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Original Research Article

COMPARISON OF RETROGRADE INTRARENAL SURGERY OUTCOME VERSUS PERCUTANEOUS NEPHROLITHOTOMY IN RENAL STONES >2 CM IN DIAMETER IN LOWER CALYCES AT A TERTIARY CARE HOSPITAL

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Abstract: *This study aimed to compare the outcome of Retrograde Intrarenal Surgery and Percutaneous Nephrolithotomy in treating renal stones larger than 2 cm in diameter in lower calyces at a tertiary care hospital. A randomized control trial was conducted at the Department of Urology, Bahawal Victoria Hospital, Bahawalpur, for 8 months from 01-06-2021 to 01-02-2022 using a non-probability purposive sampling technique. Seventy patients met the inclusion and exclusion criteria and were enrolled in the study. The patients were randomly divided into two groups using a lottery method. Group A underwent PCNL, while Group B underwent RIRS. During the procedure, the operative time was noted from the time of intubation to the time of extubation. After the procedure, the duration of hospital stay was noted, and the patients were followed up in the OPD for 12 weeks. After 12 weeks, an abdominal ultrasound was conducted to evaluate if there were any residual stones. If there were no residual stones, the patients were labeled stone-free. Seventy patients participated in the study, with a mean age of 45.51±13.68 years, ranging from 20 to 69 years. The mean age of patients in the RIRS group was 47.63 ± 13.51 years, while in the PCNL group, it was 43.40 ± 13.71 years, with a non-significant p-value of 0.198. The gender distribution among the patients revealed that 30 (42.86%) were male and 40 (57.14%) were female, with an equal distribution of males (15, 42.9%) in both the RIRS and PCNL groups. However, there were substantial differences in the duration of surgery, with the RIRS group having a mean operative time of 107.57 ± 6.99 minutes and the PCNL group having a significantly shorter mean operative time of 75.86 ± 7.19 minutes (p-value < 0.001). Moreover, the RIRS group had a shorter mean hospital stay, with 4.77 ± 1.03 days compared to 5.46 ± 1.09 days in the PCNL group (p-value = 0.009). Post-procedure, 63 (90%) patients achieved stone-free status, with 29 (82.9%) patients in the RIRS group and 34 (97.1%) in the PCNL group, with a non-significant p-value of 0.106. This study concluded that RIRS is a safe procedure and a good alternative to PCNL in treating renal stones larger than 2 cm in diameter in lower calyces to achieve stone-free status and length of hospital stay.*

Keywords: Percutaneous Nephrolithotomy, Retrograde Intrarenal Surgery, Renal Stones

Introduction

Nephrolithiasis, also known as kidney stones, is a prevalent medical condition characterized by the formation of solid deposits within the urinary tract, which can cause considerable pain and complications. Kidney stones are a widespread health issue globally. The prevalence varies based on geographical regions and populations but has steadily risen over the past few decades. It affects both genders, though men are generally more commonly afflicted. The risk of kidney stone development increases with age, though these stones can emerge at any age, including in children. Men are more susceptible than women, with a male-to-female ratio typically ranging from 3:1 to 2:1. The prevalence of kidney stones displays geographical disparities. Regions with hot and arid climates, such as the southeastern United States, the Middle East, and parts of Asia, tend to have higher rates of kidney stone formation, often attributed to factors like dehydration due to elevated temperatures. Dietary choices significantly influence kidney stone formation. Diets high in sodium, animal protein (particularly red meat), and foods rich in oxalates (such as spinach, rhubarb, and chocolate) elevate the risk. Conversely, diets abundant in calcium and citrate may have a protective effect. Sedentary lifestyles and insufficient hydration are also risk factors.

Nephrolithiasis, a prevalent condition affecting 10-12% of our population, can lead to end-stage kidney disease if left untreated. Over the past two decades, significant technological advancements and the miniaturization of medical instruments have revolutionized the treatment of kidney stone disease (Zhu et al., 2019). Presently, there has been a substantial reduction in open surgical procedures due to the widespread adoption of minimally invasive techniques (Srisubat et al., 2014). The movement of stones within the kidney causing renal colic and obstructions from calculi can result in a loss of kidney function. Recently, there has been an increase in the incidence of kidney stones, likely attributable to changing climate and environmental factors (Ferakis and Stavropoulos, 2015). To alleviate these obstructions, urologists select various treatments based on the calculi size, ranging from less than 0.6 cm to over 3.0 cm in diameter (Rassweiler et al., 2016). As the prevalence of renal stones continues to rise, multiple treatment options have emerged. Current approaches for managing renal stones encompass extracorporeal shock wave lithotripsy (ESWL) and percutaneous nephrolithotomy (PCNL).

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Traditionally, the choice of treatment method depended on the stone's size, with PCNL typically employed for larger stones (>2 cm) and ESWL or retrograde intrarenal surgery (RIRS) for smaller or intermediate-sized stones.

It is worth noting that RIRS is considered a viable and secure alternative to PCNL in treating inferior calyceal stones (Kim, 2016). Deciding between PCNL and RIRS should be based on the surgeon's expertise, patient preference, and financial considerations (Singh and Panda, 2018). One trial found that the mean operative time was 71.66 ±10.36 min with PCNL while 109.66±20.75 min with RIRS (p>0.05), mean hospital stay was longer with PCNL (> 4 days) while with RIRS, patients discharged within 3 days of procedure (p>0.05) and stone-free rate was 92.72% with PCNL and 84.31% for renal stones ≥2 cm in lower calyces (p>0.05).[7]But another trial found that the mean operative time was 75.55±21.5 min with PCNL while 100.26±33.26 min with RIRS (p<0.05) (Karakoç et al., 2015).

This study compares the outcome of RIRS versus PCNL inrenal stones ≥2 cm in diameter in lower calyces. In this study, the results will help to determine the more appropriate way to remove renal stones of size >2cm in the local setting and can alter the management protocols to get better outcomes to improve our practice and update local guidelinesfor the management of patients with renal stones in lower calyces.

Methodology

This Randomized control trial was conducted at the Department of Urology, Bahawal Victoria Hospital, Bahawalpur, for 08 months, i.e., 01-06-2021 to 01-02-2022, using– a non-probability purposive sampling technique. A sample size of 70 cases, 35 cases in each group, is calculated with 80% power of the study, 5% significance level, and taking an expected percentage of stone-free rate, i.e., 91.9% with PCNL and 66.7% with RIRS for renal stones >2 cm in lower calyces. This study included patients aged 20 to 70 years of both genders who presented with one or more stones larger than 2 cm in the lower calyces. These patients experienced symptoms such as flank pain for more than a week. The study excluded patients with specific conditions, including renal failure (creatinine levels above 2.0 mg/dL and receiving dialysis), coagulopathy (prothrombin time greater than 15 seconds), urinary tract infection (confirmed by medical records), recurrent stones in the same location (documented in medical records), and pregnant females. Patients were then randomly assigned to two groups. Group A underwent percutaneous nephrolithotomy (PCNL), while Group B underwent retrograde intrarenal surgery (RIRS), and the operative time was recorded from intubation to extubation. After the procedure, patients were transferred to the post-surgical ward and subsequently discharged, with the duration of hospital stay noted. Patients were followed up in the outpatient department (OPD) for 12 weeks. After this period, an abdominal ultrasound was performed to determine if any residual stones were present. Patients with no residual stones were labeled "stone-free," while those with residual stones were managed according to the hospital's protocol. Data from the study were entered and analyzed with the help of SPSS version 26.0. Quantitative variables such as age, BMI, duration of symptoms, stone size, operative time, and hospital stay were presented as mean values with standard deviations. Categorical variables such as gender, hypertension, smoking, and stone-free status have been presented as frequencies and percentages. A comparison of outcomes between the two groups was made for mean operative time and hospital stay using independent samples t-tests, while–a chi-square test was employed for stone-free status at 95 % CI. Subgroup analyses were performed by stratifying data based on age, gender, height, weight, BMI, hypertension, smoking, stone size, and duration of symptoms. Within each stratum, the respective significance tests were applied, and again, a p-value of less than 0.05 was considered significant.

Results

In this study, a total of 70 patients with nephrolithiasis were enrolled. The mean age of the patients was 45.51±13.68 years (range; 20 to 69 years). When comparing the two treatment groups, RIRS and PCNL, the mean age of patients in the RIRS group was 47.63 ± 13.51 years, while in the PCNL group, it was 43.40 ± 13.71 years, with a non-significant p-value of 0.198. The gender distribution among the patients revealed that 30 (42.86%) were male and 40 (57.14%) were female, with an equal distribution of males (15, 42.9%) in both the RIRS and PCNL groups. Additionally, there were no significant differences in height, weight, or BMI between the two treatment groups, with p-values of 0.830, 0.650, and 0.830, respectively. Hypertension was noted in 10 (28.6%) patients in the RIRS group and 12 (34.3%) patients in the PCNL group, with no statistically significant difference (p-value = 0.607). Smoking was identified in 16 (45.7%) RIRS patients and 18 (51.4%) PCNL patients (p-value = 0.632). Regarding patient residence, 33 (47.14%) were from rural areas, and 37 (52.86%) were from urban areas, with similar proportions in both treatment groups. Socio-economic status (SES) distribution showed that 44 (62.86%) patients were from the low SES group, 21 (30%) from the middle SES group, and 5 (7.14%) from the high SES group. Specifically, 21 (60%) RIRS patients and 23 (65.7%) PCNL patients belonged to the low SES category, and these differences were not statistically significant (p = 0.342). Regarding clinical parameters related to kidney stones, the mean stone size, disease duration, and the number of stones showed no significant differences between the RIRS and PCNL groups, with p-values of 0.262, 0.391, and 0.910, respectively. However, there were substantial differences in the duration of surgery, with the RIRS group having a mean operative time of 107.57 ± 6.99 minutes and the PCNL group having a significantly shorter mean operative time of 75.86 ± 7.19 minutes (p-value < 0.001). Moreover, the RIRS group had a shorter mean hospital stay, with 4.77 ± 1.03 days compared to 5.46 ± 1.09 days in the PCNL group (p-value = 0.009). Post-procedure, 63 (90%) patients achieved stone-free status, with 29 (82.9%) patients in the RIRS group and 34 (97.1%) in the PCNL group, with a non-significant p-value of 0.106. Subgroup analyses based on age, gender, hypertension, height, weight, BMI, smoking status, stone size, duration of symptoms, and socio-economic status did not reveal significant differences in stone-free rates between the two treatment groups.

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Additionally, when stratified by residence and SES, the stone-free status remained comparable, with p-values exceeding 0.05.

Table. 1 Comparison of operative time between study groups stratified by age, gender, height, weight, BMI, and residence

Study variables		Study Groups	n	Mean	SD	p-value
Age Groups	≤ 50	RIRS	23	106.61	6.89	**<0.001**
		PCNL	23	76.91	7.78	
	>50	RIRS	12	109.42	7.09	**<0.001**
		PCNL	12	73.83	5.63	
Gender	Male	RIRS	15	109.47	6.66	**<0.001**
		PCNL	15	75.93	8.76	
	Female	RIRS	20	106.15	7.05	**<0.001**
		PCNL	20	75.80	5.99	
Height (m)	≤ 1.7	RIRS	24	106.58	6.56	**<0.001**
		PCNL	22	76.14	6.25	
	>1.7	RIRS	11	109.73	7.72	**<0.001**
		PCNL	13	75.38	8.82	
Weight(kg)	≤ 75	RIRS	12	105.83	7.06	**<0.001**
		PCNL	14	76.64	7.21	
	>75	RIRS	23	108.48	6.93	**<0.001**
		PCNL	21	75.33	7.31	
BMI (Kg/m2)	≤ 25	RIRS	7	109.29	7.99	**<0.001**
		PCNL	10	76.00	7.94	
	>25	RIRS	28	107.14	6.81	**<0.001**
		PCNL	25	75.80	7.04	
Residence	Rural	RIRS	16	106.38	6.344	**<0.001**
		PCNL	17	73.00	5.831	
	Urban	RIRS	19	108.58	7.508	**<0.001**
		PCNL	**18**	**78.56**	**7.454**	

Table. 2 Comparison of operative time between study groups stratified by stonesize, duration of symptoms, HTN, smoking, and SES

Operative Time		Study Groups	n	Mean	SD	p-value
Stone Size	≤ 2	RIRS	11	107.36	7.34	**<0.001**
		PCNL	14	74.21	7.57	
	>2	RIRS	24	107.67	6.98	**<0.001**
		PCNL	21	76.95	6.89	
Duration of symptoms	Male	RIRS	14	107.71	6.474	**<0.001**
		PCNL	10	76.10	6.154	
	Female	RIRS	21	107.48	7.467	**<0.001**
		PCNL	25	75.76	7.683	
Hypertension	Yes	RIRS	10	108.20	5.371	**<0.001**
		PCNL	12	77.17	8.255	
	No	RIRS	25	107.32	7.625	**<0.001**
		PCNL	23	75.17	6.665	
Smoking	Yes	RIRS	16	107.44	6.055	**<0.001**
		PCNL	18	76.61	7.838	
	No	RIRS	19	107.68	7.853	**<0.001**
		PCNL	17	75.06	6.581	
SES	Low	RIRS	21	107.14	7.255	**<0.001**
		PCNL	23	73.78	7.798	
	Middle	RIRS	10	108.40	6.899	**<0.001**
		PCNL	**11**	**79.91**	**3.618**	

Table. 3 Comparison of hospital stays between study groups stratified by age,gender, height, weight, BMI, and residence.

Hospital Stay		Study Groups	n	Mean	SD	p-value
Age Groups	≤ 50	RIRS	23	4.65	0.982	**0.002**

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		PCNL	23	5.61	0.941	
	>50	RIRS	12	5.00	1.128	**0.745**
		PCNL	12	5.17	1.337	
Gender	Male	RIRS	15	4.73	1.223	**0.053**
		PCNL	15	5.60	1.121	
	Female	RIRS	20	4.80	0.894	0**.089**
		PCNL	20	5.35	1.089	
Height (m)	≤ 1.7	RIRS	24	4.92	0.881	**0.058**
		PCNL	22	5.50	1.144	
	>1.7	RIRS	11	4.45	1.293	**0.064**
		PCNL	13	5.38	1.044	
Weight(kg)	≤ 75	RIRS	12	5.17	0.835	**0.283**
		PCNL	14	5.57	1.016	
	>75	RIRS	23	4.57	1.080	**0.020**
		PCNL	21	5.38	1.161	
BMI (Kg/m2)	≤ 25	RIRS	7	4.71	1.113	**0.221**
		PCNL	10	5.40	1.075	
	>25	RIRS	28	4.79	1.031	**0.023**
		PCNL	25	5.48	1.122	
Residence	Rural	RIRS	16	5.19	0.655	**0.405**
		PCNL	17	5.47	1.179	
	Urban	RIRS	19	4.42	1.170	**0.008**
		PCNL	**18**	**5.44**	**1.042**	

Table. 4 Comparison of hospital stay between study groups stratified by stone size,duration of symptoms, HTN, smoking, and SES

Hospital Stay		**Study Groups**	**n**	**Mean**	**SD**	**p-value**
Stone Size	≤ 2	RIRS	11	4.36	1.027	**0.018**
		PCNL	14	5.57	1.284	
	>2	RIRS	24	4.96	0.999	**0.159**
		PCNL	21	5.38	0.973	
Duration of symptoms	Male	RIRS	14	4.57	1.089	**0.610**
		PCNL	10	4.80	1.033	
	Female	RIRS	21	4.90	0.995	**0.009**
		PCNL	25	5.72	1.021	
Hypertension	Yes	RIRS	10	4.80	1.317	**0.068**
		PCNL	12	5.83	1.193	
	No	RIRS	25	4.76	0.926	**0.080**
		PCNL	23	5.26	1.010	
Smoking	Yes	RIR	1	4.9	1.06	**0.30**
		PCNL	18	5.33	1.138	
	No	RIRS	19	4.63	1.012	**0.009**
		PCNL	17	5.59	1.064	
SES	Low	RIRS	21	4.71	1.056	**0.084**
		PCNL	23	5.30	1.146	
	Middle	RIRS	10	5.00	0.943	**0.105**
		PCNL	**11**	**5.73**	**1.009**	

Discussion

Urinary stone diseases are reported to be the third most common health problem after urinary tract infections and prostate diseases worldwide. When formulating a treatment plan, various factors come into play, including the size, location, and quantity (single or multiple) of stones, the condition of the urinary system, any accompanying medical conditions, the patient's age, and activity level. For kidney stones measuring 2 cm or larger in diameter, percutaneous nephrolithotripsy (PCNL) is typically the recommended initial treatment option. However, retrograde intrarenal surgery (RIRS) has gained popularity due to its exceptional safety record and ability to be repeated, especially when dealing with smaller stones 11,12. In this study, after the procedure, in the RIRS group, 29(82.9%) patients were stone-free,and in the PCNL group, 34(97.1%) patients were stone-free (p-value=0.106). A study by Orhan Karakoç et al. (Karakoç et al., 2015)[9] they found that the duration of hospital stays was notably shorter for patients in the RIRS group compared to those in the PCNL group (1.56±0.8 days versus 4.57±2.1 days, respectively; p<0.001). Additionally, after the first management session, the rates of achieving a stone-free status were 66.6% for the RIRS group and 91.8%

for the PCNL group. This choice is supported by the fact that RIRS exhibits a lower rate of complications compared to PCNL while maintaining a stone-free rate similar to ESWL. In a study by Bozkurt et al. which included 42 PCNL and 37 RIRS patients with renal stones measuring between 1.5 and 2 cm, the success rates were reported as 92.8% for PCNL and 89.2% for RIRS (Bozkurt et al., 2011). Notably, recent technological advancements have expanded the applicability of RIRS to stones larger than 2 cm. The overall successful outcomes associated with RIRS, even after multiple sessions, have been reported as ranging from 77% to 93% for renal stones exceeding 2 cm in size (Breda et al., 2008; Hyams and Shah, 2009; Matlaga and Assimos, 2002; Riley et al., 2009).

The reported findings originate from a study investigating the efficacy of two surgical approaches for managing kidney stones. The study first examined the number of stones in each group, revealing no statistically significant difference between RIRS and PCNL patients. However, a notable contrast emerged in surgical duration, with PCNL procedures being considerably shorter than RIRS surgeries. Interestingly, despite the brevity of PCNL procedures, patients in the RIRS group enjoyed a shorter hospital stay. Perhaps the most critical aspect of the study was the stone-free status achieved after the surgical intervention. In 2011, Akman et al. conducted a study involving patients with renal stones measuring 2–4 cm in size (Akman et al., 2012). Their findings revealed successful outcomes in 73.5% after a single session of RIRS and more than 90% following the first session of PCNL. Interestingly, the procedure's efficacy had increased to 91.2% after an average of 1.2 RIRS sessions. In another study by Kursad Zengin et al. , (Zengin et al., 2015) RIRS demonstrated a comparable success rate, causing fewer complications than percutaneous nephrolithotomy (PNL) for treating larger stones .

In this study, the RIRS group had a mean operative time of 107.57±6.99 minutes, while the PCNL group had a significantly shorter mean operative time of 75.86±7.19 minutes (p-value < 0.001). Similarly, in the RIRS group, the mean hospital stay for patients was 4.77±1.03 days, whereas in the PCNL group, the mean hospital stay was slightly longer at 5.46±1.09 days (p-value = 0.009). A study by Akman et al. reported that when the surgical procedure's duration exceeded 58 minutes in patients undergoing PCNL, there was an increased need for blood transfusions. Consistent with these findings, another study by Zhuohang Li et al. demonstrated that the mean operating time in the RIRS group was longer than that in the UMP (ureteroscopic lithotripsy) group (95.61 ± 21.9 minutes vs. 55.0 ± 16.1 minutes, $p < 0.001$) (Li et al., 2020)

A meta-analysis conducted by C. Zheng et al. reported that when comparing RIRS and other treatment modalities, it was found that hospital stay was shorter in RIRS (Nerli et al., 2015). These findings support the conclusion that RIRS is a safe and effective procedure. In another study, it was reported that for renal stones larger than 2 cm located in the lower calyces, there were significant differences between PCNL and RIRS. The mean operative time for PCNL was 75.55+21.5 minutes, while for RIRS, it was 100.26+33.26 minutes ($p < 0.05$). Similarly, the mean hospital stay for PCNL was 4.57+2.1 days, whereas for RIRS, it was significantly shorter at 1.56+0.8 days ($p < 0.05$). Additionally, the stone-free rate was higher for PCNL at 91.9% compared to 66.7% for RIRS ($p < 0.05$). These results highlight the differences in these two procedures when dealing with renal stones larger than 2 cm in the lower calyces (Karakoç et al., 2015).

In this study, a total of 70 patients were enrolled. The mean age of the patients was 45.51±13.68 years, with minimum and maximum ages of 20 and 69 years, respectively. When comparing the two treatment groups, RIRS and PCNL, the mean age of patients in the RIRS group was 47.63 ± 13.51 years, while in the PCNL group, it was 43.40 ± 13.71 years, with a non-significant p-value of 0.198. A study conducted in India by Nerli et al, (Nerli et al., 2015) reported 41.48 ± 11.7 years mean age of the patients with nephrolithiasis, similar to our results. Another French study conducted by Pri et al. (Prié et al., 2001) reported 42.2 ± 10.83 years of mean age of male patients with nephrolithiasis, similar to our results. Zhang et al. have also reported from China 48.92 ± 11.08 years mean age of the patients with nephrolithiasis, similar to our results (Zhang et al., 2019).

The gender distribution among the patients revealed that 30 (42.86%) were male and 40 (57.14%) were female, with an equal distribution of males (15, 42.9%) in both the RIRS and PCNL groups. A study conducted in India by Nerli et al. [22] has also reported 60 % male patients with nephrolithiasis with only 40 % female patients, indicating the same findings consistent with our study results. Another French study conducted by Pri et al. [23] reported that 69 % of patients with nephrolithiasis were male, similar to our results. Zhang et al. [24] also reported 62 % of male patients with nephrolithiasis from China, similar to our results.

Conclusion

This study concluded that Retrograde Intrarenal Surgery is a safe procedure and a good alternative to Percutaneous Nephrolithotomy in renal stones >2 cm in diameter in lower calyces in terms of stone-free and length of hospital stay of the patients. Hence, it can be safely employed to achieve desired outcomes in patients with renal stones > 2cm in diameter in lower calyces. However, the operative time was significantly longer in the Retrograde Intrarenal Surgery group than in the Percutaneous Nephrolithotomy group.

Declarations

Data Availability statement
All data generated or analyzed during the study are included in the manuscript.
Ethics approval and consent to participate.
Approved by the department Concerned.
Consent for publication
Approved
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Not applicable

Conflict of interest

The authors declared an absence of conflict of interest.

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