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Flexible Ureteroscopy with Laser Lithotripsy versus Extracorporeal Shock Wave Lithotripsy in Management of Ureteric Stones in Pediatric Age Group

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ABSTRACT

Background: pediatric stone disease is one of the most common urological issues in pediatric urology practice. The incidence of urinary stone disease is increasing in children in last decades. **Aim of the Work:** determination of the efficacy and outcome of flexible ureteroscopy using holmium Yttrium aluminium garne laser lithotripsy and compare its results with that of Extracorporeal shock wave lithotripsy EWSL in management of ureteric stones in pediatric age group. **Patients and Methods**: this study included 40 patients in pediatric age group. Complaining of upper ureteric stones less than (1cm). Patients underwent either ESWL or Flexible Ureteroscopy randomly according to 1: 1 ratio. The procedures were done at Eldemerdash hospital and National Institute of Urology and Nephrology. The patients were divided into two groups. Group A: Patients undergone extracorporeal shock wave lithotripsy (ESWL). Group B: Patients received flexible ureteroscopy and laser lithotripsy. **Results:** there was no statistically significant difference found between the two studied groups regarding age, sex, size and BMI, and stone free rate. Also there was highly statistically significant difference as regard hospital stay. The SWL group required a shorter period of hospitalization and there was highly statistically significant difference between the two groups regarding duration of the procedure which is more prolonged in flexible group. **Conclusion:** flexible URS lithotripsy and laser are considered a safe, highly efficient, minimally invasive, and reproducible surgery technique -with a higher stone free rates and less postoperative complications, after a single procedure, when compared to ESWL- for management of upper ureteric calculi in children after failure of ESWL.

Keywords: Flexible Ureteroscopy, Laser Lithotripsy, Extracorporeal Shock Wave Lithotripsy, Ureteric Stones.

INTRODUCTION

In recent decades, the incidence of pediatric stone disease has increased markedly. The disease incidence has raised 6–10 % annually over the last two decades also Population-based observational studies have estimated contemporary incidence to range from 36 to 145 per 100,000 children [(1)]. Also the increase in incidence in both sexes, indicated that girls showed a greater increase more than boys [(2)]. In pediatric patients a predisposing factor for stones can be found in more than 75% of children. The majority of cases have a metabolic disorder [(2)]. Children are regarded as high-risk recurrent stone formers rates range from 19 to 34 % at a mean follow-up of 2–3 years [(1)]. The three main treatment options available for pediatric stones treatment are Extracorporeal shock wave lithotripsy (ESWL), ureteroscopy (rigid and flexible), Percutaneous nephrolithotomy (PCNL) and open surgery has been reserved for complex stones associated with abnormal anatomy [(2)]. ESWL was used in pediatric stones in 1986, which showed safety, efficacy and complications equivalent to adult and its efficacy for upper tract stones has been reported as ranging from 68% to 84% [(2)]. Due to technical problems that arise with localization and focusing of ureteric stones in children, success rates with ESWL are lower for distal ureteric stones [(3)]. Extracorporeal shock wave lithotripsy in the pediatric population has higher success rate due to number of reasons including smaller body volumes and increased ureteral compliance allowing passage of stone fragments. Also, Dimercaptosuccinic acid (DMSA) scanning post-ESWL did not identify any evidence of renal scarring [(2)]. The advantage of flexible ureteroscopy in children includes high stone-free condition rates, low complication rates, minimal radiation exposure and short hospitalization periods [(3)]. The indication of flexible ureteroscopy has been extending, including intrarenal stones, ESWL failure, morbid obesity, musculoskeletal deformities and bleeding diathesis [(4)]. Initial concerns were raised regarding the traumatic sequelae to the pediatric ureter like Perforation, ischemia, stricture and reflux were expected following URS in children [(5)]. URS was found to be superior to ESWL in a prospective randomized study, rendering 94% stone free after one session compared with 43% stone free following SWL [(5)].

AIM OF THE WORK

To assess the safety, efficacy and outcome of flexible ureteroscopy using holmium Yttrium

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aluminium garne (YAG) laser lithotripsy and compare its results with that of Extracorporeal shock wave lithotripsy EWSL in management of ureteric stones in pediatric age group.

PATIENTS AND METHODS

Our study was a randomized double armed clinical trial done over 40 patients in pediatric age group who Complaining of upper ureteric stones less than (1cm). Patients underwent either ESWL or Flexible Ureteroscopy randomly according to 1: 1 ratio. The procedures were done at National Institute of Urology and Nephrology. **The study was approved by the Ethics Board of Ain Shams University .**The patients were divided into two groups. **Group A:** Patients undergone extracorporeal shock wave lithotripsy (ESWL), **Group B:** Patients received flexible ureteroscopy and laser lithotripsy. ***Inclusion Criteria:*** 1- Age (pediatric age) less than 12 years for both genders, 2- Upper ureteric stone, 3- Stone less than 1cm, 4- Single ureteric stone, 5- Radiopaque stones. ***Exclusion Criteria:*** 1- Patients with previous history of ESWL or Endourological intervention, 2- Elevated serum creatinine according to age (more than 0.7 mg/dL), 3- Moderate or severe hydronephrosis, 4- Bilateral pathology, 5- Febrile patients, 6- Uncorrected bleeding disorders or coagulopathies. ***Pre-operative Assessment and Procedure***: 1- History was taken from all patients, 2- General and local examination, 3- Routine preoperative investigations (Complete blood count, liver enzymes, kidney functions, bleeding profile and fasting blood sugar), 4- Urine analysis and culture were performed to ensure that Patients have sterile urine before the procedure, 5- Imaging assessments for stone location and pelvi-calyceal anatomy. A. Plain X-ray (KUB), pelvi abdominal ultrasonography (U/S) and Non-contrast multi slice CT urinary tract, 6- An informed consent was obtained from all parents including counselling on treatment options, procedure and potential complications need for follow up. All patients were given prophylactic antibiotics (3rd generation cephalosporin) at the induction of anesthesia. All procedures were done with the patient under general anesthesia.

Statistical analysis: Statistical analysis was carried out on the data of our 40 patients included in this study using SPSS (Statistical Package for the Social Sciences) version 23. Data were summarized using mean, standard deviation, median, minimum and maximum in quantitative data and using frequency (count) and relative frequency (percentage) for categorical data. For comparing categorical data, Chi square ($\chi 2$) test was performed. Exact test was used instead when the expected frequency is less than 5. Correlations between quantitative variables were done using Spearman correlation coefficient. P-values less than 0.05 were considered as statistically significant.

RESULTS

Table (1): Comparison between group A and group B regarding age, sex, size, BMI and house field unit

		Group A No. = 20	Group B No. = 20	Test value	P-value	Sig.
Age	Mean±SD Range	10.05 ± 1.73 7 – 12	10.40 ± 1.35 8 – 12	-0.712•	0.481	NS
Sex	Female Male	9 (45.0%) 11 (55.0%)	8 (40.0%) 12 (60.0%)	0.102*	0.749	NS
Size (cm)	Mean±SD Range	0.85 ± 0.08 0.7 – 1	0.89 ± 0.10 0.8 – 1	1.397•	0.171	NS
BMI	Mean±SD Range	20.62 ± 1.32 18.5 – 23	20.69 ± 1.64 18 – 24	-0.159•	0.874	NS
House field unit	Mean±SD Range	750 ± 105.13 600 – 900	1110 ± 116.53 900 – 1300	-10.258	0.000	HS

NS: Non-significant p>0.05; S: Significant p<0.05; HS: Highly significant p<0.01

*: Chi-square test; •: Independent t-test

Table shows that there were no statistically significant differences found between the two studied groups regarding age, sex, size and BMI preoperatively. There was a highly significant statistical difference between the two groups regarding house field unit.

Table (2): Comparison between group A and group B regarding time of operation

Time of operation (min)	Group A No. = 20	Group B No. = 20	Test value	P-value	Sig.
Mean±SD Range	38.95 ± 6.95 25 – 50	65.15 ± 9.72 50 – 70	9.806•	< 0.001	HS

Mean duration of the procedure was 38.95 ± 6.95 minute for single session of ESWL ranged from 25-50 minute in group A, while in group B it was 65.15 ± 9.72minute ranged from 50 – 70min. There was a highly significant statistical difference

(*P*< 0.001) between the two groups regarding duration of the procedure.

Table (3): Comparison between group A and group B regarding pain postoperative and Analgesics usage

Post-operative pain and analgesic use		Group A	Group B	Test value	P-value	Sig.
Pain postoperative day 1	Mean±SD	2.90 ± 1.02	5.40 ± 1.47	-6.260	0.001	HS
	Range	2 – 4	4 – 8			
Pain postoperative 2 weeks	Mean±SD	1.00 ± 1.03	1.00 ± 1.03	0.000	1.000	NS
	Range	0 – 2	0 – 2			
Analgesia post operative	No	15 (75.0 %)	10 (50.0%)	2.667	0.102	NS
	Yes	5 (25.0 %)	10 (50.0%)			

All patients in both groups suffered from pain in day one post-operatively with mean 2.90 ± 1.02 in group A and mean 5.40 ± 1.47 in group B, according to Wong-backer face pain scale (A pain scale that was developed by Donna Wong and Connie Baker. The scale shows a series of faces ranging from a happy face at 0 which represents "no hurt" to a crying face at 10 which represents "hurts worst." Based on the faces and descriptions, the patient chooses the face that best describes their level of pain. There was a highly significant statistical difference (P = 0.001) between the two groups regarding pain postoperative day 1. Mean pain score two weeks post-operatively was 1.00 ± 1.03 in group A while it was 1.00 ± 1.03 in group B. There were no significant statistical differences (P = 1.000) between both groups regarding mean pain score two weeks post-operatively. As regard analgesic use, five patients representing (25%) in group A suffered from post-operative pain that required usage of analgesics in the form of NSAID for at least 24 hours. While ten patients representing (50%) in group B suffered from `post-operative pain that required usage of analgesics in the form of NSAID for at least 24 hours. There were no significant statistical differences (P = 0.102) between both groups regarding mean pain score two weeks post-operatively regarding post-operative usage of analgesics.

Table (4): Comparison between group A and group B regarding re-treatment rate, axillary procedure

		Group A		Group B		Test value*	P-value	Sig.
		No.	%	No.	%			
Re-treatment rate	No	14	70.0%	20	100.0%	7.059	0.008	HS
	Yes	6	30.0%	0	0.0%			
Auxiliary procedure	No	17	85.0%	17	85.0%	0.000	1.000	NS
	Yes	3	15.0%	3	15.0%			

This table shows that 6 patients in group A representing 30% needed retreatment three of them needed a second session while the other three needed a third session of ESWL, while in group B there wasn't any patients needed retreatment. There was a highly significant statistical difference (P= 0.008) between the two groups regarding retreatment rate between two groups. Three patients in group A representing 15% of patient needed auxiliary procedure in form of (flexible ureteroscopy and ureteric stent fixation) also three patients in group B needed auxiliary procedure in form of (ureteric stent fixation and ESWL). There were no significant statistical differences (P =1.000) between both groups regarding auxiliary procedure.

Table (5): Comparison between group A and group B regarding Post -operative Fever

		Group A		Group B		Test value*	P-value	Sig.
		No.	%	No.	%			
Post op. Fever	No	19	95.0%	16	80.0%	2.057	0.151	NS
	Yes	1	5.0%	4	20.0%			

One patient in group A suffered from high grade fever > 38.5 representing 5% of patients. While four patients in group B had so representing 20% of patients. There were no significant statistical differences (P = 0.151) between both groups regarding post- operative fever. Those patients were managed by antibiotics and analgesic for one week without need for hospital admission.

Table (6): Comparison between group A and group B regarding Post -operative hematuria

		Group A		Group B		Test value*	P-value	Sig.
		No.	%	No.	%			
Post-operative Hematuria	No	17	85.0 %	19	95.0 %	1.111	0.291	NS
	Yes	3	15.0 %	1	5.0%			

All patients in both groups developed hematuria but Three patients in group A developed moderate hematuria (score 4 out of 10) that persist more than 24 hours who representing 15% of patients. While in group B one patient had moderate hematuria that persisted more than 24 hours. Those were managed by conservative treatment (fluids and bed rest). There were no significant statistical differences (P = 0.291) between both groups regarding post-operative hematuria.

DISCUSSION

The three main treatment options available for pediatric stones treatment are Extracorporeal shock wave lithotripsy (ESWL), ureteroscopy (rigid and flexible), Percutaneous nephrolithotomy (PCNL) and open surgery has been reserved for complex stones associated with abnormal anatomy [(2)]. Extracorporeal shockwave lithotripsy was used in pediatric stones in 1986, which showed safety, efficacy and complications equivalent to adult and its efficacy for upper tract stones has been reported as ranging from 68% to 84% [(2)]. Due to technical problems that arise with localization and focusing of ureteric stones in children, success rates with ESWL are lower for distal ureteric stones [(3)]. Flexible ureteroscopy with holmium laser (FURS) in children has multiple advantages including high stone-free condition rates, low complication rates, minimal radiation exposure and short hospitalization periods [(3)]. ***Khalil*** [(6)] reported that stone-free rate after one session was significantly higher in the URSL group in relation to the SWL group (80% vs. 56.8%, respectively, P < 0.05). ***Tawfick*** [(7)] achieved the 92% stone free rate with ureteroscopic lithotripsy of proximal ureteric stone, and initial stone free rate for in situ SWL was 58%. As SWL was performed in 71 patients and urteroscopy in 76 patients, ***Nerli et al.*** [(8)] reported that (90%) children, complete stone clearance was achieved after a single session of flexible as study was done over 80 patients. ***Kumar et al.*** [(9)] reported that the free rate was (74/90) 82.2% for group EWSL vs (78/90) 86.6% for group F-URS (p = 0.34) ***Stamatiou et al.*** [(10)] reported that Twenty-one children out of 26 (80.7%) were stone free at first ESWL session. Only 5 patients required multiple ESWL sessions. In our study the stone free rate was 70 % in the ESWL group after single session while it was 85 % in Flexible Ureteroscopy group. ***Kumar et al.*** [(9)] indicated that the retreatment rate was significantly greater in group ESWL in comparison to group URS (61.1% vs 1.1%) as the study was over 90 patients and the auxiliary procedure rate was comparable in both groups (21.1% vs. 17.7%). In our study (30%) of patients in ESWL needed re treatment while there weren't any patients needed retreatment in URS group (0%). while (15%) of both groups needed axillary procedure. ***Cocuzza et al.*** [(11)] ***revealed*** that the Mean operative time for F-URS was 52.54 ±12.39 minutes**.** ***Javanmard et al.*** [(12)] reported that Mean operation duration for F-URS was 66-90 min while it was 72-90 min ESWL group for the three sessions (which mean 24-30 min for single session). In our study Mean operation duration for F-URS ranging from 50 – 70 minutes while it was 25-50 mintues for single session of ESWL**.** ***Zhang*** [(13)] showed that the mean length of hospital stay was greater for patients undergoing URS compared with SWL group**.** In our study the Mean hospital stay was 3-4 hours in group ESWL after single session while it was 34-46hrs in group undergoing laser and F-URS. ***Khalil*** [(6)] reported that (16.2%) patients developed hematuria post ESWL was managed conservatively while (2.2%) as the study was done over 37 in ESWL group 45 patient in URS group, ***Karlsen et al.*** [(14)] ***displayed*** that haematuria rates (assessed according to a visual analogue score) were significantly higher after URS than SWL. In our study 15.0% of patients suffered from hematuria post ESWL while 5% of patients post ureteroscopy. ***Khalil*** [(6)] reported that 4 % of patients developed fever >38 in ESWL group. While 4.4 % of patients in Flexible Ureteroscopy group. ***Zhang et al.*** [(13)] study over 90 patients reported that 2 cases had mild fever of >38.5 °C which was managed with antibiotics in ESWL group while 6 patients had mild fevers of >38.5 °C which had to be managed with antibiotics in URS group (post-operative fever more in URS group). In our study one patient of ESWL group had post-operative fever >38 representing 5 % of patients. While four patients representing 20 % of patients developed fever > 38 in Flexible Ureteroscopy group. ***Karlsen et al.*** [(14)] reported that the percentage of patients in need of analgesics was 30% for Eswl group while 49% was for URS group. ***Lee et al.*** [(15)] observed that pain post ESWL was lower than URS group. In our study, 25% of patients in ESWL group required usage of analgesics in the form of NSAID for >24 hours. While 50 % patients in uretroscopy group required usage of analgesics in the form of NSAID for 24 hours only. ***Khalil*** [(6)] reported that there was no

statistically significant difference in the rate of complications between the SWL and URSL (24.3% vs. 15.6%, respectively) study over 82 patients. In ESWL group six (16.2%) patients developed hematuria, two patients (5.4%) were complicated by steinstrasse, and one patient (2.7%) had febrile UTI that necessitated hospitalization and intravenous antibiotic. While in URS group Minimal ureteral perforation was seen in three (6.7%) patients, prolonged postoperative hematuria for five days in one (2.2%) case, and postoperative fever in two (4.4%) cases. ***Zhang et al.*** [13] study on 90 patients remarked that 5 cases had failed access to the urethral orifice or large residual fragments, 6 patients showed migration. And 3 cases had ureter perforation as regard URS complication. ***Lee et al.*** [15] reported significantly higher complication rates in the URS group compared with the SWL group. In our study the complication is equal in both groups. 9 patients in ESWL group developed complication in form of (hematuria, fever and Steinstrasse) while 9 patients in flexible ureteroscopy group developed complication in form of (hematuria, fever, false submucosal passage, stone migration and ureteric perforation). 9 patients in group A developed complication in form of (hematuria, fever, Steinstrasse and flexible+DJ fixation) while in group B 9 patients developed complication in the form of (hematuria, fever, false passage, stone migration, perforation and DJ fixation).

CONCLUSION

Flexible URS lithotripsy and laser are considered a safe, highly efficient, minimally invasive, and reproducible surgery technique -with a higher stone free rates and less postoperative complications, after a single procedure, when compared to ESWL- for management of upper ureteric calculi in children after failure of ESWL.

CONFLICTS OF INTEREST

There are no conflicts of interest.

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