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ESWL in situ or ureteroscopy for ureteric stones?

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Summary. As documented by follow-up data on ureteric stones in 1259 ureteric units treated, ESWL in situ on advanced lithotriptors with stone location by ultrasonography and fluoroscopy was successful without any retrograde ureteric manipulation in 98% of stones in the upper, 71% in the iliac, and 84% in the distal ureter; 85% of the units were stone-free within 3 months: ancillary measures were needed in 11% and the stone-free state was reached after a median of 39 days. The results obtained with treatment after manipulation of the stone from the upper and mid-ureter by retrograde instrumentation were similar, but ancillary measures were needed in 20% of cases. Endoscopic management with rod-lens ureteroscopes was highly efficient in the distal and mid-ureter, but involved a complication rate of about 11% and required general anaesthesia. In the upper ureter it was abandoned in favour of the two former methods. Endoscopic stone removal has been greatly facilitated by the development of ultrathin, semirigid ureteroscopes 6.2–9 F in diameter, as well as by laser and pneumatic lithotriptors that operate through their minute working ports. Of the stones impacted in 127 ureteric units, 97% were successfully managed at the first attempt, involving an overall complication rate of 6%. Although ESWL in situ without any instrumentation remains the primary treatment of choice for stones in the upper and distal ureter, primary ureteroscopy is again being employed more frequently for stones in the iliac ureter, which are more difficult to focus, and small stones in the distal ureter, as well as in patients unwilling to accept the prolonged time until the urinary tract becomes stone-free after ESWL. This resulted in an increase in the frequency of ureteroscopy as the primary treatment for ureteric stones from 9% in 1990 to 32% in 1991.

In a decade of experience with extracorporeal shockwave lithotripsy (ESWL) and endourological manipulation in the management of urinary calculi, these techniques have been standardized to an extent that leaves little room for controversy. In the time dominated by one lithotriptor, the original Dornier HM3 (Dornier, FRG), this also appeared true for stones impacted in the ureter. Although ureteric stones could also be treated in situ on the Dornier HM3 [8, 13, 16, 20], stones in the distal third of the ureter were usually removed with the ureteroscope [2], and stones in the middle and upper thirds were manipulated back into the kidney and treated by ESWL there (pushback/ESWL) at most centres until very recently [10, 11, 14].

With the advent of newer lithotriptors with flat, tubless operating tables and stone location systems combining fluoroscopy and ultrasonography, in situ ESWL treatment was greatly facilitated [1, 6, 14, 15, 17]. The prospect of avoiding any direct patient manipulation suddenly became very attractive, in particular as most of these lithotriptors are anesthesia- and even pain-free. In an almost parallel development, the outer diameter of ureteroscopes was reduced significantly both by using fiberoptic bundles for image transfer [4] and the availability of pulsed-dye lasers [3, 9] and pneumatic lithotriptors (19) for stone fragmentation through working channels smaller than 1 mm in diameter. Being thinner than 9 F in diameter, these semirigid instruments can be inserted into the ureter without the need for dilatation and advanced without any loss of vision, so that virtually every stone can be reached and fragmented. As a result of these technical refinements, the choice of treatment for the various types of ureteric stone has again become a matter for debate. This article presents our experience with the new methods over the past 5 years, and the conclusions we draw from them for a therapy of choice in the light of these developments.

Materials and methods

During the period covered by this report, 1987 to 1991, ESWL treatment on advanced lithotriptors was freely available to all our patients (Wolf Piezolith 2300, stone location by ultrasonography; Siemens

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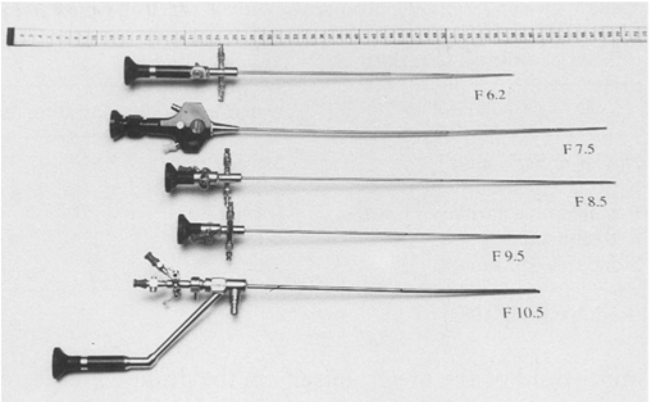

Fig. 1. Semirigid ureteroscopes with fibreoptic image transmission and working ports ranging from 1–2.1 mm in diameter (second from top Candela Miniscope, Wayland, Ma., USA; all others R. Wolf, Knittlingen, FRG)

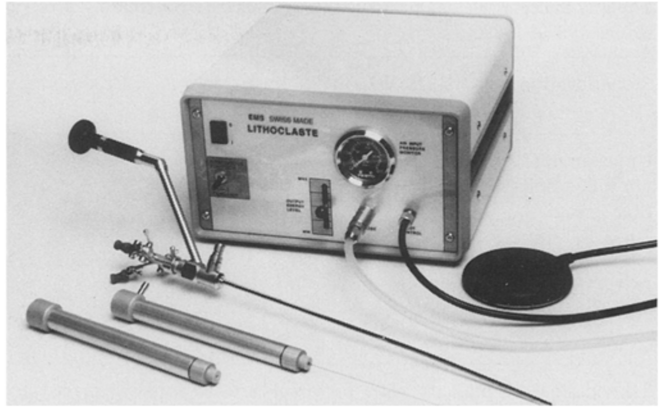

Fig. 2. Pneumatic contact lithotriptor with 0.7 mm lithotripsy probe (Lithoclaste, EMS, Lausanne, Switzerland) and purpose-built 8.2-F semirigid ureteroscope with straight 1.3-mm working port (R. Wolf, Knittlingen, FRG)

Lithostar, stone location by fluoroscopy; Wolf Piezolith 2500, stone location by in-line ultrasonography and fluoroscopy). Treatment on the Lithostar was performed under intravenous sedo-analgesia (5–10 mg diazepam and 0.3 mg buprenorphine hydrochloride or 15 mg piritramide IV) in 94.5% of cases, and under general anesthesia in 5%, the latter usually in the context of retrograde ureteral manipulations. Except in the case of children too young to cooperate, piezoelectric ESWL was always performed without any medication. For administrative reasons, the initial ESWL treatment was always performed as an inpatient procedures, whereas retreatments were usually performed on outpatients. The full range of 9.5- to 12.5-F rod-lens ureteroscopes, ultrasonic lithotripsy (R. Wolf, FRG) with sonotrodes 0.9–1.5 mm in diameter, and electrohydraulic lithotripsy with electrodes down to a diameter of 2.3 F (Riwolith, R. Wolf, FRG) was available over the entire period. Starting in 1989, semirigid ureteroscopes ranging from 6.2 to 10.5 F in diameter and 28 cm to 43 cm in lenght were added (Fig. 1). The Candela MDL-1000 (Candela, Wayland, Ma, USA) lithotriptor became available in 1989 and was later exchanged for the air-cooled updated MDL-2000 system. A pneumatic contact lithotriptor (Lithoclaste EMS, Lausanne, Switzerland) with lithotripsy probes of 0.7 and 1 mm was obtained in 1990. In addition, a variety of flexible active and passive ureteroscopes 7.5 to 12 F was available but was only rarely employed for treating ureteric calculi.

If a stone was to be dislodged from the ureter into the kidney via retrograde manipulation, this was usually attempted under IV sedo-analgesia, first by trying to dislodge the stone by means of a rather rigid 5-F ureteral catheter with a bent tip and, if this failed, by forced irrigation with 10–20 ml saline using an open-ended 7-F catheter that was advanced to immediately below the stone with the help of a guide wire. If the stone could be manipulated back into the kidney, an indwelling double-pigtail stent was inserted and the stone immediately treated by ESWL on the same table [1]. If the stone could not be dislodged, the patient was usually anesthetized and subjected to ureteroscopy in the same session. Primary ureteroscopy was always performed under general anesthesia, and an indwelling double-pigtail ureteric stent was almost always left in place after endoscopic manipulation. The patients were usually discharged from the hospital on the following day, and the stents were removed 1–7 days later as an outpatient procedure. These endoscopic procedures have been standardized at these institutions for years, and details have been published in detail elsewhere [12, 18]. Infected and obstructed collecting systems were routinely drained by percutaneous nephrostomy for 2–3 days prior to any stone treatment, but once infection was controlled the stone was treated with standard techniques. Follow-up examination consisted of plain films and renal ultrasonography performed at our institution by one of the authors 1 day, 1 month and 3 months after treatment.

In 1987/1988, the primary choice of treatment was not standardized and in part depended on the urologist's preferences. In general, stones in the upper and distal thirds of the ureter, being readily focusable, were treated by ESWL in situ, whereas stones in the iliac (= mid–) ureter were subjected to the pushback/ESWL approach or ureteroscopy. During this period, the pushback technique was never attempted from the distal ureter, and retrograde ureteroscopy was not selected as primary treatment for stones in the upper ureter. By late 1988, the good results of ESWL in situ and the rather dismal results of pushback/ESWL had become apparent. In 1989, all stones in the upper and distal ureter were therefore subjected to primary ESWL in situ in a prospective study to evaluate the true efficacy of this approach. As a consequence, only 9% of all ureteric stones treated in 1989 were subjected to primary ureteroscopy and only 7% to the pushback/ESWL technique, these figures being more or less tantamount to the percentage of stones impacted in the iliac ureter.

Primary ureteroscopic manipulations, being confined to the distal and iliac ureter, were almost exclusively performed with the short (32 cm) versions of the rod-lens ureteroscopes during this period, since they bend less than the longer instruments and therefore involve less loss of vision. This disadvantage was eliminated with the availability of the semirigid ureteroscopes with fibreoptic bundles. Considerably thinner instruments (6.2- to 8.5-F ureteroscopes) could now be advanced with ease up to the uretero-pelvic junction. As the narrow working channel of these instruments precluded the use of ultrasonic lithotripsy, and we found electrohydraulic lithotripsy to be considerably more tedious than laser lithotripsy, the latter method was adopted for almost all endoscopic stone disintegrations. In contrast to other authors [3], we do not attempt to clear the ureter of all minute fragments by repeated basketing; we usually stop after breaking the stone down to minute fragments and insert an indwelling double-pigtail stent. The stent is removed on an outpatient basis 3–7 days later, and all remaining stone debris is in general passed within hours thereafter. Laster lithotripsy can be tedious with some very hard calcium oxalate monohydrate and cystine stones. If a stone proves resistant to laser lithotripsy, a special 8.2-F ureteroscope with a straight working channel is inserted and the stone is fragmented by pneumatic lithotripsy (Fig. 2). In this technique, a thin steel probe is propelled against the stone under vision very much like a jackhammer. Every large stone breaks up rapidly with this approach with minimal soft tissue trauma, but smaller fragments are difficult to "corner" with the probe; they are therefore further reduced by laser lithotripsy. As a result of this technical progress, we have hardly used the pushback/ESWL technique in the last 2 years, and endoscopic treatment is again being used for stones in the proximal ureter (see Table 5).

Results

Of 1385 ureteric units with ureteric calculi treated from 1987 to 1989, follow-up data for 3 months or until the

Table 1. Success rates of primary therapy selected for treating ureteric stones 1987 – 1989[a]

Stone location	ESWL in situ	Push back/ ESWL	Ureteroscopy
Upper ureter (n = 604 units)	89%	88%	–
Iliac ureter (n = 197 units)	71%	81%	86%
Distal ureter (n = 458 units)	84%	–	94%

[a] Excluding 14 patients with proximal ureter stones managed by antegrade ureteroscopy

unit was stone-free was available in 1259 cases (91%). If success is defined as solving the clinical problem without having to resort to other techniques, ESWL in situ proved to be just as successful in the upper third of the ureter as the more invasive pushback/ESWL (Table 1). As a rule, results were poorest in the iliac ureter, ureteroscopy being clearly superior here even when rod-lens instruments were used. In the distal ureter, ureteroscopy was only marginally better than ESWL in situ. For evaluating overall morbidity, the rate of postoperative ancillary measures-which reflects the complication rate, the stone-free rate, the retreatment rate and the time until the stone-free state is reached also have to be taken into account (Table 2).

The results obtained in the prospective study of 1989, in which all stones in the upper and distal ureter were subjected to primary ESWL in situ, show that results improve with practice and perseverance. Ancillary measures usually consisted in ureteroscopy for stones that could not be focused or fragmented; over 94% of all stones in the proximal and distal ureter were treated successfully without any direct patient manipulation (Table 3). The stone-free rate at 3 months now equalled the results obtained by ureteroscopy, particularly in the distal ureter. In order to evaluate the influence of obstruction, the results for stones in non-dilated ureters were compared to those for stones causing severe obstruction. Surprisingly, obstruction had no influence on the fragmentation rate, the rate of ancillary measures or the stone-free rate in the

Table 2. Overall results of primary therapy of ureteric stones in 1259 ureteric units

	ESWL in situ	Push back/ ESWL	Ureteroscopy
Postoperative ancillary measures	11%	22%	10%[a]
Retreatment	38%	36%	5%
Stone-free <3 months	85%	86%	93%
Stone-free after (days; median)	39	31	7

[a] Excluding indwelling double-pigtail stents, which were routinely inserted

Table 3. Overall results of a prospective study in which all patients with upper and distal ureteric stones presenting for treatment were subjected to ESWL in situ as primary therapy

	Upper ureter	Distal ureter
No. of ureteric units	216	161
No fragmentation	3%	4%
Postoperative ancillary measures	5%	6%
Retreatment	36%	28%
Stone-free <3 months	90%	95%

(Rudolfstiftung 1989)

upper third of the ureter. Results in the distal ureter were excellent for obstructing stones, but significantly worse ($P < 0.01$) in the absence of obstruction (Table 4). Analysis according to stone size gave almost identical figures, with stones larger than 10 mm corresponding to the results obtained in the severely dilated ureter.

Ureteroscopy was highly effective, but naturally more invasive (Table 5). When rod-lens instruments with an

Table 4. Effect of obstruction on results of ESWL in situ (same study as Table 3)

	Upper ureter degree of obstruction		Distal ureter degree of obstruction	
	None[a]	Severe[b]	None[a]	Severe[b]
No. ureteric units	36	128	39	39
No fragmentation	–	2%	13%	2%
Postoperative ancillary measures	–	11%	10%	15%
Retreatment	39%	39%	36%	40%
Stone-free <3 months	80%	88%	82%	95%

[a] Ureter normal in pretherapeutic iVP and at ultrasonography
[b] Ureter dilated to at least double the diameter of the contralateral unaffected system

Table 5. Results of ureteroscopy

	Rod-lens ureteroscopes >10.5 F	Semirigid ureteroscopy 6.5 – 9.5 F	
Period	1/1987 – 12/1989[a]	9/1990[a] – 12/1991	
No. ureteric units	196[b]	127	
Stones in upper ureter	–	15%	
mid ureter	66%	54%	
distal ureter	34%	31%	
Immediately successful	85%	97%	100%
Success at 2nd attempt	5%	3%	
Additional ESWL	7%[c]	19%[c]	
Failure (Ureterolithotomy)	1%	–	
Perforation, stent problems fever >38 °C, colic	11%	5%	
Stone formation around fragmented laser fibre	–	0.8%	

[a] 1 – 9/1990 both types of instruments were used
[b] Excluding antegrade ureteroscopy in 14 units
[c] Fragments dislocated into kidney

outer diameter of more than 10.5 F were used, about one-tenth of patients had minor, but annoying complications. Morbidity was significantly reduced both with the semirigid, thinner instruments and laser/pneumatic lithotripsy. Although the patients treated in this way now also included more difficult cases with stones in the upper third of the ureter, the complication rate was cut by almost half and, more importantly, the problem of ureteric obstruction was immediately solved in 97%, mainly because the instrument could always be advanced to the stone.

Discussion

The experience reported in this paper shows that:

- The pushback/ESWL approach is considerably more invasive than ESWL in situ, yet the results are no better. We failed to dislodge the stone in almost 20% of patients, mainly with severely obstructing, impacted stones (1). Most of these patients can be treated successfully by ESWL in situ, sparing them the morbidity of IV sedation or anesthesia, retrograde ureteral manipulation and the insertion and subsequent removal of a stent.
- All ESWL techniques resulted in high retreatment rates, regardless whether the stone was treated in situ or pushed back into the kidney. We observed no significant difference between piezoelectric and electromagnetic ESWL, but obviously the retreatment rate is mainly lithotriptor-specific. El Faqih et al. [5] reported an 8% retreatment rate when using the Dornier HM3 for in situ treatment of stones in the distal ureter, and others [8, 13, 20] report similar figures. This is due not only to the higher peak pressure of this lithotriptor, but also to the considerably larger high-pressure focal zone, which does not require pinpointing of the focus precisely onto the stone. Nevertheless, we feel that the significantly lower morbidity of newer lithotriptors compensates for this disadvantage. The cost of painless, outpatient ESWL treatment at our institution is at present approximately US $ 500.
- The fastest way of rendering patients stone-free is ureteroscopy, but the ultimate outcome in terms of the 3-months stone-free rate is identical for endoscopic and ESWL techniques. Although we have noted a lower rate of pain, fever and renal colic after ESWL in situ of ureteric stones as compared with ESWL of renal stones, the threat of these events happening remains until the urinary tract is stone-free, and the anxiety and apprehension connected with this certainly also contribute to the overall morbidity of ESWL in situ.
- Thinner, semirigid ureteroscopes cause fewer complications and less soft tissue trauma, since they are easier to insert. Nevertheless, they too involve a complication rate and, at least in our experience, require general anesthesia and often ureteral stenting. Moreover, larger stone fragments are flushed back into the kidney in almost one-fifth of patients, although this rate could probably be reduced by more prudent disintegration at lower energy levels. Theoretically, most fragments could be retrieved by endoscopic manipulation, but we prefer to treat them by ESWL as soon as possible, which adds to the cost of treatment.
- Stones in the iliac ureter and small stones in the distal ureter are difficult to focus, and the results of ESWL in situ are poor.

There is clearly no single therapeutic modality for treating all ureteric stones that is superior to all others. The patient must be offered the complete spectrum of ESWL and endoscopic methods, and the choice of treatment has to be tailored to the individual stone situation as well as the patient's preference with respect to the morbidity and time involved in the process of treating the problem. In general, a stone impacted at a readily focusable location in the proximal and distal ureter is best treated by ESWL in situ, provided the patient accepts that it will be a long time before the urinary tract becomes stone-free. Stones in the iliac ureter and small stones in the distal ureter are difficult to focus on the lithotriptor, and primary ureteroscopy is the treatment of choice for these stones, despite the need for anesthesia and the higher morbidity. In borderline situations, for example when poorly radiopaque stones are impacted in the lumbar ureter at a rather low level and focusing may cause problems, the low morbidity and cost of ESWL in situ may still justify an attempt at this approach; in case of failure it does not complicate subsequent endoscopic manipulation. Due to the significantly reduced morbidity of ureteroscopy when semirigid thin endoscopes and laser or pneumatic lithotripsy are used, however, we currently favour early endoscopic manipulation, giving more consideration to the patient's wish to become stone-free as fast as possible. This has resulted in an increase of ureteroscopy as primary treatment of ureteric stones to 32% in our practice in 1991, as against 9% in 1990. As the diameter of the newer instruments comes close to that of "seeing" ureteral catheters, manipulation under fluoroscopy alone, such as flushing the stone back into the kidney and treating it by ESWL there, has in our view lost its justification as primary treatment.

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