Original Article

# Comparison of Safety Outcome and Complication of Slow Descent Technique Versus Bulls Eye Technique in Percutaneous Nephrolithotomy

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## Abstract

**Background:** Percutaneous nephrolithotomy (PCNL) is the gold standard for treating kidney stones larger than 2 cm in diameter. The first and most significant step in doing a PCNL is to create percutaneous renal access. The progressive descent and bull's-eye techniques of operation are the two basic strategies for obtaining suitable percutaneous renal access under fluoroscopic surveillance. In this article, the rates of success and complication for these two surgeries are compared. **The Aim of the Study:** The objective of the research is to make a comparison to the results and morbidities of patients who had percutaneous nephrolithotomy (PCNL) using the progressive descent strategy to those who had bulls-eye PCNL. **Patients and Methods:** Between October 2019 and May 2021, 200 patients with simple renal stones were haphazardly specified to one of these groups depending on the percutaneous renal access method employed for PCNL. The bulls-eye strategy was utilized on patients in group 1 (n = 100), whereas the steady descent method was employed on patients in group 2 (n=100) Patients who required several access points were thrown out of the study. The results of the preoperative, surgical, and postoperative follow-ups were assessed and compared. **Results:** No significant variation was noticed in patient demographics among the groups (stone size, body mass index, mean patient age, or stone location). The operation time was shorter for the slow descent method, the fluoroscopic screening time (FST) was shorter for the slow descent method, and the length of hospitalization was equivalent in both groups. Those in Group 1 had a larger postoperative drop in hematocrit than patients in Group 2.The rate of blood transfusion, however, was comparable in both groups (7.5 percent). Despite the fact that group 1 had a larger complication rate than group 2, no meaningful difference was found. **Conclusions**: The current research indicates that PCNL can be safely made by emplyong a pair of access techniques: the slow descent technique less operative time and less radiation exposure time. There was a correlation between both access techniques and comparable hospital stays as well as success and complication rates. Because the access tract was properly aligned with the infundibulum throughout the gradual descent, there was less blood loss and less force needed to be applied.

**Keywords:** Nephrolithotomy, Fluoroscopy, Bull's-eye, Safety, Radiation, Access, Tract

## Introduction

### 1.1 Background

In comparison to non-closed surgical treatments and shock wave lithotripsy, percutaneous nephrolithotomy (PCNL) for treating renal stones and several associated renal disorders has been shown to be effective and has endured the test of time. The operation has a reputation for being free of the failures and contraindications associated with shock wave lithotripsy, and it has its own indications. This form of surgery has reached new heights in terms of safety and efficiency thanks to advancements in instrumentation, radiologic imaging, and urological expertise.

Urolithiasis has been a problem in human culture for millennia. Because of the frequency and recurrence of urinary tract calculi, treatment may be seen as a difficult

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health-care task. Renal stone therapy has developed from open surgery to minimally invasive surgery. In 1941, Rupel and Brown published the first report on the getting rid of kidney stones through nephrostomy.[1] Techniques, expertise, and tools all increased dramatically. In 1976, Goodwin *et al.*[2] described percutaneous nephrolithotomy. (PCNL). By incorporating renal ultrasonic lithotripsy and an endoscope, Alken et al. enhanced the method. Because of the size, location, form, and composition of the stones, PCNL is still necessary in certain situations even though extracorporeal shock wave lithotripsy (ESWL) and flexible ureteroscopic stone removal are commonly utilized therapy techniques for renal stones.[3] Recently, the European Association recommended PCNL as the initial course of therapy for inferior, many, or big calyx stones.[4] Because PCNL has a lower morbidity, requires less time to operate, and has fewer postoperative problems than open stone surgery, it has basically supplanted the latter.[5,6] Due to renal stone recurrences, some people who have had open stone surgery in the past need PCNL.[7,8] The recurrence rate of stones may reach 50% within 5-7 years.[9] Scar tissue and other structural changes in the kidney generated by PCNL or open stone surgery may affect PCNL in the future. Some studies have indicated that prior open stone surgery increases the chance of PCNL failure,[10] whereas others have reported that prior open stone surgery has no influence on PCNL outcome.[11,12] PCNL is recommended for situations with stones greater than 20mm2, struvite or cystine stones, stone removal failure with ESWL, or anatomical deformity.[5,13] PCNL, on the other hand, carries a significant morbidity risk, with recent trials reporting a complication rate of 20.5 percent.[14]

The purpose of this research was to make a comparison with two procedures for the efficiency and complications of PCNL in patients who have and do not have a history of open renal stone surgery, as well as in case persons whose PCNL therapy had failed or recurred.

As a result of recent developments in equipment and fluoroscopy, the integrity of percutaneous surgery has substantially improved.

The American Association of Urology (AUA) recommends PNL as the main and first-line therapy for staghorn renal calculus, but the European Association of Urology (EAU) guidelines support PNL for renal calculus >2cm and bottom pole stone >1.5cm.

The objective of staghorn renal stone treatment is to remove all of the stones. The percutaneous technique for stone removal has been improved and developed to the point that it is currently the standard of care for treating renal calculus. Balaji *et al.*[15] categorized difficult renal calculi based on the size of stone, its place, renal function, and infection.

The number of accesses in difficult renal stones is dictated by the size of stone, the architecture of the pelvi-calyceal system (PCS), stone dissimination, the Guys score, the patient's general condition, and the surgeon's competence.

## 1.2 Indications for PCNL

1. The PCNL was recommended by the AUA as a primary treatment for staghorn calculi. 9.2 Patients with a bottom pole renal stone with a diameter greater than 10mm.[9,10]
2. Anatomical abnormalities that impede ESWL (such as morbid obesity and musculoskeletal deformity).[9,11]
3. Hard stones, since they have a low stone-free percentage and require many operations,
4. When ESWL and ureteroscopy therapies fail.[9,11]
5. Abnormalities of the upper urinary tract (e.g., horseshoe kidney stones, calyceal diverticular stones, PUJ obstruction, and ectopic kidneys).[9,11]

## 1.3 Contraindications and Limits of PCNL

1. Congenital and acquired irreversible coagulopathy (1-3-1-Absolute).[12,13]
2. Pregnancy, active UTI (except for Staghorn stone), or pyonephrosis
3. Coexisting disorders (for example, diabetes, splenomegaly, retro-renal colon disease, severe respiratory or cardiovascular disease).[12,13]
4. Obesity is associated with morbidity.[14]

## Malformations of the Vertebrae

A mechanism for gathering duplicates Kidneys that are not rotated appropriately.

## 1.4 PCNL Technique

PCNL employs either prone or supine procedures, or both positions are adjusted. Access is essential for guaranteeing excellent stone removal, which results in fewer complications and necessitates fewer further treatments. PCNL is often made in the prone position. It has various advantages, including less visceral organ injury, a greater puncture site surface area, a multiple entrance method, and more room for instrument adjustment. This technique, however, has a number of drawbacks: It is detrimental to blood circulation and respiratory function. It lengthens the surgery, especially in obese individuals, and if the operation is done in spinal or epidural anesthesia, switching to a general anesthetic becomes difficult. Due to body habitus, it is often hard for the sick persons to lie in a prone posture in illnesses like ankylosing spondylitis, severe lordosis, or kyphosis. Finally, the sick persons is exposed to additional radiation in the prone position.[16]

When doing prone PCNL under fluoroscopy, the "bull's eye" method offers surgeons greater control over the needle and subsequent tract dilatation.[17]

A retrograde pyelogram with diluted contrast is used to obstruct the collecting system. When rotating the image intensifier 20º–30º to the surgeon in the axial plane, the targeted posterior calyx is recognized; this ensures entry into the collecting system around Brodel's line. For lower pole access, fluoroscopy is oriented 5–10º in the caudal direction and 5–10º in the cranial direction.

An angled hydrophilic-tipped guide wire is placed into the needle using fluoroscopy. A calyx's fornix may be the most secure route to attain direct access to the system. In general anesthesia, case persons were placed in the lithotomy posture and a ureteral catheter was implanted. Fluoroscopy was used to accomplish percutaneous access on prone patients, and all pressure sites were cushioned.[7-9,18]

### 1.4.1 The Bull's-eye Method

A contrast substance was applied to impede the collection mechanism. After that, the fluoroscopy arm was turned thirty degrees in the direction of the surgeon, following the axis of the relatively avascular Brodel line and the posterior row of calices. An 18-gauge needle was used to find and pierce the proper backside calix. The fluoroscopy arm was vertical and at a 90-degree angle while the needle, also known as the bull's-eye, was advanced employing a hemostat. The obturator was removed after the needle tip had reached the desired calix or stone. A urine output confirmed the appropriate placement.

### 1.4.2 Method of Slow Descend

After the system was distended and opacified by contrast instillation, the best way to get into the gathering system was determined by positioning the C-arm at a 30-degree angle. The C-arm was positioned vertically and obliquely to determine the orientation of the puncture line. With the C-arm upright, the 18-gauge needle was pushed in the direction of the calix. To ensure optimal puncture depth, the needle's cephalad-caudad movements were made with the C-arm in an oblique posture. By moving it in two axes, the C-arm was suitably positioned. To enlarge the tract up to 30F, Amplatz renal dilators were used, and a 30F Amplatz sheath was put in under fluoroscopic guidance.[19]

### 1.5 Complications of PCNL

### 1.5.1 Access Related Complications

**Bleeding:** The basic consequence of PCNL is bleeding that necessitates a blood transfusion. Injuries to nearby organs:[20]

Pulmonary and pleural injury (overall risk 1–4.5 percent).[21]

Colonic damage is caused by congenital renal fusion or ectopic kidneys, prior loin surgery, a left-sided operation, old age, a bloated colon, or slender people.[22]

**Duodenum Injuries:** These occur infrequently after perforating the right renal pelvis or the lower collecting system.[23] Injuries to the liver and spleen (rare).

Chyluria (caused by injuring the lymphatic system):[24]

Stone retrieval-related complications.[25] Sepsis (which occurs at a rate of 0.6–1.4% in PCNL patients). It can happen exogenously as a result of renal access or endogenously as a result of infected urine or a fractured infected stone.

**Extravagance:** (up to 7% of cases due to perforation in the collecting system). Extrarenal stone migration (due to collecting system perforation. Unless the urine or the stone is infectious, it is not dangerous.[26]

Foreign body retention can cause infections, the formation of new stones, and granulomatous responses.[27]

Infundibular stenosis (occurs in 2% of PCNL patients).[28]

Nephrocutaneous fistula: (It occurs seldom and is linked with distal blockage caused by remaining stone tiny parts, stricture, edema, blood clot, and/or retained foreign body).

**Air embolism:** it is too rare and may occur when air is injected into the collecting system.[29]

### 1.6. Aim of the Study

The objective of the paper is to compare the outcome and complications of the bullseye technique with slow descent method.

## Patients and Methods

From October 2019 to October 2022, the same surgical team treated 200 patients with simple kidney stones. Patients were divided randomly to a pair of groups based on the renal access method employed by the surgeon to establish access (AA, AT): the bull's eye approach (group 1) or the progressive descent method (group2). Employing computer-generated fundamental random tables, randomization was carried out in a 1:1 ratio. Characteristics of the patient and the operation, as well as perioperative and postoperative factors such surgery time, FST, hematocrit change, rates of success and complication, and length of stay in the hospital, were compared between the two groups. A single, sizable pelvic or caliceal stone measuring more than 1.5 cm was required for PCNL inclusion. The research excluded participants with complicated kidney stones and those requiring multiple entry points. Every one of the one hundred ill-persons signed a consent form before making the surgery. All of them had preoperative complete blood cell counts, urine cultures, bleeding and coagulation profiles, and renal function testing. Noncontrast CT, US, and intravenous urography are all part of the radiologic examination. Guyes' score was used to compute the stone burden. Hydronephrosis was classified as either moderate/severe or nil/mild using US standards.

In general anesthesia, patients were first placed in the lithotomy posture and a 5F ureteral catheter was put in. Patients were in the prone position and C-arm fluoroscopy was adopted to establish percutaneous access. Every pressure point had a cushion. The renal puncture was performed using the two access procedures that were previously described.[7-9,18] On the first postoperative day, plain radiography of the kidneys, ureters, and bladder was attained. On the second surgical day, the nephrostomy tube was removed from patients who had no stones and those who had clinically minimal leftover fragments (CIRF). After three months, all persons were subjected to a spiral CT scan. The findings were categorized as stone-free, CIRFs, or failed (residual stones). Four non obstructing, non infectious, and asymptomatic residual tiny parts were categorized as CIRFs.[15] Tefekli and colleagues presented a modified Clavien grading system for classifying problems.[19]

## Results

Over a two-year period, 200 patients with uncomplicated renal stones received PCNL. For renal access, the bull's-eye approach was employed in 100 persons (group 1), while the gradual descent method was employed in other 100 persons (group 2). Concerning stone size, average age, male/female percentage, body mass index (BMI), and grade of hydronephrosis, there were no statistically significant differences among the groups (Table 1). Table 1 illustrates the locations of renal stones in each group of patients. No statistically significant differences were noticed among the groups concerning stone position. Only the top and lower calyces were percutaneously accessed. For all persons who had stones in the renal pelvis, the posterior lower calix was the site of puncture, except for two individuals in group 1. By employing dilated upper pole techniques, the pelvic stone was shattered in these people. Take a look at Table 2.

Table 2 shows that group 2's gradual descent had reduced FST and operative time.

**Table1: Patient Demographics, Parameters of Stone, and Statistical Group Differences.**

| | | Group 1 (Needle Eye) | Group 2 (Triangulation) | P-Value |
|---|---|---|---|---|
| Gender | Male | 64 (64%) | 80 (80%) | 0.452 |
| | Female | 36 (36%) | 20 (20%) | |
| Stone Location | Pelvis | 32 (32%) | 40 (40%) | 0.615 |
| | Midpolar | 8 (8%) | 8 (8%) | |
| | Upper | 20 (20%) | 8 (8%) | |
| | Lower | 40 (40%) | 40 (40%) | |
| Hydronephrosis Degree | Nil or Mild | 52 (52%) | 56 (54%) | 0.823 |
| | Moderate -Severe | 48 (48%) | 44 (44%) | |
| BMI (mean) | | 30.2 | 27.4 | 0.115 |
| Stone size mean(Range) | | 465.3(419.2-517.6) | 397.7(288.5-475.5) | 0.340 |

The case persons in Grp 1 showed a substantially higher postoperative reduction in hematocrit than those in Grp 2 (3.2–7.4 vs. 2-4.5, P = 0.002). Nevertheless, the rate of blood transfusion was equal in all groups. In groups 1 and 2, total rates of success of 84 and 92 percent (such as CIRFs in 8 % and 12%, respectively) were attained (P = 0.0456). With remaining stones (four in group 1 and two in Grp 2) were treated with SWL as a supplementary treatment method. Both groups did not have a significant (Clavien grade IV) urosepsis complication. For urine leakage, two patients in Group 1 required a chest tube, and one patient in Grp 2 required a Double-J placement. Table 2 details the complications that were observed. Although group 1 had a greater complication rate, the difference was not statistically significant. In conclusion, there was no significant difference in hospitalization time between groups (P = 0.345).

**Table 2: Summarizes the Preoperative and Postoperative Findings.**

| | | Group 1 (Needle Eye) | Group 2 (Slow Descend Method) | P-Value |
|---|---|---|---|---|
| Duration of operation (minutes) | | 30-68 | 20-65 | 0.005 |
| FST (minutes) | | 1.4-4 | 1.1-3.5 | 0.003 |
| Targeted Calyx | Upper pole | 16 (16%) | 8 (8%) | 0.61 |
| | Lower pole | 84 (84%) | 92 (92%) | 0.43 |
| Stone free status | Free of stones | 76 (76%) | 80 (80%) | 0.92 |
| | CIRF8 | 8 (8%) | 12 (12%) | |
| | Rest | 16 (16%) | 8 (8%) | |
| Hematocrit decrease | | 3.2-7.4 | 2-4.5 | 0.002 |
| Hospitalization time (days) | | 1-10 | 1-4 | 0.345 |
| Complications | | 8 | 6 | 0.76 |

FST stands for fluoroscopic time of screening, and CIRF stands for clinically insignificant residual parts.

**Table 3: Showing Complications of both Groups.**

| Complications | Group 1 (Needle Eye) | Group 2 (Slow Descend Method) |
|---|---|---|
| Grade I Fever | 2 | 2 |
| Grade II Blood transfusion | 2 | 2 |
| Grade Urinary tract infection | 2 | 1 |
| Grade III Double J placement | 0 | 1 |
| Grade III Pneumothorax | 2 | 0 |
| Grade IV | 0 | 0 |
| Grade V | 0 | 0 |

## Discussion

Because PCNL is an endoluminal surgery carried out through a gate,appropriate access to the renal gathering system is important to the operation success. Failure of the acess may cause unfavorable consequences or the failure of the whole procedure to have best puncture we should go in a straight line between the skin and the infundibulum. Because it avoids significant artery damage, allows for greater endoscope mobility, and facilitates access to the calices, transparenchymal backside puncture of the calix is the desired method of entrance to the gathering system.[30] On the other hand, identifying the posterior calix in a 2D radiographic evaluation may be difficult. Michel *et al.*[31], postulated that the calix directly lateral to the medial calix (the 2nd calix) is mostly face posteriorly and have the most posterior placement. To make sure of sufficient access to the collecting system, one group recommended percutaneous lower-pole renal puncture with a focus on the second calix. In a different investigation, the posterior calix was identified by means of air reversing pyelography during percutaneous renal access.[32] Air pyelography, according to these authors, allows for speedier identification of the right entry point, does not obstruct the look of stone, and reduces exposure to radiation. For 84, 28, and 16 participants in this investigation, bottom, mid, and upper pole access was employed, respectively. The investigation revealed no statistically significant distinction among these groups' planned calibrations. We normally choose to puncture the lower posterior calix in order to gain access to individuals with pelvic stones in addition to those with stones that are renal midpolar. Although lower pole renal stones are more technically hard to remove owing to more heterogeneity in three-dimensional anatomy, upper-pole access has a higher frequency of thoracic complications. The 26–28 progressive descent strategy is typically utilized while approaching the lower pole.[23] In this experiment, three patients in group 2 were given upper-pole access. Among these patients, only one had a hemothorax. In group 2, one patient in group 1 had upper-calix access through the intercostal area, whereas in Gr3, high-calix access was conducted via the subcostal region. Additional crucial elements of the first percutaneous renal access include the kind of access, imaging modalities (e.g., fluoroscopy versus US), and the operator (urologist versus radiologist). It seems that US is more effective than fluoroscopy at preventing significant intrarenal vascular damage.[24] According to recent studies, using a colour US Doppler for guiding during PCNL dramatically reduces the rates of transfusion and blood loss.[25]

In Eastern and European states, the percutaneous renal access is designed by urologists themslves, but interventional radiologists typically perform access in the United States.[14,16,26,33] In research that made comparisons urologists' accesses to radiologists' accesses, the authors reported that patients whose access was taken by urologists had a much higher stone-free rate.[26,33] This gap might be attributed to radiologists' unfamiliarity with the PCNL process phases. In Table 2, Lu *et al.*[26] reported higher rates of complication in the radiologist-made access group, although Tomaszewski and colleagues discovered no substantial difference in access-related difficulties among groups. Nonetheless, no data was provided on the access strategy used in these experiments. Multiplanar fluoroscopic scanning is essential for a successful kidney puncture. Based on unique fluoroscopy projections, the needle's mediolateral and cephalad-caudad movements, as well as puncture depth, must be changed in both techniques (such as the leaning, perpendicular, and 30-degree positions).[9,18] Retaining the needle's alignment in various directions could possibily be hard and timewasting. Moreover, having access may require manifold tries. Slow descent (group 2) exhibited statistically significant decreased operating time and FST (P = 0.005 and P = 0.003, respectively). A modren study compared and contrasted a pair of access methods in an animal model. The researchers revealed that the learning curves of both procedures were similar, with the triangulation methodology having a greater FST.[17] Sampaio[23] proposed a change that eliminated the need to rotate the C-arm, thereby reducing exposure to radiation. According to the Clavien classification, blood loss requiring transfusion is a level II complication that is a common result of PCNL.[19] Bleeding rates were recorded as ranging from 0.8 to 45 percent.[19] Bleeding rates were recorded from 0.8 to 45 percent.[27-28] Bleeding is prevalent after percutaneous renal access, but it can be as a result of parenchymal damage during various aspects of the therapy, like tract dilation, stone breaking up, and stone elimination, or from vascular lesions produced by arteriovenous fistulae or pseudoaneurysms.[29] Extreme torque applied to the stiff nephroscope might cause kidney injury and bleeding.[9]

Patients with tough kidney stones and those requiring many accesses were excluded from this research to exclude the effect of stone type and the number of access on perioperative and postoperative parameters.

Furthermore, the size of the tract, nephroscope, dilatation type, and lithotripters used in both groups were equivalent. Diabetes and hypertension, for example, were shown to be independent predictors of bleeding risk. Patients suffering from such disorders, on the other hand, were not studied and hence were not included from the study. The size of the stones in all groups was comparable.[10] Hematocrit fell significantly higher in Grp 1 than in Grp 2 (7.6–3.7 vs 4.8–2.1, P = 0.001). This disparity might be explained by the triangulation method creating parallel access to the infundibulum. This method encourages the use of rigid devices while limiting excessive torque, which can cause parenchymal damage and bleeding.[34] Nonetheless, there was no statistically significant difference among these groups concerning transfusion proportions (5 percent versus 5 percent). Additionally similar were the two groups' rates of complications and overall success.

A series of factors, including the length of the procedure and hospital stay, the success of renal access, and the frequency of complications, interact. The effectiveness of this cascade depends on the acquisition of access effectively. Strong predictor of perioperative and postoperative problems, operational time is a perioperative metric affected by patient, stone, and operation-related variables.[12]

The most important parameters impacting operation times were revealed to be the existence of hydronephrosis, size and type of stone, and experience of operator. Kidney access to the hydronephrotic kidney may be simpler. Preserving renal access, on the other hand, could possibly be more hard in highly hydronephrotic kidneys. Exploration of distributed tiny parts of stone may cause the procedure to take longer.[11] In this paper, there was no significant difference in the grade of hydronephrosis among a pair of groups.

BMI is another sick person-related factor that influences process parameters. Because of restricted renal access, poor fluoroscopic vision, and confusing anatomic standards, the PCNL approach is more problematic in obese persons (BMI >30) than in nonobese ones.[33]

Extra subcutaneous and peri/pararenal adipose tissue may obstruct access to the proper calix in obese people, making 3D design difficult.[11] There were no obese people in this research, and the BMIs were equivalent in all groups.

Patients in this research had comparable stone kinds and sizes, and there was no discernible difference in operating times between the two groups using different access techniques.

## Conclusions and Recommendations

### Conclusions

our study reveals that PCNL is possibly performed safely by employing two access methods: the slow descent technique less operative time and less radiation exposure time. Both access techniques had similar hospitalization periods, and complication and success proportions. The slow descent was related with less blood loss owing to well alignment of accessing tract with the infundibulum, thus reducing the need for employing extreme torque.

### Recommendation

We recommend the both method for enterance to renal collecting system during pcnl, with shorter time and less exposure to radiation by the slow descent method

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