Safety of Shock Wave Lithotripsy for Treatment of Pediatric Urolithiasis: 20-Year Experience

Stephen J. Griffin, Marc Margaryan, F. Archambaud, A. Sergent-Alaoui and Henri B. Lottmann

From the Pediatric Surgery Service, Necker Hospital for Sick Children (SJG, HBL) and Nuclear Medicine Service, Trousseau Hospital (AS-A), Paris, Pediatric Surgery Service, University Hospital of Nancy, Vandœuvre-lès-Nancy (MM) and Nuclear Medicine Service, University Hospital of Bicetre, Bicetre (FA), France

Abbreviations and Acronyms

^{99m}Tc = ^{99m}technetium

DMSA = dimercapto-succinic acid

F2 = focal area zone

SWL = shock wave lithotripsy

Submitted for publication September 21, 2009.

Purpose: This retrospective study was designed to assess the impact of shock wave lithotripsy on the pediatric kidney using pretreatment and posttreatment ^{99m}technetium dimercapto-succinic acid renal scintigram.

Materials and Methods: A total of 182 patients 5 months to 19.8 years old (mean 5.3 years) were treated for renal calculi with shock wave lithotripsy during a 20-year period. Pretreatment evaluation included clinical assessment, urine culture, renal ultrasound and plain abdominal radiograph with or without excretory urogram. Dimercapto-succinic acid scintigram was performed before and 6 months after completion of treatment in 94 patients (52%).

Results: Patients underwent 1 to 4 sessions of shock wave lithotripsy per kidney with at least 1 month between treatments. Median number of shocks delivered per session was 3,000 (IQR 2,601 to 3,005). No new scars were observed on any posttreatment dimercapto-succinic acid scan. Regarding renal function, patients fell into 1 of 4 groups. Group 1 (66 patients, 70%) had normal function on dimercapto-succinic acid scan before and after treatment, group 2 (18, 19%) had decreased function in the affected kidney on pretreatment scan with no change after treatment, group 3 (2, 2%) had impaired function in the treated kidney that was transient (1) or permanent (1) and group 4 (7, 7%) had improved function in the treated kidney.

Conclusions: Shock wave lithotripsy is an effective treatment for renal calculi in children. Renal parenchymal trauma associated with extracorporeal shock wave lithotripsy does not seem to cause long-term alterations in renal function or development of permanent renal scars in children.

Key Words: child, kidney calculi, lithotripsy, safety, urolithiasis

SINCE first reported in 1980 by Chaussy et al,[1] shock wave lithotripsy has become an important modality for treating urinary tract stones. The recent advent of smaller and flexible ureteroscopes has led to increasing application of shock wave lithotripsy in the management of stones in adults. This has not necessarily been the case in children. While shock wave lithotripsy has been shown to be effective and safe in the short term in large series of children,[2–4] the long-term safety in children is still debated. Renal damage from shock wave lithotripsy, initially thought solely due to sheer stress, is now thought to be due largely to vascular insult caused by cavitation, renal vasoconstriction and free radical formation. Theoretically the smaller vessels in the kidney of a child may be at greater risk.

0022-5347/10/1836-2332/0
THE JOURNAL OF UROLOGY®

Vol. 183, 2332-2336, June 2010
Printed in U.S.A.
DOI:10.1016/j.juro.2010.02.030

This study addresses the issue of safety of SWL in a large cohort of patients treated at our institution during the last 20 years. Patients were evaluated before and after SWL with DMSA scintigraphy to assess relative renal function after treatment and development of SWL related renal scarring.

MATERIALS AND METHODS

A total of 182 patients were treated for symptomatic renal calculi or calculi larger than 6 mm between 1988 and 2008. During the course of the study we used 4 different lithotriptors, including a Sonolith® 3000 (14 kV), a Nova (14 to 20 kV, Direx Medical Systems, Paris, France), a Modulith® SLX and, most recently, a Compact Delta (Dornier MedTech, Kennesaw, Georgia). Stones were targeted using ultrasound alone or in combination with fluoroscopy by a single pediatric urologist (HBL). Number of sessions and shock waves delivered per session were recorded. When more than 1 session was required an interval of at least 1 month passed before further treatment commenced.

Preoperatively patients were assessed clinically with urine culture, renal tract ultrasound and ^{99m}Tc DMSA scintigram. When patients presented with an obstructed system or a large stone burden a Double-J® stent was inserted before commencement of SWL.

Urine was taken for culture 1 week before the scheduled date of SWL. If the culture was positive, patients were treated with oral or intravenous antibiotics of appropriate sensitivity for 5 days, starting 2 days preoperatively. Patients with negative cultures received ceftriaxone sodium 50 mg/kg at induction.

All patients were well hydrated throughout the procedure with an intravenous fluid bolus, and most received 0.5 mg/kg furosemide intravenously at the end of the session. This approach optimizes urine flow, creating a fluid interface around the stone to aid impact of the shock wave, and helps facilitate elimination of stone fragments. For similar purpose intravenous fluid therapy is maintained in addition to oral fluids for up to 48 hours postoperatively.

The kidneys and upper abdominal organs were evaluated with ultrasound with or without fluoroscopy and/or plain abdominal radiograph at the end of a treatment session and at 24 to 48 hours after treatment to assess stone fragmentation, renal dilatation and presence of any acute injury to the kidney or surrounding organs. Further evaluation was performed at 1 and 3 months after treatment, and annually thereafter with clinical assessment, urine culture and ultrasound examination of the renal tract with or without plain abdominal radiograph.

A total of 94 patients (52%), including 71 children younger than 5 years (48 infants), all stone-free, underwent ^{99m}Tc DMSA scintigraphy at least 6 months after completion of treatment. These findings were compared to pretreatment DMSA scintigrams to determine the incidence of acquired scars after SWL and to ascertain whether treatment had led to reduced renal function on the treated side. A decrease in relative function of 5% or more was deemed significant.

RESULTS

A total of 182 patients (mean age 5.3 years, range 5 months to 19.8 years) were treated for renal calculi during the 20-year study period. Median number of shocks delivered per session was 3,000 (IQR 2,601 to 3,005). Patients underwent 1 to 4 sessions of SWL per kidney with at least 1 month between treatments. Complications were uncommon. Steinstrasse developed in 2 patients (1%) and 2 had posttreatment pyelonephritis (1 with an associated renal pelvic blood clot).

During the 20-year period 2 patients had little or no function in the affected kidney on pretreatment DMSA scintigram and subsequently underwent nephrectomy. A total of 94 patients (52%), all stone-free, underwent posttreatment ^{99m}Tc DMSA scintigram. All except 3 were rendered stone-free by SWL monotherapy (2 underwent open pyelotomy before SWL and 1 underwent open surgery after SWL). No new renal parenchymal scars were observed on posttreatment DMSA scans. Regarding renal function, patients fell into 1 of 4 groups (see table).

Most patients (89%) had no change in function after treatment (see figure). Seven patients had a greater than 5% increase in relative function in the treated kidney, whereas 3 had a greater than 5% decrease. For 2 patients this condition was transitory.

An 11-year-old child had a relative decrease in function of 8% on the ipsilateral side, with spontaneous resolution at 3.5 years after treatment. A 17-month-old child also experienced an 8% reduction in relative function on the treated side, which had resolved on DMSA scintigram 6 months later. A 13-year-old patient with a significant bilateral stone burden who had bilateral Double-J stents inserted at SWL was lost to followup for a time after treatment on the right side. The patient subsequently had an asymptomatic chronically obstructed system, and had a permanent significant loss of function due to steinstrasse and obstruction of the Double-J stent. He subsequently underwent right nephrectomy and open stone removal on the left side. Loss of function in this case was attributed to obstruction rather than shock wave damage to the kidney.

Renal function before and after extracorporeal SWL measured by DMSA scan

Group	No. Pts (%)	Findings
1	66 (70)	Normal function pretreatment + posttreatment
2	18 (19)	Decreased function in affected kidney pretreatment, no change posttreatment
3	3 (3)	Impaired function in treated kidney (permanent in 1 pt)
4	7 (7)	Improved function in treated kidney