



SMJ- Sohag Medical Journal, Vol. 29 No (2) 2025

Print ISSN1687-8353

Online ISSN2682-4159

Original Article

Risk Factors Of Percutaneous Nephrolithotomy Complications In Patients With History Of Previous Renal Surgery

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Abstract

Background:

Open surgery has been largely replaced by percutaneous nephrolithotomy (PCNL) as the primary management for large or multiple kidney stones. In general, surgeons can anticipate technical issues that may be linked to increased complication rates and, potentially, a reduced rate of success when conducting operation in an anatomical region that has been earlier operated on⁽²⁾. A variety of studies have attempted to assess the PCNL results in cases with and without a open renal operations history⁽⁴⁾

Their findings have been inconsistent or even incompatible, with some sources indicating lower success rates and/or increased complication risks related to POS⁽⁴⁾, whereas others have not observed any significant differences among the POS and non-previous open renal surgery (nPOS) groups⁽⁶⁾. Although there have been numerous studies conducted since the 1980s, this issue continues to be a topic of contention and is still being debated.

Keywords: Open Renal Surgery, PCNL, Renal calculi

DOI : 10.21608/SMJ.2025.336121.1511

Received: November 13 , 2024

Accepted: December 11 , 2025

Published: May 01, 2025

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Citation: Mostafa Mohammed Mohammed . et al., Risk Factors Of Percutaneous Nephrolithotomy Complications In Patients With History Of Previous Renal Surgery

SMJ,2025 Vol. 29 No (2) 2025 86- 93

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Introduction

Nephrolithiasis has been on the rise. Despite earlier epidemiologic studies have demonstrated that males were two to three times more likely to develop kidney stones than females. A strong correlation between kidney stone disease and Mets traits has been demonstrated in epidemiological research⁽⁴⁾

Fernstrom and Johansson initially described the percutaneous nephrolithotomy (PCNL) in 1976.⁽¹⁾ PCNL is kidney stones larger than 2 cm initial treatment option , as recommended by the European Urology Guidelines. RIRS or ESWL are the second-line treatments. Endourology and ESWL are both considered to be comparable alternatives for stones that measure between 1 and 2 cm. Nevertheless, PCNL is only recommended for calculi that are less than 1 cm in the event of failure or undesirable circumstances for RIRS of ESWL.. (Guidelines 2020).

Patients who have undergone prior open renal surgery (POS) frequently exhibit retroperitoneal scarring surrounding the kidney, pelvicalyceal anatomy distortion, and, in certain instances, colon displacement.

In general, surgeons can anticipate an operational issue while conducting surgery in an anatomical area that has been earlier operated on. It may be correlated with a potentially, a lower success rate, an elevated complication rate, and, longer operating time⁽²⁾

Methods:

This is a non-systematic review of the literature that primarily concentrates on the PCNL complications risk factors.

Percutaneous nephrolithotomy Complications

PNL complications have been estimated to occur at a rate of 20-83%. Due to the fact that the majority of PNL outcomes current assessments only report rates for procedure particular complications, it is challenging to identify and compare the PNL true complication rates⁽³⁾

By employing the adapted Clavien complication grading system to evaluate the complications that are most frequently linked with PNL, other researchers have endeavored to standardize the related complications reporting .

Hemorrhagic Complications: Perioperative hemorrhage may result from the parenchymal vessels rupture throughout tract dilation or kidney tear

throughout excessive nephrostomy sheath bending. A complication is deemed to be a hemorrhage that necessitates a transfusion or the cessation of the operation.⁽⁴⁾

Predictive factors for hemorrhagic complications include a prolonged operative time, large stones (staghorn), dilation with a large access sheath, and multiple punctures.⁽⁴⁾

The rupture of the primary renal vessels as a consequence of accidental dilation is an extremely uncommon complication (0.4%) that can be life-threatening and required an emergency nephrectomy. The dilation process should always be performed over a stiff guidewire that has been properly coiled within the system or advanced down the ureter. When a dilator is abruptly inserted, it redirects dilation forces away from the hilum.⁽⁵⁾

In the early stages bleeding in the postoperative period is observed promptly following the removal of the nephrostomy sheath and is the result of bleeding from either vessels located in the nephrocutaneous track or parenchymal renal vessels (i.e., subcostal vessels").⁽⁵⁾

Arteriovenous fistulas and arterial pseudoneurysms are additional causes of delayed hemorrhage. These complications are exceedingly uncommon, occurring in only 1.2% of all cases.⁽⁶⁾ Typically, they are discovered by error following a radiologic evaluation for another reason (e.g., renal colic) and resolve without incident.⁽⁷⁾

Subcapsular renal or perinephric hematomas are exceedingly uncommon hemorrhagic complications. They are typically diagnosed inadvertently following a radiologic evaluation for an unrelated condition (e.g., renal colic) and typically resolve without incident⁽⁷⁾

Blood loss following PCNL is the consequence of either renal parenchymal trauma or perinephric vessel injury. However, bleeding may also transpire throughout the postoperative period, intraoperative instrument manipulation, tract dilatation, or needle puncture.

Gupta and colleagues discovered that intraoperative bleeding was not significantly different in cases who had never undergone an open nephrolithotomy (7.2%) in comparison with those who had undergone an open nephrolithotomy(4.4%).⁽⁷⁾

The meta-analysis conducted by Hu et al. demonstrated that cases with POS had an

angiographic embolization higher risk and a greater decrease in haemoglobin⁽⁶⁾

Additionally, A PCNL is typically conducted at a location where anatomical changes, inflammation, and adhesions may result in vascular complications following prior surgery⁽⁹⁾

Additionally, the kidney's mobility may be impaired by retroperitoneal and caliceal fibrosis. In such instances, the nephroscope may be subjected to sufficient torque during the operation to induce lacerations in the kidney, resulting in hemorrhaging.⁽³⁾ This could account for the increased decrease in haemoglobin in the group that underwent open renal surgery previously.

Thoracic complications: The pleura's present in the percutaneous puncture route is likely to lead to a variety of perioperative pleural complications, such as hydrothorax, mild pneumothorax (PTX), and, in uncommon cases, hemothorax⁽⁸⁾

In the preponderance of cases, PTX following PNL is typically minor and resolves without treatment. Nevertheless, it is imperative to conduct routine radiological surveillance until the condition is resolved.

Intraoperative hydrothorax may result from the irrigation fluid introduction into the pleural cavity. Pleural effusion can be conservatively managed through prolonged renal drainage if it is modest. A transthoracic drain should be implanted if a significant amount of fluid accumulates.⁽⁵⁾

Hemothorax and UT are exceedingly uncommon complications. Hemothorax may be the consequence of an intercostal artery lesion or, less frequently, a direct lung puncture. Urothorax typically occurs when a renal-pleural fistula remains after the nephrostomy drain is removed as a result of an unexpected perioperative pleural violation that has not resolved.



Chest X-ray of urinopleural fistula

The chest cavity and the collecting system should be drained, preferably through a small-bore chest catheter and a new nephrostomy. The chest tube should be removed first after the urine has ceased to flow, followed by the nephrostomy a few days later.⁽⁵⁾ Following the cessation of urine drainage, the chest catheter should be removed, and the nephrostomy a few days later.⁽⁵⁾

Risk factors for thoracic complications:

A- Subcostal access (1.4%) was related to with thoracic complications lower than supracostal percutaneous renal access (5.3%). lower risk

B- The overall complication rate was significantly influenced by obesity, which was evident in the supracostal hemothorax of an obese case.

In comparison to a subcostal approach, patients who underwent a supracostal approach experienced a 10-fold increase in the incidence of thoracic complications, according to Yadav et al.⁽⁹⁾

C- Access is facilitated by the utilization of additional cephalad and intercostal space. The authors concluded that the 10-space accession is primarily associated with a 16-fold higher thoracic complication rate than the 11th intercostal space.⁽¹⁰⁾

D-Refraining from employing a functional sheath The sheath should be advanced into the renal collecting system to reduce the efflux of irrigation into the retroperitoneum and pleural space.. The surgeon should be alerted to a potential issue by

an apparent discrepancy between the inflow and discharge of irrigant. In this instance⁽¹⁰⁾

Fever/sepsis: fever is a common postoperative complication in PNL, with a total prevalence of 10.8%.⁽¹¹⁾

Conservative management with a brief course of intravenous antibiotics is generally efficient in the majority of cases. Detection of preoperative bacteriuria is a recognized cause of infectious complications in stone disease and should be managed correspondingly through urine cultures conducted prior to surgery.⁽¹³⁾

These are the factors that induce the postoperative sepsis risk : renal anomalies, neurogenic bladder dysfunction, preoperative bacteriuria, an extended surgical procedure, and elevated intrarenal pressure.⁽⁵⁾

Despite the relatively frequent infectious complications occurrence following PNL, We must underscore the fact that a globally approved regimen for perioperative ATB prophylaxis has not yet been defined. Infection prevention in cases with preoperative sterile urine is regarded as comparable with either a single-dose prophylaxis or a short-term prophylaxis⁽¹⁴⁾

And an insignificant difference in the postoperative fever prevalence between cases and cases who had received open stone surgery prior to PCNL.⁽¹⁴⁾

Urine leak from nephrocutaneous fistula (NCF): In the presence of large-bore nephrostomy catheters, the urine leakage out of NCF is more prominent. The catheterization duration is prolonged, and no internal ureteral drainage is employed.⁽¹²⁾

The treatment approach for almost all cases with persisting urine leakage from NCF must involve the double-J (DJ) stent placement that relieves the symptom and performing a obstruction radiologic evaluation⁽¹²⁾

Intravascular hemolysis, which has the potential to be fatal, is a risk associated with irrigation with water throughout percutaneous renal surgery⁽¹²⁾

The pelvicalyceal system rupture: In order to prevent a rupture that would result in the postoperative urinoma formation, the specialist's objective was to reach the system in a precise and secure manner during lithotripsy..⁽¹³⁾

Regarding major venous damage or collecting system perforation, persistent irrigation may end up in intravascular or extravascular extravasation of nonelectrolytic isotonic fluid. This may contribute to hyponatremia and other electrolyte abnormalities, renal or hepatic dysfunction, and alterations in cognitive function.

High-pressure irrigation of the system, forced insertion of rigid guidewires and dilators, and forced use of lithotripsy for impacted calyceal stones are all high-risk factors for major system rupture. In order to access distant calyces an further risk for the collecting system perforation due to excessive percutaneous accessions angulation with the nephroscope .⁽⁵⁾

The dilation of the tract is impeded by retroperitoneal and perinephric scarring. In order to promote dilatation, a surgical blade may be employed to make a sharp incision in the fascia⁽⁵⁾ Balloon dilation is advised due to the elevated possibility of renal perforation correlated with the utilization of metal dilators for dilation. In our department, metal dilators are being utilized effectively, and the pelvic perforation prevalence is extremely low⁽⁶⁾. This may be attributable to the fact that a significant amount of renal calculus is being removed utilizing this dilatation technique.

Organ injury:

Colon injury: Colon rationalization is uncommon (as stated in nearly 0.6% of the average population), so that's likely the reason for its low occurrence.⁽¹⁶⁾

On the left side, the retrorenal colon typically appears and is most likely to be located in close proximity to the kidney inferior pole.⁽¹⁷⁾



Nephrostomy tube transverses the left colon (retrorenal colon) (Smith textbook of endourology, 2012).

The colon perforation risk is elevated in cases with the colon to the kidney posterior displacement.

- 1: previous major abdominal surgery
- 2: institutional bowel and neurological disorders leading to a swollen colon
- 3: Other patients who are at a higher risk include slender females with minimal retroperitoneal fat, anterior calyceal puncture, prior extensive renal surgery, kyphoscoliosis, Horseshoe kidney and renal fusion or ectopia other forms.⁽¹⁸⁾

The risk of colon injury may be elevated by a puncture site that is located laterally. A typical location for the colon is either anterior or anterolateral to the lateral renal border. As a result, the risk of colon damage can usually be restricted to whenever a puncture is carried out lateral to the posterior axillary line.

Patients who are at an elevated risk of developing a retrorenal colon may undergo renal percutaneous accessing under ultrasound guidance.⁽¹⁹⁾ If there is any apprehension regarding colonic injury, it is strongly advised that the patient undergo a preoperative CT scan in the supine position..

In certain instances, CT-guided accessibility should be examined when the chance for reaching the collecting system is limited⁽²⁰⁾

It is imperative to promptly identify a colonic perforation in order to mitigate the severity of the

infectious consequences. Colonic perforation should be suspected in the event that the case demonstrates intraoperative or immediate postoperative, peritonitis signs, the passage of gas or excrement through the nephrostomy tract, or diarrhea or hematochezia.⁽²¹⁾

Alternatively, the presence of colonic contrast can be detected through postoperative nephrostography prior to nephrostomy removal. Fluid resuscitation, ATB therapy, and the usage of pressors may be required for controlling such patients. If those treatments fail to alleviate the patient's health issue, it is recommended that CT imaging be conducted to assess for any unforeseen retroperitoneal or abdominal complications that may lead to sepsis, such as colonic perforation.⁽²²⁾

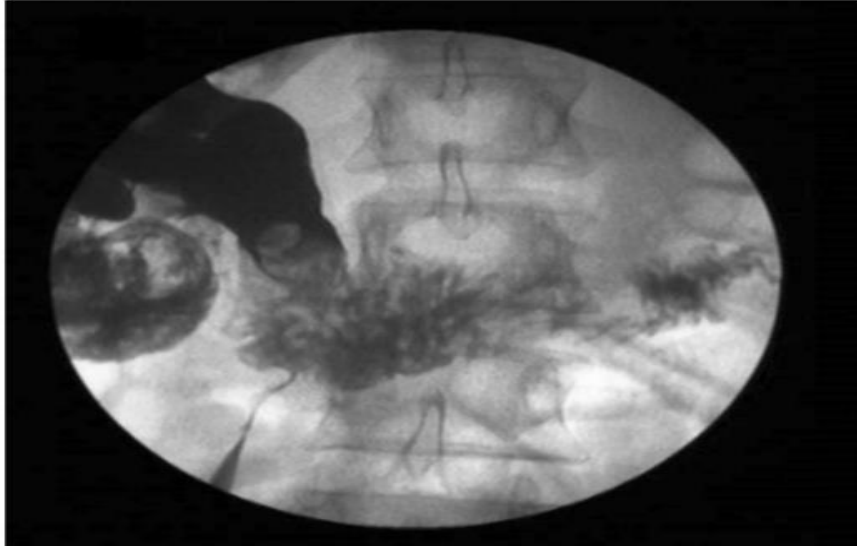
Without the need for open surgery, the majority of cases with colonic lesions can be managed if the penetration is retroperitoneal and the patient does not have peritonitis or sepsis.

With fluoroscopic assistance, the nephrostomy tube is pulled into the colon, and a Foley catheter is left in place in the bladder to ensure a low urinary pressure system. Implantation of an indwelling DJ stent. This eventuality facilitates the closure of the medial colonic wall and the recovery of the renal collecting system..⁽²³⁾

The colostomy tube is withdrawn after 5–7 days, and the Foley catheter is eliminated. However, it continues to function as a drain outside the colon if the colostogram or a retrograde pyelogram does not evidence extravasation or colonic communication with the collecting system. After 2–3 days

(7–10 in total), the tube is removed when the lateral colonic wall is anticipated to have closed.⁽²⁴⁾

If conservative management fails, peritonitis, sepsis, or intraperitoneal colonic perforation occurs, open surgical exploration is recommended, and a colostomy is typically required.⁽²⁴⁾



Characteristic fluoroscopic image of contrast extravasation in the case of duodenal injury (Smith textbook of endourology, 2012)

This phenomenon may result from the renal pelvis perforation throughout dilation, the working sheath implantation, or the stone removal. As a result of cases's instability or a significant perforation, open surgical repair is required..

However, nonoperative managing may be attempted for patients with minor lesions to the small bowel and no symptoms of sepsis or peritonitis.

In this group, ATBs are managed, and gastrointestinal rest is attained through parenteral hyperalimentation and nasogastric suction. In order to guarantee sufficient drainage, the nephrostomy catheter must be positioned accurately.

Splenic injury: The prevention of associated morbidity and mortality can be achieved by promptly diagnosing and treating splenic injuries, as the consequences of overlooked injuries are potentially fatal.

In patients who are undergoing PNL and have severe abdominal pain, hemodynamic instability, or excessive blood loss, it is essential to maintain a high level of suspicion for splenic trauma or

Small intestine injury: Due to their proximity to the right kidney, the duodenum 2nd and 3rd sections may sustain damage throughout percutaneous renal surgery. However, this is an exceedingly uncommon complication of PNL and more uncommon than colonic perforation.

vascular injuries during the perioperative period.⁽²⁵⁾

The spleen is at a higher risk of injury during percutaneous renal procedures due to the following factors: splenomegaly, an intercostal approach, the accession site (a more lateral placement), and retrorenal spleen.⁽²⁵⁾ There was a significant mortality rate associated with the splenic injuries non-operative management. Nevertheless, the successful conservative management of a small number of patients has been facilitated by advancements in imaging and novel grading systems for splenic injuries, thereby excluding the need for laparotomy and splenectomy.⁽²⁵⁾

Liver injury: Liver injury during PNL is exceedingly uncommon. Hepatomegaly is a risk factor; consequently, it is recommended that patients with this condition undergo a preoperative CT scan.⁽²⁵⁾

Conservative management of hepatic trauma is the norm, and surgical exploration is only necessary in patients who are hemodynamically unstable. In order to promote the formation of the tract, the nephrostomy catheter should be remained in place

for nearly a week.. In order to prevent a Renobiliary fistula, it is advisable to simultaneously remove the Nephrostomy tube and insert a DJ catheter⁽⁵⁾

Neurologic complication: Neurologic complications following PNL are exceedingly uncommon. The T12 dermatome is typically affected by reported complications, including transient paraplegia and focal neuropathy.⁽²⁾

Gulani and colleagues found that postoperative complications were more prevalent in cases who had undergone prior to stone surgery than in those who had not. Nevertheless, the difference was insignificant. The Clavien complication score was higher in recurrent stone cases than in fresh cases, but the difference was statistically insignificant ($p = 0.217$)⁽⁶⁾

Margel and colleagues compared the PNCL efficacy and morbidity in cases who had undergone nephrolithotomy in the past to those who were primary cases. Patients with nephrolithotomy history existing with a higher incidence of secondary procedures, according to their findings⁽¹¹⁾

Conclusion:

For patients who have undergone open nephrolithotomy, PCNL is both safe and efficacious. Unfortunately, cases that have experienced prior kidney surgery necessitate a surgeon with extensive experience in order to mitigate the possibility of significant complications during PCNL.

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