexpected" corporal fibrosis should be "expected": the prevalence of significant corporal fibrosis encountered during penile prosthetics. J Sex Med. 2015;12 **This abstract reported that even in "straight-forward" cases, corporal fibrosis requiring specialized techniques or instruments occurred in >25% of cases**.
11. Levine LA, Rybak J. Traction therapy for men with shortened penis prior to penile prosthesis implantation: a pilot study. J Sex Med. 2011;8:2112–7.
12. Tsambarlis PN, Chaus F, Levine LA. Successful placement of penile prostheses in men with severe corporal fibrosis following vacuum therapy protocol. J Sex Med. 2017;14:44–6.
13. Canguven O, Talib RA, Campbell J, de Young L, el Ansari W, al-Ansari A. Is the daily use of vacuum erection device for a month before penile prosthesis implantation beneficial? A randomized controlled trial. Andrology. 2017;5:103–6.
14. Anele UA, Le BV, Burnett AL. Suprapubic cystostomy for the management of urethral injuries during penile prosthesis implantation. Sex Med. 2014;2:178–81.
15. Perito P. Urethral injury during inflatable penile prosthesis: a new repair. Video J Prosthet Urol. 2014;1.
16. Mulcahy JJ. The prevention and management of noninfectious complications of penile implants. Sex Med Rev. 2015;3:203–13.
17. Levine LA, Becher EF, Bella AJ, et al. Penile prosthesis surgery: current recommendations from the international consultation on sexual medicine. J Sex Med. 2016;13:489–518.
18. Pearlman AM, Terlecki RP. Proximal corporal perforation during penile prosthesis surgery: prevention, recognition, and review of historical and novel management strategies. J Sex Med. 2018;15:1055–60.
19. Mulcahy JJ. Crural perforation during penile prosthetic surgery. J Sex Med. 2006;3:177–80.
20. Knoll LD, Furlow WL. Corporeal reconstruction and prosthetic implantation for impotence associated with non-dilatable corporeal cavernosal fibrosis. Acta Urol Belg. 1992;60:15.
21. Wilson SK. Rear tip extender sling: a quick and easy repair for crural perforation. J Sex Med. 2010;7:1052–5.
22. Caraceni E, Utizi L, Angelozzi G. Pseudo-capsule "coffin effect": how to prevent penile retraction after implant of three-piece inflatable prosthesis. Arch Ital Urol Androl. 2014;86:135–7.
23. Kaufman JM, Weldon TE. Cylinder aneurysm of parylene-coated American Medical System (AMS) 700CX penile prosthesis. J Sex Med. 2008;5:2713–5.
24. • Wilson SK, Mora-Estaves C, Egydio P, et al. Glans necrosis following penile prosthesis implantation: prevention and treatment suggestions. Urology. 2017;107:144 **This article is the only article that summarizes all previous reports of glans necrosis and highlights the need for immediate device explantation**.
25. Perito P, Wilson S. The history of nontraditional or ectopic placement of reservoirs in prosthetic urology. Sex Med Rev. 2016;4:190–3.
26. Ziegelmann MJ, Viers BR, Lomas DJ, Westerman ME, Trost LW. Ectopic penile prosthesis reservoir placement: an anatomic cadaver model of the high submuscular technique. J Sex Med. 2016;13:1425–31.
27. Clavell Hernandez J, Trost L, Kohler T, et al. Emerging complications following alternative reservoir placement during inflatable penile prosthesis placement: a 5-year multi-institutional experience. J Urol. 2018.
28. • Henry G, Hsiao W, Karpman E, et al. A guide for inflatable penile prosthesis reservoir placement: pertinent anatomical measurements of the retropubic space. J Sex Med. 2014;11:273 **This article provides objective measurments demostrating that vital structures within the pelvis are suprising close to the ring but can be protected with use of bladder decompression and trendelenberg positioning**.
29. Capoccia EM, Phelps JN, Levine LA. Modified inflatable penile prosthesis reservoir placement into space of retzius: comparing outcomes in men with or without prior pelvic surgery. J Sex Med. 2017;14:968–73.
30. Lane BR, Abouassaly R, Angermeier KW, Montague DK. Three-piece inflatable penile prostheses can be safely implanted after radical prostatectomy through a transverse scrotal incision. Urology. 2007;70:539–42.
31. Vollstedt A, Gross MS, Antonini G, Perito PE. The infrapubic surgical approach for inflatable penile prosthesis placement. Transl Androl Urol. 2017;6:620–7.

32. Kramer AC, Chason J, Kusakabe A. Report of two cases of bladder perforation caused by reservoir of inflatable penile prosthesis. J Sex Med. 2009;6:2064–7.
33. Garber BB, Morris A. Intravesical penile implant reservoir: case report, literature review, and strategies for prevention. Int J Impot Res. 2013;25:41–4.
34. Brison D, Ilbeigi P, Sadeghi-Nejad H. Reservoir repositioning and successful thrombectomy for deep venous thrombosis secondary to compression of pelvic veins by an inflatable penile prosthesis reservoir. J Sex Med. 2007;4:1185–7.
35. da Justa DG, Bianco FJ Jr, Ogle A, Dhabuwala CB. Deep venous thrombosis due to compression of external iliac vein by the penile prosthesis reservoir. Urology. 2003;61:462.
36. Cefalu CA, Deng X, Zhao LC, Scott JF, Mehta S, Morey AF. Safety of the "drain and retain" option for defunctionalized urologic prosthetic balloons and reservoirs during artificial urinary sphincter and inflatable penile prosthesis revision surgery: 5-year experience. Urology. 2013;82:1436–9.
37. Wilson SK, Cleves M, Delk JR. Scrotal hematoma prevention following penile prosthesis implantation: to drain or not to drain. J Urol. 1996;155:634A.
38.• Sadeghi-Nejad H, Ilbeigi P, Wilson SK, et al. Multi-institutional outcome study on the efficacy of closed-suction drainage of the scrotum in three-piece inflatable penile prosthesis surgery. Int J Impot Res. 2005;17:535 **This retrospective study demonstrates the minimal risk of infection and hematoma when using closed suction scrotal drains post-operatively**.
39. Wilson SK, Costerton JW. Biofilm and penile prosthesis infections in the era of coated implants: a review. J Sex Med. 2012;9:44–53.
40. Darouiche RO, Wall MJ Jr, Itani KM, et al. Chlorhexidine-alcohol versus povidone-iodine for surgical-site antisepsis. N Engl J Med. 2010;362:18–26.
41. Mandava SH, Serefoglu EC, Freier MT, Wilson SK, Hellstrom WJG. Infection retardant coated inflatable penile prostheses decrease the incidence of infection: a systematic review and meta-analysis. J Urol. 2012;188:1855–60.
42. Eid JF. Penile implant: review of a "no-touch" technique. Sex Med Rev. 2016;4:294–300.
43. Zargaroff S, Sharma V, Berhanu D, et al. National trends in the treatment of penile prosthesis infections by explantation alone vs. immediate salvage and reimplantation. J Sex Med. 2014;11:1078.
44.• Lopategui DM, Balise RR, Bouzoubaa LA, et al. The impact of immediate salvage surgery on corporeal length preservation in patients presenting with penile implant infections. J Urol. 2018;200:171 **This study highlights the significant difference in penile length in patients treated with immediate salvage surgery following implant infection.**
45. Mulcahy JJ. Long-term experience with salvage of infected penile implants. J Urol. 2000;163:481–2.
46.• Gross MS, Phillips EA, Balen A, et al. The malleable implant salvage technique: infection outcomes after mulcahy salvage procedure and replacement of infected inflatable penile prosthesis with malleable prosthesis. J Urol. 2016;195:694 **This multi-center study discusses the use of MIST technique for salvaging infected IPP with use of a malleable device**.