Best Practice & Research Clinical Obstetrics and Gynaecology 54 (2019) 2–11

Contents lists available at ScienceDirect

Best Practice & Research Clinical Obstetrics and Gynaecology

journal homepage: www.elsevier.com/locate/bpobgyn

1

Management of urological injury at the time of urogynaecology surgery

Lisa Kaestner, MBChB, FCUrol, MMed, Consultant Urologist

Division of Urology, University of Cape Town, Groote Schuur Hospital, Cape Town, South Africa

Keywords:
Urological
Injury
Urogynaecology
Bladder
Urethra
Ureter

A B S T R A C T

The presentation and management of bladder, ureteric and urethral injuries during and following urogynaecology surgery are discussed. Applied anatomy is reviewed, and the surgical management of injuries diagnosed intra- and post-operatively is discussed.

Introduction

A urological injury is one of the most feared complications for pelvic surgeons. Although all surgeons intend to 'first not harm', often injury to urological organs is inevitable because of unmodifiable patient-related factors or pathological processes. This is particularly true in cases of uncontrolled bleeding in the pelvis intraoperatively or due to distorted anatomy from a large uterus, endometriosis or previous surgery. Surgeon experience and surgical approach may also affect complication rates [1].

Experience and a good knowledge of anatomy should limit complications; however, urological complications may occur after seemingly uncomplicated procedures in experienced hands [2].

Urological injuries prolong hospital stay and morbidity; however, long-term outcomes, particularly for injuries identified intraoperatively, are excellent.

The role of cystoscopy and ureteric stenting during pelvic floor procedures

Routine cystoscopy following pelvic floor procedures increases the intraoperative identification of injuries; however, it does not have an impact on injuries identified post-operatively. The morbidity of cystoscopy is low and adds little additional time to a procedure [3].

E-mail address: la.kaestner@uct.ac.za.

https://doi.org/10.1016/j.bpobgyn.2018.06.007
1521-6934/

Injuries to the bladder and the proximity of these injuries to the ureteric orifices can be assessed. Retrograde pyelography may also be performed to confirm or exclude ureteric injuries. A surgical table that allows screening is necessary if retrograde pyelography is considered. Ureteric catheters can be placed in high-risk cases, and DJ stents can be placed if injuries are identified.

Ureteric stents are useful in patients with a high risk for ureteric injury. Although ureteric catheters have not been shown to decrease the risk of ureteric injury, they do increase the intraoperative identification of injuries [4]. Stents are not without complications; therefore, there is no role for routine stenting. Stents should be reserved for patients assessed as having high risk for ureteric injury or in situations where a technically challenging surgery is anticipated.

Bladder injuries

Intraoperative identification

Most bladder injuries are identified intraoperatively [5]. A visible hole, visible catheter or copious amounts of clear fluid in the intraoperative field suggest injury. Macroscopic haematuria or gaseous distension of a catheter drainage bag during a laparoscopic procedure should prompt assessment of the bladder for injury.

Dilute methylene blue flushed through the urethral catheter may assist in identifying the injury.

Cystoscopy can confirm the injury intraoperatively and assess the position of the injury. Ureteric orifices may also be inspected for clear jets of urine if there is concern for ureteric injury. In large injuries, the bladder may not distend on filling. Cystoscopy can be done with a flexible cystoscope without changing the supine position of the patient.

On-table cystography may be helpful in selected cases.

Post-operative identification

Bladder injuries are missed more often during laparoscopic procedures [6]. These injuries may present with a variety of symptoms including urine leak into drains, per vagina, through incisions or extravasation into the surrounding tissue. Sepsis, abdominal distention, abdominal tenderness, ileus or renal dysfunction may occur because of urine collected in the peritoneal cavity. Symptoms may present only after urinary catheter removal, and they may be accompanied by inability to void or by decreased urinary output.

Patients who present with abdominal pain, distension or fever after catheter removal should be investigated for bladder injury. Profound renal dysfunction may result when significant quantities of urine collect in the peritoneal cavity causing absorption of urinary constituents through the peritoneum. Renal dysfunction resolves promptly once urine is drained by urethral catheter insertion and bladder repair [Table 1].

Table 1
Symptoms and signs of bladder injury.

Intra-operative
Visible haematuria
Gaseous distention catheter bag
Urinary catheter visible
Hole visible in the bladder
Copious fluid in the operative field
Post-operative
Pyrexia
Copious clear fluid from drains/vagina/incisions/extravasation into the local tissue
Abdominal distention (after catheter removal)
Visible haematuria
Inability to void or low urine output (after catheter removal)
Renal dysfunction
Peritonitis/abdominal pain
Ileus

A urine leak should prompt simultaneous investigation for both ureteric and bladder injuries, as concomitant injuries may occur.

Both cystography and computed tomography (CT)—cystography have excellent sensitivity for the detection of bladder injuries. Passive filling by clamping the catheter after intravenous contrast administration is insufficient to exclude a bladder injury [7]. Retrograde filling of the bladder with sufficient volumes of contrast medium is necessary to exclude or confirm bladder injury. Extraperitoneal injuries appear as flame-shaped contrast leaks from the bladder. Intraperitoneal injuries display contrast pooling around loops of bowel, thus revealing the outlines of these loops.

Principles of bladder repair

Intraoperatively identified injuries

Trocar injury to the bladder during the insertion of sub-urethral tape identified intraoperatively can be managed by removal and repositioning of the tape with urethral catheter drainage of the bladder for 2–7 days [8].

Non-trocar placement injuries should be repaired by vesicorraphy as described below.

Post-operatively identified injuries

In post-operatively identified injuries, a distinction should be made between intraperitoneal and extraperitoneal injuries. Intraperitoneal injuries require vesicorraphy. Extraperitoneal injuries, unless very large and associated with a collection/sepsis, can be managed conservatively with catheter drainage and follow-up to ensure resolution.

General principles of repair

Most injuries involve the base of the bladder. Care should be exercised during repair to avoid obstruction of the ureteric orifices or intramural ureter during repair. Ureteric re-implantation may be necessary to facilitate bladder repair if the ureter is too close to the edge of the injury to perform a satisfactory repair.

A tension-free mucosa-to-mucosa vesicorraphy with absorbable sutures on a non-cutting needle is recommended. There is no difference between single- or double-layer vesicorraphy.

The delicate edges of the bladder should be handled with care, and instruments that could cause crushing or further damage to the tissue should be avoided.

The bladder can be filled (not over-filled) with dilute methylene blue to check for overt leak at the repair site.

The greater omentum can be sutured over the bladder repair during abdominal repair. If this is planned, a suture should be placed at the most distal edge of the injury before the injury is closed. This suture facilitates correct placement of the omentum, particularly if the injury is deep in the pelvis, as vision may be obscured once the injury is closed. During the vaginal approach, a pedicled labial fat pad (Martius flap) can be mobilised from the labia majora to secure over the repair site before closure of the vagina.

A large bore urethral catheter should be left in situ for at least 7–10 days. If abdominal repair is done, place a drain close to the repair to drain early leak from the repair.

In cases with severe haematuria, a suprapubic catheter, in addition to the urethral catheter, should be considered to facilitate good drainage of the bladder [Table 2].

In patients without a risk for impaired healing, where a satisfactory repair was performed, no cystogram is required before catheter removal. Gentle cystography should be performed 10 days post-operation to exclude a persistent leak in patients who have had complex repairs or a complicated post-operative course.

Ureteric injuries

The intraoperative identification of ureteric injuries is often missed, particularly during laparoscopy [5]. Haematuria is unreliable in the identification of ureteric injuries. A high index of suspicion should

Table 2
Principles of vesicorraphy.

Ensure ureteric orifices and intra-mural ureter are not in proximity to injury
• Re-implant ureter if necessary for good vesicorraphy
Complete vesicorraphy
• Do not handle the bladder edges with crushing instruments
• Use absorbable sutures and non-cutting needle
• Double or single layer
• Mucosa-to-mucosa
• Tension free
Drain with large bore urethral catheter/s
• Consider a second catheter (suprapubic) in complex repair or if haematuria
• 7–10 days
Consider Omentum or Martius flap
• Omentum-abdominal approach
• Martius flap – vaginal approach
Drain
• Abdominal approach
Consider “gentle” cystography
• Complex repair
• Complicated post-operative course
• Increased risk of poor wound healing

be maintained for subtle signs and symptoms, as injuries may occur during seemingly routine procedures.

Visual identification of the ureter during pelvic surgery and prophylactic stents in high-risk cases should be used to prevent and assist in the intraoperative diagnosis of ureteric injuries.

The ureter may be injured by transection, inclusion in pedicle sutures, crushing by clamps, thermal energy sources applied in proximity and kinking due to prolapse procedures.

Many injuries will only present once the symptoms of obstruction appear or when the injured ureter sloughs resulting in a urine leak multiple days post-operatively.

Basic principles

The usual path of the ureter over the psoas muscle is near to the gonadal vessels. Once it crosses the bifurcation of the iliac vessels, it continues in the bed of the ovary along the pelvic sidewall. It runs beneath the uterine artery (‘water under the bridge’) before traversing medially at the level of the ischial spine towards the bladder within the base of the broad ligament and through the cardinal ligament. It traverses the bladder wall obliquely to enter at the trigone [Fig. 1].

The adventitia of the ureter has a rich capillary plexus that can be damaged by skeletonising the ureter during over-zealous dissection, crushing or manipulation of the ureter with instruments [Fig. 2]. The ureteric blood supply is from multiple branches that originate medially above the pelvic brim and laterally below the pelvic brim.

The ureter exhibits peristalsis, and its rich network of capillaries have a characteristic appearance, which may aid in its identification.

Intraoperative identification

Suture ligation or inadvertent clamping of the ureter can be managed by the removal of the ligature/clamp and ureteric stenting. The greater omentum may be wrapped around the ureter to improve vascularity. Consider mobilising it off the transverse colon if necessary.

In cases of suspected injury or where the ureter is not identifiable, cystoscopy and ureteric catheter insertion may confirm an injury or assist in the identification of the ureter.

In partial ureteric injuries above the pelvic brim involving less than 50% of the circumference, with minimal devascularisation, simple repair can be done over a stent with absorbable sutures. In cases

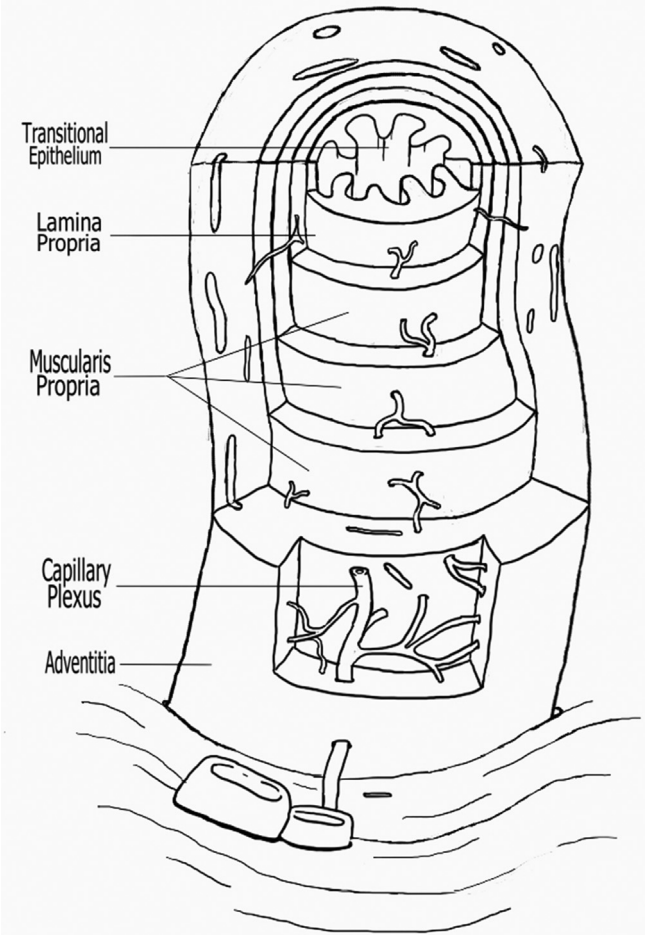

Fig. 1. The micro-vascular circulation of the ureter.

with more extensive injury, especially thermal injuries, debridement and spatulated end-to-end anastomosis (uretero-ureterostomy) [Fig. 3] over a stent with absorbable sutures is recommended [9].

As the delicate ureteric blood supply runs within the adventitia on the outer aspect of the ureter, handling of the ureter with instruments should be minimised to avoid crushing and damage, which could result in the breakdown of the repair or strictures.

Injuries below the pelvic brim should be re-implanted into the bladder (uretero-neocystostomy) as often the injury affects vascularity of the ureter. Uretero-neocystostomy is usually completed by an extra-vesical approach in the case of isolated distal ureteric injuries. Non-viable tissue is debrided from the proximal ureteric stump. It is unnecessary to tie off the distal (bladder side) ureteric stump unless vesico-ureteric reflux is present. The debrided proximal ureteric stump should be widely spatulated by making a longitudinal incision of approximately 1 cm. After filling the bladder, a suitable site allowing a tension-free ureteroneocystostomy is selected. If a tension-free anastomosis does not appear possible, an alternative procedure, as described below, should be considered. Two stay sutures should be inserted at the selected site before a cystotomy is performed. The cystotomy should be large enough to accommodate a mucosa-to-mucosa anastomosis to the spatulated ureteric stump. Stay sutures are helpful, as they prevent retraction of the bladder mucosa from the edges of the cystotomy and facilitate 'no touch' handling of the bladder during the anastomosis. A mucosa-to-mucosa anastomosis over a

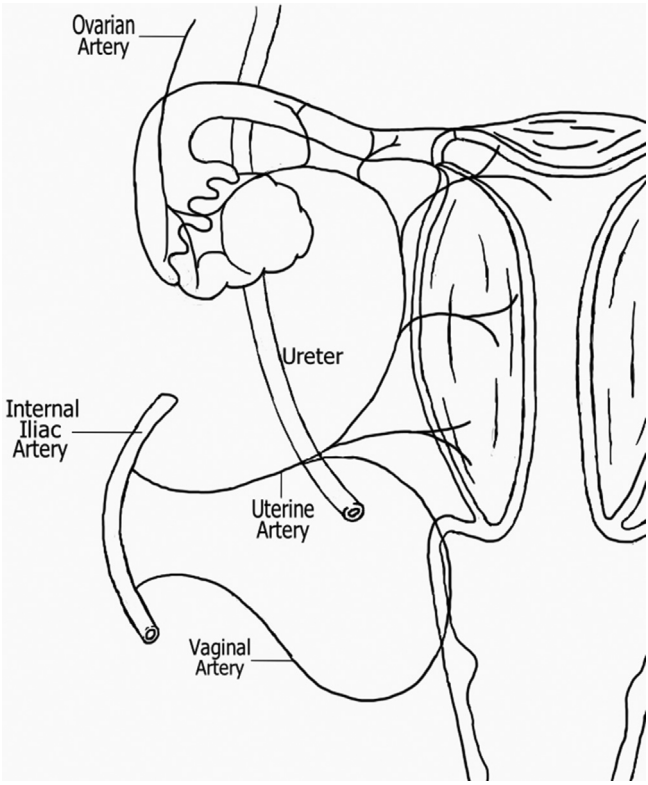

Fig. 2. The anatomic relations of the pelvic ureter.

double-J stent is completed with an absorbable suture. This type of anastomosis is refluxing but is preferred due to the increased risk of obstruction in non-refluxing re-implants. Non-refluxing re-implants require a longer length of ureter than a standard refluxing re-implant and are therefore rarely feasible unless the injury is very distal.

In cases of significant loss of ureteric length, or when tension-free uretero-ureterostomy is not possible, ancillary procedures may be necessary. A psoas hitch, Boari flap, Monti-Yang ileal interposition, ileal ureter or nephrectomy can be considered.

In an unstable patient, a feeding tube or ureteric catheter can be placed through the injury into the ureter and secured by non-absorbable suture. The tube/catheter is brought out through the skin to allow drainage of urine. Once the patient is fully resuscitated, reconstruction can be performed. In these cases, it is imperative to avoid dissection/mobilisation of the ureter, which could further damage the blood supply. Simple ligation of the ureter and nephrostomy can also be done in unstable patients [10].

Post-operative identification

Flank pain, fever, ileus, ascites, renal dysfunction, abdominal distension and copious clear fluid from the vagina/drain/surgical incisions may suggest a ureteric injury.

In patients with baseline normal function and two kidneys, obstruction of one kidney may not result in an abnormal serum creatinine level. CT-IVP (intravenous pyelogram) is the gold standard for the workup of suspected ureteric injury.

Emergency nephrostomy drainage of a hydronephrotic kidney may be necessary to allow management of sepsis and improvement of renal dysfunction before repair can be contemplated.

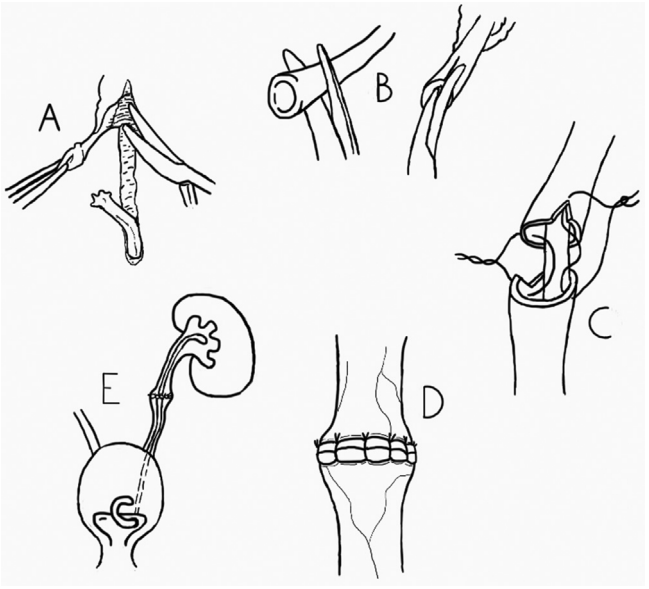

Fig. 3. Principles of uretero-ureterostomy. A. Debride ureteric edges, mobilise if length required; B. Widely spatulate ureteric edges by making a longitudinal incision from the ureteral end proximally; C. Use an internal stent; D. Perform end-to-end tension-free anastomosis with absorbable sutures and E. Drain the area of the anastomosis. Consider wrapping repair with omentum.

Cystoscopy and retrograde pyelography can confirm the diagnosis and allow the insertion of a stent in some cases. If stenting fails, exploration and repair as described above are indicated. Patients managed with stenting should be followed up carefully after stent removal to exclude late strictures and uretero-vaginal fistulae [Fig. 4].

All patients who have a ureteric stent placed should be carefully counselled, and the plan for removal should be carefully documented. A forgotten stent may cause severe complications.

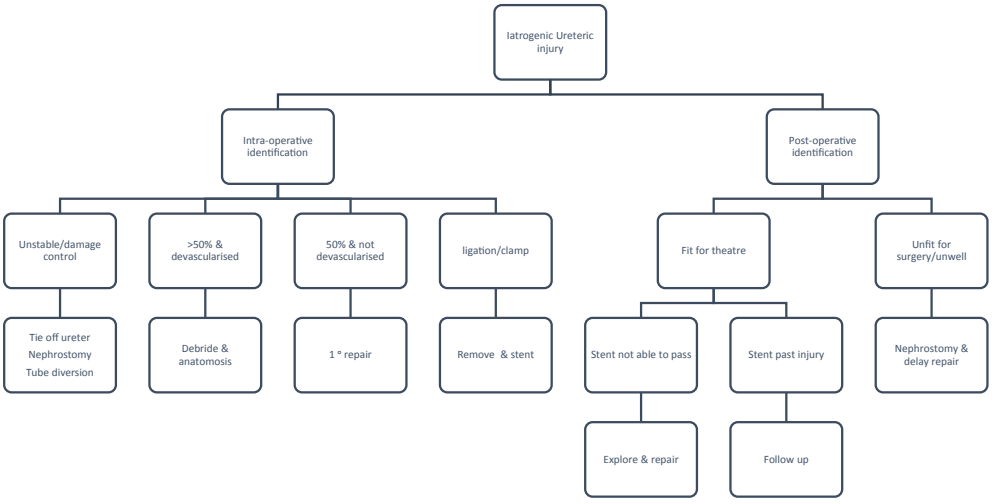

Fig. 4. Management of iatrogenic ureteric injuries.

Urethral injury

Urethral injuries, although uncommon, are potentially devastating injuries with long-term sequelae. The urinary incontinence often associated with injuries causes significant morbidity. Injuries may be encountered during vaginal mid-urethral sling placement or patients may present with delayed mesh urethral erosions [11]. Injuries may also occur during anterior colporrhaphy or other anterior vaginal surgery.

Basic principles

The female urethra is approximately 4 cm long. The layers of the urethra from inside to outside are epithelium, spongy vascular sub-mucosa, smooth muscle and fibro-elastic connective tissue. The sub-mucosa has a dark red, spongy appearance and bleeds profusely when injured.

Palpation of a urethral catheter and catheter bulb may assist orientation of the urethra in the surgical field. This is particularly useful in severe prolapse where the anatomy is distorted.

Intraoperative identification

Suspected injuries may be assessed using cystoscopy. It should, however, be noted that a short-beak cystoscope is required to adequately assess the female urethra. Flexible cystoscopy may be useful.

In the event of injury, insertion of any mesh should be avoided. Tension-free repair over a catheter should be completed with absorbable sutures on a round needle. Care should be taken, as the delicate nature of the urethra makes it prone to tearing during suture placement.

The use of a Martius flap as the second layer closure is highly recommended, as it may improve outcomes of repair and facilitate future surgery, if required, for incontinence. A Martius flap is a pedicled fibro-fatty flap that is mobilised from the labia majora. A longitudinal incision of approximately 8 cm is made over the labia majora. The incision should extend to a depth that is adequate to identify the labial fat. The fat pad has a dual vascular supply entering from anterior (superior) and posterior (inferior). The flap can be raised on either of these pedicles, although the posterior pedicle is more commonly used. The fat pad can be grasped with a Babcock to facilitate retraction during mobilisation. The flap should be carefully mobilised off the skin and the underlying ischiocavernosus and bulbocavernosus muscles. The unwanted pedicle is divided and suture ligated. The suture on the flap end can be left long to facilitate transfer to the vaginal incision. A tunnel, which is wide enough to admit the flap without compressing the vascular supply, is created to deliver the flap to the vaginal incision. The flap is passed through the tunnel by grasping the long suture with a curved forceps and gently guiding the flap through. If the tunnel is wide enough, the flap should pass through easily. The flap is secured in a position with a few absorbable sutures [12]. Although synthetic slings are contraindicated in the setting of urethral injury, autologous fascial slings can be considered at the time of urethal repair. Rectus fascia or fascia lata can be harvested for utilisation as pubovaginal slings to treat stress urinary incontinence [13]. Autologous slings are also useful in other high-risk patients where synthetic slings are contraindicated.

Post-operative identification

Patients with missed urethral injuries may present with urethro-vaginal fistulae, obstructive voiding, sepsis and erosion of the mesh into the urethra.

In these cases, formal excision and repair with a Martius flap are recommended. Unfortunately, a significant number of these patients will have long-term sequelae from these injuries despite repair.

Litigation

Complications, especially those not diagnosed intraoperatively, are a concerning source of litigation. In the event of a urological complication, particularly in complex injuries, the involvement of an experienced urology colleague is advisable [14]. Beyond the benefits of assistance with clinical

decisions and surgical management, the support provided by a colleague in shouldering the burden of a complication is invaluable.

Summary

Although urological injuries are common in urogynaecologic surgery, patients with these injuries are unlikely to experience long-term sequelae. A significant number of these injuries will not be identified intraoperatively, especially ureteric injuries. A high index of suspicion should be maintained to ensure early diagnosis and management.

Practise points

- Choose an appropriate procedure and approach after assessing the patients' risk of complications and their expectations
- Maintain a high index of suspicion to identify urologic injuries
- Identify and manage complications as promptly as possible to limit morbidity

Research agenda

- More research is needed to identify high risk factors for complications.

Conflicts of interest

None.

Acknowledgement

The author acknowledges Robin Zimmer for preparing the artwork.

References

[1] Wallis CJ, Cheung DC, Garbens A, Kroft J, Carr L, Nathens AB, et al. Occurrence of and risk factors for urological intervention during benign hysterectomy: analysis of the National surgical Quality improvement Program database. Urology 2016;97:66–72.
[2] Findley AD, Solnik MJ. Prevention and management of urologic injury during gynecologic laparoscopy. Curr Opin Obstet Gynecol 2016;28(4):323–8.
[3] Teeluckdharry B, Gilmour D, Flowerdew G. Urinary tract injury at benign gynecologic surgery and the role of cystoscopy: a systematic review and meta-analysis. J Minim Invasive Gynecol 2014;21(4):558–66.
[4] Brandes S, Coburn M, Armenakas N, McAninch J. Diagnosis and management of ureteric injury: an evidence-based analysis. BJU Int 2004;94(3):277–89.
[5] Gilmour DT, Baskett TF. Disability and litigation from urinary tract injuries at benign gynecologic surgery in Canada. Obstet Gynecol 2005;105(1):109–14.
[6] Cordon BH, Fracchia JA, Armenakas NA. Iatrogenic nonendoscopic bladder injuries over 24 years: 127 cases at a single institution. Urology 2014;84(1):222–6.
[7] Wirth GJ, Peter R, Poletti PA, Iselin CE. Advances in the management of blunt traumatic bladder rupture: experience with 36 cases. BJU Int 2010;106(9):1344–9.
[8] MacDonald S, Terlecki R, Constantini E, Badlani G. Complications of transvaginal mesh for pelvic organ prolapse and stress urinary incontinence: tips for prevention, recognition, and management. Eur Urol Focus 2016;2:260–7.
[9] Elliott SP, McAninch JW. Ureteral injuries: external and iatrogenic. Urol Clin North Am 2006;33:55–66.
[10] Smith 3rd TG, Coburn M. Damage control maneuvers for urologic trauma. Urol Clin North Am 2013;40(3):343–50.

[11] Kowalik CG, Cohn JA, Kakos A, Lang P, Reynolds WS, Kaufman MR, et al. Road to recovery after transvaginal surgery for urethral mesh perforation: evaluation of outcomes and subsequent procedures. Int Urogynecol J 2018;29(6):887–92.
[12] Kasyan G, Tupikina N, Pushkar D. Use of Martius flap in the complex female urethral surgery. Central Eur J Urol 2014;67(2):202–7.
[13] Morton H, Hilton P. Urethral injury associated with minimally invasive mid-urethral sling procedures for the treatment of stress urinary incontinence: a case series and systematic literature search. BJOG 2009;116:1120–6.
[14] Dwyer PL. Urinary tract injury: medical negligence or unavoidable complication? Int Urogynecol J 2010;21:903–10.