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ORIGINAL ARTICLE

Comparison of renal pelvic pressure and postoperative fever incidence between standard- and mini-tract percutaneous nephrolithotomy

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Abstract This study was proposed to compare the clinical effectiveness of mini-tract percutaneous nephrolithotomy (MPCNL) with standard-tract percutaneous nephrolithotomy (SPCNL) and verify whether MPCNL is associated with both higher renal pelvic pressure (RPP) and incidence of postoperative fever. A total of 228 patients with kidney stone were randomly allocated to the MPCNL group ($n = 114$) and SPCNL group ($n = 114$). Both intraoperative and postoperative indexes along with the incidence of complications were compared between the two treatment groups. RPP was measured using a baroreceptor which was connected to an open-ended ureteric catheter during the operation of percutaneous nephrolithotomy. The MPCNL group exhibited significantly longer average operation time, more average amount of flush water, and lesser average amount of bleeding during the operation than the SPCNL group ($p < 0.05$). Moreover, significantly lesser average amount of postoperative serum creatinine, shorter average hospital stay, and more average amount of postoperative hemoglobin were observed in the MPCNL group than in the SPCNL group ($p < 0.05$). MPCNL were more applicable to clear caliceal stones ($p < 0.05$), whereas SPCNL were more effective for the removal of simple pelvic stones. The difference in the incidence of postoperative fever between the two treatment groups also appeared to be significant ($p < 0.05$). Logistic regression provided

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solid evidence that both RPP and its accumulation time at which RPP $\geq$ 30 mmHg significantly affected the incidence of postoperative fever. MPCNL was correlated with both higher RPP and increased likelihood of postoperative fever compared with SPCNL.

Introduction

Kidney stone is one of the most severe disease occurring in the urinary system, and its incidence is steadily rising; 10.6% of men and 7.1% of women in the United States are affected by kidney stones according to the National Health and Nutrition Examination Surgery [1]. In addition, this disease is usually observed with an unfavorable recurrence rate, for instance, about 50% of patients encounter recurrence within 5 years [1]. Several risk factors have been verified for the induction of kidney stone, including hyperoxaluria, hypercalciuria, hyperuricosuria, hypocitraturia, undue urinary acidity, cystinuria, and low urine volume [2]. Furthermore, kidney stone may be accompanied by disorders, including full-blown renal colic and dysuria and urinary tract blockage and infection, which may finally result in renal failure [3].

The currently available diagnosis of nephrolithiasis generally indicates abnormality in uric elements; therefore, treatment strategies are mainly concentrated to target uric calcium, uric sodium, and uric acid [2]. To be specific, extracorporeal shock wave lithotripsy has been developed to disintegrate kidney stones by applying shock waves in the upper urinary tract and kidney, yet it is limited by the relatively low cure rate of kidney stone [2]. Instead, other interventions with minimum invasiveness, such as percutaneous nephrolithotomy (PCNL), have been widely accepted as the preferred first-line treatment for patients with kidney stone, especially for those with large and complicated renal calculi [4]. In particular, standard-tract PCNL (SPCNL) and mini-tract PCNL (MPCNL) therein are safe and efficacious approaches for the elimination of kidney stones [5]. For one thing, SPCNL is usually dilated up to 24—26F with larger channel and lower perfusion pressure, yet blood loss and blood vessel rupture are two common adverse effects. For another, MPCNL with smaller service aisle between 16 and 18F may overcome the above limitations and reduce damage to kidney at the cost of extended operation time [6].

Accumulating evidence has shown that intrapelvic pressure, which is remarkably increased during the operation of PCNL, is closely related to the irrigation pressure and the location of kidney stones [7]. Systemic absorption of irrigation fluid, which may contain bacteria or endotoxins caused by high renal pelvic pressure (RPP), may lead to postoperative fever [8]. Although technological improvement and increase in surgical practices have reduced the risk of complications, such as bleeding, fever, infection, and kidney loss [9], PCNL operation factors including tract size, tract number, operation time, and tract dilation approach may still influence the incidence of postoperative complications [9].

To the best of our knowledge, there are only few researches that are able to clarify how surgical treatment conditions for managing kidney stones are related to the incidence of postoperative complications. Therefore, this study attempted to unveil such an association by comparing the status of RPP and postoperative complications between SPCNL and MPCNL.

Materials and methods

Subjects

This retrospective study included 228 adult patients who underwent PCNL in DongTai People's Hospital, Dongtai Affiliated Hospital of Nantong University from March 2014 to July 2015. These 228 patients were randomly allocated to the MPCNL group ($n = 114$) and SPCNL group ($n = 114$). PCNL operations were performed by surgeons who had at least an experience of 5 years. All the patients were diagnosed with plain film X-rays, computed tomography, or intravenous pyelogram. The patients were excluded if: (1) they were $<$ 18 years old; (2) they underwent a surgery on the ipsilateral kidney; (3) they had nephrostomy tube placed on the ipsilateral kidney before the surgery. Moreover, patients were diagnosed with sepsis if they suffered from life-threatening organ dysfunctions caused by abnormal host responses to infections [10]. Specifically, the systemic inflammatory response syndrome was confirmed if at least two of the following conditions were present: (1) body temperature $>$ 38°C or $<$ 36°C; (2) heart rate $>$ 90 beats/min; (3) respiratory rate $>$ 20 times/min or $PaCO_2 < 32$ mmHg (4.3 kPa); (4) white blood cell (WBC) count $>$ 12000/mm^3 or $<$ 4000/mm^3, or neocyte (i.e. neutrophilic stab granulocyte) $>$10% [11]. The experimental procedures were approved by the ethics committee of the DongTai People's Hospital, Dongtai Affiliated Hospital of Nantong University. All the patients and their relatives provided signed informed consents prior to the trial.

PCNL operation procedure

The operation was initiated when patients were under general anesthesia. A 6-Fr external ureteral catheter (Boston Scientific Corporation, Miami, FL) was retrogradely placed into the pelvicalyceal system. Next, patients were placed in the prone position and areas under pressure were protected by pads. The appropriate calyx for puncture was selected using an 18G coaxial needle (Cook Inc., USA), which was guided by a 5-multicolor ultrasound instrument (Hitachi-Aloka Medical, Japan) based on the anatomy of the

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