

Percutaneous Nephrolithotomy Complications in 671 Consecutive Patients

A Single-Center Experience

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Purpose: To evaluate major and minor complications of percutaneous nephrolithotomy (PCNL) and their management in our consecutive cases.

Materials and Methods: We reviewed medical records of 671 patients who had undergone PCNL in our center from March 2000 to March 2006. The demographic data, stone parameters, PCNL complications, and stone-free rate were evaluated. Multiple parameters were evaluated for their association with PCNL complications using Chi-Square test.

Results: Complications occurred in 203 (30.3%) patients; renal parenchymal injury in 103 (15.4%), peri-operative bleeding in 42 (6.3%), late bleeding in 6 (0.9%), renal collecting ducts injury in 35 (5.2%), fever in 7 (1.0%), colon perforation in 2 (0.3%), major vessels injury in 3 (0.4%), pneumothorax in 3 (0.4%), and hemothorax in 2 (0.3%) subjects. Mortality occurred in 1 patient with colon perforation (0.15%).

Conclusion: Percutaneous nephrolithotomy has low complication rate in experienced hands.

Keywords: complications, percutaneous nephrolithotomy, urogenital system, kidney calculi, hemorrhage

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INTRODUCTION

Percutaneous nephrolithotomy (PCNL) was defined as a surgical treatment for removal of the renal stones in the 1970s.^(1,2) Today, this procedure should be the first option for the treatment of single large or multiple renal stones and those in the inferior calyx.⁽³⁾ Percutaneous stone removal was suggested as the first line treatment option for the management of staghorn calculi by the American Urological Association Nephrolithiasis Clinical Guidelines panel.⁽⁴⁾ Furthermore, PCNL has been advised for the treatment of large, hard, or infected stones, obstructive stones, and extracorporeal shock wave lithotripsy (SWL) failure.⁽⁵⁾

Although percutaneous renal surgery is less invasive than an open procedure, complications may occur. Percutaneous nephrolithotomy is a successful, less invasive surgery (> 90%) at the cost of greater complications (> 10%).^(6,7) There are some complications that may be predictable or unpredictable, such as hemorrhage, collecting system injuries, contiguous organ injuries, intra-operative technical complications, hypothermia, fluid overload, sepsis, stricture formation, nephrocutaneous fistula, renal loss, and death.^(6,8) In this study, we evaluated the incidence and types of complications, with special attention to bleeding and adjacent organ injuries.

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MATERIALS AND METHODS

In this study, the data from all the patients who had undergone PCNL in Ekbatan Hospital in Hamadan, Iran, between 2000 and 2006, were reviewed retrospectively. The ethics committee of Hamadan University of Medical Sciences approved the study.

Serum levels of electrolytes, creatinine, and hemoglobin were recorded and intravenous urography data were evaluated. A single endourologist had performed all of the PCNLs.

The necessary data were collected from the patients' medical records and analyzed with SPSS software (the Statistical Package for the Social Sciences, Version 16.0, SPSS Inc, Chicago, Illinois, USA) using Chi-Square test. *P* values less than .05 were considered statistically significant.

TECHNIQUE OF PCNL

Single-stage PCNL was performed in all the patients as the standard procedure. The kidney was punctured under fluoroscopy guidance as standard. Depending on the existence of hydronephrosis, the working tract was dilated using Alken dilators or one-shot technique.^(9,10) Nephroscopy was done with rigid nephroscope. Pneumatic/ultrasonic devices (Swiss LithoClast Master, EMS, Nyon, Sz) were used for lithotripsy using a standard nephroscope (26 F).

For removal of stone fragments, suction irrigation device and/or grasping forceps were used. Stone fragments were retrieved with 3-pronged grasping forceps. Fluoroscopy and contrast nephrography were done to evaluate the stone-free status at the end of the operation. The number and type of access depended on the size of the treated stones (staghorn stone versus single pelvic stone) and localization (upper or lower pole).

POSTOPERATIVE CARE

At the end of the procedure, a 22 or 24 F Foley catheter was used as a nephrostomy tube. An antegrade nephrography was carried out 24 to 48 hours after the procedure. The tube was removed if no extravasation or retained calculi were present. On the first postoperative day, all the patients had complete blood count Postoperative

kidneys, ureters, and bladder (KUB) x-ray was routinely done in all the subjects. Symptoms and KUBs were used to evaluate the complications and stone remnants, respectively.

RESULTS

The study consisted of 671 patients, including 417 (62.0%) men and 254 (38.0%) women, with the mean age of 40.7 years (range, 1 to 87 years). The mean duration of the operation was 45 minutes (range, 35 to 125 minutes) and the mean postoperative hospital stay was 36 hours (range, 1 to 3 days).

The right and left kidneys were affected in 370 (55.0%) and 301 (45.0%) patients, respectively. There was no PCNL for the solitary kidneys, kidney anomalies, chronic renal failure, or synchronous bilateral stones. No open conversion occurred in the patients.

Complications occurred in 203 (30.3%) patients; peri-operative bleeding in 42 (6.3%), late bleeding in 6 (0.9%), fever with no signs of urosepsis in 7 (1.0%), renal collecting ducts injury in 35 (5.2%), renal parenchymal injury in 103 (15.4%), colon perforation in 2 (0.3%), major vessels injury in 3 (0.4%), pneumothorax in 3 (0.4%), and hemothorax in 2 (0.3%) patients. Mortality occurred in 1 patient with colon perforation (0.1%). Hemorrhage was considered a major complication when it was severe enough to terminate the operation or caused blurred vision at the time of working and/or blood transfusion was needed.

Pre-operative and operative characteristics in relation to complications of PCNL are demonstrated in Table 1. As Table 1 shows, there was no difference in PCNL complications regarding the kidney site (right versus left), severity of hydronephrosis, stone size, history of previous procedures, and the tract number ($P = .593$, $P = .861$, $P = .938$, $P = .265$, and $P = .073$, respectively). A significant difference was only reported in PCNL complications regarding stone and tract locations ($P = .030$ and $P = .001$). There was no significant association between complications and age ($P = .643$).

Complete stone-free rate was reported in 617

Table 1. Significant pre-operative and operative characteristics in relation to complications in percutaneous nephrolithotomy.

Variable	Complication	P
Stone Location, n (%)		
Upper calyx, n = 68 (10.13%)	n = 19 (28.0%)	.030
Middle calyx, n = 11 (1.6%)	n = 5 (45.5%)	
Lower calyx, n = 93 (13.8%)	n = 32 (34.4%)	
Pelvic, n = 499 (74.4%)	n = 147 (29.5%)	
Stone Size (cm), n (%)		
< 2, n = 118 (17.6%)	n = 33 (28.0%)	.938
> 2, n = 404 (60.0%)	n = 125 (31.0%)	
Staghorn stone, n = 149 (22.2%)	n = 45 (30.0%)	
Hydronephrosis Severity, n (%)		
Mild, n = 439 (65.4%)	n = 127 (29.0%)	.861
Moderate, n = 212 (31.6%)	n = 72 (34.0%)	
Severe, n = 20 (3.0%)	n = 4 (20.0%)	
History of Open Stone Surgery, n (%)		
Yes, n = 25 (3.7%)	n = 6 (24.0%)	.265
No, n = 646 (96.3%)	n = 197 (30.5%)	
Tract Number, n (%)		
One, n = 590 (88.0%)	n = 177 (30.0%)	.073
Two, n = 81 (12.0%)	n = 26 (32.0%)	
Tract Location, n (%)		
Supracostal, n = 199 (29.6%)	n = 64 (32.2%)	.001
Infracostal, n = 472 (70.4%)	n = 139 (29.5%)	

(92.0%) patients while in the remaining 54 (8.0%) subjects, it was partial, which denotes presence of stone remnants less than 5 mm or insignificant remnants. Re PCNL and SWL was needed in 34 (5.0%) and 20 (3.0%) patients, respectively. The failure rate was zero.

DISCUSSION

Stone burden is a major factor determining the morbidity of the PCNL.⁽¹¹⁾ However, it is important to note that having a safe and effective percutaneous access is essential in performing an uneventful and successful PCNL.^(12,13) According to the literature, the total complication rate of PCNL was found 83%.⁽¹⁴⁻¹⁹⁾ The complications of PCNL are divided into the major and minor categories. The minor complications include pain (49%), fever (30%), urinary tract infection (11%), and renal colic (4%). The two major complications of PCNL are septicemia (4.1%) and severe hemorrhage requiring blood transfusion (2.7%).⁽²⁰⁾

Although open stone surgery is needed for some specific renal stones,⁽²¹⁾ no open conversion occurred in our patients.

In a study by Lee and colleagues on 500 patients who underwent PCNL, the most common complication was bleeding, with a 12% transfusion rate.⁽²²⁾ Renal hemorrhage is the most worrisome and frequent complication of PCNL, which has been often addressed.⁽²³⁾ However, severe bleeding leading to complications, such as hypovolemic shock or renal failure, may occur in less than 3% of patients.⁽²⁴⁻²⁶⁾ Severe hemorrhage may occur at the time of needle passage, dilation of the tract, or during nephrostomy creation.^(19,27,28) The two key factors determining the transfusion rate are large stone burden and use of multiple access tracts.⁽¹¹⁾ In our study, the incidence was 0.6%, much smaller than previously reported studies.^(29,30) Although a blood transfusion rate of 5% to 18% was reported in the literature,^(14-19,23,24,31,32) our intra-operative transfusion rate was zero and postoperative transfusion rate occurred in 4 (0.6%) patients. In the study by Turna and associates on 193 PCNLs, the transfusion rate was reported as high as 23.8%.⁽⁶⁾

The probability of vascular lesions increases when the nephrostomy tract passes close to the renal hilus or goes directly posteriorly to it. The high pressure system of a lacerated artery will leak into the lower pressure system of a vein or parenchyma leading to arteriovenous fistula or pseudoaneurysm formation, respectively. Doing the initial puncture with bull's-eye technique or creation of a postero-lateral puncture may decrease the chance of injury.^(23,29,33) Our puncture procedure was with the bull's-eye technique.

Excessive bleeding during PCNL can be managed by some maneuvers, like placement of a larger nephrostomy tube, nephrostomy tube clamping, hydration, and balloon tamponade. The bleeding is mainly venous in origin and is controllable with above maneuvers.⁽³⁴⁾ In our study, only 1 (0.15%) patient needed angiographic embolization of the bleeding renal artery, two weeks after PCNL. Whereas Kessaris and colleagues reported 0.8% of their subjects needed angioembolization due to intractable bleeding.⁽²⁹⁾ Most of our intra-operative bleeding was controlled conservatively.

Occurrence of vascular lesions depends mainly on the total number of punctures. It would be

logical that with decreasing the total number of punctures, the risk of damage to the renal vasculature would be decreased.^(28,29)

The rates of major complications were 0.9% to 4.7% for septicemia and 0.6% to 1.4% for renal hemorrhage needing intervention.^(14-19,23,24,31,32,35-40) The total rates of access-related pleural and colonic complications were 2.3% to 3.1% and 0.2% to 0.8%, respectively. The risk of injury to the pleura and lung increases (10%) if the puncture is above the 12th rib.⁽¹⁰⁾ If puncture is through the pleura, a chest tube has to be inserted for prevention of hydrothorax or hemothorax. Rate of pleural injury in our study was 0.7% (5 subjects, 2 hemothorax and 3 hydrothorax), which only occurred with the supracostal access and were all controlled with chest tube insertion.

Several risk factors contribute to the colonic injury during PCNL, such as left-sided procedure, an extremely lateral percutaneous nephrostomy tract, horseshoe kidney, advanced patient's age, distended colon, an associated colon obstruction, a hypermobile kidney, a retrorenal colon, and extreme thin patients.^(11,38) Perforation of the colon can be seen in less than 1% of subjects.⁽⁴⁰⁾ Furthermore, the urologist should be very careful if the patient has had a history of gastrointestinal surgery, which increases the potential risk of the duodenal or colon injury.⁽³⁸⁾

After reviewing a series of 200 patients on abdominal computed tomography (CT) scan, the rate of posterolaterally or retrorenally positioned colon has been reported in 1% of the general population.⁽⁴¹⁾ However, the low incidence of this complication does not justify the routine use of CT scan.⁽¹¹⁾ Only a selected group of patients, including those with ectopic kidney, a retrorenal colon, any form of splenomegaly, and hepatomegaly require CT-guided percutaneous access to perform PCNL.^(11,42)

In the case of extraperitoneal colon perforation, the gastrointestinal tract must be separated from the urinary system.⁽¹⁰⁾ We had two cases of colon perforation; in the first one, the perforation was diagnosed intra-operatively and was managed with laparotomy and primary repair of the intraperitoneal colon injury. The second patient

was a 50-year-old thin woman, in whom PCNL was done for removal of a 2.5-cm left renal pelvic stone. The procedure was successful and she was discharged on the 2nd postoperative day uneventfully. She was readmitted on the 7th postoperative day with peritonitis and laparotomy was done for creation of a colostomy. She died after 3 days with sepsis.

Septicemia can be seen as a result of infection introduction via the access tract to the kidney or working with the infected stones. Following PCNL, fever is significantly higher and more frequent in patients with infected urinary stones than in those with sterile stones.^(10,43) Therefore, prophylactic antibiotics and drainage of a pyonephrotic kidney is mandatory prior to PCNL.⁽¹⁰⁾ Antibiotics can be applied as single-dose or short-course prophylaxis with no significant differences between these two regimes in the occurrence of postoperative infections.^(24,44) The total time of procedure and the amount of irrigation fluid are major risk factors for occurrence of postoperative fever.^(10,35) It is important to preserve low pressure in the collecting system and keep the duration of surgery to minimum (< 90 minutes).⁽¹⁰⁾ Our mean operation time was 45 minutes.

Perforation of the collecting system is the common reason for fluid extravasation and its systemic absorption.⁽¹⁰⁾ We used an open flow system with normal saline as irrigant. Following PCNL and in the case of severe perforation of the collecting system, urine extravasation may occur. Postoperative symptoms are flank pain or persistent infection. For the percutaneous drainage of the urinoma and as a temporizing measure of the collecting system injury, nephrostomy catheters or double-J stent insertion may become necessary.⁽¹⁰⁾ We did not have any case of urinoma or persistent urine leakage.

In a patient with history of open stone surgery, PCNL is time-consuming and may lead to use of auxiliary procedures, probably due to presence of scar tissue and some anatomic changes in the operated kidney.⁽⁴⁵⁾ In our study, there was no difference in complication rate between the patients with open stone surgery and without it, which is compatible with other studies.^(45,46)

Table 2. An overview of PCNL complications in the literature and their comparison with our study

Literature	Our experience			
Extravasation	n = 582 (7.2%) ⁽¹⁹⁾	n = 35 (5.2%)		
Renal hemorrhage	n = 318 (0.6%) ⁽³¹⁾	n = 1854 (1.4%) ⁽²³⁾	n = 42 (6.3%)	
Transfusion	n = 582 (11.2%) ⁽¹⁹⁾	n = 103 (17.5%) ⁽³⁷⁾	n = 4 (0.6%)	
Fever	n = 582 (22.4%) ⁽¹⁹⁾	n = 7 (1.0%)		
Sepsis	n = 582 (0.8%) ⁽¹⁹⁾	n = 318 (2.2%) ⁽³⁷⁾	n = 128 (4.7%) ⁽³⁸⁾	0
Colonic injury	n = 1000 (0.2%) ⁽¹⁾	n = 582 (0.2%) ⁽¹⁹⁾	n = 5039 (0.2%) ⁽³⁹⁾	n = 2 (0.3%)
Pleural injury	n = 128 (2.3%) ⁽³⁸⁾	n = 582 (3.1%) ⁽¹⁹⁾	n = 5 (0.7%)	
Acute pancreatitis	n = 315 (0.3%) ⁽¹⁰⁾	0		
Peri-operative mortality	n = 318 (0.3%) ⁽³¹⁾	n = 582 (0.3%) ⁽¹⁹⁾	n = 315 (0.3%) ⁽¹⁰⁾	0

An overview of PCNL complications in the literature and their comparison with our study are demonstrated in Table 2.

CONCLUSION

Based on our findings, the PCNL complications were related to stone burden, stone location, the type of access, and finally, surgical expertise and equipment. Although the rates of some complications, such as blood transfusion, were reported higher in the literature, our rates were significantly lower.

CONFLICT OF INTEREST

None declared.

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