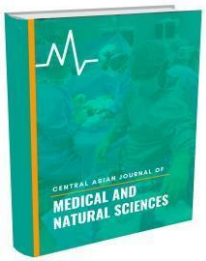

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Article

Ureteroscopy in Unconventional Stone Cases

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Abstract: Ureteroscopy (URS) is increasingly utilized in the management of urinary stone disease across a spectrum of non-standard clinical scenarios. This review synthesizes evidence on URS application in challenging situations including bilateral urolithiasis, single kidney stones, obesity, renal transplant recipients, pregnant women, and pediatric patients. Drawing from a comprehensive literature review, this article evaluates outcomes, complications, and adherence to current guidelines from the European Association of Urology (EAU) and the American Urological Association (AUA). Notably, bilateral URS, although associated with lower stone-free rates and higher reoperation rates compared to unilateral procedures, demonstrates safety and efficacy. URS in single kidney patients exhibits favorable stone-free rates with manageable complications. In obese individuals, URS proves comparable to outcomes in the general population. URS emerges as a viable option for urolithiasis in renal transplant recipients, pregnant women, and children, offering high stone-free rates and acceptable morbidity. The review underscores the importance of obstetric support in pregnant patients and emphasizes the acceptability of URS and extracorporeal shock wave lithotripsy (ESWL) as first-line therapies for pediatric stones. Despite advancements in URS technology facilitating its use in diverse clinical scenarios, further randomized controlled trials are warranted to validate its efficacy across these populations.

Keywords: Urolithiasis, Ureteroscopy, Bilateral Stones, Single Kidney, Obesity, Renal Transplant

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1. Introduction

Urolithiasis or urinary stone disease is one of the most common problems in modern urology. On average, the risk of urolithiasis incidence ranges from 1 to 20% [1]. The incidence of this disease is higher in males and it often manifests at the most active age [2].

Ureteroscopy (URS) and retrograde intrarenal surgery (RIRS) are modern methods of minimally invasive treatment of urolithiasis, which are becoming increasingly widespread. The effectiveness of endoscopic methods of stone removal is not inferior, and for large and complex stones it is superior to extracorporeal shock wave lithotripsy (ESWL). Until now, the subject of numerous discussions is the choice of method for fragmenting large kidney stones. In approximately 15-20% of cases with URS (especially with stones in the upper third of the ureter), stones migrate to the kidney, which subsequently requires ESWL. At the same time, in 18-20% of cases, URS makes it possible to eliminate the "stone chain" formed after ESWL. Thus, ESWL and URS serve as complementary minimally invasive methods for removing ureteral stones, the combination of which allows achieving 98-99% effectiveness [2,3].

At the same time, the use of URS, as one of the least invasive methods of treating urolithiasis, in non-standard clinical situations is of great clinical interest. Clinical scenarios that do not fully fit into the guidelines include cases of urolithiasis with bilateral upper urinary tract stones, the presence of stones in patients with a single kidney, in obese patients, with a transplanted kidney, in pregnant women, as well as urolithiasis in children.

2. Materials and Methods

A literature review was performed in the PubMed, Science Direct and Google Scholar using the keywords: urolithiasis, ureteroscopy, bilateral stones, single kidney, obesity, renal transplant, urolithiasis in pregnancy, urolithiasis in children.

3. Results

1. URS for Bilateral Upper Urinary Tract Stones.

Bilateral urolithiasis is quite common, but clinical guidelines do not endorse planned, one-stage (in one session) bilateral removal of kidney stones, although there is a significant amount of published data regarding bilateral URS. CROES (Clinical Research Office of Endourological Society) global URS study enrolled 2153 patients treated for multiple kidney and/or ureteral stones, of whom 1880 (87.3%) and 273 (12.7%) underwent unilateral and bilateral URS in one session, respectively [4]. Analysis of the results demonstrated lower stone-free rates (SFRs), high reoperation rates, and longer operative times for simultaneous bilateral URS compared to unilateral ones.

In a study by Ingimarsson J.P. et al. (2017) the results of 117 bilateral URS in one session for kidney and/or ureteral stones in 113 patients were analyzed. SFR at 6 weeks was 91%. Ureteral injuries occurred in 2.1% of cases, all of which were eliminated by installing a ureteral stent within 2 weeks. Short-term complications were mild, mostly grades I-II according to the Clavien-Dindo classification (n=15), and the rest were classified as grade III (n=4). At 6 weeks postoperatively, none of the patients showed evidence of ureteral stricture, hydronephrosis, or renal failure. Of note, 11% of patients required emergency hospitalization after surgery, and an additional 12% were admitted to the emergency department within 30 days of the procedure with pain, fever, or other symptoms. Another 19% of patients complained of stent-associated symptoms or renal colic after stent removal. The authors admit that these figures may indicate a higher level of discomfort after simultaneous bilateral URS [5].

There are data from a number of studies on the results of simultaneous bilateral ureteroscopy [6-10]. According to their results, SFR after one session varied between 52-90%. One long-term follow-up study showed that 4.5% of patients developed ureteral strictures within 6-12 months after surgery [11].

Despite the demonstrated safety and effectiveness of bilateral URS, many urologists are reluctant to perform bilateral URS. Rivera M.E. et al. (2018) surveyed 153 members of the Endourological Society regarding their preferences in the treatment of bilateral urolithiasis. The majority of specialists preferred to perform simultaneous bilateral URS (48%) rather than bilateral percutaneous nephrolithotripsy (PCNL) (38%) [12,13].

2. URS for Urolithiasis in Patients with a Single Kidney.

In a systematic review by Pietropaolo A. et al. (2018) had been united 696 patients who underwent URS for a single kidney stones' (stone size varied from

10 to 27 mm), the SFR rate was 72%. Complications occurred in 16.4% of patients, with serious complications (grade III or higher according to the Clavien-Dindo classification) occurring in only 2% and including ureteral perforation (n=6) and ureteral rupture (n=4) [14]. The American Urological Association (AUA) Guidelines state that one of the criteria for not performing ureteral stenting after URS is a normal functioning contralateral kidney [15].

3. URS for Urolithiasis in Obese Patients.

In the modern world, the problem of obesity is becoming of great significance. The connection between obesity and urolithiasis has been proven, which, accordingly, leads to an increase in the number of interventions for urolithiasis in obese patients [16]. In a systematic review by Ishii H. et al. (2016), which included 835 patients with an average body mass index (BMI) of 40.5 kg/m2 and an average stone diameter of 14.2 mm. The overall SFR was 82.5% and the complication rate was 9.2%, which is comparable to results obtained with URS in the general population [17]. Although the complication rate in morbidly obese patients in this review was 17.6%, all complications were relatively mild in severity and classified as Clavien-Dindo grade II. Krambeck A. et al. [18] analyzed data from the CROES study, including more than 10,000 patients after URS with documented BMI. 17.4% of patients were overweight and 2.2% had morbid obesity. Patients with higher BMI had higher reoperation rate (16.8%). SFR was 87%. Intraoperative complications occurred in 5.1% of patients and there was no association with BMI.

In a systematic review and meta-analysis by Wang W. et al. (2022) on efficiency and safety of URS in obese and morbidly obese patients 13 studies were analyzed. 4,583 normal-weight patients, 2,465 obese patients, and 291 morbidly obese patients were included in the study. It was obtained that URS performed in obese patients and morbidly obese patients demonstrates the same efficacy and safety as well as in normal-weight patients group [19].

AUA experts have recognized the influence of obesity on the success of ESWL and the need to consider endoscopic treatment methods when ESWL success is unlikely [20]. Therefore, URS should be considered as first-line therapy in obese patients with stones that cannot be treated by ESWL and in cases where stone size does not preclude URS.

4. URS for Urolithiasis of a Transplanted Kidney

Transplanted kidney stones can impair the function of the organ and cause serious complications if urodynamics are impaired. Small transplanted kidney stones can be crushed using prone ESWL, while URS by antegrade or retrograde assess and PCNL are also possible options.

A small study by Hyams E. et al. [21], assessed the results of URS with retrograde (n=7) or antegrade (n=5) access. With an average stone size of 8 mm, all patients were stone free, with the exception of one patient who had a residual fragment of 2 mm in size, which eventually passed spontaneously. Although data on the use of URS in kidney transplant patients are limited and technical difficulties exist, attempting to use URS to remove kidney stones from a transplanted kidney seems reasonable. To provide maneuverability of the flexible ureteroscope and to protect the ureter it is recommended to use the ureteral sheath.

5. URS for Urolithiasis During Pregnancy.

Stone formation incidence during pregnancy is known to be between 1:188 and 1:4600 and is the most common cause of hospitalization in pregnant women for non-obstetric reasons [22,23,24]. There is evidence of a similar incidence of stone formation in pregnant and non-pregnant women, however, stones during pregnancy can be a difficult and emergent situation.

For urolithiasis in pregnancy, in cases where conservative treatment was ineffective, ureteral stenting or percutaneous nephrostomy was performed with sequential replacement of drainages during pregnancy. Despite this, URS is known as applicable method of urolithiasis management in pregnant, with a number of studies demonstrating a high SFR and perioperative morbidity similar to those in non-pregnant females [25-27]. European and American guidelines notice that in clinical situations where watchful waiting alone is not sufficient, URS is an acceptable alternative to long-term stenting or percutaneous nephrostomy in pregnant women [3,15]. Therefore, the recommendation for the use of URS in the management of medium-sized (less than 15 mm) ureteral stones requires appropriate obstetric support and endourological intervention in such situations should be performed by an experienced endourologist. In the presence of large or complex stones URS should be postponed for the period after childbirth [13].

6. URS for Urolithiasis in Children.

Recent years scientific data indicate an increasing prevalence of urinary stone disease in pediatric urology and the need for surgical interventions in this regard [28,29]. ESWL is a fairly successful method for the management of stones in children, because in most cases there is no need for ureteral stenting, and stone fragments in children pass away more easily. SFR after ESWL in children ranges from 57-92% [3]. There are specific EAU and AUA recommendations for the management of stones in pediatric urology, due to the higher SFR values after ESWL in children. A meta-analysis by Assimos D. et al. (2016) showed that SFRs after URS for ureteral stones ≤10 mm and >10 mm was 95% and 78%, respectively [20]. Given the comparable SFRs for URS and ESWL, either treatment modality is acceptable for ureteral stones in children. It should be noted that the AUA does not routinely recommend pre-stenting before URS due to the success of the ureteroscopic approach in most cases.

As with the adult guidelines, the AUA considers both URS and ESWL to be acceptable first-line treatment options for kidney stones ≤20 mm in children. For kidney stones larger than 20 mm URS is not offered [3,20]. The EAU endorses ESWL as first-line therapy for all stones <20 mm and in clinical situations when ESWL not expected to succeed or fails URS is considered a good alternative [4]. European and American guidelines do not use stone location as a deciding factor for optimal management of kidney stones.

4. Discussion

Bilateral kidney and/or ureteral stones that fall under established URS guidelines can be removed ureteroscopically during a single anesthesia session, no guidelines have been established for duration of the procedure or number of stones for bilateral procedures in a single session. Additional information should be provided to patients about the fact that bilateral interventions and/or ureteral stenting may lead to greater discomfort and a higher probability of hospitalizations and emergency conditions. It is important to note that without

further recommendations, management of bilateral kidney and/or ureteral stones should be performed on the basis of a surgeon's decision [13].

Patients with a single kidney and, accordingly, single ureter, have the same indications for URS as patients with two kidneys. In patients with a single kidney ureteral stenting after URS is a highly recommended procedure [15].

In obese patients URS is an attractive treatment option because it requires very little changes to the standard procedure or the need for specialized instrumentation, as it is necessary for PCNL. As for ESWL, it cannot always be recommended for such patients due to the large distance from the skin to the stone, which reduces the effectiveness of ESWL. The EAU guidelines suggest the use of URS as first-line therapy in patients with severe obesity [3].

Results of retrograde URS in patients with a transplanted kidney depends on the degree of tortuosity of the ureter and the location of the ureteral opening. Manipulations to the ureters implanted in the bladder might be difficult and require a variety of guidewires, catheters and sheaths. EAU experts note that all treatment options, including flexible URS, PCNL and ESWL, are possible, but recognize that ESWL may be accompanied by a low SFR due to the complex localization of the stone [3].

In urolithiasis during pregnancy ESWL is contraindicated and PCNL is generally avoided because of the X-ray exposure. Only URS is a definitive stone removal procedure that can be offered during pregnancy [3,15]. It must be emphasized that most cases on the use of URS in pregnancy are performed by experienced endourologists from large academic centers.

In pediatric urology the treatment of stones that cannot be disintegrated by ESWL makes URS an attractive option due to the miniaturization of ureteroscopes and no need for prior ureteral stenting.

Conclusions. Thus, miniaturization and technical improvement of equipment for URS makes this procedure one of the methods of choice in the treatment of urolithiasis in non-standard clinical situations. However, more randomized clinical trials are needed in this direction.

5. Conclusion

In conclusion, this comprehensive review underscores the expanding role of ureteroscopy (URS) in managing urinary stone disease across various challenging clinical contexts. The evidence presented highlights the safety and efficacy of URS in addressing conditions such as bilateral urolithiasis, single kidney stones, obesity-related stone disease, urolithiasis in renal transplant recipients, pregnant women, and pediatric patients. Despite the observed lower stone-free rates and higher reoperation rates associated with bilateral URS, its demonstrated safety profile suggests its viability as a treatment option. Moreover, URS in single kidney patients and obese individuals yields favorable outcomes comparable to those in the general population, emphasizing its versatility and effectiveness. Importantly, the review emphasizes the need for obstetric support in pregnant patients undergoing URS and underscores the acceptability of URS and extracorporeal shock wave lithotripsy (ESWL) as primary treatments for pediatric stones. However, further randomized controlled trials are warranted to validate the efficacy of URS across these populations and to explore potential refinements in technique and technology. Overall, the findings suggest that the miniaturization and technical advancements in URS equipment position it as a preferred method for managing urolithiasis in non-standard clinical situations, paving the way for continued research and innovation in this field.

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