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Retrospective Study

Clinical study on the minimally invasive percutaneous nephrolithotomy treatment of upper urinary calculi

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Abstract

BACKGROUND

Upper urinary tract stones are very common in my country, with an incidence of 1% to 5% in the North and an even higher incidence of 5% to 10% in the south. The incidence rate in the south is higher than that in the north, mainly due to the water quality, climate and eating habits of the region. From the perspective of sex, incidence is more likely in males than females. In the high-incidence population, young adults are most prone to stones. Men in the age range of 25 to 40 years are more likely to have stones.

AIM

To observe the therapeutic effect of minimally invasive percutaneous nephrolithotomy (mPCNL) on upper urinary tract stones and its influence on the renal function of patients.

METHODS

Patients with upper urinary tract stones who were treated in our hospital from February 2017 to March 2018 were selected as research subjects and were divided into the PCNL group and the mPCNL group according to the random number table method. The general conditions of the two groups of patients were observed during the perioperative period, and the differences in stone clearance, pain, renal function indicators and complication rates were compared between the two groups to determine which were statistically significant ($P < 0.05$).

RESULTS

The operation time of the mPCNL group was longer than that of the PCNL group ($t = -34.392$, $P < 0.001$), and the intraoperative blood loss of the mPCNL group was more than that of the PCNL group ($t = 34.090$, $P < 0.001$). There was no difference in renal function indices between the two groups of patients before treatment, and there was no difference in the levels of serum creatinine, β_2 microglobulin or retinol binding protein in the mPCNL group after treatment. The visual analog

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scale score of patients in the mPCNL group was lower than that of the PCNL group ($t = 12.191$, $P < 0.001$), and there was no significant difference in the stone clearance rate between the two groups (χ^2 value = 1.013, $P = 0.314$). There was no significant difference in the incidence of urine extravasation, dyspnea and peripheral organ damage between the two groups (χ^2 value = 1.053, $P = 0.305$). At 1 mo after treatment and 3 mo after treatment, the quality of life of the mPCNL group was lower than that of the PCNL group, and the Qmax level of the mPCNL group was higher than that of the PCNL group.

CONCLUSION

mPCNL has a good therapeutic effect on upper urinary tract stones, with a high stone clearance rate without causing kidney damage or increasing the incidence of complications, and thus has good application value.

Key Words: Percutaneous nephrolithotomy; Minimally invasive percutaneous nephrolithotomy; Upper urinary calculi; Calculi; Renal function; Complications

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Core Tip: Upper urinary tract calculi formation is a common clinical urinary system disease. In recent years, with the development of minimally invasive technology, surgical treatment has played an important role in treating upper urinary calculi, causing less trauma to patients and mild stress responses. However, there are few clinical reports on the impact of minimally invasive percutaneous nephrolithotomy (mPCNL) on patients with inflammatory factors, and because of the different levels of technology, some minimally invasive surgeries have frequent postoperative complications. The purpose of this study was to further confirm the therapeutic effect of mPCNL in upper urinary calculi.

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INTRODUCTION

Urinary calculi formation is a common clinical urinary disease. It currently ranks first in the incidence of urological diseases. In recent years, the incidence of urinary calculi has increased yearly with changes in modern people's life pressures and diet. Traditional treatments have been the use of medicine to remove the stones, but their effect is moderate, and relapse is common after these types of treatment[1]. In recent years, surgical treatment has played an important role in the treatment of urinary calculi. Traditional percutaneous nephrostomy surgery is invasive, which can easily cause bleeding and cause greater trauma to patients, especially when larger stones are involved. Many limiting factors inhibit the wide application of this method. In recent years, with the development of minimally invasive technology, microchannel technology has reduced damage to the renal cortex by reducing the size of the nephroscope, which not only ensures the effect of the surgical treatment but also reduces harm to the patients[2]. To further analyze the clinical treatment effect of minimally invasive percutaneous nephrolithotomy (mPCNL) on upper urinary tract stones, this study was performed to provide a basis for clinical guidance.

MATERIALS AND METHODS

General information of the patients

Patients with upper urinary tract stones who were treated in our hospital from February 2017 to March 2018 were selected as the research subjects. The inclusion

Table 1 Comparison of the general conditions of the two groups of patients during the perioperative period

Group	Case	Operation time (min)	Intraoperative blood loss (mL)
PCNL group	40	92.68 ± 6.39	148.79 ± 10.03
mPCNL group	40	150.42 ± 8.48	84.25 ± 6.54
<i>t</i> value		-34.392	34.090
<i>P</i> value		< 0.001	< 0.001

mPCNL: Minimally invasive percutaneous nephrolithotomy.

criteria were as follows: (1) Adults; (2) Those who were diagnosed with upper urinary tract stones; and (3) Those who had no other serious diseases of the urinary system. The exclusion criteria were as follows: (1) Patients with incomplete clinical data; and (2) Patients with urinary system infection. According to the inclusion and exclusion criteria, a total of 80 study subjects were included, including 40 cases in the PCNL group (22 males and 18 females, aged 30-65 years old, with an average age of 39.02 ± 2.68 years) and 40 cases in the mPCNL group (25 males and 15 females, aged 28-64 years old, with an average age of 39.05 ± 3.12 years old). The two groups of patients were comparable with no obvious differences in general information, such as age and sex. The study was reviewed and approved by the hospital ethics committee.

Method

Both groups of patients underwent general anesthesia. After satisfactory anesthesia was achieved, the bladder lithotomy position was taken, an F4-6 ureteral catheter was placed, the patient was moved to a prone position, and the puncture area was determined under ultrasound guidance on the patient's posterior axillary line, 11th intercostal space, under the 12th rib. A 17.5 g renal puncture needle was used to puncture the renal calyces, after which the needle core was removed and physiological saline was injected through the catheter; the renal passage was established, after which a guide wire was inserted for expansion, and then an F16 peeling sheath was inserted.

PCNL group: The condition of the ureter was observed, a dilator was used for dilation, and an F24 working sheath was inserted; the ultrasound energy was set to 80% after inserting the nephroscope, after which ultrasound or pneumatic ballistics was used for lithotripsy, and the calculus in the neck of the kidney was clamped and clipped.

mPCNL group: A ureteroscope was used to observe the condition in the kidney, and a pneumatic ballistic probe was used to crush the stones; the larger stones were removed with a foreign body forceps, and an infusion pump was used to discharge the smaller stones sequentially. If necessary, dual-channel lithotripsy treatment was carried out.

After stone removal, the ureteral catheter was withdrawn from both groups. If it was difficult to explore the renal pelvis, a zebra guide wire was inserted into the lumen of the ureteral catheter to expose the position of the renal pelvis. An F5-7 double J tube was inserted anteriorly, and an ostomy tube was inserted for urinary catheterization, resulting in more bleeding. The patient was compressed with a clipped fistula tube to stop the bleeding, hemostatic and anti-infective treatments were given after the operation, and the patient was strictly required to stay in bed.

Evaluation index

The general condition of the two groups of patients during the perioperative period was observed, and stone clearance, pain, renal function indicators [serum creatinine (Cr), β_2 microglobulin (BMG) and retinol binding protein (RBP)], serum inflammation indicators (interleukin-6, tumor necrosis factor- α , C-reactive protein) and differences in the incidence of complications were compared. The evaluation of visual analog scale (VAS) was carried out by the visual analog scoring method. The specific method was as follows: A 10 cm horizontal line was drawn on paper; one end of the horizontal line was 0, indicating no pain, the other end was 10, indicating severe pain, and the midsection indicated different degrees of pain.

Statistical analysis

After data entry, SPSS 11.5 software was used for analysis. Counting and measu-

rement data are expressed as examples and the mean $\pm$ SD, respectively. The comparison of general conditions, pain conditions and renal function indices of the two groups of patients during the perioperative period was analyzed by *t*-test. The comparison of stone clearance and complication rates between the two groups of patients was statistically processed by the chi-square test, which showed statistical significance ($P < 0.05$).

RESULTS

Comparison of the general conditions of the two groups of patients during the perioperative period

The operation time of the mPCNL group is longer than that of the PCNL group ($t = -34.392$, $P < 0.001$) and that the intraoperative blood loss is greater than that of the PCNL group ($t = 34.090$, $P < 0.001$) (Table 1).

Comparison of renal function indices of the two groups of patients before and after treatment

There is no difference in renal function indices between the two groups of patients before treatment, and after treatment, there is no difference in the levels of Cr, BMG and RBP in the mPCNL group (Table 2).

Comparison of pain and clearance rate between the two groups

Table 3 shows that the VAS score of patients in the mPCNL group was lower than that of the PCNL group ($t = 12.191$, $P < 0.001$) and that there was no significant difference in the stone clearance rate between the two groups (χ^2 value = 1.013, $P = 0.314$).

Comparison of the incidence of complications between the two groups

There is no significant difference in the incidence of urine extravasation, dyspnea, and peripheral organ damage between the two groups ($\chi^2 = 1.053$, $P = 0.305$) (Table 4).

Comparison of postoperative recovery of the two groups of patients

One month after treatment and 3 mo after treatment, the quality of life of patients in the mPCNL group is lower than that of the PCNL group, and the Qmax level is higher than that of the PCNL group. The difference is statistically significant ($P < 0.05$) (Table 5).

DISCUSSION

Kidney stone formation is a common disease in the urinary system. In recent years, its prevalence has shown an increasing trend. Kidney stones generally occur in the renal pelvis and calyces of patients. When the stone diameter is large, the probability of stone removal is reduced. Some patients may have no clinical signs for a long time. When stones cause obstruction of the patient's urinary system, they cause kidney function damage, which results in long-term renal insufficiency, and thus treatment should be carried out as soon as possible[3,4]. Studies have shown that the factors affecting the formation of stones are relatively large and are related to many factors, such as environment, diet, age, and genetics. On one hand, the stone-forming substances in the urine are in a state of supersaturation, and the substances that promote the formation of stones have increased; on the other hand, renal tubule damage to the epithelial cells leads to stone formation[5]. At present, surgical treatment has become an important method for the treatment of kidney stones. Traditional open surgery is more traumatic for patients and has a slow postoperative recovery. Therefore, with the rapid development of minimally invasive techniques, more options are provided for the treatment of kidney stones[6]. Percutaneous nephrolithotomy is widely carried out in clinical practice, but the blood supply of the human renal cortex is abundant, while the blood supply of the renal medulla is lower. The outer diameter of the traditional standard channel is larger, and kidney damage is serious, so bleeding easily occurs. During this process, the patient's tolerance is reduced due to prolonged surgery, and the damaged renal parenchyma has greater bleeding. Surgery will cause expansion of the damage, the formation of small blood clots in the bleeding, and changes in renal hemodynamics, which may easily cause the

Table 2 Comparison of renal function indexes of the two groups of patients before and after treatment

Group	Cr (μmol/L)		BMG (ng/L)		RBP (mg/L)	
	Before therapy	After treatment	Before therapy	After treatment	Before therapy	After treatment
PCNL group	124.35 ± 8.11	124.36 ± 7.42	3.16 ± 1.01	3.15 ± 0.22	55.34 ± 5.68	55.38 ± 6.03
mPCNL group	124.33 ± 7.45	124.37 ± 5.88	3.15 ± 0.98	3.17 ± 0.38	55.32 ± 4.97	55.35 ± 7.49
<i>t</i> value	0.011	-0.007	0.045	-0.288	0.017	0.020
<i>P</i> value	0.495	0.497	0.482	0.387	0.493	0.492

mPCNL: Minimally invasive percutaneous nephrolithotomy; Cr: Serum creatinine; BMG: β2 microglobulin; RBP: retinol binding protein.

Table 3 Comparison of pain and clearance rate between the two groups

Group	Case	VAS	Clearance rate, <i>n</i> (%)
PCNL group	40	3.52 ± 0.61	40 (100.00)
mPCNL group	40	2.27 ± 0.22	39 (97.50)
<i>t</i> /χ ² value		12.191	1.013
<i>P</i> value		< 0.001	0.314

mPCNL: Minimally invasive percutaneous nephrolithotomy; VAS: Visual analog scale.

Table 4 Comparison of the incidence of complications between the two groups of patients

Group	Case	Urine extravasation	Difficulty breathing	Damage to surrounding organs	Total incidence
PCNL group	40	2	0	1	3
mPCNL group	40	1	0	0	1
χ ² value					1.053
<i>P</i> value					0.305

mPCNL: Minimally invasive percutaneous nephrolithotomy.

Table 5 Comparison of postoperative recovery of the two groups of patients

Group	QOL		Qmax	
	1 mo after treatment	3 mo after treatment	1 mo after treatment	3 mo after treatment
PCNL group	1.95 ± 0.34	1.76 ± 0.24	12.86 ± 1.44	15.38 ± 2.54
mPCNL group	1.68 ± 0.52	1.55 ± 0.31	15.73 ± 1.72	18.36 ± 2.19
<i>t</i> value	2.749	3.388	8.092	5.620
<i>P</i> value	0.007	0.001	< 0.001	< 0.001

mPCNL: Minimally invasive percutaneous nephrolithotomy; QOL: Quality of life.

perfusion fluid to return. The flow causes infectious stones and bacteria to enter the bloodstream, aggravating the damage to the kidneys[7,8].

In this study, a microchannel percutaneous nephrolithotomy was used to treat kidney stones. This method improved the traditional standard channel nephrolithotomy. The expansion channel used in the microchannel was an F14-18, and a ureteroscope was used instead of the nephroscope to allow for the full flexibility of the ureteroscope. Due to the small diameter of the scope, it can enter the renal pelvis and calyces through the fistula, especially for partial renal calyx stenosis, and can pass

smoothly[9,10]. Microchannel percutaneous nephrolithotomy uses ultrasound guidance to observe the structure of the puncture channel in real time and distinguish the collection system, the renal calyx, and the location of kidney stones, which helps the physician grasp the position of the puncture needle, the puncture angle and the depth and avoid the puncture. This route prevents damage to the nearby pleura and spleen [11-15]. The establishment of an ideal percutaneous renal channel is an important factor for successful stone removal. Clinically, a path with a relatively thin renal cortex and fewer blood vessels should be selected according to the location, size and outflow tract of the stone to establish a puncture channel as long as possible to reach the junction of the target renal calyx, renal pelvis and ureter. It is convenient to maximize the operating angle and facilitate the placement of the double J tube anteriorly[16-18]. Microchannel percutaneous nephrolithotomy can also use an ultrasonic lithotripsy probe to quickly suck the stone fragments and the perfusate out of the body while directly looking at the ultrasonic lithotripsy through the working channel, accelerating the outflow of the perfusate, and effectively reducing the pressure in the renal pelvis. There is no need to repeatedly clamp and remove the stone. By reducing the puncture caliber, reducing the loss of renal cortex and reducing the pressure in the renal pelvis, the stone removal rate is greatly improved[19]. To prevent iatrogenic kidney laceration from causing hemorrhage due to excessive expansion of the mPCNL operation, the needle should be punctured at a suitable position under ultrasound guidance to avoid overextension of the puncture. At the same time, the anesthesiologist can cooperate to maintain the kidney to fix the kidney. Pulmonary inflation allows the kidney to move down and fix it in place, which effectively reduces the difficulty of puncture. At the same time, it can preventively reduce the mucosal congestion and edema caused by stones due to the administration of antibacterial drugs before surgery. At the same time, attention should be given to monitoring the coagulation factors[20].

This study showed that patients in the mPCNL group had a longer operation time than those in the PCNL group and had more intraoperative blood loss than those in the PCNL group, indicating that mPCNL treatment for urinary calculi is more complicated and that blood loss during the operation is greater. After treatment, there was no difference in the levels of Cr, BMG and RBP in the mPCNL group, indicating that the two surgical methods do not have a significant impact on the renal function of patients with urinary calculi. The VAS score of patients in the mPCNL group was lower than that in the PCNL group. There was no significant difference in the stone removal rate between the two groups, indicating that mPCNL can reduce pain in the treatment of urinary calculi. Both methods can effectively remove stones. There was no significant difference in the incidence of urinary extravasation, dyspnea, and peripheral organ damage between the two groups of patients, indicating that the application of mPCNL for the treatment of urinary calculi will not increase the occurrence of complications and is safe to use. The advantage of this study lies in the analysis of the clinical efficacy of the two surgical methods applied to urinary calculi, which provides a basis for further clarifying the choice of treatment options for urinary calculi. The clinical features of the patient's calculi and the economic situation should be considered for a reasonable selection of surgical options. This study included a limited number of patients, and long-term follow-up observation was not possible. Therefore, further multicenter, large-sample, randomized controlled trials are needed for in-depth demonstration.

CONCLUSION

In summary, mPCNL has a good therapeutic effect on upper urinary tract stones. The stone removal rate is high, and this method will not cause kidney damage or increase the incidence of complications. Thus, it has a good application value.

ARTICLE HIGHLIGHTS

Research background

Upper urinary tract stones are very common in China. However, there are few clinical reports on the impact of minimally invasive percutaneous nephrolithotomy (mPCNL) on patients with inflammatory factors, and because of the different levels of technology, some minimally invasive surgeries have frequent postoperative complications.

Research motivation

The authors studied the mPCNL on upper urinary tract stones and its influence on the renal function of patients.

Research objectives

This study aimed to observe the therapeutic effect of mPCNL on upper urinary tract stones.

Research methods

The authors selected patients as research subjects and were divided into the PCNL group and the mPCNL group.

Research results

The Qmax level of the mPCNL group was higher than that of the PCNL group.

Research conclusions

mPCNL has a good therapeutic effect on upper urinary tract stones.

Research perspectives

The purpose of this study was to further confirm the therapeutic effect of mPCNL in upper urinary calculi.

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