Original Article

Early Complications of Diagnostic and Therapeutic Ureteroscopy

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Abstract

Objective: The aim of this study is to report early complications of diagnostic and therapeutic ureteroscopy and to grade each complication according to modified Clavien classification system (MCCS). **Materials and Methods:** Through a prospective study conducted from March to September 2017, all patients who underwent diagnostic and therapeutic semirigid ureteroscopy were evaluated. The procedure was performed by different surgeons. The recording data included patient demographics, ureteroscopy site (left, right, or bilateral), aim of ureteroscopy (diagnostic or therapeutic), operative time, additional intervention, stone-free rate, double J stent placement, and complications which were graded according to the modefied clavien classification system with their management. **Results:** One hundred and fifty patients were included in the study. The average age was 39.9 years and male-to-female ratio 2.3/1. The number of patients who underwent right, left, and bilateral ureteroscopy was 74 (49.3%), 64 (42.3%), and 12 (8%), respectively, so the overall number of ureteroscopy procedures was 162. Diagnostic ureteroscopy was done in 20 (13.3%) patients and therapeutic ureteroscopy in 130 (87.7%). Complications occurred in 37.3% of patients. According to MCCS, Grade I, II, IIIa, IIIb, IVa, IVb, and V complications were detected in 40 (26.6%), 6 (4%), 10 (6.7%), 14 (9.3), 0 (0.0%), 2 (1.3%), and 0 (0.0%) of cases, respectively. **Conclusion:** Ureteroscopy becomes the prevailing procedure for different ureteral pathologies mainly stones with a good safety and efficacy. It is important to adopt a precise classification system for reporting the complications of ureteroscopy. Most of the complications are of low grade and they are amenable to conservative management. The complications of ureteroscopy will continue to decline as the ureteroscopic technology evolved.

Keywords: Clavien classification system, complications, ureteroscopy

Introduction

Upper urinary tract observation and treatment have been augmented by recent advances in ureteroscopic technology. Ureteroscopy has gradually become a major technique for the diagnosis and treatment of lesions of both the ureter and the intrarenal collecting systems.

The first use of rigid ureteroscope was done by Perez-Castro Ellendt and Martinez-Pineiro in the early 80s till it reached to a small caliber semirigid and flexible instrument nowadays, with improvement of other ureteral access, endoscopic lithotripter, and interventional accessories. This continuous improvement facilitates retrograde ureteroscopic diagnosis and therapeutic intervention of different upper urinary tract diseases mainly urinary calculi in addition to ureteral stricture, upper urinary tract transitional cell carcinoma, and essential hematuria.

With increased surgical experience and improvements in endoscopic equipment, the number of overall and severe complications had decreased. In their experience of 2735 retrograde ureteroscopy procedures over a 10-year period, Geavlete *et al*. confirmed that 77% of their complications appeared in the first 5 years compared to only 23% in the past 5 years.[1] Likewise, Harmon *et al*. described a reduction in the rate of major complications from 6.6% to 1.5% over time.[2] The number of intraoperative and postoperative complications is decreased with increased surgeon experience.[3]

At the same time, the efficacy of treatment increased and risk of complications decreased with using smaller semirigid and

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flexible ureteroscopes. Abdel-Razzak and Bagley demonstrated that the 6.9F semirigid ureteroscope did not need ureteral orifice dilatation giving a clearer picture for diagnostic purposes.[4] In a comparison of conventional rigid ureteroscopes (9.5–11.5F) with small caliber semirigid ureteroscopes (6–7.5F), Francesca *et al*. reported a threefold decrease in complications with the latter instruments.[5]

In recent years, intraoperative complications are reviewed along with those occurring in the early postoperative period. In addition, events are classified based on their severity. Minor complications make up the majority of incidents encountered during and after ureteroscopy. These can be effectively managed by nonoperative means with minimal sequelae. Major complications constitute injuries that necessitate operative intervention or they are life threatening. In two large series, open surgery was performed in only 0.22% of patients.[1,6] Although these complications are clearly rare, they can have enduring effects that contribute to long-term morbidity.

In general, complications of ureteroscopy are classified into early and late, major, and minor, but recently, according to their severity, they are classified into grades using specialized systems. Perioperative complications are still in need of a succinct, widely acceptable definition, and a precise grading system for their severity. Hence, a standardized classification system offering a common platform for communication among urologists is essential.[7] The Clavien classification system was initially used for grading complications of general surgery, and later on, it has been modified and validated further and currently its use is prevailing in most aspects of urology.[8,9]

The aim of this study is to evaluate our URS results and to test the feasibility of modified Clavien classification system (MCCS) for indicating the types and severity of perioperative complications of ureteroscope.

Materials and Methods

Through a prospective study, 150 patients underwent diagnostic and therapeutic ureteroscopy in the period between March 1, 2017, and August 30, 2017, in both Azadi Teaching Hospital/Duhok and Vajeen Private Hospital/Duhok. Ureteroscopy was done by different surgeons, and all patients were assessed preoperatively by urinalysis, complete blood count, renal function test, and urine culture (if indicated), abdominal ultrasonography, and plain abdominal X-ray (kidney, ureter, and bladder [KUB]). In certain circumstances, noncontrast urinary tract computed tomography scan and intravenous urography were performed.

Inclusion criteria included all eligible patients who underwent ureteroscopy during the period of this study, all patients aged older than 16 years, and both sexes were included. Exclusion criteria were only patients who refused to be included in the study. The recording data included patient demographics, ureteroscopy site (left, right, or bilateral), aim of ureteroscopy (diagnostic or therapeutic), operative time, additional intervention, stone-free rate, double J stent placement, and complications which were graded according to the MCCS with their management [Table 1].

All patients received prophylactic antibiotic at induction of anesthesia (aminoglycosides or third-generation cephalosporins or fluoroquinolones), and all procedures have been done under general anesthesia or spinal anesthesia with patients in lithotomy position. Two sizes of ureteroscope were used in this study (storz 6.5 and 9.5 Fr), and the ureteric pathologies whether a stone or any other pathology were managed accordingly. When the stone was detected, it was either retrieved directly using Dormia basket or using either holmium YAG laser or pneumatic lithotripter, the stones crushed into small fragments and left to be passed spontaneously or retrieved by Dormia basket.

Insertion of ureteral double J stents was only used for those patients who had clear edema, mucosal damage, perforation, and stricture or having residual stone fragments based on the surgeon's decision.

Table 1: Patient's characteristics

Parameter	Value
Age (years)	
Mean	39.9
Range	18-80
Sex, *n* (%)	
Male	104 (69.3)
Female	46 (30.7)
Laterality, *n* (%)	
Right	74 (49.3)
Left	64 (42.7)
Bilateral	12 (8)*
Aim of URS, *n* (%)	
Diagnostic	20 (13.3)
Therapeutic	130 (86.7)
Diagnosis, *n* (%)	
Stone	140 (93.3)
Stricture	6 (4)
PUJ obstruction	2 (1.3)
Ureteric tumor	2 (1.4)
Size of URS used, *n* (%)	
9.5 French	76 (50.7)
6.5 French	74 (49.3)
Intracorporeal lithotripsy, *n* (%)	
Laser	54 (36)
Pneumatic	30 (20)
Not used	66 (44)
Stone-free rate, *n* (%)	110/140 (78.65)
JJ stent placed, *n* (%)	68/150 (45.3)
Mean operative time (min)	
Mean	34.1 min
Range	18-72 min
Mean hospital stay (days)	
Mean	1.38 days
Range	1-7 days

*A total of 162 URS procedures were performed in 150 patients as 12 patients underwent bilateral URS. URS: Ureteroscopy

Operative time measured from the insertion of ureteroscope through the urethra into the upper tract till the end of the procedure. Stone clearance is defined as patient free of stones till 4 weeks following ureteroscope. Following recovery from anesthesia, plain X-ray of the abdomen KUB done to ensure stone-free status and double J stent position, and then, patients discharged unless otherwise there is an indication for keeping patients in the hospital. Indwelling ureteral stent was removed within 2–4 weeks postoperatively.

Hematuria was classified into transient and persistent. Any hematuria for the first 6 h postoperatively was neglected, but hematuria from 6 to 48 h considered as transient hematuria and those persist for more than 48 h considered as persistent hematuria.

We evaluate the procedure from the beginning till the end, the operative findings have been reported, and intraoperative and/or early postoperative complications were classified and graded according to MCCS. In patients with more than one complication, each one was graded separately according to their levels.

MCCS was used to classify the complications of semirigid URS. It is classified into five grades. Grade I included those events that encountered without adverse consequences and they usually did not require radiologic, endoscopic, or surgical interventions; Grade II includes those with blood transfusions or urinary tract infection. Grade III includes those requiring intervention under local or general anesthesia and Grade III classified into IIIa and IIIb. Grade IV composed of either an organ dysfunction, such as myocardial infarction, renal failure (Grade IVa), or multiorgan dysfunction and urosepsis (Grade IVb). Grade V complication was death [Table 2].[10]

Table 2: Complications of ureteroscope classified according to the modified Clavien classification system (*n*=150)

Grade	Complications	*n* (%)
Grade I	Fever	8 (5.3)
	Mild mucosal injury or abrasion	18 (12)
	Transient serum creatinine elevation	0
	Transient hematuria	12 (8)
	Persistent hematuria	0
	Mechanical failure (failure to access the ureter)	2 (1.3)
	All	40 (26.6)
Grade II	Blood transfusion	0
	Urinary tract infection	6 (4)
	All	6 (4)
Grade IIIa	Urinoma or extravasation	4 (2.7)
	Hematoma in bladder	0
	Stone migration	6 (4)
	All	10 (6.7)
Grade IIIb	Double J stent migration	1 (0.7)
	False passage (submucosal tunnel)	8 (5.3)
	Ureteral perforation	5 (3.3)
	Ureteral avulsion	0
	Ureteral stricture	0
	All	14 (9.3)
Grade IVa	Myocardial infarction and pulmonary embolism	0
	Renal failure	0
	All	0
Grade IVb	Urosepsis	2 (1.3)
	Multiorgan dysfunction	0
	All	2 (1.3)
Grade V	Death	0
All		72 (48)

Statistical analysis

Descriptive statistics for study participants were presented in Table 1 using frequencies and percentages for categorical variables as well as means and ranges for continuous variables. Procedural complications were illustrated in Table 2 and stratified according to their MCCS grades. All analyses were performed using Microsoft Excel, version 2016.

Results

A total of 150 patients with average age of 39.9 years (range 18–80) were included in this study. With regard to the gender of patients, the results show that the male patients represent 69.3% and the female patients represent 30.7% with a male-to-female ratio nearly 2/1. Regarding the site of ureteroscopy, the number of patients who underwent right, left, or bilateral ureteroscopy was 74 (49.3%), 64 (42.3%), and 12 (8%), respectively, so the overall number of ureteroscopy procedures was 162. The number of patients who underwent diagnostic ureteroscopy was 20 (13.3%) patients while those with therapeutic ureteroscopy were 130 (87.7%) [Table 1].

Following the initiation of the procedure, the diagnosis was confirmed before any other intervention. A total of 140 (93.3%) patients were diagnosed as having ureteric stone and 10 (6.7%) patients diagnosed as having other conditions such as ureteric stricture (6 patients, 4%), pelviureteric junction obstruction (2 patients, 1.3%), and ureteric tumor (2 patients, 1.4%). All patients were managed according to their underlying diagnosis.

Two sizes of ureteroscope were used in this study (6.5 Fr) used in 76 (50.7%) patients and (9.5 Fr) used in 74 (49.3%) patients. Intracorporeal lithotripters were used in those patients having ureteric stone. Holmium YAG laser was used in 54 (36%) and pneumatic lithotripter was used in 30 (20%) patients. The overall stone-free rate was achieved in 110/140 (78.65%) patients who were managed for ureteric stone. Double J ureteral stent was inserted in 68 (45.3%) patients and it was removed at 2–4 weeks postoperatively. The mean operative time was 34.1 min (range = 18–72 min). The mean hospital stay was 1.38 days (range = 1–7 days).

Seventy-two complications were reported in 56 patients (37.3%) and those patients with more than one complication were graded separately. The number of patients having one, two, or three complications was 43, 10, and 3 patients, respectively.

According to MCCS, Grade I, II, IIIa, IIIb, IVa, IVb, and V complications were detected in 40 (26.6%), 6 (4%), 10 (6.7%), 14 (9.3), 0 (0.0%), 2 (1.3%), and 0 (0.0%) of cases, respectively. The classification of the complications illustrated in Table 2.

Discussion

Ureteroscopy is a successful procedure and is performed worldwide for the treatment of different ureteral pathologies. Its success rate depends mostly on the size and location of the pathology. It is mostly performed for the management of upper urinary calculi.[11]

There are a considerable overlap and lack of specification in reporting surgical outcomes which may be termed as complications, morbidity and/or mortality, mishaps, unfavorable incidents, and the need for further treatment. The definition of postoperative complications is "any break through the ideal postoperative course that is not inherent in the procedure and does not comprise a failure to cure."[12]

Although URS is an invasive option for the management of ureteral conditions, it has a high success rate extending from 85.6%[13] to 95.7%,[14] especially when it is used for the management of ureteral stone. In this study, we achieved an overall stone-free rate of 78.65%.

In general, most ureteroscopic complications are minor and they are conservatively treated, and only few major complications have been reported. The overall complication rates range from 3.5%[12] to 26.3%[15] to 57.9%.[16] In our study, we report 72 complications in 56 patients (37.3%). This relatively high complication rate attributed to some factors: some of the minor complications may be underreported in the previous studies before a clear classification system has been made and most of the large studies with low complication rates came from the centers with long experience and they are usually a single surgeon series, but in our study, ureteroscopy was done by different surgeon with variable experience, so the complications reported were widely differ from one surgeon to another; therefore, the numbers of intraoperative and postoperative complications are decreased with increased surgeon experience.[3]

According to MCCS, we classified the complications into five grades. Grades I and II are equivalents to minor complications while Grades III–V are classified as major complications. The use of MCCS system was straightforward, rapid, and easy to assign each complication to its appropriate grade. Minor complications represent 30.6% and major complications represent 17.3% [Table 2].

Grade I complications were the most common in this study (26.6%) and represent 40/72 (55.5%) of all complications. Mucosal injury or abrasion was the most common complication and it was reported in 18/150 patients (12%) and represent 18/72 (25%). This complication fluctuates widely from one study to another ranging from 2.8%[11] to 24%.[5] Mucosal abrasion reported in 11 patients when 9.5 Fr ureteroscope (7 of them with pneumatic lithotripsy) was used and other 7 cases with 6.5 Fr ureteroscope and holmium YAG laser. The larger the size of ureteroscopy the more the friction applied to ureteral mucosa so the more the rate of mucosal injury.[1,16] Double J ureteral stent was inserted for 14 patients when there was a considerable bleeding, edema, or a mucosal flap which might cause obstruction.[17]

The next complication was hematuria which occurred in 12/150 patients (8%), and in this study, it represents 12/72 (16.6%) of all complications. Ten patients of those who developed hematuria had indwelling double J stent and the hematuria was transient and resolved spontaneously, and no persistent hematuria was recorded. Elashry *et al*. reported transient hematuria in 2.2%,[18] while in Mandal *et al*., it reached to 19%.[19] Persistent hematuria ranged from 0.1% to 2%.[20]

The complications related to infections ranged from mild fever which was clinically insignificant to high fever which occurs in urosepsis. The definition of fever is any temperature equal to 38.3°C or more as described in the literature.[21,22] The lowest reported rate of fever following ureteroscopy was 1%,[20] but it might be as high as 20%.[23] In this study, fever was noticed in 8 patients (5.3%) which was transient and graded separately from other complications associated with fever such as urinary tract infection ($n = 6$ [4%]), extravasation ($n = 4$ [2.3%]), and urosepsis ($n = 2$ [1.3%]). Hence, the overall rate of fever in this study was 20/72 (27.7%) of all complications. All patients with fever were treated successfully with antibiotic and those with extravasations are managed with indwelling double J ureteral stent and antibiotic while two patients with sepsis developed mild renal impairment and they were transferred to intensive care unit and treated with antibiotic and discharged from the hospital after 1 week with uneventful sequalae.

Proximal stone migration was observed in 6 patients (4%). Four of them were in the upper ureter and two in the mid-ureter, and in 4 patients, stone migration occurred when pneumatic lithotripsy used, and in one case, holmium YAG laser was used, and in one case, stone migration into the kidney occurred even without the use of intracorporeal lithotripsy. El-Nahas *et al.* reported a high rate (35%) of secondary procedure to manage a proximal stone migration following ureteroscopy for ureteral calculi.[23] Aridogan *et al*. revealed that the rate of stone migration was more with proximal ureteral stone (29%) than mid or lower ureteral stone (6%).[24] In this study, all proximal stone migrations were managed with double J stent insertion followed by either extracorporeal shock wave lithotripsy or second ureteroscopy. Several studies revealed that the risk of stone migration is more with pneumatic lithoclast than holmium YAG laser lithotripsy due to jackhammer mechanism of lithoclast.[25-27]

False passage occurs in 8 patients (5.3%) which is caused by forced or improper placement of ureteroscope or by misplaced guidewire without full penetration of the ureteral wall. In six patients who developed false passage, 9.5 Fr ureteroscope was used, and only in two patients, 6.5 Fr ureteroscope was used.

Of those patients who developed false passage, four of them were treated for ureteral stricture and the rest were treated for ureteral stone. False passage was managed by reinsertion of double J stent after proper placement of a guidewire. Al-Awadi *et al*. reported 15 false passage (18.3%) in their study,[10] but in our study, the rate of false passage complication was (5.3%) which represents 8/72 (11.1%) of all complications.

Ureteral stent migration occurred in only one patient in this study (0.7%) and the patient presented with ureteric colic 2 days after ureteroscopic removal of a ureteral stone and double J insertion. Plain X-ray of the abdomen KUB had taken which revealed proximal stent migration into the upper ureter which removed later on. The rate of stent migration was higher in other studies. Cheung *et al.* reported five instances of proximal stent migration and seven instances of distal stent migration.[28] Öğreden *et al*. reported 16 patients (1.9%) with ureteral stent migration.[16]

Although the ureteral perforation incidence was decreased over the last few decades, it remains one of the serious complications. Ureteral perforation was reported in 5/150 patients (3.3%) in this study. Three of them were with 9.5 Fr ureteroscope and one with 6.5 Fr. Old literature showed higher rate of perforation. Stoller *et al.* reported perforation rate of 15.4% using 12.5 Fr ureteroscope.[29] With development of smaller diameter ureteroscope, the perforation rate is decreased to a rate ranged from 1.6%[12] to 6.25%.[30] In this study, all cases of perforations were diagnosed intraoperatively and double J ureteral stenting was done three of them, and in other two patients, perforation was large which necessitates open conversion and stones were removed and extravasated fluid drained and double J stent reinserted. The risk of open conversion was 1.3% which represents 2/72 (2.7%) of all complications. The rate of open conversion in other literature ranged from 1% (6) to 3.2%.[31]

No ureteral avulsion was reported in this study. Recent studies show that the rate of ureteral avulsion was 0.16%.[11] Furthermore, Grade IVa and V complications were not encountered in this study.

The overall complications rate in our study was 48%. Although the rate of complications decreased with improving instrument and advancing technology, the complication rate seems to be higher with MCCS. High minor complications rate in Grades I and II of this study might be the cause because these minor events were not considered complication in the previous series because they did not depend on MCCS.[16]

MCCS was proved to be precise, practical, simple, and quick to grade the complications of ureteroscopy. On the other hand, it needs to be more comprehensive and to include other vital parameters such as hospital stay, management cost, and readmission rate.

This is the first study to use real-life data to evaluate early complications associated ureteroscopy in the main urology center in Duhok Governorate. The limitations of this study include: First, inability to report late postoperative complications related to ureteroscopy such as renal failure and ureteral stricture due to brief period of this study. Second, sample size is relatively small and does not allow for powered association and adjustment of confounders. Third, it is imperative to conclude that procedural complications may differ based on who is performing it; hence, surgeons experience.

Conclusion

Ureteroscopy becomes the prevailing procedure for different ureteral pathologies mainly stones with a good safety and efficacy. Therefore, it is important to adopt a precise classification system to report complications of surgical procedures which should be updated and convenient to accommodate various and rapidly expanding surgical field. With good patient's selection, most of the complications are of low grade and they are decreased with the use of smaller size ureteroscope, good experience, and holmium laser stone fragmentation.

Most of the major complications can be avoided with careful attention to the technique. For each case, safety measures should always be employed. Even so, complications can occur at any time. Most of the complications in recent studies are amenable to conservative management. The complications of ureteroscopy will continue to decline as the ureteroscopic technology evolved.

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Conflicts of interest

There are no conflicts of interest.

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