Percutaneous Nephrolithotomy vs Open Pyelolithotomy for Renal Pelvis Calculi

Chaiyong Nualyong, M.D.*
Tawatchai Taweemonkongsap, M.D.*
Sunai Leewansangtong, M.D.*
Suchai Soontrapa, M.D.*

Abstract : Objective: To compare the stone free rate and morbidity of percutaneous nephrolithotomy (PCNL) and open pyelolithotomy for a single renal pelvis stone. Patients and methods: A retrospective study was performed by reviewing case records of patients who underwent stone removal surgery between August 1994 and March 1999. The inclusion criteria was a single renal pelvis stone which was not smaller than 3 cm^2 in surface area. Patients in the open pyelolithotomy group who had concurrent nephrotomies were excluded. There were a total of 46 patients of which 25 had undergone PCNL and 21 had undergone pyelolithotomy. Both groups were compared in terms of age, sex, stone surface area, haematocrit, blood urea nitrogen, serum creatinine, operative time, complications, stone free rate, adjunctive procedures, doses of postoperative analgesic injection, length of hospital stay, and time to return to normal work. Statistical analysis was performed by Chi-square test and t-test. Results: Preoperative status of the two groups were similar. The operative time was comparable between the two groups. The stone free rate of the PCNL group and the pyelolithotomy group were 92% and 95% respectively which was not statistically different. Five patients in the PCNL group needed ancillary procedures while only one patient in pyelolithotomy group did. Overall complications of the PCNL group and the pyelolithotomy group were 28.6% and 28% respectively which were comparable. Severe bleeding due to arterio-venous fistula occurred in 2 patients of the PCNL group. However, the complication could be managed successfully by selective embolisation. Disruption of uretero-pelvic junction occurred in one patient of the pyelolithotomy group and was repaired

*Department of Surgery, Faculty of Medicine Siriraj Hospital, Mahidol University, Bangkok 10700, Thailand.

successfully. The number of doses of postoperative pethidine injection to lessen pain was lower in the PCNL group when compared with the pyelolithotomy group (mean 0.96 dose vs 1.95 doses, p<0.003). Length of hospital stay was comparable between the two groups. Time to return to normal work was shorter in the PCNL group when compared with the pyelolithotomy group (mean 13.7 days vs 36.3 days, p<0.001). Conclusions: PCNL is a safe and effective method to treat renal pelvis stones compared to open pyelolithotomy and offers less postoperative discomfort and shorter recovery period.

เรื่องย่อ : **การเปรียบเทียบการผ่าตัด Percutaneous Nephrolithotomy และ Open Pyelolithotomy ในนิ่วในกรวยไต**

ไชยยงค์ นวลยง พ.บ.,* ธวัชชัย ทวีมั่นคงทรัพย์ พ.บ.,* สุนัย ลีวันแสงทอง พ.บ.,* สุชาย สุนทราภา พ.บ.*

*ภาควิชาศัลยศาสตร์ , คณะแพทยศาสตร์ศิริราชพยาบาล , มหาวิทยาลัยมหิดล, กรุงเทพมหานคร 10700

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วัตถุประสงค์ : เพื่อเปรียบเทียบผลการรักษาและข้อแทรกซ้อนระหว่างการผ่าตัด percutaneous nephrolithotomy กัน open pyelolithotomy สำหรับนิ่วในกรวยไต

ผู้ป่วยและวิธีการ : เป็นการศึกษาย้อนหลังโดยการค้นเอกสารผู้ป่วยที่ได้รับการผ่าตัดรักษานิ่วในระหว่างเดือนสิงหาคม พ.ศ. 2537 จนถึงเดือนมีนาคม พ.ศ. 2542 โดยศึกษาในผู้ป่วยนิ่วก้อนเดียวในกรวยไตที่มีขนาดพื้นที่ผิวไม่น้อยกว่า 3 ตารางเซนติเมตร ผู้ป่วยในกลุ่ม open pyelolithotomy ที่มีการผ่าตัดผ่านเนื้อไตร่วมด้วยจะถูกคัดออก ในการศึกษาครั้งนี้มีผู้ป่วยจำนวนทั้งสิ้น 46 ราย โดย 25 ราย ได้รับการผ่าตัด percutaneous nephrolithotomy และ 21 รายได้รับการผ่าตัด open pyelolithotomy ทั้งสองกลุ่มได้รับการเปรียบเทียบในเรื่องของ อายุ เพศ ขนาดพื้นที่ผิวของนิ่ว อีมาโตคริต ยูเรียในโตรเจนในเลือด ซีรั่มครีอะตินิน ระยะเวลาในการผ่าตัด ภาวะแทรกซ้อนหลังผ่าตัด อัตราความสำเร็จของการผ่าตัด การผ่าตัดเสริม จำนวนครั้งของการฉีดยาระงับปวดหลังการผ่าตัด ระยะเวลาในการอยู่โรงพยาบาล และระยะเวลาการฟื้นตัวหลังผ่าตัด การคำนวณทางสถิติใช้ Chi-square test และ t - test

ผลการศึกษา : สภาวะก่อนผ่าตัดของผู้ป่วยทั้งสองกลุ่มไม่แตกต่างกัน ระยะเวลาในการผ่าตัดของทั้งสองกลุ่มไม่แตกต่างกัน ความสำเร็จในการผ่าตัดของกลุ่ม percutaneous nephrolithotomy และ open pyelolithotomy เท่ากับ ร้อยละ 92 และ 95 ตามลำดับ ซึ่งไม่มีความแตกต่างทางสถิติ ผู้ป่วย 5 รายในกลุ่ม percutaneous nephrolithotomy และผู้ป่วย 1 รายในกลุ่ม open pyelolithotomy จำเป็นต้องได้รับการผ่าตัดเสริม ภาวะแทรกซ้อนโดยรวมของกลุ่ม percutaneous nephrolithotomy และกลุ่ม open pyelolithotomy เท่ากับร้อยละ 28.6 และ 28 ตามลำดับ มีภาวะแทรกซ้อนเลือดออกรุนแรงจาก arterio-venous fistula เกิดกับผู้ป่วย 2 รายในกลุ่ม percutaneous nephrolithotomy ซึ่งแก้ไขได้สำเร็จด้วยการทำ embolisation มีภาวะแทรกซ้อนคือการขาดของ uretero-pelvic junction เกิดขึ้นกับผู้ป่วย 1 รายในกลุ่ม open pyelolithotomy แต่ได้รับการซ่อมแซมได้สำเร็จเช่นกัน จำนวนครั้งของการฉีดยาระงับปวดหลังผ่าตัดในกลุ่ม percutaneous nephrolithotomy น้อยกว่าในกลุ่ม open pyelolithotomy (ค่าเฉลี่ย

0.96 ครั้ง 1.95 ครั้ง, $p < 0.003$) ระยะเวลาในการอยู่โรงพยาบาลของทั้ง 2 กลุ่มไม่แตกต่างกัน ระยะเวลาการฟื้นตัวในกลุ่ม percutaneous nephrolithotomy สั้นกว่าในกลุ่ม open pyelolithotomy (ค่าเฉลี่ย 13.7 วัน เทียบกับ 36.3 วัน, $p < 0.001$)

สรุป : การผ่าตัด percutaneous nephrolithotomy เป็นวิธีที่ปลอดภัยและมีประสิทธิภาพสำหรับการรักษานิ่วในกรวยไตเมื่อเปรียบเทียบกับการผ่าตัด open pyelolithotomy แต่มีความเจ็บปวดหลังผ่าตัดน้อยกว่าและระยะเวลาในการฟื้นตัวสั้นกว่า

INTRODUCTION

Treatments for renal stones comprise extracorporeal shock-wave lithotripsy (ESWL), percutaneous nephrolithotomy (PCNL), and open surgery. Although ESWL is the least invasive form of treatment, it offers the lowest result in terms of stone free rate of the three methods, especially when applied to a stone larger than 3 cm. in diameter[1]. PCNL was introduced to treat renal calculi by Fernstrom and Johansson in1976,[2] and has become the preferred treatment over conventional open surgery because of reduced postoperative discomfort and a quicker convalescence for the patient.[3,4] However, PCNL might not be able to clear some large stones in one session and may lead to adjunctive procedures such as ureteroscopic manipulation for the steinstrasse, and/or double J stent insertion. In contrast, open surgery, though more invasive than PCNL, can be used to clear the stone completely in one setting especially if there is only a single stone no matter how big it is. In addition, although PCNL is a minimally invasive technique, it needs renal puncture and tract dilation which can cause renal parenchymal injury. Although there have been reports comparing PCNL with open stone surgery,[5,6] none is for the single renal pelvis stone which can actually be removed via a pyelotomy without the need to do nephrotomies which can lead to renal parenchymal injury. Herein the two treatments for single renal pelvis calculus, PCNL and open pyelolithotomy, were compared.

MATERIALS AND MATHODS

Case records of 46 patients who had undergone either PCNL or pyelolithotomy for single renal pelvis calculus between August 1994 and March 1999 were evaluated. Staghorn and calyceal stones, multiple renal stones, and stones with surface area less than 3 cm^2 were excluded. In addition, cases with concurrent nephrotomies in the pyelolithotomy group were also excluded. Of these 46 patients, 25 had PCNL and 21 had pyelolithotomy. All patients were evaluated according to age, sex, stone surface area, haematocrit (Hct), blood urea nitrogen (BUN), serum creatinine (Cr), operative time, operative complications, stone free rate, adjunctive procedures, doses of postoperative analgesics, length of hospital stay, and time to return to normal work. Stone surface area measurement was followed as described by Lam[7]. Cumulative operative times were the sum of each procedure if there were repeated sessions such as second or third PCNL. The time was limited to the actual procedure only and did not include periods of induction and rever-

sal of anesthesia . Stone free rate was defined as no stone or stone size less than 2 mm detected by radiographic study (usually plain KUB). Adjunctive procedures were any of the following procedures: percutaneous nephrostomy, ureteroscopy, double J stent insertion, and ESWL, which were needed apart from PCNL and pyelolithotomy. Postoperative analgesics were assessed as the number of doses of either pethidine or morphine (50 mg of pethidine was equivalent to 5 mg of morphine) injection required postoperatively to lessen pain. The period starting from the first postoperative day (counting from the first operation if there were more than one) until discharge was defined as length of hospital stay. Time to return to normal work was defined as the period of time starting from the first postoperative day till the day patients were able to do things normally in daily life. These were obtained by reviewing the case records for the PCNL group and by letter questionnares for the pyelolithotomy group.

The technique of PCNL used here was as follows[8]. All procedures were done under general anesthesia. Firstly, the patient was placed in the lithotomy position and a ureteric catheter was inserted in order to opacify the collecting system during the time of renal access and to prevent distal migration of fragments at the time of stone disintegration. Next, the patient was turned to a prone position with the side to be punctured slightly rotated upward 30 degrees. Renal access was done under C-arm fluoroscopy. A guide wire was introduced into the collecting system after successful puncture and the tract was dilated up to 30 Fr. mostly with a fascial dilator(Cook Urological) except in the case of previous renal surgery where telescopic metal dilators were required to dilate the hard scar. Amplatz sheath was used in all cases and stones were disintegrated with an ultrasonic or lithoclast lithotriptor. Nephrostomy tube no. 24-28 Fr. was inserted at the end of the procedure. Postoperative plain KUB was done to detect any residual stones in the collecting system or ureter before removing the nephrostomy tube. Residual stones, if present, were managed by either conservative treatment or ESWL.

The operative technique of pyelolithotomy was that of conventional open stone surgery through flank incision described by Woodruff[9]

Difference between the two groups was determined by using Chi-square test or Student's t-test where appropriate. The result was considered significant when p value was less than or equal to 0.05.

RESULTS

The important preoperative characteristics of the two groups are shown in Table 1. All parameters of the two groups were comparable except for one patient with a solitary kidney and four patients with previous ipsilateral stone operations which were found in the PCNL group.

Operative results are shown in Table 2. Four patients in the PCNL group needed 2 sessions to complete the procedure while the rest of the group underwent one session. The pyelolithotomy group required one operation in all cases. The mean operating time between the two groups was not statistically different. The stone free rates in the PCNL group and the pyelolithotomy group were 92% and 95% respectively which were not statistically different. However, there were 5 patients in the PCNL

Table 1 Preoperative data of PCNL group and pyelolithotomy group

	PCNL	Pyelolithotomy	P value
No. of patient	25	21	
Age in years (mean±SD)	44±11.8	41±16.5	0.478
Sex			
male (%)	18 (72)	15 (29)	1.0
female (%)	7 (28)	6 (71)	
Haematocrit (%)	39±4.2	37±6.1	0.394
Blood urea nitrogen (mg/dl)	14±3.7	17±11.4	0.235
Serum creatinine (mg/dl)	1.2±0.3	1.4±1	0.292
Stone surface area (cm^2)	4.04±1.5	4.3±1.1	0.549
Solitary kidney (%)	1 (4)	0	
Previous ipsilateral open stone surgery (%)	4 (16)	0	

group who needed ancillary procedures whereas only one patient in the pyelolithotomy group did. To alleviate obstruction from residual fragments in the ureters after PCNL, a double J stent insertion was required in 2 patients, and ureteroscopy was performed in one patient. Furthermore, 2 patients with residual stones (size 1 cm^2) after PCNL subsequently needed ESWL. One patient in the pyelolithotomy group had bleeding and urine leakage complications and needed a double J stent insertion to solve the problems. Of the pyelolithotomy group, one had a residual stone off less than 5 mm in size which was treated conservatively.

Complications of the two groups were not statistically different as shown in Table 2. Bleeding which required blood transfusions occurred in 5 patients in the PCNL group and in one patient in the pyelolithotomy group . Arterio-venous fistula occurred in 2 patients with PCNL but were managed successfully by selective embolisation. Uretero-pelvic junction disruption occurred in one case of the pyelolithotomy group whose renal pelvis was the intrarenal type. This was repaired and a double J stent was retained for 4 weeks with satisfactory result.

The number of doses of pethidine injection required postoperatively in the PCNL group were less when compared to the pyelolithotomy group and this was statistically different (mean 0.96 dose vs 1.95 does, $p<0.003$). The lengths of hospital stay were similar in the two groups. Postoperative recovery period of the PCNL group was shorter than that

Table 2 Intraoperative and postoperative results

	PCNL	Pyelolithotomy	P value
No. of patients	25	21	
Operating time (min)	142±54.8	128±37.7	0.343
Stone free rate (%)	23 (92)	20 (95)	1.0
Ancillary procedure, no. (%)	5 (20)	1 (4.8)	0.198
double J stent insertion	2 (8)	1 (4.8)	
ureteroscopy	1 (4)	0	
ESWL	2 (8)	0	
Complications, no. (%)	7 (28)	6 (28.6)	1.0
bleeding	5 (20)	1 (4.8)	
arterio-venous fistula	2 (8)	0	
perforation	1 (4)	0	
obstruction	3 (12)	1 (4.8)	
prolonged urine leakage	1 (4)	1 (4.8)	
fever	1 (4)	4 (19)	
wound infection	0	1 (4.8)	
uretero-pelvic disruption	0	1 (4.8)	
Postoperative pethidine injection (no. of doses)	0.96±1.01	1.95±1.16	0.003
Hospital stay (days)	8.4±4.2	8.7±5.4	0.802
Recovery period (days)	13.7±4.3 (n=22)	36.3±15.1 (n=14)	<0.001

of the pyelolithotomy group and the difference was statistically significant (mean 13.7 days vs 36.3 days, $p<0.001$).

DISCUSSION

The stone free rate of percutaneous nephrolithotomy in this study was 92 % which was comparable to many reports.[10,11,12] Furthermore, when the PCNL group was compared to the pyelolithotomy group with similar preoperative status, both groups still showed a comparable stone free rate. The percutaneous stone surgery is theoretically more technically demanding compared with open pyelolithotomy and may need longer operative time to perform. Furthermore, PCNL may not be able to

clear a single renal pelvic stone, if large, in one session and this will lead to ancillary procedures to eliminate residual stones. Therefore many urologists who are not acquainted with PCNL prefer to manage a single renal pelvic stone by one session of open pyelolithotomy which is more comfortable than PCNL. However, PCNL can be performed within the same length of operative time as open pyelolithotomy once the learning curve has been passed. PCNL has been performed over five years in our Unit and the technique has already been refined. Hence it required the same length of procedure time as did open pyelolithotomy in this study. In addition, although ancillary procedures following PCNL were required in five patients, two of these were only double J stent insertions under local anesthesia to alleviate ureteral obstruction caused by stone fragments. ESWL and ureteroscopy were required in two patients with residual stones, and in one patient with ureteral obstruction caused by stone fragments. It was noted that ureteroscopy required only regional anesthesia to perform. All these ancillary procedures were acceptable and tolerable to patients if the success rate was high and morbidity was low as achieved by PCNL in this study. Complications are worrisome in percutaneous stone surgery especially bleeding which can occur during renal puncture and tract dilation and might make the urologist reluctant to perform PCNL. Furthermore, open pyelolithotomy can be done without the need to enter renal parenchyma, and therefore the risk of bleeding is reduced. In this study, bleeding complications occurred more in the PCNL group compared with open pyelolithotomy (20% vs 4.8%), and two of these were caused by arterio-venous fistula which was considered to be serious. These were high compared to other reports.[13,14] However it was also noted that this serious complication as occurred in the early period of this study series which might reflect the inexperience of the operator at the beginning.

There is much discussion about renal damage after PCNL resulting from tract puncture and tract dilation when compared with open pyelolithotomy which needs no renal parenchymal dissection at all. Although we did not compare preoperative and postoperative renal function in this study, the renal effects of PCNL have already been well documented in the literature.[15,16,17] There are certainly some scars at the nephrostomy site, but ^{99m}DTPA and ^{99m}DMSA scintigraphy have proven that no loss of functioning renal parenchyma occurs with these scars.

Postoperative hospital stays were not statistically different between the PCNL group and the pyelolithotomy group although four patients in the PCNL group underwent two sessions of procedures. It seemed to be clear in this study that patients of the PCNL group had advantages over those of the pyelolithotomy group in terms of postoperative pain and recovery periods. In addition to more discomfort and longer recovery period, many patients who had open pyelolithotomy usually suffered from niggling pain and occasional lumbocele caused by wound herniation.

In conclusion, percutaneous nephrolithotomy is a safe and effective method of removing a single stone in renal pelvis and offers less postoperative discomfort and shorter recovery period as compared with open pyelolithotomy.

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