Where Is It Logical to Break-Up A Ureter Stone with Endoscopic Surgery?

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Abstract

Aims: Today, we have technology to break up a ureter stone in ureter as well as in renal pelvis during ureterorenoscopic procedures. In the past, when this option was not available, the surgeons improved several techniques and antiretropulsion devices in order not to let the stone migrate through renal pelvis. However, we still do not know whether it is advantageous to dust a stone in ureter where it is impacted or in a wider area such as renal pelvis. This study was carried out to clarify whether it is advantageous to breaking an upper ureter stone up where it is enclaved or in a wider area such as renal pelvis. Study Design: The data of 134 patients who underwent semirigid ureterorenoscopy (srURS) due to single and primary upper ureteral stones were included in our study and analyzed retrospectively. The patients were divided into two groups according to the development of spontaneous push-up during surgery (Group 1: non-push-up group, Group 2: push-up group). Results: Laboratory findings were changed significantly in both groups before and after surgery. However, this change was not significant between the groups. Operation times were statistically similar in both groups in contrast with the literature. Stone-free rates were significantly higher in srURS than in flexible ureterorenoscopy (fURS) ($p<0,05$). Complication rates were also found similar in this study. Conclusion: The application of srURS after fixing an upper ureter stone at its location using a Stone Cone® results in higher stone-free rates than pushing it back in order to dust it in renal pelvis. We recommend srURS supported by an antiretropulsion method as a treatment for upper ureteral stones.

Introduction

Urinary stones are a group of diseases that occupy the agenda of the medical world with both their frequency and high recurrence rates.[1] Over the last 60 years, great strides have been made in urinary stone treatment, and in the previous two decades, endoscopic surgeries have taken the lead in treatment.[2,3]

Ureterorenoscopy (URS) and flexible ureterorenoscopy (fURS) are commonly used surgical methods in ureter stone treatment. Although it is not possible to cure kidney stones with URS, since the introduction of fURS, even kidney stones can be treated endoscopically when accessed through the urethral meatus.[2] One of the most important advantages of fURS in ureter stone treatment is that stone push-up that could cause the termination of URS in the past does so no longer. Nowadays, if a stone is pushed up, surgeons can stop performing URS and begin using fURS to treat stones in the kidney, allowing surgeries to be completed successfully.[4,5]

Different techniques and devices have been used to mitigate the push-up problem.[6,7] However, it is not clear if these methods are truly necessary with today's technology. To go a step further and dust the stone after pushing it into the kidney instead of dusting it in a narrow area in the ureter might be more advantageous.

In this study, our aim is to compare the clinical parameters of semirigid URS (srURS) in the upper ureter with fURS for upper ureteral stones which are pushed-up during srURS perioperatively.

Materials and Methods

Between January 2018 and October 2020, the data of 134 patients who underwent srURS due to single and primary upper ureteral stones that could not be passed naturally were included in our study and analyzed retrospectively. The retrospective study design was chosen because it would be unethical for surgeons to intentionally cause stone migration during surgery. The necessary permissions were obtained from the local ethics committee (protocol number: 2017-KAEK-189_2020.11.11_02) for the use and analysis of this data. The patients were divided into two groups according to the development of push-up during surgery. Group 1 comprised 73 patients without stone push-up, and our standard srURS procedure was applied to this group. Group 2 contained the remaining 61 patients, who underwent fURS due to spontaneous stone push-up. Surgeries were performed by four surgeons experienced in endourological procedures. Preoperative complete blood count, routine biochemical analysis (glucose, creatinine, electrolytes), complete urinalysis, and urine culture were obtained from all patients. Patients with signs of infection and pyuria were operated on after receiving appropriate oral therapy and obtaining a sterile urinalysis result. Patients with persistent urinary infections were not included in the study. Furthermore, the data of patients with irreversible hydroureteronephrosis for any reason, stones reported to be enclaved during surgery, a history of nephrocalcinosis, a history of a urinary anomaly, a history of nephrectomy, a history of chronic renal failure, and a JJ stent in the preoperative period were not included in the evaluation.

Surgical Procedures

Before srURS, cystourethroscopy was performed on patients. A Stone Cone® was placed in the ipsilateral ureter under fluoroscopy during cystoscopy. Ureteral access was made with a 9.5F semi-rigid ureterorenoscope (Karl Storz, Tuttlingen, Germany) under the guidance of a guidewire. After the stone was reached by the ureterorenoscope, it was dusted with a 272 µm holmium: YAG laser (Ho YAG Laser; Dornier MedTech; Munich, Germany / Dornier Med-Tech GmbH, Medilas H20 and HSolvo, Wessling, Germany) at a frequency of 8-12 Hz and energy level of 0.8-1.5 W. No stone was extracted at the end of the procedure. The procedure was completed by placing a JJ stent in the ureter. At the end of the procedure, a 16F Foley catheter was placed in the patient's urethra. The time from entrance into the urethral meatus to the end of JJ stent placement was recorded as the surgical time.

fURS was performed on patients who developed stone push-up during ureteral access or Stone Cone® placement for upper ureteral stones. Our standard srURS procedure was carried out for dilatation. Then, a ureteral accessory sheath (UAS) (Elite Flex, Ankara, Turkey) was placed over the guidewire into the ureter. Following this, the stones were reached by advancing the flexible ureteroscope (Flex-X2, Karl Storz, Tuttlingen, Germany / Karl Storz, Flex X2, GmbH, Tuttlingen, Germany). The stones were dusted with a 272 µm laser. No stone fragment was extracted. A JJ stent was placed in the ureter. At the end of the procedure, a 16F Foley catheter was placed in the patient's urethra. When srURS was used but was not effective, it was not included in the surgery time. The time from the entrance to the urethral meatus to the end of JJ stent placement after starting to fURS was recorded as the surgical time.

Patient Follow-Up

On the first postoperative day, patients received direct urinary system radiography to check for the presence of opaque stones and ultrasonography to check for the presence of non-opaque stones. All patients underwent non-contrast computed tomography in the first month postoperatively. JJ stents were removed three weeks postoperatively in all patients. The procedure was considered successful for patients with a residual stone fragment of 2 mm or less. Follow-up or medical expulsive therapy was applied to patients with residual stone fragments larger than 2mm. A summary of Clavien-Dindo classification for complications is given in Table 2.[8]

Statistical Analysis

All statistical analyses were performed with the IBM®SPSS® Statistics version 25 data analysis program (IBM Corp. Released 2017. IBM® SPSS®Statistics version 25.0. Armonk, NY: IBM Corp). The distributions were determined according to the skewness and kurtosis values. Normally distributed data were given as mean ± standard deviation, while median (minimum-maximum) values were given when no normal distribution was observed. Student t-tests and Mann-Whitney U tests were used for numerical data to compare the two groups. A chi-squared test was used for categorical data. The significance level for the p-value was 0.05.

Results

The demographic and clinical data of the cases are summarized in Table 1. We observed no statistically significant difference between patients in both groups in terms of age, body mass index (BMI), laboratory data, presence of hydronephrosis, stone size, stone density, operation time, and complication rates ($p > 0.05$).

The hemoglobin (Hb) and creatinine (Cre) levels of the patients before and after surgery were compared separately, and a significant change was observed (Table 1). While the median value in group 1 was 14.50 g / dL before surgery, it was observed to be 13.05 g / dL postoperatively. In group 2, the mean value of 14.30 g / dL decreased to 13.30 g / dL postoperatively. In group 1, the mean creatinine value was 0.94 mg / dL preoperatively and 0.87 mg / dL afterwards. The creatinine change in Group 2 was 0.89 mg / dL preoperatively versus 0.83 mg / dL postoperatively. The grade 3 and higher hydronephrosis record of the patients were below 7% in both groups.

Complication rates were similar in both groups ($p > 0.05$) (Table 1). After the operation, 1 patient from group 1 and 3 patients from group 2 developed renal colic. The patient in group 1 was steinstrasse. Additional interventions were performed in these 4 patients in the second session (stage 3). Urosepsis developed secondary to ureteral perforation in one patient from group 1 (stage 4). The patient recovered following appropriate parenteral antibiotherapy and intensive care support. Urinary infection developed in one patient in group 2 (stage 2) which improved following oral antibiotherapy given in accordance with urine culture. One patient had a fever of >38.5°C, which recurred with antipyretic therapy. Macroscopic hematuria was observed in one patient. He improved with bed rest and standard hydration practices. (Table 2)

Discussion

The development of stone push-up during URS was a significant problem that resulted in the termination of urinary stone surgeries in the past. Sun Y et al. reported this rate as 10% for all ureteral stones, while Knispel et al. reported it as 40% for upper ureteral stones.[9,10] To address this problem, various manipulations and antiretropulsion devices or techniques have been developed. In an experimental study, Patel et al. showed that the inclination of the patient on the operating table can preclude the development of push-ups during ureteroscopy.[11] Zehri et al. reported that gel instillation to the proximal part of the stone increased stone-free rates.[12] Dretler demonstrated that a ureteral balloon advanced over a guidewire to the proximal part of the stone is useful in averting push-up.[13] A year later, Dretler reported the successful results of a device called a Stone Cone®.[14] Wang et al. reported that an N-trap occlusion device is effective in preventing stone migration.[15] Heat-sensitive polymers, Lithovac, Lithocatch, Parachute and PercSys devices have also been developed and put into use.[16–18] As can be seen here, stone push-up directly affecting stone-free rates and unsuccessful surgery was a situation that occupied the agenda of urology in the past. However, with the introduction of laser lithotripsy and fURS, today stone push-up is no longer such an impediment to successful surgical completion. Even if a ureter stone migrates retrograde to the kidney during URS, the surgeon can continue the surgery by altering the surgical instrument and successfully complete the operation.

It is known that intrarenal pressure increases during both URS and fURS. It has been shown that the use of UAS during fURS significantly reduces intrarenal pressure.[19,20] This can be considered an advantage of fURS over URS. However, whether this creates a clinical result in terms of renal functions is a matter of some controversy. In a study conducted on patients who underwent fURS, Yang et al. did not detect a significant increase in creatinine on the first postoperative day and in the 1st month postoperatively in stones smaller than 3 cm, while they reported that there was a significant increase in creatinine on the first postoperative day in stones larger than 3 cm and that this regressed in the first postoperative month.[21] Based on this, a temporary deterioration of renal function can be expected, especially in cases where surgery time is prolonged. Öztekin et al. reported that they did not detect a significant creatinine change either preoperatively or postoperatively between the two groups who underwent fURS and URS.[22] In this study, although our operative times were not long in both groups, we did not observe a significant difference between pre-and postoperative creatinine levels.

Considering the larger number of manipulations of fURS, operation time is expected to be longer in fURS than srURS. In a study where they compared fURS with srURS in the treatment of upper ureteral stones, Kartal et al. reported that operation times where fURS was performed were significantly longer.[4] Similar findings were also reported by Karadag et al.[23] Although Özkaya et al. reported that the use of UAS in patients who underwent fURS shortened the operation time compared to those who did not use UAS, Galal's study comparing fURS with URS showed that operation times where srURS was carried out were significantly shorter.[5,24] In our study, although the average length of operations using srURS were shorter than those using fURS, these differences were not statistically significant.

It is evident that the development of push-up in ureter stones during surgery will make a significant difference between fURS and srURS in terms of stone-free rates and surgery success. Researchers have developed antiretropulsion devices to prevent stone push-up.[18,25] In addition, methods such as putting patients in the Trendelenburg position or applying gel to the proximal part of the stone have been employed to increase stone-free rates.[6,12,26] As the surgical technology and technique of fURS improves, it seems likely that push-up cases that develop during srURS will be able to be treated more easily, and there will no longer be a need for antiretropulsion techniques or devices. However, there are scarcely any studies in the literature comparing the stone-free rates of srURS with antiretropulsion and fURS. In their study, in which they did not use an antiretropulsion device, Karadag et al. reported that stone-free rates were superior when fURS was used compared to srURS both directly after surgery and in the following months.[23]Similarly, Kartal et al. reported a significant stone-free rate in fURS procedures compared to srURS without antiretropulsion.[4] Galal et al. found fURS superior in terms of stone-free rates as a result of their studies comparing rigid URS and fURS, which they performed without using an antiretropulsion device.[5] However, they added the comment that if they had used a Stone Cone® or N-Trap basket, a higher rate would probably have been achieved using rigid URS. In our study, stone-free rates were significantly higher when srURS was performed compared to fURS. This may be because we used a Stone Cone® as a standard part of the srURS procedure. In addition, leaving the stone fragments and dust particles in the natural flow path of urine may have given this result.

During URS, the surgeon works in a narrow space and may cause iatrogenic damage to the fragile tissue of the ureter, especially in impacted stones. Furthermore, complication rates are lower when fURS is used.[5,27] Özkaya et al. reported that complications such as fever, infection, and unsuccessful surgery are less common when using UAS in fURS.[24] Therefore, fURS seems to be a more advantageous method. However, not all the data in the literature supports this point of view. Kartal et al. reported that they could not find a significant difference in intraoperative complication rates between fURS and srURS in upper ureteral stones.[4]Karadag et al. also reported that there was no difference in intraoperative complications.[23] Finally, Galal et al. reported no significant difference between both intraoperative and postoperative complications.[5] In our study, no statistically significant difference regarding complication rates was found between the two groups.

In light of all this information, it seems that preferring fURS over srURS in an upper ureteral stone will not make a difference in terms of renal functions; indeed, the possibility of using UAS during fURS may even provide other benefits.[24] Although the shorter operation time of srURS in the literature suggests that dusting such stones at the location of impaction in the ureter will give faster results, no significant difference was shown in terms of operation times in this study. While it has been reported in the literature that srURS without using antiretropulsion will obtain a lower score than fURS in terms of stone-free rates, we have shown in this study that srURS using antiretropulsion can be superior to fURS in terms of stone-free rates. Moreover, there is no significant difference between these two surgical options regarding complication rates in upper ureteral stones.

The limitations of our study include a retrospective design, a small sample size, and a short follow-up period. Prospective studies should be conducted with larger patient groups. The advantage of our study is that there are few studies comparing URS or srURS with fURS in upper ureteral stones. In addition, it is a unique study in the literature comparing stone dusting after stone push-up with stone dusting performed in the ureter.

Conclusion

While choosing between fURS or srURS in patients with an upper ureteral stone, the idea of pushing a stone that can easily be treated with srURS to the kidney and, instead, treating it with fURS is not supported by the findings of this study. The application of srURS after fixing an upper ureter stone at its location using a Stone Cone(r)results in higher stone-free rates. For these stones, fURS and srURS give similar results in terms of laboratory values, complication rates and operation time. As a result, we recommend srURS supported by an antiretropulsion method as a treatment for upper ureteral stones.

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Table Legends

Table 1. Demographic and clinical parameters of two groups

Table 2. The numerical distributions of complications between the groups due to Clavian-Dindo classification.

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