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TOPIC PAPER

PCNL in the twenty-first century: role of Microperc, Miniperc, and Ultraminiperc

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Abstract
Introduction The indications for PCNL have seen a paradigm shift in the past decade. In the earlier years, PCNL was done for large-volume stones such as complex multiple calyceal calculi, staghorn stones. The advent of miniaturization of instruments ushered in smaller scopes, smaller retrieval devices, and energy sources. The miniaturization of instruments also was responsible in the paradigm shift in the indications for PCNL. These miniaturized instruments and accessories obviate the need to dilate the tract beyond 20 Fr. Various studies in the past have confirmed that reducing the tract size potentially also reduces the complications of percutaneous surgery.
Materials and Methods In this article, we discuss the new developments in percutaneous surgery in the past decade with emphasis on techniques of Microperc, Miniperc, and Ultraminiperc.
Conclusion The newer techniques with Miniperc are suited for stones 1.5–2 cm in size. Microperc and Ultraminiperc may be suitable for stone sizes <1.5 cm. These are also suited for special situations such as diverticular stones and pediatric moderate-sized stones. The indications of these newer techniques compete with those of extracorporeal shockwave lithotripsy and flexible ureteroscopy.

Keywords PCNL · Microperc · Miniperc · Ultraminiperc

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Introduction

The indications for PCNL have seen a paradigm shift in the past decade. In the earlier years, PCNL was done for large-volume stones such as complex multiple calyceal calculi, staghorn stones. Various studies in the past have confirmed that reducing the tract size potentially also reduces the complications of percutaneous surgery [1]. This led to the concept to reduce the tract size and miniaturization. The advent of miniaturization of instruments ushered in the development of smaller scopes, smaller retrieval devices, and energy sources. The miniaturizations of instruments also were responsible for paradigm shift in the indications for PCNL. These miniaturized instruments and accessories obviated the need to dilate the tract beyond 20 Fr. In this article, we discuss the new developments in percutaneous surgery in the past decade with emphasis on techniques of Miniperc, Microperc, and Ultraminiperc.

Miniperc

Miniperc was first described in 1997 [2] with ureteroscopy sheath. Standard Miniperc technique was described with 12-Fr rigid nephroscope and 15-Fr sheath in 2001 [3]. This was the first time when the standardized instruments dedicated for Miniperc were developed. All the further steps in miniaturization occurred later. The Storz Miniperc system was developed 6 years later. Conventionally, Miniperc is the term coined for PCNL with tract size less than or equal to 20 Fr [4].

Miniperc has been shown to have equal stone-free rates and reduced morbidity, blood loss, pain compared to standard PCNL [5–7].

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Armamentarium for Miniperc (Fig. 1)

The two frequently used Miniperc systems are by Storz and Wolf. Storz Miniperc is also called as modular miniature nephroscope system with automatic pressure control. It is available in three sizes 15/18, 16.5/19.5, and 21/24 Fr sheaths. This describes inner and outer circumference of the sheath. It comes with its own dilators with end hole accommodating the glide wire. The other component of the assembly includes telescope with 6.7 Fr working channel for instrument up to 5 Fr with 22 cm length. There is an irrigation channel on sheath as well as on the working channel. However, the telescope can be used with any appropriate size Amplatz sheath. Eye piece is oblique.

Wolf Miniperc nephroscopes are available in two sizes, outer sheath size of 15 and 18 Fr.

It comes with its own dilators with end hole accommodating the glide wire. Nephroscope is common with 12° and 6 Fr working channel and 14 Fr size. However, the telescope can be used with any appropriate size Amplatz sheath.

Accessories of Miniperc (Fig. 2) (Storz and Wolf): 2- and 5-mm-diameter forceps are available (alligator type or triflange type or mouse tooth type). Because of small size of forceps, these are very delicate and liable to damage very easily. Stones can also be removed with baskets.

Miniperc procedure

Once perfect puncture is confirmed, then glidewire® (Terumo, Tokyo, Japan) is passed into the pelvicalyceal system. Following this, the dilator and sheath of respective Miniperc system is placed. The energy source for stone fragmentation is either laser or pneumatic. Stone fragments are either flushed out from kidney by irrigation through the ureteric catheter or stones are extracted by Nitinol basket or with forceps. Another advantage of Miniperc is it does not require forceps for the removal of fragments so it is less traumatic, quicker, and cheaper. If the fragments are sufficiently small enough to come out of the sheath, they can be removed by irrigation from ureteric catheter. The irrigation from ureteric catheter increases the pressure in pelvicalyceal system, and sheath is low pressure vent to this. This creates the so-called vacuum cleaner effect, and the fragments slip out of the sheath. This effect does not occur so prominently in standard PCNL as compared to Miniperc,

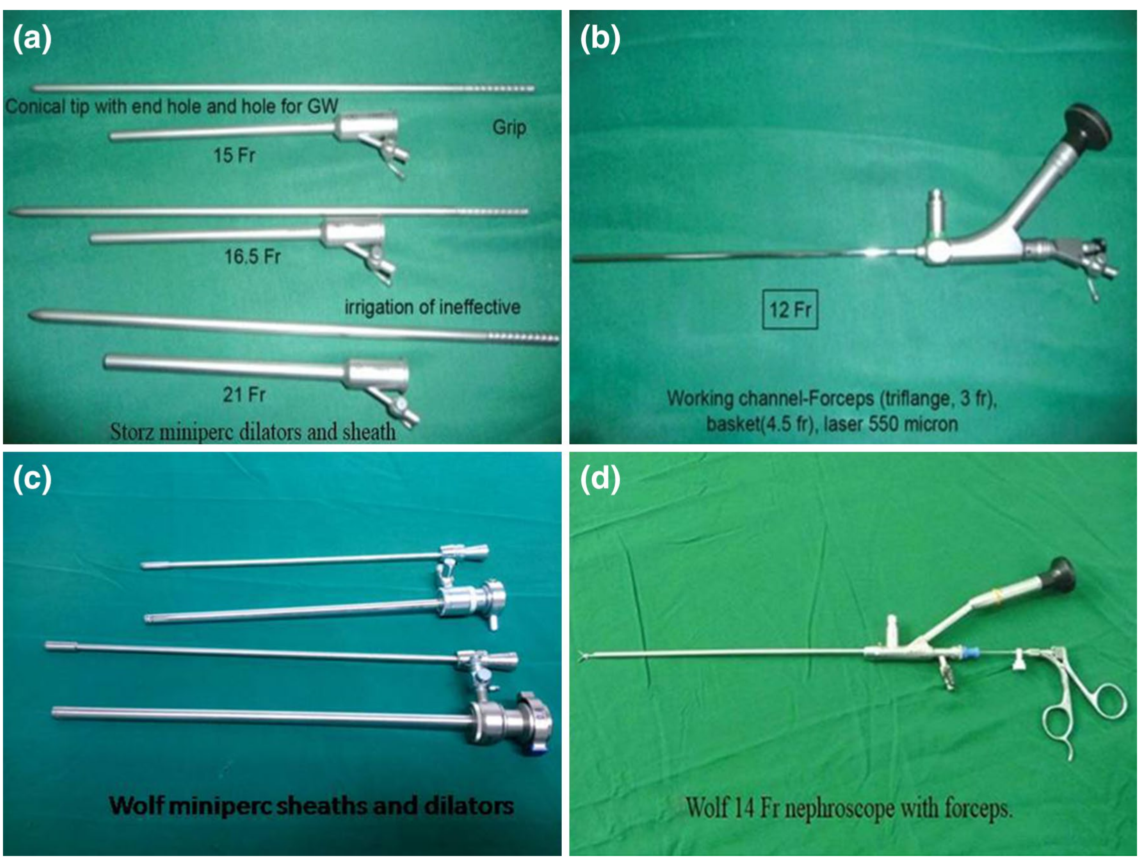

Fig. 1 **a** Storz Miniperc dilators and sheath. **b** 12-Fr nephroscope with specifications. **c** Wolf Miniperc dilator with Amplatz sheath. **d** Wolf 14-Fr nephroscope with forceps

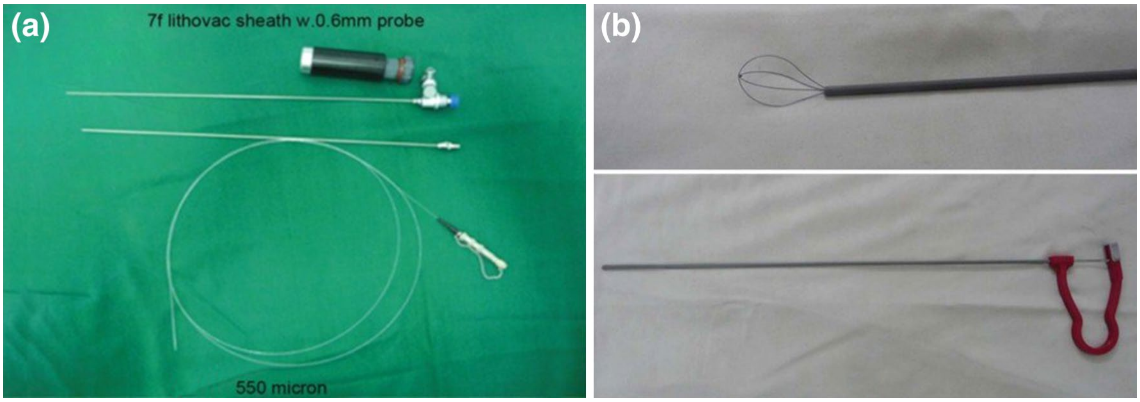

Fig. 2 Miniperc accessories

and this is the fundamental difference between these two types of PCNL. This difference is related to cross-sectional area of sheath, length of sheath, and weight of fragments formed in Miniperc compared to standard PCNL.

Another significant advantage of Miniperc compared to Ultraminiperc and Microperc is flexible and nephroscope can be easily passed in Miniperc sheaths. So during fragmentation or during irrigation if stone flies into different calyces, then they can be extracted with flexible nephroscopes. This cannot be done with Microperc and Ultraminiperc systems. The procedures if uneventful can be done as tubeless procedures. DJ or ureteric catheter may be placed at the end or procedure.

Current literature

Miniperc is associated with similar clearance rate as the standard PCNL but is associated with decreased hemoglobin drop, hospital stay, analgesic requirement, and complication rates [5–7]. These studies have compared Miniperc with standard PCNL for <2 cm size renal stones.

Microperc

Introduction

"How small can we go?" This was the hypothetical question and the basis of developing this technique. A "perfect" puncture is key to successful completion of percutaneous surgery. Markus Bader and colleagues presented their work of "see-through needle" for gaining access to the collecting system at the AUA meeting at San Fransisco, CA [8]. The concept was based on the fact that the "see-through needle" helped the surgeon to be sure that the puncture was accurate and into the desired calyx. Once the puncture was done, the rest of the procedure was completed as a standard percutaneous procedure. Desai and colleagues further developed the concept wherein the procedure was completed through the needle itself obviating the need to dilate the tract [9]. The key component of this new technique was excellent optics. This technique was christened as "Microperc." Theoretically, the advantage perceived was limiting and/or obviating the complications of tract dilatation.

Armamentarium

Basic armamentarium for a Microperc includes the needle (acts like a conduit for passage of energy source, optics, and irrigation), the optics (flexible), energy source (laser or ultrasonic lithotripsy), and irrigation through the pump.

The individual description of the components is as follows:

The needle

The needle is 4.8 Fr (1.6 mm) and is smaller in comparison with the currently used access needles for standard PCNL needles that are 1.3 mm in diameter.

The needle has three parts:

The parts of the needle are as follows (Fig. 3):

(a) The outer sheath acts as a conduit for passage of optics and energy source such as laser.
(b) The central part comprises of a beveled hollow needle.
(c) The innermost part is a radiopaque stylet. The needle assembly in addition comprises of an 8-Fr hollow sheath that can be used instead of the needle. This sheath is useful for tackling larger stone burden. If this sheath is used, the procedure is termed "mini-Microperc." An ultrasound probe can be used for the fragmentation of the stone for a "mini-Microperc."

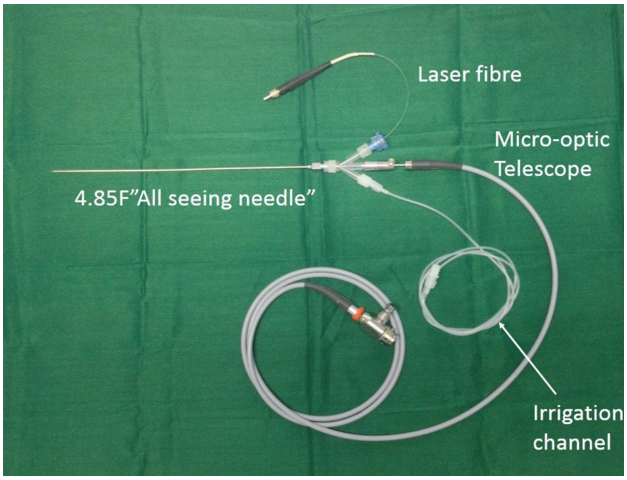

Fig. 3 Parts of Microperc assembly

Optics

The fiber optic telescope (10,000 pixels) was initially used for endoscopic inspection of the lacrimal duct. The unique feature of this telescope is its flexibility. It consists of microoptics 0.9 mm in diameter with a 120° of view and resolution up to 10,000 pixels.

Energy source

Laser is the choice for the disintegration of the calculus. The energy source should be set in such a way that the calculus is evaporated in dust rather than having larger fragments. The laser fiber used is 275 µm. If an 8-Fr sheath is used, an ultrasound energy source can be used.

The assembly

The completed assembly of a Microperc system includes the outer and middle beveled hollow sheath in place. The hub of the needle is compatible for the attachment of a three-way channel. One port of the channel offers attachment for entry of the laser fiber, the central port helps in insertion of optics, and the lateral port is reserved for irrigation. The assembly can be assembled and deployed after achieving access or can be inserted with the assembly in place, the latter being more cumbersome for the surgeon (Fig 3).

Indications for Microperc

In our center, we do Microperc for stones with house field units >1,200 and <1.5 cm, and for stones 1.5–3.0 cm, we perform Miniperc.

The contemporary indications are as follows:

1. Renal calculi less than 10 mm in size regardless of location.
2. Renal calculi in the lower calyx less than 10 mm in size not amenable to flexible ureteroscopy because of difficult anatomy (acute lower calyceal angle, long infundibulum).
3. Potential application in pediatric urolithiasis and anomalous kidneys such as ectopic kidneys.

Procedure

The technique of achieving access in Microperc mirrors that of a standard PCNL. Prior to commencing the procedure, a 8-Fr catheter is placed per urethrally. A larger catheter placed in the ureter helps easy egress of the irrigation and avoids build up of pressure in the pelvicalyceal system. The principle remains “short straight tract from the skin through subcutaneous tissue through the fornix into the desired calyx.” The importance of a perfect puncture cannot be overemphasized in Microperc. The puncture is achieved either under fluoroscopic guidance or ultrasound guidance. The assembly can be in position while achieving access, if such is the case the surgeon would be able to visualize the access tract, that is, he can see the needle traversing the skin subcutaneous tissue and then into the calyx. Once the access is achieved, the fragmentation is initiated, the intent being to dust the stone and not to create fragments. Important points pertinent to technique of Microperc are as follows:

1. It is of utmost importance that the puncture should be in the desired calyx. This is critical as in the event of the stone migrating into a distant calyx or an access into an inappropriate calyx, targeting the migrated stone could be challenging.
2. Any oozing from the puncture would hamper the vision; hence, the puncture should be optimal.
3. The potential hazard of rising intrapelvic pressures should be kept in mind. The consequences are mitigated by placing a large bore ureteric catheter in the ureter and pushing the irrigation fluid intermittently.
4. The currently available “Microperc” instruments lack the ability to mechanically remove the fragments, and hence, the stone should be dusted and not fragmented.

Current literature

Success rates

The stone-free rate following Microperc is reported in the range of 85–93 %. Desai et al. [9] reported the stone-free rate of 90 %. The stone-free rate in lower calyceal calculi was 85.7 % [10]. In series of 30 patients, Armagan et al. [11] reported a stone-free rate of 93 % in medium-sized renal calculi.

In a recent comparison between Microperc and RIRS, the stone-free rates in the Microperc and RIRS groups were not statistically different (97.1 vs. 94.1 %, $P = 1.0$). The operating time was similar in both the groups. Complications and hospital stays were similar in either of the groups. No patient in the study in either of the group required blood transfusion. The authors concluded that, for the management of small renal calculi, Microperc is as safe as RIRS. This study suggested that the RIRS is associated with higher need for the placement of DJ stents, whereas Microperc causes more hemoglobin drop, increased pain, and higher analgesic requirements [12].

Microperc in children

Microperc is a technically feasible, safe, and efficacious modality in treating renal calculi in pediatric age group. At our center, we performed a study assessing feasibility of Microperc in children. The mean age was 8.5 ± 4.4 years (11 months–15 years). Average stone size was 13.3 ± 4.7 (7.5–24.9) mm. One patient had extravasation, which was managed with nephrostomy drainage. Mean hemoglobin drop and hospital stay were 0.5 ± 0.2 g/dL and 2.1 ± 0.8 days, respectively. Two patients (13.3 %) had Clavien grade 1 complication in the form of fever and flank pain. 14 (93.3 %) children were stone-free at 1 month with one (6.7 %) requiring Miniperc for the clearance of residual fragments in the follow up.

The perceived advantage in this age group is no need to dilate the tract in small kidneys, thus potentially avoiding complications.

Ultraminiperc (UMP)

Decreasing the tract size will further decrease the complications maintaining similar stone-free rate. This is the basis to further narrow the tract size. Desai et al. [13] described the Ultraminiperc (UMP) technique.

Armamentarium and procedure

The important component of UMP is a novel 6-Fr Mininephroscope. This Mininephroscope can be passed through an 11- to 13-Fr metal sheath. Stones are fragmented with laser. Single-step dilation is achieved under ultrasound or fluoroscopy control [13], a unique feature of this technique is the availability of the side channel on the metal sheath. This can be used for irrigation and/or egress of fragmented stones.

Procedure

The fragmentation is done with a 200- to 300-µm laser fiber at 10–20 W. The vision is maintained with an irrigation pump. The irrigation pump offers the dual purpose of a good vision and clearing the fragments through the working channel of the sheath [13].

Indications

There is a paucity of literature as regards the results of UMP. Current data suggest that UMP is indicated in moderate-sized stones [13].

Current literature

The mean stone size was 14.9 mm. The mean operative time was 59.8 min. The stone-free rate at first postoperative day and first month was 88.9 and 97.2 %, respectively. The average hospital stay was 3.0 ± 0.9 (2–5) days. Complications included sepsis in 2 cases, urinary extravasations in 1 case, and fever in 3 cases. No patients needed blood transfusion. In none of the cases did the authors place anephrostomy tube. The authors in this paper however admit that due to the lack of appropriate device, the fragment retrieval becomes challenging, thus increasing the operative time [13].

Conclusions: smaller tracts: the changing paradigm

The newer techniques with Miniperc are suited for stones 1.5–2 cm in size. Microperc and Ultraminiperc may be suitable for stone sizes <1.5 cm. These are also suited for special situations such as diverticular stones and pediatric moderate-sized stones. The indications of these newer techniques compete with those of extracorporeal shockwave lithotripsy and flexible ureteroscopy.

The concerns remain for raised intrapelvic pressures and inability to retrieve larger fragments. Larger multi-institutional studies and innovations in optics may partly solve these outstanding issues

Conflict of interest None.

Ethical standard The data presented by the authors have been approved by the appropriate ethics committee and have therefore been performed in accordance with the ethical standards laid down in the Declaration of Helsinki 1964 and its later amendments.

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