AIM OF THE WORK

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The aim of this work is to assess the efficacy and safety of flexible ureterorenoscopy for the management of upper urinary tract urolithiasis in children.

PATIENTS

AND

METHODS

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Between June 2012 and October 2013, we prospectively analyzed the records of 20 children (range 11 month to 9 years) who were treated for urinary tract stones in Urology Department, Alexandria University.

Inclusion criteria

- Male and female children below 18 years old.
- Impacted upper ureteric stones.
- Renal stones more than 7mm.
- Failed Extracorporeal Shock Wave Lithotripsy or contraindication to ESWL.
- Children with uncorrected bleeding diathesis.

Exclusion criteria

- Current urinary tract infection.
- Renal insufficiency.
- Presence of distal obstruction to the stone.
- Urinary stone more than 2cm and / or stag-horn stones.

There were 9 boys and 11 girls (mean age 4.4 ± 2.17 years), with 13 patients (65 %) being under the age of 6 years (preschool age). 20 patients (100 %) had upper-tract stone, including 18 patient with renal stones and 3 ureteral stones. 4 patient (20 %) had lower-tract stone, including 3 ureteral and 1 urinary bladder stones All patients were submitted to:

- **History taking** including age, sex, family history, geography, socioeconomic status, stone site and number , clinical symptoms, presence of associated metabolic or anatomic abnormalities and history of prior surgical operation e.g. augmentation cystoplasty.
- **Clinical examination** general and local abdominal examination for palpable abdominal swelling, scars and evaluation of the spine for dimples or other defects.
- **Routine laboratory investigations**: complete urinalysis, culture and sensitivity, if there was infection appropriate antibiotic was given to sterilize urine before intervention, complete blood count (CBC), coagulation profile, urea and creatinine.
- **Radiological evaluation including**:
  Plain abdominal radiography (KUB), gray-scale ultrasonography (US) and Low radiation dose non contrast multisclice CT abdomen and pelvis.

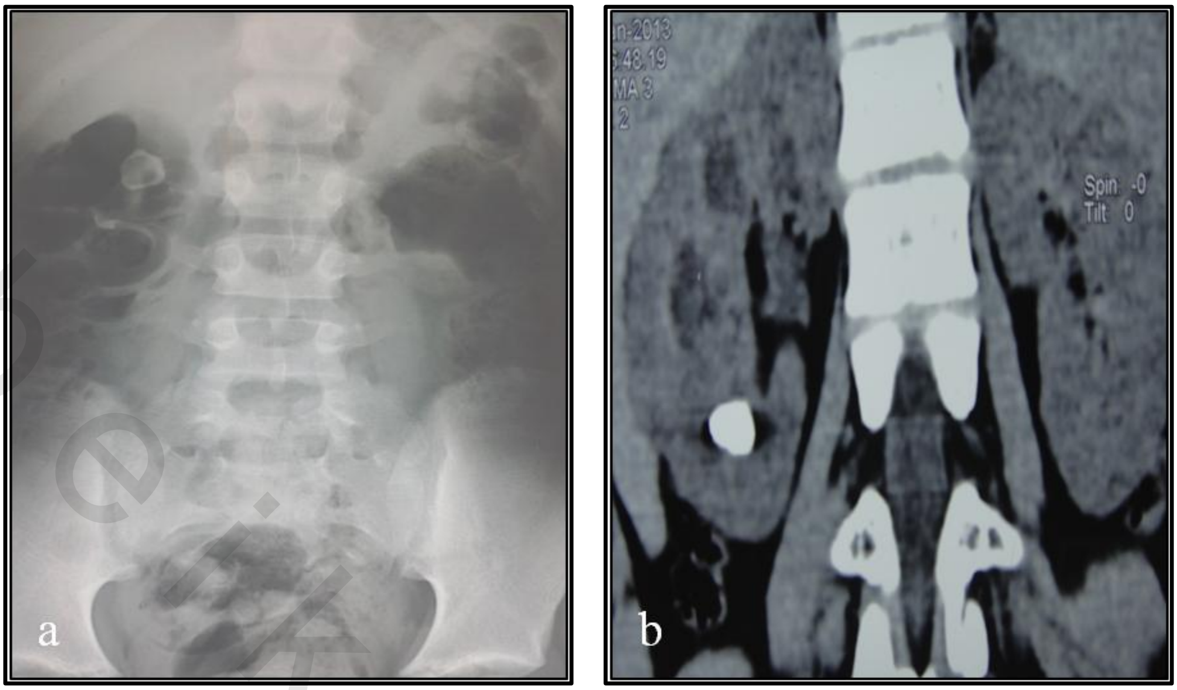

Fig 7: 6 years female child (a) plain x ray showing radiopaque shadow in the right hypochondrium (b) multisclice CT abdomen and pelvis showing lower calyceal stone.

After of an informed consent was signed by the parent explaining possible outcome and possible complications of the procedure all children were treated by both semi-rigid and flexible renoureteroscopy and holmium laser lithotripsy under general anesthesia, with placement of ureteric stent.

Data including Patient criteria (age, sex, predisposing factors, symptoms at presentation, family history of urolithiasis) and Stone criteria (stone length and width, and location) were collected. Type of endoscopic equipment used and energy source, operative time and technique, postoperative outcome, hospital stay, ancillary procedures and complications were recorded.

Table (1): Criteria used for choosing ureterorenoscopy for pediatric urolithiasis.

Inclusion criteria	Exclusion criteria
• Male and female children below 18 years old. • Impacted upper ureteric stones. • Renal stones more than 7mm. • Failed Extracorporeal Shock Wave Lithotripsy or contraindication to ESWL. • Children with uncorrected bleeding diathesis.	• Current urinary tract infection. • Renal insufficiency or Presence of distal obstruction to the stone. • Urinary stone more than 2cm and / or stag-horn stones.

Patient

A total of 20 children (24 renal units) were treated for renal and upper ureteric stones using both semi-rigid and flexible ureterorenoscopy at our department.

They were 9 boys and 11 girls. Mean patient age was 4.47 ± 2.17 years (range 11 months to 9 years). The right upper tract side was affected in 7 patients, the left upper tract side was affected in 9 and bilateral stones were present in 4. Retrograde intrarenal surgery was performed in 1 patient following previous PCNL, in 1 patient following residual stones post ESWL, in 2 patients following previous ureteroscopy for lower ureteric stones and in 1 patient following suprapubic cystolitholapaxy for urinary bladder stone.

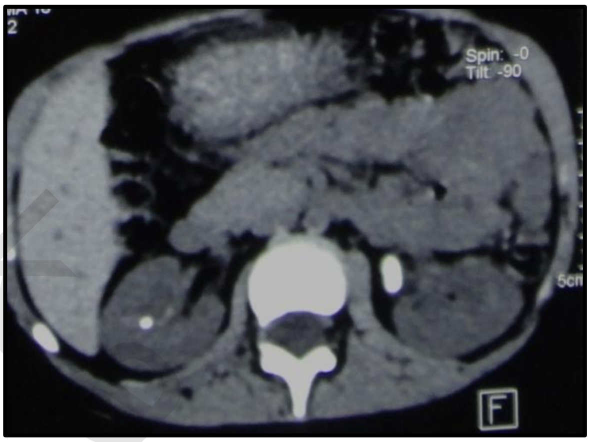

Fig 8: 4 years old boy having bilateral residual renal stones post PCNL in the renal pelvis and middle calyx and in the upper ureter on left side.

Urine culture and sensitivity was performed to all patients, and if infection was diagnosed antibiotics were administrated for 1 week preoperatively to sterilize the urine. Radiological evaluation included plain X-ray abdomen and pelvis, U/S and low radiation non contrast multisclice CT abdomen and pelvis.

The preoperative factors analyzed were age, gender, medical comorbidities, preoperative urinary tract infection, serum creatinine level, stone size and side, and degree of hydronephrosis. The operative factors recorded were Operative time, laser energy used, radiation exposure time, intraoperative complications and stone-free status.

The postoperative factors recorded were Plain KUB, ultrasound abdomen and pelvis, analgesic requirement, postoperative complications and hospital stay.

Technique

All the procedures were performed in supine position and patient’s lower legs are bent outward (<90) under general anesthesia. Positioning the patient in the lateral decubitus position (Fig. 9) enables the movement of a stone or its fragments, by making it (them) move from the lower calyx toward the infundibulum or better still, toward the renal pelvis. If it is the left kidney, the patient is positioned in the right lateral decubitus position. If it is the right kidney, the patient is positioned in the left lateral decubitus position. Positioning the patient in the Trendelenburg position (Fig. 9) enables the movement of a lower-pole calculus or its fragments toward the infundibulum, or better still toward the renal pelvis.

Fig. 9: 7 year's old female child positioning the patient in the lateral decubitus position and positioning the patient in the Trendelenburg position.

The surgeon stood between the legs of the patient, and the assistant behind him. The anesthetists were at the head of the patient.

- The instrument table was placed under the patient's lower right leg at the same level as the buttocks. This allowed the surgeon to align all the instruments and the ureteronoscope level with the patient.
- The endoscopy tower and the fluoroscopy screens were placed on the right of the patient (to the left of the surgeon).
- The screens of endoscopy tower and fluoroscopy should be side by side.
- The C-arm control unit was placed on the left of the patient (to the right of the surgeon).
- The X-ray tube was placed above the operating table.
- The C-arm, covered by a sterile drape, was placed just above the patient.
- The laser unit was put behind and against the instrument table. The laser fiber was connected to the laser unit and immediately put down on the instrument table aligned with the laser, the table, and the patient. We recommended fixing the fiber to the table with saline-soaked compresses so that it does not fall off the instrument table.

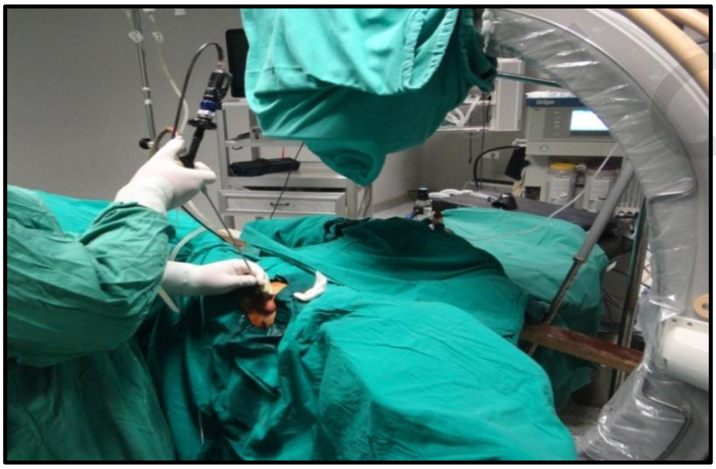

Fig 10: Showing position of C-arm tube, monitors and main surgeon.

Irrigation pressure

Hydrostatic Pressure

- The simplest way was to position the fluid bag 100 cm above the patient creating an irrigation flow of 40 mL/min by the working channel free of the ureterorenoscope.
- This flow fall at 4 mL/min if an instrument of 3 Fr was introduced in the working channel.

Manual High Pressure

- To increase temporarily the pressure in the renal caliceal cavities, by applying manual pressure to the drip.

Pressure Cuff

- To increase the pressure in the renal caliceal cavities for a continuous period, it was possible to use a pressure cuff placed around the fluid bag. However, in this case, we were able to know the exact pressure in the system by sphygmomanometer

High Pressure with a Syringe

- A way to increase pressure temporarily is to use a connected syringe directly over the working channel of the ureterorenoscope.

Under fluoroscopic guidance, 0.025 floppy-tip Teflon safety Guide Wire was used for all flexible ureterorenoscopy procedures. It is inserted at the beginning of the operation during the cystoscopy and is secured to the patient's left inner thigh with a clip or sticky tape. It should be coiled (like a "circle").

Ureteroscopy was performed with an 8 Fr, Karl Storz semi rigid ureteroscope, Ureteroscope introduced into urethra, avoiding damage to penile urethra. Ureterovesical junction (UVJ) dilatation was omitted in all cases. Ureteroscope pass UVJ helped by, firstly hydrodilatation guided safety-wire, and finally with oscillated movements allowing a rotation of tip of instrument, looking for center of ureter. If difficulty was encountered during the ureteroscopic introduction, another working wire was introduced and the ureteroscope was advanced over it.

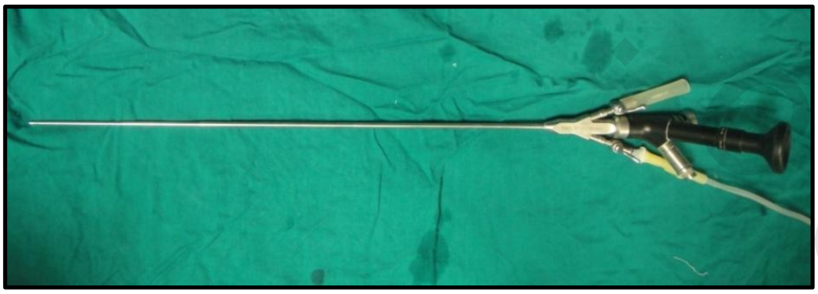

Fig 11: 8 Fr Karl Storz semirigid ureteroscope.

The ureteroscope was then advanced upward till reaching the stone followed by holmium: YAG laser disintegration. Using the laser fiber was moved over the stone surface that results in stone vaporization and fragmentation. A laser fiber of 365 um was utilized. The laser energy of (1.1–1.4 J) at a pulse rate of (10–14 Hz) with maximum power of 15 W was applied. Stones were fragmented into several small pieces regardless to its size without any trial for gravels removal.

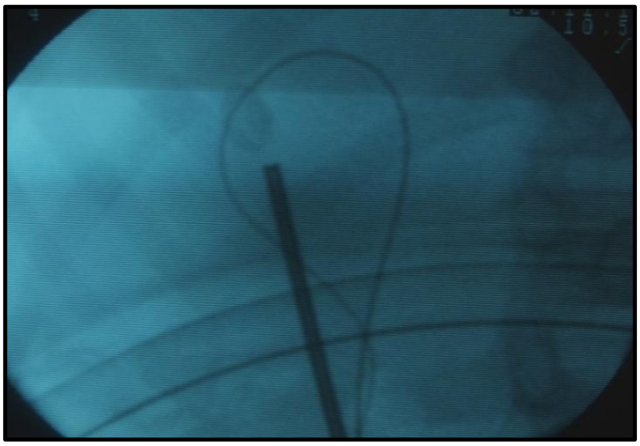

Fig 12: Intraoperative positioning of 8 Fr semi rigid ureteroscope against the stone in the renal pelvis.

We completed the procedure using Karl Storz FLEX-X2 7.5 Fr flexible ureterorenoscope. Insertion of another safety guidewire was done under vision through the working channel of the semi rigid ureteroscope before withdrawing it from kidney. Two 150-cm-long and 0.025- or 0.035-in. diameter guide wires (one safety, one working wire) should be used. Standard floppy-tipped polytetrafluoroethylene (PTFE) wire could be used, but we strongly recommended using stiff hydrophilic wires. A safety wire should always be employed when the intended procedure involves placing and removing and then replacing the F-URS. The safety wire was fixed to the drape and remains in place for later use to replace the working wire or to place a stent at the end of the procedure.

Use of teats

We used "teats" (a specific port seal enabling the use of a liquid irrigation instrument that does not leak. This is made of a silicone O-ring, which can adapt to all diameters of the instruments in the working channel. This ring provided a perfect seal to obtain an optimum irrigation flow at the distal tip of the endoscope and not lose liquid at the point of entry level of the working channel. (Figure 12)

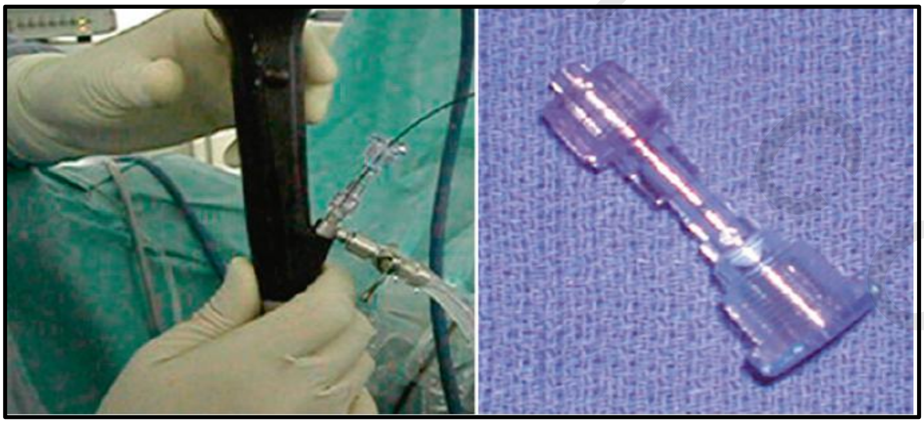

Fig. 13: Port seal (Karl Storz) fitted on the working channel of the flexible URS.

Insertion of the flexible Ureterorenoscope into the Ureteral Meatus

- The insertion of the ureterorenoscope in the renal cavities was done over the working guide wire and under fluoroscopic control. The ureterorenoscope is therefore without its cold-light cable, the camera, and irrigation.
- We tried to keep the ureterorenoscope straight by using both hands to fix the distal tip of the ureterorenoscope, and the assistant must hold the handle of the ureterorenoscope.
- We carefully fit the ureterorenoscope over the guide wire so as not to damage the working channel and then slide the ureterorenoscope over the guide wire.
- In male patients, the penis was held upwards to straighten the urethera.
- The cold-light cable, the camera, and the irrigation were attached to the ureterorenoscope once the scope was inside the collecting system.
- The guide wire was withdrawn and the examination of the renal cavities can begin.

We also noticed that under fluoroscopic control, the endoscope may block and bend the ureteral meatus. It is said that the ureterorenoscope does "the big back." This situation occurs frequently when the ureteral meatus is stenosed or pin-point. We have first tried the "shoehorn" technique, it is necessary to turn the distal tip of the ureterorenoscope 180° so that the top part, containing all the optic fibers, moves towards the bottom. In this position, the guide wire is going to lift the "roof" of the ureteral meatus, which can be flexed to follow the slope of the ureterorenoscope towards the renal calyceal cavities:

After the placement of the F-URS into the kidney, the intrarenal collecting system was explored, starting with the upper-pole calices, followed by the middle calices, and, finally, the lower-pole calices. The exploration is performed under endoscopic vision and fluoroscopic guidance.

During RIRS of the right kidney, the entrances of the calyx groups – upper-pole, middle, and lower-pole calycies were seen on the left of the endoscopy screen and to enter one of these calycies we rotated the dominant hand in the clockwise direction and in the same time did ventral deflection and then we push the ureterorenoscope by the non-dominant hand.

During RIRS of the left kidney, the entrances of the calyx groups – upper-pole, middle, and lower-pole calycies were seen on the right of the endoscopy screen and to enter one of these calycies we rotated the dominant hand in the anticlockwise direction and in the same time did ventral deflection and then we push the ureterorenoscope by the non-dominant hand.

When the flexible ureterorenoscope was positioned in the renal calyceal cavities, the vision was often poor and blurred (blood, urine, contrast). Contrast was injected through the working channel to opacify the collecting system for fluoroscopic imaging and determination of the position of the URS and measure the infudibulopelvic angle.

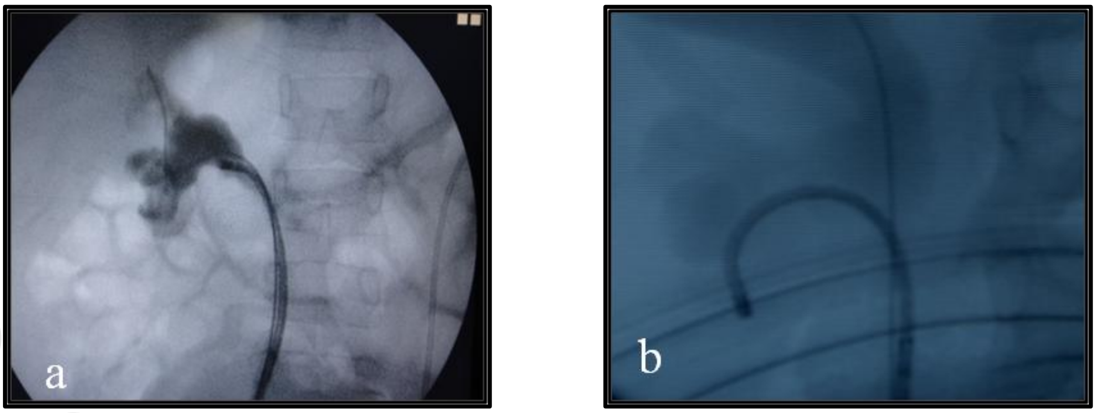

Fig 14: Showing poisoning of F-URS in pelvicalyceal system after injection of contrast (a) F-URS in the renal pelvis (b) F-URS in the lower calyx.

Through the 3.6 Fr working channel of F-URS we passed the 200 μ laser fiber under fluoroscopic screen holding the F-URS in straight position avoiding damage of the working channel by sharp and stiff laser fiber. We avoided the risk of distal perforation of the ureterorenoscope by an ill-timed withdrawal of the laser fiber at the moment of the fragmentation, it is recommended to fix it by holding the seal at its maximum Thus, and the O-ring will block the laser fiber, preventing all movement.

The fiber was advanced a few millimeters beyond the end of the working channel, and the green aiming beam was switched on. The F-URS with the fiber in place is placed against the stone, and fragmentation is started (initial setting: 10–14 Hz, 1.1–1.5 J).

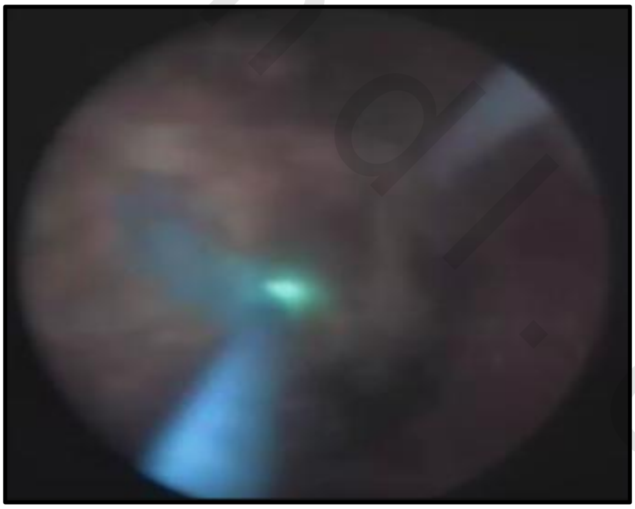

Fig 15: Showing positioning of contact holmium yag laser against surface of the stone.

We used “Trapped Fragmentation.” technique to minimize the inconvenience that may occur due to movement of the stone or its fragments.

If the stone’s movements were resulted from the patient’s breathing, we asked the anesthetists to put the patient in apnea for a few minutes or to make the patient breathe at “low frequency” (6–9/min) in order to reduce the movements of the diaphragm on the kidney and consequently on the stone.

We optimized this fragmentation, by starting the fragmentation of stones from the outside toward the center and from the surface toward the bottom by making small holes all around the stone comparable to the outside edge of a postage stamp. The sheer number of these little holes enabled a very fine fragmentation of the stone. This fragmentation technique has the advantage of not producing large fragments, necessitating that each one has a fragmentation or an extraction. In order to get very fine fragments near the end of the procedure we lowered laser fragmentation energy and increased the laser frequency to get the “popcorn” effect of laser.

Management of lower-pole calculi

When the lower-pole calculus was located, a nitinol basket (1.5–2.4 Fr) was inserted with the endoscope kept undeflected and the stone was captured. The stone was displaced to the upper calyceal system, or into the renal pelvis. The stone was released, and the nitinol basket was withdrawn. A laser fiber (200–365 µm) was introduced into the working channel.

If we couldn't displace the stone toward the upper pole or the renal pelvis (impacted stone), we fragmented it in situ using a small-diameter (150–200 µm) laser fiber. At the end of the procedure, a complete exploration of the intrarenal cavities was obtained to ensure that no fragments had been left behind.

Prevention of Stone Fragment Accumulation in Lower Calyx

At the end of the procedure saline was injected into the working channel of the F-URS, to flush the fragments toward the upper calices and the renal pelvis, and to clear any remaining contrast and then we aspirated this fragments using the suction system.

When stone fragmentation was completed, the pelvicalyceal system was inspected for presence of any trauma and retrograde pyelogram was done to assess integrity of the system. Safety guide wire was kept in place and the F-URS was withdrawn slowly with inspection of the ureteric wall for any trauma and lastly jj stent (size vary according to the age of the child) was left and removed cystoscopically after 2-4 weeks.

The patients were followed postoperatively for any complications as urinary tract infection, fever, or pain. U/S and KUB were performed 2 weeks postoperatively to evaluate the presence or absence of obstruction or significant stone gravels.

Figure 16: Showing postoperative plain KUB of 2 years old male child following RIRS and laser fragmentation of radiopaque left renal pelvis stone.

RESULTS

RESULTS

Descriptive results

A total of 20 consecutive children (24 renal units) were treated for renal and upper ureteric stones using both semi-rigid and flexible ureterorenoscopy at our department between June 2012 and October 2013 were analyzed regarding preoperative evaluation, intraoperative data, postoperative assessment and outcome of the management during follow up.

I. Patient demographics

Table (2, 3 and 4) shows the perioperative demographic data of the studied patients. Mean age 4.47 ± 2.17 (range from 11 months to 9 years) 45% of the patients were male,13 (65%) patients were at preschool age, 1 patient (5%) has other comorbidity (cerebral palsy), out of the 20 children 5 patients underwent prior interventions for urolithiasis, 1 (5%) child underwent right PCNL, 1 (5%) child underwent percutaneous suprapubic cystolitholapexy for large UB stone, 1(5%) child underwent left ESWL for lower calyceal stone and 2 (10%) female child underwent right ureteroscopy for lower 1/3 ureteric stones.

The most common presenting symptom was hematuria in 8(40%) patients. The other common symptoms were flank or abdominal pain in 7 (35%) patients, 6 patient (30%) patients had urinary-tract infection at presentation, confirmed by urine culture and 2 (10%) children were asymptomatic.

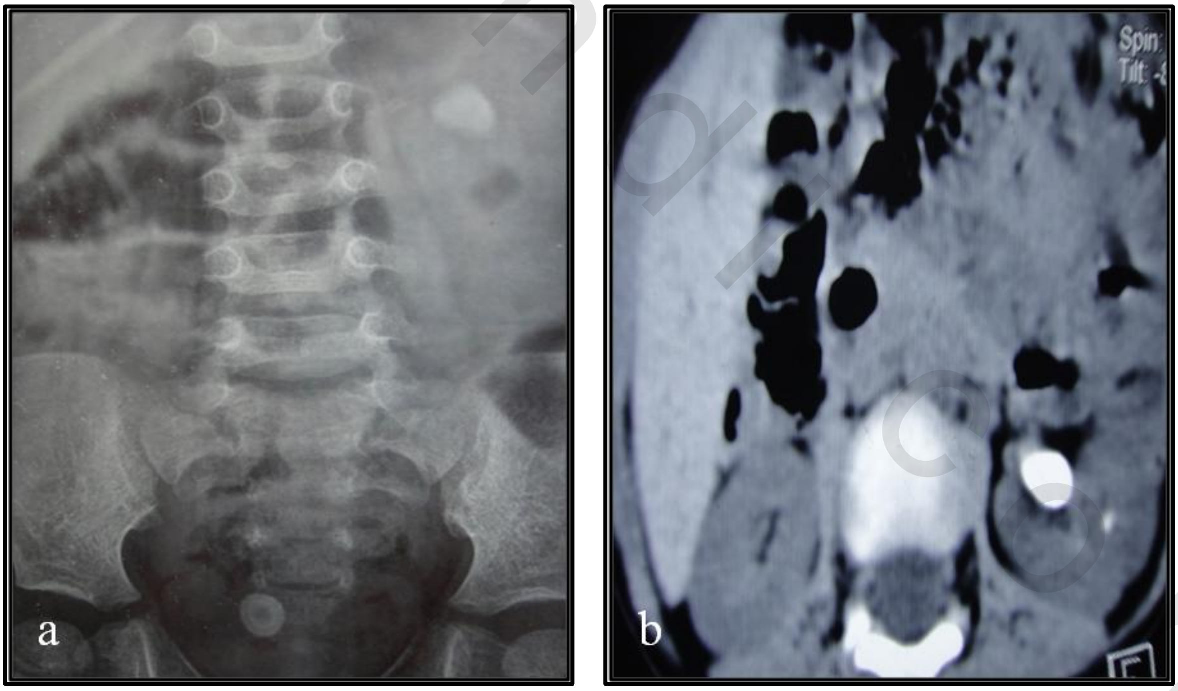

Fig 17: Showing (a) plain KUB (b) multisclice CT abdomen and pelvis of 2 years old male child having left renal pelvis stone (20 mm) and urinary bladder stone.

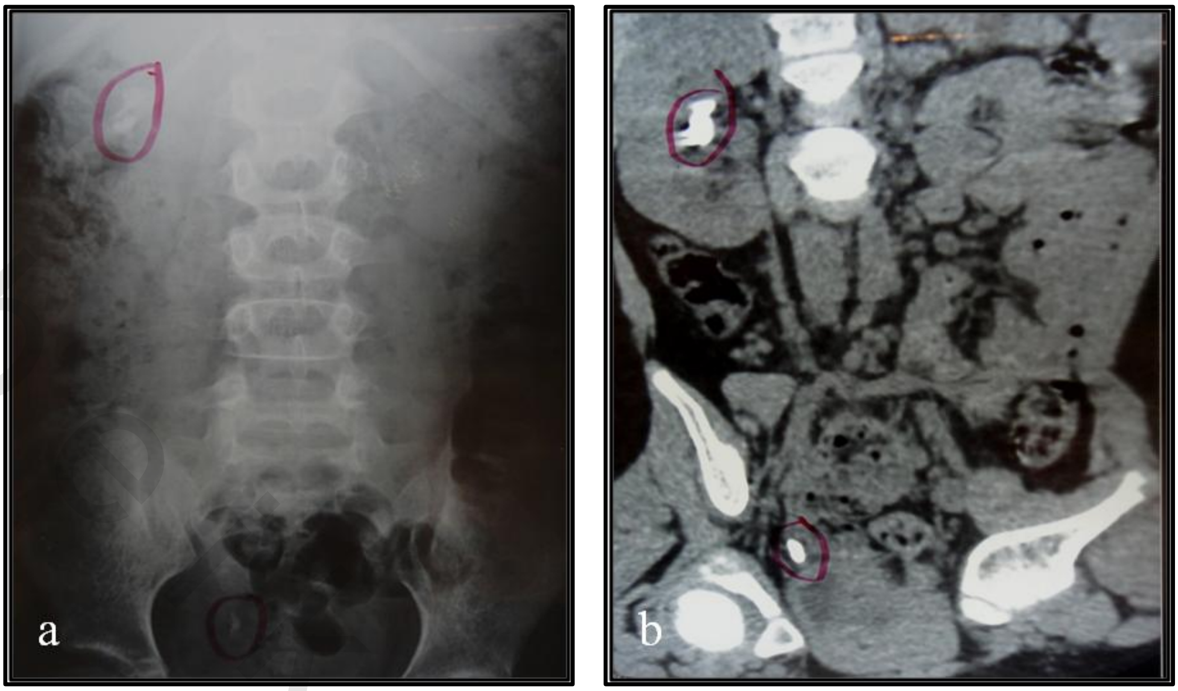

Fig 18: Showing (a) plain KUB and (b) coronal cut of multisclice CT abdomen and pelvis in 5 years old female child having right middle calyceal renal stone and right lower third ureteric stone.

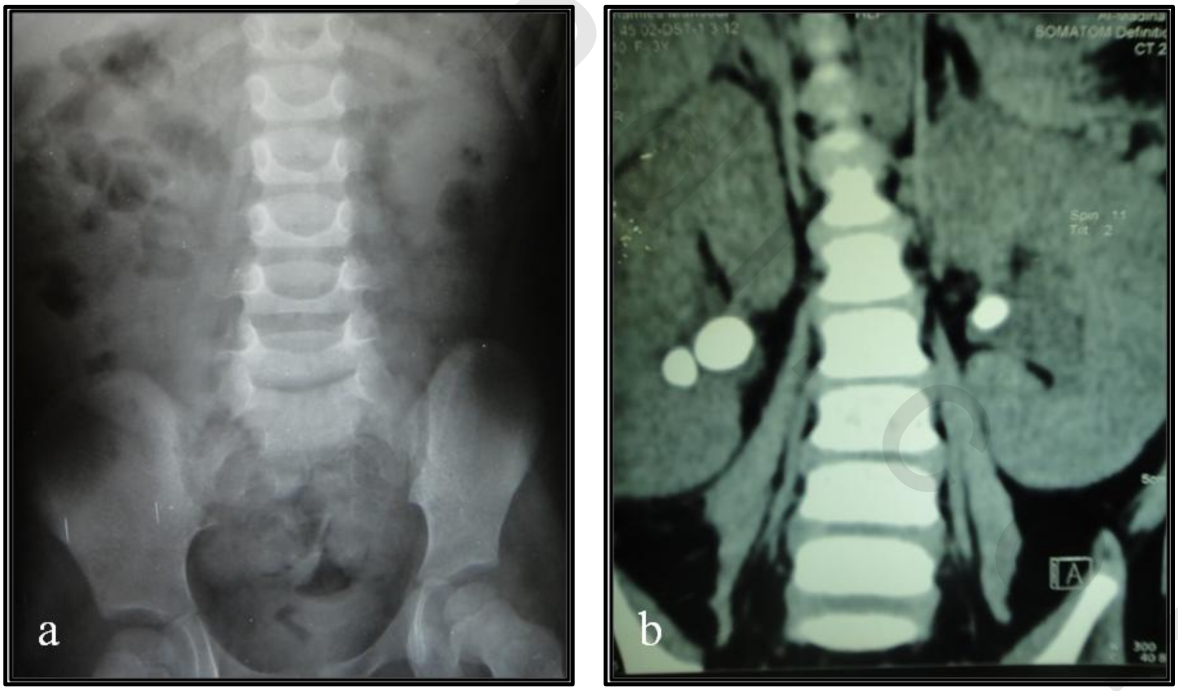

Fig 19: Showing (a) plain KUB (b) coronal cut of multisclice abdomen and pelvis of 4 years old female child having bilateral radiolucent renal pelvis stones and right lower third ureteric stone with medical history of cerebral palsy.

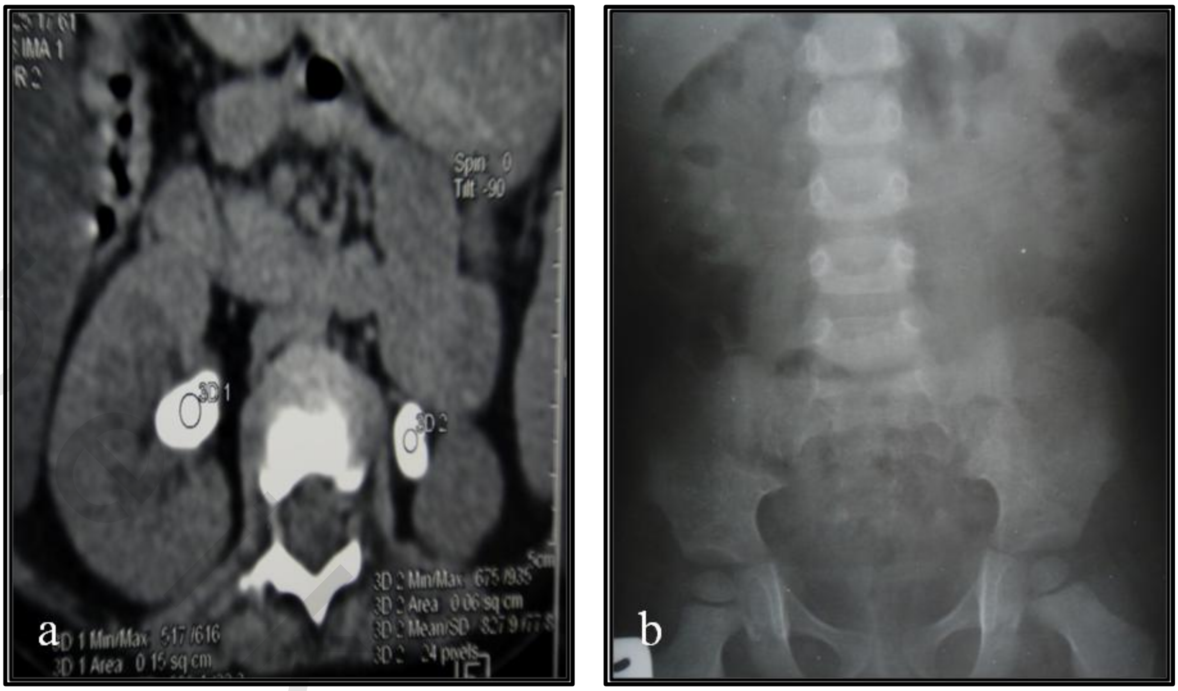

Fig 20: Showing 1.5 years old boy with bilateral radiolucent renal pelvis stones.

Table (2): Distribution of the studied cases according to demographic data (n=20).

	No.	%
Sex		
Male	9	45.0
Female	11	55.0
Age (years)		
<2	1	5.0
2 - <4	6	30.0
4 - <6	6	30.0
≥6	7	35.0
Preschool age	13	65.0
School age	7	35.0
Min. – Max.	11month – 9 years	
Mean ± SD.	4.47 ± 2.17	
Median	4.0	

Table (3): Distribution of the studied cases according to presence of co-morbidity and history of prior urologic intervention for urolithiasis (n=20).

	No.	%
History		
No comorbidity or urologic history	15	75.0
Cerebral palsy	1	5.0
Right PCNL	1	5.0
Suprapubic cystolitholapexy	1	5.0
Left ESWL	1	5.0
Lower ureteroscopy	2	10.0

Table (4): Distribution of the studied cases according to presenting symptoms (n=20).

	No.	%
C/P		
Abdominal pain	7	35.0
Asymptomatic	2	10.0
Hematuria	8	40.0
UTI	6	30.0

II. Procedures, techniques, and instrumentation

Tables (5, 6, 7 and 8) show distribution of the studied cases according to size of stone, HU, side, stones position in kidney and ureter and stones number in relation to its position in the kidney.

The stone burden was calculated by adding the length of the longest axis of each stone. For the 20 children stones size ranged from 8-20 mm and the HU about 280-1120 with 5 (25%) children having radiolucent stones, 2 (10%) having faint radiopaque stones and 13 (65%) having dense radiopaque stones. 7 (35%) children had right sided kidney stones, 9 children (45%) had left sided kidney stones and 4 (20%) children had bilateral kidney stones.

3 (15%) children had lower calyceal stones, 13 (65%) children had renal pelvic stones, 2 (10%) of them having associated upper calyceal stones, 3 (15%) children with bilateral renal pelvic and 1(5%) child had associated upper third ureteric stone. 2 (10%) children had middle calyceal stones and 2 (10%) children had upper ureteric stones without associated kidney stones. Total number of upper urinary tract stones was 27 stones of which 4 (14.81%) in the lower calyx, 2 (7.40%) in upper calyx, 16 (59.25%) in the renal pelvis, 2 (7.40%) in the middle calyx and 3 (11.11%) in the upper ureter. Serum creatinine levels were not elevated in any of the patients.

Table (5): Distribution of the studied cases according to size and HU of stones (n=20).

	Min. – Max	Mean ± SD.	Median
Size of stone	8.0 – 20.0	13.75 ± 4.53	14.0
HU	280.0 – 1120.0	739.75 ± 258.77	845.0

Table (6): Distribution of the studied cases according to laterality of stones (n=20).

	No.	%
Site		
Right kidney	7	35.0
Left kidney	9	45.0
Bilateral	4	20.0

Table (7): Distribution of the studied cases according to position of stones in the kidney and ureter (n = 20).

	No.	%
Site		
Lower calyx	3	15
Upper calyx	2	10
Renal Pelvis	13	65
Upper 1/3Ureter	3	15
Middle calyx	2	10

Table (8): Distribution of number of stones in the studied cases according to its position in the kidney (n = 27).

	No.	%
Site		
Lower calyx	4	14.81
Upper calyx	2	7.40
Renal Pelvis	16	59.25
Upper 1/3Ureter	3	11.11
Middle calyx	2	7.40

In 4 children there were associated lower urinary tract stones, 1 (5%) of them in the urinary bladder and 3 (15%) in the right lower ureter.

Table (9): Distribution of the studied cases according to number of stones in the upper and lower urinary tract (n=20).

	No.	%
Number of stones		
Lower urinary tract	4	20.0
Upper urinary tract	27	100.0
Min. – Max.	1.0 – 4.0	
Mean ± SD.	1.60 ± 0.82	
Median	1.0	

13 renal units (54.2%) were associated with grade I hyderonepherosis and 11 renal units (45.8%) were not associated with back pressure

Table (10): Distribution of the studied cases according to presence of hyderonepherosis (n=24).

	No.	%
Hyderonepherosis		
No	13	54.2
Yes	11	45.8

DJ stents were inserted in 6 children 2 weeks before RIRS, in 2 (10%) children after ureteroscopy for management of lower 1/3 ureteric stones, 1 (5%) child after suprapubic cystolitholapexy, 1 (5%) child to manage obstructive uropathy and uremia (bilateral DJ in bilateral ureteric stones) and 2 (10%) children having tight ureter DJ stents were inserted to dilate the ureter before RIRS.

Hyderodilation was used in all cases. No balloon dilation was used. All children were operated under general anesthesia in lithotomy position operative time range (30.0-95.0 min) and lithotripsy time range (20.0-50.0 min), however in the one case in the study we couldn't found the lower calyceal stones.

Table (11): Distribution of the studied cases according to operative time and lithotripsy time (n=20).

	Min. – Max.	Mean ± SD.	Median
Operative time (min)	30.0 – 95.0	52.0 ± 16.50	45.0
lithotripsy time	20.0 – 50.0	32.37 ± 9.91	30.0

III. Postoperative outcome

Table (12) shows the immediate postoperative outcomes of RIRS procedure for upper urinary tract stone management in children. The mean hospital stay length was 1.25 ± 0.64 days (range from 1-3 days). All patients required only non-steroidal anti-inflammatory drugs for management of postoperative pain. 2 (10%) children suffered low grade fever on day 0 of the procedure.

Table (12):Distribution of the studied cases according to hospital stay (n=20).

	No.	%
Hospital stay (days)		
1 day	17	85.0
2 days	1	5.0
3 days	2	10.0
Min. – Max.	1.0 – 3.0	
Mean ± SD.	1.25 ± 0.64	
Median	1.0	

IV. Follow up and outcome

Table (13 and 14) shows the outcome of RIRS on follow up of the patients. The stone-free rate was assessed radiologically in all patients in the immediate postoperative period by KUB and US. Stone free rate after single session of RIRS was 16 (80%) children on follow up by plain X-ray abdomen and pelvis and ultrasonography. Residual stone was found in 4 (20%) children, 3 (15%) found in the lower calyx and 1 (5%) in left middle ureter. 1st case had 2 lower calyceal stones and there was inability to access the stones by the flexible ureterorenoscpy due to very acute infundibulopelvic angle of lower calyx. 1 (5%) child who had residual stone fragment was one of the patient having bilateral upper urinary tract stones.

Auxiliary procedures were done in 7 (35%) children, 4 (20%) children for management of residual stone fragments after RIRS, 1 (5%) of them underwent mini PCNL for lower calyceal stones and 3(15%) underwent another session of RIRS after 6 weeks for complete stone disintegration. 4 (20%) children underwent RIRS for management of upper urinary tract stones on the contralateral side. Stone free rate after 2nd session of RIRS was (95%).

Table (13): Distribution of the studied cases according to stone free rate after one session of RIRS on follow up (n=20).

	No	%
Stone free rate after single session of RIRS	16	80.
Residual fragments	4	20.

Table (14): Distribution of the studied cases according to second endourological interventions (n=20).

	No	%
2^{nd} endourologial intervention	**7**	**35.0**
2^{nd} endourologial intervention for Residual stone fragments	4	20.0
RIRS on the contralateral side	4	20.0

Analytic Results

Univariate analysis was done to determine both the dependent and independent predictors of the perioperative outcomes, complications

1. Stone free rate

Table (15) shows the efficacy of RIRS (stone free rate) for management of upper urinary tract stones in relation to different parameters. This table shows that age, sex, site of stones, density of stones, size, of stones, preoperative jj stent insertion and use of suction system have no significant impact on stone free rate. It also shows that lower calyceal stones were associated with higher residual stone rate ($^{FE}p = 0.368$), use of suction system lower residual stone rate ($^{FE}p = 0.619$) , preoperative jj stent insertion increase stone free rate ($^{FE}p =0.267$).

Table (15): Relation between stone free rate and different parameters.

	Efficacy of RIRS		Test of sig.	p
	Stone free rate (n = 16)	**Residual fragments (n = 4)**		
Age (year)				
Min. – Max.	0.92 - 8.0	2.50 - 9.0		
Mean ± SD	4.18 ± 1.96	5.63 ± 2.93	t = 1.201	0.245
Median	4.0	5.50		
Sex				
Male	8 (50%)	1 (25%)	$\chi^2 = 0.808$	$^{FE}p = 0.591$
Female	8 (50%)	3 (75%)		
Size of stone (mm)				
Min. – Max.	8.0 – 20.0	10.0 – 20.0		
Mean ± SD	12.97 ± 4.31	15.25 ± 4.11	t =0.795	0.437
Median	13.0	15.50		
HU				
Min. – Max.	280 – 1120	290 – 930		
Mean ± SD	742.8 ± 259.5	727.5 ± 295.1	Z = 0.284	0.777
Median	845.0	845.0		
Site				
Lower calyx	1 (6.6%)	2 (40%)	$\chi^2 = 1.250$	$^{FE}p = 0.368$
Upper calyx	2 (12.5%)	0 (0%)	$\chi^2 = 0.556$	$^{FE}p = 1.000$
Renal pelvis	10 (62.5%)	3 (60%)	$\chi^2 = 0.220$	$^{FE}p = 1.000$
Upper ureteric	3 (18.8%)	0 (0%)	$\chi^2 = 0.882$	$^{FE}p = 1.000$
Middle calyx	2 (12.5%)	0 (0%)	$\chi^2 = 0.556$	$^{FE}p = 1.000$
Pre - operative DJ				
No	10 (62.5%)	4 (100%)	$\chi^2 = 2.143$	$^{FE}p = 0.267$
Yes	6 (37.5%)	0 (0%)		
Use of suction system				
No	7 (43.75%)	1 (25%)	$\chi^2 = 0.469$	$^{FE}p = 0.619$
Yes	9 (56.25%)	3 (75%)		

t: Student t-test
Z: Z for Mann Whitney test
χ^2:value for Chi square
FE: Fisher Exact test

2. Operative time, lithotripsy time and hospital stay

Table (16) shows operative time, lithotripsy time and hospital stay in relation to sex difference in studied patients. Sex has no significant impact on operative time, lithotripsy time or hospital stays.

Table (17) shows the impact of age, size and density of stones on operative, lithotripsy time and hospital stays. Age (P=0.010) and size of stone (P=0.001) have significant positive impact on lithotripsy time. Density of stone (P=0.032) has significant negative impact on hospital stay. Otherwise other factors have no significant impact on operative, lithotripsy time or hospital stays.

Table (18) shows no significant impact of pre-operative jj stent insertion on operative, lithotripsy time and hospital stay. However there was insignificant difference between use and absence of suction system, Table (19) shows that use of suction system lower lithotripsy time.

Table (20) shows that site of stone has insignificant impact on operative time. One of the cases presented with lower calyceal stones had operative time about 30 min as the procedure was finished without laser fragmentation of the stones because of inability to access this stone by flexible ureterorenoscopy. Operative time was higher in the upper calyceal stones as it were associated with renal pelvis stones on same side. Operative time was lower in patient having upper ureteric stones (about 35 min).

Table (21) shows that the lithotripsy time was the lowest in patient with upper ureteric stones followed by middle calyceal then renal pelvis stones and lastly upper calyceal stones as it were associated with renal pelvis stone on same side. However site of stone has insignificant impact on lithotripsy time.

Table (16): Relation between sex and different studied parameters.

	Sex		Test of sig.	p
	Male (n = 9)	**Female (n=11)**		
Operative time (min)	**n = 9**	**n= 11**		
Min. – Max.	30.0 – 70.0	35.0 – 95.0		
Mean ± SD.	48.89 ± 14.74	54.55 ± 18.09	t = 0.754	0.460
Median	45.0	45.0		
Lithotripsy time (min)	**n = 8**	**n =11**		
Min. – Max.	20.0 – 50.0	20.0 – 50.0		
Mean ± SD.	30.63 ± 11.78	33.64 ± 8.69	t = 0.643	0.529
Median	27.50	30.0		
Hospital stay (day)	**n = 9**	**n= 11**		
Min. – Max.	1.0 – 2.0	1.0 – 3.0		
Mean ± SD.	1.11 ± 0.33	1.36 ± 0.81	Z = 0.550	0.582
Median	1.0	1.0		

t: Student t-test
Z: Z for Mann Whitney test

Table (17): Correlation between age, size of stone, and HU with operative time, lithotripsy time and hospital stay.

	Age (years)		Size of stone		HU	
	r	p	R	p	r	p
Operative time (min)	0.202	0.394	0.253	0.282	-0.085	0.720
Lithotripsy time (min)	0.577*	0.010	0.640*	0.001	0.219	0.315
Hospital stay (day)	-0.177	0.455	0.348	0.133	-0.480*	0.032

r: Pearson or Spearman coefficient
*: Statistically significant at $p \leq 0.05$

Table (18): Relation between pre-operative DJ and different studied parameters.

	Pre - operative DJ		Test of sig.	p
	No (n=14)	Yes (n= 6)		
Operative time (min)	**n =14**	**n = 6**		
Min. – Max.	30.0 – 75.0	40.0 – 95.0		
Mean ± SD.	50.0 ± 14.68	56.67 ± 20.90	t = 0.821	0.422
Median	45.0	52.50		
Lithotripsy time (min)	**n =13**	**n =6**		
Min. – Max.	20.0 – 50.0	25.0 – 45.0		
Mean ± SD.	31.92 ± 10.90	33.33 ± 8.16	t = 0.281	0.782
Median	30.0	32.50		
Hospital stay (day)	**n =14**	**n =6**		
Min. – Max.	1.0 – 3.0	1.0 – 3.0		
Mean ± SD.	1.21 ± 0.58	1.33 ± 0.82	Z = 0.199	0.842
Median	1.0	1.0		

t: Student t-test
Z: Z for Mann Whitney test

Table (19): Relation between use of suction systems and different studied parameters.

	Use of suction system		Test of sig.	p
	No (n=8)	**Yes (n= 12)**		
Operative time (min)	**n =8**	**n = 12**		
Min. – Max.	30.0 – 70.0	35.0 – 95.0		
Mean ± SD.	51.87 ± 14.37	52.08 ± 18.39	t = 0.027	0.979
Median	50.0	45.0		
Lithotripsy time (min)	**n =7**	**n =12**		
Min. – Max.	20.0 – 50.0	20.0 – 50.0		
Mean ± SD.	35.71 ± 9.75	30.41 ± 9.87	t = 1.133	0.273
Median	35.0	30.0		
Hospital stay (day)	**n =8**	**n =12**		
Min. – Max.	1.0 – 3.0	1.0 – 3.0		
Mean ± SD.	1.25 ± 0.70	1.25 ± 0.62	Z = 0.186	0.910
Median	1.0	1.0		

t: Student t-test
Z: Z for Mann Whitney test

Table (20): Relation between sites of stones and operative time.

	N	Operative time (min)		
		Min. – Max.	**Mean ± SD.**	**Median**
Site				
Lower calyx	**3**	30.0 - 55.0	42.50 ± 17.67	42.50
Upper calyx	**2**	70.0 - 95.0	82.50 ± 17.68	82.50
Renal pelvis	**13**	35.0 - 95.0	53.85 ± 17.81	45.0
Upper ureteric	**3**	35.0	35.0	35.0
Middle calyx	**2**	40.0 - 50.0	45.0 ± 7.07	45.0
F (p)		1.690 (0.199)		

F: F test (ANOVA)

Table (21): Relation between sites of stones and lithotripsy time.

	N	Lithotripsy time (min)		
		Min. – Max.	**Mean ± SD.**	**Median**
Site				
Lower calyceal	**2**	35.0		
Upper calyceal	**2**	40.0 - 50.0	45.0 ± 7.07	45.0
Renal pelvis	**16**	15.0 - 50.0	32.94 ± 10.32	30.0
Upper ureteric	**3**	20.0 - 25.0	21.67 ± 2.89	20.0
Middle calyceal	**2**	20.0 - 30.0	25.0 ± 7.07	25.0
F (p)		2.144 (0.113)		

F: F test (ANOVA)