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Research Article

Comparison of the Effects of Minimally Invasive Percutaneous Nephrolithotomy and Open Surgery on Kidney Stones

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Abstract: ***Objective:*** To compare the treatment effects of minimally invasive percutaneous nephrolithotomy and open surgery on kidney stones. ***Methods:*** From November 2018 to November 2019, 80 patients with kidney stones who were treated in our hospital were selected and divided into two groups according to the random number table method. Each group contained 40 patients. The patients in control group were treated with open surgery while the patients in observation group were treated with minimally invasive percutaneous nephrolithotomy. The surgical indicators, rate of stone removal, and adverse events were compared between the two groups. ***Results:*** There was no statistically significant difference in surgical time between the two groups ($P>0.05$). Compared with the control group, the observation group had less intraoperative blood loss and shorter hospital stay, and the differences were statistically significant ($P<0.05$). The stone clearance rate (95.00%) in the observation group was higher than that in the control group (77.50%), and the difference was statistically significant ($P<0.05$). Compared with the control group, the incidence of postoperative adverse effects was lower in the observation group, and the difference was statistically significant ($P<0.05$). ***Conclusion:*** Minimally invasive percutaneous nephrolithotomy for kidney stones is effective in reducing the intraoperative blood loss, shortening the length of hospital stay, improving the rate of stone clearance and reducing the occurrence of adverse effects. Therefore, this treatment method should be promoted for clinical use.

Keywords: Kidney stones; Minimally invasive percutaneous nephrolithotomy; Open surgery; Stone clearance

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1 Introduction

Kidney stones are a relatively common urological disease with clinical manifestations of hematuria, urinary stones, and renal insufficiency. Kidney stones have a high clinical incidence and the daily life and work of the individuals with kidney stones are severely affected[1]. In the past, surgery was often used to treat this disease. The most common form of surgery that is used to treat kidney stones is open surgery, which can effectively remove stones and relieve clinical symptoms in patients. However, this invasive treatment procedure renders traumatic consequences to the patients as they are associated with postoperative adverse effects. Thus, open surgery is no longer suitable to cater to the needs of modern medical treatment[2-3]. Therefore, there is an urgent need to find safer and more effective treatments. Based on this, this study further compares the effects of minimally invasive percutaneous nephrolithotomy and open surgery on kidney stones, which are shown in the following.

2 Materials and methods

2.1 Baseline information

Eighty patients with kidney stones admitted in our hospital from November 2018 to November 2019 were selected and divided into two groups according to the random number table method. Each group consisted of 40 patients. The control group consisted of 28 male and 12 female individuals; aged 36-62 years, with an average age of (51.32 ± 4.28) years. Out of the 40 patients, 23 were reported to have single stones while the remaining 17 patients had multiple stones. On the other hand, there were 27 male and 13 female individuals in the observation group; aged 35-64 years, with an average age of (51.27 ± 4.31) years. Out of the 40 patients, 24 were reported to have single stones while the remaining 16 patients had multiple stones. Comparing the baseline information between the two groups, the difference was not statistically significant (P>0.05). This study was carried out with the approval of the Medical Ethics Committee of our hospital.

2.2 Inclusion criteria

The study participants who were recruited in this study were diagnosed as having kidney stones by urinary tract X-ray imaging, abdominal computed tomography, and urinary Color Doppler ultrasound examination. The diameter of the stones was ≤ 2 cm. The patients and their families voluntarily signed informed consent. The patients who had combined heart, liver, lung and other organ dysfunction, surgical contraindications, malignant tumors, and poor compliance with treatment were excluded from the study.

2.3 Methods

2.3.1 Routine treatment and preoperative examination

After admission, the patients in both observation and control groups were routinely treated for kidney stones. The routine treatment includes drinking a large amount of water, consuming a low-salt diet, pain relief, and anti-infection practices. Preoperative blood, urine and renal function tests were also performed in both groups.

2.3.2 Open surgery

The open surgery was performed in patients of the control group. The patient was placed in the supine lateral position and treated with epidural anesthesia or general anesthesia. The cloth was disinfected as a routine practice. After the anesthesia had taken effect, an incision was made in the 12 ribs of intercostal space, and the skin and subcutaneous tissue were separated. The renal pelvis was bluntly separated to the large part of the kidney, the renal pelvis in the sinus was cut and the stones were removed with stone forceps. After stone removal, the renal pelvis was rinsed with normal saline, and the wound was closed layer by layer after hemostasis.

2.3.3 Minimally invasive percutaneous nephrolithotomy

Minimally invasive percutaneous nephrolithotomy was performed in the observation group. The patient was placed in the bladder lithotomy position and was treated with epidural or general anesthesia. Routine disinfection was performed. Under the ureteroscope, the ureteral catheter was inserted into the affected renal pelvis of the patient. The catheter was fixed on the ureter to prevent it from falling off. The end of the ureter was placed in normal saline to simulate artificial hydronephrosis, and the affected side of the abdomen was elevated to a height of about 15 cm so that the patient was in the prone position. By using ultrasound B scan, the position, size and number of kidney stones and the status of hydronephrosis in the affected kidney were determined. Then, the puncture was performed. A small 1.5-cm incision was made at the intersection of the posterior axillary line and the 12 costal margins. After puncturing to the pelvis of the stone, a guide wire was inserted after the puncture and the puncture channel was gradually expanded to 16F to establish a percutaneous renal channel. Subsequently, a percutaneous nephroscope sheath was placed and the stones were explored. The ultrasonic lithotripter was used to crush the stone. The lavage fluid was excreted from the body, and carefully examined for the presence of residual stones and bleeding. After the operation, the 5F double J tube was placed on the affected side of the ureter and a F20 nephrostomy tube was placed. Patients in both groups were treated with antibiotics against infections.

2.4 Observation indicators

The surgical indicators, stone clearance, and adverse events were recorded and compared between the two groups. The surgical indicators include the time of surgical operation, the amount of bleeding during the surgical operation and the length of hospital stay. The abdominal urinary plain film was reviewed after surgery, and the stones were removed. It was either no stones or stone with a diameter ≤4 mm. The stone residues had a diameter >4 mm. On the other hand, the adverse effects include postoperative bleeding, incision infection, and fever.

2.5 Statistical analysis

The data were analyzed using SPSS 20.0 software. The quantitative variables were expressed as $\bar{x} \pm s$. Independent sample t test was used for comparison between the two groups, while paired sample t test was used for comparison within group. The qualitative variables were expressed as percentages. The data of qualitative variables were analyzed using χ^2 test. The difference with $P<0.05$ is considered statistical significant.

3 Results

3.1 Comparison of surgical indicators

Comparing the surgical operation time between the two groups, the difference was not statistically significant ($P>0.05$). Compared with the control group, the observation group had less intraoperative blood loss, shorter hospital stay, and the difference was statistically significant ($P<0.05$). Refer to Table 1.

Table 1. Comparison of surgical indicators between the two groups ($\bar{x} \pm s$)

Group	Surgical operation time	Amount of intraoperative blood loss	Length of hospital stay
Control group(n=40)	98.25±11.36	29.34±5.67	11.08±2.84
Observation group (n=40)	102.27±11.58	16.29±5.31	8.42±2.46
t	1.567	10.625	4.478
P	0.121	0.000	0.000

3.2 Stone clearance rate

In the control group, 31 stones were removed, and the stone clearance rate was 77.50%. In the observation group, 38 stones were removed, and the stone clearance rate was 95.00%. The stone clearance rate was higher in the observation group, and the difference was statistically significant ($\chi^2 = 5.165$, $P = 0.023$).

3.3 Adverse effects

Compared with the control group, the incidence of adverse effects in the observation group was lower, and the difference was statistically significant ($P<0.05$). Refer to Table 2.

Table 2. Comparison of adverse effects between the two groups n (%)

Group	Postoperative bleeding	Wound infection	Fever	Total incidence
Control group (n=40)	4(10.00)	3(7.50)	5(12.50)	12(30.00)
Observation group (n=40)	0(0.00)	1(2.50)	1(2.50)	2(5.00)
χ^2				8.658
P				0.003

3.4 Discussion

The formation of kidney stones is mainly related to age, gender, environmental factors, drinking habits, and occupations. Smaller stones can cause stabbing pain in the waist and abdomen of patients, and the pain is paroxysmal, which seriously affects the patient's quality of life[4-5]. In the past, minimally invasive percutaneous nephrolithotomy and open surgery have often been used to treat this disease, and both have achieved good clinical results. However, special studies in the medical field on comparing the effects of the two surgical methods are scarce[6].

Having this in mind, this study was designed to investigate the use of two surgical procedures to treat patients with kidney stones, and to observe their effects on surgical indicators, stone clearance rate and adverse effects. The results showed that there was no significant difference in the surgical operation time between the two groups. Compared with the control group, the observation group had less intraoperative blood loss and shorter hospital stay. The observation group had higher stone clearance rate. The incidence of adverse effects in the observation group was low, indicating that minimally invasive percutaneous nephrolithotomy for kidney stones is effective in reducing the amount of intraoperative blood loss, shortening the length of hospital stay, increasing the rate of stone clearance, and reducing adverse effects. The reason for this is that open surgery is a traditional surgical operation for kidney stones, and its advantages include wide surgical field and easy access to stones. However, because of the risk of more severe trauma in open surgery, the amount of bleeding during the surgical operation increases, and the length of hospital stay is prolonged which is not conducive to the postoperative rehabilitation[7-8]. In minimally invasive percutaneous nephrolithotomy, the surgical incision is small and easy to operate. Through ultrasound guidance during surgery, the internal structure of the patient's kidney can be clearly observed through different ways, and the location and size of the stones and the relationship with the surrounding tissues can be determined. According to the actual situation, a targeted surgical plan is formulated, and the stone removal operation can effectively avoid the damage to the surrounding tissues, which is conducive to the patient's postoperative recovery[9]. The ultrasonic lithotripter is used to crush and remove the larger kidney stones. The technique can increase the comprehensiveness of this operation. However, there are still many deficiencies in clinical treatment of this surgical operation. During the operation, it should be noted that the ultrasound probe should be placed on the patient's waist and back longitudinally before puncture, and the patient's kidney should be carefully explored before puncture treatment. Puncture treatment is performed on the posterior and lateral sides of the kidney of the patient to avoid vascular injury caused by the puncture. If the size of kidney stone is found to be large during the operation, the edge of the stone should be taken for lithotripsy to facilitate the excretion of the stone and shorten the time of surgery[10-11]. Li et al[12] and other research results show that minimally invasive percutaneous nephrolithotomy for the treatment of renal calculi in patients is associated with less intraoperative blood loss, which is conducive to patient recovery. This conclusion is consistent with the results of this study.

In summary, minimally invasive percutaneous nephrolithotomy as a treatment of kidney stones is effective in reducing the amount of intraoperative blood loss, shortening the length of hospital stay, increasing the rate of stone clearance and reducing the incidence of adverse effects. Hence, this treatment is worthy of promotion in clinical setting.

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