# Inital Experience in the Treatment of Childhood Nephrolithiasis by ESWL

A. STEPHANIDIS, A. KARAYANNIS, E. KARAYOTAS, K. GIANNAKIS, V. MICHAEL, and P.A. ANDROULAKAKIS

Renal calculi in children are not very common. Their incidence is estimated to be 1-2 per million in children less than 15 years [7,16]. In the United States it ranges between 1 in 1000-7600 hospital admissions annually, whereas in the United Kingdom there are 100 new cases of childhood urolithiasis per year [3,9]. These figures correlate well with the incidence of renal calculi found at our institution [1].

ESWL was introduced in 1982 by Chaussy and associates as a non invasive method for the treatment of upper urinary calculi in adults [4,5]. Since its introduction ESWL has gained worldwide acceptance, and since 1986 it has also been applied to a limited number of pediatric patients [12]. However, in comparison to adults this procedure theoretically carries more risks in children. A relatively greater area of kidney and surrounding soft tissues are exposed to the high pressure focal zone, and the shock wave effect may be more detrimental to growing structures than to mature organs [10,11,15]. Although this theoretical point has not been proved to date, it is apparent that more time is needed to establish the long term effects of shock waves on growing organs.

The encouraging initial clinical results and limited morbidity from previous reports prompted us to use ESWL on a selected group of patients at our Department in cooperation with the ESWL Unit of Athens University Medical School. Herein, we report our results and conclusions from the treatment of these children.

## Materials and Methods

Between March 1991 and March 1994 10 patients, 6-14 years old (mean age 11,9 years) were treated with the Dornier HM 3 Lithotrjtor (Table 1). These patients were selected from a total of 21 patients treated for urolithiasis at our Department during the same period. The selection of the patients was done basically according to the initial indications proposed by Chaussy et al, in 1982 [5] (Table 2).

Preoperatively, an excretory urogram (IVP) was obtained and the number, size, location and radiodensity of all calculi were documented. All children underwent a complete history and physical examination, blood tests for renal function, complete blood count, prothrombin time, partial thromboplastin time, urinalysis, urine culture and a complete metabolic work-up according to our standard protocol [1].

Clinical presentation of our patients included flank pain or colic in 6 patients (60%), urinary infection in 4 (40%) and hematuria in 2 (20%).

During ESWL 8 children received a general anaesthetic, but for 2 intravenous sedation was used. The energy level at the start of each treatment was set at 17 Kv for the first 100 shock waves, and thereafter the intensity was increased and maintained at 18 Kv. The procedure was terminated when the fragmentation of the stone(s) was fluoroscopically evident, otherwise it was continued up to a maximum of 2000 shock waves per kidney and then it was terminated regardless of the result. A plain abdominal film and renal ultrasound were obtained at the second postoperative day. These imaging procedures were repeated after 3 months.

Patients were considered to be free of stone(s) if there was complete absence of all fragments at 3 months after the last ESWL session. Treatment was considered partially successful if there was residual fragment(s) equal to or less than 50% of the initial

Table 1. Analysis of clinical characteristics and ESWL results in our patients

| Age | Sex | Site | No of sessions | No of shocks | Voltage | Result* |
|---|---|---|---|---|---|---|
| 13 | F | Solitary in renal pelvis | 1 | 1,800 | 18 | Free of stone |
| 12 | F | Solitary in renal pelvis | 1 | 1,500 | 18 | Free of stone |
| 11 | F | Bilateral multiple caliceal | 3 | 1,250-2,000 | 18 | Failure in both sides* |
| 6 | M | Solitary in renal pelvis and multiple caliceal | 4 | 1,650-2,000 | 18 | Failure* |
| 13 | F | Multiple caliceal | 1 | 2,000 | 18 | Partial success* |
| 13 | M | Solitary in renal pelvis | 1 | 1,600 | 18 | Free of stone |
| 13 | M | Solitary in renal pelvis | 1 | 2,000 | 18 | Free of stone |
| 12 | M | Bilateral solitary in renal pelvis | 2 | 2,000 | 18 | Failure in both sides* |
| 14 | M | Solitary in renal pelvis | 1 | 1,852 | 18 | Free of stone |
| 12 | F | Solitary in renal pelvis and multiple in lower pole calyx | 1 | 2,000 | 18 | Partial success* (Solitary pelvic disintegrated, caliceal unchanged) |

* *See text for details.*

**Table 2. Criteria for ESWL**

- Solitary stone in renal pelvis
- Multiple caliceal stones
- No cystine stones
- No evidence of anatomical obstruction
- Sterile urine
- Body height > 120 cm
- Absence of coagulation disorders

**Table 3. Summary of ESWL results in solitary pelvic and multiple caliceal stones**

| | ESWL RESULTS | | | |
|---|---|---|---|---|
| Site of stone(s) | No of renal units | Free of stone (complete clearance) | Partial success | Failure |
| Solitary in pelvis | 7 | 5 | - | 2 |
| Solitary in pelvis +multiple caliceal | 2 | - | 1* | 1 |
| Multiple caliceal | 3 | - | 1 | 2 |
| Total | 12 | 5(41.6 %) | 2(16.6%) | 5(41.6%) |

Complete clearance in solitary pelvic: 6/9(66.6%)
Partial success in multiple caliceal: 1/5 (20%)

* *Solitary was completely disintegrated.*

stone burden. Finally, if residual fragment(s) was more than 50% of the initial stone burden the treatment was considered a failure (Table 1).

## Results

A total of 12 kidneys in the 10 children required 16 sessions for the treatment of their renal calculi (Table 1). In 2 children with bilateral nephrolithiasis, ureteral stents were placed before ESWL and simultaneous bilateral treatment was performed. Post-lithotripsy hospitalization ranged between 1-4 days (mean 2.5 days). Complications included skin ecchymoses in the flank, noted in 6 patients who all had received 2000 shocks. Mild renal colic occurred in 1 patient and was relieved by oral analgesics alone. Mild macroscopic hematuria of less than 24 hours duration was seen in 6 patients. The immediate postoperative ultrasound study showed the absence of any intrarenal or subcapsular hematomas or obstruction in all of our patients.

Following radiographic evaluation at 3 months after ESWL 5 of the 7 renal units with initially solitary pelvic calculi were free of stones. Partial success was seen in 2 renal units, one with multiple caliceal stones and one with a combination of multiple caliceal plus a solitary pelvic stone; in this case the pelvic stone was completely disintegrated but the caliceal stones remained unchanged in number and size. In the remaining 5 renal units ESWL failed. Two had solitary uric acid calculi in the renal pelvis and ESWL was unsuccessful because of poor focusing of the shock waves upon the stones. The other 3 had multiple caliceal stones, additionally a solitary pelvic stone. In 2 of the former 3 renal units, ESWL was repeated 1 and 3 times respectively at 2-month intervals without, however, any evidence of further stone fragmentation.

Overall, ESWL was successful (complete stone clearance) in 6/9 kidneys with solitary pelvic calculi (66.6%) and partially successful in only 1/5 kidneys with multiple caliceal stones (20%) (Table 3).

## Discussion

In the limited series concerning ESWL treatment for childhood nephrolithiasis that have been reported up to date the overall rate of stone free children varies from 70-82% [8,13,14]. In our patients, complete stone clearance following ESWL was 66.6% for solitary calculi in the renal pelvis and partial success was 20% for multiple caliceal stones. If these results are expressed according to the total number of renal units, complete stone clearance was 41.6% and partial success 16.6% (Table 3).

Perhaps differences in selection criteria account for these wide variations in results. Our patients were sent for ESWL according to somewhat strict criteria, namely the ones that had been proposed when the experience in ESWL treatment was limited [5]. This is because our basic principle in the decision to refer children for ESWL was the safety of our patients. This is clearly reflected by the fact that our protocol incorporated a low intensity in voltage (maximum 18 Kv) and a limited number of shock waves (up to 2,000) per session [2,6,17]. In addition it should be noted that, contrary to other "Pediatric" series in the literature, the age of our patients was ≤14 years, because in our country Children's Hospitals do not admit patients beyond the age of 14.

We have been somewhat disappointed by the unsuccessful outcome of ESWL in small caliceal stones. Our explanation for this, is the poor effect of shock waves with the lack of surrounding urine (fluid) in stones lying in small calices in contact with the caliceal epithelium. Had these stones been lying within large hydronephrotic calices, the outcome of ESWL would be much better. This also explains why the repeat ESWL sessions in these patients were unsuccessful too. For this reason we shall not attempt in the future to treat such patients by ESWL.

In view of our limited experience, we conclude that ESWL, (a) is an acceptable mode of treatment in childhood nephrolithiasis in cases with solitary stones in the renal pelvis <2 cm, and (b) it is not suitable for multiple, though small, stones lying within narrow (non hydronephrotic) calices. Although we have not encountered any serious complications, the long term observation of patients submitted to ESWL is mandatory in order to exclude the risk of late untoward effects, i.e. hypertension, kidney scarring or tubular dysfunction.

## References


1. Androulakakis PA, et al: Paediatric urolithiasis in Greece. Br J Urol 67:206, 1991
2. Androulakakis PA: Treatment of renal stones in children. European Urology Update Series 1:7, 1992
3. Boddy S, et al: Extracorporeal shock wave lithotripsy and percutaneous nephrolithotomy in children. J Pediatr Surg 22:223, 1987
4. Chaussy C, Berndel W, Schmiedt E: Extracorporeally induced destruction of kidney stones by means of shock waves. Lancet 2:1265, 1980
5. Chaussy C, Schmiedt E, Jocham D, et al: First clinical experience with extracorporeally induced destruction of kidney stones by shock waves. J Urol 127:417, 1982
6. Frick J, Sarıca K, Köhle R, et al: Long-term follow-up after extracorporeal shock wave lithotripsy in children. Eur Urol 19:225, 1991
7. Ghazali S: Childhood urolithiasis in the United Kingdom and Eire. Br J Urol 47:739, 1975
8. Kroovand LR, Harrison LH, Mc Cullough D: Extracorporeal shock wave lithotripsy in childhood. J Urol 138:1106, 1987
9. Kroovand LR: Stones in pregnancy and in children. J Urol 148:1076, 1992
10. Marberger M, Türk C, Steinkogler I: Piezoelectric extracorporeal shock wave lithotripsy in children. J Urol 142:349, 1989
11. Mishriki SF, Wills MI, Mukherjee A, et al: Extracorporeal shock wave lithotripsy for renal calculi in children. Br J Urol 69:303, 1992
12. Newman DM, Coury T, Lingeman JE, et al: Extracorporeal shock wave lithotripsy experience in children. J Urol 136:238, 1986
13. Nijman RJM, Ackaert K, Scholtmeijer RJ, et al: Long term results of extracorporeal shock wave lithotripsy in children. J Urol 142:609, 1989
14. Sigman M, Laudone VP, Jenkins AD, et al: Initial experience with extracorporeal shock wave lithotripsy in children. J Urol 138:839, 1987
15. Thomas R, Frentz JM, Harmon E, et al: Effect of extracorporeal shock wave lithotripsy on renal function and body height in pediatric patients. J Urol 148:1064, 1992
16. Walther PC, Lamm D, Kaplan GW: Pediatric urolithiasis: a ten year review. Pediatrics 65:1068, 1980
17. Wilson TW, Preminger GM: Update on urinary stone disease. Extracorporeal shock wave lithotripsy. Urol Clin N Amer 17:234, 1990



**Antony Stephanidis, MD**
Department of Pediatric Urology
Aghia Sophia Children's Hospital
Athens