Extracorporeal Shock Wave Lithotripsy in Prepubertal Children: 22-Year Experience at a Single Institution With a Single Lithotriptor

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Purpose: The sophistication of percutaneous nephrolithotomy and ureteroscopy challenges the efficacy of ESWL® for urolithiasis in prepubertal patients. We evaluated our long-term experience with ESWL in these patients and determined its efficiency.

Materials and Methods: We retrospectively reviewed the charts of all prepubertal patients who underwent ESWL. We evaluated the need for tubing, the 3-month stone-free rate, the need for additional ESWL, and the effect of stone size and location, and cystinuria on the 3-month stone-free rate.

Results: Between 1986 and 2008, 119 males and 97 females with a mean age of 6.6 years who had urolithiasis underwent ESWL using the Dornier® HM3 lithotriptor. We treated 157 children with renal calculi with an average ± SD diameter of 14.9 ± 8.9 mm, of whom 66 (42%) required a tube in the urinary system. The 3-month stone-free rate was 80% and 31 patients (19.7%) needed an additional procedure. Stone location did not affect the stone-free rate but stone size did. We treated 59 patients for ureteral stones with an average stone length of 9.5 ± 4.8 mm, of whom 41 (69%) required tube insertion. The 3-month stone-free rate was 78% and 13 patients (22%) needed an additional procedure. The 3-month stone-free rate did not depend on stone location or size. The rate was 37.5% in patients with cystinuria and 82.5% in all others ($p < 0.0001$). Six patients (2.8%) had complications.

Conclusions: The 3-month stone-free rate after ESWL in prepubertal patients is 80% and 20% of patients require additional procedures. ESWL is most effective for kidney stones less than 11 mm. ESWL has inferior results for cystine stones compared to other calculi. Complications are rare.

Key Words: kidney, ureter, calculi, lithotripsy, cystine

Abbreviations and Acronyms

3SFR = SFR 3 months after ESWL

PCNL = percutaneous nephrolithotomy

SFR = stone-free rate

Study received institutional review board approval.

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CHAUSSY et al revolutionized the treatment for urinary calculi by developing the Dornier HM3 lithotriptor and introducing ESWL.[1] Since the early 1980s, ESWL has been done in children[2] and it later became the gold standard for pediatric renal[3–5] and ureteral[6,7] stone disease. Currently ESWL is also successfully used in infants.[8] Regardless of ESWL efficacy its overall reported success rate in the pediatric population is 46% to 100%, necessitating additional treatment sessions in many patients, mainly those with large or staghorn calculi.[9] In the last 2 decades more invasive treat-

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ment modalities have been developed, such as PCNL and ureteroscopy. Recent technical improvements in scope design also enable the use of these treatments in the prepubertal pediatric population with 86% to 92.5% reported success for PCNL[10–12] and 96% to 100% for ureteroscopy with minimal morbidity.[13,14] The sophistication of invasive pediatric lithotripsy has challenged ESWL as the treatment of choice in the prepubertal pediatric population. Thus, we retrospectively evaluated the results of ESWL in prepubertal patients to determine its success and compared our success rate to recently published data on PCNL and ureteroscopy.

PATIENTS AND METHODS

We retrospectively reviewed the prospective electronic database of all patients who underwent ESWL at our institution since the introduction of the unmodified Dornier HM3 lithotriptor. We included in analysis all children who underwent ESWL at age 12 years or less. There were no study exclusion criteria. The diagnosis of urolithiasis was confirmed by plain abdominal x-ray, ultrasound and during the last decade also by computerized axial tomography in select cases. Renal function was determined in most cases by excretory urography and in some by ^{99m}technetium-dimercapto succinic acid renal scan. Postoperative renal function and 3SFR were determined by the same imaging modalities. We assessed 3SFR, the requirement for tubing and additional treatments, the effect of stone size and location, and cystinuria on 3SFR, and complications. We divided our patients into 3 age groups, including ages 0 to 2, 3 to 5 and 6 to 12 years, and summarized results separately for each group. We used the Student t test to compare continuous variables and the chi-square test to compare categorical variables.

RESULTS

A total of 15,695 ESWL sessions were done in 10,791 patients at our institution between 1986 and 2008. The study group comprised 119 males and 97 females (2.00%) from this group with a mean age of 6.6 years (range 8 months to 12 years). All males were circumcised. ESWL was done with the unmodified Dornier HM3 lithotriptor with all patients under general anesthesia. Table 1 lists stone disease etiologies.

Of the patients 87 males and 70 females (72.7%) with a mean age of 6.3 years (range 10 months to 12 years) had renal calculi. Average ± SD stone size was 14.9 ± 8.9 mm and maximal stone size was 55 mm. Stone distribution included 109 renal pelvic (69.4%), 37 caliceal (23.6%) and 11 staghorn (7%) calculi. Of 66 patients (42%) who required tube insertion before or during ESWL 20 (30.3%) needed nephrostomy, 23 (38.4%) needed a double pigtail stent and 23 (38.4%) needed a ureteral catheter. Indications for nephrostomy or stent insertion were complete obstruction, pyonephrosis, stone diameter greater than 20 mm, staghorn calculi and concomitant ureteral stones. All nephrostomies were inserted before ESWL at a separate session, and all stents and ureteral catheters were inserted at the ESWL session. Externalized ureteral catheters were inserted in cases of radiolucent (uric acid) or poorly visualized calculi. We injected contrast material via this catheter during ESWL to better visualize collecting system anatomy. These catheters were removed promptly upon the conclusion of ESWL. We also analyzed our results according to age groups, including ages 0 to 2, 3 to 5 and 6 to 12 years (table 2). The only statistically significant difference among these groups was the need for tubing with older age associated with a lesser tubing requirement ($p = 0.0004$).

Table 1. *Stone etiology*

Etiology	No. Pts
Hypercalciuria	14
Cystinuria	8
Oxaluria	5
Hyperuricemia	2
Hyperuricosuria	4
Hypocytraturia	2
Hyperparathyroidism	1
Medullary sponge kidney	1
Hyperphosphatemia	1
Renal tubular acidosis	3
Immobilization	5
Nephrocalcinosis	2
Total	48

A total of 126 patients (80.1%) were stone-free 3 months postoperatively, 17 (10.8%) required an additional procedure to achieve stone-free status and 14 needed a third procedure. The subsequent SFR was 91.1% after a second session and 97.4% after a third session. The need for tubing was not affected by stone size ($p = 0.31$), or caliceal or pelvic location ($p = 0.66$). Neither patient age ($p = 0.22$) nor stone location ($p = 0.8$) had any statistically significant effect on 3SFR. Stone size 10 mm or less showed an 86.4% 3SFR but for calculi greater than 20 mm 3SFR was only 62.5% after 1 ESWL session ($p = 0.03$).

We treated 32 males and 27 females with a mean age of 7.3 years (range 10 months to 12 years) for ureteral calculi. Average stone size was 9.5 ± 4.8 mm (maximum 32). Of the stones 28 (47.5%) were in the proximal ureter, 5 (8.5%) were in the mid ureter, necessitating a prone patient position for ESWL, and 26 (44%) were in the distal ureter. Before ESWL a tube was inserted in 41 patients (69%), including nephrostomy in 6 (14% of tubes overall), a double pigtail stent in 9 (21%) and an externalized ureteral catheter in 26 (63%). Indications for nephrostomy or stent insertion were complete obstruction, pyone-