

Evaluation Of Percutaneous Nephrolithotomy Complications And Knowing The Predictive Value Of Risk Factors

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Abstract:

Background: Percutaneous nephrolithotomy (PCNL) was a very effective and less risky technique for the removal of bigger or more intricate kidney stones. **Objective:** This study was focused on assessing the clinical outcomes associated with percutaneous nephrolithotomy complications as well as determining the predictive value of risk factors outcomes. **Patients and methods:** 77 patients who underwent percutaneous kidney stone removal surgery, aged between (20-50) years, were collected from different hospitals in Iraq for

a period from March 5, 2022, to November 25, 2023. Moreover, we recorded patients' data during and after the percutaneous nephrolithotomy (PCNL) surgery in terms of duration of operation, puncture site, duration of hospital stays, success rate, duration of nephrostomy, number of cases admitted to the intensive care unit, mortality rate, and duration of recovery. This study aimed to determine the rate of complications, pain, quality of life, and the prognostic value of risk factors affecting patients after surgery. **Results:** The current study showed that males had an average rate of 47 cases, which was considered more than females, with 30 cases. The most common symptoms were back pain, and 18 patients had fluctuating pain intensity. Locations of kidney stones: 26 patients were in the Staghorn stone, 22 patients were in the renal calyx, 17 patients were in the renal calyx, and 12 patients were in the ureter. Blood WBC was 8.42 ± 2.73 [$\times 10^9/L$], Hemoglobin (gm/dL). It was 15.6 ± 1.2 , the duration of the surgical procedure was 131.8 ± 64.5 minutes, the duration of stay in the hospital was 4.3 ± 2.6 days, the rate of clinical complications included 5 cases, the most common of which were bleeding and infection, which included two cases each, the mortality rate was zero, the duration of recovery and follow-up each. It was usually a month. The most prominent criteria beyond the health quality of life for patients were physical function, which included 92.75 ± 5.60 , and psychological function, which included 91.87 ± 3.91 . **Conclusion:** Percutaneous kidney stone removal (PCNL) technique is considered the most effective and high-quality technique in reducing complications and improving the quality of life for patients.

The main causes include primary glomerulonephritis, chronic pyelonephritis, hypertension, atherosclerosis, diabetic nephropathy, secondary glomerulonephritis, tubulointerstitial disease, hereditary kidney disease, long-term use of antipyretics and analgesics, exposure to heavy metals, etc. .

1. Efforts should be made to clarify the cause of chronic renal failure. It should be clarified whether the renal damage is primarily glomerular damage, renal tubulointerstitial lesions, or renal vascular lesions, so that targeted treatment can be based on clinical characteristics. .
2. Reversible factors that promote the progressive deterioration of renal function in chronic renal failure should be identified, such as infection, drug-induced kidney damage, metabolic acidosis, dehydration, heart failure, blood pressure falling too quickly or too low, etc.
3. Attention should be paid to looking for certain factors that aggravate the gradual deterioration and decline of kidney function in chronic renal failure, such as hypertension, hyperlipidaemia, hypercoagulability, high-protein food intake, massive proteinuria

Keywords: *Percutaneous nephrolithotomy (PCNL); Postoperative complications; Stones location; and Risk factors*

Introduction

Introduction

The occurrence of urolithiasis has been a persistent problem throughout human civilization, where the management of patients with urinary tract calculi is seen as a healthcare issue due to its high prevalence and tendency to recur [1,2,3]. The treatment of renal stones has undergone tremendous advancements, transitioning from traditional open surgery to less invasive surgical methods. Since the initial documentation of the extraction of kidney stones using nephrostomy by Rupel and Brown in 1941[4,5]

The surgical treatment of renal tract stone disease has advanced over the past twenty years with the development of minimally invasive procedures such as ESWL and PCNL and PCNL, or percutaneous nephrolithotomy, is now a frequently conducted technique in patients with renal calculi [6,7]and Due to the high likelihood of kidney stone recurrence, re-intervention is frequently

necessary for these individuals. Recent reports have indicated increased rates of failure in percutaneous [8,9] nephrolithotomy (PCNL) procedures among patients who had previously undergone open interventions. However, a recent study demonstrated that past open stone surgery or PCNL does not have an impact on the outcomes and complications of subsequent PCNL procedures. Consistent with our results, several investigations have demonstrated the feasibility of doing PCNL without any associated difficulties in patients who have previously undergone open surgery or PCNL [10,11,12]. The average duration of the surgical operation in this study was notably longer in groups of patients who had undergone one or more previous stone surgeries or a previous PCNL treatment. Margel et al. and Tugcu et al. have also shown that patients with a history of previous open nephrolithotomy experienced lengthier operational times [13]

Percutaneous nephrolithotomy (PCNL) is a technique that carries minimal risk and few complications when conducted by skilled professionals. Frequent complications of Minimally invasive PCNL include fever and bleeding [13], while less common but more severe issues such as renal parenchymal injury and colon perforation may also occur. However, serious complications like massive haemorrhage and pleural injuries are rare in Minimally invasive PCNL. Shock wave lithotripsy can effectively address issues associated with percutaneous nephrolithotomy (PCNL), hence reinforcing the safety of the treatment [14].

The occurrence of complications in percutaneous nephrolithotomy (PCNL) is determined by various parameters, such as the duration of surgery, puncturing of the upper pole, and a high Guys Stone Score. Additional risk factors comprise of being female, having a positive urine culture, infectious stones, higher blood leukocytes, preoperative stenting, repeated puncture access, prolonged surgical time, and postoperative residual stone [15,16].

Patients and methods

We conducted a cross-sectional study of patients who had kidney stones. Demographic and clinical characteristics were collected before surgery to remove percutaneous kidney stones and amounted to 77 patients whose ages ranged between (20 - 50) years and who were collected from different hospitals in Iraq for a period from March 5, 2022, to November 25, 2023. Demographic data for patients with kidney stones included age, sex, symptoms, comorbidities, ASA, smoking status, education level, and income. Diagnoses of kidney stones were made in terms of size (500 - 699), (700 - 899), (900 - 1099), (1100 - 1300), locations (Staghorn's stone, renal pelvis, renal calyx, ureter), and number of stones in the kidney (< 3 , ≥ 3).

Intraoperative outcomes Our study recorded intraoperative and postoperative clinical data for percutaneous nephrolithotomy (PCNL) in terms of operation duration, puncture site, duration of hospital stay, success rate, nephrostomy duration, number of cases admitted to the ICU, mortality rate, and recovery time. Our results showed examinations and biochemical diagnoses compared before and after surgery in terms of Blood WBC [$\times 10^9/L$], Hemoglobin (gm/dL), Urine WBC [μL], Serum albumin (g/dL), Serum creatinine (micromoles/L).

This study evaluated patients' preoperative and postoperative pain scores on the VAS scale during a 4-week clinical follow-up. Also, this study evaluated the quality of life of patients in terms of preoperative and postoperative physical function, social function, psychological function, and activity function. This study determined the clinical complications of patients after percutaneous nephrolithotomy surgery.

In addition, this study determined with a multivariate analysis the prognostic value of risk factors affecting patients in the long term. This study relied on the systematic analysis and design of clinical data for patients who underwent percutaneous nephrolithotomy using SPSS software, version 22. This study excluded some data related to patients who had the same surgery, as these criteria included all patients who had undergone other previous surgeries, or who were less than 20 years old or older than 50 years old, or patients who had serious chronic diseases.

Results

Table 1: Clinical demographic characteristics of patients in this study.

Characteristics	Number of patients [77]	Percentage [%]
Age [years]		
20 – 29	24	31.17%
30 – 39	25	32.47%
40 – 50	28	36.36%
Sex		
Male	47	61.04%
Female	30	38.96%
Symptoms		
Back pain	24	31.17%
Fluctuating pain intensity	18	23.38%
Frequent urination	13	16.88%
Painful urination	14	18.18%
Hematuria	8	10.39%
Comorbidities		
Obesity	35	45.45%
Metabolic Syndrome	60	77.92%
Diabetes	27	35.06%
Chronic Kidney Disease	12	15.58%
Hyperparathyroidism	9	11.69%
ASA		
I	12	15.58%
II	40	51.95%
III	25	32.47%
Smoking status		
Yes	35	45.45%
No	42	54.55%

Day of antibiotic use before surgery (days)	1.46 ± 0.53	
Education status		
Primary	13	16.88%
Secondary	16	20.78%
College/University	48	62.34%
Income status, \$		
> 800	32	41.56%
< 800	45	58.44%

Table 2: Preoperative diagnostic findings in patients with kidney stones.

Characteristics	Number of patients [77]	Percentage [%]
Stone location		
Staghorn stone	26	33.77%
Renal pelvis	17	22.08%
Renal calyx	22	28.57%
Ureter	12	15.58%
Size of kidney stones, mm^2		
500 – 699	15	19.48%
700 – 899	14	18.18%
900 – 1099	22	28.57%
1100 - 1300	26	33.77%
Number of stones		
< 3	50	64.94%
≥ 3	27	35.06%

Table 3: Clinical outcomes associated with patients who undergo intraoperative and postoperative percutaneous nephrectomy (PCNL).

Characteristics	Clinical outcomes
Operative time [min]	131.8 ± 64.5
Puncture site, N [%]	
Upper	16 [20.78%]
Middle	23 [29.87%]
Lower	38 [49.35%]
Length of stay in hospital, days	4.3 ± 2.6
Success rate [%]	
Initial stone-free rate %	60 [77.92%]
Overall stone-free rate %	77 [100%]
Nephrostomy duration, days	5.8 ± 5.4
PICU admission	0 [%]
Mortality rate, N [%]	0 [0%]
Recovery time, weeks	3.8 ± 0.2
Follow-up time, days	27.4 ± 2.6

Table 4: Biochemical test outcomes in terms of preoperative and postoperative.

Biochemical parameters	Preoperative	Postoperative
Blood WBC [$\times 10^9/L$]	12.6 ± 2.5	8.42 ± 2.73
Hemoglobin (gm/dL)	12.4 ± 0.3	15.6 ± 1.2
Urine WBC [$/\mu L$]	502.14 ± 992.11	330.14 ± 129.56
Serum albumin (g/dL)	5.2 ± 3.4	4.4 ± 1.2
Serum creatinine (micromoles/L)	82.71 ± 32.86	70.54 ± 9.65

Table 5: Assessment pain scores of patients in terms of preoperative and postoperative by VAS scale.

Biochemical parameters	Preoperative	Postoperative
Week 1	6.3 ± 0.2	4.1 ± 0.2

Week 2	7.4 ± 1.0	3.3 ± 0.4
Week 3	8.4 ± 0.6	1.8 ± 0.04
Week 4	8.5 ± 0.8	0

Table 6: Assessment of quality of life for patients in terms of preoperative and postoperative.

Biochemical parameters	Preoperative	Postoperative
Physical function	43.61 ± 8.82	92.75 ± 5.60
Social function	52.11 ± 12.47	88.90 ± 9.83
Psychological function	66.81 ± 8.48	91.87 ± 3.91
Activity function	56.60 ± 5.81	89.65 ± 5.71

Table 7: Postoperative complications outcomes.

Complications	Number of patients [77]	Percentage [%]
Bleeding	2	2.6%
Infection	2	2.6%
Damage to surrounding organs	0	0%
Fluid collection around the kidney	1	1.3%
Persistent or recurrent stones	0	0%
Ureteral injury	0	0%
Total	5	6.49%

Table 8: Predicted outcomes of multivariate analysis of risk factors effected on patients.

Risk factors	OR [CI 95%]	P-value
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Age	1.62 [0.4 – 2.5]	0.0233
Stones size	1.78 [0.65 – 3.85]	0.0252
Serum albumin	0.812 [0.34 – 4.67]	0.0228
Serum creatinine	2.58 [0.6 – 3.67]	0.0485
Smoking status	4.85 [2.63 – 7.92]	0.0174
Diabetes	2.41 [0.85 – 2.96]	0.0288
Obesity	3.84 [1.65 – 5.50]	0.0483
Bleeding	4.69 [3.67 – 6.85]	0.0328
Infection	3.53 [1.05 – 4.52]	0.0136
Urine WBC	3.01 [1.04 – 3.85]	0.0245

Discussion

The clinical results recorded those patients in the age group between (40 - 50) had the highest rate and included 28 patients. Males had an average rate of 47 cases, and were more frequent than females (30 cases). Twenty-four patients had back pain, and 18 patients had a greater fluctuation in pain intensity. The symptoms were widespread with accompanying diseases, which included metabolic syndrome in 60 patients, obesity in 35 patients, and diabetes in 27 patients. The percentage of patients who smoked was 45.45%, and non-smokers was 54.55%, and the duration of antibiotic use before surgery was 1.46 ± 0.53 days.

The diagnostic results and examinations of the patients showed in terms of the location of the kidney stones, which included 26 patients in the Staghorn stone, 22 patients in the renal calyx, 17 patients in the renal calyx, and 12 patients in the ureter. The size of the kidney stones was (1100 - 1300) mm², which included 26 patients and (900 - 1099) mm² were 22 patients, (500 - 699) mm² were 15 patients, (700 - 899) mm² were 14 patients, stones < 3 were 50 patients, and stones ≥ 3 were 27 patients. For the postoperative biochemical parameters of patients, Blood WBC was 8.42 ± 2.73 [$\times 10^9/L$], hemoglobin (gm/dL) was 15.6 ± 1.2 , urine WBC [μL] was 330.14 ± 129.56 and serum albumin (g/dL) was 4.4 ± 1.2 and serum creatinine (micromoles/L) was 70.54 ± 9.65 .

Regarding the intraoperative and postoperative results of percutaneous nephrectomy (PCNL), the duration of the surgical procedure was 131.8 ± 64.5 minutes, the puncture site, which included the upper part included 16 patients, the middle included 23 patients, and the lower part included 38 patients. The duration of hospital stay was 4.3 ± 2.6 patients. Days the duration of nephrostomy was 5.8 ± 5.4 days, the mortality rate was zero, the rate of patients admitted to intensive care was zero cases, and the duration of recovery and follow-up each was mostly a month. The rate of clinical complications included 5 cases, the most common of which were bleeding and infection, which included two cases each. Quality of life standards after surgery showed success, the most prominent of which were physical function, which included 92.75 ± 5.60 , and psychological function, which was 91.87 ± 3.91 . The average postoperative pain in the first week was 4.1 ± 0.2 , the second week was 3.3 ± 0.4 , the third week was 1.8 ± 0.04 , and the fourth week was zero.

Prior studies found percutaneous nephrolithotomy as a technique that is well-tolerated which has a minimal risk of significant complications or mortality where typical mild problems like temporary fever or leaking of the nephrostomy tube usually disappear on their own, while the ongoing progress in PNL technology, more adoption of the treatment, and further refinement of the method were expected to lead to a continuous reduction in complication rates [17,18,19,20].

Conclusions

Our study on PCNL indicates that it is the most effective and optimal procedure compared to other surgeries in removing kidney stones because this technique shows advantages in terms of shorter surgical duration, better quality of surgery, faster recovery rate, complication rate, and less postoperative pain, which results in a significant improvement in the patient's quality of life in the long term.

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