Lithotripter Outcomes in a Community Practice Setting: Comparison of an Electromagnetic and an Electrohydraulic Lithotripter

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Purpose: We assessed patient outcomes using 2 widely different contemporary lithotripters.

Materials and Methods: We performed a consecutive case series study of 355 patients in a large private practice group using a Modulith® SLX electromagnetic lithotripter in 200 patients and a LithoGold LG-380 electrohydraulic lithotripter (TRT, Woodstock, Georgia) in 155. Patients were followed at approximately 2 weeks. All preoperative and postoperative films were reviewed blindly by a dedicated genitourinary radiologist. The stone-free rate was defined as no residual fragments remaining after a single session of shock wave lithotripsy without an ancillary procedure.

Results: Patients with multiple stones were excluded from analysis, leaving 76 and 142 treated with electrohydraulic and electromagnetic lithotripsy, respectively. The stone-free rate was similar for the electrohydraulic and electromagnetic lithotripters (29 of 76 patients or 38.2% and 69 of 142 or 48.6%, $p = 0.15$) with no difference in the stone-free outcome for renal stones (20 of 45 or 44.4% and 33 of 66 or 50%, $p = 0.70$) or ureteral stones (9 of 31 or 29% and 36 of 76 or 47.4%, respectively, $p = 0.08$). The percent of stones that did not break was similar for the electrohydraulic and electromagnetic devices (10 of 76 patients or 13.2% and 23 of 142 or 16.2%) and ureteroscopy was the most common ancillary procedure (18 of 22 or 81.8% and 30 of 40 or 75%, respectively). The overall mean number of procedures performed in patients in the 2 groups was similar (1.7 and 1.5, respectively).

Conclusions: We present lithotripsy outcomes in the setting of a suburban urology practice. Stone-free rates were modest using shock wave lithotripsy alone but access to ureteroscopy provided satisfactory outcomes overall. Although the acoustic characteristics of the electrohydraulic and electromagnetic lithotripters differ substantially, outcomes with these 2 machines were similar.

Key Words: kidney calculi, ureteral calculi, lithotripsy, equipment and supplies, treatment outcome

Abbreviations and Acronyms

PL = power level

SFR = stone-free rate

SW = shock wave

SWL = SW lithotripsy

URS = ureteroscopy

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THE treatment of kidney stone disease has changed dramatically in the last 30 years beginning with the first successful SWL treatment by Chaussy et al in 1980 in Germany.[1] Initial SWL cases were encouraging and SWL quickly gained acceptance as the preferred initial treatment approach for most renal and many ureteral calculi.[1–7]

Since the introduction of the HM3 lithotripter (Dornier MedTech, Wessling, Germany), there has been a substantial effort to improve lithotripter technology and yet outcomes have worsened. Reports of approximately 50% or lower SFRs using SWL are not uncommon.[8–10] Multiple factors may affect this decrease in outcomes but logic points to the design changes that narrowed the focal zone and eliminated the water bath. Lithotripsy with the HM3 device was typically performed with the patient under anesthesia. In an effort to make treatment anesthesia-free manufacturers enlarged the aperture of the shock source, thereby spreading the acoustic field to minimize discomfort at the skin.[11] This resulted in narrowing the focal width, making it more difficult to hit a stone moving due to respiratory excursion.[12,13] Another critical design change came about with the push to make lithotripters more readily transportable. Replacing the water bath with a dry treatment head led to smaller modular systems but necessitates the use of coupling medium such as gels and oils, which tend to capture air pockets that interfere with SW transmission.[14–16]

We assessed the effectiveness of SWL in a high volume private practice, a setting in which lithotripsy is typically the primary initial method of treating uncomplicated stone cases. We had the unique opportunity to test the performance of 2 contemporary lithotripters that represent different concepts in SW delivery. The electromagnetic Storz Modulith SLX has a narrow focal width (approximately 3 to 4 mm) and it generates high acoustic pressure (approximately 50 MPa at PL-7) while the electrohydraulic LithoGold LG-380 has a much broader focal width (approximately 20 mm) and produces much lower pressure SWs (approximately 20 MPa at PL-9).[17,18] The coupling system of the electromagnetic device uses a partial water bath but the electrohydraulic device has a dry treatment head. Because a narrow focal width limits the ability to hit a moving stone and it is difficult to achieve good coupling with a dry treatment head, we examined these divergent technologies representing the advantages and limitations in lithotripter design.

MATERIALS AND METHODS

In this institutional review board approved, consecutive case series study we prospectively recruited 355 patients from a clinical urology practice in southern Indiana. The first 155 patients underwent SWL using the LithoGold LG-380 electrohydraulic lithotripter. After this device was replaced 200 patients were treated with the Modulith SLX electromagnetic lithotripter. In each group patients under general anesthesia underwent lithotripsy at 60 SW per minute using a stepwise power ramping protocol incorporating a 3-minute pause in SW administration.[19] Treatment was initiated at PL-3 (150 SWs) followed by a 3-minute pause before treatment was resumed at escalating steps using 50 SWs per step to a maximum setting of PL-9. Imaging was repeated every 500 SWs. Lithotripsy was halted when the surgeon considered that the stone was broken to completion or a maximum number of SWs were delivered (3,000 by the electrohydraulic and 4,000 by the electromagnetic lithotripter). Multiple surgeons involved in the study were assisted by the same technical team. The lithotripsy protocol was proposed by the Indiana University researchers but the First Urology group performed patient recruitment, lithotripsy, followup timing and the choice of additional procedures.

Followup was done at 2 to 4 weeks by plain x-ray of the kidneys, ureters and bladder. Paired preoperative and postoperative films were analyzed by a dedicated genitourinary radiologist. The SFR was defined as no residual fragments remaining after single session SWL without an ancillary procedure.

In the electrohydraulic and electromagnetic groups patients were excluded from the study due to multiple stones (41 and 38), unclear stones on preoperative imaging (11 and 3) and loss to followup (10 and 16, respectively). In addition, in the electrohydraulic group patients were excluded due to recent SWL (7), age less than 18 years (4), missing postoperative data (3), recent URS, duplicate enrollment and bladder tumor (1 each). One patient in the electromagnetic group was excluded due to ultrasound followup only. Thus, lithotripsy outcomes were assessed in 76 and 142 patients treated with the electrohydraulic and electromagnetic devices, respectively.

Data were analyzed with JMP® 10.0. We used the t-test or chi-square test, or generalized linear models as appropriate with significance considered at $p < 0.05$.

RESULTS

The table lists the clinical characteristics of the patient population. The distribution of renal vs ureteral cases did not differ between the lithotripters (Fisher exact test $p = 0.08$). Mean $\pm$ SD stone size was larger in the electrohydraulic group (8.5 ± 3.4 vs 7.4 ± 3.5 mm, Wilcoxon rank sum test $p = 0.007$). Followup was 14 days or less in 63.2% and 56.9% of cases in the electrohydraulic and electromagnetic groups, respectively (see table). Overall SFR was similar in the electrohydraulic and electromagnetic groups (29 of 76 patients or 38.2% and 69 of 142 or 48.6%, $p = 0.15$) with no difference in the stone-free outcome for renal stones (20 of 45 or 44.4% and 33 of 66 or 50%, $p = 0.70$) or ureteral stones (9 of 31 or 29% and 36 of 76 or 47.4%, respectively, $p = 0.08$, see table). The mean number of SWs used to treat patients with the electrohydraulic lithotripter was lower than the number