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A Comparison of Holmium YAG Laser and Electrokinetic Lithotripter in Pediatric Ureteral Stone Treatment

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Abstract

Background: We evaluated endoscopic treatment of ureter stones with a holmium: yttrium-aluminum-garnet laser (Ho: YAG) lithotripter and an electrokinetic lithotripter (EKL) in children.

Methods: Patients with ureteral stones, admitted to the pediatric surgery department of our hospital between November 2011 and January 2015, were evaluated retrospectively. Demographic data, initial symptoms, age, sex, stone size, preoperative renal pelvis diameter, use of a jj stent, and complications were recorded. We used a 4.5 Fr semirigid ureterorenoscope with a Ho: YAG lithotripter and an EKL to treat ureteral stones.

Results: In patients treated with Ho: YAG lithotripter, a total of 17 ureteroscopic procedures were performed on seven female and six male children having a mean age of 7.62 $\pm$ 4.46 years. Seven of these patients had right, five had left, and one had bilateral ureteral stones, with a mean diameter of 8.96 $\pm$ 3.52 mm. Preoperative pelvis renalis diameter was 16.22 $\pm$ 11.45 mm. A jj stent was used in all patients. Abdominal pain, hematuria, nausea-vomiting, and pollakiuria were the initial symptoms with complications such as hematuria, ureteral damage, infection, and spontaneous jj stent removal. In three cases, fragmentation was not successful and we needed a second session. In the EKL group, a total of 18 ureteroscopic procedures were performed on ten female and six male children with a mean age of 6.81 $\pm$ 3.67 years. Six of these patients had right, eight had left and two had bilateral ureteral stones, with a mean diameter of 8.26 $\pm$ 2.83 mm. Mean preoperative pelvis renalis diameter was 10.18 $\pm$ 2.66 mm. No jj stent was used in these patients. Initial symptoms were abdominal pain, hematuria, nausea-vomiting, vomiting, dysuria, and pain in the costovertebral region, while hematuria was also among the postoperative complication. In two cases, fragmentation was not successful and an extra session was needed.

Conclusions: Either of Ho: YAG lithotripter or EKL are effective and can be successfully used in ureteroscopic management of pediatric ureterolithiasis. The complication rate was slightly lower when an EKL was used.

Keywords: Child, Urolithiasis, Lithotripsy

1. Background

The development of instruments in endourology has improved the management of ureteral stones in pediatric patients. Small-caliber ureteroscopes increase stone-free rate and decrease complications. Ureteroscopy (URS) is the first-line treatment option in urolithiasis rather than shock wave lithotripsy (SWL) (1, 2). Pneumatic, electrokinetic, and holmium: yttrium-aluminum-garnet laser (Ho: YAG) lithotripters are being used in urolithiasis management (3, 4). There is not sufficient reports about use of electrokinetic lithotripters in children. We evaluated and compared the results of endoscopic treatment of ureter stones by Ho: YAG lithotripter and electrokinetic litotripter (EKL) in children. We also aimed to discuss our suggestions in either of the treatment methods.

2. Methods

We retrospectively analyzed the records of children with distal ureterolithiasis who had been admitted to two different departments between November 2011 and January 2015 The demographic data, initial symptoms, age, sex, stone size and location, preoperative renal pelvis diameter in millimeters, use of a jj stent, and complications were recorded. All patients had preoperative routine blood tests, urine analysis, urinary ultrasonography, and a plain abdominal X-ray. They received antibiotic prophylaxis, and ureteroscopy was performed under general anesthesia.

We used a 4.5 Fr semirigid ureterorenoscope (4.5/6.5 Fr; R. Wolf, Knittlingen, Germany) with a holmium YAG laser lithotripter (Group 1, Education and Research Hospital) and an electrokinetic lithotripter LithoRapid; (Olympus, Rohrdorf, Germany) (Group 2, faculty of medicine hos-

pital). In EKL, a metal probe with a magnetic core provides a stroking movement against the stone; this movement is accelerated due to the electromagnetic principle. During ureteroscopy, we used a manual hydrodilatation pump and isotonic fluids to avoid hyponatremia and hypothermia. Neither active nor passive ureteral dilatation was made. After fragmentation, smaller stones were allowed to move spontaneously, and if needed, a forceps was used to remove the stones. Based on the stone analysis reports, medical therapy involving dietary recommendations was applied. We used three Fr jj catheters postoperatively in Group 1 because of ureteral edema and trauma. Follow-up was made by ultrasonography at three weeks, and if stone-free status was observed, the jj catheters were removed under general anesthesia.

We utilized descriptive statistics for statistical analysis. The Mann-Whitney U test, Spearman's correlation test, and chi square test were performed for comparisons of groups, using the statistical software package SPSS version 19.0. A P value < 0.05 was considered statistically significant.

3. Results

In patients treated with the holmium YAG laser lithotripter, a total of 17 ureteroscopic procedures were performed on seven female and six male children having a mean age of 7.62 ± 4.46 years. Seven of these patients had right distal, five had left distal, and one had bilateral ureteral stones, with a mean diameter of 8.96 ± 3.52 mm. Preoperative pelvis renalis diameter was 16.22 ± 11.45 mm. A three Fr jj stent was used in all patients postoperatively and removed under general anesthesia. Complications were hematuria, ureteral damage, infection and spontaneous jj stent removal (Table 1). In three cases, we were unsuccessful at lithotripsy in the first session. One case was due to ureteral damage, which was managed with a jj stent placement. In the other two cases, the stone was attached to the ureteral wall and so inadequate lithotripsy was performed. We performed a second session after four weeks, and recovery in the patient with ureteral damage was uneventful with all patients being stone free. Infections reported in urinary cultures were treated with appropriate antibiotics.

In the electrokinetic lithotripter group, a total of 18 ureteroscopic procedures were performed on ten female and six male children with a mean age of 6.81 ± 3.67 years. Six of these patients had right distal, eight had left distal, and two had bilateral ureteral stones, with a mean diameter of 8.26 ± 2.83 mm. Mean preoperative pelvis renalis diameter was 10.18 ± 2.66 mm. Hematuria was among the postoperative complications (Table 1). We did not use any jj stents in these patients. In two cases, fragmentation was not successful and we needed an extra session. We did not need an open surgery for the complications or fragmentation failure. All patients were evaluated with plain radiography and ultrasonography one week after URS. We used the same method in either groups for the treatment of persistent stones in the second session. The stone-free rate was 100% in both groups. Statistically, there were no differences between age, stone size, or preoperative pelvis renalis diameter in either group (P values: 0.522, 0.688, 0.421 respectively). We were able to have a biochemical analysis in 50 % of patients. Calcium oxalate stones were observed in each group.

4. Discussion

Hereditary factors, diet, geographic location, and socio-economic status affect the occurrence of stones (5). In endemic countries, such as Turkey, metabolic factors, like hypocitraturia and hyperuricosuria, are also considered as risk factors for stone formation, especially in preschool-age children (6). The first step of management should be identification and, if possible, the reduction of these risk factors (7). Extracorporeal shock wave lithotripsy (ESWL), percutaneous nephrolithotomy (PNL), retrograde intrarenal surgery (RIRS), and open surgery are the treatment options for urolithiasis in children.

URS with a pneumatic lithotripter, EKL, and Ho: YAG lithotripters are the first-line treatment in urolithiasis management (3, 4). A metal probe with air pressure pushing the stone is the main mechanism of a pneumatic lithotripter (3), whereas in EKL, an electric coil generates an electromagnetic field that causes probe vibration (8). In the present study, we evaluated the endoscopic treatment of ureter stones by Ho: YAG lithotripter and EKL in children. There is not adequate knowledge about application of EKL in children. This is the first study in children that compares both lithotripsy systems.

Several studies have compared the clinical efficacy of SWL and URS. Vorreuther et al. evaluated adult patients with ureteral stones who had SWL minimum once in life and found no difference between lithotripsy systems in the efficacy of stone fragmentation and stone-free rates (3). Menezes et al. found similar results in adult patients with ureteric stones refractory to SWL (8). Eden et al. compared efficacies of intracorporeal and extracorporeal lithotripsy in adults for distal ureteral calculi. They suggested in situ SWL for small (< 8 mm) and URS and lithoclast fragmentation for large (> 8 mm) distal ureteral calculi (9), although the effectiveness of SWL in reducing ureteral stones in children and for stone-free rates during the first session is not impressive but requires a second (even a third) session (10).

Table 1. Data analysis and P values

	Group 1 (Ho: YAG)		Group 2 (EKL)		P Value
Mean age (year)	7.62 ± 4.46		6.81 ± 3.67		0.522[a]
Male	6		6		
Female	7		10		
Total, n	13		16		
Ureteroscopic procedure	17		18		
Initial symptom					
	Abdominal pain	10	Abdominal pain	10	
	Macroscopic hematuria	1	Macroscopic hematuria	3	
	Nausea-vomiting	1	Nausea-vomiting	3	
	Pollakuria	1	Dysuria	1	
			Costovertebral pain	1	
Stone size mean	8.96 ± 3.52 mm		8.26 ± 2.83 mm		0.688[a]
Stone location					
	Right ureter	7	Right ureter	6	
	Left ureter	5	Left ureter	8	
	Bilateral ureter	1	Bilateral ureter	2	
Preoperative pelvis renalis diameter mean	16.22 ± 11.45 mm		10.18 ± 2.66 mm		0.421[a]
Postoperative complication					
	Hematuria	5	Hematuria	4	
	Ureteral damage	1			
	Infection	1			
	Spontan jj stent removal	1			
Stone free rate	100%		100%		

[a] Mann-Whitney Test.

These findings suggest that URS should be the initial surgical intervention for ureteral stones in children. In our study, we preferred URS with Ho: YAG lithotripter and EKL in ureteral stones.

Several reports have evaluated lithotripters in the management of ureteric stones. Vorreuther et al. treated 57 adult patients with ureteral stones and did not find any difference between the pneumatic lithotripter and EKL systems (3). Forty-six adult patients with ureteric stones refractory to treatment by SWL were treated with lithoclast (pneumatic) and EKL. There was no significant difference in the stone-free rate, procedure duration, or proximal stone migration rate (8). However, in 38 adult patients with mid or lower ureter stones, lithoclast was reported to be more effective than EKL (11). The efficacy of the Ho: YAG lithotripter and a pneumatic lithotripter in treating 216 ureteral stones was reported to be the same as in a retrospective adult study. Author concluded that there was no difference in the operative time and success rate (12). Similarly, Degirmenci et al. compared the Ho: YAG lithotripter and a pneumatic lithotripter in adults and reported that each method is efficient and has a high success rate, especially in distal-impacted ureteral stones (13). The lithoclast, Ho: YAG lithotripter, and stonebreaker lithotripter, which is nonelectric and powered by high-pressure carbon dioxide gas, were used for distal ureteral calculi. These are considered to be equally effective in all systems (14). In contrast, Atar et al. evaluated the pneumatic lithotripter and the Ho: YAG lithotripter in pediatric ureteral stones. Although either of lithotripters were effective and successful, a high stone-free rate and a lower complication rate was achieved with Ho: YAG lithotripsy (15). As previously discussed, studies evaluating lithotripters, especially in children, are rare, and no study has compared the effectiveness of the Ho: YAG lithotripter and the EKL in both adults and children. Our results did not show any differ-

ence between initial symptoms, age, sex, or stone size in either group. There was slightly increase in preoperative renal pelvis diameter in the Ho: YAG group, but this was not statistically significant. This increase may be due to ureteral impaction of stones. Ureteral damage occurred in one patient (the Ho: YAG group) as a different complication; it is possible that the causes were ureteral inflammation due to stone impaction and unforeseen ureteral damage. Compared with the Ho: YAG lithotripter, EKL, a rheostat, and a handset, including an electric coil generating an electromagnetic field, vibrate the probe. This transmits vibrations to the distal end of the probe and fragments the stone (8). Differently from the Ho: YAG lithotripter during pushing to the foot switch in the EKL limits the jackhammer effect, and we assume that this limitation decreases ureteral injury. The decision to replace the jj catheter in the Ho: YAG group was made based on ureteral inflammation and ureteral damage. We add here that the learning curve may be another affecting factor.

Both the pneumatic lithotripter and the Ho: YAG lithotripter were used safely and effectively in prepubertal children with ureteral stones without active or passive ureteral dilatation (16). In infants with stone disease, retrograde intrarenal surgery with the Ho: YAG lithotripter and a pneumatic lithotripter has been described as a first-line therapy in most patients (17). However, Elsheemy et al. reported a higher failure rate for patients under 2 years of age with the Ho: YAG lithotripter (4). In a retrospective study in adults, authors reported the safety and efficacy of EKL, especially in distal ureteral stones (18).

Comparing efficacy of Ho: YAG lithotripter and EKL we didn't find any difference statistically. Both lithotripters can be used in children. On the other hand, complication rate of Ho: YAG lithotripters is higher than EKL. Additionaly Ho: YAG lithotripsy is an expensive treatment option compared to EKL.

4.1. Conclusions

URS is the first-line treatment of distal ureteral stones in the pediatric population. Effectivity and stone-free rates are similar in both Ho: YAG laser lithotripter and EKL. The complication rate is slightly lower when EKL is used, but each method can be used with minimal morbidity and also EKL is a cheaper treatment option in comparison with Ho: YAG lithotripter.

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