Laser or Pneumatic Lithotripsy in Pediatric Ureteral Stones: Which One is More Effective?

Çocukluk Çağı Üreter Taşlarında Lazer veya Pnömotik Litotripsi: Hangisi Daha Etkin?

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ABSTRACT

Objective: The aim of this retrospective study was to compare the effectiveness of pneumatic and laser lithotripsy in the treatment of pediatric ureteral stones.
Methods: Among 60 cases of ureteral stones with a complete clinical follow-up between 2008 and 2012, clinical variables of patients, localization and stone load before ureteroscopy, energy source of lithotripsy, complication rate and follow-up period were evaluated retrospectively. Indication for ureteroscopy was accepted as the failure of extracorporeal shockwave lithotripsy, clinically significant obstructive uropathy and acute symptomatic patients.
Results: Thirty-six (60%) and 24 (40%) patients underwent the pneumatic and the laser lithotripsy, respectively. There was no statistically significant difference between the two groups preoperatively in terms of gender (p = 0.133), age (p = 0.211), stone size (p = 0.101), stone load (p = 0.850) and location (p = 0.301). After pneumatic and laser lithotripsy, 6 (16%) and 4 (16.7%) patients had clinically significant residual stones, respectively (p = 0.83). Residual stones were seen in the upper ureteral stones that migrated up during lithotripsy.
Conclusion: Both of the lithotripsy methods were found to be equally effective in pediatric populations. On the other hand, lower complication rates obtained in laser lithotripsy incline us to use the laser lithotripsy because of its safety as an energy source.

Key Words: Ureteroscopy, pediatics, laser, pneumatic, lithotripsy

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ÖZET

Amaç: Bu retrospektif çalışmanın amacı çocukluk çağı üreter taşlarında pnömotik ve lazer litotripsinin etkinliğini karşılaştırmaktır.
Yöntemler: Üreter taşı nedeniyle 2008-2012 yılları arasında takip edilen 60 hastanın, klinik değişkenleri, taş yeri ve taş yükü, kullanılan enerji kaynağı, komplikasyon oranları, takip süresi retrospektif olarak incelenmiştir. ESWL başarısızlığı, klinik anlamlı obstrüktif üropati ve akut semptomatik hastalar üreterorenoskopi endikasyonu olarak değerlendirilmiştir.
Bulgular: Sırasıyla 36 ve 24 hastaya pnömotik ve lazer litotripsi yapılmıştır. Gruplar arasında cinsiyet (p=0.133), yaş (p=0.211), taş boyu (p=0.101), taş yükü (p=0.850) ve yeri (p=0.301) incelendiğinde anlamlı fark saptanmamıştır. Pnömotik ve lazer litotripsi sonrası sırasıyla 6(16%) ve 4(16.7%) hastada anlamlı rezidü izlenmiştir. Rezidü taşlar üreter üst uç taşlarının litotripsi sırasında yukarı kaçması sonucu olmuştur.
Sonuç: Pediatrik populasyonda her iki litotripsi yöntemi de benzer şekilde etkin bulunmuştur. Öteki taraftan lazer litotripsinin komplikasyon oranlarının daha düşük olması lazer litotripsinin daha güvenli bir enerji kaynağı olduğunu göstermektedir.

Anahtar Sözcükler: Üreterorenoskopi, pediatri, lazer, pnömotik, litotripsi

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INTRODUCTION

Ureteral calculi are encountered less frequently in children than adults with a total of 7% (1). Urinary stones could be found in all urinary tract and the 20% of these is ureteral stones (3). Previously, the treatment of urinary stones was performed with open surgery but the major overwhelming problem that was encountered was the high incidence, especially the high recurrence rate in pediatric urinary stone disease. In order to overcome this important recurrent issue, minimal invasive approaches become the major source of treatment modalities with the development of lithotripsy technology and miniaturization of endoscopic equipments. Pediatric ureteral stones can be managed either with extracorporeal shock wave litotripsy (SWL) and/or ureteroscopy (URS) using the energy source of pneumatic, electrohydraulic, ultrasonic, laser for intracorporeal lithotripsy.

In 1929, first pediatric URS was applied with a cystoscope on a 2-week-old infant with posterior urethral valves. URS for distal ureteral stone was previously reported by Ritchey et al in 1988(5). After that and with the development of small diameter instruments, ureteroscopic approach has become more popular with children. Pediatric ureteral stones <3 mm generally spontaneously fall down with the larger stones likely requiring endourologic treatment. (4) In this manner, SWL and URS are recommended as the first-line treatment modality in the EAU guidelines (26). Furthermore, although pediatric ureter is much more dynamic than its adult counterpart, which means that SWL should be applied before URS, there are a lot of centers which directly apply URS rather than SWL for pediatric ureteral stones (13, 25). This brings up the fact that URS might become more and more popular in the treatment of pediatric ureteral stone disease, and may even be considered as the first-line treatment modality rather than SWL in the future.

In this study, we aimed to compare the surgical results and the effectiveness of pneumatic and laser lithotripsy for the treatment of ureteral stone disease in pediatric age groups.

MATERIAL AND METHOD

We reviewed the records of 60 children younger than 16 years who underwent URS for ureteral stone between 2008 and 2012 in the Urology Department of Gazi University School of Medicine, retrospectively. Age, gender, the preoperatively SWL treatment and the number of sessions, location and size of the stone, peroperative complications, postoperative result and the follow-up duration were recorded. All patients were evaluated preoperatively with kidney function tests, urine analysis, urine cultures and radiological imaging (plain abdominal film, ultrasonography, intravenous urography or non-contrast spiral tomography).

The indication for surgery was unsuccessful SWL, clinically significant obstruction, acute symptomatic ureteric calculi causing upper urinary tract dilatation. Negative urine culture was indispensable and if there was positive culture, the proper antibiotics were prescribed according to the antibiogram until the culture negativity was provided. All procedures were performed under general anaesthesia in lithotomy position and before the operation patients received prophylactic antibiotics according to their body weight. 9.5Fr cystoscope (Karl Storz, Germany) was used for an initial cystoscopy. Ureteroscopy was carried out by using a 7,5F ureteroscope (Karl Storz, Germany) combined with either a pneumatic lithotriptor (Swiss Lithoclast, Switzerland) or a holmium YAG:laser (Dornier Holmium Laser). Stones were completely fragmented into small pieces and large fragments were removed with semi-rigid forceps, and if there was an indication, double-j stent was inserted through the ureter.

Intraoperative and postoperative complications were noted according to the Satava (23) and the modified Clavien system, respectively (24). All children were examined with routine urine tests, plain abdominal film, and if there was an indication, ultrasonography or intravenous urography or non-contrast spiral tomography were obtained during the follow-up.

Documentation and statistical analysis was done by SPSS®, version 18.0. Mann-Whitney, Kruskal Wallis and chi-square tests were used to carry out comparisons. Parameters were compared and statistical significance was defined as $p < 0.05$.

RESULTS

Ureteral dilatation is not routinely applied in our clinic and none of our study patients underwent ureteric orifice dilatation during the procedures. Lithotripsy was performed with pneumatic lithotriptor (PL) and laser lithotripter (LL) in 36 (60%) and 24 (40%) children, respectively. In the PL group, there were 21 male and 15 female patients. In the LL group, 11 male and 13 female children underwent URS. The mean ages of the groups were 9, 11 and 7.04, respectively**.** Thirty-six percent and 29% patients in the PL and the LL group had undergone SWL as the first-line treatment, respectively. SWL were performed at most twice per patient, and the period between interventions were at minimum 10 days. In the PL group, 7 stones were located in the upper, 1 in mid-ureter and 28 in the lower ureter. In the LL group 3, 4, 17 stones were found in the upper, middle and lower ureter, respectively. Stone sizes were similar with 6,27 ± 2,03 mm in the PL group and 7,08 ± 1,66 mm in the LL group with the range of 3-13 mm. Stone burdens were 55,5 ± 31,2 mm^2 **,**53,87 ± 25,52 mm^2 respectively (Table 1). There was no significant difference in terms of gender (p = 0.133), age (p = 0.211), diameter (p = 0.101), stone burden (p = 0.850) and localization (p = 0.850) between two groups. The only statistically significant parameter was the complication rate which was seen in the PL group (p = 0.035). Six (16%) and 4 (16.7%) children in the PL and LL groups were not stone free postoperatively (p = 0.83). A double-j stent was inserted to 13 of 36 (36.1%) PL patients and 15 of 24 (62.5%) LL patients. The indication of d-j catheter insertion was residual fragments and significant tissue edema. All stents were removed in about postoperative 3-4 weeks. Residual stones were mainly seen in upper ureteral stones that migrated proximally during lithotripsy. Four upper ureteral stones in the PL group that migrated to kidney needed a second-line SWL treatment. All residual stones in the LL group passed spontaneously after the removal of ureteral stents.

Six intraoperative complications were seen in the PL group according to Satava Classification, and no postoperative complication was noted based on modified Clavien classification. All complications were reported as Grade 1 due to the proximal migration of the stone. A two-year-old girl with proximal ureteral stone suffered a grade 3 complication, undergoing ureterolithotomy because of the inability to reach the stone.

Table 1. Comparison of pneumatic and laser lithotripsy.

Variable			Pneumatic lithotripsy	Laser Lithotripsy	P value
Gender	F		15(%25)	13(%21,7)	0,206
	M		21(%35)	11(%18,3)	
Age			9,11±4,21	7.04±4,92	0.211
Stone size			6,27±2,03	7,08±1,66	0.101
Stone burden			55,5±31,2	53,87±25,52	0.850
Stone localisation	upper		7	3	
	mid		1	4	0.850
	lower		28	17	
Significant residual stone			6 (%16)	4 (%16.7)	0.83
Satava Class. -Stone migration		G1	5	0	**0.035**
-conversion to open surgery/ureterolithotomy		G3	1	0	

DISCUSSION

Previously SWL has been accepted as the first-line therapy of symptomatic ureteral and kidney stones, due to its minimally invasive nature (6). With the development of technology, the small caliber of ureteroscope and ancillary equipments, ureteroscopy in pediatric ureter stones is recommended as the first-line therapy in the 2010 guidelines of EAU together with SWL (7). Most children require sedoanalgesia for SWL. In 2003, Hoskings et al. studied the management of adult distal ureteral stones comparing SWL and ureteroscopy by gender.

Treatment was successful in 72% of patients undergoing SWL, and 95% of the ureteroscopy group (8). In another adult patient study conducted by Verze et al., SWL and ureteroscopy were compared and stone free rates were reported as 92.7% vs. 44%, and the retreatment rates as 94% vs. 85% , respectively (9). In a study from Italy, SWL and ureteroscopy were compared among 31 children. Sixteen out of 17 (94%) patients in ureteroscopy group was stone free. In SWL group, the stone free rate was 43% (6 of 14) after the first session, 64% (9 of 14) after the second session. The five patients of SWL group underwent successful ureteroscopy (11). These studies show that these two treatment modalities have almost the same clinical success with SWL group having more auxially measures. It seems in these studies that URS is a successful and efficient treatment modality, and is generally reserved for unsuccessful SWL sessions.

In a study from Ohio, Minevich et al. performed 65 endoscopic lithotripsy on children with a success rate of 98%. Dilatation of ureter was required in 23 cases, and a double-j catheter was inserted to 55 patients. No intraoperative complication was recorded. Ureteral stricture developed in one child that was corrected endoscopically (12). Galal et al. reported 16 ureteroscopic children cases, 9 (56%) were treated with pneumatic lithotripter, 7 (44%) children received only stone extraction without lithotripsy. He reported a stone free rate of 89%. There was no intraoperative complications. Early postoperative complications were insignificant hematuria in 2 patients, and renal colic and fever in 3 patients (13). URS in children seems to be safe with satisfying results, and has become a first-line treatment in many centers.

Different energy sources of lithotripsy is applied during URS. The Swiss Pneumatic lithoclast was developed in Switzerland in 1989, and first publications were presented in early 1990s (14). Its disadvantages are ureteral perforation and the proximal migration of stone after the stroke that can be exceeded by constricting the stone to the ureter wall in experienced hands. Another option used for lithotripsy is the holmium:YAG (yytrium-aluminum-garnet) laser, with different sizes (150,550µm) of fibers, that prevents the migration of stone proximally, and fragments the stone into smaller pieces without the indication to extract fragments.

When Holmium laser is used during lithotripsy, stone free rates in the previous studies were between 84.3% and 100% (16, 17, 18). In a study of Uygun et al., 120 laser lithotripsy procedures were performed in 111 children within different locations of the urinary tract. One-hundred-and-two (91.9%) patients were reported as stone free, and the success rate was 81.3% for renal stones, and 100% for ureter and bladder without any complications (18). In a multi-institutional retrospective study from Turkey, Dogan et al. treated 670 pediatric ureteral stones of 642 children. The stone free rate was 92.8%, and complications occurred in 8.4% of the cases (54 of 642), which were mostly low grade and self-limiting. Multivariate analysis showed that operation time was the only statistically significant parameter affecting the complication rate (25). These studies show us that laser lithotripsy is widely and successfully applied in the treatment of pediatric ureteral calculi with minimal morbidity.

Seong Soo Jeon et al. compared the PL and LL lithotripsy in adults and reported that the LL lithotripsy is a safer energy source with better clinical results. The immediate stone-free rates were 96.0% in the laser group and 73.1% in the pneumatic group. Ureteral perforation was seen in two patients of PL group, and no complications were seen in the LL group. The proximal migration of the stone were seen in 6 and 1 patient(s), respectively (21). Similarly, Tipu et al. compared different energy sources and reported a stone free rate of 92% in the LL group, and of 82% in the PL group. Complication rate was 4% in the LL group, and14% in the PL group (22). In a study, Yapanoglu et al. compared PL and LL in pediatric ureteroscopy. A total of 36 children were included. The stone-free status was achieved in 81.1% and 100% of the patients. Complication rates were 36.4% and 4%, respectively (27). In another comparative pediatric study, 64 children were examined and stone free rates (p=0.022) and complication rates (p = 0.024) were statistically significant in favor of the LL group(16). In our study, there were 6 (14%) complications in the PL group whereas in the LL group, no complication was detected. The comparative studies of pneumatic and laser lithotripsy show, as our study does, that laser lithotripsy seems to be a safer energy source with a lower complication rate.

CONCLUSION

Although limited data are reported in the literature about their comparisons, the pneumatic and laser lithotripsy in the ureteroscopic treatment of pediatric ureteral stones might be considered as the first-line treatment modalities with the development of technology and surgeon experience. Both lithotripsy methods were found to be equally effective in pediatric populations.

On the other hand, lower complication rates obtained in the laser lithotripsy incline us to use the laser lithotripsy because of its safety as an energy source.

Conflict of Interest

No conflict of interest was declared by the authors.

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