Introduction

Injury to the ureter is a risk of any pelvic or abdominal surgery, including laparoscopy and uroscopy. The ureter is especially susceptible to injury during vascular, gynecologic, urologic, and colonic operations. Gynecological surgery remains the most common cause of ureteral injuries; total abdominal hysterectomy is the operation most commonly responsible for a ureteral injury. Other rare causes are secondary to cervicocystopexies both pubic or vaginal, ovarian surgeries, and uterine aspiration. The overall incidence of ureteral injury varies between 0.5% and 10%. Damage to the ureter

Key Words: 'JJ' stent, stenting, ureterovaginal fistula
after external violence is quite rare, occurring in <4% of all penetrating and <1% of all cases of blunt trauma. Analysis of 13 published studies concluded that the following procedures contribute to iatrogenic ureteral injuries: hysterectomy (54%), colorectal surgery (14%), pelvic procedures such as ovarian tumor removal (8%), transabdominal urethropexy (8%), and abdominal vascular surgery (6%). The total incidence of ureteral injury after gynecologic surgery is reported to be 0.5% to 1.5%, and after abdominoperineal colon resection, it ranges from 0.3% to 5.7%. Currently, the reported rate of ureteral injury varies between 0.5% (experienced surgeons) and 14% (inexperienced surgeons) after laparoscopic hysterectomy presently, laparoscopic assisted vaginal hysterectomy is the most common cause of iatrogenic ureteric injury worldwide, however, in developing, countries open gynecological surgeries still remain the most common cause. Risk factors for the development of ureterovaginal fistulae include endometriosis, obesity, pelvic inflammatory disease, as well as radiation therapy and pelvic malignancy. Nevertheless, Symmonds has noted that the patient with a ureteral injury following gynecologic surgery is typically one who had an uncomplicated, technically easy hysterectomy for the minimal disease. Thus, except for those oncologic cases where a segment of ureter is deliberately excised, many ureteral injuries are likely due to technical or iatrogenic factors.\(^1\) The morbidity associated with such injury may be serious, resulting in increased hospital stay, compromise of the original surgical outcome, secondary invasive interventions, reoperation, potential loss of renal function, and deterioration of the patient’s quality of life. To decrease the incidence of iatrogenic ureteral injury, a sound knowledge of abdominal and pelvic anatomy is essential. Loss of continuity of the ureter may result from division or laceration, or from ischemic necrosis related to clamping, ligation, or damage to the blood supply of the ureter.\(^1\) Traditionally, most ureterovaginal fistulas have been repaired by ureteroneocystostomy.\(^5\) Endourological techniques are highly successful in treating posthysterectomy ureteral injuries.\(^6\)

**PATIENTS AND METHODS**

This study involved patients referred and managed in the department of urology for posthysterectomy ureteric injuries for benign conditions during 2 years from March 2011 to February 2013. During this period, a total of 14 patients with 16 ureteric injuries were treated. The mean age was 38.5 years (24–60-year-old).

All 14 patients suspected to have genitourinary injuries underwent pretreatment evaluations including history and physical examination. Information was sought on, primary surgery done, intraoperative difficulties and postoperative complications. The various investigations done included: ultrasound of the urinary tract, serum creatinine, urine culture and sensitivity, intravenous urogram (IVU)/computed tomography (CT) scan, cystoscopy and retrograde pyelography (RGP) [Figures 1-7].

**Figure 1:** Intravenous urogram of patient s/o right lower ureteric injury

**Figure 2:** Intravenous urogram of patient with left ureterovaginal fistula posthysterectomy showing leak

**Figure 3:** Retrograde pyelogram showing in initial difficulty in passing guidewire in patient with left ureterovaginal fistula
RESULTS

There were 16 iatrogenic ureteric injuries in 14 patients over a 2-year period. Hysterectomy was the cause of injury in all the cases, among whom 12 were abdominal, and 2 were vaginal hysterectomies. The clinical presentation and the radiological findings of all the patients are tabularized in Table 1. Two patients presented with anuria, among whom one had ureteric, and bladder injury with hemoperitoneum as detected by ultrasonography (USG) underwent emergency laparotomy and bilateral ureteral reimplantation with bladder repair. Another patient underwent RGP followed by stenting on the right side, on the left side, we were unable to put a stent, so percutaneous nephrostomy (PCN) was done followed by antegrade stenting later. Two patients presented with septicemia and pyonephrosis were managed initially with PCN followed by balloon dilatation and JJ stenting. Of ten patients who presented with urinary leak, seven patients were successfully stented. Another three patients, in whom stenting was not possible initially and PCN was also not possible due to compact PCS as the ureter directly opened into the vagina, underwent ureteric reimplantation [Table 2]. No nephrectomies were performed. The overall successful resolution of ureteric injuries in JJ stent group in this series was 100%. Complications were wound infection in one patient, prolonged urinary leak in 1, both of which were managed conservatively and incisional hernia in one which required surgical correction. There was no mortality attributable to these ureteric injuries. Follow-up in all these patients was done at 1 month, 3 months, and 9 months after stent removal or definitive procedure. IVU was done in only those patients who showed hydronephrosis on USG [Figure 8]. In this study, two patients who underwent ureteric reimplantation showed hydronephrosis at 3 months follow-up, however, IVP showed no obstruction.

DISCUSSION

Injury to ureter is a known complication of pelvic or abdominal surgery, including laparoscopy and ureteroscopy. The incidence of iatrogenic ureteral injury during major gynecologic surgery is estimated to be about 0.5%–1.5%. The most common etiology for ureterovaginal fistulae is a surgical injury to the distal ureter, which is most commonly caused by gynecologic procedures. The vast majority of ureterovaginal
fistulae occur during procedures for benign rather than malignant indications, hysterectomy being the most common cause.\textsuperscript{[5]} Iatrogenic ureteric injuries have increased markedly during the past two decades. Gynecological laparoscopic procedures account for more than half of the injuries, and the most common location is the lower ureter.\textsuperscript{[6]} The injury or fistula may become apparent either immediately or much more commonly, in a delayed fashion several days to weeks after surgery. Constitutional symptoms may result from hydronephrosis secondary to ureteral obstruction or urinary extravasation into the retroperitoneal space. The clinical history of ureterovaginal fistula is usually straightforward. Typically, a gynecologic procedure, such as hysterectomy, is involved. Poor intraoperative exposures, coupled with heavy bleeding at the operative site, are often the risk factors. The presence of normal upper tracts on imaging essentially rules out ureteral injury; however, the finding of partial ureteral obstruction associated with urinary leakage from the vagina strongly suggests the presence of an ureterovaginal fistula.\textsuperscript{[9]} Various investigations such as USG abdomen, three gauze test, IVU, Cystoscopy and RGP, CT urography, and magnetic resonance (MR) urography can

### Table 1: Clinical and radiological findings

| Clinical presentation                                      | Radiological findings                                      |
|-----------------------------------------------------------|-----------------------------------------------------------|
| Anuria with b/l flank pain following abdominal hysterectomy | USG abdomen-b/l altered renal echogenicity with mild HUN   |
| Urinary incontinence and leak per vagina                  | IVU-contrast in the left distal ureter showing abrupt disruption with leakage of contrast collecting posterosuperiorly to the urinary bladder |
| History of abdominal hysterectomy 11 days back            | USG-moderate HD, focal edematous left VUJ. Collection along left paracolic gutter |
| Left flank pain, vomiting, fever with chills, loss of appetite | Left side PCN and nephrostogram-complete obstruction at the level of left lower ureter |
| History of abdominal hysterectomy 2 weeks back            | USG-moderate HD with proximal HU                           |

| Leak per vagina                                           | IVU: Left side HU up to bladder base                      |
| Vaginal hysterectomy 1 month back                        | USG-right kidney; Diffusely decreased cortical echogenicity with right HD with proximal HU with internal echoes in dilated PCS |
| Difficulty in micturition, urinary leak, and burning micturition | IVU-right HUN till lower end with obstruction at S1, S2 |
| History of abdominal hysterectomy 2 weeks back            | IVU-right HUN due to lower ureteric obstruction            |

| Urinary incontinence with history of abdominal hysterectomy 45 days back | USG-right kidney showing HUN and right perinephric inflammatory mass or abscess |
| Complaints of the right flank pain and fever               | Nephrostogram: Stricture at the lower ureter with mild HUN |
| History of vaginal hysterectomy 10 days back               | CT-right kidney mild HUN with ureterovaginal fistula      |

| Continuous urinary incontinence; history of abdominal hysterectomy 1 week back | USG-left kidney showing mild HUN due to lower ureteric obstruction |
| Complaints of the left flank pain                           | USG-right kidney showing mild HUN due to lower ureteric obstruction |
| History of abdominal hysterectomy 2 days back               | USG-left kidney showing mild HUN due to lower ureteric obstruction |
| Complaints of the right flank pain                          | USG-b/l HUN with increased cortical echogenicity           |
| History of abdominal hysterectomy 4 days back               | USG-right kidney shows mild HUN due to lower ureteric obstruction |
| Complaints of the left flank pain                           | USG-left kidney shows mild HUN due to lower ureteric obstruction |

**USG:** Ultrasonography, **HD:** Hydronephrosis, **HU:** Hydroureter, **HUN:** Hydroureteronephrosis, **HDUN:** Hydroureter, b/l: Bilateral, **IVU:** Intravenous urogram, **PCS:** Pelvicalyceal system, **PCN:** Percutaneous nephrostomy, **VUJ:** Vesicoureteric junction, **HDN:** Hydronephrosis, **HN:** Hydronephrosis, **CT:** Computed tomography

### Table 2: Surgical procedures undertaken

| Surgical management                                      | Number of affected ureters | Percentage |
|---------------------------------------------------------|----------------------------|------------|
| JJ stenting                                              | 11                         | 68.75      |
| Ureteric reimplantation                                  | 3                          | 18.75      |
| Laparotomy with bladder injury repair                   | 2                          | 12.5       |
| with bilateral ureteric reimplantation                  |                            |            |

**Figure 8:** Postoperative intravenous urogram of patient who underwent laparotomy and B/l ureteric reimplantation
be used to confirm the clinical diagnosis. USG abdomen shows hydroureretonephrosis/pyonephrosis. Three gauze test differentiates vesicovaginal fistula (VVF), ureterovaginal fistula, and stress incontinence. In this test, 100 ml of 1:5 diluted methylene blue solution is instilled into the bladder through an urethral catheter after placing three dry sterile swabs in the upper, middle, and lower third of the vagina. The patient is then asked to walk around for 10 min, after which the swabs are removed and examined. If the lower swab is wet and stained blue, it indicates stress incontinence. If the upper swabs are wet and blue, that indicates VVF, and if the upper swabs are wet but not stained blue, it is an indication of ureterovaginal fistula. IVU demonstrates ureteric injury and hydroureretonephrosis, with cutoff of the contrast at the injured site of the ureter and contrast leak. CT and MR urography are used increasingly for detection of ureteric injuries and demonstrates hydroureretonephrosis due to ureteric stricture and ureterovaginal fistula. An RGP is helpful to diagnose ureteral injury, and the placement of ureteral stent could be attempted at the same time. In our series, open hysterectomy done for benign diseases was the cause of ureteric injury in all the patients. The presenting symptoms were leak per vagina, abdominal pain, fever, and anuria. JJ stenting was possible in patients who presented early (<2 weeks). Leak resolved completely in whom stenting was possible (100% success in all ten patients). In those patients where stenting was not possible underwent ureteric reimplantation because of failed antegrade stenting or failure to do PCN. If we look into the literature [Table 3] Selzman et al. reported that ureterovaginal fistulas resolved in all seven patients treated with an internal ureteral stent. Al-Awadi et al. reported a success rate of 59.4% with “JJ” stent insertion in their series of 75 patients with ureteral injuries. A combined ureteroscopic and fluoroscopic technique to re-establish ureteral integrity has been reported to be a successful treatment. Early intervention is recommended in the treatment of the iatrogenic ureterovaginal fistula, to minimize morbidity, discomfort, and cost. JJ stenting should be attempted in all patients presenting with ureteric injuries. If unsuccessful, these are the candidates for PCN or ureteric reimplantation depending on the clinical situation.

**CONCLUSION**

Posthysterectomy ureteric injury is not an uncommon complication of pelvic surgery. Simple hysterectomy for benign diseases is the most common cause of injury. The patient with ureteric injury should be evaluated and intervened at the earliest. Patients presenting early, within 2 weeks after hysterectomy have higher chances of success with endourological procedures, obviating the need for open surgery.

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**Conflicts of interest**

There are no conflicts of interest.

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