



Beyond Percutaneous Nephrolithotomy: Embracing Retrograde Intrarenal Surgery for Large Renal Stones: Prospective Randomized Study

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Abstract

Background : Retrograde intrarenal surgery (RIRS) and percutaneous nephrolithotomy (PCNL) are two common procedures used to treat large renal stones. This work aimed to evaluate the safety and efficacy of flexible ureterorenoscopy with laser lithotripsy (FURSL) in the management of large renal stones in comparison with the gold standard PCNL for the management of large renal stones 25 – 40 mm in size.

Methods : This prospective study was carried out on 100 patients who received RIRS or PCNL for renal stones with sizes ranging from 25 mm to 40 mm. The research was composed of two groups: the PCNL group (n= 50) and the FURSL group (n= 50). with exclusion of cases with anatomical abnormalities, cases with history of previous surgery patient with coagulopathy.

Results: The location of the stone was significantly varied among both groups (P value =0.006). Operative time was significantly higher in Group FURS than Group PCNL (P value <0.001) and hospital stay was significantly lower in Group FURSL than Group PCNL (P value <0.001). Complications (fever, colonic injury, stein Struss, haematuria, and bleeding) were insignificantly variant among both groups. The total number of patients who needed auxiliary procedure like 2nd session of FURSL were significantly higher in Group FURSL than in Group PCNL (P value <0.001). need for ESWL as auxiliary procedures were insignificantly variant among both groups.

Conclusion: Both FURS and PCNL have shown safety and efficacy in managing sizable renal stones. The selection between each technique should be individual according patient factors and urologist preference.

Keywords: Retrograde Intrarenal Surgery; Percutaneous Nephrolithotomy; Large Renal Stones; FURSL.

INTRODUCTION

Minimally invasive surgical procedure known as Retrograde Intrarenal Surgery (RIRS) has been more popular in recent years for the removal of big renal stones (25-40 mm) [1]. Two typical methods for treating big kidney stones are RIRS and Percutaneous Nephrolithotomy (PCNL). In recent years, RIRS has emerged as a potential alternative to PCNL for treating bigger stones. RIRS involves the use of flexible ureteroscope to access the kidney through the bladder and urethra, without the need for any incisions. This technique allows for a thorough investigation of the stone and the entire urinary tract can be removed and fragmented using laser [2,3]. Compared to the traditional PCNL approach, which involves making a small incision in the back to access the kidney [4], RIRS has many benefits, including less pain, postoperative discomfort, an expedited recovery period, and decreased duration of hospitalization

Moreover, RIRS is correlated with a reduced likelihood of consequences, such as infection and hematuria so making it a more secure alternative for individuals with concurrent medical conditions [5,6]. Moreover, recent research has shown that RIRS may exhibit comparable efficacy to PCNL in addressing the management of sizable renal stones measuring between twenty-five and forty mm [7]. As a result of these benefits, RIRS is increasingly being recognized as the future replacement of PCNL for the treatment of large renal stones. Many medical centers around the world have already incorporated RIRS into their standard practice for the treatment of stones. However, the choice of the most appropriate approach for each patient should be made based on the individual features of the patient's medical history and the stone and preferences [8].

METHODS AND PATIENTS

Study Design

This prospective randomized controlled study included a total of 100 patients with large renal stones (25-40 mm) who received treatment between January 2020 and March 2024. Fifty underwent PCNL and fifty underwent FURSL. Computer generated randomization numbers were used for random allocation and each patient code was kept in opaque sealed envelope. Patient were randomly allocated with 1: 1 allocation ratio into two groups in a parallel manner, PCNL group and FURSL group. approval for this study from the local ethical committee authorities was obtained, each patient signed an informed consent. stone size 25-40 mm in each group. With exclusion of patients with previous renal surgery, anatomical renal abnormalities and patient with coagulopathy. The research was carried out in compliance with the principles outlined in the Declaration of Helsinki and received approval from the hospital ethics committee.

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Patient Selection

In this research, a hundred twenty-seven patients were evaluated for eligibility, twenty-seven patients did not meet the criteria. The remaining patients were allocated into two groups fifty patients in group (one) treated with RIRS and fifty patients in group (two) treated with PCNL. Data was analyzed statistically and collected retrospectively from medical records for all patients. We obtained approval for this research from the local ethical authorities, and each patient signed an informed consent form. January 2020 and March 2024. Fifty underwent PCNL and fifty underwent FURSL

Data Collection

The research gathered data pertaining to several aspects, including patient demographics, stone size, stone-free rates (SFRs), surgical time, hospital stay, the need for auxiliary operations, and complications. The definition of SFR in this research refers to the complete absence of any remaining stones or fragments less than 3 mm, as determined using CT imaging one month after the procedure of surgical.

Surgical Techniques

All RIRS and PCNL procedures were performed by experienced urologists. RIRS was performed using disposable flexible ureteroscopy and holmium laser lithotripsy with combined fragmentation & dusting techniques. PCNL was performed using a standard technique with fluoroscopic guidance and combined pneumatic /ultrasonic lithotripsy.

PCNL (PERCUTANEOUS NEPHROLITHOTOMY) TECHNIQUE

Anesthesia

The procedure is typically performed under general anesthesia, Occasionally, regional anesthesia may be used. Patient positioning: The patient is placed in a prone (face-down) position on the operating table. The surgeon will ensure that the patient is properly aligned and supported to maintain stability throughout the procedure.

Incision and access

Under fluoroscopy, a small incision in the patient's back, usually in the area corresponding to the kidney containing the stones. In some cases, multiple incisions may be made. The incision is made through the skin, subcutaneous tissue, and muscle layers.

Guidewire placement

A needle is inserted through the incision into the kidney's collecting system under fluoroscopic guidance (X-ray imaging). A guidewire is then passed through the needle and into the kidney, which helps create a pathway for the subsequent steps.

Dilation

After the guidewire is in place, a series of dilators of increasing size are passed over the wire to enlarge the access tract. This step allows the surgeon to introduce the nephroscope (Storz 26 FR,)

Nephroscopy

Once the access tract is dilated, the nephroscope is inserted into the kidney. The nephroscope provides visualization inside the kidney and allows the surgeon to identify and locate the kidney stones.

Stone removal or fragmentation

Depending on the size and number of stones, either remove the stones in their entirety or fragment them into smaller pieces for subsequent removal. Various techniques can be used, including mechanical

fragmentation, ultrasonic or pneumatic lithotripsy, laser lithotripsy, or a combination of these methods.

Stone extraction

The fragments or whole stones are removed from the kidney using specialized instruments, such as stone graspers or baskets. In some cases, a larger stone may need to be fragmented into smaller pieces before extraction.

Drainage tube placement

After the stones are removed, a drainage tube (nephrostomy tube) is temporarily placed through the access tract into the kidney to allow any remaining stone fragments, blood, or fluid to drain out. The tube is typically connected to a collection bag outside the body. The remaining is for two to three days.

Closure

Once the drainage tube is in place, the access tract is closed with sutures. A JJ stent was left in the ureter to facilitate urine drainage for two to four weeks.

Pain medications and antibiotics are prescribed to manage pain and prevent infection. The length of the hospital stay can vary depending on the patient's condition and the complexity of the procedure.

FURSL technique is a minimally invasive technique used to treat kidney or ureteral stones. It involves using a flexible ureteroscope, a thin and flexible instrument, to visualize and access the stones in the urinary tract. Laser lithotripsy is then used to fragment the stones into smaller pieces, which can be either retrieved or allowed to pass naturally. Here's an overview of the technique:

Anesthesia

The procedure is typically performed under general anesthesia. Occasionally, regional anesthesia or sedation may be used.

Patient positioning

The patient is usually placed in a lithotomy position, similar to the position used for gynecological examinations. This position allows optimal access to the urinary tract.

Ureteroscope insertion: A flexible ureteroscope is inserted into the urethra and advanced through the bladder and into the ureter. The ureteroscope is equipped with a working channel through which various instruments can be passed.

Stone identification

Once the ureteroscope is in position, the surgeon visually inspects the urinary tract to locate the stones.

Laser lithotripsy

When a stone is identified, laser lithotripsy is employed to break the stone into smaller fragments. A laser fiber is inserted through the working channel of the ureteroscope and positioned near the stone. The laser emits high-energy pulses that fragment the stone without damaging the surrounding tissues.

Stone fragmentation and retrieval

The laser is used to fragment the stone into smaller pieces (fragmentation technique) or dust (dusting technique). The fragments can be grasped and removed using specialized stone retrieval tools, such as stone baskets or graspers. Alternatively, smaller stone fragments may be left in place to allow for spontaneous passage.



Additional procedures

In some cases, additional procedures may be required to fully remove or treat the stones, this is according to the results of the CT scan after one month of the first procedure. For instance, if a stone is too large to be removed in one piece, it may be necessary to fragment it further using laser lithotripsy and retrieve the fragments individually. In certain situations, a temporary ureteral stent JJ STENT, was placed to ensure the passage of stone fragments and to promote healing.

Completion and recovery

Once the stones have been adequately treated, the ureteroscope is removed, and the patient is taken to the recovery area for observation. Pain medications and antibiotics may be prescribed, and post-procedure instructions, such as fluid intake recommendations, may be provided. The patient's recovery time can vary, depending on the complexity of the procedure and the size and number of stones treated.

STATISTICAL ANALYSIS

This prospective randomized controlled study included a total of 100 patients with large renal stones (25-40 mm) who received treatment between January 2020 and March 2024. Fifty underwent PCNL and fifty underwent FURSL Computer generated randomization numbers were used for random allocation and each patient code was kept in opaque sealed envelope. Patient were randomly allocated with 1: 1 allocation ratio into two groups in a parallel manner, PCNL group and FURSL group. approval for this study from the local ethical committee authorities was obtained, each patient signed an informed consent. stone size 25-40 mm in each group. With exclusion of patients with previous renal surgery, anatomical renal abnormalities and patient with coagulopathy. The research was carried out in compliance with the principles outlined in

the Declaration of Helsinki and received approval from the hospital ethics committee.

RESULTS

In this study, a hundred twenty-seven patients were assessed for eligibility, twenty-seven patients did not meet the criteria. The remaining patients were allocated into two groups (fifty patients in group PCNL and fifty patients in group FURSL). All allocated patients were followed up and analyzed statistically (Figure 1).

Sex and age were insignificantly variant among both groups. BMI was significantly lower in group FURS than in group PCNL (P value =0.018) (Table 1). The size of the stone, side, and HU was insignificantly variant among both groups. SFR was significantly lower in group FURS than in group PCNL. The location of the stone was significantly varied among both groups (P value =0.006) (Table 2, Figure 1). Operative time was significantly higher in Group FURS than Group PCNL (P value <0.001) and hospital stay was significantly lower in Group FURS than Group PCNL (P value <0.001). Complications (fever, colonic injury, stein Struss, haematuria, and bleeding) were insignificantly variant among both groups (Table 3, Figure 2).

DISCUSSION

Renal stones are a prevalent urological issue that may lead to problems and substantial pain if not taken seriously. The therapy of renal stones of considerable size, namely those above 2 cm, is a complex task that needs a specialized approach. Retrograde PCNL and FURSL are often used techniques in the management of large renal calculi [9,10]. The objective of this prospective randomizes controlled study was comparative research was to evaluate the safety and effectiveness of FURSL and PCNL in managing big renal stones measuring between 25

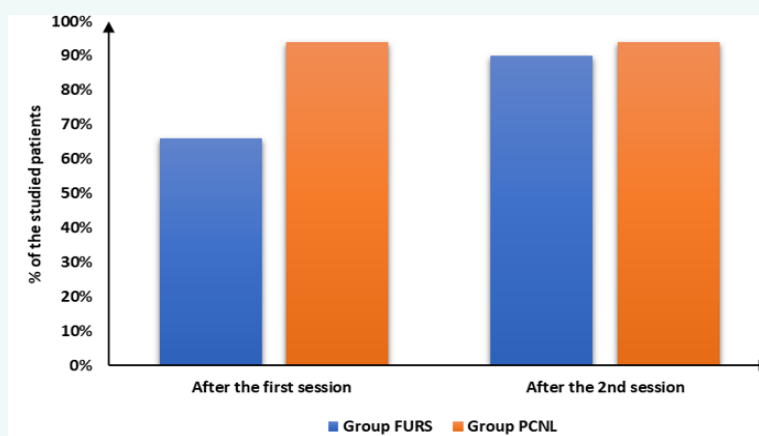


Figure 1: Stone free rate of studied groups

Table 1: This table demonstrated the demographic data of the studied groups

		Group FURS (n=fifty)	Group PCNL (n=fifty)	P value
Age (years)		47.7 ± 58.03	41.96 ± 9.35	0.492
Sex	Male	28 (56%)	30 (60%)	0.685
	Female	22 (44%)	20 (40%)	
BMI (kg/m ²)		33.98 ± 5.45	36.72 ± 5.93	0.018*

Data are demonstrated as average ± SD or frequency (%). BMI: Body mass index.



Table 2: Features of stone of the studied groups

		Group FURS (n=fifty)	Group PCNL (n=fifty)	P value
Size of stone (mm)		36.52 ± 3.83	36.22 ± 4.21	0.710
HU		706.74 ± 249.61	749.06 ± 205.18	0.357
Side	Right	26 (52%)	20 (40%)	0.229
	Left	24 (48%)	30 (60%)	
SFR (%) post 1 st session		33 (66 %)	47 (94 %)	0.004*
Post 2 nd session		45(90%)		
Location	L, M, U	18(36%)	4(8%)	0.006*
	P, M	6(12%)	12(24%)	
	P	13(26%)	20(40%)	
	P, L	13(26%)	14(28%)	

Data are demonstrated as mean ± SD. HU: The Hounsfield unit. SFR: stone-free rate %. = was defined as the absence of any residual stones or fragments larger than three mm on CT imaging at one month postoperatively. L = lower calyx M = middle calyx. P= renal pelvis U = upper calyx.

Table 3: Operative time, complications, and hospital stay of the studied groups

	Group FURS (n=fifty)	Group PCNL (n=fifty)	P value
Operative time (min)	154.6 ± 16.17	92.9 ± 16.69	<0.001*
Hospital stay (days)	1.69 ± 0.43	3.04 ± 0.67	<0.001*
Complications			
Total	6 (12%)	10 (20%)	0.275
Fever	3 (50%)	4 (40%)	1.00
Stein Struss	1 (16.7%)	0 (0%)	1.00
Haematuria	2 (33.3%)	2 (20%)	1.382
Bleeding	0 (0%)	3 (30%)	0.242
Colonic injury	0 (0%)	1 (10%)	1.00

Data are demonstrated as average ± SD or frequency (%)

Table 4: Number of patients who need the procedure of auxiliary

	Group FURS (n=fifty)	Group PCNL (n=fifty)	P value
Total	17 (34%)	3 (6%)	<0.001*
2 nd session of FURS	12 (24%)	0 (0%)	<0.001*
ESWL	5 (10%)	3 (6%)	0.715

Data are demonstrated as frequency (%). ESWL = extracorporeal shock wave lithotripsy

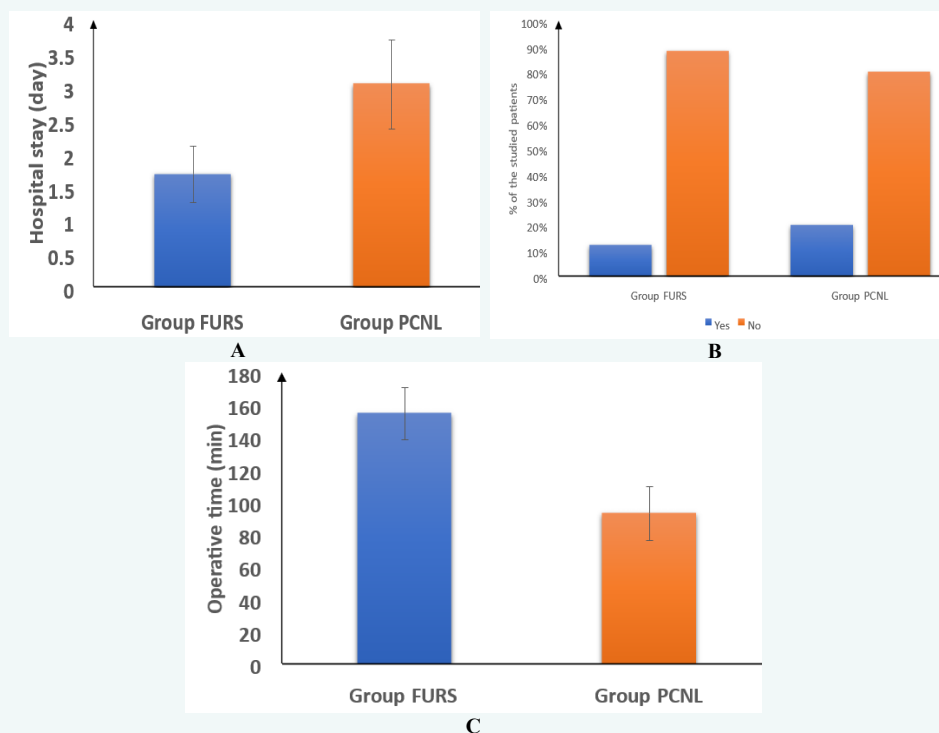
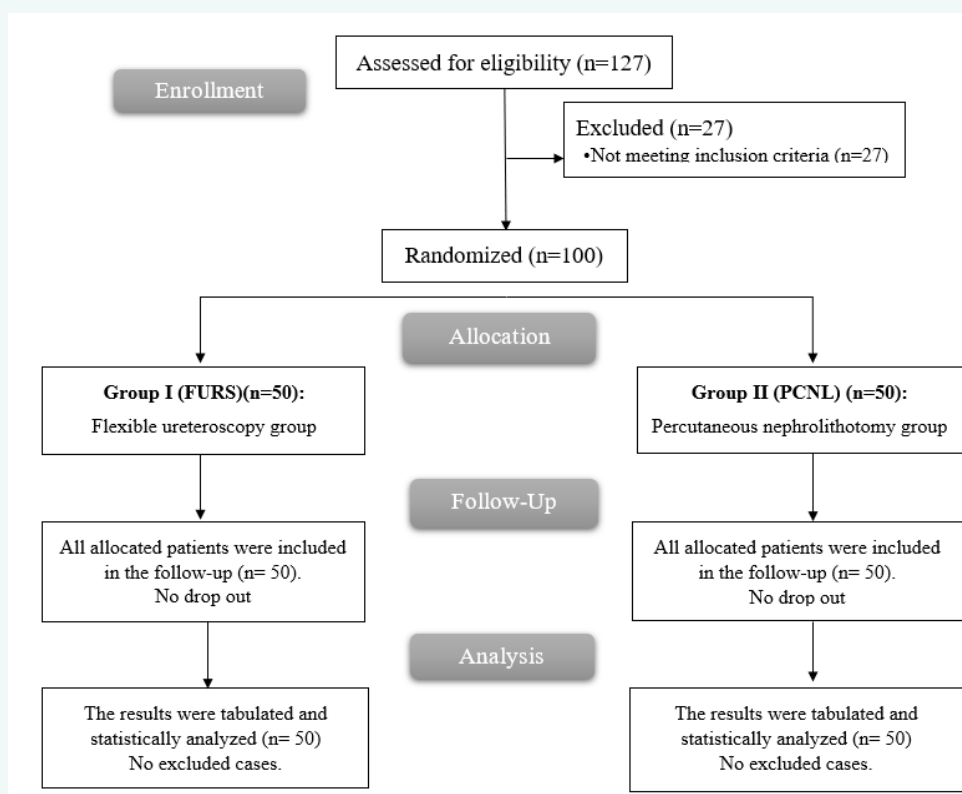


Figure 2: A) Hospital stay, B) Complications, C) Operative time of studied groups



Flow Chart Figure 1: CONSORT flowchart of the enrolled patients



and 40 mm. The research had a sample of one hundred individuals who were allocated into two distinct groups: Group FURS, consisting of fifty patients, and Group PCNL, also including fifty patients. The patients were subjected to follow-up post procedures and then underwent statistical analysis. The demographic features of the groups under investigation exhibited no statistically important disparities in terms of gender and age. Nevertheless, there was a notable disparity in BMI between Group FURS and Group PCNL. There were no important differences observed in the features of the stones, such as Hounsfield unit (HU), side, and size, between the two groups. Nevertheless, Group PCNL exhibited a significantly higher SFR compared to Group FURS. There was no disparity in the positioning of the stone between the two groups. The duration of the surgical procedure was notably longer in Group FURS compared to Group PCNL; however, the length of hospitalization was considerably shorter in Group FURS in contrast to Group PCNL. There were no important differences in complications between the two groups. Patients in Group FURS required considerably more supplementary procedures and FURS sessions overall than patients in Group PCNL. The findings of ESWL (extracorporeal shock wave lithotripsy) were comparable among the two groups. The results of this research suggest that both PCNL and FURS are safe and effective for the large renal stones treatment. However, PCNL had a shorter operative time and a higher SFR, while FURS had a shorter hospital stay. FURS and PCNL have been studied extensively for the treatment of big renal stones, and the findings have been compared in many trials. Studies have shown that both treatments are safe and effective, although their findings have been inconsistent. PCNL has been proven to have a shorter operational time and greater stone-free rate and, whereas FURS has been shown to have a shorter hospital stay in certain trials. Procedure selection depends on patient-specific factors such as surgeon preference, stone size, and stone placement [10-12]. Numerous research studies have evaluated the safety and efficacy of PCNL and FURS for the treatment of large renal stones. A meta-analysis by Zhu et al. [13], included seventeen research and found that PCNL had a higher stone-free rate than FURS (OR 2.39, 95% CI 1.92–2.97, $p < 0.001$) but had a higher risk of complications and a longer hospital stay. Another meta-analysis by Zhang et al. [14], included eighteen researchers and found that PCNL had a higher stone-free rate (OR 2.58, 95% CI 1.98–3.37, $p < 0.00001$) and a shorter operative time than FURS but had a higher risk of complications and a longer hospital stay. In contrast to our study, several studies have shown a higher stone-free percentage in their FURS group, with figures of sixty-six percent after the first session and ninety percent after the subsequent session. Research conducted by Wang et al. [14], revealed a stone-free percentage of 78.9% after two FURS for stones over two centimeters in size. Nevertheless, the stone-free rate observed in our PCNL cohort (94 %) aligns with the rates documented in existing scholarly literature. According to a meta-analysis conducted by Zhang et al. [15], the collective stone-free rate after PCNL for stones above two centimeters was found to be 87.7%. The hospital stay reported in FURS group (1.69 ± 0.43 days) is shorter than that reported in some research. For example, research by Bozkurt et al. [16], reported an average hospital stay of 2.7 days after FURS for stones larger than two cm. The hospital stay reported in our PCNL group (3.04 ± 0.67 days) is consistent with that reported in the literature. A meta-analysis by Zhang et al. [15], reported a pooled average hospital stay of 3.8 days after PCNL for stones larger than two cm. The duration of the operational time observed in FURS group, with an average of 154.6 ± 16.17 minutes, exceeds the findings reported in some previous research. An investigation conducted by Cui et al. [17], revealed that the average duration of the surgical procedure was 105.8 minutes after the use of FURS for the treatment of stones above two centimeters in size. The operative time reported in our PCNL group (92.9 ± 16.69 minutes) is consistent with that reported in the literature. A meta-analysis by Zhang et al. [15], reported a pooled average operative time of 98.3 minutes after PCNL for stones larger than two cm. In brief, the findings of our research align with the existing literature, but there are some discrepancies in stone-free rates, surgical time, and duration

of hospitalization. The observed discrepancies might potentially be attributed to variances in patient demographics, the placement and size of the stones, the specific surgical approach used, and the level of expertise possessed by the surgeon. The selection of the surgical method needs to be predicated upon the unique attributes of the patient, including factors such as BMI, the surgeon's taste, and the precise position of the stone.

CONCLUSION

Both FURS and PCNL have shown safety and efficacy in managing sizable renal stones. The selection between drawbacks associated with each technique is difficult and these treatments necessitates a meticulous assessment of the respective merits. Additional research is required to validate the findings of this research and determine the most effective approach for managing big renal stones. But still the selection is individualized according to patient characters, stone characters and surgeon preference.

FUTURE

We hope to develop more potent & powerful laser machines with fast stone disintegration, also the development of different suction techniques for the removal of dust & small fragments during the procedure & also will help in reducing intrarenal pressure.

CONSENT

Informed consent was obtained from all individual participants included in the study.

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