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Original Article

The effects of standard channel and micro-channel percutaneous nephrolithotomy on the L-6, TNF-α, CRP, and PCT levels and renal function in patients with kidney stones

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Abstract: Objective: This study analyzed the effects of standard channel and micro-channel percutaneous nephrolithotomy on the levels of tumor necrosis factor-α (TNF-α), interleukin-6 (IL-6), C-reactive protein (CRP), procalcitonin (PCT), and renal function. Methods: The clinical records of 103 patients with kidney stones were retrospectively collected and divided into two groups based on the treatment: group A (n=52, standard channel percutaneous nephrolithotomy (SCPN)), and group B (n=51, micro-channel percutaneous nephrolithotomy (MCPN)). The two groups were compared in terms of their surgical indicators, stone clearance rates, the TNF-α, IL-6, CRP, PCT, serum creatinine (Scr), and blood urea nitrogen (BUN) levels, and complications. Results: The two groups showed no differences in their stone clearance rates (SCR), Scr and BUN levels, or the complication rates. However, group A exhibited lower intraoperative blood losses and intraoperative fluid infusions, longer hospital stays, shorter durations of surgery, and lower serum inflammatory factor indexes such as TNF-α, IL-6, CRP, and PCT. Group A also showed more cases of hemorrhage and fewer cases of fever than group B. Conclusion: MCPN is as effective as SCPN in treating kidney stones. SCPN can effectively reduce the serum levels of the inflammatory factors, but with more intraoperative blood loss.

Keywords: Standard channel, microchannel percutaneous nephrolithotomy kidney stone, renal function, inflammatory factors

Introduction

Kidney stones are a urinary system disease with a high prevalence rate. They are caused by an abnormal accumulation of crystalline substances such as cystine, uric acid, oxalic acid, and calcium in the kidney [1]. Kidney stones are common in young adults, and no significant difference has been found in the incidence of stones in the left and right kidneys [2]. The risk factors for kidney stones include occupation, dietary habits, environment, genetics, race, gender, and age [3, 4]. Meanwhile, drugs, urinary tract infections, obstructions, nutritional deficiencies, being bedridden, and metabolic disorders may also lead to kidney stones [5].

Percutaneous nephrolithotomy is a procedure used to remove kidney stones. It is the most effective technique for making sure a patient is stone-free, is less invasive than a full open surgery, and exhibits a higher SCR and a shorter recovery time [6].

There are two commonly used channels in percutaneous nephrolithotomy: the standard channels (20-26F) and the micro-channels (16-18F). The success of percutaneous nephrolithotomy lies in the successful establishment of the stone channels. It not only has a clinical effect, which affects not only the SCR, but also infections and blood loss. Therefore, a suitable stone channel should be finalized in percutaneous nephrolithotomy to improve the SCR [6, 7].

Most research centered on kidney stones focuses mainly on the choice of surgical method, but little attention has been paid to the choice of stone channels in percutaneous nephrolithotomy. This study mainly explores the effects of SCPN and PCPN on the SCR, the TNF-α, IL-6, CRP, and PCT levels, and renal function in patients with kidney stones.

Materials and methods

Data

The clinical data of 103 patients with kidney stones were retrospectively collected and grouped based on the treatment method. The two groups included Group A (52 patients, SCPN) and Group B (51 patients, MCPN). (1) The inclusion criteria were patients with renal stones who showed indications for surgery, and patients with normal coagulation functions before surgery; (2) The exclusion criteria were patients who had contraindications for surgery or malignant tumors or patients who could not tolerate the surgery. This study was approved by the Ethics Committee of Fuyang District Chinese Medicine Hospital of Hangzhou. All study participants provided written informed consent before participating in the study.

Methods

All the patients underwent a preoperative CT, ultrasound, or x-ray imaging to determine the size and location of their kidney stones as well as the degree of hydronephrosis. Under continuous epidural anesthesia, the patient was kept in the lithotomy position. Retrograde intubation was performed through the ureter on the affected side. An F5 ureteral catheter and an F16 bladder catheter were inserted to the renal pelvis and fixed with each other; the surgical position was adjusted to the prone position. After the kidney rest was elevated, the puncture was performed with the guidewire using ultrasound positioning.

Group A underwent SCPN using a fascial dilator from F8 to F24. The nephroscope and F24 Peel-away sheath were placed when the fascial dilator reached F24. The pneumatic lithotripsy was used to crush the stones. Group B was treated with MCPN, and the fascial dilator was used from F8 to F16. Then the nephroscope and F16 peel-away sheath were inserted, and pneumatic lithotripsy was adopted to crush the stones. Double-J stents and nephrostomy tubes were left in both groups after the surgery and removed at 3-7 days after the operations. The patients in both groups underwent ultrasonography 5 days after their operations to determine the residual stones.

Outcome measurement

Surgical indicators: the intraoperative blood losses, durations of the surgeries, intraoperative infusion volumes, and hospital stays were compared between the two groups.

Stone clearance rate: the clearance rates of multiple kidney stones and solitary kidney stones were calculated on basis of the results of the postoperative ultrasound review.

Serum inflammatory factors: 2 ml fasting venous blood was drawn in the morning from the two groups before and 3 days after their surgeries and centrifuged at 3000 r/min to obtain the serum. The IL-6 and TNF-α were tested using ELISA (Enzyme-linked immunosorbent assay, Hebei Changtian Pharmaceutical Co., Ltd.) detection. The PCT was tested using an immunoassay detection kit (BRAHMSPCT, Germany), and the CRP was measured using a high-sensitivity CRP kit (Bohilech). Each operation was performed in strict accordance with the corresponding kit's instructions.

Renal function: brachial vein blood was drawn in a fasting state before and after surgery in the two groups to determine the serum Scr and BUN levels with a bioanalyzer.

Complications: septic shock, sepsis, fever, bleeding, etc.

Statistical analysis

SPSS 22.0 was used for the statistical analysis. The measurement data were expressed as the mean ± standard deviation. Data that confined to a normal distribution were tested using independent sample t tests. Data that did not confine to a normal distribution were evaluated using Mann-Whitney U tests. Comparisons within groups were examined using paired t tests; count data were expressed as [n (%)] and compared using X^2 tests. $P<0.05$ indicated statistical significance.

Results

Baseline data

There were no statistically significant differences in the baseline data such as gender, average

Table 1. Baseline data [n (%)]/($\overline{x}$±s)

Data		Group A (n=52)	Group B (n=51)	t/X^2	P
Gender	Male	30 (57.69)	28 (54.90)	0.082	0.775
	Female	22 (42.31)	23 (45.10)		
age		47.59±8.16	47.62±8.19	0.019	0.985
Stone size (cm)		3.38±0.52	3.42±0.49	0.416	0.689
Location					
Renal Pelvis		8 (15.38)	9 (17.65)	0.012	0.885
Renal calyces		12 (23.08)	11 (21.57)		
Kidney cast stones		20 (38.46)	20 (39.22)		
Staghorn calculi		12 (23.08)	11 (21.57)		
Stone type					
Multiple kidney stones		28 (53.85)	27 (52.94)	0.009	0.927
Solitary kidney stones		24 (46.15)	24 (47.06)		

Table 2. Comparison of the surgical indicators in the two groups ($\overline{x}$±s)

Grouping	Intraoperative blood loss (ml)	Duration of surgery (min)	Intraoperative infusion volume (ml)	Hospital stay (d)
A (n=52)	158.96±7.15*	115.63±6.12*	1568.96±25.63*	17.96±2.15*
B (n=51)	122.52±1.25	126.89±8.56	1327.85±12.63	11.02±2.15
t	35.859	7.691	60.372	16.379
P	0.000	0.000	0.000	0.000

Note: *indicates compared with group B, P<0.05.

Table 3. Comparison of the SCR in the two groups [n (%)]

Group	cases	Multiple kidney stones	Solitary kidney stones
A	52	71.43% (20/28)	75.00% (18/24)
B	51	70.37% (19/27)	70.83% (17/24)
X^2		0.008	0.106
P		0.931	0.745

age, stone size, or type between the two groups (P>0.05) (**Table 1**).

Comparison of the surgical indicators in the two groups

The intraoperative blood losses and infusion volumes were (158.96±7.15) mL and (1568.96 ±25.63) mL in group A, which were greater than the values of (122.52±1.25) mL and (1327.85± 12.63) mL, respectively in group B. The lengths of the hospital stays and the durations of the surgeries were (17.96±2.15) d and (115.63± 6.12) min, respectively in group A, which were longer and shorter than the values of (11.02±2.15) d and (126.89±8.56) min, respectively in group B (P< 0.05) (**Table 2**).

SCR comparison

The SCR of multiple kidney stones was 71.43% in group A and 70.37% in group B, which showed no statistically significant difference (P>0.05). The SCR of solitary kidney stones was 75.00% in group A and 70.83% in group B, which showed no statistically significant difference (P>0.05) (**Table 3**).

Comparison of the serum inflammatory factors in the two groups

There was no statistically significant difference in the IL-6, TNF-α, CRP, or PCT levels between two groups before surgery (P>0.05); At 3 days after surgery, the IL-6, TNF-α, CRP, and PCT levels of group A were (24.82±2.15) ng/L, (45.12±3.28) ng/L, (41.28±2.28) mg/L, and (0.78±0.53) ng/L, respectively, which were lower than those of (28.85±3.28) ng/L, (53.12±3.96) ng/L, (50.96±3.68) mg/L, and (0.99±0.62) ng/L, respectively of group B (P<0.05) (**Figures 1-4**).

Comparison of the renal function indices in the two groups

Before surgery, BUN and were (17.58±3.12) μmol/L and (208.96±8.52) μmol/L in group A, and (17.62±3.09) μmol/L and (208.99±5.49) μmol/L in group B, which indicated no statistically significant difference (P>0.05). After surgery, the BUN and Scr were (16.99±2.15) μmol/L and (199.85±6.12) μmol/L in group A, and (16.92±2.16) μmol/L and (198.85±6.09) μmol/L in group B, which showed no statistically significant differences (P>0.05) (**Table 4**).

Comparison of the complications in the two groups

After surgery, there were 1, 2, 4, and 8 cases of septic shock, sepsis, fever, and hemorrhage in

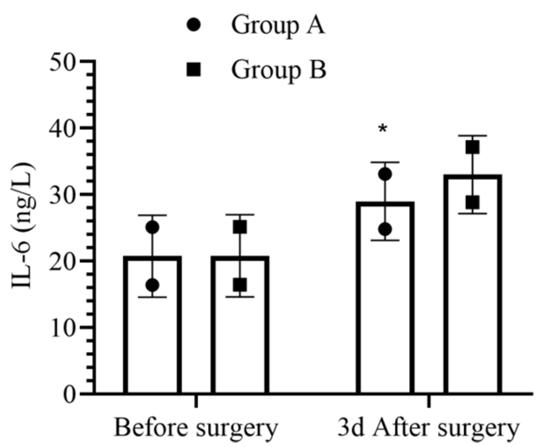

Figure 1. Comparison of the IL-6 levels before and after surgery in the two groups. *indicates compared with group B, *P*<0.05.

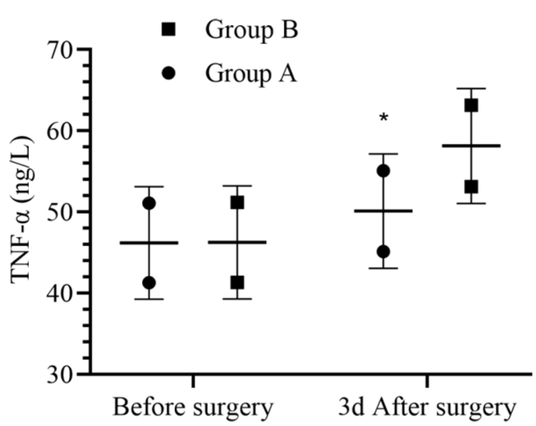

Figure 2. Comparison of the TNF-α levels before and after surgery in the two groups. *indicates compared with group B, *P*<0.05.

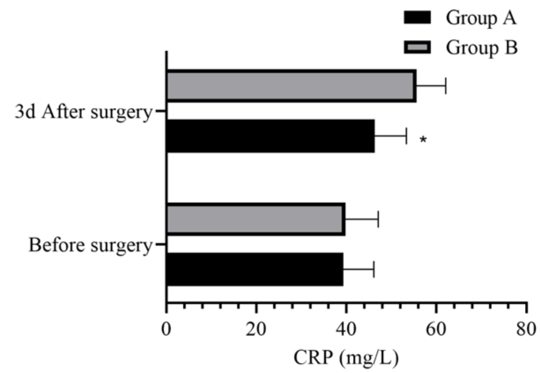

Figure 3. Comparison of the CRP levels before and after surgery in the two groups. *indicates compared with group B, *P*<0.05.

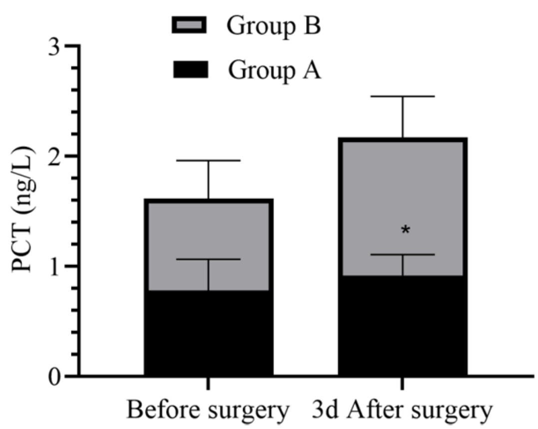

Figure 4. Comparison of the PCT levels before and after surgery in the two groups. *indicates compared with group B, *P*<0.05.

group A, with an incidence of complications of 28.85%, while there were 1, 3, 10, and 2 cases of septic shock, sepsis, fever, and hemorrhage in group B, with an incidence of complications of 31.37%. There were more cases of hemorrhage and fewer cases of fever in group A than there were in group B (*P*<0.05). However, there was no difference in the incidence of complications between the two groups (*P*>0.05) (**Table 5**).

Discussion

Percutaneous nephrolithotomy is one of the most commonly used surgical methods for kidney stones [8]. Standard channel percutaneous nephrolithotomy was performed with 24F-26F cardiac enlargement. The additional holmium laser lithotripsy could significantly improve the clinical efficacy, but it also could cause renal disease, seriously affecting patients' postoperative rehabilitation [9, 10]. Improvements in minimally invasive endoscopic techniques have brought out microchannel percutaneous nephrolithotomy, which reduces the channel onto 14-18F [11]. There is a correlation between the size of the channel and the efficiency of stone clearance, the internal pressure of the renal pelvis, as well as kidney injury. However, the efficacy and safety of standard channel vs microchannel percutaneous nephrolithotomy on kidney stones has not been determined [12, 13].

Okan [14] concluded that smaller channels can reduce kidney damage and intraoperative blood loss and improve surgical safety. However, other scholars deemed that narrowing the

Table 4. Comparison of the renal function indices in the two groups ($\overline{x}$±s)

Group	BUN (μmol/L)		Scr (μmol/L)	
	Before surgery	After surgery	Before surgery	After surgery
A (n=52)	17.58±3.12	16.99±2.15	208.96±8.52	199.85±6.12
B (n=51)	17.62±3.09	16.92±2.16	208.99±5.49	198.85±6.09
t	0.065	0.165	0.021	0.831
P	0.948	0.869	0.983	0.408

Table 5. Comparison of the complications in the two groups [n (%)]

Group	Case	Septic shock	Sepsis	Hemorrhage	Fever	Total incidence
A	52	1 (1.92)	2 (3.85)	8 (15.38)	4 (7.69)	15 (28.85)
B	51	1 (1.96)	3 (5.88)	2 (3.92)	10 (19.61)	16 (31.37)
X^2						0.078
P						0.779

channel will affect the lithotripsy and stone extraction during surgery [15]. The results in this study showed that the MCPN exhibited a longer duration of surgery, but less intraoperative blood loss and infusion volume, and a shorter length of hospital stay than SCPN, suggesting that MCPN can significantly reduce the risk of bleeding, but may negatively affect stone extraction and prolong the duration of surgery. In addition, the study also showed that the clearance rates of multiple nephrolithiasis and solitary nephrolithiasis in the two groups were similar, suggesting that either method will not affect SCR [16].

The renal function index is used to evaluate kidney injury. In theory, MCPN should have fewer negative effects on kidney function compared with SCPN [17, 18]. However, the results of this study demonstrated that there was no statistically significant difference in BUN or Scr between the two groups before and after surgery (P>0.05), we think this may be closely related to renal functional reserve. Only when the kidney damage reaches a threshold will there be a noticeable change in renal function. The treatments in this study are both minimally invasive surgery, and the damage to the kidneys is limited, so there is no significant difference in the postoperative renal function index [19, 20].

Although percutaneous nephrolithotomy has the benefits of being minimally invasive and having a rapid postoperative recovery, the operation will bring mechanical damage, which will stimulate the production of TNF-α, IL-6, CRP, PCT and other inflammation-stimulating factors by fibroblasts, monocyte macrophages, etc. There is a connection between these factors and the inflammation level [21, 22]. The results of this study show that the levels of TNF-α, IL-6, CRP, and PCT on the 3rd day after surgery were increased in both groups, suggesting that surgery will trigger stress reactions. However, he levels of TNF-α, IL-6, CRP, and PCT after surgery in the SCPV were lower than the levels in the MCPN. This may be because MCPN does less damage to the renal parenchyma. However, the vision of MCPN and the movements of lithotripsy instruments in MCPN are limited, and a high-pressure water pump is used for continuous irrigation during surgery to increase the perfusion pressure.

The bacteria and stones in the renal pelvis will enter the blood along with the washing fluid, leading to serious postoperative inflammation.

Patients treated with SCPN experience more severe bleeding and showed fewer cases of fever (*P*<0.05) This reason may be that the small amount of blood loss during SCPN reduces the chances of pathogenic media entering the blood circulation, so its postoperative fever rate is relatively low. However, the renal pelvis pressure needs to be reasonably adjusted due to the difficulty of microchannel flushing, and the patients must be treated with anti-infectives in time during and after surgery to reduce risk of bacterial infections [23].

In summary, MCPN is as effective as SCPN in treating kidney stones. SCPN can effectively reduce the serum levels of the inflammatory factors, but with more intraoperative blood loss. However, the cohort in this study was small, so it is necessary to further expand the sample size in the future for a more in-depth exploration.

Disclosure of conflict of interest

None.

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