Cellular and Molecular Biology

CMB Association Publisher

Journal homepage: www.cellmolbiol.org

Potential Risk of Calcified Nanoparticles for Recurrent Urinary Tract Infection after Minimally Invasive Percutaneous Nephrolithotomy for Renal Calculi

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ARTICLE INFO

Original paper

Article history:
Received: October 25, 2021
Accepted: March 11, 2022
Published: March 31, 2022

Keywords:
Cnps, Renal Calculi, Minimally Invasive Percutaneous Nephrolithotomy, Infection

ABSTRACT

Among urolithiasis, urolithiasis is a more extensive and difficult to treat disease. In recent years, with the development of endoscopic equipment and related surgical methods, a new treatment, namely minimally invasive percutaneous nephrolithotomy, appears and is widely used in the treatment of renal calculi. It has been developed for more than 50 years since its appearance. Its advantages are a high stone clearance rate, small surgical trauma, fewer intraoperative and postoperative complications, and a short recovery time for postoperative patients. It is widely used in clinical treatment. The purpose of this paper is to study the potential risk factors of recurrence and the possibility of urinary tract infection in patients with renal calculi after minimally invasive percutaneous nephrolithotomy (MPCNL) with calcified nanoparticles, so as to obtain correct nursing knowledge and reduce recurrence and infection. In order to explore the renal calculi caused by calcified nanoparticles (CNPs), we established a rat model of renal calculi, injected CNPs into rats, collected experimental samples after a specified time, and determined NGAL, OPN and MCP-1 by enzyme-linked immunosorbent assay (ELISA) and compared them with the formation of crystallization. In the study of the possible influencing factors of septic shock after PCNL, we established a multivariate regression analysis and model, used statistical methods and professional statistical software, and used the method of classified data analysis to find out the influencing factors. After the experiment, we found that positive urine culture ($P < 0.05$) and preoperative urinary tract infection ($P < 0.05$) were significant influencing factors, and the total accuracy was 99.2%. At the same time, it is concluded that calcium nanoparticles can promote the retention, adhesion and aggregation of calcium salt crystals in the kidney, and then lead to the formation of stones.

DOI: http://dx.doi.org/10.14715/cmb/2022.68.3.28

Introduction

Before minimally invasive surgery was widely used, there were two main methods for the treatment of renal calculi, one was open surgery, and the other was drug Litholysis (1-2). Among them, after open surgery, renal function damage is serious, and there are many kinds of intraoperative and postoperative complications; The effect of drug treatment on Litholysis is even more disappointing to clinicians (3-4). With the development of endoscopic equipment and related surgical methods, the above two traditional urolithiasis therapies are gradually being replaced (5-6). Minimally invasive surgery is widely respected by clinicians because of its advantages of the short operation time, small incision and fast postoperative recovery (7-8).

Many doctors and researchers have analyzed the problem of recurrent infection after minimally invasive percutaneous nephrolithotomy and proposed solutions. For example, some scholars take the phenomenon of urinary sepsis after PCNL as the starting point and find that the stone area, operation time and other factors are the important factors of this disease through multivariate regression analysis. Through univariate analysis, gender, preoperative urine culture positive and other factors are the key variables of this disease (9). Some scholars also studied the biliary tract infection after cholelithiasis removal, selected patients as the research object, and carried out univariate and multivariate regression analyses from gender, age and past medical history to find the correlation between postoperative biliary tract

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infection and the above factors (10).

The main research work of this paper is divided into two parts, one is to study the risk of urinary tract infection in patients with renal calculi after minimally invasive percutaneous nephrolithotomy, and the other is to study the pathogenesis of calcified nanoparticles on renal calculi. In this paper, we used CNPs to establish a rat model of renal calculi, injected CNPs into rats, collected experimental samples after a specified time, and determined NGAL, OPN and MCP-1 indicators by enzyme-linked immunosorbent assay (ELISA) and compared them with crystallization. In the study of the possible influencing factors of septic shock after PCNL, we established a multivariate logistic regression analysis and model, used statistical methods and professional statistical software, and used the method of classified data analysis to find out the influencing factors.

The Risk of Postoperative Recurrent Urinary Tract Infection

Multivariate Logistic Regression Analysis and Model Establishment

In the established logistic regression equation, we defined the independent variables as gender, age, diabetes history, affected side, positive urine culture, preoperative urinary tract infection, stone size, stone type and degree of hydronephrosis, and the dependent variables as septic shock. After adjusting for confounding factors, urine culture and combined urinary tract infection were still significant variables (11-12). The logistic regression model was established as follows:

$$p = \frac{e^{\alpha+\beta_1 x_1+\beta_2 x_2+...+\beta_m x_m}}{1+e^{\alpha+\beta_1 x_1+\beta_2 x_2+...+\beta_m x_m}} \quad [1]$$

Parameters in the model α Is a constant term, which represents the natural logarithm of the ratio (the probability ratio of y = 1 and y = 0) when the independent variables are all 0. Parameter βj (J = 1,2,..., m) is the logistic regression coefficient, which means that when the value of other independent variables remains unchanged, the value of the independent variable increases by one unit, resulting in the change of logarithm to natural logarithm; X was the independent variable, X1 was positive urine culture, X2 was preoperative urinary tract infection.

Percutaneous Nephrolithotomy (PCNL)

The patient was in the prone position, the surgical area was strictly disinfected, and B-ultrasound was used to assist in positioning, to determine the location of stones and hydronephrosis. According to the principle of puncture, percutaneous puncture and fistulation were carried out. The path was selected to be closest to the location of stones and facilitate lithotripsy. At the same time, the puncture point of all renal calyces could be reached to establish the working channel. Under normal circumstances, the puncture point is under 12 intercostals and between 11 and 12 intercostals. After a successful puncture, pull out the inner core and see the urine flow out, detain the safety guide wire, take out the puncture needle, make a skin incision of 10 mm up and down here, use the expander to expand the channel to F16, and detain the expansion sheath at the same time to observe whether there is bleeding If not, channel 24F was continued to be dilated with an expanding sheath and an indwelling sheath (13-14). If there is no special case, the ultrasonic probe is used for lithotripsy and aspiration at the same time, so as to shorten the operation time as much as possible. If the stone hardness is too high, the pneumatic lithotripsy can be used to break the stone into small pieces, The ultrasonic probe was used to strike the stone and suck out the smaller fragments. Before the end of the operation, check whether there is a large residual stone in the kidney. If there are no residual or residual stone fragments, and there is no obvious bleeding, the mirror can be withdrawn and the nephrostomy tube can be retained and fixed on the skin (15-16).

Risk Factors of Urinary Sepsis after PCNL

There was no significant relationship between age and channel size and the incidence of urinary sepsis after PCNL. As far as age is the influencing factor, there are different reports at home and abroad. The immunity of the body is decreased, which can increase the occurrence of postoperative complications to a certain extent. However, when the study was put into the group, some serious basic diseases were excluded first, which weakened the immunity of the body to some extent. The channel used in this group was only 18F and 20f. The operators chose the appropriate peel-away sheath according to a load of stones. Therefore, there was no obvious advantage between the two groups.

Prevention and Treatment of Urinary Sepsis after PCNL

Preoperative

Women, especially the elderly women, should be vigilant, complicated with infection and obstruction, try to control infection or remove obstruction first and then operate. After the operation, they attach great importance to and closely observe the changes in the disease. In addition, if positive urine culture is found before reoperation, anti-infection should be paid attention to. At the same time, we should pay attention to the basic diseases of patients and strictly control the disease. For patients with low immunity, paraplegia and urogenital system deformity, the patients should make the condition stable before operation and increase the tolerance to operation and complications.

During Operation

Strictly control the operation time and perfusion volume, and stage operation if necessary. The prolonged operation time and the increase in perfusion volume are the high-risk factors of urinary sepsis after PCNL under constant pressure perfusion. For an experienced operator, the appropriate surgical equipment and channel size should be selected according to the complexity of the stones and the patient's physical condition. The operation can be performed in stage I or stage II.

When dealing with the stricture calyces or renal diverticulum stones, we should study the CT and urography before the operation, and be familiar with the direction of the narrow calyx and the anatomical relationship with the collection system.

The application of glucocorticoids and diuretics. The operation results showed that pyelouria was pyuria or purulent moss was more than that of pyelouria, and the operation was stopped in time, and the renal fistula and (or) double J tube were placed, and the operation was to be performed in phase II; The patients with a longer operation time were given dexamethasone 10mg/30min in time to improve microcirculation; If too much perfusion is found during operation, for example, more than 20L, intravenous injection of furosemide should be given to reduce edema and heart load.

Post Operation

Ensure smooth drainage. The key to reducing urinary sepsis after PCNL is to drain smoothly. In a clinical, if drainage is not smooth, it is usually necessary to replace the double J or renal fistula, adjust the depth of the renal fistula, and flush the renal fistula with low pressure to solve these problems and keep the drainage smooth.

Enzyme Linked Immunoassay

OD value is expressed as a horizontal coordinate by the concentration of NGAL standard, and the OD value of the standard object detected is taken as a vertical coordinate. A standard curve is drawn on this horizontal coordinate axis, and then the corresponding concentration is found according to the OD value detected by the sample to be tested, and the corresponding concentration is found according to the standard curve diagram detection results, Then, the real concentration of the sample to be measured is obtained by multiplying it by the multiple of dilution concentration. The content of OPN and MCP-1 in the urine of rats was measured by the same method in different periods (17-18).

Hematoxylin Eosin (He) Staining

The renal tissue sections were sealed with paraffin and paraffin for 10 minutes and treated according to the concentration gradient (100%, 95%, 85%, 70%), and then treated after the sections. In this case, the slices were placed in alcohol at all levels for 3 minutes. Wash the kidney tissue with running water for 10 minutes, and then rinse with distilled water for some time. 5 minutes later, the staining was performed with 0.5% iridescence (he). In addition, according to the concentration gradient, the alcohol tissue sections were dehydrated with different concentrations (70%, 85%, 95%, 100%), and the dehydration time of each level of alcohol was 2min. The renal tissue sections were removed with xylene for 10min, and the neutral liquid was closed, and the renal tissue crystal state was observed under 400 times normal optical microscope, and no pathological changes were confirmed (19-20).

Stone Target Tracking and Location Algorithm based on CT Image

Projection-Mapping Prediction Algorithm

The establishment of the model: it is assumed that there are some components of the maximum frequency in the received signal, so only a few subband-limited periodic signals can be considered. The advantage of this method is to reduce the problem to several subspace optimization steps and find the optimal signal result in each subspace. Then, within an acceptable error range, the trajectory of the observed signal is projected into the subspace to obtain the most matching periodic function. The projection signals obtained in each subspace are compared to obtain the optimal signal in the whole period. It is assumed that the observed data Yi is an instantaneous trajectory sampled at different times with noise Ni.

$$y_i = f(t_i) + n_i, i = 1,2,\ldots,N \qquad [2]$$

Where f is the real value of the position in a continuous period. If f (T) is a finite bandwidth function in the period T, it is linearly combined with the Fourier transform to get the following result:

$$f(t) = \sum_{k=-k}^{k} c_k^{\,j2\pi kt/T}, k = \left\lfloor \frac{T}{2\Delta t} \right\rfloor \qquad [3]$$

Among them, c_k is the coefficient of Fourier change. The above formula under time can be expressed in vector form:

$$f = G_t c \quad [4]$$

Considering the trajectory of observations, the present problem is the optimization problem in the period.

$$T^* = \arg\min\min \| y - G_t c \| \qquad [5]$$

Thus, the trajectory of the closest periodic signal in the sample (with the minimum multiplication error) can be given by the following formula:

$$f^*(t) = \sum_{k=-k}^{k} c_k e^{j2\pi kt/T^2} \qquad [6]$$

Automatic Positioning Algorithm

For the collected CT image, the preprocessing should be carried out first. Firstly, the region of interest (ROI) is found by the two-dimensional Otsu algorithm, and then the ROI to be studied is determined by the entropy function. This region is much smaller than the whole image so that the processing amount of the image in the operation process can be reduced, and the running speed can be improved and the system delay is reduced. K of pixels with coordinates (x, y) on the image expressed by G (x, y) × The average gray value of the K neighborhood (recorded as J). The expression of G (x, y) is:

$$g(x,y) = \left\lfloor \frac{1}{k^2} \sum_{m=-\frac{k-1}{2}}^{\frac{k-1}{2}} \sum_{n=-\frac{k-1}{2}}^{\frac{k-1}{2}} f(x+m, y+n) \right\rfloor \qquad [7]$$

A picture of M × We can calculate the probability density by using the binary (I, J) which is composed of the average gray value of each pixel node and the average gray value of its adjacent region.

$$p_{ij} = \frac{f_{ij}}{M \times N} \qquad [8]$$

Location Algorithm

It is known that the distance between X-ray and image intensifier is 2D, and the rotation axis of the C-arm is at the midpoint. First, set the space coordinate of the target point to be calculated as (x, y, z), then according to the geometric relationship, the relationship between the spatial coordinate point and the normal projection coordinate can be obtained,

$$\frac{d-Z}{2d} = \frac{X}{x_1} \qquad [9]$$

$$\frac{d-Z}{2d} = \frac{Y}{y_1} \qquad [10]$$

According to the geometric relationship, the relationship between the spatial coordinates and the oblique projection coordinates can also be obtained,

$$\frac{d-Z'}{2d} = \frac{X'}{x_1} \qquad [11]$$

$$\frac{d-Z'}{2d} = \frac{Y'}{y_1} \qquad [12]$$

The relationship between (x, y, z) and (x ', y', Z ') can be obtained by the coordinate transformation formula.

Real-Time Tracking Method of Respiratory Motion based on Monocular Vision

Because the change of target position caused by breathing movement is instantaneous, and there is no universal law, the target position will drift in the observation process, so the target position is difficult to track and locate. In order to simplify the research process, a moving mean filter window can be introduced to make the size of the window correspond to the patient's breathing cycle. And because the average position prediction tracking algorithm does not need the instantaneous coordinates of each state, but is obtained by a general trajectory trend, it can realize the tracking and positioning process.

Quality Control

In order to avoid errors in the design, statistics and analysis of this experiment, we need to adopt strict test measures to eliminate errors caused by bias. The basic measures are as follows: (1) research audit stage: full access to relevant domestic and foreign literature, fully understanding the research direction of the background, methods, and materials. In addition, the inclusion criteria and exclusion criteria should be clear, and the differences caused by geographical and environmental factors between the two groups should be reduced as far as possible, so as to reduce the confounding factors that can affect the indicators to reach the equilibrium between groups. The questionnaires in the same study need to be unified. (2) Data collection: Participants in this study need systematic training to understand the whole process of scientific research, and be able to understand the meaning and standard of each index; Check and proofread the original data regularly, and hand it to the teacher for proofreading; The collection and input should be carried out according to the unified procedure; The clinical data and contents of patients need special epidemiological investigators and accurate records. (3) Operation stage: the necessary auxiliary examination before the operation was strictly improved, the contraindications of operation were excluded, and the indications of operation were made clear; Aseptic operation and other procedures should be strictly implemented during the operation; The instruments and materials used in the operation should be used in strict accordance with the regulations, so as to reduce the measurement bias; The operation and operation in the research process need to be completed by specific person in the same operating room, and the use of various equipment needs to be consistent. (4) Data analysis stage: data input and proofreading need two people to ensure their accuracy and reliability; In order to ensure the correctness of the results, it is necessary to review the related confounding factors in data analysis, so as to reduce the interference to the results.

Materials and methods

Study on the Possible Influencing Factors of Septic Shock after PCNL

Data Sources

Methods: The clinical data of 893 patients with upper urinary tract stones who underwent PCNL in the First Affiliated Hospital of a university from January 2015 to October 2020 were analyzed, including 543 males and 375 females, aged from 1 to 83 years (mean 49 years), with a stone size of 5 to 67.8 mm (mean 19.9 mm).

Inclusion and Exclusion Criteria

All patients who were diagnosed as renal calculi or upper ureteral calculi by CT scan and IVU before the operation had undergone percutaneous nephrolithotomy. Discharge criteria: A. patients with blood diseases, tumors and oral immunosuppressive agents. B.Patients with severe cardiovascular and cerebrovascular diseases.C. patients with renal malformation, polycystic kidney, horseshoe kidney and ureteropelvic junction obstruction.

Determine the Possible Influencing Factors of Septic Shock after PCNL

According to the literature reports, we summarized the following possible influencing factors: patient characteristics (gender, age), stone characteristics (stone size, number), preoperative factors (urinary tract infection, positive urine culture, diabetes history, creatinine level, days of antibiotic use), intraoperative factors (number of operation channels, operation time), and preoperative degree of hydronephrosis.

Data Collection

All patients were diagnosed by urinary CT and IVU before the operation, and the main data were recorded as follows: a. general information: age, gender, preoperative diabetes mellitus and urinary tract infection;b.Laboratory examination: blood routine, urine routine, urine culture, liver and kidney function;c.Stone condition: size, number and complexity. Kidney condition: degree of hydronephrosis; e.Operation conditions: antibiotic application days, operation time, number of operation channels;f.Postoperative conditions: body temperature, blood pressure, heart rate, blood transfusion.

Method

1) Stone target location tracking and prediction process

For the acquired CT image, the ROI of the region of interest is selected by two-dimensional Otsu, and then the ROI is determined by the entropy function, which can reduce the amount of calculation on the image in the whole process, so as to reduce the system delay caused by image processing to a certain extent. Then, the location of the stone target is given by the location algorithm and prediction algorithm. So as to achieve real-time tracking.

2) Percutaneous nephrolithotomy

After locating the location of the calculi in the kidney by the stone tracking method described above, the percutaneous renal puncture channel was established. With the help of the third generation EMS ultrasonic lithotripsy system, the selective use of ultrasonic lithotripsy, ballistic lithotripsy and holmium laser lithotripsy was used. Before the end of the operation, the residual stones in the renal pelvis and ureter were checked again. If necessary, multi-channel lithotripsy or secondary lithotripsy could be established. After the operation, the ureteral stent and F20 nephrostomy tube were indwelling, fixed and clamped.

3) Postoperative evaluation

Septic shock was confirmed when the following two conditions were met simultaneously: one was the existence of the infection source. The other is that it meets the diagnostic criteria of SIRS.

4) Statistical processing

With the help of statistical software, the database of patients was created and statistically analyzed, and then the influencing factors were identified by classified data analysis, including patient factors (gender, age), stone factors (stone size, number), preoperative factors (urinary tract infection, positive urine culture, history of diabetes, creatinine level, days of antibiotic use) The relationship between intraoperative factors (number of operation channels, operation time), preoperative hydronephrosis degree and septic shock after PCNL was analyzed by the logistic regression model. The significance and fitting effect of the model were tested. To find out the high-risk factors of septic shock after PCNL, and take targeted intervention measures in preoperative preparation, so as to reduce the incidence of septic shock.

The Study of the Recurrence of Renal Stones Caused by Calcified Nanoparticles

Test Materials and Instruments

1) Experimental animal

40 male SD rats 3 months old weighed 150-200g.

2) Animal feeding environment

The temperature in the animal feeding room is generally kept at 20-25 ℃, the relative humidity is 40-60%. In 12 hours, the temperature is alternately in the daytime and at night, and the ventilation is good. The rats are fed with the feed of ordinary poultry so that the rats can quote tap water that meets the water standard of residents.

3) Reagents for experiment

1 mol / L hydrochloric acid solution, phosphate buffer (PBS), 1640 culture medium, fetal bovine serum inactivated by irradiation, pentobarbital sodium, neutral formaldehyde, distilled water, von Kossa staining kit, nuclear solid red staining kit, xylene, alcohol, hematoxylin, eosin, neutral gum, NGAL enzyme-linked immunoassay kit in rats, OPN ELISA kit in rats MCP-1 ELISA kit was used in rats.

4) Instrument for experiment

Surgical instruments: Animal holder, hemostatic forceps, super clean operating table, ophthalmic scissors, knife handle, surgical blade, tissue clamp, syringe, liquid transfer gun, gun head, electronic balance, EP tube, cryostat, thermostatic box, water bath box, refrigerator, high-speed centrifuge, centrifugal tube, mortar, cell culture bottle, metabolism cage, enzyme standard instrument, disposable needle tube filter, slicer, slide carrier Cover glass, ordinary optical microscope, microscope and photographing system.

Experimental Methods

1) Preparation of CNPs suspension

The stone samples of patients who underwent percutaneous nephrolithotomy were taken. Remove the liquid from the bottom of the pipe by desalting, neutralizing, washing, grinding, filtering and centrifuging. 10% (volume fraction) of heat-inactivated liquid was inoculated with liquid at the bottom of tube γ- FBS was cultured in 1640 medium at 37 ℃, 5% CO2 and 95% O2 for 6-8 weeks, and the medium were replaced every 30 days. The CNPs suspension was made from the samples without pollution by morphological identification by an inverted phase-contrast microscope and von Kossa staining.

2) Animal experimental group

40 male SD rats of 3 months old were randomly divided into four groups, each group was 10: CNPs induced Stone Group (A1, A2, A3 group) and blank control group (group B). Rats in each group were fed with normal rat feed and tap water for 1 week to adapt to the environment. When the rats in group A were given CNPs suspension, the rats in group B were given the same amount of saline as the blank control.

3) Collection of experimental specimens

The rats have collected 6 hours of urine in the metabolic cage at 4 hours, 12 hours, 24h, 1 week, 2 weeks and 8 weeks after CNPs injection (10 rats in group A and all B rats were randomly selected in each period). The urine collected in the test tube was centrifuged at 3000 rpm, then the supernatant was taken and frozen in the refrigerator at - 80 ℃. Rats were killed in batches at 1 week, 2 weeks and 8 weeks after CNPs injection (group A1 was killed in the first week, rats in group A2 were killed in the second week, rats in A3 and B groups were killed at the 8th week), and the kidneys were removed and then opened along the longitudinal axis. Then 10% (volume fraction) neutral formaldehyde solution was used to fix (optical microscope for standby), and air injection was used to kill the rats.

4) Observation index

The kidney tissue was embedded and sectioned by paraffin, then the von Kossa staining and nuclear fixation red staining were observed under a light microscope to determine whether there were brown or dark brown calcium salt crystals in the kidney, so as to determine the realization of the model modeling in rats; After he staining, the crystal formation and pathological changes were observed under the general light microscope. The content of NGAL, OPN and MCP-1 in the urine of rats was determined by ELISA. The relationship between the above factors and crystal formation was compared and analyzed.

5) Von Kossa + Nuclear fixation red re-dyeing

Paraffin-sealed kidney tissue sections were dewaxed with xylene for 10 minutes, then water was added, and then the sections were washed continuously with distilled water for 5 minutes; 2% silver nitrate solution was evenly spread over the sliced surface and incubated under direct irradiation of 60-watt incandescent lamp for 60 minutes (at room temperature); Carefully remove silver nitrate solution on the surface of the sample, rinse the slice with distilled water for 2 minutes; Cover all 5% sodium thiosulfate solution on the slice surface. After 5 minutes in a room temperature environment, carefully remove sodium thiosulfate on the sample surface, and then rinse the slice with distilled water for 2 minutes; The sections were re-stained with 0.1% nuclear solid red dye for 2 minutes, and then the sections were washed with distilled water for 10 seconds; After dehydration and transparent treatment, drop a drop of neutral gum and cover the glass. The renal stones were observed in the experimental group under 400 times ordinary light microscope to determine whether the model of renal stones caused by CNPs was successfully constructed.

Results and discussion

Analysis of Septic Shock after PCNL

General Condition of Patients

The clinical data of 918 patients were divided into quantitative data and qualitative data, and descriptive statistical analysis was performed respectively. The quantitative data included age, preoperative creatinine level, stone size, number of operation channels, operation time, preoperative antibiotic application days. The results are shown in Table 1; Qualitative data included gender, preoperative diabetes history, positive urine culture, preoperative urinary tract infection, degree of hydronephrosis, affected side and stone type. The results are shown in Table 2. Both age and stone size converted to qualitative data are included in Table 2.

Table 1. General information of patients (Quantitative data)

variable	minimum value	Maximum
Age (years)	1	83
Stone size	5	68.2
Number of operation channels	1	4
Operation time (min)	15	150
Preoperative creatinine (μol/L)	18	1194
Days of antibiotic application before the operation	1	17

Table 2. General information of patients (qualitative data)

variable	Classification and assignment	Number of cases
Gender	1:woman	358
	2:man	534
age group	1:≤40 years old	221
	2:40-60 years old	518
	3:≥60 years old	179
Preoperative diabetes history	0 : no	817
Preoperative urinary tract infection	0 : no	812
	1 : yes	106
Stone size	1 : ≤10	89
	2 : 10-20	492
	3 : 20-30	217
	4 : ≥30	120
Degree of hydronephrosis	1 : nothing	148
	2 : light	312
	3 : moderate	294
	4 : severe	164

Treatment Effect and Comparison between Septic Shock Group and Normal Group

There were 9 patients with septic shock after PCNL, accounting for 0.9% of the total number of cases, and 909 normal patients after PCNL, accounting for 99.02% of the total number of cases. In statistical analysis, t test or Mann Whitney U test were used for quantitative data, and no significant factors were found. The qualitative data were analyzed by chi square test or Fisher exact probability method. The indicators with statistical significance were positive urine culture ($P < 0.05$) and preoperative urinary tract infection ($P < 0.05$).

Test of Logistic Regression Model

Hosmer lemeshow method was used to test the goodness of fit of the model. According to the prediction probability of the model, all observation units are divided into ten equal parts, and then the Pearson chi square is calculated according to the measured and theoretical values of each strain variable. See Figure 1 for details.

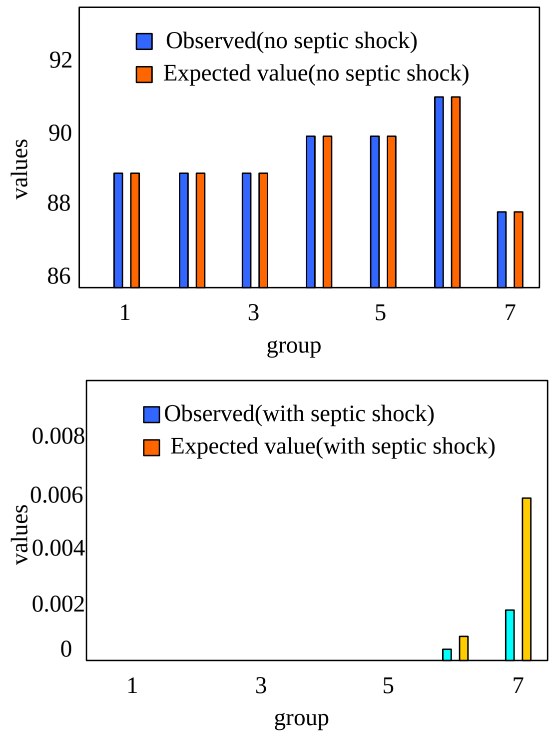

Figure 1. Hosmer lemeshow goodness of fit test contingency chart

According to the data shown in Figure 1, we can calculate the Hosmer lemeshow statistics, and get $P > 0.05$. Because the zero hypothesis is set to fit the data well, we judge the logistic regression model established for this group of data as rejecting the zero hypothesis and pass the test.

Risk Factors of Septic Shock after PCNL

1) Gender

A total of 358 female patients in this study, 5 of them developed septic shock after PCNL, the incidence rate was 1.38%, which was significantly higher than that of male patients (0.56%). However, chi square test showed that there was no significant difference between the two, which may be related to the small sample size. The subsequent increase of sample size may maximize the difference. Combined with the previous domestic and foreign studies and the incidence of septic shock in female patients after PCNL, female is a high risk factor of septic shock after PCNL.

2) Stone size

There was no significant difference in stone size between septic shock group and normal group by Mann Whitney U test ($P = 0.569 > 0.05$). However, by calculating the shock rate (0, 1.25%, 0 and 1.96%) of four groups with different stone diameters (≤ 10 mm, 10-20 mm, 20-30 mm and > 30 mm), we found that the probability of septic shock after PCNL for upper urinary calculi with stone diameter between 20-30 mm and > 30 mm was higher, which indicated that the overall stone size level of septic shock group was larger.

3) Urine culture was positive

In this study, the incidence of septic shock in patients with positive and negative urine cultures after PCNL was 2.8% and 0.5%. Univariate analysis showed that there was a significant difference between the two groups ($P = 0.035 < 0.05$). For patients with positive urine culture, a drug sensitivity test should be performed before operation, and sensitive antibiotics should be used to prevent infection before operation according to the results of bacterial culture, so as to reduce the high shock rate caused by bacterial resistance as far as possible. Therefore, to reduce the risk of septic shock after PCNL, preoperative urine culture, appropriate antibiotic treatment and active antibiotic prevention for patients with negative urine culture are the key preventive measures for septic shock.

4) Preoperative urinary tract infection

In this study, the probability of septic shock was 0.1% in the group without preoperative urinary tract infection and 7.1% in the group with preoperative urinary tract infection. Multivariate logistic regression analysis showed that $P = 0.000 < 0.05$. We should pay enough attention to the patients with urinary tract infections before the operation, but the false appearance that the infection is controlled after the application of antibiotics is easy to confuse people. It may be an effective method to find pathogenic bacteria by multiple urine cultures before operation and appropriately prolong the time of antibiotic application.

Research Results and Analysis of Renal Stone Recurrence Caused by Calcified Nanoparticles

Results of Cnps Culture and Von Kossa Staining

In the sixth week, the medium of the experimental group began to appear with milky white turbidity, and at the eighth week, white floccules could be seen in the medium of the experimental group. Under the ordinary light microscope, CNPs were observed to aggregate into clusters, some of them were adherent growth, a large number of CNPs were floating growth and irregular browning movement. After von Kossa staining, a large number of CNPs were aggregated into clumps, which were brown or dark brown. In the blank control group, there were no obvious white floccules at 8 weeks, and there was no brown mass after von Kossa staining.

Comparison of NGAL Levels in Urine of Rats at Different Time Periods

The comparison of NGAL levels in the urine of rats at different periods is shown in Figure 2.

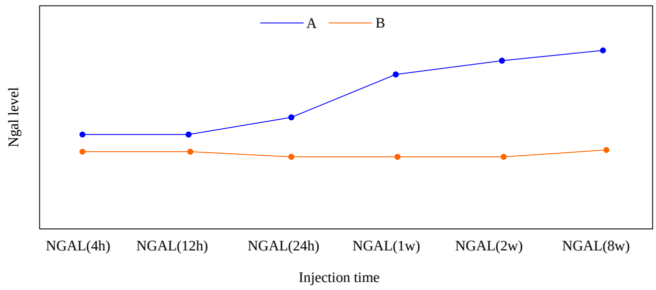

Figure 2. Comparison of NGAL levels in the urine of rats at different periods

The results of one-way ANOVA showed that compared with group B, NGAL level in the group a began to increase significantly at 4 h after injection of CNPs ($P < 0.05$), and NGAL level in group A also increased in different degrees at other periods ($P < 0.05$).

Comparison of OPN Levels in Urine of Rats at Different Time Periods

The specific results of OPN levels in urine of rats at different time periods are shown in Figure 3.

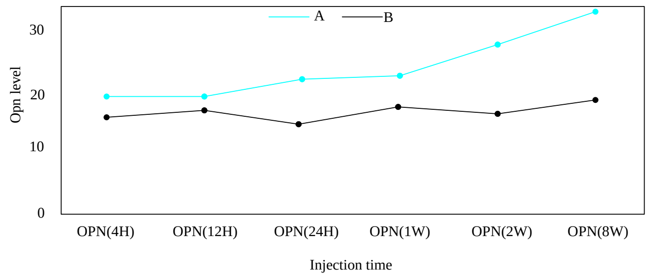

Figure 3. Comparison of OPN levels in the urine of rats at different time periods

Compared with the level of urinary OPN 4 hours after injection, the level of urinary OPN in the group an increased slowly before 2 weeks, while the level of urinary OPN in group B fluctuated up and down, without statistical significance ($P > 0.05$); After 2 weeks, the level of OPN in the group a began to increase significantly and reached the highest level at 8 weeks ($P < 0.05$), while the level of OPN in group B had no statistical significance ($P > 0.05$). In one-way ANOVA, the level of OPN in group A was significantly higher than that in group B from 2 weeks to 8 weeks after injection ($P < 0.05$).

Comparison of MCP-1 Levels in Urine of Rats at Different Time Periods

The comparison of MCP-1 levels in the urine of rats at different periods is shown in Figure 4.

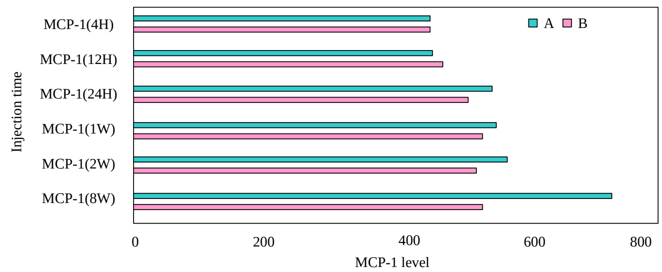

Figure 4. Comparison of MCP-1 levels in the urine of rats at different periods

As can be seen from Figure 4, compared with the rats 4 hours after CNPs injection, the level of MCP-1 in the urine of rats in group A showed a slowly increasing trend 2 weeks ago, while the level of MCP-1 in the urine of rats in group B fluctuated up and down; After 2 weeks, the content of MCP-1 in the group a began to increase significantly and reached the highest level at 8 weeks ($P < 0.05$). The change in urine MCP-1 in group B was still not statistically significant ($P > 0.05$). In one-way ANOVA, the level of MCP-1 in group A was significantly higher than that in group B from 2 weeks to 8 weeks after injection ($P < 0.05$).

The Results of Microscopic Examination of Rat Kidney at Different Time Periods and Their Correlation with the Contents of NGAL, OPN and MCP-1

Two weeks after CNPs infection, calcium crystals began to form in renal tubules, and OPN was involved in this process. CNPs can damage the epithelial cells of the kidney, and with the increase in the degree of damage, the deposition of crystal calcium increases, while the deposition of OPN in urine increases. The expression of MCP-1 in the kidney was stimulated by calcium salt crystal and increased with the increase of crystal content. The amount of calcium salt crystal deposition in renal tubules of group A at different time periods is shown in Table 3.

Table 3. Calcium salt crystal deposition in renal tubules of rats in group A at different time

time	number	Calcium salt crystal deposition in renal tubules				Stone forming rate
		+++	++	+	-	
1 week	10	0	0	0	10	0
2 week	10	0	0	54		50%
8 week	10	0	263			80%

In Table 3, + + + indicates that crystals can be seen in most renal tubules. ++ means that crystals can be seen in about half of the lumen. + means that there are some crystals in individual renal tubules, which are sporadic; - It means that there is no crystal.

Conclusions

With the development of imaging and endoscopic technology and equipment, percutaneous nephrolithotomy has been widely popularized and developed. Patients with renal calculi have a low-risk and high cure rate. However, we should pay more attention to the complications of PCNL as well as its advantages of PCNL. However, while paying attention to the advantages of PCNL, we should also pay more attention to the complications caused by PCNL. CNPs can produce calcium phosphate crystals in the physiological concentration of calcium and phosphorus. After entering the body, CNPs will gather in the kidney, damage renal tubular epithelial cells, promote the retention, adhesion and aggregation of calcium crystals, and then lead to the formation of stones. Therefore, calcified nanoparticles should be used with caution in medical treatment.

Acknowledgments

Not applicable.

Interest conflict

The authors declare that they have no conflict of interest.

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