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Complicaciones de la ureteroscopia. Prevención, detección oportuna y tratamiento

Complications of retrograde ureteroscopy. Prevention, early recognition, and treatment

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Resumen

La ureteroscopia es un procedimientos comúnmente efectuado en pacientes con diversos padecimientos del aparato urinario superior. Debido al progreso en la tecnología y desarrollo de destrezas médicas se ha incrementado su utilización en todo el mundo, por lo que actualmente representa un método fundamental en el área de la urología. Sin embargo, como cualquier otro procedimiento quirúrgico, la ureteroscopia no está exenta de complicaciones, de tal modo que el conocimiento y experiencia es de suma importancia para la práctica urológica. Por tanto, el objetivo de este estudio fue revisar las complicaciones más frecuentes en la práctica de la ureteroscopia.

PALABRAS CLAVE: Ureteroscopia; complicaciones intraoperatorias; urolitiasis.

Abstract

Ureteroscopy is a common management option for multiple upper urinary tract conditions. Propelled by technologic improvements and expanding physician expertise, its use is increasing worldwide, and it is currently an important element in the armamentarium of the urologist. However, as with any other medical therapy, ureteroscopy is not complication-free, and it is essential for the practicing urologist to recognize and manage those events. We present herein a review of common complications in ureteroscopy.

KEYWORDS: Ureteroscopy; Intraoperative complications; Urolithiasis.

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INTRODUCTION

Ureteroscopy is part of the mainstream treatment modalities for the diagnostic and therapeutic management of urinary tracts conditions, mainly related to urinary stones. Technologic advances and increasing expertise since the late twentieth century have led to the widespread adoption of this minimally invasive option.

A recent survey has shown that in the United States, ureteroscopy is the third most common in-patient management choice for urinary stones, with more than 15,000 retrograde intrarenal surgeries (RIRS) being performed in 2009.[1]

However, ureteroscopy, as is the case with any medical intervention, is not complication-free. It has a reported overall complication rate under 20%[2] in early case series, and of 6.7% in later reports.[3] Even though the frequency of complications is decreasing, early recognition and management are paramount. The aim of our study was to provide a review of the current ureteroscopy complication profile. A non-systematic literature review was conducted utilizing the

PubMed database. Systematic reviews, original research, and case series were eligible.

Risk factors, complication scales, and prediction tools

Complications secondary to ureteroscopy can broadly be divided into two general groups: systemic complications, reported to occur in less than 2.38% of cases, causing procedure mortality (0.06%),[4] such as sepsis; and local complications, such as ureteral perforation, avulsion, or stricture.

Several risk factors for ureteroscopy complications have been reported in the literature. Some are patient-related, such as the presence of stones in the kidney or proximal ureter, sex, older age, comorbidities (as measured by the Charlson comorbidity index), stone size (50% complication rate if stone diameter is >10 mm),[5] previous history of shockwave lithotripsy, impacted stone, and emergent hospital admission. Others are operator-related, such as the experience of the surgeon, general anesthesia, and operative time.[4-8] Interestingly, in some studies, procedure duration has been linked not only to overall complications, but also to an increased risk of ureteral perforation ($p = 0.0005$).[7]

Sugihara et al., using a large nationwide data set (>12,000 patients), stated that risk factors for severe adverse events (SAEs) include procedure time (which was proportionally related to the occurrence of SAEs [OR: 1.58 in 90-119 min to 4.28 in ≥ 210 min, compared with ≤ 59 min; each $p < 0.05$])[4] and hospital volume (inverse relationship with the occurrence of severe adverse events in which centers performing ≥ 39 procedures/year had 40% less SAEs than centers carrying out ≤ 15 procedures/year). The authors defined severe adverse events as at least one of the following: in-hospital mortality, postoperative medication related to septic shock or disseminated intravascular coagulation, blood transfusion, or postoperative interventions related to shock management or organ support. Using those variables, the authors constructed a simple nomogram for predicting severe adverse events, with the disadvantage that it is only applicable after the procedure has been performed.

The use of classification tools for ureteroscopy complications has also been reported. Their utility lies in the standardization of procedure complications, both in definition and in severity or grade, which could lead to increasingly homogeneous reporting in the scientific literature and to similar patient information.

In our opinion, the simplest complication classification scheme is the modified Clavien Classification System (MCCS), which has been previously validated for use in ureteroscopy. In the report by Mandal et al. the complication rate was at the higher end of the scale, but the majority of complications (22%) were grade 1-2 (minor).[8] The main advantage of using the MCCS is its simple and intuitive quality. However, given that some ureteroscopy complications are inherent to the endoscopic nature of the procedure, we believe there is a considerable gap in that grading system (i.e., ureteral wall disruptions can be given the same MCCS grade, regardless of the size of the disruption). In addition, some RIRS complications only appear after a considerable length of time, and therefore we feel that the MCCS does not fully address long-term complications (i.e., ureteral strictures).

In an effort to close those MCCS gaps, two other ureteroscopy complication scales have been developed. A multicenter group from Europe created the post-ureteroscopic ureteral lesion scale (PULS).[9] It is based on the endoscopic findings of mucosal lesion (grade 1), submucosal lesion (grade 2), full thickness ureteral wall injury (grades 3 and 4), and complete ureteral

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transection (grade 5). The authors also suggest that injury grade according to the PULS can safely identify patients that are candidates for post-ureteroscopic ureteral stent insertion. A major caveat of the PULS is that it has only been reported on in the original trial, and so further data is warranted.

Traxer et al.[10] designed a classification scheme for evaluating ureteral wall injury due to the use of a ureteral access sheath. In their prospective study, the authors found that although ureteral access sheath-related injury was quite common, occurring in almost half of the patients (46.5%), most of the lesions were classified as low-grade (86.6%), involving only the ureteral mucosa. High-grade lesions compromising the ureteral smooth muscle (grade 2) occurred in just 10.1% of the cases, and grade 3 injury (ureteral perforation) occurred in only 3.3%.

Furthermore, the risk factors for high-grade injury from ureteral access sheath insertion in their population were male sex, older age, and a lack of pre-stenting. This last risk factor conferred a 7-fold higher risk for injury. That study highlights the importance of a thorough top-to-bottom ureteral visual inspection as a standard step during ureteroscopy. It is still unclear whether the use of their classification has any impact on long-term complications.

The Satava classification has been specifically modified by a group in Turkey for use in endoscopic complications.[11] That modified classification system stratifies complications according to the management needed to treat the patient. Its advantage over the original classification is that it does not allow patients with severe endourologic complications to be grouped together with those that have less serious complications, thus preventing skewing of the true complication grade.

The abovementioned classification systems are relatively new and have yet to be widely adopted by the worldwide endourologic community, making further studies an absolute necessity.

Urinary tract infection and sepsis

Infectious complications after ureteroscopy are reported in approximately 1% of the patients, with sepsis occurring in less than 0.4%.[3] Although rare, urinary tract infection and sepsis can have severe consequences, and so most treatment guidelines recommend the use of a short-term prophylactic antibiotic in patients undergoing RIRS.[12-13] In a thought-provoking study, Martov et al., using the Clinical Research Office of the Endourological Society (CROES) URS Global Study database, reported that the worldwide use of prophylactic antibiotics is not completely standardized, with some countries reporting 100% compliance, whereas in others it was only 13%. The risk factors for post-ureteroscopy urinary tract infection in that study were female sex, Crohn's disease (OR: 5.5), or cardiovascular disease (OR: 0.46) and an ASA score of 3 or higher (score of 3 [OR: 9.16] and score of 4 [OR: 15.5]). Surprisingly, urinary tract infection rates were similar and unaffected by antibiotic use,[14] and the overall urinary tract infection rate in the study was 2.2% (ureteral stones 0.6 *vs* 0.4%, renal stones 1.6 *vs* 1.1% in the group receiving antibiotics and the group that did not, respectively). Further randomized trials are required to corroborate that issue, in the face of increasing global antibiotic resistance.

Another important outcome is the development of systemic inflammatory response syndrome (SIRS), a well-defined condition that critically affects patients and is usually related to severe urinary tract infection or urosepsis. Although most often it is self-resolving and transient, it can progress to multiple organ failure, hemodynamic instability, and death. In a retrospective review, a group from China reported that after ureteroscopy, the SIRS rate in their cohort was 8.1%,[15] and significantly correlated with stone size (OR=1.691; 95% CI, 0.879–3.255), small-caliber ureteral access sheath (OR=2.293; 95% CI, 0.730–7.200), irrigation flow rate (OR=1.161; 95% CI, 1.096–1.230) and struvite stones (OR=3.331; 95% CI, 0.971–11.426), providing the clinician with at least two modifiable variables for reducing the risk factors of SIRS: ureteral access sheath size and irrigation rate.

In view of the limitations of the published data, our recommendations for the prevention of infective complications are mostly in line with the consensus opinion of experts. Ideally, patients undergoing ureteroscopy should have a preoperative sterile urinary tract or culture-specific antibiotic treatment. During ureteroscopy, every effort should be made to maintain low intrarenal pressures and avoid prolonged operative times.[12,16] Since severe septic complications usually present early (within the first 6 hours) a short observation period in the clinic or recovery room has been advocated,[17] but that suggestion comes from a very small retrospective case series report conducted at the end of the last century. In patients that do go on to develop signs and symptoms of urosepsis, prompt and early intervention with antibiotics, supportive care, and a multidisciplinary focus can be lifesaving.

Ureteral wall injury

Ureteral wall injury comprises a broad spectrum of lesions. From mucosal abrasion to full thickness tissue insult, superficial abrasions are probably under-reported, but in a large case series of patients, 1.5%[18] developed that type of intraoperative complication. Further injury to the ureteral wall can result in a ureteral mucosal flap or false passage (1%),[17] commonly seen at the site of obstruction that is either anatomic or caused by a stone, in which a guidewire or ureteroscope is forcefully (and usually blindly) advanced against resistance. If there is further force into the ureteral wall, either from endoscopic manipulation or by the lithotripsy device, perforation is the next injury level, with a reported rate of about 0.65 to 1% in ureteroscopy.[3] Balloon dilation of the ureter has also been involved in ureteral perforations, which in earlier case series reached 23%[19] when dilated up to a 24-Fr diameter. Newer case series using 18 Fr as the maximum dilation diameter report lower ureteral perforation rates (1.9%).[20] The most common anatomic site of ureteral perforation is the middle ureter, followed by a nonsignificant difference between the proximal and distal ureter, respectively.[21]

Ureteral Avulsion

The extreme of ureteral wall injury, fortunately its occurrence is very rare and accounts for less than 2% of the lesions in the reported case series. The mechanism of injury is excessive tissue traction force (antegrade or retrograde), which leads to complete circumferential ureteral wall disruption.

Ureteral avulsion was originally described in the past century, the era when blind basketing was the only minimally invasive approach to urinary stone disease.[22] Later on, the large bore ureteroscope (12.5 to 11.5 Fr) was also responsible for this type of lesion. The frequency of avulsion appears to be diminishing over time, from 0.5 to 0%,[21] most likely because of technologic advances and increased surgical experience.

Historically, and due to its intrinsic anatomy, most avulsions occurred in the proximal ureter. Disputing that fact, recent data from a large study showed the middle ureter to be the most common site of ureteral avulsion (0.03%), despite there being no statistically significant difference in relation to anatomic location.[23]

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An even more infrequent lesion is the scabbard type injury. It occurs in both the cranial and caudal locations and thus a variable length of the complete ureter is extruded, as opposed to just the distal part, as in cases of conventional avulsion.[24] Because there is very little or no tissue left to plan for reconstruction, it is the most extreme form of ureteral avulsion. The reported cases have all occurred with modern small-sized (≤ 9.5 Fr) semi-rigid ureteroscopes (SRU), a finding also corroborated by Tepeler et al.[11] They hypothesize that the pathophysiology of said lesion is most likely due to an initial avulsion at the distal ureter or ureterovesical junction (the largest diameter of a SRU increases along the shaft to 12-14 Fr) when advancing the ureteroscope in an antegrade fashion, and a secondary lesion occurs at the proximal ureter when the endoscope is retracted (while the distal ureter is tightly wedged in the shaft of the ureteroscope). Therefore, a ¨fixed¨ or "tractioned" distal ureter is *sine qua non* for that type of lesion, not at all like the classic or proximally fixed ureteral avulsion.

Several technical points are recommended to prevent the occurrence of ureteral lesions. Gentle instrument manipulation and avoidance of lithotrite activation under poor visibility conditions are paramount, and correct instrument selection and availability should also be ensured. Basketing should only be performed for small stones/fragments, being careful to entrap only stone material and not ureteral mucosa. The basket and its contents should be removed under constant visual observation and forceful basket extraction should be avoided.

The restriction of excessive force is essential for preventing avulsion and cannot be overly emphasized, either when introducing an endoscope or when withdrawing urinary stones or devices. Any excessive form of drag, resistance, or tightness involving the movement of the ureteroscope should immediately raise the awareness level of the clinician and prompt action to reduce the instrumentation force, possibly switching to either a smaller bore or a flexible ureteroscope. Although many centers routinely perform middle and proximal semi-rigid ureteroscopy, the unique mechanism of the scabbard injury should be preventable if flexible ureteroscopy is selectively used above the iliac vessels. Also, intramural ureteral dilation may prevent this type of complication by making the distal ureteral lumen wider than the ureteroscope, thus preventing the initial lesion.

If the SRU does become difficult to extract, endoscopic or surgical ureterotomy/meatotomy for endoscope removal should be considered,[24] since the management of ureteral avulsion is extremely complex and carries a high risk of ureteral stricture or nephrectomy.

The treatment of most ureteric lesions can be accomplished through prompt recognition, and depending on the severity of the injury, careful thought should be given to procedure discontinuation. If the lesion involves deep layers or all the ureteral layers, urinary drainage either through a ureteral stent or a nephrostomy tube is mandatory. In cases of ureteral avulsion, formal surgical repair, depending on the length of available ureter, should be performed.

Stone extrusion

Stone extrusion is actually the result of an initial ureteral wall injury. It occurs when the urinary stone or its fragments are accidentally driven through a previous ureteral perforation and finally remain in the periureteral retroperitoneal fat. The reported incidence is between 0.18 and 2.3% of ureteroscopies.[11,18,23]

Prevention of that complication depends on the prevention of ureteral perforations. Thus, exercising good endourologic principles is paramount:

gentle manipulation, good visualization, and adequate use of lithotripsy devices. Any transmural ureteral lesion should increase the physician's awareness of the extrusion. That complication is usually diagnosed intraoperatively upon viewing extruded stones.

Urinary drainage must be ensured during the ureteral wall healing phase (4-6 weeks) and is usually done by placing a ureteral stent. The intraoperative management of the extruded fragments is based on small case series that recommend leaving them *in situ*, in lieu of attempting extraction, given that such efforts usually lead to more tissue trauma and a wider perforation.[18,23] Kriegmare et al., employing the non-removal policy, failed to find any post-ureteroscopy complications in a small case series of extruded stones in 15 patients that were followed for a mean of 22 months.[25] At least 3 other case series[26–28] support such action, providing that there is no stone-related infection. That scenario could become further complicated by the development of a paraureteral abscess.

Stone granuloma

Stone granuloma is an exceedingly rare complication with only a few case reports published since its initial description in 1993 by Dretler et al.[29] It is thought to occur when stone material becomes imbedded in the ureteral wall after lithotripsy or stone manipulation. During ureteral healing, macrophages, lymphocytes, and giant foreign body cells surround the stone fragments and create a granuloma,[30] the hallmark histologic finding. It can result in concomitant ureteral stricture due to the inflammatory reaction and ensuing intense tissue fibrosis. Strictures originating from a stone granuloma are usually resistant to further endourologic management and can only be resolved through formal surgical resection and ureteroplasty. To prevent its occurrence, experts recommend careful stone fragmentation and manipulation. In the case of ureteral wall injury, thorough efforts should be made to remove all stone material from the lesion itself and its vicinity.[29-30]

Bleeding complications

Ureteral bleeding during ureteroscopy is usually more of a hindrance than a true complication. RIRS bleeds are commonly self-contained and secondary to endoscope manipulation and stone destruction. In one report from an eastern European center, bleeding complications were divided into intraoperative bleeding (affecting visibility enough to cause early procedure termination), which was very infrequent (0.1%), and postoperative bleeding or persistent hematuria, occurring in 2.4% of the patients.[18] In a later report with a very large cohort (n = 11,885), intraoperative and postoperative bleeding occurred in 1.4% and 0.4% of the patients, respectively, with only a 0.2% transfusion rate.[3] Prevention strategies to decrease bleeding complications include careful operative technique and lithotripsy, as well as judicious use of irrigation.

Retrograde stone migration

Retrograde stone migration is also more of a nuisance than a true complication, especially in centers in which flexible ureteroscopes are readily available. In the CROES prospective database and other case series, stone migration is shown to be a fairly common occurrence (9.5 to 12.2%),[3,31] and numerous technical modifications (low flow irrigation, lubricating gel plug) and devices have been developed to counter this problem.

Ureteral Stricture

Ureteral stricture is a feared late complication of ureteroscopy and it occurs in 0.3-4.4% of patients according to reports in the literature.[3,21,32] The risk factors for the development of this

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complication are impacted stones and ureteral perforation,[33] favoring the hypothesis of ureteral trauma, ischemia, and subsequent healing.

Careful ureteral handling through gentle scope manipulation and careful energy use are the cornerstones of stricture prevention. Most patients that develop a ureteral stricture present with some amount of flank pain, which is a key finding in early diagnosis, but a significant number of patients have silent or asymptomatic strictures (23%).[34] Due to those findings, Beiko et al. suggest routine imaging follow-up in symptomatic patients (pain or fever), but also in subjects that have risk factors, such as chronic stone impaction, significant ureteric trauma, pre-existing renal functional impairment, or endoscopic evidence of stricture. Other studies show that asymptomatic patients with impacted stones >2 cm and those with a history of complicated ureteroscopy also merit imaging follow-up[32] that should be performed up to at least 18 months post-procedure.

The ureteroscope malfunction of ¨frozen ureteroscope¨

A rare but potentially disastrous reported complication occurs when a flexible ureteroscope intracorporeally loses the mechanical ability to regain its straight shape, either because it maintains an extremely flexed or kinked distal shape or because it creates a wider diameter than that of the ureter. Initially reported by Anderson et al.[35], this complication has sporadically been reported in the medical literature. The mechanical failures described so far have involved the control cables, deflection rings, and insulation coating of the flexible ureteroscope.[35-37] The relevance of that equipment malfunction depends on the degree of flexion of the endoscope. Mild degrees are probably not apparent to the operators or cause no adverse effects, but as the grade increases, it becomes much wider than the ureteral diameter and thus the endoscopist is not able to withdraw the instrument. Forceful removal attempts may risk ureteral avulsion and emergent surgical removal is sometimes necessary.

A recent online survey by Hubosky et al. showed that 3.2% of the respondents (n = 8) have experienced a frozen or locked ureteroscope.[36] Upon further investigation, using a medical device reporting (MDR) database, those same authors stated that from 2000 to 2015 there were 2 more medical device reports related to stuck flexible ureteroscopes, bringing the total number of reported cases to 10, but this condition is most certainly greatly underreported.

Interestingly, to our knowledge, the accordion type mechanism has occurred in at least 3 cases (2 in the Tanimoto et al. report[37] and one in the present authors' unpublished experience) with the concomitant use of a ureteral access sheath. An extremely hypothetical explanation for this type of mechanism is that when flexed, the rubber coating (either through a normal or previously damaged area) becomes trapped at the edge of the opening of the ureteral access sheath and upon forceful retraction, the fixed sheath could lacerate the coating (cheese shredder effect). To more clearly understand the event, further exploration, possibly with an in vitro model, is warranted. Due to the rarity of this complication, there is not a full understanding of the mechanism. However, intrinsic device defects, normal wear-and-tear, faulty reprocessing, and surgical technique (pulling a flexed scope out of a narrow opening) have been implicated.

Multiple strategies have been reported to deal with this condition. The first is a keen situational awareness, given that no endoscope in a highly deflected position should be retracted through a narrow area, thus preventing the condition. If it does present, and the ureteroscope is bent (crochet hook mechanism), manual rectification of the shaft of the ureteroscope (extra stiff guidewire, ureteral access sheath, coaxial dilator), albeit often unsuccessful, should be attempted.[35-36] Attempts to disassemble the endoscope have also been reported (cutting the endoscope handle). If those maneuvers are not successful, or the ureteroscope is unbent but unable to be withdrawn from the kidney (accordion mechanism, usually suspected by a straight, normal looking endoscope on fluoroscopy, because the bunched up rubber coating is radiolucent), then gentle attempts should be made to traction the instrument to remove it, or in the worst case scenario, move it to a less demanding anatomic region of the urinary tract for surgical removal with the greatest of care, given that excessive traction can result in ureteral avulsion. There is a low threshold for formal surgical or antegrade percutaneous removal and at present there is no evidence-based information on the safest course of action for managing that complication.

Unplanned emergency room visit and readmission

Bloom et al. found that after uncomplicated ureteroscopy, 15.6% of their patients returned to the emergency room within 30 days (a mean 5 days post-ureteroscopy), chiefly due to pain (66%). Of the 5.8% that were ultimately readmitted to the hospital, the main causes were fever or pain (43.8%). In the multivariate analysis, high blood pressure (OR: 3.30, p = 0.04), COPD (OR: 5.17, p = 0.004) and a surgical or medical complication (OR: 7.96, p = 0.010) were significant for readmission.[37] Better patient counseling to address post-RIRS pain and ureteral stent symptoms, as well as prophylactic pharmacologic therapy, should be included in a prevention strategy for unplanned emergency room visits. However, in relation to drug treatment for ”stent syndrome“, there are still many shortcomings, and its use is off-label.

Clinicians should be aware that patients with comorbidities, especially cardiopulmonary ones, or intraoperative complications have at least a three-fold higher risk of being readmitted and perhaps should be targeted for prophylactic pre-admission or immediate post-procedure admission.

Conclusions

As the second decade of the twenty-first century approaches its end, retrograde intrarenal surgery holds its position as a leading technique for the management of urinary tract diseases. Both the evolving technology and operator experience behind ureteroscopy have led to a slow but progressive increase in its treatment envelope. We now increasingly tackle larger and more complex stone burdens, and the complication rates, although as yet considerable, are progressively decreasing. Further work is still required in the form of clinical trials and technologic developments to increase our capability to prevent, diagnose, and treat RIRS-related complications.

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