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Review

Percutaneous nephrolithotomy (PCNL) a critical review

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HIGHLIGHTS

- Percutaneous nephrolithotomy (PCNL) is the preferred treatment of choice for renal calculi.
- The usual indications for PCNL are stones larger than 20 mm, staghorn, partial staghorn calculi.
- The reduction in tract size in PCNl has reduced the complications without affecting stone clearance rate.

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ABSTRACT

Introduction: Percutaneous nephrolithotomy (PCNL) is the preferred treatment of choice for renal calculi. PCNL has evolved remarkably since the eighties when it was first described.
Approach: Approach might be by either supine or prone and the access is made with the help of either fluoroscopy or ultrasound. Recently endoscopy guided puncture has also been described.
Miniaturization: Traditionally the tract size for PCNL used to be 30Fr. Even though the stone clearance rate was good there were complications such as bleeding With the advent of excellent optics and advances in stone fragmentation the tract size has reduced to a great extent which has reduced the complications without compromising the stone clearance.
Complications: The complications related to access might be injury to pleura, and other visceral organs. The other complications are bleeding, infection and incomplete stone clearance.
Conclusion: PCNL has emerged as most efficient procedure among these approaches to stone removal, though not devoid of complications and requirement for skills. The drive for minimal invasive approach should not compromise stone clearance, latter being the core principle of endourology. In skilled hands PCNL is the answer to stone questions we as urologist face day to day. though which form of PCNL is to be chosen depends on surgeons skill level and discretion.

1. Introduction

Percutaneous nephrolithotomy (PCNL) is the preferred treatment of choice for renal calculi. PCNL has evolved remarkably since the eighties when it was first described.

The indications have changed over the years with the introduction of others techniques such as extracorporeal shockwave lithotripsy (ESWL) and flexible ureteroscopy. In the early years, large stones were treated with PCNL and smaller ones left for ESWL. The concepts have changed in context to miniaturization of instruments and advancements in energy and optics where even smaller stones are treated with PCNL with minimal morbidity and better stone clearance rates.

2. Indications of PCNL

The usual indications for PCNL are stones larger than 20 mm, staghorn, partial staghorn calculi. The contraindications for PCNL include pregnancy, bleeding disorders, uncontrolled urinary tract infections [1].

PCNL is the treatment of choice for large stone. PCNL attains stone free rates of upto 95%. AUA guidelines recommend PCNL as a treatment of choice for staghorn calculi. Larger stones in the lower pole are best managed by PCNL as the first treatment option [2]. Data from metaanalysis suggests that larger lower polar stones have lower clearance rates and higher retreatment rates [3]. PCNL is considered to be a gold standard in management of calyceal diverticular stones. In comparison to ESWL, PCNL has higher stone free rates with similar recurrence rates and complication rates [4]. The stone free rates for PCNL range in between 85 and 93%, the

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added advantage of PCNL include it provides excellent access for obliteration of the diverticular sac [5].

2.1. Pre operative evaluation

The preoperative evaluation involves a close study and analysis of imaging which includes a CT IVU. This helps in deciding the primary calyx of puncture through which the majority of the stone bulk is to be cleared, stones situated in separate calyces and which are unlikely to be cleared through the primary tract are also identified. The secondary tracts are usually created in these calyces. Recently staghorn morphometry is used in prediction of number of tracts and stages in which a stone can be cleared [6].This can be done by means of a software which uses the CT scan images to analyse the data.(3D-DOCTOR™; Able Software Corp., USA).

2.2. The approach

The choice of puncture either fluoroscopic or ultrasound guided is dictated by the calyceal anatomy and the surgeon expertise in a particular technique. Regardless of the choice of access ureteric catheter is placed in all cases.

The reasons for placement of ureteric catheter are as follows:-

1) The ureteric catheter helps in instillation of contrast or saline which in turn helps to opacify and or distends the pelvicalyceal system helping in percutaneous access.
2) If the endourologist decides to defer on placement of a double J stent a ureteric catheter will serve the purpose.
3) The ureteric catheter acts as a medial most reference point during dilatation of the PCNL tract. The dilators should not ideally overshoot this reference point.
4) The ureteric catheter in this place helps in inadvertent migration of broken fragments into the ureter.

2.3. Position for gaining access

2.3.1. Supine or prone PCNL

The conventional PCNL is done in a prone position. This allows direct access to the posterior calyx. In prone position, the bowels do not come in the line of puncture. PCNL can also be done in supine which has the advantages of combined ante grade and retrograde approaches easier switch of regional to general anesthesia and usefulness in patients with cardiac co morbidities. But in supine position, we would not be able to establish multiple channels and the space is limited. In Valdivia position, the operative time is more and it also has a less stone clearance rate. The Barts modification of Valdivia position uses both X ray and USG in combination [7].

Algorithm for management of renal calculus (EAU2016).

Renal stone(all but lower pole 10-20 mm)
>20 mm– 1)PCNL 2)RIRS or ESWL>
10-20 mm– ESWL or endourology
<10 mm – 1)SWL or RIRS 2)PCNL
Lower pole stone (10 -20 mm)
Unfavourable for ESWL ––endourology Favourable for ESWL –– ESWL

2.4. Choice of access

2.4.1. Ultrasound guided access

The obvious advantages of ultrasound guided access are well known, they include, no radiation, minimal chance of visceral injury and proven safety in pregnancy. The downside of using ultrasound as an access modality are need for expertise, need for fluoroscopy in dilatation stage of the procedure.

2.4.1.1. Technique. The sector probe (3 Mhz or 5 Mhz) is generally used for gaining access. The puncture is ether done free hand or using a needle guide. Depending on the make of the ultrasound probe, the puncture guide can be either situated on the side or the centre of the probe. The electronic dotted line in most cases corresponds to the path of the needle. For proper visualization of the needle an echo tip needle is useful. Alternatively the serrated side of the needle should face the probe.

The ultrasound probe should be scanned posterior to anterior. The first calyx to be seen would be the posterior calyx. The probe should thereafter be positioned in such a way that the calyx, infundibulum and the pelvis is seen. Ideally the needle should be seen throughout its course. The prerequisite for this would be a sharp needle or a motionless/steady probe. The site of needle entry should be marked on the skin. The needle is inserted with jiggling motion in the subcutaneous tissue thereafter the needle is advanced through the cup of the calyx into the desired calyx. Ideally the trajectory of the needle should be seen throughout the course. The appropriate puncture is confirmed with egress of clear urine.

3. Fluoroscopic guided puncture

3.1. Fluro guided PCNL

The advantages of fluoroscopic guided puncture are ability to gain access to the kidney through an end on posterior calyx. The obvious disadvantage of this approach is increased risk of radiation to the operator, patient as well as the surgeon. Further, unlike the ultrasound guided access there is no real time visualization of visceral organs such as the kidney or the liver, thus potentially adding to risk of injury to these organs.

Kidney should be approached from below the 12th rib to reduce the risk of pleural complications. The site of entry on the skin is usually just inferior and several centimeters medial to the tip of the 12th rib.

The triangulation technique is the commonest technique used for achieving fluoroscopic guided puncture. The C-arm is placed over the patient in the vertical position. A retrograde pyelogram is obtained, and the skin over the desired calyx is marked. The C-arm is then rotated 30° toward the surgeon for an end-on view of the posterior group of calyces. The skin site over the calyx is marked lateral to the first site. Move in a vertical line inferiorly until a site 1–2 cm below the 12th rib is reached. This third site is marked and serves as the site of needle entry. From this point, the needle is advanced to the junction of the vertical plane and the 30-degree plane. Access is achieved at the junction of all three axes [8].

The exact puncture can assessed by the parallax technique. In this technique the Carm is kept at 90° (A)and an access gained, once this is done the Carm is rotated 30° (B) towards the surgeon. If the position of the needle in (A) and (B) both are the same the access is gained.