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INJURIES ENCOUNTERED DURING RIGID URETEROSCOPY IN TRAINING CENTERS

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Objective To analyze the peroperative injuries encountered during ureterorenoscopy (URS) in two training centers in Egypt over a four-month period.

Patients and Methods A prospective computerized database of 88 patients (38 males and 50 females) who underwent URS at two urologic university training centers (Al-Azhar University Hospital, Cairo and Assiut University Hospital, Assiut, Egypt) between July and October 2003 was analyzed. The procedures were elective in all cases. The indication for URS, the state of the ureter, associated pathologies, intraoperative injuries encountered and their management were recorded for analysis.

Results All but seven patients were operated for therapeutic indications, mainly stone disease and ureteric strictures. Peroperative injuries were encountered in 14 patients (15.9%) with the commonest type being mucosal laceration (57%) followed by minor ureteric perforations. Major injuries in the form of ureteric avulsion, laceration and extravasation were noted in 2% of the cases. The procedure was associated with inadvertent bladder or urethral injury in three patients. In all cases the diagnosis of the ureteric injury was prompt and confirmed by intraoperative ureterography. Treatment was started immediately.

Conclusion URS, although an important tool in the management of upper tract pathology, is an invasive procedure, especially for therapeutic indications. It may result in significant complications that may jeopardize the integrity of the concerned renal unit. Recent technology in the design of ureteroscopes and their accessories may minimize injuries, especially if applied in teaching hospitals where the learning curve of URS is a demanding task.

Key Words ureteroscopy, injuries, training center

INTRODUCTION

In contemporary practice endoscopic treatment of ureteric calculi and strictures is increasingly possible due to recent advances in the design of ureteroscopes and their accessories.[1,2] Ureterorenoscopy (URS) includes the use of endoscopes, accessories, fluoroscopy and energy source in a properly chosen patient and demands familiarity and dexterity in handling the instruments whose use otherwise may be associated with several complications[3]. The incidence and severity of complications has changed with the evolution of surgical techniques and the improvement of instrumentation[1,4] but life-threatening complications are still encountered and may be varied in a teaching hospital where urologists have different levels of experience.

This study was done during a training scholarship at Al-Azhar University Hospital, Cairo, Egypt, provided by the Société Internationale d'Urologie (SIU) to one of the authors (NHM). It was designed to evaluate the types of injuries and their management as encountered in two departments of urology in Egypt (Al-Azhar University, Cairo, and Assiut University, Assiut) where endoscopy is widely available and performed regularly in the treatment of a wide variety of ureteric pathology.

PATIENTS AND METHODS

A prospective computerized database of 88 patients who underwent URS at Al-Ahzar University Hospital, Cairo (68 patients) and Assiut University Hospital, Assiut (20 patients) be-

Table 1: Indications for Ureteroscopy in 88 Cases

Indication	No. of Pts
Therapeutic endoscopy (n=81)	
Lithotripsy / stone retrieval	56
Stricture dilation / stone	19
Removal of impacted double-J catheter	3
Removal of migrated double-J catheter	2
Endopyelotomy	1
Diagnostic endoscopy (n=7)	
Solitary kidney / stones	2
Bilharzial ureteritis	1
Ureteric tumor resection	1
Retroperitoneal fibrosis	1
Strictured Boari flap	1
Duplicated ureter	1

Table 2: Sites of Stones and Ureteric Strictures

Site	Stones	Strictures
Distal third	52	12
Mid-third	2	3
Proximal third	0	4
Bilateral (distal)	2 (4 stones)	0
Total	58/88 = 66%	19/88 = 21.6%

tween July and October 2003 was analyzed. The age range was 14 -70 years with a median age of 52 years. Fifty patients were female and 38 were male.

All patients were elective and fully investigated and were found fit for the procedure. Investigations done regularly included: complete blood count (CBC), clotting profile (prothombin time, activated partial thromboplastin time), electrolytes/urea and creatinine. Routine urine culture was done and parenteral antibiotic administration was given before the operation according to the sensitivity pattern of the microbes cultured. Routine radiological investigations done included: intravenous pyelography (IVP), sonography and renography (in selected cases). Magnetic resonance urography was done for an optimum evaluation of two patients with solitary kidneys and stones in the ureter.

The ureteroscopes used were rigid with variable sizes from 6 – 12 F. Miniscopes had the sizes 6 – 9 F. The usual accessories for URS were mostly available and these included: stone graspers and baskets, guide wires (0.025'- 0.038', PTFE / 0.025-038' Nitinol), double-J (JJ) and ureteric catheters, cone-tipped and open-ended, size 5, 6F. Ureteric dilation, especially in order to treat strictures, was routinely done by ureteric dilators (balloon or Teflon). Stone fragmentation was done by various types of lithotriptors depending on which was available in the centre; these included, pneumatic (most commonly available), ultrasonic, electrohydraulic and laser lithotriptors. Close monitoring of the procedure by a camera was possible in all cases.

Ureteroscopy was required for diagnostic or therapeutic reasons. Indications included various ureteric pathologies, such as stone disease, strictures and tumor resection. Others were bilharzial ureteritis, retroperitoneal fibrosis, duplex ureters and the retrieval of migrated or impacted stents (Table 1). URS was done more often for therapeutic (93.1%) reasons to cure pathology and less commonly as part of the diagnostic (6.9%) workup of the patient. Stone retrieval was the commonest procedure done, followed by the management of strictured ureters involving dilation of the stricture with dilators. Less commonly URS was done to retrieve an impacted or migrated double J stent or for endopyelotomy of an obstructed pelviureteric junction. Other indications for URS were the diagnostic workup of patients with a suspected ureteric tumor, bilharziasis and the assessment of the ureter of a solitary kidney with multiple strictures and stones. URS was also applied for the diagnosis of a duplicated ureter and to stent kinked dilated ureters caused by retroperitoneal fibrosis. One of the patients with a solitary ureter had a stenotic Boari flap. In this case URS was indicated to place a stent across it to drain the obstructed kidney. (Table 1)

Stones and strictures were the commonest indication for URS. Fifty stones were located at the distal end of 52 ureters and 2 were in the mid-ureter. There was no patient with a proximal ureteric stone. Two patients had impacted stones in the distal third of both ureters leading

Table 3: Types of Injuries encountered during URS

Type of Injury	No. of Patients	Diagnosis
Mucosal laceration		
- due to impacted stone	4	bleeding
- due to guide wire injury	4	bleeding
Perforation		
- by Lithoclast probe	1	extravasation of urine
- by guide wire	3	extravasation of urine
Laceration		
- tear caused by ureteroscope	1	extravasation, urinary ascites, abdominal distension, loin pain
Avulsion due to Dormia injury	1	bleeding, prolapsed ureter

to obstruction and were, therefore, managed urgently. During ureteroscopy in one of the patients the ureteric orifice was not seen on cystoscopy; it was incised resulting in bladder injury. (Table 2)

Nineteen patients had ureteric strictures; most of these strictures (12/19) were located in the distal third of the ureter. The middle and proximal ureters were not commonly affected by strictures. (Table 2)

RESULTS

Fourteen out of 88 patients (15.9%) sustained intraoperative injuries during URS including three patients (3.4%) who had bladder or urethral injuries.

Of these injuries ureteric mucosal laceration was the most common injury and was caused either by the guide wire or during disimpaction of a stone. A sudden gush of blood was the presenting sign of injury in each situation. Perforation of the ureteric wall occurred in one situation when attempting fragmentation of an impacted stone by the lithoclast. Ureteric perforations were also caused during the insertion of a guide wire. A severe and life-threatening laceration by the endoscope occurred in one patient with a torn distal ureter leaving a 4 cm longitudinal laceration on the wall of the ureter which resulted in copious extravasation of irrigation fluid into the peritoneum and, thus, a rapidly distending abdomen. The patient went into shock and was resuscitated. Emergency laparotomy was done to repair the tear and drain the extravasation. Several liters of urine and extravasated irrigation fluid were drained from the patient's peritoneal cavity. A long segment of the ureter was excised to repair a ragged 4 cm long ureteric injury. Morbidity was significant and the patient was hospitalized for three weeks.

Prolapse of the ureteric mucosa was seen in another patient; it had been caused by the Dormia basket that had entrapped the ureteric mucosa during retrieval of a stone from the distal ureter. The bulging, bleeding mucosa rapidly changed to blue due to ischemia and was quickly incised longitudinally to salvage the mucosa and basket. (Table 3)

In general all injuries sustained occurred during manipulation with the ureteroscope. In two patients, isolated injuries resulted from guidewires (without URS) which had been passed in order to stent the ureter prior to ESWL for a kidney stone.

While the ureter was most commonly affected (14 patients; 15.9%), the bladder and urethra were uncommon sites of injury associated with URS. However, in two patients (2.2%) a false passage was created by the ureteroscope during passage through the ure-

thra. There was sudden bleeding per urethram; the passage became blind and it was not possible to continue the procedure. The bladder was perforated in one patient (1.1%) where the ureteric orifice was not easily visualized and a resectoscope was used to 'incise' the ureteric orifice. The bladder was inadvertently perforated with copious bleeding and extravasation of irrigating fluid into the extravesical space and peritoneum.

It was observed that some patients had more than one pathology in the ureter or an associated condition that might have rendered the ureter more vulnerable to injury during URS. Seven of the 14 injured ureters (50%) were strictured, mostly due to bilharziasis, tuberculosis, bacterial inflammation and stone impaction. Intraoperatively the stone was usually located just proximal to the stricture or was impacted in the stricture. Mobilizing the stone from the fragile tissue was often associated with injuries. The remaining seven cases (50%) had a history of previous failed attempts at ESWL. Each attempt at ESWL is frequently accompanied by inflammatory reaction and this may render the ureter fragile to URS whenever it is used. At least three previous failed attempts at ESWL before reverting to URS were documented in those patients.

Laterality was studied to determine which of the ureters was more commonly injured. Fifty of 88 (57%) URS were performed on the right ureter and 38 (43%) on the left. Out of 14 injured ureters, 10 (70.5%) were on the right and 4 (29.5%) on the left side.

Mucosal lacerations were treated by passing a double-J stent immediately and leaving it indwelling for a week. Ureteric perforations were more severe injuries associated with urinary extravasation and were treated by double-J (JJ) stenting for at least three weeks. Patients with ureteric lacerations and urinary ascites had immediate laparotomy and copious peritoneal lavage. The ureter was débrided and immediate anastomotic repair was done. The ureter was then stented and the stent retrieved cystoscopically after three weeks. Ureteric avulsion due to injury by a Dormia basket was treated by incising the entrapped mucosa and retrieval of the entrapped Dormia. The ureter was stented with a JJ stent for six weeks.

Bladder rupture was managed by open surgical repair of the laceration and urethral catheterization for 10 days, while urethral rupture by the ureteroscope was treated by suprapubic urinary diversion for two weeks.

DISCUSSION

Endoscopic examination of the upper urinary tract has developed over the last two decades from a complicated cumbersome technique to an expeditious and safe procedure[1,2,5]. In the beginning examination of the upper urinary tract depended on a small (pediatric) cystoscope employed as a rigid ureteroscope in the management of lower ureteric calculi which initially was only suitable in women[6,7]. This was soon replaced by a relatively large sized rod lens of 12F on average which was long enough to be used also in the male patient[5]. Due to various complications associated with large ureteroscopes, the last three decades have witnessed a remarkable evolution of miniature (6F)[3,8,9] and flexible, steerable instruments, and major complications have been remarkably reduced[1,2,4,5].

Ureteric injuries are important complications of URS, especially occurring in university teaching hospital settings as the surgeons involved have varying degrees of experience. The commonest indication for ureteroscopy in most series is the treatment of ureteric calculi[10], and also in the present study 93% (77/81) of all therapeutic indications for URS were stones or stone-related ureteric pathologies, while only in 6% URS was indicated for diagnostic purposes.

Two decades ago the commonest indication for URS was diagnostic endoscopy. Diagnostic endoscopic techniques are less invasive and are not commonly associated with serious injury[4,8]. Therapeutic endoscopic procedures are technically demanding and complex and require a high level of dexterity; accordingly, they are more commonly associated with more severe injury[1,5].

In the present work, stenting was the commonest cause of injury accounting for 57.1% (8/14). This observation was previously made by several authors who reported that many minor ureteric injuries were related to stents and stenting procedures[1,3,5]. The design of stents and guide wires has been improved since to provide a safe access and to secure an optimal luminal path for the ureteroscope. For this purpose, the stents have become

miniaturized, flexible and with various coatings including polymers to provide a smooth passage in transit through the ureter. The tips of the stents have been designed in a way to adapt them for various difficult situations[3,11].

Injuries caused by ureteroscopes are not common if safety guidelines are adhered to. In this study ureteroscope injury occurred during the mobilization of impacted stones. The injuries were mostly mucosal bruisings and superficial lacerations which were considered minor. A most unusual major complication was a complete tear of the wall of the distal ureter in one patient (0.7%). This caused a life-threatening extravasation of urine into the peritoneal cavity and shock, and urgent laparotomy was done. This complication is not common but may be associated with heavy-handed endoscopy which is common at the steep part of the learning curve.[11]

Other perforations considered as major were caused by the lithoclast which fragmented the stone and perforated the ureteral wall. The commonly used device was the pneumatic lithoclast. Lithoclast injury has been reported to account for 0.4% of complications encountered with lithotripsy and may be due to inadvertent repeated contacts of the lithoclast with the mucosa. Injuries resulting from the electrohydraulic lithoclast are more serious than those resulting from the pneumatic lithoclast[11,12]. Moreover, laser lithoclasts may cause quite severe mucosal damage, while Holmium laser has been noted to cut guidewires into pieces if contact is made with the laser; the pieces may perforate the ureteric wall and are usually difficult to retrieve[12-14]. In our series, the injuries resulting from the lithoclast did not pose a problem in management; stenting was sufficient to manage the patient satisfactorily.

Mucosal entrapment and avulsion of the lower ureter was encountered in one patient (1.1%) of our series. The commonest and most dangerous site for this injury is the upper third of the ureter, because it may be associated with a devascularizing injury and loss of a long segment of the ureter requiring major ureteric replacement surgery[4,12]. Although it is rare, yet, it is a devastating injury with major morbidity. It can be encountered if a large stone is retrieved forcefully in a basket without prior fragmentation. In our case the injury involved the lower ureteric segment of a female patient. The prolapsed mucosa was entrapped by the Dormia basket at the external ureteric meatus. An incision in the longitudinal plane was sufficient to free the Dormia. The prolapsed mucosa was spontaneously reduced and the ureter was stented for six weeks with no evidence of ureteral loss on follow-up. In a devascularizing avulsion the distal ureter may be damaged requiring excision of that segment and reimplantation or repair[11,15].

Urethral injuries are not commonly reported during URS[1,4,5] but they may be encountered during urethroscopy done with the ureteroscope by inexperienced urologists in training. A wide false passage into the proximal urethra was created in one of our patients (1.1%) resulting in hematuria and extravasation of urine into the perineum warranting suprapubic urinary diversion by Foley catheter for two weeks.

Bladder injury during URS is rare. In our series it occurred in one patient during an attempt to locate the ureteric orifice with the ureteroscope and to cut for the ureteric orifice. The distal end of the ureter was strictured and a stone was located in the distal ureter. The bladder was perforated at excision resulting in extravasation of fluid. Exploration was done followed by stone removal and reimplantation of the ureter . Difficult ureteric orifices may be localized by cutting for them by TUR, by creating diuresis or injecting intravenous dyes like indigocarmine or methylene blue to make the ureteric orifice visible more easily[11].

Pathologic ureters appear to be more prone to injury. In this study all ureters had an underlying stricture or had had previous failed ESWL on repeated attempts. Most patients had had ESWL at least three times without successful stone fragmentation, and URS was the salvage technique. Half of the injured ureters were either strictured or had had previous failed ESWL. ESWL and strictures may render the tissues friable due to inflammatory reaction rendering them more prone to injury; the same effect that may be noticed in previously irradiated ureters[11].

While 57% of the URS were on the right and 43% on the left ureter, 71% of all injuries occurred on the right side. The reason for the higher involvement of the right ureter by injury remains speculative because there are no known normal major anatomic differences between the two ureters.[16] The pathology that will need surgical manipulation may distort normal

anatomy of the ipsilateral ureter increasing its risk for injury[11].

All injuries were diagnosed intraoperatively, and on-table retrograde ureterography showed extravasation in all cases of perforation. Abdominal signs and increasing pain were obvious in the major complication with associated shock. Excessive bleeding not cleared by irrigation fluid at URS was the first sign in minor injuries; the first reaction was to stop insertion of the ureteroscope and assess the situation. In perforation injuries there was a perceived resistance while passing the guide wire.

Delayed perforations and other complications were not included in this study. These may present long after URS, where the patients may present with urinoma, infection, hematuria and strictures.[1,2,5,6,17] There is a significant relationship between the surgeon's competence and the instruments used on one hand and the complications and wear and tear of the endoscopes on the other as reported in previous studies[17,18] but this parameter was not included in our study. It would have been interesting to study in detail the incidence of injury inflicted and damage to ureteroscopes in relation to the experience of the surgeon.

We conclude that, although ureteroscopy is an important tool in the management of upper tract pathology, it is significantly invasive, especially in therapeutic endoscopy. The technique is difficult to learn and the learning curve in a teaching hospital is steep. Significant and life-threatening complications may occur despite recent advances in the design of ureteroscopes and accessories. Good patient selection, however, and expert handling will reduce the incidence of complications. Prompt diagnosis of the complication and early treatment are important to secure a satisfactory outcome.

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RESUME

Les complications rencontrées pendant l'urétéroscopie rigide

Objectifs: Nous avons évalué les complications rencontrées pendant l'urétéroscopie dans deux centres de formation en Egypte pendant une durée de quatre mois. **Patients et méthodes:** Un total de 88 patients (38 hommes et 50 femmes) avec un âge médian de 52 années (28 - 70 années) ont subi une urétéroscopie (URS) entre le 4 juillet et le 3 octobre 2003. Tous les patients étaient éligibles. L'indication de l'URS, l'état de l'uretère, les pathologies associées, les complications rencontrées et leur traitement ont été évalués. **Résultats:** Il y avait deux groupes de patients: 81 patients ont subi une URS thérapeutique et 7 endoscopies diagnostiques. 14 uretères 14/88 (15.9%) ont été blesses. Les lésions les plus communément rencontrées étaient la lacération de la muqueuse urétérale dans 57% des cas. Des lésions majeures en forme d'avulsions urétérales, de lacérations urétérales et de lésions de la vessie se sont produites dans 2% des cas. Dans tous les cas le diagnostic était immédiat confirmé par urétérographie et un traitement a été entamé immédiatement. **Conclusion:** L'urétéroscopie est un outil important dans la prise en charge de la pathologie du haut appareil mais est surtout considérablement invasif. En dépit des avancées récentes dans la conception d'objectifs et d'accessoires, l'URS peut être associé à des complications considérables et potentiellement morbides quand elle est réalisée dans des centres de formation où la courbe d'apprentissage d'une tâche difficile peut affecter les résultats totaux. La bonne sélection des patients et la maîtrise technique réduiront le taux de complications. Le diagnostic précoce des complications et la prise en charge précoce sont impératifs.

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