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Nightmares in Urology: Open Science

Double-J Stent Misplacement in the Inferior Vena Cava and Right Atrium: A Urovascular Nightmare

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Abstract

Ureteral injury may occur during abdominopelvic surgery given its anatomic path and proximity to surrounding organs. We present a case in which a patient required ureteral reimplantation following injury during a hysterectomy. The patient underwent a seemingly uncomplicated robotic ureteral reimplantation with ureteral stent placement. However, postoperative imaging demonstrated extension of the stent from the bladder to the right atrium. It appeared that the gonadal vein was reimplanted rather than the ureter. In a combined urology-vascular surgery case, gonadal vein implantation into the bladder was confirmed. Through-and-through access from the right internal jugular vein to the urethra was established. The ureteral stent was removed and the gonadal vein was embolized, with urology follow-up for planning and scheduling of ureteral reimplantation. Vascular involvement by ureteral stents has considerable risks and often requires further surgery. Ureteral injury can occur even in the hands of experienced surgeons and has a considerable impact on patients. Recognizing important anatomy and using operative techniques to differentiate from nearby structures, such as the gonadal vein, may help in preventing ureteral injury and assisting with repair of ureteral injury.

Patient summary: We describe a case in which a patient had an injury to her ureter, the tube that transports urine from the kidney to the bladder. When trying to repair this, a blood vessel (the gonadal vein) instead of the ureter was accidentally connected to the bladder. We discuss the resulting complications and management, similar cases, and important anatomy concepts and surgical techniques to prevent this type of injury.

1. Introduction

Robot-assisted ureteral reimplantation has comparable outcomes to those with open and laporoscopic approaches in the hands of experienced robotic surgeons [1,2]. Ureteral reimplantation is commonly performed in the management of ureteral strictures and after ureteral injuries. Historically performed as open or laparoscopic cases, the relatively new

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emergence of robotic ureteral reimplantation warrants further discussion of possible complications.

Here we present a case in which an iatrogenic vesicovenous fistula was created between the gonadal vein and urinary bladder during robot-assisted ureteral reimplantation. This led to migration of a double-J ureteral stent into the inferior vena cava (IVC) and right atrium.

2. Complication event

A 47-yr-old female was transferred from an external hospital on postoperative day 2 following a robot-assisted laparoscopic right ureteroneocystostomy. She had undergone a total abdominal hysterectomy 4 months earlier for surgical treatment of uterine leiomyomatosis, which was complicated by an unrecognized right ureteral injury. The patient was readmitted thereafter with a urine leak and urinoma, which were managed with a right percutaneous nephrostomy tube, intraperitoneal drain placement, and antibiotics.

After a period of convalescence, she underwent a seemingly uncomplicated elective robotic ureteral reimplantation. An abdominal plain film was obtained in the recovery area (Fig. 1), revealing the proximal loop of the right double-J ureteral stent overlying the tenth vertebral body. Computed tomography revealed a maldeployed ureteral stent with the proximal curl in the right atrium and the distal curl in the bladder (Fig. 2). This was concerning for iatrogenic vesicovenous fistula creation between the right gonadal vein and bladder.

The patient was transferred to our institution for further management. She was hemodynamically stable on arrival, breathing comfortably on room air. Physical examination revealed laparoscopic incisions sealed with Dermabond, a right percutaneous nephrostomy tube with clear yellow urine, a drain to bulb suction with serosanguinous output, and a Foley catheter to gravity with clear yellow urine. A vascular surgeon was consulted for co-management.

3. Complication management

The urology and vascular surgery teams proceeded to the endovascular suite for ureteral stent removal and possible vascular interventions. The vascular surgery team obtained vascular access via the right internal jugular vein. A venogram showed a patent IVC without concern for thrombosis. The proximal curl was clearly seen in the superior IVC (Fig. 3). The vascular surgery team made several attempts to intubate the right gonadal vein in order to establish wire access but were unsuccessful.

The decision was made to proceed with cystoscopy. The distal curl was visualized within the bladder. There was no active bleeding through or around the ureteral stent. The stent was grasped, brought to the level of the urethral meatus, and cannulated with a hydrophilic guidewire. Under live fluoroscopy, the guidewire was advanced into the abdominal IVC, where the vascular surgeon was able to grasp it with a Goose Neck (Amplatz, Minneapolis, MN, USA) snare lasso. The guidewire was then brought out through the right internal jugular vein, establishing through-and-through access from the right internal jugular vein to the urethra. At this point the stent was removed while maintaining wire access. The cystoscope was reintroduced into the bladder, and again there was no active bleeding from the gonadal vein-bladder anastomosis

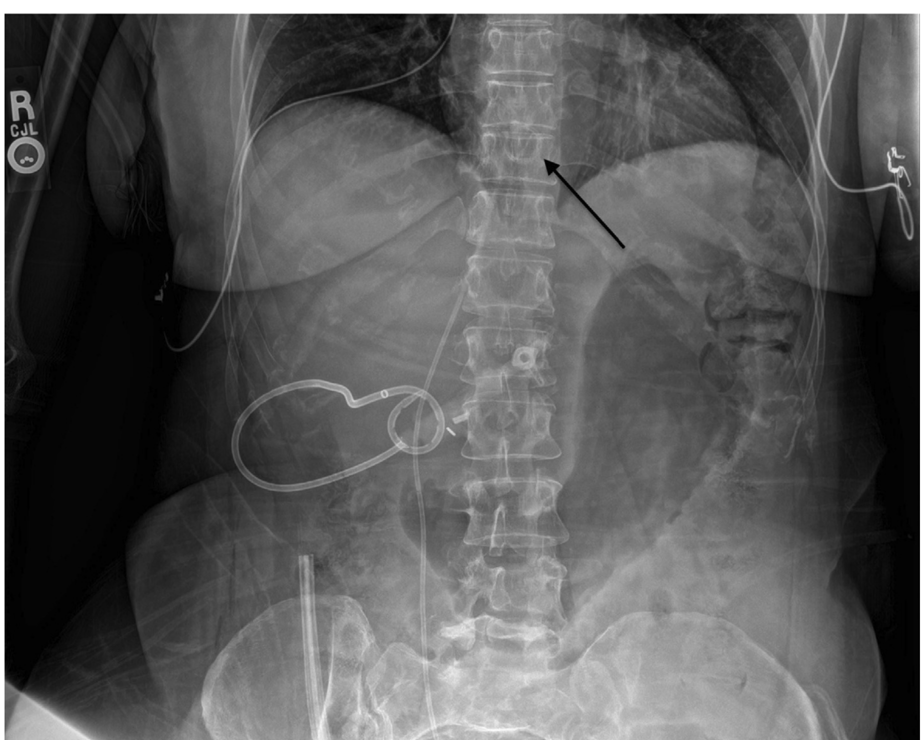

Fig. 1 – Abdominal X-ray in the immediate postoperative period at the external hospital, showing a medially placed ureteral stent with a proximal end (black arrow) located in the right atrium.

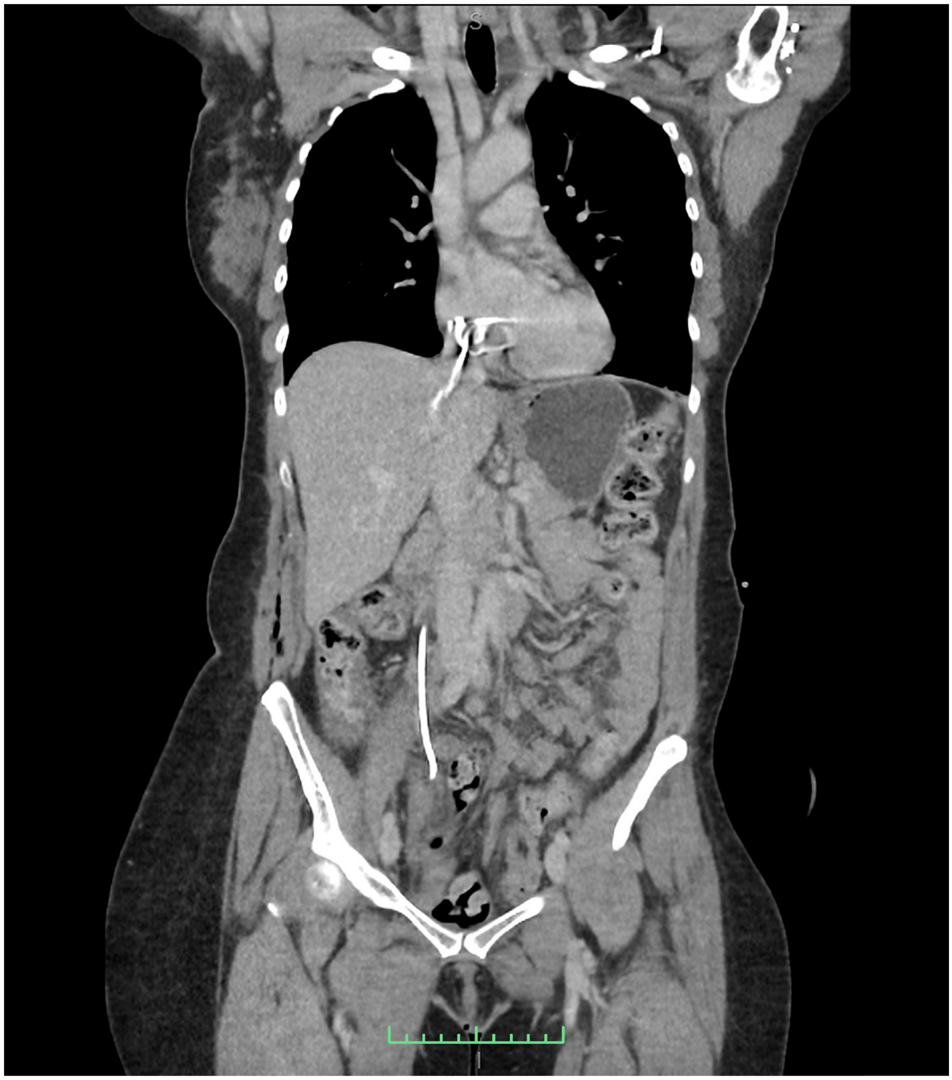

Fig. 2 – Computed tomography of the abdomen/pelvis (coronal slice) in the immediate postoperative period at the external hospital. A ureteral stent appears to extend from the bladder to the right atrium within the inferior vena cava.

(Fig. 4). A joint decision between the vascular surgery and urology teams was made to proceed with coil embolization of the gonadal vein with future vessel ligation during right ureteral reimplantation. Using the established internal jugular-to-urethral access, the vascular surgery team successfully performed coil embolization of the gonadal vein. The wire was removed through the urethra. The patient's neck was dressed in standard sterile fashion. After 24 hours of observation, she was discharged home on aspirin 81 mg daily.

The patient was followed up in the urology clinic 1 mo after the gonadal vein embolization. She reported that she was doing well. Scheduling and workup for future ureteral reimplantation were initiated.

4. Discussion

We present a rare complication in which the gonadal vein was inadvertently reimplanted into the bladder during robotic ureteral reimplantation. Using endoscopy and fluoroscopy, urology and vascular surgery teams brought the distal end of the ureteral stent to the level of the urethral meatus and established wire access from the urethra to the internal jugular vein. This access facilitated additional minimally invasive diagnostics and interventions by the vascular surgeons, as prior attempts to establish wire access into the gonadal vein ostium were unsuccessful owing to the small vessel caliber that already housed a 6F ureteral stent. Ultimately, the gonadal vein was embolized, with a reattempt at ureteral reimplantation scheduled for a later date.

We believe that this represents only the third case reported in the literature describing inadvertent implantation of the gonadal vein into the bladder, followed by stent placement into the gonadal vein, IVC, and right atrium. Although rare, ureteral stent migration, misplacement, and erosion into the vascular system have been reported. We give a brief overview of cases of vascular involvement by ureteral stents and their management, and then discuss ureteral injury (UI) and important anatomical, surgical, and clinical considerations for its prevention.

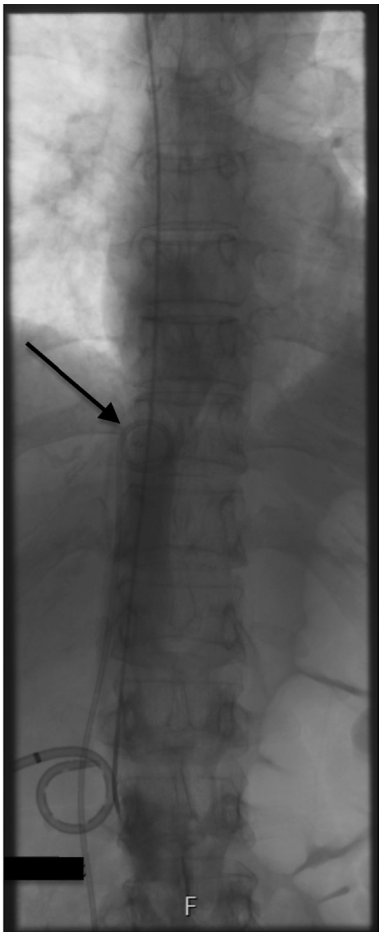

Fig. 3 – Following patient transfer, a venogram demonstrated a patent inferior vena cava without concern for thrombosis. The proximal curl of the JJ stent (black arrow) can be seen within the superior inferior vena cava.

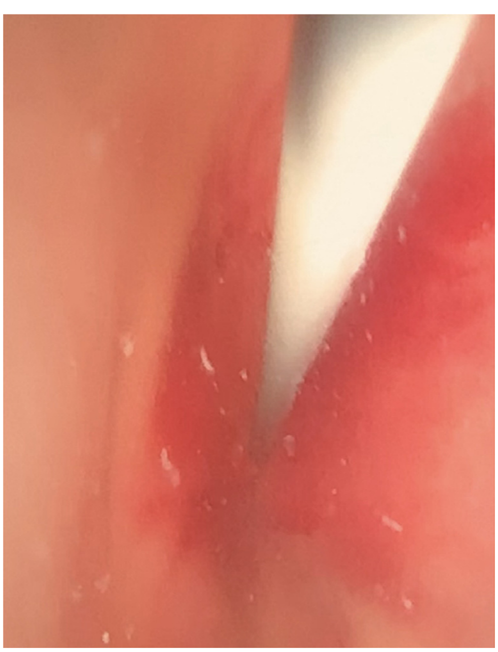

Fig. 4 – Cystoscopic view of the gonadal vein-bladder anastomosis site following JJ stent removal while maintaining wire access. Minimal bleeding was noted from the site.

4.1. *Review of vascular involvement by ureteral stents*

Vascular involvement by ureteral stents has occurred via migration, erosion, or maldeployment. We present these events, categorized by context in which the ureteral stents were introduced.

4.1.1. *Involvement following ureteral reimplantation*

Management of maldeployed ureteral stents in the vascular system after ureteral reimplantation has previously been reported. Two other case reports described gonadal vein implantation into the bladder during open ureteroneocystostomy. In both cases, the patients underwent reimplantation of the ureter into the bladder without complication [3,4]. Kim et al. [5] described a case in which ureteral reimplantation was performed after a ureteral injury that occurred during hysterectomy. A couple of weeks later, the ureteral stent was identified with its proximal end in the IVC and distal end in the gonadal vein, possibly because of misplacement or migration of the stent. The distal end could not be visualized in the bladder, so an endovascular approach with vascular access via the right and left femoral veins was performed. In tandem, the stent was brought out from the gonadal vein into the IVC with an instrument inserted via the left femoral vein, and then a vascular gooseneck snare was used to encircle the stent and bring it out via the right femoral vein. No interventions to the gonadal vein were undertaken.

4.1.2. *Involvement following retrograde stent placement*

Urinary stents have also been maldeployed into the vascular system after retrograde placement. Falahatkar et al. [6] described a case in which ureteral stent placement after an unrecognized ureteral injury during a total abdominal hysterectomy resulted in a stent with its proximal end within the intrapericardial IVC and distal end within the left external iliac vein. No endourologic approach was feasible, so the stent was grasped and brought out via an endovascular approach through the left femoral vein. Notably, the patient developed a deep venous thrombosis that was treated [6]. Similarly, ureteral stent placement for urolithiasis resulted in bloody output in another case, with plain film in the recovery area demonstrating a stent deployed in the left iliac vein and IVC. Ureteroscopic stent removal was unsuccessful and open removal via vascular surgery was necessary [7]. In a case involving stent placement for urolithiasis in a 12-wk pregnant woman, the stent could no longer be identified after delivery during routine cystoscopy. Cross-sectional imaging identified the stent extending from the right atrium to the abdominal IVC. It was removed via the right common femoral vein using a curved guide [8]. In another case, bilateral ureteral stent placement resulted in left-sided stent placement into the IVC. The authors elected for laparoscopic removal in this case [9]. Finally, a patient requiring chronic ureteral stents with routine exchange began experiencing hematuria from the ureteral orifice. Imaging revealed that the stent was within the right iliac vein, extending to the hepatic veins inside the IVC. After cystoscopic removal, the authors noted that bleeding into the urinary tract was unlikely given the lower pressure within the venous system [10].

In several cases, the stents remained in place for an extended period of time. A patient requiring a stent for nephrolithiasis had a stent involving the IVC in place for more than 3 yr and ended up requiring cardiopulmonary bypass to perform sharp dissection to free the stent from the tricuspid leaflets and atriocaval junction [11]. In another case, a stent placed after open left pyelolithotomy migrated into the IVC. This was further complicated by the development of thrombosis, probably because the stent migration was not recognized until 5 mo after deployment. The stent was removed via a percutaneous nephroscopic approach and the patient was treated with anticoagulation and antibiotics, with eventual resolution of the thrombus [12].

4.1.3. Involvement following antegrade stent placement

Urinary stent maldeployment in the vascular system has also occurred after antegrade placement. In one case, antegrade stent placement after open renal calculus extraction was confirmed intraoperatively. However, in the recovery area the patient developed shortness of breath, pleuritic pain, and expiratory wheezing. An echocardiogram and plain film identified a stent within the right ventricle and left pulmonary artery. The stent was removed through the right femoral vein using vascular retrieval forceps. Anticoagulation was started for a segmental pulmonary embolism [13]. In another case, a stent was deployed after percutaneous nephrolithotomy, with subsequent development of hemodynamically unstable atrial fibrillation. A stent in the left pulmonary artery and right heart was identified and removed via the right femoral vein [14]. Tang et al. [15] presented a case in which a stent placed following right percutaneous nephrolithotomy could not be identified during cystoscopic removal. A plain film demonstrated the proximal aspect in the thoracic cavity and distal aspect within the renal pelvis. The stent was removed via an endovascular approach. Notably, the authors stated that urine flow into the venous system is favored by pressure differences and recommended antibiotic prophylaxis after stent removal if there is suspicion of an iatrogenic fistula. Our group elected to proceed without antibiotics since the fistula was closed with an embolization coil.

4.2. Ureteral injury incidence, detection, presentation

UI most often results iatrogenically from surgical procedures. Hysterectomy, as in our case, accounts for >50% of iatrogenic UI cases, with incidence rates estimated at 0.03–1.5% [16–18]. Failure to recognize UI intraoperatively, as occurred in our case, has been reported at rates of 60–90%, with considerable implications for patient outcomes [19]. Patients presenting postoperatively may experience signs and symptoms of renal obstruction, such as flank pain, a febrile postoperative course, ileus, a urine leak, and a rise in serum creatinine [20]. Delayed UI detection is associated with significantly higher rates of 90-d readmission, sepsis, urinary fistula, acute renal injury, and death [19,21]. Furthermore, postoperative UI detection typically requires temporary urinary diversion and multiple procedures or operations for definitive management, which has a considerable negative impact on patient mental health, patient-partner relationships, employment, litigation, and health care costs [17,20,21].

Given the significant negative impact on patient outcomes for intraoperative versus postoperative detection of UI, emphasis should be placed on intraoperative assessment of the urinary tract before surgical closure. Intraoperative detection of UI allows for same-surgery intervention and correction by a urologist or urogynecologist. The two most common methods for assessment for intraoperative detection include preoperative stent placement and end-of-case intraoperative cystoscopy [19]. Although routine use of stents during gynecologic surgery does not reduce the incidence of UI, it may improve intraoperative detection and repair [19,22]. Routine use of intraoperative cystoscopy is intriguing, as it has been demonstrated that UI detection is five times greater with intraoperative cystoscopy than without it (~95% of UIs vs 18%) [18]. However, its universal use is limited by cost effectiveness, physician availability, training limitations, and low specificity. Furthermore, injury secondary to vascular or thermal injury may be missed intraoperatively [18]. Until more evidence is presented, routine cystoscopy is probably more appropriate in cases of higher risk and complexity, or with suspicion of UI [19].

4.3. Anatomic and operative considerations for UI prevention

The ureteral anatomic path and its proximity to abdominopelvic structures are the main reasons for injury during abdominopelvic operations. The ureter retroperitoneally traverses distally from the ureteropelvic junction along the anterior surface of the psoas muscle, across the sacroiliac joint, along the bony pelvis and iliac vessels, and into the bladder. As they extend from the kidney to the posterior wall of the bladder, the ureters travel under the gonadal vessels, over the common iliac arteries near their bifurcation, and under the uterine artery or vas deferens [23].

Recognition of the relationship of the ureter to the gonadal vasculature has important implications in urologic and gynecologic surgery, especially in our case, in which the gonadal vein was inadvertently implanted into the bladder instead of the ureter. The gonadal veins arise from the pampiniform plexus (ovarian veins for women, testicular veins for men) and then ascend anterior to the psoas major muscle and lateral to the ureter before crossing the ureter anteriorly and entering the anterolateral IVC. On the left side, the left gonadal vein ascends similarly but enters the left renal vein rather than the IVC [24].

In females, the ureter has additional important anatomic relationships with the uterus, making it particularly vulnerable to injury. The ureter lies posterior to the ovaries, uterine arteries, and broad ligament; lateral to the uterus and infundibulopelvic ligament; and medial to the anterior vessels [16]. Most commonly, UI occurs where the ureter passes posteriorly to the uterine vessels and at the level of the infundibulopelvic ligament [25]. Other important structures near the ureter and targeted in common surgeries include the right-side ascending colon, cecum, and appendix, and the left-side descending and sigmoid colon [23].

One might expect that cutting of the gonadal vein is associated with bleeding, but this is not always the case owing to pneumoperitoneum. Lack of bleeding on gonadal vein injury complicates discrimination of the ureter from the gonadal vein discrimination. Therefore, in addition to understanding the general anatomy of the ureter and its path, a solid understanding of how to differentiate the ureter from other structures is key for injury prevention. Intraoperatively, the ureter presents as a white, tubular, muscular structure that exhibits peristalsis. In comparison, the gonadal vein has a blue color and does not exhibit peristalsis. Furthermore, the gonadal vein is thin-walled in comparison to the ureter. This may help with identification during open surgery. However, lack of haptic feedback in robotics may make it more difficult to differentiate the two tubular structures, especially in a previously operated field. For patients with an indwelling nephrostomy tube, injection of fluid can also help to confirm ureter identification before reimplantation.

An adequate understanding of these important anatomic relationships and intraoperative considerations are essential for UI prevention during abdominopelvic surgery.

4.4. Patient perspective

The patient provided written consent for inclusion in this report. The patient has reported frustration following this unfortunate series of events, but has expressed gratitude that it was caught before serious associated complications. Furthermore, she is hopeful that her case will serve as a teaching opportunity so that others can avoid similar mistakes.

5. Conclusions

Unintended gonadal vein–to-bladder anastomosis during ureteral reimplantation is a devastating complication that requires further interventions to remove a maldeployed stent, treat an iatrogenic fistula, and ultimately complete the ureteral reimplantation. Identification of the ureter can be challenging, even for expert surgeons, and understanding the ureteral anatomy and its course through the abdominal cavity is important for UI prevention and correction. It is not known whether clinically significant hematuria would develop, but angiographic vessel embolization after stent removal can be considered. Stents in the venous system can precipitate thrombus formation, especially if they are placed in pulmonary arteries or are in place long-term. Prompt recognition, swift action, and continued learning are crucial to managing and ultimately preventing such a devastating complication.

Conflicts of interest: The authors have nothing to disclose.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.euros.2022.10.016.

References

[1] Babbar P, Yerram N, Sun A, et al. Robot-assisted ureteral reconstruction – current status and future directions. Urol Ann 2018;10:7–14. https://doi.org/10.4103/UA.UA_94_17.

[2] Seetharam Bhat KR, Moschovas MC, Patel VR, Ko YH. The robot-assisted ureteral reconstruction in adult: a narrative review on the surgical techniques and contemporary outcomes. Asian J Urol 2021;8:38–49. https://doi.org/10.1016/j.ajur.2020.11.001.

[3] Kochhar G, Rudrawadi S, Rajan K, Laddha PJ. Black pearl in urology: inadvertent anastomosis of gonadal vein to ureter leading to malpostioning of stent into the inferior vena cava. Turk J Urol 2019;45:S178–80. https://doi.org/10.5152/tud.2018.85453.

[4] Maheshwari PN, Oswal AT, Wagaskar VG. A double J stent misplaced in the inferior vena cava during Boari flap repair. Indian J Urol 2016;32:71–3. https://doi.org/10.4103/0970-1591.173113.

[5] Kim TN, Lee CH, Kong DH, Shin DK, Lee JZ. Misplacement or migration? Extremely rare case of cardiac migration of a ureteral J stent. Korean J Urol 2014;55:360–2. https://doi.org/10.4111/kju.2014.55.5.360.

[6] Falahatkar S, Hemmati H, Gholamjani MK. Intracaval migration: an uncommon complication of ureteral double-J stent placement. J Endourol 2012;26:119–21. https://doi.org/10.1089/end.2011.0469.

[7] Ioannou CV, Velegrakis J, Kostas T, et al. Caval migration of a ureteral J-stent after simultaneous ureter and iliac vein perforation during its placement for obstructive pyelonephritis. Int Angiol 2009;28:421–4.

[8] Hajji M, Bennani MS, Bekkali S, Jroundi L. Intracaval migration of ureteral stent. J Belg Soc Radiol 2015;99:28–30. https://doi.org/10.5334/jbr-btr.842.

[9] Mao XW, Xu G, Xiao JQ, Wu HF. Ureteral double J stent displaced into vena cava and management with laparoscopy: a case report and review of the literature. World J Clin Cases 2018;6:1160–3. https://doi.org/10.12998/wjcc.v6.i16.1160.

[10] Özveren B, Şahin A. Re: Intracaval migration: an uncommon complication of ureteral double-J stent placement. (From: Falahatkar S, Hemmati H, Gholamjani Moghaddam K. J Endourol 2012;26:119–121). J Endourol 2013;27:1069–71. https://doi.org/10.1089/end.2012.0656.

[11] Hastaoglu IO, Tokoz H, Kavlak E, Bilgen F. Double J ureteral stent displaced through the right ventricle. Interact Cardiovasc Thorac Surg 2014;18:853–4. https://doi.org/10.1093/icvts/ivu037.

[12] Jiang C, Fu S, Chen J, et al. Migration of a double J stent into the inferior vena cava: a case report. Medicine 2019;98:e15668.

[13] Michalopoulos AS, Tzoufi MJ, Theodorakis G, Mentzelopoulos SD. Acute postoperative pulmonary thromboembolism as a result of intravascular migration of a pigtail ureteral stent. Anesth Analg 2002;95:1185–8. https://doi.org/10.1097/00000539-200211000-00011.

[14] Chang CK, Wu YH, Shih MCP, Geng JH. Intracardiac migration of the ureteral double-J stent during percutaneous nephrolithotomy. Medicina 2021;57:939. https://doi.org/10.3390/medicina57090939.

[15] Tang Z, Li D, Xiao L, et al. Re: Intracaval migration: an uncommon complication of ureteral double-J stent placement. (From: Falahatkar S, Hemmati H, Gholamjani Moghaddam K. J Endourol 2012;26:119–121). J Endourol 2012;26:1100–1. https://doi.org/10.1089/end.2012.0038.

[16] Engelsgjerd JS, LaGrange CA. Ureteral injury. StatPearls. Treasure Island, FL: StatPearls Publishing; 2021.

[17] Khalife T, Fatchikov T, Anil G. Intraoperative genitourinary injuries during a hysterectomy: risks, management, and mitigation strategies. J Gynecol Surg 2021;37:190–6. https://doi.org/10.1089/gyn.2021.0041.

[18] Teeluckdharry B, Gilmour D, Flowerdew G. Urinary tract injury at benign gynecologic surgery and the role of cystoscopy: a systematic review and meta-analysis. Obstet Gynecol 2015;126:1161–9. https://doi.org/10.1097/AOG.0000000000001096.

[19] Blackwell RH, Kirshenbaum EJ, Shah AS, Kuo PC, Gupta GN, Turk TMT. Complications of recognized and unrecognized iatrogenic ureteral injury at time of hysterectomy: a population based analysis. J Urol 2018;199:1540–5. https://doi.org/10.1016/j.juro.2017.12.067.

[20] Hove LD, Bock J, Christoffersen JK, Andreasson B. Analysis of 136 ureteral injuries in gynecological and obstetrical surgery from completed insurance claims. Acta Obstet Gynecol Scand 2010;89:82–6. https://doi.org/10.3109/00016340903433974.

[21] Locke JA, Neu S, Herschorn S. Morbidity and predictors of delayed recognition of iatrogenic ureteric injuries. Can Urol Assoc J 2022;16:E1–6. https://doi.org/10.5489/cuaj.7271.
[22] Chou MT, Wang CJ, Lien RC. Prophylactic ureteral catheterization in gynecologic surgery: a 12-year randomized trial in a community hospital. Int Urogynecol J Pelvic Floor Dysfunct 2009;20:689–93. https://doi.org/10.1007/s00192-008-0788-3.
[23] Lescay HA, Jiang J, Tuma F. Anatomy, abdomen and pelvis, ureter. StatPearls. Treasure Island, FL: StatPearls Publishing; 2021.
[24] Karaosmanoglu D, Karcaaltincaba M, Karcaaltincaba D, Akata D, Ozmen M. MDCT of the ovarian vein: normal anatomy and pathology. Am J Roentgenol 2009;192:295–9. https://doi.org/10.2214/AJR.08.1015.
[25] Manoucheri E, Cohen SL, Sandberg EM, Kibel AS, Einarsson J. Ureteral injury in laparoscopic gynecologic surgery. Rev Obstet Gynecol 2012;5:106–11.