Reservoir induced bladder rupture: a complication of inflatable penile prosthesis revision surgery

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Reservoir induced bladder rupture is a rare complication of inflatable penile prosthesis (IPP) revision surgery. Our aim is to review the literature and describe our experience with this complication using two case reports that involved reusing an in-situ reservoir. In each case, an episode of gross hematuria indicated that a bladder rupture had occurred. From our experience, we propose ways to possibly avoid and if necessary, manage this rare complication.

Key Words: inflatable penile prosthesis, device malfunction, revision surgery, reservoir complications, bladder rupture

Introduction

An inflatable penile prosthesis (IPP) is an option for men with erectile dysfunction (ED) who have either failed prior therapies or choose to forgo other treatment options. Mechanical malfunction, although infrequent, still exists despite improvements in both prosthetic design and surgical technique.[1] If the device malfunctions, it may be revised by either complete removal with replacement of all components (including the reservoir) or, retention of the reservoir with replacement of only the affected parts. Reusing the in-situ reservoir remains an option in most scenarios as improvements in the reservoir design have demonstrated excellent mechanical reliability of this component.[1]

Bladder injury is a rare, but potentially devastating complication of IPP revision surgery. Despite its infrequent occurrence, bladder injury is the most common case report in the literature followed by external iliac compression, ileal conduit erosion, and small bowel obstruction.[1-3] In contrast to bladder erosion, which is a delayed complication of revision surgery, bladder rupture is an immediate complication of revision surgery following in-situ reservoir reinflation. As expected, both prior pelvic surgery and radiation can increase the risk of this complication.[1]

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Herein, we present a case series of reservoir induced bladder ruptures during IPP revision surgery along with management recommendations. We further discuss strategies that may help to avoid this complication.

Case 1

A 58-year-old male underwent an open prostatectomy for prostate cancer in 1996 followed by radiation therapy in 2006. In 2010, he had an IPP placed for ED refractory to medical management. A Coloplast device was implanted during the initial surgery using a penoscrotal approach with placement of a 125 cc left-sided space of Retzius reservoir. Postoperatively, he reported no issues until 2015, when he noted incomplete erections associated with pump dysfunction. A pelvic CT scan was obtained to evaluate the reservoir, which demonstrated a deflated reservoir with no evidence for peri-reservoir stranding or collection. Three months later, he underwent IPP revision surgery where a break in the cylinder tubing was found as it attached to the pump. The cylinders, pump and tubing were removed and replaced while leaving the reservoir in-situ. The reservoir was initially filled with 150 cc in attempt to "break the capsule" that may have formed around the deflated reservoir. There was no loss of saline, confirming reservoir integrity. The reservoir was then refilled with 70 cc of injectable saline without notable back pressure and quick connectors were used to align the tubing. In the recovery area, gross hematuria was noted within the Foley bag. A CT cystogram was performed demonstrating a small left sided extraperitoneal bladder leak in the area of the IPP reservoir. The patient was counseled regarding the bladder rupture complication, along with the risks and benefits of different management options including: 1) immediate bladder repair versus a trial of a Foley catheter, 2) replacement of the 3-piece penile prosthesis with contralateral reservoir placement versus ectopic reservoir placement, and/or 3) placement of a malleable prosthesis. The patient elected to treat the bladder rupture with Foley drainage in addition to replacing the 3-piece penile prosthesis with a contralateral ectopic (posterior rectus) reservoir. Unfortunately, in spite of Foley drainage, a persistent bladder leak into the old reservoir space to the left of the bladder was noted on follow up CT cystogram 2 weeks later. The patient declined further conservative management and pursued a robotic assisted 2-layer bladder closure. Two weeks later, a follow up cystogram demonstrated resolution of the bladder leak, and the Foley catheter was removed. Thereafter, the patient was able to successfully cycle the IPP for penetrative intercourse.

Case 2

A 67-year-old male with ED following a robotic assisted laparoscopic prostatectomy (RALP) for prostate cancer in 2006 underwent IPP placement in 2010 after failed management with oral medications, intraurethral medications and intracavernosal injections. An AMS 700 penile implant with a 65 cc reservoir was placed via a penoscrotal approach with left-sided space of Retzius reservoir placement. The patient did well until 2018, when he was no longer able to inflate the cylinders due to pump dysfunction. A pelvic CT scan was obtained demonstrating a deflated reservoir without stranding. Ten months later, the patient subsequently underwent elective IPP revision surgery. Intraoperatively, the cylinder tubing extending from the pump was found to have a leak. The pump and cylinders were replaced, while the reservoir was left in place. After the in-situ reservoir was overinflated to "break the capsule" and confirm reservoir integrity, it was left with 65 cc of saline and connected to the tubing using quick connectors. Upon closing dartos, the patient was noted to have gross hematuria. Due to our higher level of suspicion for bladder rupture (based on our prior experience with patient #1), an intraoperative cystogram was performed demonstrating a questionable, faint extraperitoneal bladder leak. This prompted further cystoscopic evaluation, whereby direct cystoscopic visualization confirmed a small bladder rupture exposing a portion of the reservoir. After discussions with his next of kin, we performed immediate removal of all component parts through the existing penoscrotal incision. Rather than prolonging the surgery and possibly increasing the risk of infection by placing a new 3-piece penile prosthesis in a potentially non-sterile field, the decision was made to place a Coloplast malleable prosthesis to provide adequate sexual function while maintaining corporal length and integrity. The increased morbidity associated with an additional incision for cystorrhaphy was avoided by placement of a Foley catheter for conservative management of the bladder rupture. Follow up cystogram 2 weeks later was negative for urinary extravasation. The Foley catheter was thus removed, and the patient had a successful trial of void. In follow up, the patient was satisfied with his malleable prosthesis and elected to forgo additional surgery for replacement of a 3-piece penile prosthesis.

Discussion

During IPP surgery, the bladder may be injured through a variety of mechanisms, not limited to inadvertent surgical placement of the reservoir into the bladder, gradual erosion into the bladder, and rupture into the bladder after an in-situ reservoir is reinflated during revision surgery. In the literature, there are 25 case reports of bladder injuries due to IPP reservoirs, with 7 cases occurring following revision surgery with in-situ reservoir reinflation, Table 1.[1-8]

O'Brien was the first to report such a complication in 1984.[7] He reported that two patients developed hematuria following reinflation of the in-situ reservoir. Intravesical reservoir location was confirmed using cystoscopy. The repair proceeded with exploration, bladder repair, and contralateral reservoir replacement.

Two years later, in 1986, Fitch and Roddy described their case where a popping noise was heard upon reinflation of an in-situ reservoir.[4] In this case, gross hematuria was noted postoperatively with an intravesical reservoir noted cystoscopically. The reservoir was removed through a suprapubic incision, the bladder was repaired, and a new reservoir was placed in the contralateral retroperitoneal space. The authors hypothesized that the lengthy delay in IPP revision surgery likely contributed to this complication due to the development of a thick fibrous capsule around the deflated reservoir and recommended repairing malfunctioning devices as quickly as possible in order to decrease this risk.

In 2009, Kramer et al published their two cases of bladder rupture where gross hematuria was noted in the immediate postoperative period.[6] A pfannenstiel incision was used to remove the reservoir from the bladder, repair the bladder, and salvage the device by placing a new reservoir in the contralateral space of Retzius. They agreed with the prior recommendation from Fitch and Roddy to perform revision surgery as soon as possible to prevent the fibrous capsule from forming around the deflated reservoir.

In 2012, Levine and Hoeh described difficulty in refilling the in-situ reservoir followed by a sudden give.[1] Cystoscopy was performed for hematuria and revealed an intravesical reservoir. A suprapubic incision was utilized to remove the reservoir, repair the bladder, and plug the pump tubing. This patient subsequently returned to the operating room for placement of a new reservoir, which was connected to the indwelling cylinders and previously plugged

TABLE 1. **Bladder rupture cases following reinflation of an in-situ reservoir during revision surgery**

Authors	Year	Number of cases	Presentation	Management
O'Brien et al[15]	1984	2	postoperative hematuria cystoscopy revealed reservoir in bladder	exploration, bladder repair, contralateral reservoir placement
Fitch and Roddy[9]	1986	1	postoperative hematuria cystoscopy revealed reservoir in bladder	exploration, bladder repair, contralateral reservoir placement
Kramer et al[12]	2009	2	postoperative hematuria CT scan showed intravesical reservoir cystoscopy confirmed reservoir in bladder	exploration, bladder repair, contralateral reservoir placement
Levine and Hoeh[2]	2012	1	postoperative hematuria cystoscopy revealed reservoir in bladder	exploration, bladder repair, explantation of reservoir, plugged cylinder and pump tubing, delayed reservoir placement
Gupta et al[17]	2017	1	postoperative hematuria unknown evaluation	exploration, bladder repair, contralateral reservoir placement

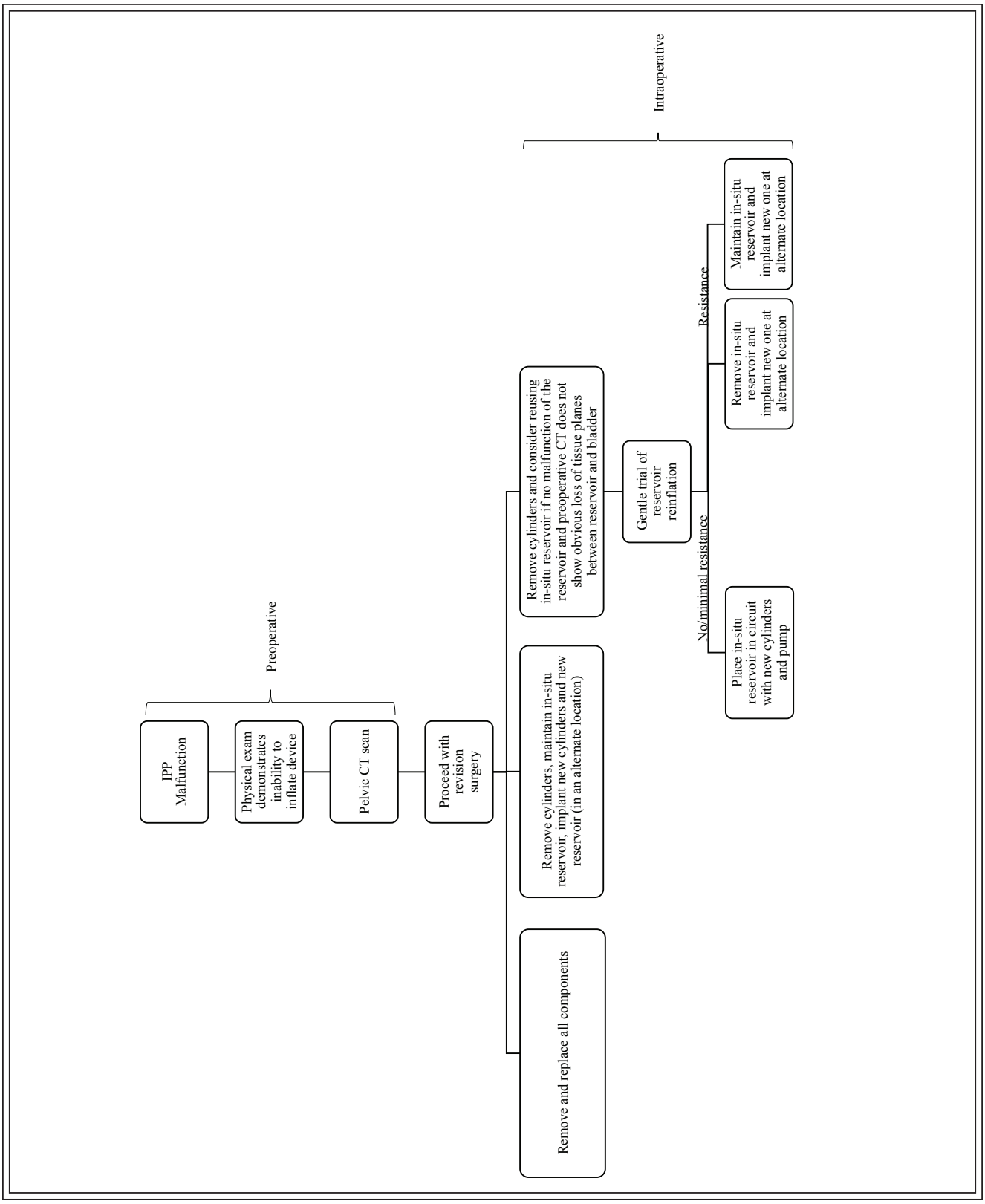

Figure 1. Algorithm for preoperative workup of IPP malfunction and intraoperative management during revision surgery.

pump tubing. Levine and Hoeh recommended that other urologists proceed with caution when reusing in-situ reservoirs, especially in patients with prior pelvic surgery or radiation, which increases the risk of bladder rupture due to scarring and diminished elasticity of the tissues.

The most recent case report was published by Gupta et al in 2017.[8] In this case, the malfunctioning device was repaired within a week of device dysfunction in attempt to decrease the time a fibrous capsule had to develop around the deflated reservoir. Despite the prompt repair, resistance was encountered after refilling the in-situ reservoir with 15 cc of injectable saline. Gross hematuria was noted shortly afterwards. The bladder was repaired immediately, with a new reservoir placed contralaterally. Following this, the authors state that they no longer reuse reservoirs and practice according to the "drain and retain" principle, which involves draining and then maintaining the old reservoir while placing a completely new system with the new reservoir in a different location.[8]

Based on these prior case reports and our experience, we advocate for early surgical revision after IPP failure due to a presumed fluid leak. This would limit the time for a new fibrous capsule to form around the deflated reservoir mitigating the risk for capsule rupture upon reinflation. Moreover, a preoperative pelvic CT scan can localize the reservoir, especially if placed by another surgeon, and assess for reservoir proximity to the bladder. When the device is in close proximity to the bladder with loss of tissue planes, the urologist should be aware that this patient may be at higher risk for bladder rupture during reservoir reinflation and proceed with extreme caution. The CT scan may also identify other associated pathology, such as stranding, which may prompt reservoir removal due to concern for a subclinical infection.

Removing and replacing reservoirs during revision surgery for device malfunction remains controversial.[6] On one hand, a high percentage of explanted devices are found to have positive cultures, which argues for removal of all components.[9] On the other hand, a multicenter study by Henry et al found that revision-related washout decreases implant capsule tissue culture positivity and, thus, complete removal may be unnecessary.[9] In addition, extensive scarring may make reservoir removal challenging and may even require a secondary incision resulting in increased operative time and related morbidity.[1,6] In attempt to avoid this increased morbidity associated with reservoir removal, some surgeons recommend that either: 1) the old reservoir is left in-situ defunctionalized with the placement of a new reservoir in an alternative location ("drain and retain") or, 2) the in-situ reservoir is reused after it is confirmed to be intact.[5,6]

If reuse of an in-situ reservoir is being considered, reservoir reinflation can be attempted prior to connecting the reservoir to the new pump and cylinders as suggested by Kramer et al.[6] If there is no or minimal resistance encountered in a device, the in-situ reservoir may be placed in circuit with new components.[6] If resistance is encountered, there is an option to leave the old reservoir defunctionalized and implant a new one in a different location.[3,6] This practice, commonly referred to as "drain and retain" is the practice followed by Gupta et al.[8] Kramer et al, on the other hand, recommend removal of a defunctionalized reservoir given the risk for infection and complications associated with retained reservoirs.[6] Similarly, Garber and Morris recommend either reusing the in-situ reservoir or replacing all components based on patient preference following a thorough preoperative discussion of risks and benefits.[3] While a retrospective study of 98 IPP revision surgeries with retained reservoirs found that minimal complications are associated with retained reservoirs,[5] Garber and Morris state that a defunctionalized reservoir serves no purpose and can "only cause trouble".[3]

Our recommendation is to perform a gentle attempt at reinflation of an in-situ reservoir during revision surgery if: 1) the device is not directly in contact with the bladder based on preoperative imaging, 2) there is no CT evidence for stranding that represents a subclinical infection, and 3) there is minimal back pressure when inflating a reservoir to the capacity necessary for cylinder and pump filling. We no longer adhere to the practice of reservoir overdistention in an attempt to "break the capsule," which was previously performed to reduce the risk for auto-inflation due to a capsule tightly squeezing and limiting reservoir filling. If resistance is encountered prior to the capacity needed for full cylinder inflation, we recommend removal of the defunctionalized reservoir and washout of the space prior to placement of a new reservoir in an alternative location. A preoperative workup for IPP malfunction and intraoperative management options for revision surgery are shown in Figure 1.

If IPP revision surgery involves reuse of an in-situ reservoir, gross hematuria following reservoir reinflation should be considered a bladder rupture until proven otherwise.[1,4,6-8] We advocate for immediate inspection with a cystogram, and cystoscopy, if the cystogram is negative or indeterminate (as the reservoir can mask bladder injury due to it abutting the vesicotomy). If a bladder rupture is confirmed, there are several management options for the bladder, cylinders and pump, and reservoir, which are shown in Figure 2.

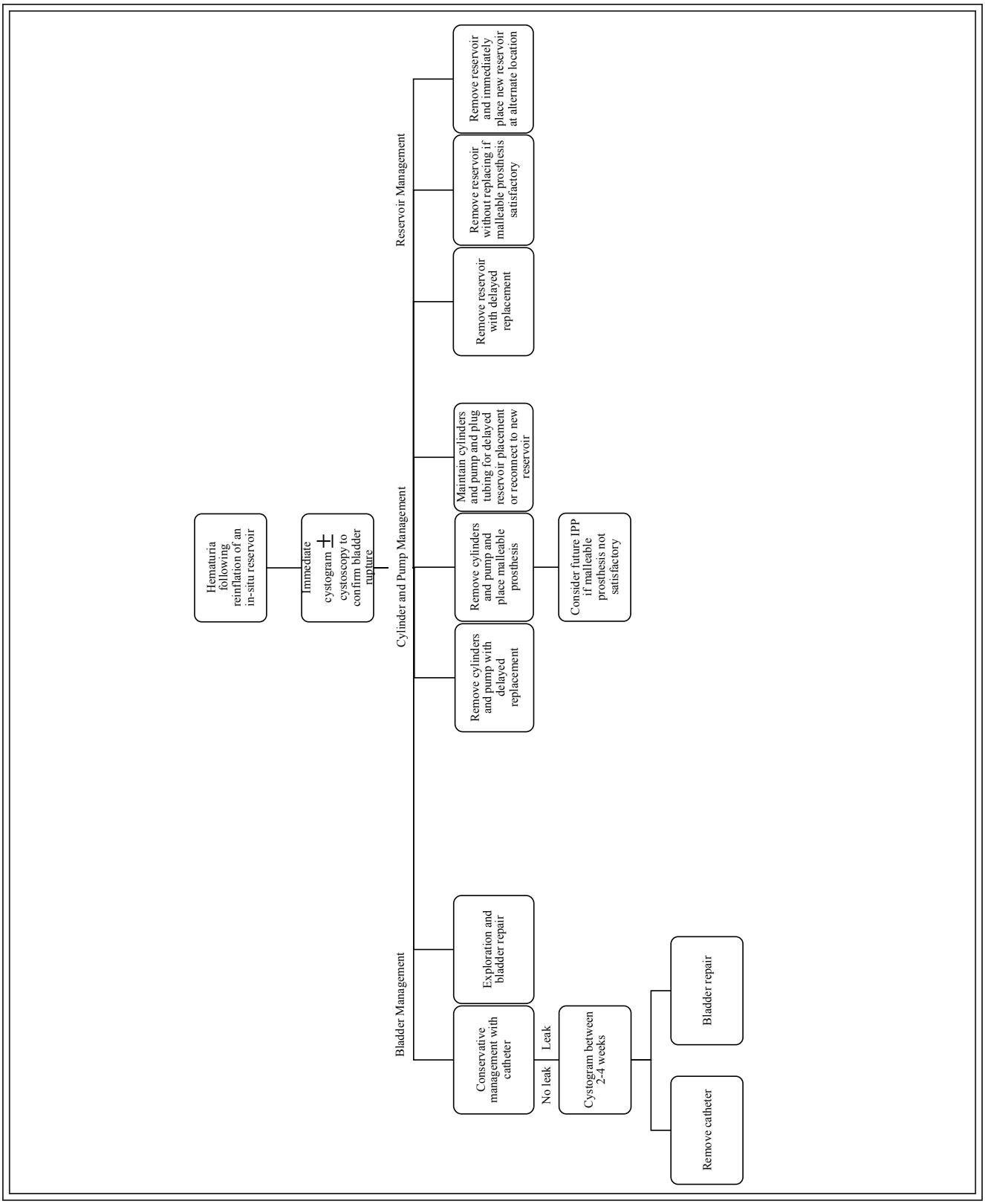

Figure 2. Management options of the bladder, the cylinders and the pump, and the reservoir after confirmation of bladder rupture via cystogram ± cystoscopy performed for hematuria following reinflation of an in-situ reservoir.

It has been proposed that a bladder injury may be managed by either performing a bladder repair or inserting a Foley catheter or suprapubic cystostomy tube until the bladder is healed.[10] In all prior case reports of bladder rupture, bladder management involved an incision for reservoir removal and subsequent layered bladder closure.[1,4,6,7] In our experience we have found that reservoir removal can be performed using the same IPP revision incision with conservative (Foley) management of the bladder rupture. Bladder ruptures associated with space of Retzius reservoirs are typically extraperitoneal and heal with conservative management. If conservative management fails as it did with the patient presented in case #1, a bladder repair may be pursued at that time. The patient in case #1, with a history of radiation, was at a higher risk of failure due to poor tissue quality. For these type of higher risk patients, an upfront bladder repair may be warranted. Otherwise, a trial of a Foley catheter can be considered for those with a small bladder defect to avoid the morbidity associated with another incision for primary repair.

In terms of management of the penile prosthesis components, we recommend immediate removal of all component parts with washout if there is a concern for infection with exposure to urine. Removal of all components with delayed replacement is a suboptimal option due to corporal scarring and associated penile shortening, which would make delayed replacement of the cylinders particularly difficult. Delayed replacement of the reservoir at an alternative location to plugged tubing of the cylinders and pump can be performed after the bladder leak has resolved if infection is a concern. A better option, if risk for infection has been mitigated, is for the cylinders and pump to be reconnected immediately to a new reservoir placed in an alternative location as a salvage technique. If a Foley catheter is placed for management of the bladder injury, it is important to note that bacteriuria can occur within a few days, putting the revised IPP system at risk if now-infected urine leaks through the bladder and contacts any of the IPP components. In this case, a malleable prosthesis would minimize the risk of infection due to infected urine as it is completely intracorporal. Thereafter, a patient may decide to pursue a 3-piece penile prosthesis where the cylinders are could replaced into corpora sustaining minimal (additional) fibrosis or shortening. Given the various management options, a preoperative discussion with the patient in which their preferences are assessed is the best way to help guide intraoperative management of reservoir induced bladder rupture should it occur.

Conclusion

It is important for urologists to recognize the signs of reservoir-related bladder injury during IPP revision surgery. This rare complication may be avoided by: 1) replacing the reservoir if CT imaging determines that it is in intimate contact with the bladder and 2) avoiding reservoir overdistentions by filling with the minimal amount of injectable saline needed for the existing cyllinders and pump. If hematuria occurs due to reservoir-induced bladder rupture, either immediate bladder repair or Foley drainage may be considered. An alternative reservoir placement can be used as a salvage manuever or placement of a malleable prosthesis can be performed if there is a high risk for infection to preserve corporal function and length. □

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