Int J Clin Exp Med 2018;11(8):8634-8639
www.ijcem.com /ISSN:1940-5901/IJCEM0076273

Original Article

The relationship between determination of RIRS renal pelvis pressure and postoperative fever

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Received March 18, 2018; Accepted April 27, 2018; Epub August 15, 2018; Published August 30, 2018

Abstract: Objective: To explore the clinical significance of ambulatory monitoring of intrapelvic pressure in retrograde intrarenal lithotripsy with holmium laser (RIRS) and adjusting the perfusion pressure by manual irrigation. Methods: A retrospective analysis was made on 189 patients with upper tract urolithiasis undergoing retrograde intrarenal lithotripsy with holmium laser in The First People's Hospital of Yulin from August 2014 to August 2017, including 136 patients with ambulatory monitoring of intrapelvic pressure during the operation (the monitoring group) and 53 patients without monitoring (the control group). According to the intrapelvic pressure, patients in the monitoring group were divided into the high-pressure group (intraoperative renal pelvis pressure ≥ 40 cmH_2O and accumulative time > 1 min) and the low-pressure group, which were 49 cases and 87 cases, respectively. The therapeutic effects of the monitoring group and the control group were compared, and a fever (> 38 C) in 3 days after the operation was observed in each group. Results: The phase I stone-free rate in the monitoring group was 88.97% (121/136), and there was no prominent difference compared with the control group (88.67% (47/53), P = 0.954). No notable difference in mean operative time between the monitoring group and the control group was observed (56.8 ± 8.3 min VS 57.2 ± 5.5 min, P = 0.746). The incidence of fever after the operation in the control group was apparently higher than that in the monitoring group (P = 0.038), and the postoperative fever incidence in the high-pressure group was noticeably higher than that in the low-pressure group (P < 0.001).Conclusion: Ambulatory monitoring of renal pelvis pressure during RIRS and low-pressure perfusion to control intrapelvic pressure have positive significance for postoperative recovery and help to reduce postoperative fever.

Keywords: RIRS, upper tract urolithiasis, intrapelvic pressure, fever

Introduction

Stone is a common disease in the Department of Urinary Surgery, with an incidence up to 4%-10% in the population [1]. At present, minimally invasive treatment has replaced open stone surgery as the first choice for the treatment of urolithiasis. The European Association of Urology recommended in the guidelines for the treatment of renal calculi that extracorporeal shockwave lithotripsy should be the first choice for calculi less than 2 cm, while percutaneous nephrolithotomy is the first choice for those more than 2 cm [2]. However, in recent years, with the continuous developments of endoscopic urologic techniques, retrograde intrarenal surgery (RIRS) are gradually becoming mature and replacing other minimally invasive surgeries due to improved safety, efficiency and more micro-invasion. Furthermore, it has become the preferred treatment among urologists of upper urinary tract lithotomy [3, 4]. As for retrograde intrarenal surgery, lavage endoscopically in renal pelvis is the main method to keep good vision during the operation, but it has disadvantages, such as the relatively closed working environment, fine working channels, relatively narrow drainage pathway of the perfusate, and changes of intrapelvic pressure easily caused by the perfusate during the operation. Higher intrapelvic pressure can lead to a number of complications, such as fever, urine-associated bacteremia, hemorrhage due to rupture of the renal pelvis, and even infectious shock, or death [5]. Therefore, it is vital to monitor and control the changes of renal pelvis pressure in RIRS. In the meantime, the effective low perfusion flow is also a precondition for the low pressure of the renal pelvis [6]. Intraoperative control of perfusion flow is mainly determined by the way of lavage. There are mainly two kinds of lavage, including low-pressure irrigation and

irrigation with infusion pump (through ureter or kidney transdermally). Low-pressure irrigation is now widely adopted in major hospitals. Assistants can better control perfusion flow according to the operation process and the visual field of the operator. Especially when dealing with infectious stones, intermittent manual irrigation is a safe option [7, 8]. However, there are few studies on the pressure of renal pelvis in RIRS at home and abroad. Hence, in this study, 189 patients undergoing retrograde intrarenal surgery were studied, with the hope to provide a better solution for adjuvant treatments of renal calculi.

Materials and methods

General data

This study was approved by the Ethics Committee of The First People's Hospital of Yulin and informed consents were obtained. A total of 189 patients with upper tract urolithiasis undergoing retrograde intrarenal lithotripsy with holmium laser in The First People's Hospital of Yulin from August 2014 to August 2017 were enrolled, including 136 patients that received ambulatory monitoring of intrapelvic pressure during the operation (the monitoring group) and 53 patients without monitoring (the control group). The definition of high-pressure irrigation was that the total time (T) for unilateral renal pelvis pressure was not less than 40 cmH_2O and longer than 1 min during the surgery (1 mmHg = 1.33 cmH_2O). Then patients in the monitoring group were subdivided into the high-pressure group and the low-pressure group [9]. A controlled study was conducted for postoperative fever in the monitoring group and the control group, in the high-pressure group, and the low-pressure group.

All patients underwent preoperative urinary B-scan ultrasonography and non-contrast CT to determine the diameter and location of stones, and degree of hydronephrosis. Piperacillin-tazobactam was used to prevent infection 30 minutes before operation and 24 hours after operation [10].

Inclusion criteria: (1) Patients were diagnosed with nephrolithiasis and in need of surgical treatments. (2) Patients without surgical contraindication were selected. (3) Patients with negative preoperative urine culture were recruited. (4) Patients without preoperative fever were enrolled (body temperature < 38°C). Exclusion criteria: Patients were diagnosed with coagulation disorders, serious cardiopulmonary diseases, severe hypertension, uncorrected diabetes mellitus, morbidly obesity, bilateral calculi, and solitary kidney.

Treatments

Retrograde intrarenal lithotripsy with holmium laser: The operation was performed according to the literature [11]. After general anesthesia, the lithotomy position was taken. The affected ureter was examined by a rigid ureteroscope. If there was a Double-J stent staying in place, it should be removed. The renal pelvis was reached by ureteroscope; after the ureteral lesion was excluded, the zebra guidewire was placed and the ureteroscope was drawn out slowly. Subsequently, the 14/16F COOK ureter sheath (Cook, USA) was gently placed along the zebra guidewire and the renal pelvis was reached by a Storz electronic flexible ureteroscope (STORZ, Germany) through ureter sheath. Calculi were found and lithotripsy was performed with holmium laser (Lumenis, USA) after 200 μm optical fiber was placed. The diameter of stones of less than 2 mm was favorable. In the operation, one end of the blood transfusion device was connected with the perfusion junction of flexible ureteroscope, and the other end was connected with the 50 mL syringe. Manual injections of saline by assistants could ensure the clarity of the operation field. A new plain film of the urinary tract and CT were performed one day after surgery and three months after surgery respectively. If there were no retained stones or the diameter of retained stones was no more than 2 mm without clinical symptoms, it was defined as a phase I stone-free success. A Double-J stent (7F) stayed in place conventionally for 1 month [12, 13]. Nineteen patients were unable to be operated on due to ureter orifice stenosis. A Double-J stent was retained on the affected side for two weeks and then a surgery would be performed.

Monitoring of intraoperative intrapelvic pressure: The operation was performed according to the literature [14]. The renal pelvis was reached by the 2F manometry tube with ureter sheath and the lumen was filled with normal saline. A German ANDROMEDA urodynamic instrument was connected with manometry tube and an adjustment to zero was achieved at kid-

Table 1. General data

Variables	Monitoring group	Control group	T/X^2	*P* value
Number of cases	136	53		
Gender			0.074	0.786
Male	74	30		
Female	62	23		
Age (years)	51.43 ± 1.56	51.88 ± 0.96	1.959	0.052
Mean stone diameter (mm)	18.71 ± 2.29	18.54 ± 1.78	0.486	0.628
Stone location			0.061	0.805
Left kidney	64	26		
Right kidney	72	27		

Table 2. Comparison of efficacy in two groups

Variables	Monitoring group	Control group	T/X^2	*P* value
First-trimester stone-free rate	88.97%	88.68%	0.003	0.954
Mean operation time	56.8 ± 8.3	57.2 ± 5.5	0.324	0.746

ney level. If the patient underwent micro-nephrostomy before surgery, the fistula would be directly connected in order to measure pressure (The nephrostomy tube in The First People's Hospital of Yulin was SPECATH CF-B 18GaX20 cm disposable central venous catheter, and the diameter of the tube was the same as that of the 2F manometry tube). Retrograde intrarenal lithotripsy with holmium laser was performed after the urodynamic instrument was adjusted to zero. The intraoperative pressure of the renal pelvis could be obtained directly from the urodynamic instrument. The basal value and maximum value of renal pelvic pressure were recorded (IPP0 and IPPmax).

Statistical analysis

All statistical analyses was performed with SPSS18.0 software. Measurement data are expressed as mean ± standard deviation (mean ± SD) and the Student's t-test was used for comparisons between two groups; while quantitative data were expressed in terms of rate and Chi-square test was adopted for comparisons among groups. The statistical significance level was 0.05 for bilateral alpha.

Results

General data

There were 74 males and 62 females in the monitoring group, with an average age of (51.43 ± 1.56) years and an average stone diameter of (18.71 ± 2.29) mm. There were 64 cases of left kidney calculi, 72 cases of right kidney calculi, which all located in the renal calices. There were 30 males and 23 females in the control group, with an average age of (51.88 ± 0.96) years and an average stone diameter of (18.54 ± 1.78) mm. There were 26 cases of left kidney calculi, 27 cases of right kidney calculi, which all located in the renal calices. There was no apparent differences in gender, age, mean stone diameter, and stone location between the two groups (all P > 0.05). See **Table 1**.

Efficacy

The phase I stone-free rate in the monitoring group was 88.97% (121/136), while that in the control group was 88.68% (47/53), without noticeable differences (P = 0.954). Of the remaining patients, 18 of them underwent a second retrograde intrarenal lithotripsy without any retained stones and 3 received conservative treatments due to retained stones of 3 mm in diameter. No major surgery-related complications such as ureter rupture occurred in both groups. There was no outstanding difference in the operation time between the monitoring group and the control group (56.8 ± 8.3 min VS 57.2 ± 5.5 min, P = 0.746). In the monitoring group, intraoperative IPP0 was 20.6 ± 12.8 cmH_2O and IPPmax was 23.2 ± 9.1 cmH_2O. See **Table 2**.

Postoperative fever

The incidence of postoperative fever in the monitoring group was 9.56%, and that in the control group was 20.75%. The difference was statistically significant (P = 0.038). In the monitoring group, the fever incidence in the high-pressure group was 22.45% and that in the low-pressure group was 2.30%. The difference was statistically significant (P < 0.001). See **Tables 3**, **4**.

Table 3. Comparison of postoperative fever in the monitoring group and the control group

Items	Number of cases (n)	The number of postoperative fever			Total incidence of fever (%)
		Day 1	Day 2	Day 3	
Monitoring group	136	4	6	3	9.56%
Control group	53	5	3	3	20.75%
X^2					4.312
P value					0.038

Table 4. Comparison of postoperative fever in the high-pressure group and the low-pressure group

Items	Number of cases (n)	The number of postoperative fever			Total incidence of fever (%)
		Day 1	Day 2	Day 3	
High-pressure group	49	3	5	3	22.45%
Low-pressure group	87	1	1	0	2.30%
X^2					14.72
P value					< 0.001

Discussion

Currently, retrograde intrarenal lithotripsy with holmium laser, which is popular, is one of the best options for the treatment of renal calculi because of its minimal invasion, better stone fragmentation, safety and effectiveness [3, 4]. In the relatively closed working environment, because of fine working channels and continuous perfusions during the operation, flexible ureteroscope can easily lead to excessive renal pelvis pressure and the perfusate back into the vein, resulting in a series of serious complications, such as urinary septicemia or even septic shock [5]. Hence, intraoperative detection and control of renal pelvic pressure are of great importance.

In this study, patients were assigned into the monitoring group and the control group, and intraoperative perfusion was performed by manual low-pressure irrigation. In the monitoring group, the renal pelvis pressure was ambulatory monitored during the operation. The real-time change of renal pelvis pressure and the accumulative time were recorded and the perfusion pressure was controlled. The same instruments and procedures were adopted during the operation of the control group, but the intraoperative pressure of the renal pelvis was not monitored. The results of the experiment showed that the fever incidence in the control group was prominently higher than that in the monitoring group. We believe that this may be due to the ambulatory monitoring of renal pelvis pressure during RIRS and manual perfusion control of intrapelvic pressure, which has a positive effect on postoperative recovery and reduces postoperative fever and infection. Theoretically, a notable increase in intraoperative pressure of the renal pelvis can cause a series of postoperative complications [15, 16]. Intrarenal pressure is associated with the reflux of the perfusate, which brings bacteria and toxins into blood circulation, leading to an increased incidence of postoperative infectious complications [17]. *In vitro* studies have shown that renal pelvis pressure of greater than 46.55 cmH_2O can cause persistent reflux of the renal pelvic veins and lymphatic vessels, and pressure of 20-24 cmH_2O can cause reflux in the presence of infection [18]. Jung et al. considered that the critical value of intrapelvic venous reflux in RIRS was 40 cmH_2O [19]. Zhong et al. monitored intrarenal pressure in percutaneous nephrolithotomy and concluded that the pressure of renal perfusion of greater than 40 cmH_2O was related to the postoperative fever [20]. In this study, we defined that the renal pelvis pressure ≥ 40 cmH_2O and accumulative time > 1 min were the high-pressure group and the remainder were the low-pressure group. The incidence of fever in the high-pressure group was higher than that in the low-pressure group ($P < 0.001$). It showed that an increase of postoperative fever incidence would present if the renal pressure was greater than 40 cmH_2O for more than 1 minute. In the study of flexible ureteroscopic lithotripsy, Yang et al. also illustrated the relationship between renal

pressure and the risk of postoperative fever, which is consistent with our conclusion [14].

Common causes of fever after operation are preoperative infections, long operation time, and increased absorption of the perfusate resulting from high-pressure perfusion during the operation [21, 22]. Postoperative fever not only increases the hospital stay and hospitalization costs, but also may cause septic shock or even death in severe cases [23]. Related studies have demonstrated that although we strictly adhere to the aseptic technique and preoperative application of antibiotics to prevent infections in the course of surgery, we cannot completely and effectively inactivate pathogenic bacteria in infectious stones. Besides the bacteria itself, the endotoxin produced by the bacteria remains partially in the stone. Therefore, some patients still have systemic infections after surgery, or severe complications such as systemic inflammatory response syndrome (SIRS) and sepsis [24]. Furthermore, even under the control of perfusion flow, the chances of the toxin into blood will increase if the operation time is too long. At the same time, if the stone is too large and the lithotripsy time is too long, to maintain clarity of the surgical field, extra perfusate will be injected by the assistant. The more extra perfusate injected, the greater changes of renal pelvis pressure, which will increase the risk of infection as well. Chen et al. concluded that surgery for more than 192 minutes was more likely to develop severe bacteremia, consistent with our conclusion [25].

Several limitations about our study should be addressed, such as insufficient sample size, inadequate observation indexes, and a retrospective study. A larger sample size and more observation indexes will be warranted in the future study. To further verify our conclusions, a prospective and more in-depth study will be carried out.

Collectively, ambulatory monitoring of the intrapelvic pressure should be carried out in retrograde intrarenal lithotripsy and the pressure of the renal pelvis is controlled by manual low-pressure irrigation. This treatment has a positive effect on postoperative recovery and can reduce the incidence of postoperative fever and even severe infection.

Disclosure of conflict of interest

None.

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