European Review for Medical and Pharmacological Sciences 2012; 16: 1404-1408

The effectiveness of extracorporeal shock wave lithotripsy in the treatment of ureteral stones in children

N. PIRINCCI[1], I. GECIT[1], S. BILICI[3], K. TAKEN[4], S. TANIK[4], K. CEYLAN[2]

[1]Department of Urology, Yüzüncü Yil University, Faculty of Medicine, Van, Turkey
[2]Department of Urology, Selcuk University, Faculty of Selcuklu Medicine, Konya, Turkey
[3]Department of Pediatric Surgery, Yüzüncü Yil University, Faculty of Medicine, Van, Turkey
[4]Ministry of Health, Regional Training and Research Hospital, Clinic of Urology, Van, Turkey

Abstract. – PURPOSE: In our study, we evaluated retrospectively the efficacy of extracorporeal shock wave lithotripsy (ESWL) in the treatment of ureteral stones in children.

MATERIALS AND METHODS: Between the dates of 2005-2010, 62 children who were applied ESWL due to the ureteral stone in our Clinic and consisted of 42 males and 20 girls whose mean age was 6.6 ± 3.1 were evaluated. 31 (50%) of the patients were upper ureteral stone, 10 (16.1%) of them were middle ureteral stone and 21 (33.9%) of them were lower ureteral stone. The sizes of the stones were 4 to 17 mm, the average was 7.1 mm. ESWL was performed in the supine position for upper ureteral stones, in the supine/prone position for middle and lower ureteral stones.

RESULTS: Stone-free rate was determined as 93.5% in three-month follow-up of the patients. Re-treatment was done at 14.5% of the patients. The implementation of ESWL was ended unsuccessfully at 4 children (6.5%). A significant difference was not detected between three-month stone-free rates in terms of the size of the stones and location. There was not any serious complication at any of the patients.

CONCLUSIONS: According to these findings ESWL with its high stone-free rates and negligible complications is the first method to be refered in the treatment of ureteral stones in children.

Key Words:
Pediatric, Shock wave lithotripsy, Ureteral stone.

Introduction

80% of urinary tract stones can be treated with extracorporal shock wave lithotripsy (ESWL) which is a revolution of the treatment of urinary tract stone (1). Today, in the treatment of ureteral stones, ESWL and ureteroscopy are the two method of the treatment applied to as a basic (2). However, there are limited number of studies related to the use of ESWL in the treatment of ureteral stones in children[3]. Although there are some of the potential dangers in the growing child, ESWL has been reported to be highly successful in the treatment of urinary tract stones in children[4].

Pediatric urolithiasis is a rare disease with different epidemiological characteristics, and with a different incidence all over the world[5,6]. It has been reported that the urinary tract stone disease is endemic in a study from our country and 17% of the patients with urinary tract of the stone disease are younger than 14 year-old[7]. It can be benefited from ureterorenoscopy and basket practice, ureteral stendler, shock wave lithotripsy, percutaneous nephrolithotripsy or open surgery in the treatment of renal and ureteral stones in children[8].

In recent years, it has been reported that there is an increase in the formation of urinary tract stone in childhood. Because urinary tract stones tend to repeat more common in children than in adults, it should be benefited from the minimal invasive methods. Fewer complications and morbidity occur and the treatment of ureteral stones in children can be more successfully treated with small caliber ureteroscope. However, the ureteral instrumentation can be dangerous especially in younger boys. The reliability of ureteroscopy has not been established with certainty in pediatric age group.

Although the treatment of ureteral stones is standardized with guideline in adults, there is not a consensus about the etiology of pediatric urolithiasis, course and treatment algorithm. The aim of our study is to evaluate the safety and efficacy of ESWL in the treatment of pediatric ureteral stones in our Clinic which is one of the large stone centers of the eastern region of Turkey.

Corresponding Author: Necip Pirincci, MD; e-mail: necippirincci@hotmail.com

Materials and Methods

Between the dates of 2005-2010, 62 children who were applied ESWL by using Elmed branded lithotripter (electromagnetic lithotripter, Elmed Inc., Turkey) due to the ureteral stone in our Clinic and consisted of 42 males and 20 girls whose mean age was 6.6 ± 3.1 were evaluated. 31 (50%) of the patients were upper ureteral stones, 10 (16.1%) of them were middle ureteral stones and 21 (33.9%) of them were lower ureteral stones. The sizes of the stones were 4 to 17 mm, the average was 7.1 mm. ESWL was performed in the supine position for upper ureteral stones, in the supine/prone position for middle and lower ureteral stones All of the stones were identified as abdominal radiograph, ultrasound, excretory urography and by using computed tomography (CT) when necessary. ESWL was performed to 18 patients at the hospital, but to the others as outpatients.

All of the patients were evaluated with anamnesis, physical examination, urinanalysis, serum biochemical tests, bleeding and clotting time, ECG before ESWL. ESWL was performed to the patients with urinary tract infection after their urine cultures were sterile with the appropriate treatment. The procedure of ESWL was performed to the children with the weakness of cooperation under the dissociative anesthesia with ketamine. A pallet which has 20 cm aperture in its center was used to reduce the damage that ESWL waves gave the surrounding tissue and organs and exposure of X-ray beams in the direction of shock waves. It was benefited from fluoroscopic imaging to localize the stone. The position of the treatment was determined according to the localization of the stone. ESWL was performed in the supine position in children with proximal ureteral stone and in the supine or prone position in children with medium or lower ureteral stone. The treatment was started at low power and was gradually increased so that the maximum power would be 3000 shock until an appropriate power. We evaluated the size, location and number of the stone in children whom we performed the ESWL related to the stone, and we evaluated the level of the energy, the number of shock waves, the patient's exposure to the radiation, the number of ESWL sessions and the applications of auxiliary as for the treatment of the characters. We performed the duration between two sessions for two weeks to allow the passage of the stone fragments. The stone-free rates were determined by abdominal radiograph taken following the application of two weeks and three months later. The patients whose stones were radiologically detected not to be fragmented after 3 sessions were regarded as a failure. EQ (Efficacy Quotient) was used in the assessment of the effectiveness of ESWL. The value of EQ was calculated with formula of the stone-free %/(100% + re-treatment rate % + auxiliary procedures %)[9].

Statistics

It was benefited from the Chi-square test in the comparison of EQ and stone-free rates in different localization and size of the stones. We did not have an important complication during or after the application of ESWL.

Results

The number of shock wave was between 600-3000 (mean 2025±511.2). The level of the energy was between 3 and 5 for each pulse (the average level 4). Dissociative anesthesia was performed to 18 of our patients (29%). Stone-free rate was determined as 93.5%, re-treatment was determined as 14.5% and EQ was determined as %81.7 in the follow-up of three-month of the patients. Three-month stone-free, re-treatment and the rates of EQ were shown in Table I according to the size of the stone and its localization. A significant difference was not detected between three-month stone-free rates in terms of the localization of the stone ($p > 0.05$). In terms of the size of the stone, stone-free rates in the second week was correlated with the size of the stone, but three-month of stone-free rates in three groups were determined to be similar. The application of ESWL was unsuccessfully ended at 4 children (6.5%). There was the stenosis of ureteropelvic junction (upj) at the two of them and was corrected by open surgery. Ureterolithotomy was performed to one of the other two stones not broken with ESWL and ureteroscopy was performed to the other.

Clinically significant perirenal hematoma, dermal ecchymoses and anesthesia-related complication or arrhythmia were not observed in any of the patients. Urinary tract infection improved with the oral antibiotics in two patients (3.2%) and renal colic relieved with the antispasmotic and anti-inflammatory in 4 patients (6.4%) were observed. The most common stone component was found as calcium oxalate in 19 patients whose stone analysis was carried out.

Table I. Stone free rates after ESWL treatment, retreatment rates and efficacy quotient rates according to location and size of calculi.

Location	Stone	< 1 cm	1-2 cm	> 2 cm	Total
Proximal	31				
Stone-free rate		20/20 (100%)	9/10 (90%)	0	29/31 (93.5%)
Re-treatment rate		1/20 (5%)	2/10 (20%)	1/1 (100%)	4/31 (12.9%)
EQ		99.5%	75%	0	82.8%
Middle	10				
Stone-free rate		8/8 (100%)	1/2 (50%)	0	9/10 (90%)
Re-treatment rate		1/8 (12.5%)	1/2 (50%)	0	2/10 (20%)
EQ		88.9%	33.3%	0	75%
Distal	21				
Stone-free rate		14/14 (100%)	6/7 (85.7%)	0	20/21 (95.2%)
Re-treatment rate		1/14 (7.1%)	2/7 (28.6%)	0	3/21 (14.3%)
EQ		93.4%	66.7%	0	83.3%

Discussion

Significant changes have been in the treatment algorithm of the ureteral stones development of ESWL and endoscopic methods in the last 20 years. Minimal invasive techniques have replaced the open surgery not only in adults, but also in children in the treatment of ureteral stones. Minimal invasive techniques in the stone disease of the pediatric age group is more important because the recurrence of the urinary tract stones in children will be more than in adults.

In children, the stone disease of the upper urinary tract is about 1/50-1/75 of the adults[10]. ESWL and ureteroscopy are the two important methods in the treatment of the ureteral stones in children[9,11,12]. However, there is a risk of the vesicoureteral reflux-related to the ureteral dilatation carried out during the process of the ureteroscopy in children. But, the need for the ureteral dilatation has been reduced with the use of the ureteroscopes thinner than the diameter of 6,9f. Another disadvantage of this type of the ureteroscopes is that it needs technical equipment much more than adults[13,14]. In addition, the ureteroscopy done during the childhood can also lead to the ureteral injuries in both sexes in addition to the development of the urethral injury and narrowness in boys.

The first large series showing the ESWL's activity, the complications and the stone-free rates in children was published in 1986[15]. Because the efficacy and safety of ESWL have been shown in children, it has been the first selected treatment method for the kidney stone[16,17]. However, the algorithm of ESWL treatment has not been fully established in pediatric patients[18,19].

The stone fragmentation and its removal after ESWL is easier in children than in adults and starts earlier[20]. Unlike adults due to the small sizes of the body of the children, this probably depends on reaching the stone with less energy loss of the shock waves. Because the distance between the skin and stone in children is shorter, the shock waves are less absorbed by the surrounding tissue and organs and they reache the stone with less energy loss and their therapeutic effect relatively becomes more. While passing through the body tissue which is 6 cm of thickness in children, the shock waves have been reported to lose just 10-20% of their energies[20].

The ureteral lumens of children are narrower and shorter compared to the adults. Although the narrowness of the ureteral lumen in children is seen as a disadvantage for the passage of the pieces of the stone which is fragmented, the shortness of the ureter compared to the adults has compensated for it[21]. In fact, the ureter of the children is more elastic and it can more broden. This structure of the ureter makes the passage of the pieces of the stone easy and blocks the ureter to be impacted by the pieces of the stone[22]. Being softer of the stone structure in children, being relatively smaller the size of the stone and increased ureteral compliance have alone made the effectiveness of ESWL more successful than in adults in the treatment of the ureteral stones[22,23]. All of our cases tolerated the passage of the fragmented stone pieces.

It has been reported that the location of the stone was an important factor affecting the stone-free rates (11.4). Muslumanoglu et al[24] have reported that the stone-free rates in lower ureteral stones were lower than the upper and middle

ureteral stones. It has been recommended that the patients with distal ureteral stone should be treated with urethroscopy rather than ESWL. However, three-month of stone-free rates in the upper, middle and lower ureteral stones in our study were respectively 93.5, 90 and 95.2% and we found that there was no difference between the stone-free rates of the three group. Because the intensity of the pelvic bone in children is lower than in adults, shock waves lose less energy until they reach the stone and therefore higher success can be achieved in mid-ureteral stones compared to the adults.

Most of the anesthetic methods can be performed for the procedure of pediatric ESWL[19,25,26]. While ESWL can usually be performed to the big children without the need for any medication, younger children often need the anesthesia due to the lack of co-operation. The dissociative anesthesia was performed to 18 patients in our series. Any anesthetic complication was not encountered.

Although ESWL-related complications might be variable from the hematuria to the sepsis, these complications have very rarely been seen open[27]. In addition, retrospective studies in children have shown that ESWL did not lead to the renal morphology and functional changes (11.28). The blood vessels are very sensitive to the effects of ESWL. Although we have also observed the macroscopic hematuria in about 20% of our patients in our study, we did not determine the subcapsular hematoma in any of our patients.

Conclusions

According to these findings, ESWL with its high stone-free rates and negligible complications is the first method to be referred in the treatment of ureteral stones in children.

References

1) Graff J, Diederichs W, Shulze H. Long-term followup in 1003 extracorporeal schock wave lithotripsy patients. J Urol 1988; 140: 479-483.
2) Anagnostou T, Tolley D. Management of ureteric stones. Eur Urol 2004; 45: 714-721.
3) Vandeursen H, Devos P, Baert L. Electromagnetic extracorporeal shock wave lithotripsy in children. J Urol 1991; 145: 1229-1231.
4) Muslumanoglu AY, Tefekli A, Sarilar O, Binbay M, Altunrende F, Ozkuvanci U. Extracorporeal shock wave lithotripsy as first line treatment alternative for urinary tract stones in children: a large scale retrospective analysis. J Urol 2003; 170: 2405-2408.
5) Esen T, Krautschick A, Alken P. Treatment update on pediatric urolithiasis. World J Urol 1997; 15: 195-202.
6) Goel MC, Baserge NS, Babu RV, Sinha S , Kapoor R. Pediatric kidney: Functional outcome after extracorporeal shock wave lithotripsy. J Urol 1996; 155: 2044-2046.
7) Tellaloglu S, Ander H. Stones in children. Turk J Pediatr 1984; 26: 51-60.
8) Van Savage JG, Palanca LG, Andersen RD, Rao GS, Slaughenhoupt BL. Treatment of distal ureteral stones in children: Similarites to the American urological association guidelines in adults. J Urol 2000; 164: 1089-1093.
9) Nelson RN, Jose AL, Jean AI, Mauricio RN, Rodrigues Netto M. Extracorporeal shock wave lithotripsy in children. J Urol 2002; 167: 2164-2166.
10) Kroovand RL. Pediatric urolithiasis. Urol Clin North Am 1997; 12: 173-184.
11) Brinkmann O, Griehl A, Kuwertz-Broking E, Bulla M, Hertle L. Extracorporeal shock wave lithotripsy in children: efficacy, complications and long-term follow-up. Eur Urol 2001; 39: 591-597.
12) Cass AS. Comparison of first-generation (Dornier HM3) and second-generation (Medstone STS) lithotripters: treatment results with 145 renal and ureteral calculi in children. J Endourol 1996; 10: 493-499.
13) Schroff S, Watson GM. Experience with ureteroscopies in children. Br J Urol 1995; 75: 395-400.
14) Al Busaidy SS, Prem AR, Medhat M. Paediatric ureteroscopy for ureteric calculi: a 4-year experience. Br J Urol 1997; 80: 797-801.
15) Newman DM, Coury T, Lingeman JE, Mertz JH, Mosbaugh PG, Steele RE, Knapp PM. Extracorporeal shock wave lithotripsy experience in children. J Urol 1986; 136: 238-240.
16) Mishriki SF, Wills A, Mukherjee JD, Frank JD, Feneley RCL. Extracorporeal shock wave lithotripsy for renal calculi in children. Br J Urol 1992; 69: 303-305.
17) Longo JA, Netto NR Jr. Extracorporeal shock wave lithotripsy in children. Urology 1995;46: 550-552.
18) Ali Farsi HM, Mosli HA, Alzemaity M, Bahnesy AA, Ibrahim MA. In situ extracorporeal shock wave lithotripsy (ESWL) for the management of primary ureteric calculi in children. J Pediatr Surg 1994; 29: 1315-1316.
19) Vandeursen H, Devos P, Baert L. Electromagnetic extracorporeal shock wave lithotripsy in children. J Urol 1991; 145: 1229-1231.
20) Longo JA, Netto NR Jr. Extracorporeal shockwave lithotripsy in children. Urology 1995; 46: 550-552.

21) Andreesen R, Fedel M, Sudhoff F, Friedrichs R, Loening SA. Quality of semen after extracorporeal shockwave lithotripsy for lower urethral stones. J Urol 1996; 155: 1281- 1284.

22) Gofrit ON, Pode D, Meretyk S, Katz G, Shapiro A, Golijanin D, Wiener DP, Shenfeld OZ, Landau EH. Is the pediatric ureter as efficient as the adult ureter in transporting fragments following extracorporeal shock wave lithotripsy for renal calculi larger than 10 mm? J Urol 2001; 166: 1862-1864.

23) Marberger M, Turk C, Steikogler I. Piezoelectric extracorporeal shock wave lithotripsy in children. J Urol 1989; 142: 349-352.

24) Muslumanoglu AY, Tefekli AH, Altunrende F, Karadag MA, Baykal M, Akcay M. Efficacy of extracorporeal shock wave lithotripsy for ureteric stones in children. Int Urol Nephrol 2006; 38: 225-229.

25) Aldridge RD, Aldridge RC, Aldridge LM. Anesthesia for pediatric lithotripsy. Paediatr Anaesth 2006; 16: 236-241.

26) Van Horn AC, Hollander JB, Kass EJ. First and second generation lithotripsy in children: results, comparison and followup. J Urol 1995; 153: 1969-1971.

27) Farhat WA, Kropp BP. Surgical treatment of pediatric urinary stones. AUA update series 2007; 26: lesson 3.

28) Netto N, Longo J, Ikonomidis JA, Rodrigues Netto M. Extracorporeal shock wave lithotripsy in children. J Urol 2002; 167: 2164-2166.