5 Year Outcome Comparing between Lower Pole and Non-Lower Pole Approach Percutaneous Nephrolithotripsy

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Abstract

Objectives: Percutaneous Nephrolithotomy (PCNL) is considered to be the principal treatment for large kidney stones. Nephrolithotripsy approaches—namely the Lower Pole Approach and the Non-Lower Pole Approach—are widely referred to and utilized today. Currently, there is no consensus as to which approach yields the best treatment outcome or results in lowest level of complication. This study reports both treatment outcome and complications from information acquired from patients, with all sizes of kidney stones, who received PCNL treatment under both techniques at Vajira Hospital.

Methods: According to the information collected in the past 5 years, there were 72 patients who had been treated with PCNL. The information was collected in terms of stone sizes, treatment techniques, and methods. In order to compare the treatment outcome between the Lower Pole Approach and Non-Lower Pole Approach, operative time and information gathered during follow-up sessions, including complications and hospital length of stay were analyzed.

Results: According to the results, 37 out of 72 patients (51.4%) underwent the Lower Pole Approach, and 35 out of 72 patients (48.6%) underwent the Non-Lower Pole Approach. The results revealed that the stone-free rate in the Lower Pole Approach group was indifferent to that in the Non-Lower Pole Approach group (56.8% vs. 54.3% respectively, level of confidence p=0.776), and so was the average operative time in minutes (151.62±40.43 in the Lower Pole Approach group vs. 148.00±60.34 in the Non-Lower Pole Approach group, p=0.765). There were more but milder complications in the Lower Pole Approach group compared to the Non-Lower Pole Approach group (16.2% vs. 5.7% respectively, p=0.033), latter of which resulted in one case of intrathoracic complication. Moreover, it was discovered that the average length of stay in days of the Lower Pole Approach group was significantly shorter than that of the Non-Lower Pole Approach group (6.38±3.09 vs 8.06±4.14 respectively, p=0.048).

Conclusion: The kidney stone treatment of the Lower Pole Approach has equal stone-free rate as the Non-Lower Pole Approach but has a higher rate of mild complications.

Keywords: kidney stone, percutaneous nephrolithotripsy, retrospective study, stone free rate, complication

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การศึกษาเปรียบเทียบผลของการรักษานิ่วในไต โดยการเจาะไตเพื่อส่องกล้องรักษานิ่วผ่านผิวหนังบริเวณกรวยไตล่าง เปรียบเทียบกับบริเวณอื่น ๆ ย้อนหลังเป็นระยะเวลา 5 ปี

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บทคัดย่อ

วัตถุประสงค์: การเจาะไตส่องกล้องเพื่อรักษานิ่วผ่านผิวหนัง ถือเป็นการรักษาหลักในการรักษานิ่วในไตที่มีขนาดใหญ่ โดยเทคนิคการเจาะไต ที่มีการอ้างอิงและใช้กันอย่างแพร่หลายในปัจจุบัน ได้แก่ การเจาะผ่านกรวยไตล่าง และกรวยไตบน ซึ่งความคิดเห็นในปัจจุบันยังไม่สามารถสรุปได้ว่าการเจาะผ่านช่องทางไหนให้ผลการรักษาที่ดีที่สุด และมีอัตราการเกิดภาวะแทรกซ้อนต่ำที่สุด ซึ่งในการศึกษานี้ได้รายงานผลการรักษา และภาวะแทรกซ้อนจากข้อมูลผู้ป่วยที่ได้รับการรักษาโดยวิธีการเจาะไตส่องกล้องเพื่อรักษานิ่วผ่านผิวหนัง ทุกเทคนิคในนิ่วทุกขนาดในโรงพยาบาลวชิรพยาบาลโดยแบ่งเป็นการเจาะนิ่วผ่านกรวยไตล่าง และการเจาะนิ่วผ่านกรวยอื่นๆ

วิธีดำเนินการวิจัย: จากการเก็บรวบรวมแบบย้อนหลังเป็นระยะเวลา 5 ปี พบว่ามีผู้ป่วยได้รับการทำการเจาะไตส่องกล้องเพื่อรักษานิ่วผ่านผิวหนัง เป็นจำนวน 72 คน ซึ่งได้รับการเก็บข้อมูลได้แก่ ขนาดนิ่ว วิธีและเทคนิคการรักษา โดยได้วิเคราะห์ผลของการรักษาในการผ่าตัด และหลังติดตามอาการ รวมถึงภาวะแทรกซ้อน และระยะเวลาการนอนโรงพยาบาล เพื่อเปรียบเทียบผลของการรักษาระหว่าง การเจาะผ่านกรวยไตล่าง และกรวยไตบน

ผลการวิจัย: ผู้ป่วยจำนวน 37/72 (ร้อยละ 51.4) ได้รับการรักษาโดยการเจาะผ่านกรวยไตล่าง และ 35/72 (ร้อยละ 48.6) ได้รับการรักษาโดยการเจาะผ่านกรวยไตอื่นๆ ซึ่งพบว่าอัตราการหายของนิ่ว ที่ได้รับการรักษาโดยการเจาะผ่านกรวยไตล่าง ไม่แตกต่างกลุ่มได้รับการรักษาโดยการเจาะผ่านกรวยไตอื่นๆ (ร้อยละ 56.8 เทียบกับ ร้อยละ 54.3 ตามลำดับ; ค่าความเชื่อมั่น = 0.776) และค่าเฉลี่ยระยะเวลาในการผ่าตัดไม่แตกต่างกัน (151.62±40.43 ในกลุ่มที่ได้รับการรักษาโดยการเจาะผ่านกรวยไตล่าง เทียบกับ 148.00±60.34 ในกลุ่มที่ได้รับการรักษาโดยการเจาะผ่านกรวยไตอื่นๆ; ค่าความเชื่อมั่น = 0.765) แต่มีอัตราการเกิดภาวะแทรกซ้อนชนิดไม่รุนแรงมากกว่าในกลุ่มที่ได้รับการรักษาโดยการเจาะผ่านกรวยไตล่าง (ร้อยละ 16.2 ในกลุ่มที่ได้รับการรักษาโดยการเจาะผ่านกรวยไตล่าง เทียบกับ ร้อยละ 5.7 ในกลุ่มที่ได้รับการรักษาโดยการเจาะผ่านกรวยไตอื่นๆ; ค่าความเชื่อมั่น = 0.033) โดยพบภาวะแทรกซ้อนต่ออวัยวะในช่องอก หนึ่งรายในกลุ่มที่ได้รับการรักษาโดยการเจาะผ่านกรวยไตอื่นๆ และพบว่า ค่าเฉลี่ยระยะเวลาในการนอนโรงพยาบาลของกลุ่มที่ได้รับการรักษา

โดยการเจาะผ่านกรวยไตล่าง สั้นกว่ากลุ่มที่ได้รับการรักษาโดยการเจาะผ่านกรวยไตอื่นๆ อย่างมีนัยสำคัญ (6.38±3.09 ในกลุ่มที่ได้รับการรักษาโดยการเจาะผ่านกรวยไตล่างเทียบกับ 8.06±4.14 ในกลุ่มที่ได้รับการรักษาโดยการเจาะผ่านกรวยไตอื่นๆ; ค่าความเชื่อมั่น = 0.048)

สรุปผลการวิจัย: การรักษานิ่วในไตโดยการเจาะผ่านกรวยไตล่างพบอัตราการหายของนิ่วเท่ากัน แต่มีอัตราการเกิดภาวะแทรกซ้อนชนิดที่ไม่รุนแรงมากกว่า เมื่อเทียบกับการเจาะผ่านกรวยไตอื่นๆ

คำสำคัญ: นิ่วในไต การเจาะไตเพื่อส่องกล้องรักษานิ่วผ่านผิวหนัง การศึกษาย้อนหลัง อัตราการหายของนิ่ว ภาวะแทรกซ้อน

วันที่รับบทความ 25 มีนาคม 2565 **วันแก้ไขบทความ** 8 มิถุนายน 2565 **วันตอบรับบทความ** 15 มิถุนายน 2565

Introduction

Kidney stone is one of the most highly found non-communicable diseases in modern society, with Asian accounting for about 1-5% of the entire population[1]. Currently, this disease is more widely diagnosed all over the world thanks to the more advanced medical technology used for detecting kidney stones[2-4]. Kidney stone is found three times more in male than female[5], and the age interval is 30-60 years old[6-7]. Caucasian are more likely to suffer from urinary tract stone[8]; however, some additional studies found that people in tropical countries are actually the most likely to be found with such stone due to their susceptibility to dehydration and exposure to excessive sunlight[9-10]. Accordingly, it can be deducted that urinary tract stone is a disease that affects the population's health and the public health system worldwide, especially in Thailand, which has 10.6% of occurrence, 8.4% of which are from kidney stone[11]. Patients with kidney stone who do not get proper treatment will have 51-68% chance of suffering from pain or renal infection[12]. This can potentially lead to chronic renal failure.

Technology used for kidney stone treatment has been continually developed from major operations in the past, where patients had prolonged hospital length of stay and suffered many complications, to endoscopy, which is the main treatment method in the present[13]. Percutaneous Nephrolithotripsy (PCNL)—when compared to other methods—is the most effective endoscopic method for eliminating kidney stones in all sizes, especially those exceeding 1 cm, and in all locations of the kidney because it can accommodate large tool and carry out active stone removal[14-17]. The only absolute contraindications are cases with abnormal coagulation or severe renal infection. Ultimately, PCNL is one of the most popular treatments for kidney stones[17].

The literatures from the past to the present has found that the stone's position, size, and composition[18-19], as well as the patient's weight, comorbidity, and physical condition can all influence the treatment efficacy of PCNL[20- 22]. Patients with high body mass index (BMI) and comorbidity, and stones locating in the lower pole of kidney that are large in size or hard in consistency tend to have a lower success rate of PCNL than other cases. In surgical aspect, there can be many approaches regarding PCNL area selection, with the Lower Pole Approach and the Upper Pole Approach being the most widely used[23-25]. The benefit of the Lower Pole Approach is the lower chance of thoracic organ injury and blood loss, while the advantage of the Upper Pole Approach is the ease in operation because operative tools are aligned with kidney positions resulting in higher stone-free rate. However, the Upper Pole Approach can result in more thoracic organ injury and blood loss[26-27].

Surgical techniques and technologies are progressively evolving. Therefore, it is the researcher's desire to study how the efficiency and complications of both techniques are today, compared to the past.

The main objectives of this study is to compare the treatment effectiveness and complications of patients receiving PCNL via the Lower Pole Approach with other approaches. The stone-free rate, postoperative length of stay, recurrence rate, and postoperative complications in each method will also be studied.

Methods

This research is a retrospective study, which collects data from patients who were diagnosed with kidney stones and received PCNL at Vajira Hospital from December, 2015 to December, 2020. There were 72 patients diagnosed with kidney stones who received PCNL; 37 of whom underwent the Lower Pole Approach while the other 35 underwent the Non-Lower Pole Approach. The information collected from the patients included gender, age, body mass index (BMI), comorbidity, size and position of kidney stone, operative technique, stone-free rate, postoperative length of stay, recurrence rate, and postoperative complications. This research is certified by the

Institutional Ethics Review Committees, Faculty of Medicine, Vajira Hospital, Navamindradhiraj University.

Definition

The size and position of kidney stone refer to those measured from X-ray film or CT scan. The dimensions are width and length, which are measured in centimeters. BMI refers to the value calculated from the relation between a person's weight and height, which is demonstrated in mathematical formula; BMI = weight (kg)/ height (m^2).

Operative technique refers to the PCNL technique used. In this study, the techniques include the Lower Pole Approach and the Non-Lower Pole Approach. Stone-free rate refers to the cure rate of kidney stone after the operation, meaning no stone is detected in X-ray film or CT scan 4 to 6 weeks of follow-up. Postoperative length of stay refers to the period (measured in days) that the patients had to stay in the hospital for recovery or for treatment regarding complications after the operation. Recurrence rate refers to the rate that the patients had to go through any repeated procedure due to stone remnants or postoperative complications. Postoperative complications refer to the complications related to PCNL; in this context, these include excessive blood loss requiring blood transfusion, ureteric blockage, septicemia, or adjacent organ injury.

Statistical Analysis

The statistical analysis of this research is conducted using the statistical package called SPSS Statistical Software Version 23 (Chicago, Illinois, USA).

Quantitative data, including the age, gender, BMI, and comorbidity of population in each group, size and position of kidney stone, and operative techniques would be presented with mean, percentage, and standard deviation (S.D.).

Qualitative data, including the stone-free rate, postoperative length of stay, recurrence rate, and postoperative complications from each operative technique would be presented with mean, frequency, and normal distribution. They would also be tested for data correlation according to the data's characteristic and distribution. Chi-square test would be used to analyze the number of patients, gender, comorbidity, laterality of kidney stone, stone-free rate, and complications. Independent t-test would be used to analyze the age, BMI, and operative time. Mann-Whitney U test would be used to analyze the stone size, estimated blood loss, and length of stay with statistical significance of $p<0.05$.

Results

From the Table 1, there were 72 patients in this study: 37 of whom underwent the Lower Pole Approach (51.4%) and 35 of whom underwent the Non-Lower Pole Approach (48.6%). Having considered the general data in terms of age, BMI, and comorbidity of both patient groups, it was found that the difference was not statistically significant at the level of 0.05. However, in terms of diabetes occurrence, the difference was statistically significant at the level of 0.05 ($p=0.000$). The number of female patients also showed statistical significance, where the Lower Pole Approach group had more number of female patients than the Non-Lower Pole Approach group at the level of 0.05 ($p=0.024$).

In terms of postoperative length of stay, the average duration of the Lower Pole Approach group (6.36 days, S.D.=3.09 days) was shorter than that of the Non-Lower Pole Approach group (8.06 days, S.D.=4.14 days). This difference was considered to be statistically significant at the level of 0.05 ($p=0.048$). However, from the Table 2, the number of patients with complications in the Lower Pole Approach group (16.2%) was higher than that in the Non-Lower Pole Approach group (5.7%), which was also statistically at the level of 0.05 ($p=0.033$). Nevertheless, there was one case of hydrothorax in the Non-Lower Pole Approach group. Fortunately, there were no cases of mortality

in this study. After follow-up sessions, the stone-free rate was concluded to be 56.8% in the Lower Pole Approach group and 54.3% in the Non-Lower Pole Approach group, which was not statistically significant at the level of 0.05. For the immediate post-op stone free rate, 48.6% in the Lower Pole Approach group and 54.3% in the Non-Lower Pole Approach group, which was not statistically significant at the level of 0.05

Table 1:
Result

Patient characteristics	Lower pole approach	Non lower pole approach	Total	P-value
Number of patients	37(51.4%)	35(48.6%)	72(100%)	0.841
Age	50.68±12.08	48.14±12.69	49.44±12.36	0.389
BMI	25.29±3.67	24.93±3.86	25.11±3.74	0.679
Gender				
- Male	19(51.4%)	25(71.4%)	44(61.1%)	0.070
- Female	18(48.6%)	10(28.6%)	28(38.9%)	0.024
Comorbidity				
- Diabetic mellitus	7(81.1%)	10(28.6%)	17(23.6%)	0.000
- Hypertension	15(40.5%)	17(48.6%)	32(44.4%)	0.399
- Dyslipidemia	6(16.2%)	9(25.7%)	15(20.8%)	0.123
- Chronic Kidney Disease	5(13.5%)	2(5.7%)	7(9.7%)	0.074
- Cardiovascular	0	2(5.7%)	2(2.8%)	NA
Laterality				
- Right	22(59.5%)	19(54.3%)	41(56.9%)	0.574
- Left	15(40.5%)	16(45.7%)	31(43.1%)	0.592
Stone size	3.66±1.98	4.27±2.07	3.96±2.03	0.149
Estimated blood loss	231.08±190.52	224.29±180.02	227.78±184.22	0.821
Operative time	151.62±40.43	148.00±60.34	149.86±50.75	0.765
Length of stay	6.38±3.09	8.06±4.14	7.19±3.71	0.048
Stone free rate				
- Immediate				
- Free rate	18(48.6%)	18(51.4%)	36(50%)	0.841
- Residual stone rate	19(51.4%)	17(48.6%)	36(50%)	0.841
- At follow up				
- Free rate	21(56.8%)	19(54.3%)	40(55.6%)	0.776
- Residual stone rate	16(43.2%)	16(45.7%)	32(44.4%)	0.750
Number of complications	6(16.2%)	2(5.7%)	8 (11.1%)	0.033

NA not applicable

Table 2:

Complications according to the Clavien–Dindo classification between Non-Lower pole and Lower Pole approach PCNL

Grade	Lower pole approach	Non lower pole approach	Number of corrected complications
I			
Transient post-operative fever	1 (1.39%)	0	1 (1.39%)
Gross hematuria	1 (1.39%)	0	1 (1.39%)
Urine leakage at puncture site	1 (1.39%)	0	1 (1.39%)
II			
Bleeding requiring transfusion	2 (2.78%)	1 (1.39%)	3 (4.17%)
UTI managed with antibiotics	1 (1.39%)	0	1 (1.39%)
III			
Pneumothorax with chest tube	0	1 (1.39%)	1 (1.39%)
Combined Clavien–Dindo			
Grade (I + II)	6 (8.33%)	1 (1.39%)	7 (9.72%)
Grade (III + IV)	0	1 (1.39%)	1 (1.39%)
Unrelated complications	0	0	0

UTI urinary tract infection, *PCNL* percutaneous nephrolithotomy

Discussion

Today, PCNL is considered to be the principal treatment for patients with complicated or large kidney stones. Based on results from past studies, PCNL has lower complications and deaths when compared to open nephrolithotomy, yet they both have equally effective treatment results[28]. Hence, PCNL is a method that has been widely used and continuously studied.

In most PCNL practices, the Upper Pole Approach is used in cases with upper calyceal stone or staghorn stone. The complication that can be frequently found is intrathoracic because the position of the kidney is overlapped with those of pulmonary and thoracic organs. Hence, during kidney puncture, the Upper Pole approach especially the supracostal access is more prone to thoracic organ injury than the Lower Pole Approach[29]. Nevertheless, the Upper Pole Approach can access kidney stones more easily because the angle of the operative equipment can be more conveniently adjusted. This is due to the anatomical position of the kidney, where the lower pole is tilted anteriorly from the mass effect of the posteriorly lying psoas muscle, and therefore, can limit the adjustment of surgical tools in the Lower Pole Approach. Fundamentally, the advantage of the Upper Pole Approach in eliminating proximal ureteric stone is the ease of tool insertion.

For the Lower Pole Approach, the main advantage is the lower complication of thoracic organ injury. However, as aforementioned, treatments in difficult positions such as the upper calyx or the proximal ureter can be done with more difficulty due to the limitations in renal anatomy and rigid instruments, which can result in extended operative time, additional puncture, or increased occurrence of complications. Nevertheless, according to recent studies[30-31], these limitations are not always relevant because there are more options of tools and technologies available, such as flexible nephroscope, laser, and basket, all of which can increase stone fragmentation and extraction. As a result, the operation of stone

treatment in every position of the kidney can be done with the Lower Pole Approach.

In this study, the stone type and the treatment method were inadvertently randomized. It was found that the stone-free rates in the Lower Pole Approach group and the Non-Lower Pole Approach group were 56.8% and 54.3%, respectively. This result was not statistically significant, which was consistent with the miscellaneous studies[32-33]. This coincides with the objective of this research of determining the treatment result of different techniques and equipments used under different approaches.

In terms of complication, which was the main motivation in choosing different nephrolithotomy techniques, it was found that the complication rate in the Lower Pole Approach group was statistically significantly higher than that in the Non-Lower Pole Approach (16.2% and 5.7%, respectively). Complications in this study were categorized according to the Clavien-Dindo Classification[34] . All cases in the Lower Pole Approach group were Clavien-Dindo Classification I-II, while one case in the Non-Lower Pole Approach group were Clavien-Dindo Classification III, which was a case of pneumothorax requiring chest tube. The cause of such incident was involved with renal anatomy and the fact that the flexible nephroscope was not utilized in the operation in this research, explaining why the Lower Pole Approach group had more frequent complications. Therefore, it can be said that the complications in the Lower Pole Approach group was more frequent, but less severe.

For the length of stay of both groups of patients, it was found that the Lower Pole Approach group had shorter duration than the Non-Lower Pole Approach group In the Non-Lower Pole Approach group, the patient who required chest tube was admitted in the hospital for 23 days, which was consistent with the severity of complications according to the Clavien-Dindo Classification.

This research is a retrospective study with no randomization. Therefore, selective and measurement bias are inevitable. However, in order to increase the validity of this study, all sizes and types of stones were involved in the discussed treatment without exclusion. The definition of stone-free rate in this study means the condition that no stone is detected after a strict follow-up. However, the obvious limitation in this research is the lack of analysis regarding physicians involved, which resulted in different level of technical operative expertise. Nevertheless, the same operating room and equipment were used.

Conclusion

Kidney stone treatment of PCNL via the Lower Pole Approach results is equal stone-free rate, shorter length of stay, higher frequency of mild complications and lower frequency of severe complications when compared to other approaches. Fundamentally, the treatment result is determined by the patient's factors and the surgeon's expertise.

Conflict of interest

The authors declare no conflict of interest.

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