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ORIGINAL PAPER

Fragmentation without extraction in ureteral stones: outcomes of 238 cases

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Abstract We aimed to evaluate the success rates, auxiliary procedures and complications after ureteroscopic lithotripsy (URS) during which the fragments left in situ for spontaneous passage after complete disintegration into a acceptable (<4 mm) size. 238 patients with ureteral stones were treated with URS between 2005 and 2011, and disintegrated fragments (<4 mm) were left in situ for spontaneous passage. Patients were followed with radiography for 3 months and evaluated with respect to the success rates (stone-free), auxiliary procedures, complication rates and additional analgesic requirement. The median age was 42.2 ± 13.7 years, and overall stone size was 8.79 ± 2.94 mm. Significantly lower rate of stone-free status was achieved in proximal stones ($p < 0.05$). A second URS was necessary in 5% ($n = 12$) of the patients. Double-J catheter placement during initial URS did not cause any change in the rate of secondary URS ($p = 0.620$). Additional oral or intramuscular analgesia was required in 41% ($n = 97$) and 25% ($n = 59$) of the patients, respectively, after discharge. The overall stone-free rate was 95% and mean time to complete clearance was 5 days. Severe colic pain within 24 h was noted in 21 (9%), and transient hydro-ureteronephrosis in 31 (13%) patients, as minor complications. Leaving the fragments (<4 mm) in place for spontaneous passage following a successful disintegration in URS could be a reasonable approach with acceptable and comparable stone-free rates, and this approach appears to give chance of shortening the duration of operation and also avoiding from the potential morbidity of repeated manipulations during the both further disintegration and extraction.

Keywords Ureteroscopy · Ureterolithiasis · Spontaneous passage · Lithotripsy

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Introduction

Despite the successful and efficient management of kidney stones with SWL, atleast a considerable percent of the ureteral calculi still require an alternative and more direct approach due to the limitations of this method. Among these, by causing high re-treatment rates, stone-related factors such as stone volume, location and composition are the most important ones which directly affect the preference of the surgeon as well as the final outcome of the treatment [1–3]. On the other hand again, a certain subset of patients with relatively hard stones and/or severe ureteral obstruction often require a rapid relief of obstruction to avoid possible irreversible renal morphological as well as functional alterations [3–9].

Taking the above-mentioned shortcomings of SWL into account, endoscopic treatment of ureteral stones has become more common in the last 10–15 years with its increasing practical, tolerable and successful nature in skilled hands. Ureteroscopy in combination with certain auxiliary procedures has become the standard procedure in the minimally invasive management of such stones [3, 10–14]. Increased surgical experience along with newly introduced technical equipments such as new intracorporeal lithotripters (YAG laser, pneumatic, electrohydraulic and ultrasonic lithotripters) has led this modality to be

successfully applied in not only the lower, but also mid and upper ureteral stones [15–19].

Concerning the management of stones located in different parts of the ureter for a complete stone-free status, relief of all stone fragments present is the ultimate aim following the successful disintegration of main stone body. However, accumulated experiences so far have clearly shown that removal of all fragments may not be possible and/or necessary in some cases due to some certain factors. Among these factors, the most logical and accepted one is leaving the fully disintegrated particles in situ for spontaneous passage aiming not to increase operational (as well as anesthesia related) time [20–24]. Additionally, by way of decreasing the number of accesses made into the involved ureter (which is high likely to increase the risk of possible trauma), limitation of some major complications which may occur during long-lasting procedures mostly performed for upper ureteral calculi will be possible [23, 24].

In this study, we aimed to evaluate the success rates (in terms of stone-free rates), auxiliary procedures and complications noted after ureteroscopic lithotripsy (URS) during which the stones were completely fragmented into acceptable size (<4 mm) and left for spontaneous passage.

Materials and methods

A total of 238 patients (164 males, 74 females; M/F: 2.2) with ureteral stones that have been treated with semirigid ureteroscopy in combination with pneumatic or laser lithotripsy between May 2005 and January 2011, of whom disintegrated fragments left in situ for spontaneous passage, were included in the study. While the stones were located in the lower ureteral portion in 133 (56%) patients, the remaining 105 cases stones (44%) were located either in mid (69 patients, 29%) and upper ureter (36 patients, 15%). Urine analysis and culture sensitivity tests, biochemical parameters presenting renal functional status (serum calcium, phosphorus, alkaline phosphatase, creatinine, uric acid, electrolyte levels together with pH, pCO2 values) have been assessed. In our study, there was no patient with congenital urinary abnormalities, extraurinary pathologies causing obstruction, solitary functioning renoureteral unit, non-opaque stones, stones impacted to the ureteral lumen, history of previous ureteral surgery and, lastly, patients in whom balloon dilation of the ureteral orifice had been required.

Ureteroscopic lithotripsy and pneumatic and holmium YAG laser lithotripsy were performed using 8Fr semirigid ureteroscopy (Storz® endoscopy systems) under general anesthesia. No patient in this study required ureteral orifice dilation as mentioned above. Following the complete disintegration of the stone into acceptable size (<4 mm), these fragments were left in situ for spontaneous passage.

A plain abdominal radiography (KUB) and sonography were performed after 24 h to evaluate the stone-free status as well as the status of upper urinary tract. Additionally, KUB and urinary system sonography were repeated after a week, 1 and 3 months postoperatively to evaluate the stone-free status of the patients along with the improvement in renal dilation if present before the procedure. Treatment was considered successful when the plain abdominal film (and other radiographic examinations like spiral CT, sonography if necessary) showed no signs of stone fragments or only insignificant residual fragments <3 mm. In case of any suspect, all sonographic and KUB findings were further verified by unenhanced urinary system computerized tomography. Stone expulsion period till stone-free status has been well noted in each patient.

Patients were well followed and evaluated with respect to the success rates (in terms of stone-free rates and retained fragments), auxiliary procedures applied (DJ stent insertion, re-URS), complication rates observed and lastly additional analgesic requirement as well as emergent re-admission rates. Size and localization of the stones in cases requiring either perioperative Double-J placement or secondary ureteroscopy were compared with the cases requiring no additional procedure. Additionally, the possible impact of the energy type used during the first session of URS on necessity of secondary ureteroscopy has also been evaluated.

Statistical significance of the data was tested using One way ANOVA, Kruskal–Wallis and Chi-Square tests.

Results

Age of the patients ranged from 8 to 76 years with a median value of 42.2 ± 13.7 years. The overall stone size again ranged from 6 to 14 mm with a median value of 8.79 ± 2.94 mm. Demographic features of the cases and the characteristics of stones with respect to the localization are shown in Table 1.

Table 1 Patient and stone characteristics with respect to stone location

Localization	*n*	Age (mean, years)	Male/female (*n*)	Stone diameter (mean, mm)
Upper ureter	36	41.1	28/8	8.88
Mid ureter	69	43.4	45/24	9.00
Lower ureter	133	41.8	91/42	8.69
Overall	238	42.2	164/74	8.79

Table 2 Evaluation of the success rates and second URS procedures with respect to stone size and location in both groups

Localization	Stone-free		Second URS		Overall	
	n	Stone diameter (mm)	*n*	Stone diameter (mm)	*n*	Stone diameter (mm)
Upper ureter	32 (89%)	8.92 ± 2.68	4 (11%)	9.00	36	8.88 ± 2.50
Mid ureter	63 (91.5%)	8.73 ± 2.48	6 (8.5%)	11.66	69	9.0 ± 3.09
Lower ureter	131 (98.5%)	8.62 ± 2.55	2 (1.5%)	12.50	133	8.69 ± 2.92
Total	226 (95%)	8.69 ± 2.84	12 (5%)	10.92 ± 3.04	238	8.79 ± 2.94

The success rates of the procedure along with secondary ureteroscopy rates in different parts of ureter are shown in Table 2. Significantly lower rate of stone-free status was found in proximally located stones when compared with the stones located in other parts ($p = 0.036$ for mid ureter, $p = 0.001$ for lower ureter). On the other hand, however, success rates were also lower in middle ureteral stones when compared with the lower ureteral ones ($p = 0.010$).

A second ureteroscopy procedure was necessary in 5% ($n = 12$) of the patients. The reasons for second ureteroscopic stone extraction were the fragments causing obstruction ($n = 5$), and severe persistent colic pain ($n = 7$). The mean diameter of largest residual fragment was noted to be 5.2 mm (4–6 mm) during the second ureteroscopy session. Evaluation of the initial stone size between these cases and completely stone-free patients at one session did clearly show that the mean stone size was larger in cases requiring a second URS session. (10.92 ± 3.04 mm vs. 8.69 ± 2.84 mm) ($p = 0.004$) (Table 2).

Double-J catheter placement during initial URS did not cause any change in the rate of secondary URS ($p = 0.620$). While the mean stone diameter and the rate of second ureteroscopy were 10.4 mm and 5.5% in 62 patients undergoing Double-J catheter insertion during the first endoscopy, these values were 8.7 mm and 4.8% in 176 patients who required no catheter insertion respectively (Table 3).

Fifty-nine percent ($n = 141$) of the patients became completely "stone-free" without any additional dose of diclofenac sodium, however, 41% ($n = 97$) of the patients needed additional oral analgesic agents at home. Intramuscular diclofenac injection was required in 25% ($n = 59$) of the patients when they were referred to the emergency department after discharge. Summary of auxiliary and additional interventions is shown in Table 3.

For intracorporeal lithotripsy, either pneumatic or holmium laser lithotripsy was used during semi-rigid ureteroscopy (206 [87%] vs. 32 [13%] patients, respectively). Evaluation of the stone size for both modalities did not show any significant difference (mean size of 8.68 ± 2.88 mm vs. 9.68 ± 2.91 mm, respectively) ($p = 0.069$). There was again no difference with respect to secondary URS between cases treated with pneumatic and laser lithotripsy ($p = 0.498$).

The overall stone-free rate was 95%, mean time to complete clearance of stones was 5 (1–19) days, and time to the second ureteroscopy, if performed, was 26 (20–34) days. Lastly, concerning the complications, there was no major complication in any case operated in this manner in our group. However, as minor complications, severe colic pain within 24 h was noted in 21 (9%), and transient hydroureteronephrosis in 31 (13%).

Discussion

Concerning the minimally invasive management of ureteral calculi, SWL can be considered to be a highly efficacious, non-invasive, anesthesia-independent method for the majority of the cases. However, one should note that ureteral SWL often achieves good results only at the expense of repeated treatments and with the use of secondary procedures [1–4, 8]. Moreover, fragment expulsion is often accompanied by colic and bothering urinary symptoms, sometimes lasting several days. Again, the success rate is

Table 3 Patient distribution according to stone localization, auxiliary procedures applied, and additional analgesic requirement

Localization of the stone	*n*	Additional analgesics (oral)	Emergent re-admission (parenteral analgesic)	DJ catheter insertion	Secondary URS
Upper ureter	36	23 (60%)	16 (44%)	9 (25%)	4 (11%)
Mid ureter	69	32 (46%)	24 (35%)	11 (16%)	6 (8.5%)
Lower ureter	133	42 (32%)	19 (14%)	7 (5%)	2 (1.5%)
Overall	238	97 (41%)	59 (25%)	27 (11%)	12 (5%)

affected by several factors, such as stone size and location, machine type, operator's experience, secondary procedures applied and in particular re-treatment rates [25–27]. The American Urological Association Ureteral Stones Clinical Guideline Panel found that after in situ SWL monotherapy, median stone-free rates for stones <1 cm in diameter were 85 and 87% in the distal and proximal ureter, respectively. The median stone-free rate for all stones larger than 1 cm was 76% [3].

Clinical introduction of ureteroscopy has significantly changed the treatment concepts for ureteral stones. With the use of thinner instruments, urologists can approach proximal ureteral calculi in a quicker and more cost-effective manner than SWL [14–18, 25]. Adequate and immediate decompression of the obstruction is another major advantage of this approach. Regarding the success rates for ureteroscopy, the American Urological Association report found stone-free rates of 56% for stones smaller than 1 cm and 44% for stones larger than 1 cm in the proximal ureter, compared to 89 and 73% in the distal ureter [3]. Concerning the complications encountered, traditionally, ureteroscopic techniques have been associated with higher rates than SWL (9 to 11% vs. 4%) [2]. However, advances in ureteroscopic technology with the introduction of small caliber, semirigid and flexible ureteroscopes combined with the introduction of holmium YAG laser have improved stone-free rates while decreasing the risk of complications in skilled hands. Today, the incidence of ureteral trauma is lower than previously reported (up to 15% of all the ureteroscopic procedures) [3, 15].

Management of stones located in different parts of the ureter aims a successful disintegration and removal of all stone fragments present for a complete stone-free status. However, accumulated experiences so far have clearly shown that removal of all fragments may not be possible and/or necessary in some cases due to some certain factors. Among these factors, the most logical and accepted one is leaving clinically insignificant particles in situ for spontaneous passage aiming not to increase operational (as well as anesthesia related) time. Additionally, by way of decreasing the number of accesses made into the involved ureter (which is high likely to increase the risk of possible trauma), limitation of some major complications which may occur during long-lasting procedures mostly performed for upper ureteral calculi will be possible. Published data have clearly demonstrated that procedures may last longer and the incidence of complications increases in the ureteroscopic management of larger stones, impacted stones and stones located for a long period of time in the ureter [20–24, 27, 28]. Increased number of accesses into the involved ureter where edema and bleeding from the stone impacted wall of the ureter makes the procedure more complex and increases the likelihood of certain major complications among which mucosal tear, ureteral rupture and subsequent strictures are the most important ones [23, 24, 29, 30]. Moreover, it is clear that repeated accesses themselves will also increase the likelihood of ureteral wall edema formation and bleeding during the procedure which may in turn increase the propensity of ureter to major complications.

In our present study, we performed semirigid URS (using pneumatic or holmium YAG laser lithotripter) for ureteric stones and left disintegrated fragments which were small enough to pass spontaneously (<4 mm) in situ for spontaneous passage. We aimed to evaluate the success rates (in terms of stone-free rates), auxiliary procedures, repeat interventions and complication rates of semirigid ureteroscopy performed in this manner. Evaluation of our data did clearly show that when the surgeon disintegrates the calculi effectively to a size that may pass the ureter easily in a spontaneous manner, majority of the cases may become stone-free without facing any major complication. Although a significant percentage of the cases did require additional analgesic use during the passage of these disintegrated fragments, no major complication could be encountered either during or immediately after ureteroscopic stone management in our group. The ultimate stone-free rates in our patients were comparable with the overall success rates reported in the literature [12, 19, 29].

Although the main aim of all ureteroscopic stone disintegration procedures is trying to make all cases completely stone-free at one session, it is well known that this approach requires repeated ureteral accesses, as well as increased use of intracorporeal lithotripsy and/or basket catheter in the majority of the cases. This approach may again certainly lengthen the duration of the endoscopic procedure (as well as the duration of anesthesia) and increase the likelihood of certain complications. On the other hand, however, during relatively shorter operational interventions, significantly lower rates of additional as well as repeat procedures have been observed in our patients where the smaller fragments (<4 mm) were left in situ for spontaneous passage. Our results did also show that, while success rate for lower ureteral stones was 98.5%, these values were 91.5 and 89%, respectively, for mid as well as upper ureteral calculi. Taking the stone-free rates in our group after 3 months into account, it was clear that insisting on the removal of all fragmented calculi at the expense of repeated accesses and longer interventional duration along with higher auxiliary and complication rates may not be necessary and/or logical at least in cases with ureteral calculi that are high likely to pass spontaneously following successful disintegration.

Concerning the limitations of the current study, we may say that it would have been better if the study design had been made as a prospective randomized controlled one

comparing all evaluated data between the cases in which a complete stone-free status have been attempted during the first session by removing all existing calculi and our cases.

Conclusions

As a minimal invasive surgery option, semirigid ureterorenoscopic disintegration of ureteral calculi aims to eliminate the whole stone burden in a single step procedure without leaving any stone fragment inside the ureter and/or renal collecting system. However, it is clear that aiming to make the patients completely stone-free requires repeated accesses, use of additional procedures during relatively longer interventions. Although the need for secondary URS directly relates to the location as well as the size of the stone in the ureter, our results clearly demonstrate that following a successful disintegration of the stones located in different parts of the ureter, if the ureteral lumen shows no anatomical abnormality for the passage of these fragments, the technique of leaving the fragments (sizing <4 mm) in place for spontaneous passage without performing additional maneuvers trying to relieve all fragments could be a reasonable approach with acceptable and comparable stone-free rates. This approach appears to give a chance of shortening the duration of operation and also avoiding from the potential morbidity of repeated manipulations during both the further disintegration and extraction of these fragments.

Conflict of interest The authors declare that they have no conflict of interest.

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