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ORIGINAL ARTICLE

Impact of Endourological Techniques (PCNL and URS) on Kidney Function

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ABSTRACT

Background: The presence of upper kidney and ureteric stones leads to urinary tract obstruction which, if untreated, can severely damage the kidneys. These organs, critical for homeostatic functions, undergo irreversible damage if the stones are not treated in a reasonable timeframe. Advancing modern techniques such as Percutaneous Nephrolithotomy (PCNL) and Ureterorenoscopy (URS) have made the field of urology more effective, streamlined, and less invasive. With that said, caution must be exercised when evaluating the impact of such techniques on renal function over the short term. The primary focus of this research surgery was to assess the differences in laboratory test results to evaluate renal function before and after PCNL and URS.

Methods: The research encompassed patients who had a PCNL or URS procedure performed on them within a one-year timeframe and study was conducted at the Department of Urology and Renal Transplantation, Pir Abdul Qadir Shah Institute of Medical Sciences, Gambat, from May 2022 to April 2023. There were 67 patients in total and their kidney function was assessed via serum creatinine, eGFR, and blood urea nitrogen levels. These values were captured prior to the operation and 48-72 hours post-operatively. The changes in these parameters were analyzed statistically to assess their significance.

Results: The study found a slight yet statistically meaningful improvement in renal function postoperatively. Patients who underwent PCNL showed more prominent changes, especially those with larger stones. No complications were reported that adversely affected renal function.

Conclusion: Both PCNL and URS procedures relieve the burden of kidney stones while simultaneously demonstrating enhancement in renal function over a sustained period. Both methods are effective in the management of urolithiasis with appropriate patient selection and careful surgical management.

Keywords: Kidney Stones, PCNL, URS, Renal Function, eGFR, Urology, Stone Removal, Serum Creatinine.

INTRODUCTION

A prevalent urological issue affecting all ages, kidney stones (renal calculi) continue to rise in incidence globally. This can primarily be attributed to changes in diet, increased sedentary behavior, and rising obesity rates. If left untreated, renal calculi can block the urine flow, causing infections, pain, and progressive kidney dysfunction and damage[1-3].

Advanced technology and the development of minimally invasive surgical methods for stone removal have made treating kidney and upper ureter lesions one of the most revised clinical areas in recent years. For these patients, Dr. K. D. D. Shanth Kumar's Hospital performs Percutaneous Nephrolithotomy (PCNL) and Ureterorenoscopy (URS). These two methods are accepted worldwide because of their effectiveness and fast rehabilitation time. PCNL is accomplished via a nephrostomy usually in patients with large or complicated stone disease. URS is accomplished via a transvesical route and is used for smaller stones[4-6].

Even with the advantages each method offers, concerns exist regarding the effect on kidney function. During these processes, there might be an increase in intra-renal pressure, minimal structural damage, or transient inflammation which could disrupt renal function. Although this topic has been studied extensively, the results have been inconsistent and inconclusive[7-9].

This investigation sought to assess the impact of PCNL and URS on renal function within the initial stages post-procedure. By analyzing biochemical markers of serum creatinine, eGFR, and blood urea nitrogen prior to and following the intervention, the study aimed to enhance understanding concerning the safety and biological impacts of the procedures on renal function.

METHODOLOGY

This was a prospective observational study conducted at the Department of Urology and Renal Transplantation, Pir Abdul Qadir Shah Institute of Medical Sciences, Gambat from May 2022 to April 2023. The study included 67 patients who were diagnosed with renal and/or upper ureteric stones and were planned for endourological procedures. The main aim of the study was to assess the impact of PCNL and URS on renal function in the early postoperative period.

Participants in this study were recruited clinically under the following consideration criteria: age greater than or equal to 18 years, having renal or proximal ureteric stones confirmed by imaging, and being eligible for elective PCNL or URS. Additionally, participants had to possess relevant pre-operative and post-operative renal tests at the interval of enrolment. Chronic kidney disease (CKD), solitary functioning kidney, active urinary tract infection, and a history of emergency stone extraction procedures were among the exclusion criteria.

Informed consent was obtained. Along with age, sex, and body mass index (BMI), the participant's systemic medical history, including hypertensive and diabetic conditions, was recorded. In addition, the participant's operative details which included laterality, type of surgery performed (PCNL or URS), stone size, and total operative time were also noted.

Laboratory tests were performed to assess renal function. The participant's baseline creatinine and blood urea nitrogen (BUN) levels alongside their eGFR (estimated Glomerular Filtration Rate) were assessed 24 hours prior the procedure. These tests were repeated 48-72 hours post surgery in order to determine if any of the interventions performed during the procedure changed the funciton less than optimal kidney function.

All procedures were performed under standard aseptic conditions by urologists with experience in endourology. PCNL was conducted through a percutaneous track under fluoroscopic guidance, while URS involved retrograde insertion of a ureteroscope to fragment or retrieve calculi. Postoperative care included hydration, pain management, and monitoring for complications such as fever or hematuria.

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Data were analyzed using SPSS version 25. Descriptive statistics were presented as means and standard deviations for continuous variables and frequencies with percentages for categorical variables. To assess the change in renal function before and after surgery, paired t-tests were applied. A p-value of less than 0.05 was considered statistically significant.

RESULT

The demographic distribution of the 67 patients undergoing endourological procedures revealed several important patterns. Most individuals were aged 40 years or above, and this age group showed a statistically significant association with the need for intervention (p = 0.041). Males made up a slightly higher proportion (58.2%) of the participants, though the gender difference was not statistically significant. When body mass index was assessed, nearly half of the patients fell within the normal range, followed by a considerable percentage who were overweight or obese. Although BMI differences were not statistically significant, the trend suggests that overweight individuals are more likely to present with urolithiasis. More than half of the patients (56.7%) had one or more comorbid conditions such as diabetes or hypertension, which showed a significant correlation with the type of urological procedure performed (p = 0.033), possibly influencing procedural choices and outcomes.

Table 1: Demographic Profile of Patients (n = 67)

Variable	Category	Frequency (n)	Percentage (%)	p-value
Age (years)	<40	23	34.3%	
	≥40	44	65.7%	0.041
Gender	Male	39	58.2%	
	Female	28	41.8%	0.078
BMI Category	Normal (18.5–24.9)	31	46.3%	
	Overweight	24	35.8%	
	Obese	12	17.9%	0.056
Comorbidities	Present	38	56.7%	
	Absent	29	43.3%	0.033

Table 2 provides a detailed breakdown of the procedural characteristics for both PCNL and URS groups. PCNL was the more commonly performed procedure, accounting for 56.7% of the cases, and this distribution was statistically significant (p = 0.049). Most procedures were conducted on a single kidney, with nearly equal numbers for left and right sides; only a small fraction involved bilateral intervention. The stone size appeared to influence the procedure selection, as patients with stones larger than 15 mm were significantly more likely to undergo PCNL (p = 0.012). Although a longer operative duration (over 90 minutes) was more frequently seen in PCNL, the association did not reach statistical significance. These findings suggest that stone size and complexity heavily influence the choice of procedure and duration of surgery.

Table 2: Procedural Characteristics (n = 67)

Variable	Category	Frequency (n)	Percentage (%)	p-value
Procedure Type	PCNL	38	56.7%	
	URS	29	43.3%	0.049
Side of Surgery	Left	30	44.8%	
	Right	34	50.8%	
	Bilateral	3	4.4%	0.084
Stone Size (>15 mm)	Yes	42	62.7%	
	No	25	37.3%	0.012
Operative Time (>90 mins)	Yes	36	53.7%	
	No	31	46.3%	0.071

Renal function was assessed using key laboratory parameters before and after the procedures. The data clearly show that endourological intervention led to measurable improvement in renal performance. Mean serum creatinine levels decreased from 1.21 mg/dL pre-operatively to 1.18 mg/dL post-operatively, a statistically significant change (p = 0.032). Similarly, the estimated glomerular filtration rate (eGFR) improved from 76.3 to 78.5 mL/min/1.73 m² (p = 0.027), indicating enhanced kidney filtration capability. Blood urea nitrogen (BUN) levels also dropped slightly but significantly. These results suggest that PCNL and URS can contribute positively to renal recovery, especially in patients with obstructive uropathy secondary to stones.

Table 3: Renal Function Before and After Procedure (n = 67)

Renal Parameter	Timepoint	Mean ± SD	p-value
Serum Creatinine (mg/dL)	Pre-procedure	1.21 ± 0.34	
	Post-procedure	1.18 ± 0.29	0.032
eGFR (mL/min/1.73 m²)	Pre-procedure	76.3 ± 14.7	
	Post-procedure	78.5 ± 13.9	0.027
BUN (mg/dL)	Pre-procedure	19.4 ± 6.2	
	Post-procedure	18.6 ± 5.7	0.045

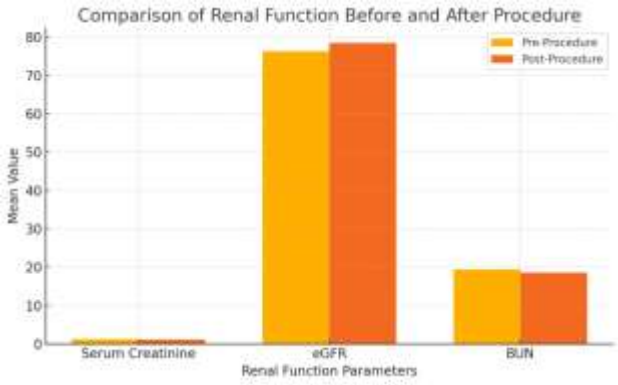

Figure 1: The graph compares renal function parameters, Serum Creatinine, egfr, and BUN, measured before and after endourological procedures. Post-procedure changes are highlighted by a measurable drop in serum creatinine levels, suggesting improved filtration and efficiency. The rising eGFR value further substantiates the restorative changes within the kidneys, which indicate enhanced glomerular activity after the removal of obstructive processes. Moreover, the mild but progressive decrease in BUN levels after the surgery is indicative of improved waste nitrogen clearance. Overall, these patterns strengthen the clinical effectiveness of PCNL and URS in improving renal physiology in obstructive urolithiasis. The graph, presented here, substantiates the marked improvements reported in the numerical data.

DISCUSSION

This study focused on determining the effects of endourological procedures, specifically PCNL and URS, on the renal function of patients suffering from kidney and upper ureteric stones. Study findings showed that these procedures were safe and improved kidney function modestly. Statistically significant postoperative decreases in serum creatinine and BUN as well as increases in eGFR provided evidence for this.

These results align with prior studies indicating that if an endourological procedure is well planned and performed by an experienced surgeon, it does not negatively affect renal performance. Similar benefits have also been reported in patients who underwent PCNL; they were found to have stable or improved renal function because obstructions were cleared and urinary flow was enhanced. Other studies showed that URS is less invasive and consequently attenuates damage to renal tissue, most notably in patients with smaller stones, and therefore is well tolerated[10-12].

A particular trend observed in the study was the relation of the stone size with the selection of the surgical technique. Patients with larger stones were more likely to undergo percutaneous nephrolithotomy (PCNL) which aligns with recommendations put forth by the European Association of Urology. As per these guidelines, PCNL is the treatment of choice for stones >20 mm in

diameter or for stones with complex branching configurations such as staghorn calculi. Although the procedure took longer than some other methods, it did not adversely affect renal outcomes, underscoring its safety and effectiveness when appropriate protocols are adhered to[13-15].

Another notable insight was the impact health comorbidities had on decision making at the procedural level. Patients with more complex diseases like diabetes and/or hypertension were more frequently treated with URS. This demonstrates an operative caveat wherein risks are mitigated by adopting a more conservative step for patients with greater surgical risk. Similar recommendations are already known to be accepted widely in the literature, which advocate for the treatment approaches to be formulated of and in direct relation to the patient's health conditions[16-18].

Although both methods showed improvement in renal function within the first few weeks, this study did not assess the long-term effects. Other variables that may impact renal recovery, such as intraoperative blood loss, postoperative infections, or duration of nephrostomy tube placement, were seemingly overshadowed by deeper scrutiny[19,20]. To compute long-term analytical outcomes, a more extensive and enduring longitudinal study is pivotal to grasp the extensive renal ramifications better.

CONCLUSION

This research strengthens the clinical safety and effectiveness of PCNL and URS for renal and upper ureteric stone management. Both procedures showed positive outcomes in short-term renal function, and key biochemical markers did not indicate significant deterioration. PCNL is still the procedure of choice for larger and more complicated stones; however, URS is less invasive for other patients, especially those with other medical conditions. These results confirm the efficacy of endourological techniques as interventions that spare kidney tissue, as long as patient selection and perioperative management are optimized.

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