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ORIGINAL PAPER

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Ureteroscopic treatment of ureteral lithiasis with pneumatic lithotripsy: analysis of 287 procedures in a public hospital

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Abstract Ureteroscopes and different lithotripsy methods have greatly improved the urologist's ability to treat ureteral stones, regardless of their location in the ureter. We retrospectively reviewed our experience with ureteroscopic pneumatic lithotriptor in 287 patients with ureteral calculi. Ureteroscopic stone treatment was performed between October 1999 and May 2004. Of 221 patients with distal ureteral calculi, 209 (group 1), and 58 of 66 patients with upper ureteral calculi (group 2) were treated successfully by ureteroscopy alone. In group 1, seven migrated stones (to the upper urinary tract) were successfully treated by ESWL later. There were five-treatment failures due to ureteral perforation which consequently required open ureterolithotomy. In group 2, there were five patients with migrated stones; two of them were sent to a percutaneous nephrolithotomy center because of previously unsuccessful ESWL attempts. Three of these with migrated stones were treated by ESWL later. In three patients, we switched to open ureterolithotomy because of ureteral rupture that required surgical repair. Ureteroscopic pneumatic lithotripsy is a safe and effective treatment modality for ureteral calculi.

Keywords Uretroscopy · Pneumatic lithotripsy · Lithiasis

Introduction

Ureteroscopy (URS) has gained widespread use for the diagnosis and treatment of supravesical urinary tract diseases. The main indications for diagnostic ureterorenoscopy are those rare lesions of the ureter or renal pelvis whose nature cannot be determined with less invasive diagnostic procedures [1]. URS is performed for the fragmentation and extraction of stones, incision of ureteral or ureteropelvic strictures, ablation or resection of ureteral malignancies, removal of foreign bodies in the urinary tract and, most frequently, for the treatment of ureteral calculi [2]. URS is a more invasive treatment option than ESWL, but the success rate of ESWL is lower, especially for distal ureteral stones (50–81%) [3–6].

Advances in ureteroscopic lithotripsy have been achieved via innovations such as miniaturization of the ureteroscope, and developments in ureteroscopic techniques and of lithotripters suitable for miniaturized endoscopes [7]. URS is the most advocated treatment for patients with ureteral calculi with stone-free rates greater than 90% after a single treatment [8]. Current intracorporeal lithotripsy technology provides the urologist with several effective options depending on the endoscopic device (rigid or flexible) used, such as electrohydraulic (EHL), laser, pneumatic or ultrasonic lithotripsy. We use pneumatic lithotripsy, as this is currently the only available modality for lithotripsy in our hospital.

In our study, we retrospectively evaluated the safety and effectiveness of URS for the treatment of ureteral stones in a general public hospital setting.

Materials and methods

A total of 287 patients, treated for ureteral calculus at the Osmaniye Public Hospital from October 1999 to May 2004, were retrospectively evaluated. These patients were divided into two groups of which group 1 consisted of patients with stones located below the pelvic brim (lower urinary tract) and group 2 of patients with stones located above the pelvic brim (upper urinary tract) (Table 1). Preoperative routine biochemical analysis, blood count, urinalysis and urine culture were

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Table 1 Patient characteristics

Patient Data			
	Group 1	Group 2	*P*
Number of patients	221	66	NS
Male	124	27	NS
Female	97	39	NS
Age	37.2 ± 11	38.0 ± 14.7	NS
Stone diameter (mm)	8.7 ± 2.2	9.6 ± 2.1	NS
Previous failure of ESWL	132 (59%)	28 (42.4%)	NS

performed for each patient. Patients with urinary tract infections were first treated, and after treatment urinary cultures were repeated. To determine stone location and size, intravenous urography was used and the stone diameter measured on plain film.

Transuretral ureteroscopic stone disintegration was performed by pneumatic lithotripters (Elmed-Turkey) and rigid URS (9 F Storz-Germany) under general anesthesia.

Ureteral dilatation was not carried out, however, ureteral catheters were inserted through the working channel of the ureteroscope into the ureter as a guide, and the ureteroscope was then rotated 180° and introduced in an upside-down orientation. In this position, the ureteral catheter spread the roof of the intramural ureter like a tent and the nose of the instrument slid straight over the trigone into the orifice [2]. After the procedure, 135 of these patients required ureteral stents (double-J or ureter catheter), while 152 did not require any stents. There were no formal criteria for stent omission. Postoperatively, all patients were evaluated in terms of pain, fever and gross hematuria. Antibiotics were postoperatively administered.

All patients were evaluated for the presence of stones on the first day, the first week and the first month, postoperatively. In case of any residual stones detected within 24 h postoperatively, oral hydration and exercise therapy were recommended. Plain film was repeated at the end of the first week. For any residual stone detected on plain film, the second session of URS was performed after 1 month. Stone analysis could not be performed due to the technical insufficiencies of the laboratory and the lack of health insurance of many patients. Two months after the last intervention, intravenous urography was performed on all patients.

Data are shown as mean ± standard deviation. The Student's *t*-test and the χ^2-test were used for the statistical analysis. $P < 0.05$ was accepted as significant.

Results

The pretreatment patient characteristics are included in Table 1. In our series, 287 consecutive patients (151 males, 136 females) with ureter stones were treated ureteroscopically.

Group 1 included 221 patients (mean age 37.2 ± 11 years; 124 males, 97 females) with stones located below the pelvic brim (lower urinary tract). Of these, 132 of the patients (59%) had had unsuccessful ESWL. The mean stone size of this group was 8.7 ± 2.2 mm. Of these 221 patients, 209 (95%) were treated successfully with URS plus pneumatic lithotripsy alone and the disintegrated fragments were passed spontaneously. URS was repeated in only five patients (2.5%) in group 1 due to residual stone, 1 month later. Seven migrated stones (to the upper urinary tract) were successfully treated by ESWL later. There were five treatment failures due to ureteral perforation, which consequently required open ureterolithotomy. Due to gross hematuria in 25 patients (11.3%) intraoperatively, we applied high pressure saline infusion to obtain a clear view of the stone surfaces, and these stones were disintegrated. The hematurias in these patients disappeared postoperatively on the first day. Eight patients with minimal ureteral perforation were treated with a double-J catheter insertion without open surgery. Of the 221 patients, 132 (59.7%) did not require any catheter, however, 89 (40.3%) were catheterized.

Group 2 included 66 patients (mean age 38 ± 14 years; 27 males, 39 females) with stones located above the pelvic brim (upper urinary tract). In this group, the mean stone size was 9.6 ± 2.1 mm. Of these 66 patients 58 (88%) were successfully treated. This group included 26 patients who had previously failed ESWL. This procedure could not be performed on eight patients, and a second session of URS was not performed in group 2. Five patients with minimal ureteral perforation were treated with a double-J catheter insertion. Five patients had migrated stones, three of whom were treated by ESWL later; two patients were sent to a percutaneous nephrolithotomy (PCNL) center due to

Table 2 Treatment results

	Group 1	Group 2	*P*
Success	95%	88%	NS
Duration of hospitalization (days)	1.2 ± 1	1.3 ± 1.1	NS
Stone migration	3.1% (7/221)	7.6% (5/66)	NS
Gross hematüria	11.3 (25/221)	10.6% (7/66)	NS
Failed (requiring open surgery)	2.2% (5/221)	4.5% (3/66)	NS
Pain requiring analgesia	42% (93/221)	45.4% (30/66)	NS
Perforations treated with double-J stent	3.6% (8/221)	7.5% (5/66)	NS
Fever (above 37°C)	11.3% (25/221)	13.6% (9/66)	NS

unsuccessful ESWL attempts. For three patients, we switched to open ureterolithotomy because of ureteral rupture that required surgical repair. Of 66 patients, 46(69.7%) needed a ureteral catheter, while 20 (30.3%) did not require any. In seven patients, gross hematuria developed intraoperatively and disappeared after the first day.

In both groups, the dominant postoperative complications were fever, pain and hematuria (Table 2). Although most of the patients were discharged on the first day, some were hospitalized for several days because of complications. Mean hospitalization was 1.2 days. Minor strictures were seen in five patients with complicated ureteral perforation. Four of these were treated with balloon dilatation and a stent, but in one patient ureteral balloon dilatation could not be achieved. This patient was referred to a university hospital. No kidney losses occurred. There was no stent dependent patient.

Discussion

In the current treatment of ureteral stones, two therapeutic methods, endoscopic lithotripsy and ESWL, are commonly performed. ESWL has been the first-line treatment for upper urinary tract stones for years. In some hands, ESWL has become the preferred treatment modality for upper tract stones [9, 10]. However, ureteroscopic lithotripsy has increasingly become an important solution for removing stone fragments after failed ESWL or for primary applications to treat ureteral stones [10]. URS is a useful option for many patients [9] such as those with failed ESWL, those with firmly impacted stones or large stones, patients with distal obstruction [11] and obese patients who cannot be treated with ESWL. In addition, ureteroscopic stone removal is also an excellent option in those patients with bleeding diathesis in whom ESWL and percutaneous procedures are contraindicated [12].

Proponents emphasize the advantages of ESWL as minimal anesthetic requirements, low complication rates and no inpatient requirement. Opponents of ESWL emphasize the high retreatment rates, long treatment time and the need for the prone positioning of patients. An advantage of URS includes the superior success rates with single treatment. URS, however, is associated with the need for general anesthesia, hospital admission and has a higher complication rate [13].

Technological advances have facilitated the treatment of more proximal ureteral stones to a point at which efficacy and safety are similar to those for URS performed for distal calculi [14].

Table 3 shows the distribution of success rates of URS series for ureteral calculi. It is clear that success in treating proximal calculi has improved significantly over the last decade, but has still not reached that obtained in treating distal stones. Our success rate of proximal calculi with URS was 88%. This result was very favorable when compared with the current treatment results of second generation shock lithotripsy (72–75%) [15]. Higher success rates of between 97–100% were reported with holmium:YAG laser [16, 17], and similar rates of between 90–93% were reported with electrohydraulic lithotripsy [18, 19].

ESWL is a less invasive treatment option, but its success rate is low for distal ureteral stones (50–81%) [3–6, 13]. Although, URS is a more invasive method, higher success rates have been reported for ureteroscopic lithotripsy. Success rates of between 90–100% were achieved using URS at the first application in the treatment of distal ureteral stones (Table 3). Success rates were 97–100% with holmium:YAG laser and 93% with EHL. Our success rate with URS was 95%.

Hollenbeck et al. reported that rates of ureteral perforation during URS with holmium:YAG laser were 7% and 3% in treated patients with proximal and distal stones, respectively [14]. However, Tawfiek and Bagley did not report any ureteral perforation with holmium:YAG laser [8]. Perforation rates with electrohydraulic lithotripsy were reported as 12–39% [18, 19]. In other studies with pneumatic lithotripsy, Sözen et al. reported a ureteral perforation rate of 1.5% [20]. In our study, ureteral perforation rates which required open surgery and minimal perforations treated with double-J stent were higher than data available from the literature. In our clinic, ureteral calculi were already treated with open surgery before 1999. Ureteroscopic equipment became available at our facility after this date. Thus, the higher perforation rates might be explained via the learning curves of the three surgeons involved. In addition, higher complication rates were due to impacted and/or large stones.

In order to avoid intraoperative complications, force should not be applied against any resistance during the intracorporeal manipulation. Guide wires may help safe crossing of the curves. Surgeons with less experience

Table 3 Distribution of success in the uretheroscopy series

Reference	Years	Proximal stone-free rates (%)	Distal stone-free rates (%)
Blute et al. [21]	1982–1985	66	90
Harmon et al. [22]	1992–1995	77	97
Tawfiek and Bagley. [6]	1995–1997	98	100
Hollenbeck et al. [12]	1997–1999	88	99
Gürbüz et al. [11]	1999–2000	94	98
This study	1999–2004	88	95

should avoid performing pneumatic lithotripsy for impacted and larger stones.

Hollenbeck et al. and Tawfiek and Bagley reported that postoperative complication rates were 1.6–3.2% [8–14]. Nutuhara et al. reported that pain requiring analgesia occurred in 15.2% of cases and fever (above 37°C) in 25.8% [7]. In another study, Küpeli et al. reported that colic pain was reported in 15.2% of cases [4]. In our study, the analgesic requirement was 42% in group 1 and 45.4% in group 2. The rate of fever was 11.3% in group 1 and 13.6% in group 2. Our results were higher than first series, but better than the second.

Ureteral stent placement after URS for urinary calculi is a common practice, although it was reported that with short operative times and minimal ureteral trauma, ureteral stents may not be necessary after URS [21, 22]. For distal ureteral stones, this rate was 40.3% and for proximal stones 69.7%. There were no formal criteria for stent placement which was dependant on the operation time, appearance of the ureter, presence of solitary kidney and operative insult (e.g., ureteral perforation).

The limitations of pneumatic lithotripsy equipment are its rigid nature, the need for ureteroscopes with straight working channels, and difficulty in crossing pelvic and other curves. The advantages of pneumatic lithotripsy are successful fragmentation, the low cost of equipment, low maintenance, the absence of disposable supply requirements, and probes having an extremely long life span.

Conclusion

According to our experience, ureteroscopic pneumatic lithotripsy is a reasonably safe and a feasible option for the treatment of ureteral calculi. High success rates can be achieved with the caution that perforations can occur for impacted calculi at a higher rate than with other modalities.

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