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# Intraoperative Complications after 8150 Semirigid Ureteroscopies for Ureteral Lithiasis: Risk Analysis and Management

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**Rezumat**

***Complicațiile intraoperatorii după 8150 de ureteroscopii semirigide: analiza riscurilor și management***

*Obiective:* Evaluarea complicațiilor ureteroscopiei retrograde semirigide pe o serie semnificativă de pacienți şi stabilirea factorilor asociați apariției acestor complicații.
*Pacienți şi metodă:* În perioada iunie 1994 – iunie 2013, au fost efectuate 8150 de proceduri ureteroscopice semirigide pentru litiază ureterală la un număr de 7456 de pacienți. Au fost utilizate ureteroscoape semirigide Wolf 8/9,8F, Storz 8 şi 10F, Olympus Endoeye digital 8,5/9,9 F). Litotriția a fost efectuată cu litotritoare pneumatice, electrohidraulice sau laser Ho:YAG. Parametrii preoperatori incluzând sexul, localizarea şi dimensiunile calculilor, impactarea, gradul hidronefrozei, numărul calculilor şi malformațiile asociate precum şi unele aspecte intraoperatorii (tipul de instrumente de extragere şi fragmentare, durata intervenției şi experiența operatorului) au fost evaluați în corelație cu rata complicațiilor.
*Rezultate:* Rata de stone-free după o singură procedură a fost de 90,9%. Incidentele intraoperatorii au survenit în 348 de cazuri (4,3%). Rata globală a complicațiilor a fost de 2,8% (228 cazuri). Acestea au fost reprezentate de leziuni ale mucoasei ureterale (139 cazuri), perforații (58 cazuri), sângerare (16 cazuri), avulsie ureterală (3 cazuri) şi migrare extraureterală a calculului (12 cazuri). Analiza statistică a demonstrat o asociere semnificativă între rata complicațiilor, pe de o parte, şi dimensiunile, localizarea şi impactarea calculilor, timpul operator şi experiența chirurgului, pe de altă parte.
*Concluzii:* Datorită progreselor tehnologice şi a creşterii experienței, tratamentul ureteroscopic retrograd al litiazei ureterale a cunoscut o creştere a eficacității în condițiile unei reduceri a complicațiilor intraoperatorii. Majoritatea acestor complicații sunt minore şi pot fi tratate conservator.

**Cuvinte cheie:** ureteroscopie retrogradă semirigidă, litiază ureterală, complicații, factori de risc, management

**Abstract**

*Objectives:* To evaluate semirigid retrograde ureteroscopy complications on a significant series of patients and to establish the factors associated with the occurrence of intraoperative complications.
*Patients and Methods:* Between June 1994 and June 2013, 8150 semirigid ureteroscopic procedures for ureteral lithiasis were performed in 7456 patients. We used semirigid ureteroscopes (8/9.8F Wolf, 8 and 10F Storz, Olympus Endoeye digital 8.5/9.9 F). Lithotripsy was done with pneumatic, electrohydraulic or Ho:YAG laser lithotripters. The preoperative parameters including gender, calculi location and size, impaction, degree of hydronephrosis, stone number and associated malformation as well as intraoperative aspects (stone extractors, fragmentation devices, operative time and surgeon experience) were evaluated in relation with complications' rate.
*Results:* The stone-free rate after a single ureteroscopic procedure was 90.9%. Intraoperative incidents occurred in 348 cases (4.3%). The overall rate of intraoperative compli-

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cations was 2.8% (228 cases). These were represented by lesions of the ureteral mucosa (139 cases), perforation (58 cases), bleeding (16 cases), ureteral avulsion (3 cases) and extra-ureteral stone migration (12 cases). Statistical analysis shows a significant association between the complication rate on the one hand and stone size, location and impaction, operative time and surgeon experience on the other hand.
*Conclusions:* Due to technological advances and increased experience, the semirigid retrograde ureteroscopic treatment of ureteral lithiasis increased efficacy, while the incidence of intraoperative complications decreased. Most of these complications are minor and can be managed by conservative approach.

**Key words:** retrograde semirigid ureteroscopy, ureteral lithiasis, complications, risk factors, management

## Introduction

The treatment for ureteral calculi has continuously evolved in the last decades, especially due to technological advances. Progresses of the instruments, the introduction of new energy sources and devices, better optical quality and the increased experience have determined high success rates of the procedures. Therefore, retrograde ureteroscopy has become a first option treatment of the stones in all locations in the ureter (1,2,3).

Meanwhile, the incidence of serious complications decreased significantly (4). However, the complications' risks still exist, some of which with major consequences.

Our study, performed on a significant number of cases, aims to evaluate the incidence of the complications, the factors associated with these problems and the treatment options of such cases.

## Patients and methods

In order to evaluate the intraoperative complications of semirigid retrograde ureteroscopy, we reviewed the medical records of patients who underwent endoscopic retrograde approach for ureteral lithiasis in our clinical department. Between June 1994 and June 2013, 8150 semirigid ureteroscopic procedures for ureteral lithiasis were performed in 7456 patients. These reached 82.5% of the total number (9878 procedures) of semirigid and flexible ureteroscopies done in this period. Bilateral ureteroscopy for ureteral lithiasis was performed in 112 cases and 524 patients underwent multiple procedures.

The patients' mean age was 54.3 years (range between 7 and 87 years).

All procedures were done after obtaining signed informed consent from the patient.

Ureteroscopy was performed under spinal or peridural anesthesia in 7645 cases (93.8%) while general anesthesia was preferred in 349 cases (4.3%). Local anesthesia with intravenous sedation was used in 156 cases (1.9%).

Patients with urinary tract infection received antibiotherapy before the procedure.

Intravenous antibiotics were routinely perioperatively given to all patients.

We used semirigid ureteroscopes (8/9.8F Wolf, 8 and 10F Storz, Olympus Endoeye digital 8.5/9.9 F). The irrigation liquids used were sorbitol, sterile water or saline solution.

Ureteral orifice and intramural ureter dilation was performed in 3910 cases (48%): balloon dilation was used in 2586 patients and axial dilation in 1324 patients. In 17 cases endoscopic meatotomy was performed, while in 318 cases the negotiation of ureteral orifice was facilitated using two guide wires. The ureter was pre-stented in 424 cases.

In 66 cases, ureteroscopy was associated with other procedures: endouretectomy in 52 cases (5 cases with ureteral duplicity), ipsilateral percutaneous nephrolithotomy in 7 cases, contralateral percutaneous nefrolithotomy in 3 cases and optical internal urethrotomy in 4 cases.

The calculi were extracted intact in 1782 cases, while 5874 cases imposed fragmentation. This was done using pneumatic, electrohydaulic or Ho:YAG laser lithotripters.

Postprocedural ureteral stenting was performed in 4732 cases (58%).

The preoperative parameters including sex, calculi location and size, impaction, degree of hydronephrosis, stone number and associated malformation as well as intraoperative aspects (stone extractors, fragmentation devices, operative time) were retrospectively evaluated in relation with the complication rate.

The associations between complications' occurrence and various pre- and intraoperative parameters were statistically analysed using univariate (chi-square test) statistical tests. $P < 0.05$ was considered statistically significant. SPSS statistical software (SPSS, Inc., Chicago, IL) was used for data analysis.

## Results

The stone-free rate after a single ureteroscopic procedure was 90.9% (7408 cases). Failure of the procedure was determined by lack of ureteroscopic access to the stone (248 cases), retropulsion of the calculi (316 cases), incomplete calculi fragmentation (26 cases), incidents or complications that imposed stopping the procedure (83 cases) or restant calculi (18 cases). Additionally, in 51 cases the procedure was stopped and an indwelling catheter was placed due to pyuria suprajacent of the calculus.

The mean operative time was 34.6 minutes (range 6 to124 minutes).

Intraoperative incidents occurred in 348 cases (4.3%). These were represented by the failure to negotiate de ureteral orifice (52 cases), or to reach the calculi due to narrowed and sinuous ureteral lumen or edema surrounding the calculi (196 cases), fixed stone baskets (54 cases), equipment damages (34 cases) or double J stent malpositioning (12 cases). All the

incidents were dealt endoscopically, except one case of fixed basket that imposed open extraction.

Migration of the calculi or stone fragment during the procedure occurred in 454 cases (5.6%). In 138 cases, the lithotripsy maneuvers continued in the pyelocaliceal system, using the semirigid instruments (62 cases), or by flexible ureteroscopic approach (76 cases). In 316 cases, the procedure was stopped and a ureteral stent was placed.

The overall rate of intraoperative complications was 2.8% (228 cases). These were represented by lesions of the ureteral mucosa (139 cases), perforation (58 cases), bleeding (16 cases), submucosal or extra-ureteral stone migration (12 cases) and ureteral avulsion (3 cases).

According to their depth and mechanism, the lesions of the ureteral mucosa were classified in: mucosal abrasion (91 cases) and false passage (48 cases). They occurred during guidewire placement (4 cases), intramural ureter dilation (15 cases), ureteroscope ascending (27 cases), lithotripsy (56 cases) or calculi extraction (37 cases). In 122 cases the procedure was successfully completed despite the lesions. In only 17 cases the intervention was stopped. Prolonged ureteral stenting weeks was performed in 16 cases, while percutaneous nephrostomy, in one case.

The ureteral perforation occurred in 58 cases (0.7%). This complication was noted during ureteral orifice dilation (3 cases), ureteroscope ascending (16 cases), lithotripsy (25 cases) or calculi extraction maneuvers (14 cases). The treatment was adapted to individual circumstances. The procedure was carried out in 14 cases. In 44 cases the maneuver was stopped, followed by double J stenting in 38 cases, percutaneous nephrostomy in 5 cases (with antegrade double J stenting in 3 cases) and open surgery with termino-terminal ureteroraphy in one case.

The incidence of submucosal or extra-ureteral stone migration was 0.15% (12 cases). In 5 cases the calculi fragment was extracted, while in 6 cases the stone was abandoned and the patient was notified for further radiological examinations. Open surgery was performed in another case.

Bleeding during ureteroscopy was usually minor, mostly as a consequence of lesions occurring during ureteroscope ascending, calculi fragmentation or manipulation. In 3 cases (0.1%), the visibility difficulties due to bleeding imposed stopping the procedure and placing a double J stent.

Ureteral avulsion was the most serious traumatic complication, occurring in 3 cases. In all cases, the stripping was caused by the forced extraction of the stone captured in the basket which got stuck to the wall.

In one case ureteroplasty was performed, while in a different case, uretero-vesical reimplantation with Boari flap was done. In the third one, the initial treatment was the endoscopic realignment of the ureter and double J stenting. Postoperatively, the evolution was unfavorable with retroperitoneal urinoma, imposing nephrectomy.

According to modified Clavien classification most intraoperative complications (154 cases) were grade 1, implying only a prolonged double J stenting. 69 cases were classified as grade IIIa and 5 cases, grade IIIb.

All intraoperative complications were identified intraoperatively and treated immediately. Most of them were solved endoscopically by double J stenting, percutaneous nephrostomy being used in 6 cases, while open surgery was necessary in only 5 cases.

Related to the preoperative parameters (*Table 1*), statistical analysis reveals a significant association between the complication rate on the one hand and stone size, location and impaction, on the other hand.

The only intraoperative parameter associated with increased complications' rate, was the operative time. As for stone extractors and fragmentation devices, the differences noticed in terms of complication rates did not reach statistical significance (*Table 2*). The surgeon's experience is an important factor for the safety of the procedure, the complication rate being significantly higher for urologists in training, by comparison to specialists (*Table 3*).

## *Comment*

During the last decade, retrograde ureteroscopy has dramatically changed the management of ureteral calculi (2). With the development of smaller calibre and flexible ureteroscopes and the introduction of improved instrumentation or energy sources, ureteroscopy evolved into a safer and more efficient modality for the treatment of stones in all locations (1,2,5).

Consequently, the incidence of complications has significantly decreased. By comparison with our previous report (6), the rate of intraoperative complications was reduced, especially for the cases with serious adverse events. However, intraoperative incidents and complications may lead to severe consequences, therefore the means of anticipation, prevention and treatment are crucial (7).

According to the Guidelines of the European Association of Urology, the overall complication rate after retrograde ureteroscopy reported in the literature varies between 9% and 25% (2). In recent years, intraoperative complications, most notably ureteral perforation rates, have dropped to less than 5% (3). A recent study of The Clinical Research Office of the Endourological Society (8) on 11,885 patients from 114 centers who received retrograde ureteroscopy, describes a low incidence of significant bleeding (1.4%), perforation (1.0%), and failure to complete the operation (1.6%). In our experience the general rate of intraoperative complications was 2.8%.

Most complications are minor and can be managed endoscopically (9). In our series, according to Clavien modified scale (10), the majority of the complications were classified in grade I, 67.5% of complications not impairing the success of the procedure. The intervention was stopped and a double J stent was placed in 27.6% of cases, while in 6 patients, a nephrostomy tube was inserted. Only 5 complications imposed open surgery.

However, even with a reduced incidence (less than 1%), major complications may be severe and may cause significant morbidity (11).

***Table 1.*** *Associations between preoperative parameters and intraoperative complications*

| Preoperative parameters | No of cases | No of complications | % | Chi-square | p value |
|---|---|---|---|---|---|
| Sex | | | | 0.96 | p – 0.325 |
| man | 4674 | 138 | 2.9% | | |
| female | 3476 | 90 | 2.6% | | |
| Calculi size | | | | 7.588 | p – 0.0225 |
| < 10 mm | 5834 | 145 | 2.5% | | |
| > 10 mm | 2148 | 78 | 3.6% | | |
| multiples | 168 | 5 | 3% | | |
| Hydronephrosis | | | | 0.81 | p - 0.937 |
| no hydronephrosis | 624 | 17 | 2.7% | | |
| grade 1 | 1732 | 50 | 2.9% | | |
| grade 2 | 3252 | 87 | 2.7% | | |
| grade 3 | 2204 | 64 | 2.9% | | |
| grade 4 | 338 | 10 | 2.9% | | |
| Stone location | | | | 10.76 | P – 0.013 |
| proximal | 2110 | 77 | 3.6% | | |
| middle | 2304 | 68 | 2.9% | | |
| distal | 3568 | 78 | 2.2% | | |
| multiple | 168 | 5 | 3% | | |
| Impaction | | | | 23.19 | P < 0.005 |
| impacted | 784 | 31 | 3.9% | | |
| non-impacted | 7366 | 197 | 2.7% | | |
| Associated malformations | | | | 0.039 | p – 1.981 |
| With malformations | 164 | 5 | 3% | | |
| Without malformations | 7986 | 223 | 2.8% | | |

***Table 2.*** *Associations between intraoperative parameters and complication rate*

| Intraoperative aspects | No. of cases | No. of complications | % | Chi square | P value |
|---|---|---|---|---|---|
| Stone extractors | 7656 | 221 | 2.9% | 1.613 | p – 0.223 |
| forceps | 5784 | 159 | 2.7% | | |
| basket | 1438 | 48 | 3.3% | | |
| forceps and baskets | 434 | 14 | 3.2% | | |
| Fragmentation devices | 5874 | 181 | 3% | 0.841 | p – 0.3282 |
| pneumatic | 4782 | 147 | 3% | | |
| electrohydraulic | 280 | 11 | 3.9% | | |
| Ho:YAG laser | 812 | 23 | 2.8% | | |
| Operative time | | | | 21.2132 | p - 0.000024 |
| < 30 min | 4354 | 98 | 2.2% | | |
| 30 to 60 min | 2823 | 82 | 2.9% | | |
| > 60 min | 973 | 48 | 4.9% | | |

***Table 3.*** *Association between surgeon experience and complication rate*

| Surgeon experience | No. of cases | No. of complications | % | Chi-square | P value |
|---|---|---|---|---|---|
| specialist | 6318 | 157 | 2.5% | 10.0979 | p – 0.0008 |
| urologist in training | 1832 | 71 | 3.9% | | |

The lesion of the ureteral mucosa, including mucosal abrasion or false passages, can occur at any stage of the procedure (7). These lesions could impair the visibility and the maneuverability during the intervention. However, in our experience, the procedure was carried out in 122/139 cases. If the lesions did not allow the completion of the procedure, a double J stent would be inserted and a repeated ureteroscopy would be done after a few days.

Ureteral perforation occurred in 58 cases (0.7%), with an obvious correlation with the diameter of the ureteroscope (12). The development of more advanced accessory instruments, including laser, less traumatic baskets, led to a raising shift in safety of the procedure. This complication could be reduced by using adequate instrumentation, avoiding forced maneuvers and by maintaining the visibility all throughout the intervention.

For most perforations, stopping the procedure and double J placement is the first option (13). If this maneuver failed, the next alternative is percutaneous nephrostomy eventually with antegrade ureteral stent insertion. In cases of impossible endoscopic or percutaneous approach, open surgical interventions remain the last choice. In our series, only 3 out of 58 cases imposed nephrostomy or open surgery.

Submucosal or extra-ureteral stone migration of calculi could be associated to ureteral perforation. Submucosal migration must be managed through stone extraction because of subsequent stenosis risk (14). However, the maneuver could be difficult, implying the risk of large ureteral perforation with retroperitoneal urinoma. Concerning the extra-ureteral stones, previous studies only found a minimal risk of strictures after this complication (15,16). In such cases, the patient must be informed of the retroperitoneal stone existence in order to avoid misdiagnosis in future radiological examinations.

In most cases, bleeding associated with ureteroscopy is minor and does not necessitate additional measures (11). The bleeding incidence that stopped the procedures varied between 0% and 2.1% (9). Although bleeding was the primary complication in only 0.3% of cases, Blute (17) noted that reduced visibility secondary to minor bleeding was the first cause which led to repeating the procedure.

Ureteral avulsion is the most serious surgical complication. In the majority of cases it appears because of excessive traction while attempting to remove a stone trapped inside a basket (18). According to our experience, its rate was reduced (the 3 cases occurred during the first period). In order to prevent this complication, especially in large proximal stones, basket extraction was avoided. Large stones needed intracorporeal lithotripsy. Basket extraction was usually performed only for small, distal stones.

In case of fixed stone basket, this incident must be managed by unsheathing the basket followed by ureteroscope withdrawa (l6). The next step is the insertion of the ureteroscope along the basket. The calculi captured by the wires must be subjected to fragmentation up to the moment of basket release.

The results of endoscopic management of this complication are disappointing, open surgery being the main indication (19). The surgical alternatives include ureteroneocystostomy, accompanied, if necessary, by a bladder psoas hitching or by a Boari flap, ureteroureterostomy, uretroplasty with interposition of an ileal segment or kidney autotransplantation. The indication is based on patient's age, lesion location and length, renal function and surgeon's experience (20).

Many studies were focused on establishing predictive factors for ureteroscopy complications. A first study was published by Schuster et al (21). Using bivariate analysis, on 320 cases, he described a significant association of ureteral perforation with increased operative time.

In a study conducted on 1235 cases, Fuganti (22) found that in univariate analysis, age, gender, previous ESWL, stone size and location were predictors of complications. After multivariate analysis, only calculi locations with previous in situ ESWL in men were significantly associated with intraoperative complications.

According to El-Nahas (23), statistically significant factors for unfavorable results were proximal ureteral stones, ureteroscopy done by surgeons other than experienced endourologists, stone impaction and stone width.

Abdelrahim (24) found that symptomatology lasting more than 3 months, a negative history of schistosomiasis, a positive history of ureteral surgery, stones above the ischial spines, stones over 5 mm in width, a dilated proximal ureter, kidneys that failed to excrete contrast medium, and involvement of a more junior urologist, were factors associated with a statistically significant higher incidence of intraoperative complications.

In our series, among the preoperative parameters, stone size, location and impaction were significantly associated with a higher complications' rate. Concerning the intraoperative features, the results of this study are similar to other data, confirming the association between the increased operative time and the risk of ureteral trauma.

Stone size is an important parameter associated with an increased risk of complications. Abdelrahim (24) proves that a stone width of greater than 5 mm was significantly associated with an increased incidence of intraoperative complications. El-Nahas (23) reported a stone width with a mean of 8 mm in cases with unfavorable results. Transverse stone diameter was thought to be the dimension which induces the most notable resistance during the extraction. Moreover, stone width is responsible for ureteral wall edema and impaction.

Local ureteral edema and inflammation caused by impaction are risk factors for submucosal false passage or extravasation (23). In addition, inserting the ureteroscope through the false passage produced by the guidewire, may lead to ureteral perforation, sometimes followed by extra-ureteral stone migration.

Other preoperative paramenters such as gender, degree of hydronephrosis, associated reno-ureteral malformations and type of stone extractors or lithotripter, did not correlate with the complication rate. Even though electrohydraulic lithotripsy is associated with an increased risk of ureteral perforation and thermal lesions, the differences noted between complication rates of various types of lithotripters did not reach the statistical significance threshold.

The intraoperative decisions of the surgeon are crucial. Stopping the procedure in case of risk of major complications is of great importance. Therefore, Tanriverdi (25) found, after multivariate analysis, that, along with stone impaction, failure to adhere to the "break'n'leave" principle was an independent predictor of complication occurrence.

Similarly to other works, our study showed that the

experience of the operator is significantly associated with the complication risk. A recent review published by Skolarikos (26) also shows that predictive factors for success of retrograde ureteroscopy, include technological advancement and surgeon experience. Therefore, supervision by an experienced endourologist is recommended when the procedure is performed by residents in training.

## Conclusions

In comparison to with our previous report, these results demonstrated that, with technological advances, the semi-rigid retrograde ureteroscopic treatment of ureteral lithiasis increased in efficacy, while the incidence of intraoperative complications decreased. Most of the complications are minor and can be managed by conservative measures.

Careful attention for the cases with increased risk for complication occurrence, instrument choice and a refined surgical technique are important for reducing untoward events.

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