The efficacy of extracorporeal shock wave lithotripsy in the treatment of ureteric stones

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This study was conducted to evaluate the efficacy of in situ extracorporeal shock wave lithotripsy treatment of ureteric stones using the Dornier MFL 5000 lithotripter. From March 1991 to June 1994, 184 patients received in situ extracorporeal shock wave lithotripsy treatment. The overall success rate was 77% (77% for upper, 69% for middle, and 81% for lower ureteric stones, respectively, no statistical significance). However, the size of the stones affected the final outcome significantly ($p < 0.05$, χ^2 test). An average of 1.23 sessions were required for each patient and the rate of major auxiliary intervention was 21%. We conclude that extracorporeal shock wave lithotripsy is an effective treatment for ureteric stones.

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Introduction

The introduction of extracorporeal shock wave lithotripsy (ESWL) has revolutionised the treatment of urinary stones. It is now the "gold standard" treatment for uncomplicated renal stones. With technological advances and increasing experience, in situ (no instrumentation) ESWL has been accepted as the treatment of choice for ureteric stones worldwide.[1-6]

The Dornier MFL 5000 Lithotripter was installed at the Queen Mary Hospital in March 1991, and was the first lithotripter in the public sector. The facility is currently shared by major regional hospitals. The Dornier MFL 5000 Lithotripter is a third generation lithotripter which was first available in 1988.[2-4] The machine delivers a spark-induced shock wave, with the shock waves focused by an ellipsoid. The variable power generator can deliver a wide range of shock wave energies enabling the fragmentation of stones under minimal analgesia. A dual modality stone localisation system (fluoroscopy and ultrasonography) is available and the unit's design as a multi-purpose table allows various urological procedures to be performed. This study was conducted to evaluate its efficacy in the in situ treatment of ureteric stones, and its impact on the management of ureteric stones in a tertiary referral centre.

Subjects and methods

From March 1991 to June 1994, 184 ureteric patients treated with in situ ESWL (179 as primary treatment; five after failed endourological procedures) were studied and factors affecting the final outcome were analysed. Factors assessed included stone size, burden (sum of maximal diameters), location, and other treatment parameters. Chi squared test and logistic regression analysis were used to test for statistical significance. The term upper ureter refers to the ureteric segment from the pelviureteric junction to above the upper border of the sacroiliac joint, the middle ureter refers to the part overlying the joint, and the lower ureter refers to the segment from below the sacroiliac joint to the vesicoureteric junction.

Initially, ESWL was conducted as an inpatient procedure, but with increasing experience, most subsequent treatments were conducted as outpatient procedures. Fluoroscopy was used primarily for stone localisation. Intravenous contrast injection or ureteric catheterisation for contrast injection were employed

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when stones were radiolucent or faintly opaque upon fluoroscopy. Ultrasound for stone localisation was employed only rarely, and its use was limited to upper and lower ureteric stones. Patients were treated in a comfortable supine position—except for middle and some lower ureteric stones—where patients adopted a prone position. Patient blood pressure, pulse, and oxygen saturation were monitored throughout the procedure. Intravenous sedo-analgesia using valium and/or pethidine were given as required.

All patients received pretreatment intravenous urogram unless contraindicated. Treatment was conducted without any manipulation (except for on-table retrograde pyelogram when indicated). Patients were followed up at two weeks, six weeks, and three months. Treatment success was defined as clearance of the stone at three months based on a good quality plain kidney-ureter-bladder film or by intravenous urography if indicated. Initial fragmentation, but incomplete clearance, was considered an indication for retreatment. Ureteric stones with poor response, persistent fragments with minimal progress, or failed repeat ESWL were criteria for auxiliary intervention.

Results

Treatment parameters

A total of 227 sessions were conducted on 184 patients (mean, 1.23 sessions; range, 1-5 sessions). The mean number of shock waves given was 2816 (SD 116). The maximum voltage used was 24 kV (SD 0.34). Intravenous sedo-analgesia was required in 113 (61%) patients.

Success rates

The overall success rate of ESWL was 77% (142/184 cases; 77% for upper, 69% for middle, and 81% for lower ureteric stones) (Table 1). Middle ureteric stones had less favourable results, but the difference was not significant. The stone size distribution is shown in Table 2, and the size of the stone affected the outcome significantly ($p < 0.05$). Stones greater than 10 mm in maximal diameter were less likely to be successfully treated. The success rates for the years 1991, 1992, and 1993 were 74%, 76%, and 85%, respectively.

Final outcome

Patients whose treatment with ESWL was unsuccessful, received ureteroscopic lithotripsy, percutaneous nephroscopy with antegrade ureterolithotripsy, or open operation as indicated. The final outcome is shown in Table 3. Four patients who failed to have the stone cleared at three months did not receive any subsequent intervention. In two of these patients, auxiliary interventions were scheduled, however, spontaneous stone passage and clearance occurred before the planned procedures had been undertaken (at 16 and 20 weeks post-treatment, respectively). They remained in the failed treatment group in the subsequent analysis. The remaining two patients did not receive further treatment because of underlying medical conditions.

Ureteric lithotripsy, percutaneous nephroscopy with antegrade ureterolithotripsy, and open ureterolithotomy were categorised as major secondary interventions and accounted for 21% of cases (38/184).

Discussion

Watson et al reported on the efficacy of the Dornier MFL 5000 Lithotripter in 1993, quoting a success rate of 72% for single treatments and 81% for repeated treatments.[2] In their series, they included retrograde manipulation for upper ureteric stone series and subsequent ESWL. Our overall results of 77% are

Table 1. Stone location and success rates

Ureter location	No. of successful outcomes	No. of patients	%
Upper	89	116	77
Middle	11	16	69
Lower	42	52	81
Total	142	184	77

χ^2 test, $p = 0.60$

Table 2. Stone size and success rates

Stone size (mm)	No. of successful outcomes	No. of patients	%
≤10	90	105	86
11-20	45	68	66
≥21	7	11	64

χ^2 test, $p = 0.006$

Table 3. Final outcome of extracorporeal shock wave lithotripsy (n=184)

Treatment given	No. of patients	%
ESWL (successful)	142	77
ESWL (unsuccessful)	42	23
Ureteroscopic lithotripsy	21	11
Percutaneous nephrolithotripsy	5	3
Open ureterolithotomy	12	7
No further treatment	2	1
Stone clearance after three months	2	1

comparable. In fact, we have better results for upper ureteric stones without the need of retrograde manipulation as part of the treatment procedure. While retrograde manipulation and subsequent shock wave lithotripsy (i.e. push-bang) may be considered minimally invasive procedures, such manipulation has not been a routine practice in recently reported series where in situ ESWL have success rates in the range of 81% to 90% using various lithotripters.[1,5-12] Admittedly, our results are not as good as the best reports, but they have improved with increasing experience.

It should also be noted that an intrinsic difference in fragmentation capacity exists between different lithotripter models. Generally, the first generation lithotripters are more powerful, with the Dornier HM3 being the prototype model. The second and third generation lithotripters tend to be less powerful, but treatment can be conducted using minimal analgesia.[13] In fact, a multicentre trial (1822 patients) studying various second generation machines concluded that second generation ESWL is less effective than first generation ESWL.[14] The decreased effectiveness results in an increased number of shocks given, decreased stone-free rate, and an increased retreatment rate. However, there is also a recent major study (13 864 patients) which reported no statistically significant difference between a second generation lithotripter (Medstone STS) and the gold standard unmodified Dornier HM3 instrument.[10] It is difficult to compare different machines, because some use fluoroscopic or ultrasound localisation, or different forms of shock wave energy (i.e. spark gap, electromagnetic, piezoelectric). Recent reports using various models are listed in Table 4.

Our success rates are very similar to the multi-centre study reported by Ehreth et al in 1994 using the same model.[3] In their series, 18.5% of patients required general or regional anaesthesia, and 75% needed some form of sedo-analgesia. In our series, only 61% of patients required intravenous sedo-analgesia. This has a significant bearing on the practice of outpatient or day case urology services.

We could not show any significant difference between success rates for different stone locations and sizes. The fact that treatment has been extended to the

Table 4. Success rate for in situ treatment of ureteral calculi using various lithotripters

Author	Year	Lithotripter model	No. of patients	Success rate (%)
First generation				
Cass[10]	1995	Dornier HM3	462	82
Benizri[7]	1992	Dornier HM3	170	90
Second generation				
Cass[10]	1995	Medstone STS	931	83
Farsi[11]	1994	Siemens Lithostar	248	89
Merhej[12]	1994	Wolf Piezolith 2300	332	81
Third generation				
Ehreth[3]	1994	Dornier MFL 5000	323 (middle & lower)	83
			658 (upper & renal)	67
Watson[2]	1993	Dornier MFL 5000	241	81
Rassweiler[1]	1992	Storz Modulith SL20	138	81-85

mid-ureter is a result of the improvement in lithotripter technology.[5,10,15] This was previously considered a "nowhere zone" because it is difficult to access by the antegrade percutaneous or retrograde ureteroscopic route for intracorporeal treatment, and difficult to localise and position for extracorporeal treatment. Firstly, a dual stone localisation system incorporating fluoroscopy and ultrasonography makes stone localisation possible in more than 95% of cases. Secondly, replacement of the conventional water bath by a water cushion gives the patient a comfortable prone position. Lastly, there is accumulating evidence that shock waves transmitted through the abdomen in the prone position do not produce significant harmful effects. The real long term effect on the intraabdominal contents is not known, although it is considered to be minimal. A reduction in the number and power of shock waves may be advisable.

Fluoroscopy has been our preferred localisation modality—including stones overlying the sacroiliac joint—as it is convenient to use, does not require expertise in diagnostic radiology, and is successful in localising the stones in most instances. Real-time fluoroscopic imaging and intravenous contrast injection often help in difficult situations. Good bowel preparation is also important. The occasional difficult-to-treat stones are small symptomatic ones which cause minimal obstruction. These may benefit from endourological intervention, should they prove unsuitable for ESWL treatment.

Stone size affects the success rate significantly, and this finding has important clinical implications. Provided that the stone receives adequate unit shock waves (number of shock waves per unit stone diameter), a giant stone is not an absolute contraindication for ESWL.[8,16] Success may be enhanced by perseverance.[5] However, the need for multiple treatment sessions and the prolonged lag period to stone clearance are important considerations in a busy lithotripter unit. In fact, these are important constraints and concerns when choosing the mode of treatment.

We treated more than 250 patients in the study period, and ESWL was selected as the primary treatment in approximately 70% of cases. The reasons for using other treatment modalities included bilateral ureteric stones with obstructive uropathy, ureteric stone in patients with only one functioning kidney, giant stone size, the presence of a concomitant urological condition requiring surgical intervention, and others. However, indications were often relative rather than absolute. The clinician's preference, patient's wishes, and the disease status were all considered. The shortage of treatment sessions affected our choice significantly.

Because of a reasonably long waiting list, we tend to offer early endourological procedures to patients with a significantly obstructed system, to avoid renal function impairment occurring due to prolonged obstruction. For lower ureteric stones in particular, we discuss the advantages and disadvantages of both ureteroscopy (85% success rate) and ESWL, and allow patients to choose between the two. It should be noted that such a policy is more a reflection of our shortage of facilities, rather than a statement about the merits of either treatment type.

Extracorporeal shock wave lithotripsy, using the Dornier MFL 5000 Lithotripter has successfully cleared stones in 77% of our patients. It is the primary treatment of choice in most instances, because of its non-invasive nature and reasonable success rate. Since its introduction, the treatment strategy for ureteric stones has altered significantly, and most patients can now benefit from this non-invasive modality.

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