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Mini- Percutaneous Nephrolithotomy (MPCNL) vs. Flexible Ureterorenoscopy (RIRS) for Renal Stones >2cm

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Abstract

Objective: To evaluate the efficacy and safety of mini percutaneous nephro-lithotripsy (mini PCNL) and retrograde intrarenal surgery (RIRS) in treatment of renal stones larger than 20mm in its longest diameter.

Patients & Methods: In a prospective randomized study including 40 patients divided into two groups each 20 patient. Group A included 12 males and 8 females with age ranged from 15 to 62 years had mini PCNL for renal pelvic and calyceal stones. Group B included 8 males and 12 females with age ranged from 18 to 65 years old had RIRS. Flexible ureteroscopy was used for pelvic and calyceal stones using holmium:YAG laser (dusting approach). In both groups the procedure outcome in terms of Operative time, Blood loss, hospital stay, complications using modified Clavien grading system , the need of auxiliary procedures , stone free rates after 3 weeks by using CTUT, were evaluated statistically.

Results: Statistical analysis of the data showed that there was insignificant difference between the {mean ± SD} of the BMI in patients of group A which was {27.850±3.183} kg/m2; while in patients of group B was {29.700±7.927} kg/m2 . Regarding stone size, there was insignificant difference between the {mean ± SD} of group A which was 2.57±0.22mm, while in group B was 2.6±0.24mm. Regarding the operative time the {mean ± SD} of group A was 104.43±14.79 minutes which was significantly (P<0.05) higher compared to group B 59.71±19.44 minutes.

As regarding hospital stay it was insignificantly (P lower 0.05) higher in group A 1.41±0.46 days compared to group B 1.29±0.44 days.

Regarding stone free rate 89 % of patients treated with group A were stone free (17 out of 20), while in group B 83.4% of patients were stone free (16 out of 20) after 3 weeks by using CTUT imaging. Regarding complications using modified Clavien grading comparison to our study in which Grade 1: 1 in group A & 0 in group B , grade 2: 1 in group A & 0 in group B , grade 3A : 1 in group A & 0 in group B also grade 3B : 0 in group A & 0 in group B also 0 in grade 4 & 5 in both groups

Conclusion: In patients with renal stones larger than 20 mm , results showed that mini PNCL has higher stone free rate and longer operative time than RIRS in expense of higher complications rate, blood loss, and longer hospital stay

1. Introduction

EUA guidelines recommend to do PCNL in large renal stones more than 2cm & also when ESWL is not feasible in lower calyx stones from 1-2cm.(1)

This technique shows high SFR ranging from 76% -98% in the literature .

Enhancements has been created as regard size of instrumentation to achieve less morbidity like blood loss , pain , renal damage . so miniature endoscope & miniature tract 11-20Fr is developed at first for pediatric patients large stones.(2-3)

Now it is considered as treatment option also for adult for different stone size & location.

RIRS is developed at first for treatment of smaller renal stones .

Using retrograde surgery attracted urologists to try to deal with much larger stones regardless time of operation.(4)

PCNL still the standard treatment for large stones as it gives high SFR although it shows high morbidity & complication rates .(5-6)

As soon as RIRS show less morbidity & complication rates urologists starts dealing with large stones by RIRS . later on EUA guidelines put RIRS as a first option of some surgeons.(6-7)

PCNL shows several drawbacks as bleeding, pain, large track, organ injury, long hospital stay, but also have advantages of about 90% SFR regardless its location.(8)

Large group of patients such as morbid obese & bleeding disorders are contraindicated for PCNL so that another modality can be tried as a non invasive method.(9)

RIRS is used for management of lower polar stones & become more popular with big advancement that facilitate its use.(10-11)

Today it is considered as an alternative for PCNL to decrease its hazards .(12-13)

Recent studies shows comparable SFR of RIRS from 77% to 90% for renal stones & 62% to 85% for lower polar stones.(14)

Several centers of urology applying RIRS shows higher success rates in treatment of large renal stones so it becomes more attractive than ESWL (15)

2. Patients and Methods

Between September 2017 and September 2019 forty patients, ranging from 15 to 65 years old, admitted to the Urology Department, presenting with renal pelvis or calyceal stone (>2cm)

Patient assessment included detailed medical history, physical examination and laboratory tests including urinalysis, urine culture, complete blood count, and serum biochemistry. Renal stone was diagnosed with computed tomography (CT) (including axial, sagittal and transverse sections). Stone size was assessed as the longest axis of the stone on CT scan.

All patients were informed about the advantages, disadvantages and probable complications of both m PNL and RIRS before the selection of the procedure.

Patients decided the surgery type by themselves without being under any influences and written informed consent was obtained from all patients prior to the surgery. Patients with the history of previous urinary stone surgery or urinary anomaly were excluded. Patients were divided into

two groups according to the patients' preference of surgery type. Group 1 consisted of 20 patients who underwent mPNL and Group 2 consisted of 20 patients treated with RIRS.

All patients were evaluated with serum biochemistry and blood count

at the day after surgery. In addition, all patients underwent CT for the stone clearance, at the first postoperative month. Treatment success was defined as stone-free status or clinically insignificant

residual fragments ≤4 mm. Patients were followed up every 3 months with urinalysis, urine culture and ultrasonography.

Stone-free status, postoperative complications, operative time and hospitalization time were compared in both groups. Chi-square and t-

-test were used for statistical analysis and statistical significance was defined as p value <0.05 at 95% confidence interval.

2.1 Operative Technique

Group 1: mPCNL

The patient was placed in lithotomy position and a 5F retrograde end flushing ureteric catheter was inserted. The tip of the catheter was sited at the renal pelvis or within the upper pole calyx, and its position was confirmed by instilling a small amount of radiographic contrast medium into the collecting system.

A Foley catheter (6-10Fr) depending on patients' age and urethral caliber size was inserted per urethra and taped to the ureteric catheter.

Of all 20 patients, we performed in supine position with the side of the interest at the edge of the table with a small cushion placed under the flank to elevate it 15-20 degrees, then sterilization of the skin by povidone-iodine 10% solution, then toweling the patient was kept warm throughout the procedure

The track was then dilated sequentially initially by using plastic fascial dilators 6, 8, and 10F up to 16 F. The 16F metal sheath was then passed over the 16F dilator, and once the tip of the sheath is confirmed within the collecting system, the dilator was removed under fluoroscopic guidance .

This metal sheath 16F has a sideway for connection with suction system which facilitate retrieval of gravels through the procedure.

Stones were fragmented using 12Fr RZ nephroscope and pneumatic lithotripsy , and the fragments removed sequentially by using various types of stone grasping. the patient ureteral catheter was withdrawn after insertion of guide wire & replacing it by JJ .

Group 2:

All procedures were performed by 7.5-Fr (Storz, FLEX-X2,) flexible ureteroscope. All patients received a third generation cephalosporin at the induction of anesthesia. Under general anesthesia, patients were placed in the lithotomy position on a fluoro- -endoscopic table. After by passing a 0.038-inch safety guidewire into the renal pelvis, a ureteral access sheath (9.5/11.5 or 12/14Fr) was placed to allow for optimal visualization, to maintain low intrarenal pressure, and to facilitate extraction of stone fragments. For the cases in which the 12/14Fr ureteral access sheath could not progress regularly under the fluoroscopic control, 9.5/11.5Fr sheath was used. The stones were fragmented by a holmium: YAG laser (Lisa; Sphinx 30 W, Katlenburg University, Germany) (272µ caliber fiber) until they were deemed small enough to pass spontaneously. At the beginning of the laser lithotripsy, the laser functioning parameters were 1.5 Joule/11 Hertz and when the stone sizes decreased to 10 mm the parameters were changed to 10 J/12 H in order to avoid the pneumatic effect of the laser, which could migrate the stone to other poles. Basket extraction of residual fragments was not routinely performed; however, some residual fragments were removed by tipless nitinol baskets for stone analysis. At the end of the procedure, a double-J stent was placed routinely in all patients. JJ stents of the patients were removed at postoperative first month.

3. Results

This study included 40 patient (20 male and 20 female) with a renal pelvis or calyceal stone (right side in 15patients and left side in 35 patients), all cases were done in supine position according to surgeon preferance. Mean ± standard deviation (SD) of age was 36.06±12.28 rang from (15-65).. Stone size, operative, and fluoroscopy times had mean ± SD of 2.37±0.22mm& (2.1-3.0)min, 84.07±26.3min (40-120), 6.96±2.32 (range 3-10 minutes), respectively.

Twenty eight patients had radiopaque stones, whereas 12 patients had radiolucent stones. Mean ±SD of hospital stay duration was 1.05±0.55 (range 1-3 days) . We observed mean preoperative hemoglobin ± SD of 13.81±0.96 (12.5-14.5)mean postoperative hemoglobin± SD of 13.18±1.09 (11.5-14.5)

only one case of m PCNL had significant bleeding for which one unit blood was transfused. One patient of m PCNL had renal pelvic perforation and extravasation which was a small perforation and resolved with Double J stent and conservative measures , nephrostomy tube was inserted in both cases. Two cases of m PCNL developed postoperative fever .

Primary stone free rate was 89% in m PCNL & 83.4 % in RIRS which increased to 100% after successfully treating the residual fragments by a second percutaneous procedure in 3 cases of m PCNL & in 5 cases of RIRS (12.5)%

Table (1) Comparison between (M PCNL) and (RIRS)according to stone character & location

	mPCNL (35)	RIRS (35)	Statistical test (x^2)	P value
Size mean ±SD	2.57±0.22mm	2.6±0.24mm	St t= 1.28	0.24
Site				
Lower calyx	4	6	FET= 9.85	0.037*
Lower calyx +pelvis	5	3		
Pelvis	3	2		
Upper calyx	2	4		
Middle calyx	6	5		
Density				
Opaque	15	13	2.7	0.18
Lucent	5	7		

Table (2) Comparison between (M PCNL) and (RIRS) according to perioperative data

	mPCNL (35)	RIRS (35)	Statistical test (x^2)	P value
Operative time/minutes mean ±SD	104.43±14.79	59.71±19.44	St t=10.83	<0.001**
Fluoroscopic time mean ±SD	8.11±2.05	5.8±1.98	St t=4.8	<0.001**
SFR				
Residual (2nd look)	3	4	0.47	0.50
Stone free	17(89)	16(83.4)		
Hospital stay mean ±SD	1.41±0.46	1.29±0.44	St t=1.19	0.24
1 day	10	15	FET= 2.84	0.25
2 days	8	5		
3 days	2	0		

4. Discussion

With high technological advancement, urologists who take charge of urolithiasis are in possession of high technique instruments, which leads to safer and more effective lithotripsy. So far PCNL is considered to be the recommended therapy for large stones > 2.0 cm by both AUA and EAU guidelines. Furthermore, with the development of the "miniPCNL" procedure, smaller access sheaths (≤20 F) are becoming increasingly popular for its relative safety. Besides, recent reports suggested that RIRS is a safer approach that could lead to less complications and Hb drop than normal tract PCNL

Standard PCNL is usually defined as working with a large sheath (24–30F).16

It was an effective way to deal with large calculi (usually >2 cm) but with high complication rate and long hospital stay. MPCNL was a potential way to decrease the complication rate and hospital stay, but its efficacy and safety were still in argument.

SFR is a key parameter to evaluate the efficacy of stone surgery.17

Of the lower pole stones, the advantage of mini-PCNL was more obvious. It was due to the unfavorable anatomy and limitations of RIRS in the treatment of lower pole stones.18

The anatomy of the kidney, such as the infundibulopelvic angle, the infundibular width, and infundibular length, can make a difference to the SFR of the lower pole stones. 19

Besides, the insertion of the laser probe reduces the deflection ability of the flexible ureterorenoscope was not conducive for RIRS to the treatment of the lower pole stones.18

The results of Pei Lu et.,al 2017 study suggest that PCNL, although associated with a longer hospital stay, has a higher stone-free rate compared with RIRS when used to treat kidney stones greater than 20 mm in children.

However, no difference was detected in terms of operation time, total stone-free rate, and complication rate

Yan et al 20. showed a complete clearance rate of 85.2% for renal calculi in preschool age children using mini-PCNL monotherapy. Likely, the stonefree rate declined dramatically in children with more than 2 stones or increased stone size (>20mm).21

Giusti et al. treated kidney stones >2 cm in diameter via RIRS. A total of 162 patients had an average stone diameter 2.7 ± 0.6 cm. The success rate was 87.7% with an average of 1.48 operative sessions per patient. RIRS was considered to be safe and effective when used to treat kidney stones >2 cm in diameter .22.

Hyams et al. used RIRS to treat 120 patients with kidney stones 2-3 cm in diameter Of these, 63% had residual stones < 2 mm in diameter and 83% residual stones < 4 mm in diameter. The complication rate was 6.7%, and 78% of patients were treated in the outpatient clinic .23.

Fluoroscopy time is important when choosing the optimal treatment. Prolonged exposure to X-rays harms both surgeon and patient. The protective maxim used is termed ALARA ([exposure is to be] as low as reasonably achievable). 24.

Today, RIRS is an excellent minimally invasive treatment alternative for intrarenal stones smaller than 2 cm and reported stones-free rates are higher at this stone size (25.26.27).

Increased experiences of the urologists and developments in the technology have created the substructure of this success. Development of new generation (bidirectional 270º flexion capacity, small caliber shaft and improved optics) flexible ureteroscopes, improved flexibility of holmium laser fibers, different and small diameter stone retrieval devices with the capability of facilitating intrarenal maneuvers have resulted in increased treatment success and decreased procedure related morbidity, in the management of renal stones (28.29).

In addition, ureteral access sheaths provided lower intrarenal pressure during prolonged procedures and facilitated the retrieval of multiple stone fragments (30.31).

All these innovations and especially increased experience in RIRS aroused the urologists' interest to the success of this procedure in larger and lower calyceal renal stones.

RIRS is known to have less complications compared to PNL (27).

Major complications secondary to RIRS are less common and decrease in time. Today, with the decreasing size of instruments, significant complications such as ureteral avulsion are extremely rare. In addition, RIRS has been provided safe in patients with high risk and co-morbidities such as pregnant woman, morbid obesity, bleeding diathesis and in whom PNL may be contraindicated (32.33)

We conducted this study to systematically analyze the outcomes of two miniature procedures, mini-PCNL and RIRS, which cause considerably lesser trauma than standard PCNL, to find which one could lead to better efficacy and safety.

SFR is the most important parameter for estimating the efficacy of two approaches. According to the synthesis analysis of data, mini-PCNL has a higher SFR than RIRS group 89 %& 83.4% Stone-free rates are correlated with the lithotripsy and the location or size of stones

According to Hongyang j ., et al 2017 Operative times were reported in 12 involved studies, and six studies indicated that mini-PCNL spent shorter operating time, while four studies favored RIRS.

In our study we found that much more time with MPCNL without statistical significance. the comparison of postoperative morbidity between mini-PCNL and RIRS.The results showed that RIRS provided a lower complication rate than miniPCNL. The complications of mini-PCNL are similar to those of PCNL; bleeding, pain, and fever are very common [34.35].

5. Conclusion

The most important drawback of mini PCNL is lengthy operative time , due to, the need for fragmentation into very small stones suitable for ureteroscopic graspers and/or baskets, and the small sheath Which may lead to diminished intraoperative field visibility. We believe the technique may be easier by the use of stone dusting technique by Laser lithotripter. We recommend also use of suction attachment to the pneumatic lithotripter to decrease the operative time through extraction of small fragments.

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