12 Access in Supine Position

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12.1 Introduction

The most remarkable and constantly debated modifications that percutaneous nephrolithotomy (PCNL) has undergone are the tract miniaturization and the patient's position. Despite safety and effectiveness between the prone and supine positions being comparable, and the fact that surgeons should be familiar with both approaches, many advantages favor supine. Hence, several centers worldwide have set supine position as their standard practice. Moreover, mini-perc has proved better outcomes for small-medium size stones when compared to retrograde intrarenal surgery (RIRS), especially for lower pole ones. Similarly, smaller tracts have proved lower hemoglobin drop and transfusion rate when compared to standard size while maintaining the stone-free rates (SFR) [1–3].

When compared to prone, the supine position makes anesthesia administration and patient positioning easier and faster, improves ergonomics and upper calyx approachability from a lower pole access, makes it easier switching to an endoscopic combined approach when needed, and also might decrease intrarenal pressure and radiation exposure [2, 4].

When percutaneous renal access was first described and then largely adopted, it was performed in a prone position as surgeons theorized it was less likely to injure the colon [5]. However, thanks to cross-sectional imaging now, we can be aware of any retro renal structures in advance and evidence suggests these injuries are uncommon in a supine position as they are in prone. Colonic injuries occur in ~0.5% of cases, and the retro renal colon is the major risk factor. Retro renal colon can be defined as the presence of colon behind a line traced from the anterolateral aspect of the vertebral bodies to the renal hilum on computed tomography (CT) scan, as reported by Prassopoulus et al. [6]. However, Hopper et al. [7], found 4.7% of the significant retro renal colon in subjects in prone whereas only 1.9% in supine due to organs' displacement by gravity. Valdivia-Uría was the first to describe supine PCNL in 1987 and since then, many advantages for supine PCNL have been reported [6–10].

Thus, urologists adopting a supine approach must acknowledge these features and be minded with the anatomical orientation to feel comfortable with it. Furthermore, the decision of miniaturizing the tracts must rely upon proper patient selection to enhance success.

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12.2 Evolution of Percutaneous Renal Access

Creating a renal access was originally an open procedure aimed at urinary diversion; however, in 1955 the first percutaneous approach was reported, and 20 years later, the first percutaneous treatment of a stone [5, 11]. Currently, minimally invasive techniques have displaced old practices with image guidance, whether fluoroscopy, ultrasound, or endoscopic-assisted view; or a combination thereof. Moreover, the created tract can be safely used either for nephroscopy, lithotripsy, tumor treatment, among others [11, 12].

Percutaneous renal access techniques were mainly established in a prone position, under fluoroscopy and using standard size PCNL (i.e., 30F), but the constant refinements to these concepts have brought a wide variety of approaches. Two major techniques are commonly spread, from which many variations and simplifications have arisen: the bull's eye and triangulation technique.

Bull's eye is performed aligning the calyx, the needle, and the fluoroscopy's intensifier (rotated 30°) obtaining a bull's eye-like image on the monitor. Then, a needle is advanced, and its trajectory is continuously traced by fluoroscopy. The major drawbacks of this technique are the higher radiation exposure and its complexity; therefore, several modifications have been communicated.

In the triangulation technique basically, the mediolateral orientation is set in the monoplanar anteroposterior view (0°) and the depth is controlled with an oblique cephalad view (30°), implying less radiation but still facing some complexity, thus simplifications and refinements have been developed as well.

Currently, there is a wide variety of modifications and mixes of these techniques and are conducted with help of US and whether in prone and supine positions. Many centers have adapted their own approach; however, for learning and academic proposes, it is important to set a standardized and reproducible technique [13, 14].

Regardless, a recent preliminary study supports the feasibility of a non-papillary puncture [15], evidence points the safest way to access is through the papilla regardless of the positioning and imaging guidance. Furthermore, most surgeons gain their own access under fluoroscopy guidance or sometimes combined with US. Nonetheless, there is a current growing awareness to prevent ionizing radiation exposure; therefore, US-guided access and endoscopically assisted puncture have attracted interest [16, 17].

12.3 Access Guidance Methods

Fluoroscopy has played a major role in renal image-guided access as it provides surgeons many advantages that might not be replaced with US. New techniques have sought to decrease radiation exposure but going totally fluoroscopy-free is still risky especially for inexperienced surgeons, as the fluoroscopy images provide important information for collecting system anatomy, orientation, stones characteristics, and location, and are paramount when complications arise, as surgeons might detect contrast extravasation, opacification of surrounding organs, and it turns easier to go back into the urinary tract when accidentally slipping out or going through a false passage. On the other hand, US has the strength to identify organs interposed in the planned tract avoiding injures, and also can detect perirenal collections, along with the key feature of preventing radiation. To date, regardless of that X-ray-free PCNL has widely been described, the safest way is to always have both image modalities available [18–22].

12.4 Position and Technique Description

In the supine position, after intubation and anesthesia administration, the patient is pulled down toward the edge of the surgical table as if placed for standard lithotomy position. However, the stone side remains straight on half of the table and the contralateral leg on the stirrup. With this, we avoid the stirrup holder bumping with our instruments especially when trying to reach an upper calyx from a low pole access when some alignment of the scope onto the patient's body. Contralateral arm also remains straight and the stone sidearm is placed over the patient's chest high enough to avoid conflict with the C-arm of mobile fluoroscopy. The patient is slightly rotated from stone side toward the opposite side, and a tubular cushion is placed below the patient from the scapula to the gluteus. A good option is using a swimming noodle (about 7 cm in diameter). The patient is then pulled laterally toward the stone side and left 5 cm inside the metallic edge of the table in order to avoid interpose with fluoroscopy [2]. Figure 12.1 displays the final supine position. Once the patient has been properly positioned and landmarks are drawn, skin prepping and draping are then carried out, a flexible cystoscope is inserted via the urethra into the bladder and the respective ureteral orifice is identified and cannulated with a guidewire, over which an occlusion balloon is placed and inflated after performing a pyelogram. In our center, we still place an occlusion balloon at the ureteropelvic junction (UPJ) in the majority of cases as we consider it very useful to facilitate the puncture by dilating the collecting system.

Fig. 12.1 Giusti's supine position for percutaneous nephrolithotomy. The stone side remains straight with the patient near the edge of the table (about 5 cm inside) with a cushion roll (about 7 cm in diameter) positioned below the flank and the contralateral leg on stirrup. The safe zone for puncture (shown in green) is comprised between the safety landmarks of the posterior axillary line, costal flange, and iliac crest

12.4.1 Choosing the Best Calyx

The proper selection of a calyx must ensure the best chances to treat the whole stone(s), and this is mostly where the bigger part of the stone is located. However, other factors are important as well, such as ruling out organ interposition, ensuring going through the parenchyma and through the papilla, and puncturing within security zone. The proper assessment of a preoperative computed tomography scan is key when planning the access. The features to be assessed are kidney anatomy and location, stone characteristics with special regards to HU density, stone-to-skin distance, surrounding fat thick and surrounding organs, hydronephrosis and obstruction, retrorenal structures, and parenchymal thickness.

For stones located in the lower calyx and renal pelvis is always easier to access from the lower pole; for stones located in the middle calyx and ureteropelvic junction, the middle calyx might be the best option; and stones located in the upper pole are mostly reachable from the lower pole in supine unlike prone (Fig. 12.2), but in some cases and upper calyx puncture might be needed (Fig. 12.3).

Nonetheless, a thorough evaluation of the anatomy must be carried out in order to decide where the puncture would be best at. However, when stones are located in parallel calyces, it is unlikely to reach them from a single access; therefore, an extra access should be considered, otherwise using flexible equipment (i.e., mini-Endoscopic Combined Intrarenal Surgery) (Fig. 12.2d).

12.4.2 Choosing the Instruments

Mini-perc instruments are available from different companies, each with its own advantages and drawbacks. Usually, mini-perc set comes with two lengths: if supine position is supposed to be adopted, longer access sheaths and dilators are suggested in order to overcome the longer tract faced in this position.

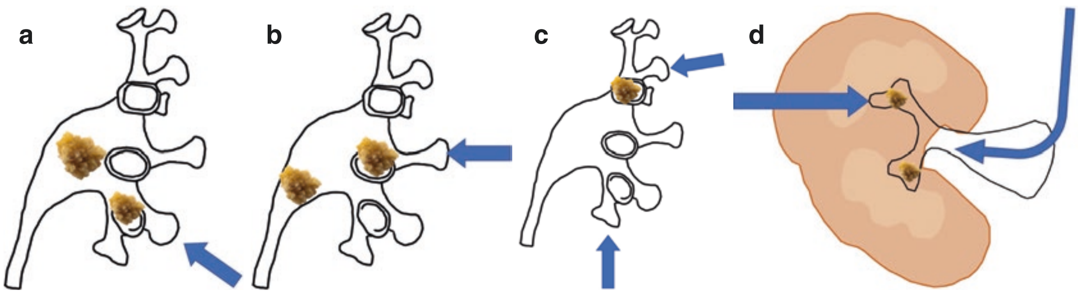

Fig. 12.2 Best approaches for different stone locations in mini-perc. (**a**), stones located in the lower pole and/or renal pelvis are better reached through a lower pole access; (**b**), stones located in the middle calyx and/or the ureteropelvic junction are better reached through a middle calyx access; (**c**), stones located and the upper pole are mostly reached through the lower pole or through an upper pole access; and (**d**), when facing stones in parallel calyx either a combined approach or additional access are needed to reach all the stones

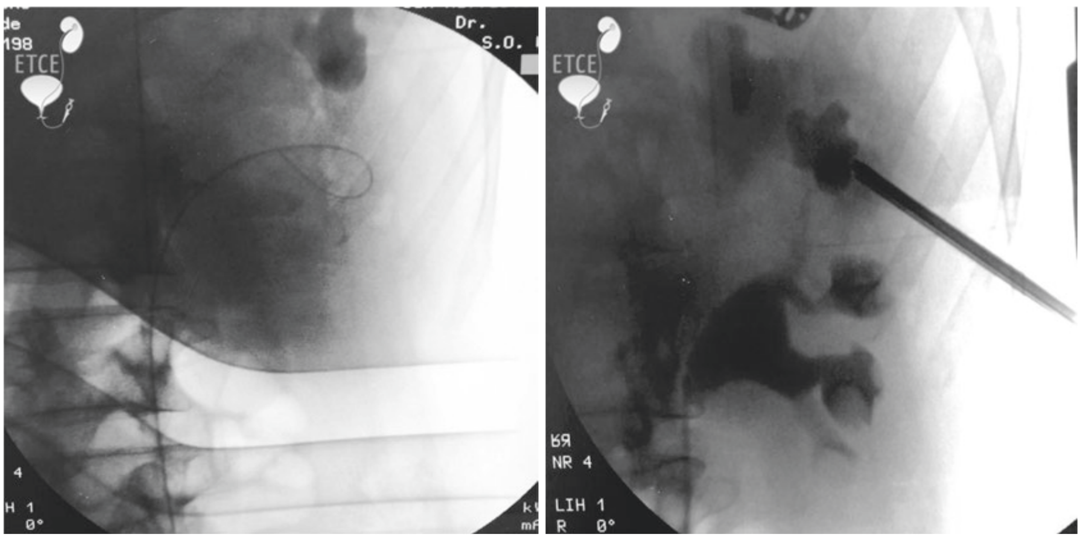

Fig. 12.3 Upper pole access for supine mini-perc

An important factor is having a difference between the access sheath and scope size of at least 3–4 Fr, in order to ensure low pressure in the kidney. Besides, bearing in mind that not all access sheath sizes fit flexible nephroscope, which are 16Fr, and can be very useful in rendering a patient stone-free. However, if the surgeon decides it is necessary to use a flexible nephroscope, it is always feasible to upsize the access. In Table 12.1, the most commonly manufactured mini-perc sets are enlisted.

12.4.3 Puncture

The wanted calyx is targeted by placing the needle over the patient by fluoroscopic biplanar view (0°) so the direction is set. Once achieved, the surgeon should back off with the needle toward the security zone and puncture the skin toward the previously set directions and with the needle in line with the infundibulum and parallel to the ground. While advancing the needle slowly and constantly checking fluoroscopically, as we

Table 12.1 Commonly manufactured mini-perc sets

Name	Company, Country	Access sheath (size × length)	Nephroscope (size × length)	Working channel* (Fr)
MIP-M	Karl Storz, Germany	15/16 Fr × 18 cm 16.5/15. Fr × 18 cm 21/22 Fr × 18 cm	12 Fr × 22 cm	6.7 (up to 5 Fr)
MIP-S	Karl Storz, Germany	(XS) 8.5/9.5 Fr × 18 cm (S) 11/12 Fr × 18 cm	7.5 Fr × 24 cm	2
Miniature Nephroscope	Richard Wolf, Germany	Continuous irrigation: 15 Fr × 20.5 cm 18 Fr × 20.5 cm Amplatz sheath: 18 Fr × 15 cm	12 Fr × 22.5	6
Mini Nephroscope	Olympus, Japan	NA	15 Fr × 23 cm	7.5 (up to 6 Fr)
Ultra mini nephroscope	SchöllyFIiberoptic GMBH, Germany	11 Fr × 22 cm 13 Fr × 22 cm Inner sheaths 6 Fr and 7.5 Fr	3 Fr	NA
Micro Perc	Guangdong Key Laboratory of Urology, China	7 Fr × 25.2 cm	3 Fr	3.3

*Some scopes have a combined irrigation/working channel and can accommodate instruments of different sizes, which are presented in parenthesis in the column
Information retrieved from manufacture's product brochure

are nearing the desired calyx, the kidney should move and the tip of the papilla should flatten, both signs of a proper depth and correct targeting. This may be easier to visualize by doing gentle push movements with the needle. Once the collecting systems have been reached, the inner part of the needle is removed to verify if urine comes out spontaneously. Conversely to prone, in supine position there is no need to aspirate with a syringe: if the needle is in, spontaneous dropping out of urine is determined by gravity. If urine does not come out spontaneously, puncture is not correct and the needle should be redirected. We suggest using an instillation mix with indigo carmine + contrast medium diluted at 50% with saline so that we ensure being inside the tract and, in case of a concomitant cyst, discriminating when puncturing it instead of collecting system. Moreover, in case of accidental loss of access, retrograde injection of the colored solution may highlight the previous path to get back into the collecting system avoiding a second challenging puncture.

If the needle is in the correct position in two-dimension fluoroscopic view but urine does not come out, it means that the correct depth is missing, and the needle must be redirected. Sometimes, when the puncture attempt fails the depth by just a few milliliters, minor direction adjustments are needed, by backing out of the kidney with the needle and advancing again with the adjusted directions. Otherwise, we can rotate the C-arm 30° toward the patient's head to see whether the needle is above the papilla, meaning the puncture is too posterior; or alternatively, the needle is below the papilla, meaning puncture is too anterior. Hence, the surgeon must back out of the kidney with the needle and safely readjust the directions by tilling down the hands to reach anteriorly or rising them up to reach posteriorly, as needed according to fluoroscopy vision (Fig. 12.4).

Fig. 12.4 In the monoplanar view (**a**) the needle might be aligned with the wanted calyx but missing proper depth. Thus, rotate the C-arm 30° toward the patient's head to notice whether the needle is displaced (**b**) below the papilla, meaning that the puncture was too anterior; or (**c**) above the papilla, meaning that the puncture was too posterior. Therefore, surgeons can realign the needle respectively with the C-arm back again at 0°

12.4.4 Dilation

With the needle properly positioned into the collecting system, a 0.038′ guide wire is inserted and advanced down to the ureter and a small skin and fascial incision are made with the scalpel. When facing difficulties cannulating the ureter, place a cobra catheter over the guidewire, remove the guidewire so that the cobra catheter can be twisted to negotiate the UPJ, and reinsert the guidewire down to the ureter. Then, an 8/10 Fr dilator is inserted, and a second guidewire must be placed for safety. Hence, one guidewire is placed into the dispenser coil and attached to the draping for safety, and the remaining guidewire is used to dilate the tract. After these steps, we are safely inside the urinary tract through the planned calyx, and therefore, the metallic dilator is placed over the guidewire by a gentle push and twist movements until inside the collecting system, always under fluoroscopic control.

Then, the metallic access sheath is placed over the dilator bearing in mind that it should be firmly held by the non-dominant hand and then removed, as the access has been safely and successfully created. Then, lithotripsy can be started (Fig. 12.5).

When facing a difficult access, a stepwise dilation is suggested. After having gained access into the collecting system with the guidewire, dilate the tract using a 9-Fr diameter set (i.e., MIP-S set) and commence nephroscopy including exploration of the entire tract to rule out eventual adjacent organ injuries and/or false passages or wrong tracts, making the needed adjustments under vision. Once assured the access is correct and injuries are ruled out, the tract size can be uneventfully increased to mini-perc or even standard PCNL.

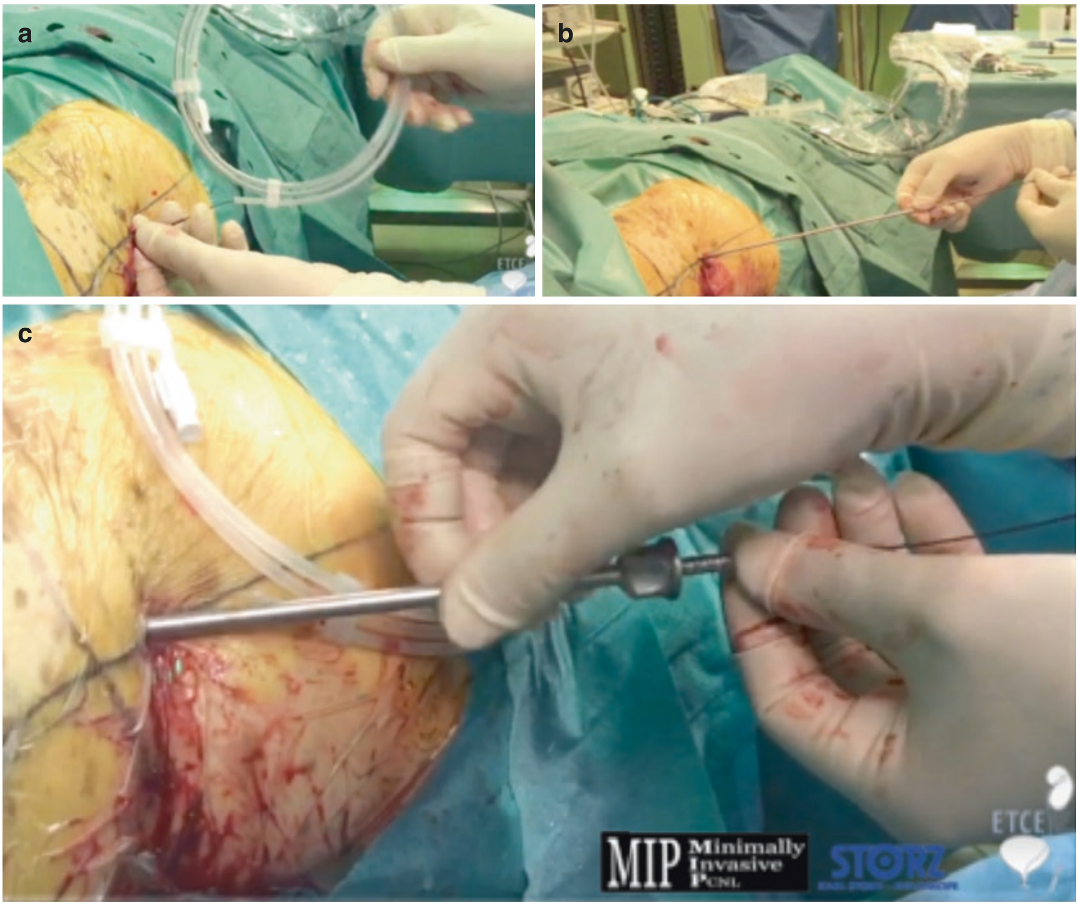

Fig. 12.5 Dilation of the tract. (**a**) once the guidewire is in, a second guidewire is placed and kept for safety in the dispenser coil attached to the drapes. (**b**) The metallic dilator is inserted into the collecting system over the guidewire, and then, (**c**) while firmly holding the metallic dilator with the non-dominant hand, the access sheath is placed over pushing and twisting forward

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