Arab Journal of Urology

ISSN: (Print) 2090-598X (Online) Journal homepage: https://www.tandfonline.com/loi/taju20

Semi-rigid ureteroscopy for ureteric and renal pelvic calculi: Predictive factors for complications and success

Khaled Mursi, Mohammed S. Elsheemy, Hany A. Morsi, Abdel-Karim Ali Ghaleb & Omar M. Abdel-Razzak

To cite this article: Khaled Mursi, Mohammed S. Elsheemy, Hany A. Morsi, Abdel-Karim Ali Ghaleb & Omar M. Abdel-Razzak (2013) Semi-rigid ureteroscopy for ureteric and renal pelvic calculi: Predictive factors for complications and success, Arab Journal of Urology, 11:2, 136-141, DOI: 10.1016/j.aju.2013.04.008

To link to this article: https://doi.org/10.1016/j.aju.2013.04.008

Published online: 05 Apr 2019.

Arab Journal of Urology (2013) **11**, 136–141

Arab Journal of Urology
(Official Journal of the Arab Association of Urology)

www.sciencedirect.com

STONES/ENDOUROLOGY

ORIGINAL ARTICLE

Semi-rigid ureteroscopy for ureteric and renal pelvic calculi: Predictive factors for complications and success ☆

Khaled Mursi, Mohammed S. Elsheemy *, Hany A. Morsi, Abdel-Karim Ali Ghaleb, Omar M. Abdel-Razzak

Department of Urology, Kasr Al-Ainy Hospitals, Cairo University, Cairo, Egypt

Received 1 March 2013, Received in revised form 19 April 2013, Accepted 23 April 2013
Available online 2 June 2013

KEYWORDS

Laser;
Lithotripsy;
Pneumatic;
Ureteroscopy;
Urinary tract stones

ABBREVIATIONS

(s)URS, (semi-rigid) ureteroscopy;
LL, laser lithotripsy;
PL, pneumatic lithotripsy;
C&S, culture and sensitivity;
US, ultrasonography;

Abstract ***Objective:*** To analyse and compare the effect of stone site and size, method of lithotripsy, and level of experience on the results and complications of semi-rigid ureteroscopy for ureteric and renal pelvic stones.

Patients and methods: Between April 2010 and May 2011, 90 patients underwent 95 ureteroscopies, using 7.5- and 9-F semi-rigid ureteroscopes, with or without pneumatic or laser lithotripsy. The peri-operative findings were analysed and compared.

Results: The mean (SD) longest diameter of the stones was 11.8 (4.5) mm. Laser lithotripsy was used in 32 cases and pneumatic lithotripsy in 26. There were complications in 35 procedures in the form of colicky pain (2%), haematuria (1%), stone migration (7%), equipment failure (5%), access failure (8%), mucosal injury (7%), fever (2%) and extravasation (3%).The calculi were successfully retrieved in 75 patients (83%). The success rate was 95%, 77%, 85%, and 53% in the lower, middle, upper ureter and renal pelvis, respectively.

Conclusions: Upper ureteric stones can be managed safely with the semi-rigid ureteroscope. Renal pelvic stones are associated with a lower success rate, and thus they were not a primary indication for ureteroscopic intervention. The secondary ureteroscopic management of renal pelvic stones improved the results of subsequent alka-

☆ This journal is partially supported by Karl Storz GmbH. That support had no influence on the peer-review of this paper, which was entirely independent of Karl Storz.

* Corresponding author. Tel.: +20 1006117755.
E-mail address: mohammedshemy@yahoo.com (M.S. Elsheemy).

Peer review under responsibility of Arab Association of Urology.

ELSEVIER Production and hosting by Elsevier

http://dx.doi.org/10.1016/j.aju.2013.04.008

PCN, percutaneous nephrostomy

linisation or shock-wave lithotripsy if they could not be eradicated completely. The failure rate was significantly small in lower ureteric stones and stones of <10 mm. Less experience, a stone size of >15 mm and patients $\leqslant 2$ years old were associated with more complications or a lower success rate. There was no significant difference in the success or complication rate between laser and pneumatic lithotripsy.

Introduction

Urolithiasis is a health problem of worldwide importance. The urological treatment of urinary calculi has changed considerably in the past 20 years. Various endourological treatments are available for urinary calculi. Despite the liberal use of ESWL, ureteroscopic lithotripsy is still the preferred treatment for managing ureteric stones at many hospitals, and achieves an immediate stone-free state in a high percentage of patients. Technological advances and more sophisticated equipment have led to greater success rates and a low morbidity in the ureteroscopic treatment of upper urinary tract stones.

Although flexible ureteroscopy (URS) is associated with improved access to the proximal ureter and superior stone-free rates, there are many reports advocating that semi-rigid URS (sURS) is a safe and successful treatment even for proximal ureteric stones [1–3]. We prospectively analysed and compared the effect of stone site and size, method of lithotripsy, method of stone extraction, level of experience, and age of the patients, on the results and complications of sURS for ureteric and renal pelvic stones.

Patients and methods

Between April 2010 and May 2011, a total of 90 patients with ureteric and renal pelvic stones were managed using sURS at Cairo University hospitals. The indications for sURS were ureteric and renal pelvic stones resistant to medical treatment, of >10 mm or associated with persistent pain, obstruction or infection. The preliminary release of urinary obstruction was via a percutaneous nephrostomy (PCN) or ureteric stenting in patients presenting with uraemia, or a clinically significant infection with obstruction. Alternatively, the stones were managed by sURS in the same session. Renal pelvic stones were not the primary cause of endoscopic intervention, and were managed secondarily during the treatment of patients with multiple stones (ureteric and pelvic), or with obstruction, to relieve pain or anuria/uraemia. These pelvic stones were basically scheduled for subsequent ESWL or alkalinisation, but primary intervention with URS under these circumstances and with precautions can lead to the complete eradication of pelvic stones or at least decreases in size for subsequent alkalinisation or ESWL. Stones associated with urinary tract anomalies or a non-functioning kidney, or patients with severe orthopaedic deformities were excluded.

Preoperative evaluation

All patients had a clinical evaluation, urine analysis with additional urine culture and sensitivity (C&S) if there was a UTI, a measurement of serum creatinine level, abdominal ultrasonography (US) and a plain abdominal X-ray. Additional IVU or CT was used, according to the level of serum creatinine and stone radiolucency. Patients with infected urine were treated preoperatively using the appropriate antibiotics according to urinary C&S. Critically ill patients, who had signs of overload, had elevated serum potassium levels, changes in the electrocardiogram, and/or a blood pH of <7.1 that was resistant to medical treatment, were treated initially by dialysis.

Operative technique

sURS was administered with the patients under spinal or general anaesthesia (all children had general anaesthesia), using 7.5- and 9-F semi-rigid ureteroscopes (Karl Storz, Germany) with or without lithotripsy (pneumatic, 'Calcusplit', Karl Storz) or laser (SphinX 30 W, holmium-YAG laser, LISA Laser Products–OHG, Germany). Ureteric stents were inserted at the end of the procedure for 1–2 days, unless there were complications, impacted stones, a solitary kidney or uraemic patients, where internal stents (JJ) were placed for 4–6 weeks. Analgesics (NSAIDs) were given when needed. Uraemic patients were discharged after stabilisation of their laboratory and clinical variables.

Follow-up

All patients were evaluated with plain radiography and abdominal US at 24 h after sURS. Success was defined as no evidence of residual stones of >2 mm in diameter. US was also used at 3 months after surgery, and patients were evaluated with CT at 6 months. Complications were classified according to modified Clavien classification system [4]. Patient age, stone size and site, operative time, use of pneumatic or laser lithotripsy, level of experience and success and complication rates were compared.

The numerical variables were compared between two groups using the unpaired Student's *t*-test for parametric data or the Mann–Whitney Rank Sum test for nonparametric data. Numerical variables were compared between three or more groups using a one-way anova for parametric data or the Kruskal–Wallis one-way anova on ranks test for nonparametric data. Categorical variables were compared using the Chi-square test or Fisher's exact test for small sample sizes. A *Z*-test (at a CI of 95%) was used for comparing single proportions. Statistical significance was indicated at $P < 0.05$.

Results

In all, 90 patients were treated for a total of 111 stones with a mean (SD, range) age of 39.9 (17.73, 1.5–70) years, and comprising 63 (70%) males and 27 (30%) females. The main presenting symptom was loin pain (Table 1). Fifty-five patients (61%) had no history of previous stone intervention while 35 (39%) had undergone previously surgery.

A UTI was detected in three patients and treated according to C&S. The mean (SD, median, range) serum creatinine level was 2.18 (0.34, 1.0, 0.5–17.0) mg/dL. It was higher than normal in 17 patients, with a mean (SD) of 6.6 (5.1) mg/dL.

Combined US and a plain abdominal film were assessed in all patients, CT in 34 (38%), and IVU in 51 (57%). The stones were multiple in nine patients (10%) and single in 81 (90%). Five patients had bilateral calculi. The stones were radio-opaque in 79 cases (88%) and radiolucent in 11 (12%). The radiological size of the stone was determined by measuring the longest diameter of the stone. In patients with multiple stones we summed the length of these stones. The mean (SD, median) longest diameter of the stones was 11.8 (4.5, 10) mm.

Operative data

Initial urinary diversion was used in six patients, as an internal stent (JJ) in four or PCN fixation in two. Dialysis was needed in another six patients. Laser lithotripsy (LL) was used in 32 patients (33%) and pneumatic lithotripsy (PL) in 26 (27%). The stones were extracted using forceps or a Dormia basket in 56 patients. Stones were extracted intact in 18 patients, while fragments remaining after lithotripsy were extracted in 38. Ureteric catheters were fixed in 44 patients (46%) for a median duration of 1 day. The stent was delayed by > 2 days in three patients waiting for a second session of sURS. A JJ stent was needed in 45 patients (47%) for a period of 4–6 weeks.

The mean (SD, median) operative duration was 73.9 (27.8, 60) min, and was 89 min for patients treated by LL, which was significantly longer than for PL (77 tmin) ($P < 0.001$). The mean (range) hospital stay after sURS in uraemic patients was 7 (2–10) days. The creatinine level in these patients stabilised at 1.2–3.5 mg/dL. In the remaining patients the mean hospital stay after sURS was 2 days.

Complications

There were complications in 35 procedures (37%; Table 2). There was no ureteric avulsion, bleeding or haematuria requiring blood transfusion, or septic complications. Complications were analysed in relation to the different locations and sizes of stones, the age of the patients, the level of surgeons' experience, whether lithotripsy was used or not and the type of lithotripsy used (LL or PL) (Table 3). Extravasation and equipment failure rates were significantly higher in patient with stones of 15.1–20 mm ($P < 0.05$) or in those with renal stones. The mucosal injury rate was significantly higher with a low level of surgeon experience ($P = 0.02$). The rate of access failure was significantly higher in patients aged ⩽2 years and in those with renal stones ($P < 0.05$). The prevalence of different complications showed no statistically significant difference in relation to side, gender or type of lithotripsy ($P > 0.05$).

Success and failure

The calculi were successfully retrieved in 75 patients (83%) using 79 sURS procedures (83%). Three patients

Table 1 Presenting symptoms.

Presentation	*n* (%) of patients
Loin pain	78 (87)
Haematuria	8 (9)
Irritative symptoms	20 (22)
Fever	1 (1)
Obstructive symptoms	1 (1)
Anuria	11 (12)
Uraemic signs	1 (1)

Table 2 Complications.

Grade*, complication	*n* (%) of procedures
I	
Transient haematuria	1 (1)
Post operative pain	2 (2.1)
II	
Fever	2 (2.1)
IIIb	
Mucosal injury	7 (7.3)
Extravasation	3 (3.2)
Access failure	8 (8.4)
Equipment failure	5 (5.3)
Stone migration	7 (7.4)
Total	35 (36.8)

* According to modified Clavien classification system [4].

Table 3 An analysis of the complications, as n or (n%) of the subtotal, and the failure rate, related to the factors assessed.

Category	*N* (%) cases	Migration	Equipment failure	Access failure	Extravasation	Mucosal injury	Failure rate	
							n or *n* (%)	*P*
Total	95	7	5	8	3	7	16	
Age (years)								
⩽2	5 (5)	0	0	3*	1	0	3	0.013*
2–12	6 (6)	1	0	1	0	1	2	
>12	84 (88)	6 (7)	5 (6)	4 (5)	2 (2)	6 (7)	11 (13)	
Type of lithotripsy								
LL	32 (34)	2 (6)	2 (6)	0	2 (6)	3 (9)	2 (6)	1.000
PL	26 (27)	1 (4)	1 (4)	0	1 (4)	2 (8)	1 (4)	
Surgeon experience (years)								
<2	14 (15)	1	1	1	0	3*	2	0.125
2–5	58 (61)	5 (9)	2 (3)	2 (3)	1 (2)	1 (2)	8 (14)	
>5	23 (24)	1 (4)	2 (9)	5 (22)*	2 (9)	3 (13)	6 (27)	
Stone size (mm)								
6–10	56 (59)	2 (4)	1 (2)	3 (5)	0	3 (5)	5 (9)	0.003*
10.1–15	27 (28)	3 (11)	1 (4)	4 (15)	0	4 (15)	7 (26)	
15.1–20	9 (10)	2	3*	1	3*	0	4	
21–30	3 (3)	0	0	0	0	0	0	
Stone site								
Renal pelvis	15 (16)	2	3*	4*	3*	1	7	0.020
Upper ureter	20 (21)	2 (10)	0	1 (5)	0	0	3 (15)	
Middle ureter	13 (14)	2	0	1	0	2	3	
Lower ureter	47 (49)	1 (2)	2 (4)	2 (4)	0	4 (9)	3 (6)	

* Statistically significant, $P < 0.05$.

were cured at the second session, so the overall success rate was 86.6% (78 patients). The failure rate was significantly higher in children aged ⩽2 years, in stones of 15.1–20 mm, and in renal stones, while it was significantly lower in lower ureteric stones and stones of <10 mm (Table 3). There was no statistically significant difference in the failure rate in relation to the type of lithotripsy or level of experience.

The stone migrated in seven cases (7%), and ureteric stents were fixed in these patients, followed by ESWL in four and alkalinisation in three with radiolucent stones. There was an equipment failure in five procedures (5%) in the form of broken forceps, lithoclast malfunction or a damaged laser fibre. There was access failure in eight procedures (8%), with failure to pass the guidewire in three (3%) and failure of dilatation in five (5%). It was not possible to dilate the ureteric orifice in three children. Five patients with access failure were converted into percutaneous nephrolithotripsy, ureterovesical implantation, open pyelolithotomy, open ureterolithotomy and JJ insertion for ESWL, while three were cured after a second session of sURS.

Discussion

The indications for ureteroscopic lithotripsy have increased with the availability of smaller semi-rigid and flexible ureteroscopes, and reliable laser technology. Methods of ureteroscopic lithotripsy include ultrasound, electrohydraulic, PL and LL. Each device has its advantages and limitations.

We prospectively analysed different factors that might affect the success and complications of managing ureteric and renal pelvic stones with sURS. We found that a lower level of surgeon experience, stones of >15 mm, patients aged ⩽2 years, and renal pelvic stones were associated with increased complication or failure rates. There was no significant difference in the failure rate in relation to the type of lithotripsy. This result is similar to that found in other studies, where proximal ureteric stones, inexperience, stone impaction and stone width were the significant factors for unfavourable results [5].

The overall success rate in the present study was 86.6%. The success rate was 95%, 77%, 85% and 53% for the lower, middle, upper ureter and renal pelvis, respectively. Hong and Park [6] reported a 6.5% failure rate, and this increased to 19.7% for upper ureteric stones. El-Nahas et al. [5] reported an 87% stone-free rate (791 procedures) after one ureteroscopic intervention. In the study by Sofer et al. [7], with a stone size of 11.3 mm and using LL, the success rate was 97% in the proximal ureter, 100% in the mid-ureter and 98% in the distal ureter. In the study by Tunc et al. [8] the overall success rate was 85.2% (60% in the upper ureter, 79.5% in the middle ureter, and 94.6% in the lower ureter) in 156 patients, using sURS with PL, for a mean stone size of 12.87 mm. Gunlusoy et al. [9] reported a

stone-free rate of 96.2% in a study of 1296 patients. The success rate was 90.5% in the upper ureter, 93.1% in the middle ureter, and 98.1% in the lower ureter. These results are better than those in the present study, which might be due to larger stones in the present study, and as more patients had undergone previous ureteric surgery.

Preminger et al. [10] reported that although the AUA recommendations favour flexible URS for treating upper ureteric stones of >1 cm, and ESWL for stones of <1 cm, there is emerging evidence that upper ureteric stones can also be dealt with safely using sURS. This agrees with the present study. El Ganainy et al. [2] reported that many similar studies promote the use of sURS for treating upper ureteric calculi, including large and impacted stones. The success rate is lower for renal pelvic stones than for ureteric stones when treated with sURS, and is associated with more complications. Thus, renal pelvic stones were not the primary indication for sURS in the present study, as noted above, and our protocol gave a satisfactory result under these circumstances and precautions.

In the present study there was a significantly higher failure rate for stones of >15 mm. A lower success rate with increasing size of stones was reported in previous studies [6,9].

There was no significant difference in the failure rate in relation to the type of lithotripsy in the present study. This was also reported by others [11,12]. Tipu et al. [13] have reported a significantly higher success rate with LL than with PL. Leijte et al. [14] reported a study on 105 patients with URS and LL, and the success rate was significantly higher for experienced surgeons (92.9%) than surgeons with less experience (50%). The total success rate in that study was 84.8%. Furthermore, there were significantly more complications with less experience. In the present study there was no significant difference in the success rate in relation to experience, which might be because the more complicated cases were undertaken by the more experienced surgeons. El-Ashry et al. [15] studied 4512 patients treated with rigid and sURS for distal ureteric stones, and showed that the increase in the surgeon's experience was significantly associated with a lower rate of intraoperative complications, from 9.4% to 3.1%, and an increase in the stone-free rate from 82% to 98%. Krambeck et al. [16] noted that the surgeon's experience might not be an important predictive factor. Schuster et al. [17] analysed data from five surgeons and noted that decreased surgeon experience was significantly associated with an increased rate of immediate postoperative complications. In the present study, the mucosal injury rate was significantly higher with less experienced surgeons.

In the present prospective study the complication rate after sURS was 37%, and all complications were grades I–III. There were mucosal complications in 7%, postoperative pain in 2%, haematuria in 1% and fever in 2% in the present study, which are similar to results from other studies [18]. There was no statistically significant difference in the rate of complications according to the type of lithotripsy in our study, as also reported by Binbay et al. [3] in a study of 288 patients. However, the rate of complications was significantly higher with PL in other studies [12,13]. In the present study there was stone migration in two patients (6%) using LL and in one (4%) using PL. Garg et al. [19] reported stone migration in four of 25 cases using PL and none with LL. Jeon et al. [12] reported stone migration in five of 26 cases (19%) using PL and in one of 25 case (4%) using LL. In another study, there was stone migration in four of 40 cases (10%) using PL and in one of 40 using LL (2.5%) [3].

Thus we had seven cases (7%) of stone migration, five (5%) of equipment failure and eight (8%) of access failure. Geavlete et al. [18] reported 4.4% stone migration, 1.4% equipment failure and 3.7% failure of access. Manohar et al. [20] reported 24% stone migration, and El Ganainy et al. [2] reported a 9% retropulsion rate.

The actual incidence of equipment malfunction is probably underestimated because of under-reporting. Abdel-Razzak and Bagley [21] reported two terminated procedures among 290 ureteroscopies because of equipment malfunction, necessitating a repeat procedure a few weeks later. Schuster et al. [17] had six (1.9%) equipment-related complications in a series of 322 procedures. Sofer et al. [7] reported laser fibre breakage in three cases in a study of 598 patients.

The limitations of the present study include relatively few patients, especially in the younger subgroups, the presence of more than one urologist in each category of experience, no stone analysis, the presence of many patients (39%) with previous surgery that might affect the results, and the lack of long follow-up after sURS for possible ureteric stricture or vesico-ureteric reflux formation.

In conclusion, although flexible URS is recommended for treating upper ureteric stones of >1 cm and ESWL for stones of <1 cm, we found that upper ureteric stones can also be managed safely with sURS. The success rate was lower for renal pelvic stones, and thus they were not the primary indication for ureteroscopic intervention. The failure rate was significantly lower for lower ureteric stones and stones of <10 mm. Less experienced surgeons, a stone size of >15 mm and patients aged $\leqslant 2$ years were associated with more complications or a lower success rate. There was no significant difference in the success or complication rates between LL and PL.

Conflict of interest/funding

None.

References

[1] Khairy-Salem H, el-Ghoneimy M, el-Atrebi M. Semirigid ureteroscopy in management of large proximal ureteral calculi: is there still a role in developing countries? *Urology* 2011;**77**:1064–8.

[2] El Ganainy E, Hameed DA, Elgammal M, Abd-Elsayed AA, Shalaby M. Experience with impacted upper ureteral stones; should we abandon using semirigid ureteroscopes and pneumatic lithoclast? *Int Arch Med* 2009;**2**:13.

[3] Binbay M, Tepeler A, Singh A, Akman T, Tekinaslan E, Sarilar O, et al. Evaluation of pneumatic versus holmium: YAG laser lithotripsy for impacted ureteral stones. *Int Urol Nephrol* 2011;**43**:989–95.

[4] Dindo D, Demartines N, Clavien PA. Classification of surgical complications: a new proposal with evaluation in a cohort of 6336 patients and results of a survey. *Ann Surg* 2004;**240**:205–13.

[5] El-Nahas AR, El-Tabey NA, Eraky I, Shoma AM, El-Hefnawy AM, El-Assmy AM, et al. Semirigid ureteroscopy for ureteral stones. a multivariate analysis of unfavorable results. *J Urol* 2009;**181**:1158–62.

[6] Hong YK, Park DS. Ureteroscopic lithotripsy using Swiss Lithoclast for treatment of ureteral calculi: 12-years experience. *J Korean Med Sci* 2009;**24**:690–4.

[7] Sofer M, Watterson JD, Wollin TA, Nott L, Razvi H, Denstedt JD. Holmium:YAG laser lithotripsy for upper urinary tract calculi in 598 patients. *J Urol* 2002;**167**:31–4.

[8] Tunc L, Kupeli B, Senocak C, Alkibay T, Sözen S, Karaoglan U, et al. Pneumatic lithotripsy for large ureteral stones: is it the first line treatment? *Int Urol Nephrol* 2007;**39**:759–64.

[9] Gunlusoy B, Degirmenci T, Arslan M, Kozacioglu Z, Nergiz N, Minareci S, et al. Ureteroscopic pneumatic lithotripsy. is the location of the stone important in decision making? Analysis of 1296 patients. *J Endourol* 2008;**22**:291–4.

[10] Preminger GM, Tiselius HG, Assimos DG, Alken P, Buck C, Gallucci M, et al. EAU/AUA Nephrolithiasis Guideline Panel 2007 guideline for the management of ureteral calculi. *J Urol* 2007;**178**:2418–34.

[11] Nutahara K, Kato M, Miyata A, Murata A, Okegawa T, Miura I, et al. Comparative study of pulsed dye laser and pneumatic lithotripters for transurethral ureterolithotripsy. *Int J Urol* 2000;**7**:172–5.

[12] Jeon SS, Hyun JH, Lee KS. A comparison of holmium: YAG laser with Lithoclast lithotripsy in ureteral calculi fragmentation. *Int J Urol* 2005;**12**:544–7.

[13] Tipu SA, Malik HA, Mohhayuddin N, Sultan G, Hussain M, Hashmi A, et al. Treatment of ureteric calculi-use of Holmium: YAG laser lithotripsy versus pneumatic lithoclast. *J Pak Med Assoc* 2007;**57**:440–3.

[14] Leijte JA, Oddens JR, Lock TM. Holmium laser lithotripsy for ureteral calculi. predictive factors for complications and success. *J Endourol* 2008;**22**:257–60.

[15] El-Ashry OM, Elgamasy AK, Sabaa MA, Abo-Elenien M, Omar HH, Eltatawy HH, et al. Ureteroscopic management of lower ureteric calculi: a 15-year single-centre experience. *BJU Int* 2008;**102**:1010–7.

[16] Krambeck AE, Murat FJ, Gettman MT, Chow GK, Patterson JW, Segura JW. The evolution of ureteroscopy: a modern single-institution series. *Mayo Clin Proc* 2006;**81**:468–73.

[17] Schuster TG, Hollenbeck BK, Faerber GJ, Wolf JS Jr. Complications of ureteroscopy: analysis of predictive factors. *J Urol* 2001;**166**:538–40.

[18] Geavlete P, Georgescu D, Nita G, Mirciulescu V, Cauni V. Complications of 2735 retrograde semirigid ureteroscopy procedures: a single-center experience. *J Endourol* 2006;**20**:179–85.

[19] Garg S, Mandal AK, Singh SK, Naveen A, Ravimohan M, Aggarwal M, et al. Ureteroscopic laser lithotripsy versus ballistic lithotripsy for treatment of ureteric stones: a prospective comparative study. *Urol Int* 2009;**82**:341–5.

[20] Manohar T, Ganpule A, Desai M. Comparative evaluation of Swiss Lithoclast 2 and holmium:YAG laser lithotripsy for impacted upper-ureteral stones. *J Endourol* 2008;**22**:443–6.

[21] Abdel-Razzak OM, Bagley DH. Clinical experience with flexible ureteropyeloscopy. *J Urol* 1992;**148**:1788–92.