ORIGINAL ARTICLE

Comparison of outcomes of supine percutaneous nephrolithotomy against retrograde intra-renal surgery

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Abstract:

Objective: To compare the efficacy of Supine Percutaneous Nephrolithotomy (PCNL) v/s Retrograde Intrarenal Surgery (RIRS) in the management of Renal Stones ≥2cm in diameter.

Material and Methods: Results of Supine PCNL and RIRS were prospectively analyzed and compared. Total 100-patients were included in this study, 50-patients in each group PCNL and RIRS by lottery method all the cases from September 2019 to September 2021 were included in this study. Results were analysed by IBM SPSS version 18. P value ≤0.05 was taken as significant.

Results: The mean duration of operation was 49.4±10.1 min in the RIRS group and 113.5±35.5 min in the PCNL group (p <0.001). The Hospital stay was significantly shorter in the RIRS group (2.84±0.8 days vs. 1.92±0.6 days in the supine PCNL and RIRS groups, respectively; p<0.001). The complete stone clearance rate is higher in supine PCNL (82%) and in RIRS are 42% (p <0.001), while fragments >4mm are 14% in supine PCNL and in RIRS are 28% (P=0.086).

Conclusion: RIRS has some advantages over supine PCNL such as shorter hospitalization time, shorter fluoroscopy time and less post-operative pain and other complications in treating renal stones ≥2cm in diameter. However, PCNL has higher SFRs with only a single session.

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Introduction:

Percutaneous Nephrolithotomy (PCNL) is the standard treatment therapy for large renal calculi of >2cm in diameter, especially staghorn calculi, calyceal diverticular calculi, or calculi in the lower calyceal system.[1]

Initial experience with PCNL was in prone position, prone PCNL has potential disadvantages, as it may cause circulatory and ventilator compromise, especially in obese patients. Additional difficulties of prone anesthesia include direct and indirect pressure effects, e.g. vascular, peripheral nerve and cervical spine injury, tracheal compression and ocular injury.[2]

Miniaturized devices were created in order to lower the morbidity without affecting the procedure's effectiveness and stone-free rates.[3] The improvements in patient posture, safer and more precise tract formation procedures, new imaging modalities, the development of intracorporeal lithotripters, and the use of flexible tools for effective collecting system screening were all included in the advances to PCNL approaches.[4]

Supine PCNL is a strong alternative to prone PCNL. All supine positions decrease operating duration, and there is no need for repositioning of patient, easier patient ventilation, protection of the patient from positional injuries, more convenient access to the patient by the anesthesiologist.[5] Complete supine nephrolithotomy (PCNL) has ability to perform simultaneous PCNL and ureteroscopic procedures, better

drainage of Amplatz sheath.[6]

PCNL may come with serious side effects such a peri-renal hematoma, water intoxication, arterio-venous fistula, development of sepsis, disseminated intra-vascular coagulation, infection, or damage to surrounding organs that might need nephrectomy.[7]

As a result of technological advancements, retrograde intrarenal surgery (RIRS) has emerged as a significant alternative for treating big renal stones.[8]

RIRS is an effective option for treating renal calculi in patients who are ineligible for PCNL and who have features predicting higher chances of complication, such as severe cardiac illness, extensive vertebral deformities, morbid obesity, or those on anticoagulant medication.[8] Indications for Retrograde intrarenal surgery (RIRS) is treatment of renal stones include radiolucent stones, bleeding disorders, the patient taking anti-coagulants, co-existence of ureteral and renal stones, and multiple renal stones unfeasible for ESWL.[8,9] The intra-operative complications of RIRS including ureteral perforation, ureteral avulsion, failure to complete the operation.[9]

The purpose of this study is to prospectively evaluate the stone clearance rate, operation time, post-operative complications, post-operative hospital stay of Supine percutaneous nephrolithotomy and Retrograde Intra-Renal Surgery (RIRS) in the management of renal calculi of >2cm and compare outcomes of both treatment modalities.

Material and Methods:

This prospective observational study was carried out at the Department of Urology, Sindh Institute of Urology and Transplantation (SIUT), from September 2019 to September 2021. The procedures used in this study adhere to the tenets of the Declaration of Helsinki. This research was conducted with approval from institutional ethics review committee. The whole treatment was offered free of cost to all the patients. Adult patients of age between 18-60 years of both genders with renal calculi of 2-3cm in size diagnosed at CT scan were in included in this study after taking informed written consent. Patient who had history of previously failed treatment, positive urine cultures, anatomical malformation, deranged coagulation profile, and deranged renal functions were excluded from this study. Total 100-patients were enrolled by non-probability consecutive technique. Lottery method was used to allocate 50-patients in each group PCNL and RIRS.

Data regarding stone size, location, and number of the stone(s), age, gender of the patient, weight, pre-operative sign and symptoms, past medical history, radiological investigations, hematological and bio-chemistry tests, stone fragmentation, surgery time, irrigation fluid, fluoroscopy time, intra-operative and post-operative complications, post-operative HB level, duration of hospital stay and stone clearance at 6-weeks follow-up were entered in pre-designed proforma to compareand evaluate two groups efficacy. All supine PCNL procedures were completed through a single percutaneous tract.

All the data was entered and analyzed in SPSS version 18.0 (SPSS for Windows, Chicago, IL, USA). Descriptive statistics was used to summarize the continuous and categorical variables. Continuous variables were presented as mean and standard deviation while categorical variables were presented as frequencies and percentages.

The Chi-square test (χ^2test) was used for comparisons of the categorical variables and the Student's t-test was applied to determine the mean comparison between two groups (age, weight, hematological tests, bio-chemistry tests, size of stone, surgery time, irrigation fluid, fluoroscopy time, post-operative HB, blood loss, hospital stay). Pearson correlation coefficient was used to determine the linear correlations among the variables. $p<0.05$ was considered as statistical significance. The whole original data set is available and will be made available upon request, subject to patient confidentiality.

Table 1: Base line characteristics of the patients

Parameters	Supine PCNL Mean(±SD)	RIRS Mean (±SD)	Mean difference	P-value
Age	35.04 ±10.9	34.84 ±12.4	**0.20**	**0.932**
Weight	72.48 ±16.9	*64.78 ±12.5*	7.70	0.011
Hematological tests				
HB	13.70 ±1.5	*12.93 ±2.0*	0.77	0.039
Platelets	276.38±60.7	*303.60±85.0*	27.22	0.68
TLC	10.97 ±12.5	*9.92 ±4.1*	1.05	0.574
INR	1.01 ±0.07	*1.03 ±0.1*	0.02	0.279
Biochemistry tests				
Urea	27.38 ±7.4	*32.48 ±24.1*	5.10	0.158
Creatinine	0.85 ±0.2	*1.17 ±0.9*	0.32	0.21
Na	140.8±4.0	*138.8 ±7.2*	2.02	0.89
K	4.21 ±0.4	*4.06 ±0.5*	0.15	0.125
Size of stone	2.54 ±0.4	*2.19 ±0.1*	0.34	<0.001
Surgery time	113.5 ±35.5	*49.4 ±10.1*	64.10	<0.001
Irrigation fluid	21.88 ±6.9	*13.28 ±2.4*	8.10	<0.001
Fluoroscope time	1.62 ±0.6	*1.00 ±0.0*	0.62	<0.001
Post-op HB	12.21±1.6	*12.53 ±2.1*	0.32	0.406
Blood loss	1.48 ±1.1	*0.40 ±0.3*	1.08	<0.001
Hospital stay	2.84 ±0.8	*1.92 ±0.6*	0.92	<0.001

PCNL= Percutaneous Nephrolithotomy, RIRS= retrograde Intrarenal surgery, SD= Standard deviation, Pvalue=Probability value, HB=Hemoglobin, TLC=Total leukocyte count, INR=International normalized ratio, Na=Sodium, K=Potassium.

Table 2: Complications of supine PCNL and RIRS

Variables	Supine PCNL	RIRS	P-value
Intra-operative complications			
Renal pelvis injury	5(10%)	_	
Unable to pass DJ due to PUJO	1(2%)	_	0.011
Bleeding from collecting system	4(8%)	_	
Post-operative complications			
Fever	32(64%)	17(34%)	0.003
Pain	9(18%)	6(12%)	0.401
Hematuria	4(8%)	1(2%)	0.169
Others			
Collection of fluid	1(2%)	_	
Leak from nephrostomy tract	1(2%)	_	0.383
Post PCNL collection	1(2%)	_	
Perinephric fluid collection	1(2%)	_	

DJ= double J stent, PUJ=pelvic ureteric junction

Results:

There were a total of 100-patients: 50-patients in the Supine PCNL group and 50-patients in the RIRS group. Mean age of the patient was 35.04±10.9 years in PCNL group and 34.84±12.4 years in RIRS group with mean difference of 0.20 years (Table 1).

The mean duration of surgery was 113.5±35.5 minutes in the supine PCNL group and 49.4±10.1 minutes in the RIRS group and the difference was statistically significant p<0.001. The mean hospital stay was significantly shorter in the RIRS group (2.84±0.8 days in the supine PCNL group and 1.92±0.6 days in the RIRS group with the pvalue of <0.001). The complete stone-free rate in the supine PCNL group was 82% and in the RIRS group was 42% at 6-weeks follow-up (<0.001). Supine PCNL had a larger decrease in hemoglobin level 1.48±1.1, while in-RIRS group hemoglobin decrease was 0.40±0.3 with the pvalue of <0.001.

A significant difference of fluoroscopy time was noticed, in supine PCNL it was 1.62±0.6 min- utes and in RIRS it was 1.00 minutes (p <0.001). In supine PCNL group for post-operative drainage a nephrostomy tube along with DJ stent was used in 17-patients (34%), nephrostomy tube alone was used in 26 patients (52%) and tubeless procedure was carried out in 7-patients (14%). In RIRS group DJ stent was used in 50-patients (100%).

The irrigation fluid used in supine PCNL was 21.88±6.9 liter; on the other hand in RIRS it was 13.28±2.4 liter with the p-value of <0.001. The complete stone clearance rate is higher in supine PCNL (82%) and in RIRS are 42% (p <0.001). The fragments ≤4mm are 4% in supine PCNL while 30% in RIRS with P value of <0.001 and fragments >4mm are14% in supine PCNL while in RIRS are 28% (P=0.086). No statistical difference in complication rate observed (Table 2).

Discussion:

Nephrolithiasis, as a cause of chronic renal failure in our population was high compared to other regions in the world this is due to high prevalence of stone disease in this region and to the late and incomplete treatment that results in renal failure. The induction of minimally invasive procedures for stone removal in SIUT has helped in the reduction of this preventable cause

of renal failure.[10] Since PCNL was first used at SIUT in 1997, it has been used to treat increasingly complicated stones such as those larger than 2cm, those larger than 1.5cm at the lower pole, stones with renal failure, and staghorn calculi. The objective of urinary stone surgery is to attain the maximum stone-free rate with minimal morbidity. Although PCNL has a high stone-free rate, it still has a number of serious complications, despite technical progress. RIRS is a good substitute for PCNL. The purpose of this study is to evaluate the efficacy of supine PCNL versus RIRS in the management of renal stones.

In 2011, Akman et al, studied patients with renal stones 2-4cm in size and reported a success rate of 73.5% with a single session of RIRS and 91.2% with a single session of PCNL (P=0.05). Hospitalization time was significantly shorter in the RIRS group (30.0±37.4 hours for RIRS and 61.4±34.0 hours for PCNL (P < 0.001).[11]

Hyams ES et al, studied 20 patients underwent percutaneous nephrolithotomy and 19 underwent RIRS for 2-3cm renal stones. Stone clearance (0 to 2mm) was superior for percutaneous nephrolithotomy vs ureteroscopy (89% vs 47%, p=0.01).[12] It also supports the result of stone clearance rate with our study.

Atis G et al, compare the PCNL and RIRS in treating 2-4cm renal stones. It shows a mean operative times were statistically longer in the RIRS group, whereas the fluoroscopy times, hospitalization times were statistically higher in the PCNL group. The stone-free rates (SFR) after a single procedure were 91.7% in the PCNL group and 74% in the RIRS group (P = 0.04).[13]

Retrospective study of 142 individuals with renal stones was done by Palmero et al, (106 underwent RIRS and 36 underwent PCNL). Even though the difference in success rates between the two groups was not statistically significant (P=0.40), their PCNL group showed a greater success rate than the RIRS group (80.6% vs 73.6%, respectively).[14] De S et al, analyzed two randomized and eight non-randomized studies, there was no significant difference between PCNL and RIRS in terms of operative time (p=0.31). PCNL provided a significantly higher stone-free rates (p<0.001), higher complication rates (p<0.001), and a larger decrease in HB level (p<0.001). RIRS led to a shorter hospital stay (p<0.001).[15]

In the study of Bryniarski et al., it was demonstrated that PCNL had higher efficacy (94%) in comparison with RIRS (75%) in a single session.[16] The creation of percutaneous renal access generally requires longer fluoroscopy time than the others steps of PCNL. However, the guide wire and ureteral access sheath were placed under fluoroscopy during RIRS. As an important advantage of RIRS over PCNL, creation of an access tract in the RIRS group is not required and significantly limits the duration of fluoroscopic screening time. In comparison to the RIRS group, the hospital stay was lengthier in the PCNL group. Nephrostomy tube implantation for improved drainage is one of the main causes of this delay. Post-operative pain can be related to the presence of a nephrostomy tube in patients who underwent PCNL, 18% patients had pain after supine PCNL, while in RIRS group 12% patients had pain.

Breda et al., investigated the effectiveness and safety of ureteroscopic lithotripsy for single intrarenal stones measuring 2-2.5cm in diameter using a 7.2F flexible ureteroscope and laser fiber and reported a mean post-procedural success rate of 93% after an average of 2.3 sessions.[17] When compared with PCNL, the most important disadvantage of RIRS is requirement for a second session. In the present study, the stone free rates were 82% and 42% after a single procedure in the PCNL and RIRS groups respectively (p <0.001). The difference of the reported SFRs in the literature may be resulted from complexity of the stones, patients' characteristics or surgeons' experience. Stone localization can be considered a predictive factor for stone-free status. In the present study, although there were no statistically significant differences in stone locations between the two groups, the upper calyceal localizations of the stones were higher in the

RIRS group, which are easier for RIRS and more difficult for PCNL procedures. It may also affect the stone-free rate (SFR) after the procedures.

In the present study, the mean operative times for RIRS and PCNL were 113.5±35.5 and 49.4±10.1 minutes, respectively (P<0.001). Our reported operative times are in concordance with the published articles in the literature.

Conclusion:
Currently, PCNL is the gold standard treatment modality for kidney stones larger than 2cm in size. However, satisfactory outcomes can be achieved with multi-session RIRS in the treatment of larger renal stones. According to our findings, RIRS has some advantages such as less post-operative pain, other complications, shorter hospitalization and fluoroscopy time in treating of ≥2cm renal stones. However, PCNL poses a higher stone free rate only with a single session. Patients should be involved in choosing the treatment technique by debating the benefits and drawbacks of each therapy.

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Role and contribution of authors:
Harris Hassan Qureshi, collected the data, references and wrote the article.

Naveed Ahmed Mahar, collected the data, references and helped in introduction writing.

Riaz Ahmed Laghari, collected the data, references and helped in discussion and result writing.

Syed Arslan Shah, collected the data, references and helped in introduction and discussion writing.

Miss Saba Suleman, collected the data, tabulated the data and helped in result writing.

Sara Rasheed Kalwar, collected the data, references and helped in discussion writing.

Gauhar Sultan, critically review the article and make final changes.

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