Symposium

Current role of microperc in the management of small renal calculi

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ABSTRACT

'Microperc' is a recently described technique in which percutaneous renal access and lithotripsy are performed in a single step using a 16 G micropuncture needle. 'Mini-microperc' is a further technical modification in which an 8 Fr sheath is used to allow insertion of ultrasonic or pneumatic lithoclast probe with suction. The available evidence indicates that microperc is safe and efficient in the management of small renal calculi in adult and pediatric population. It can also be used for renal calculi in ectopic kidneys and bladder calculi. The high stone clearance rate and lower complication rate associated with microperc make it a viable alternative to retrograde intrarenal surgery.

Key words: Laser lithotripsy, microperc, percutaneous nephrolithotomy, small renal calculi

INTRODUCTION

Urolithiasis is a common disease with globally increasing incidence and significant socio-economic implications.[1,2] The management of renal calculi has evolved considerably in the last four decades. The ideal treatment would be complete stone clearance in a single session without any trauma to the patient and prevention of any new stone formation. Though we have not yet achieved this, the available treatment modalities are continuously being modified to improve efficacy while minimizing complications. Percutaneous nephrolithotomy (PCNL), retrograde intrarenal surgery (RIRS) and shockwave lithotripsy (SWL) are the current management options for small renal calculi.[3]

PCNL, which was first described in 1976[4] has become the procedure of choice for large burden renal calculi and a management option for small renal calculi.[3] Though PCNL has a good stone clearance rate, it is associated with significant risk of complications.[5] Over the years, many modifications have occurred in the technique and instrumentation to reduce its morbidity and improve its efficacy. Most of the complications associated with PCNL including bleeding, calyceal and infundibular tear, persistent urine leak and nephron loss can be attributed to the size of the tract.[6,7] Bleeding still remains a significant morbidity with PCNL.[5,6] While most bleeding associated with PCNL can be managed conservatively, approximately 0.6-1.4% of patients require angioembolization to control intractable bleeding.[8] Traditionally, PCNL required a 30 Fr nephrostomy sheath for renal access. With the development of smaller sheaths it was found that mini-PCNL or "miniperc" could be performed with minimal damage to renal parenchyma, thereby reducing the procedure related morbidity without diminishing its therapeutic efficacy.[7,9]

Micro-PCNL or "microperc" is a recently described minimally invasive PCNL technique, which is performed using a 16 G microperc needle.[10] In this article, we describe the technique of microperc and review the recent literature regarding the current role of microperc amongst the other treatment options for the management of small renal calculi.

Technique of microperc

The procedure is usually carried out under general anesthesia. However, it can be performed under regional anesthesia if required. In lithotomy position, a 7 Fr ureteric catheter is placed through the ureter into the renal pelvis

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under cystoscopic and fluoroscopic guidance. Multiple side holes are made in the distal 5 cm of the ureteric catheter to improve the drainage and prevent clogging by stone fragments and blood clots. The ureteric catheter is fixed to 16 Fr urethral catheter and the patient is turned to prone position.

The pelvicalyceal system is gently filled with saline injected retrograde through the ureteric catheter. This creates a mild hydronephrosis, which aids in ultrasound-guided calyceal puncture. The 16 G microperc puncture needle [Figure 1] is placed into the puncture guide attachment. The use of this attachment facilitates percutaneous renal access.[11] An ideal puncture would be one that leads straight from the skin puncture site through a papilla and the target calyx into the renal pelvis along the line of the infundibulum. Usually, the stone containing calyx is targeted; if the stone is in the renal pelvis, either middle or lower calyceal puncture is preferred. Once proper puncture is achieved, the stylet is removed and antegrade contrast study is performed. If required, the puncture can be adjusted at this step under fluoroscopic guidance. However, puncture can also be achieved with fluoroscopic guidance, wherein contrast is injected from ureteric catheter and percutaneous renal access achieved. Preference of calyx remains the same as described above.

After appropriate calyceal access, a three-way connector is attached to the needle. This connects saline irrigation tube, a 'Touhy Borst' adapter to allow 272 μm laser fiber and a 0.9 mm flexible microperc telescope [Figures 2 and 3]. Saline irrigation is carried out using a mechanical pump with foot pedal control. Saline irrigation is kept to a minimum, which is just enough for proper vision. Generally, intermittent saline irrigation with a flow rate of 100 ml/min provides good vision without increasing intrarenal pressures. The ureteric catheter drains the pelvicalyceal system continuously. Intermittent manual suction through the ureteric catheter further reduces the intrarenal pressure. The stone is completely fragmented with laser. Ureteric catheter is removed along with Foley catheter in first post-operative day. Patient is discharged in first post-operative day if there is no complication.

Modifications in microperc

Since the microperc needle is of narrow caliber, it can bend if it is manipulated inside the pelvicalyceal system. Moreover, there is a theoretical risk of parenchymal tear if there is excessive intrarenal manipulation. In order to overcome these problems, an 8 Fr metallic sheath has been developed [Figure 4a]. This so-called "mini-microperc" sheath allows the attachment of the same three-way connector with accessories as in standard microperc. The sheath allows intrarenal manipulations from one calyx to

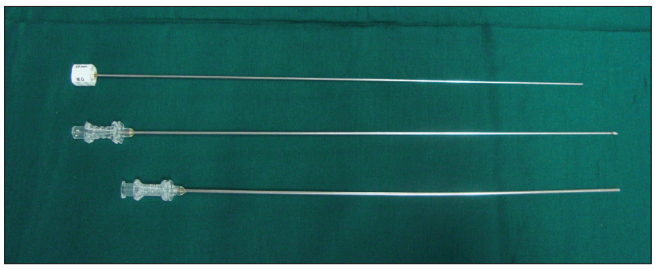

Figure 1: Three part microperc needle

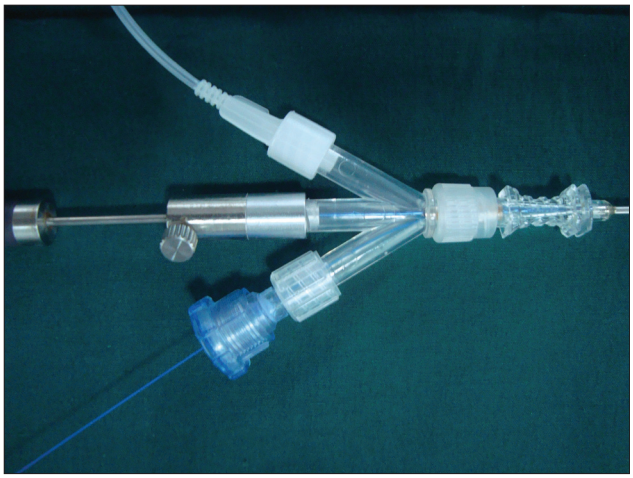

Figure 3: Close-up view of three-way connection

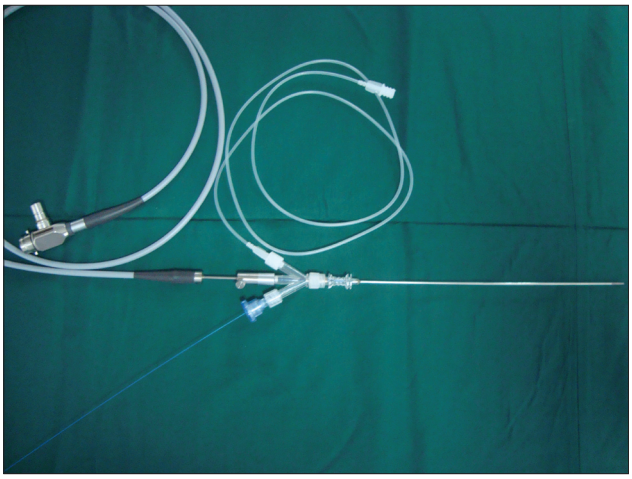

Figure 2: Setup of microperc armamentarium

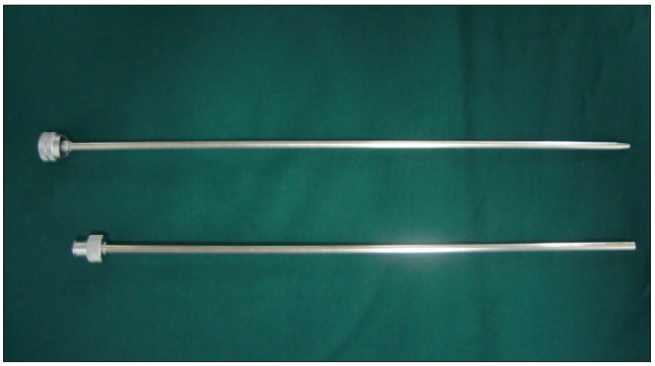

Figure 4a: Mini-microperc sheath with obturator

another. Another important advantage of mini-microperc is the ability to insert a 1.6 mm ultrasonic lithotripter, which can fragment and suck the fragments out of the kidney [Figure 4b]. Penbegul *et al.* described the use of 14 G (6.6 Fr) angiocath, which can be used as an amplatz sheath in pre-school children.[12] The microperc telescope has a 0.9 mm working diameter with 10,000 pixel resolution.

Efficacy

The stone clearance rate reported with microperc ranges from 85% to 93%.[10-12] In the initial report by Desai *et al.*, which included 10 patients, the mean stone size was 14.3 mm and clearance rate was 90%.[10] Piskin *et al.* reported a stone clearance rate of 85% at 1-month follow-up in a series of 11 patients with a mean stone size of 12.8 mm (range 7-18 mm).[13] The stone clearance rate in lower calyceal calculi (mean size 17.8 mm) was 85.7%.[14] This series included patients with failed RIRS or SWL also. Recently, Armagan *et al.* reported a stone clearance rate of 93% in a series of 30 patients with moderate sized renal calculi (mean size 17.9 mm, range 10-30 mm).[15] In our recently concluded randomized trial comparing microperc with RIRS, the stone clearance rate was 97.1% in microperc group (article under publication).

Complications

In general, complications with microperc are lower when compared with standard PCNL complications. The mean hemoglobin drop associated with microperc ranges from 0.8 g/dl to 1.4 g/dl.[10,13,14] Need for blood transfusion or angioembolization has not been reported so far. Some patients may require conversion to miniperc if the vision is poor due to clots formed during percutaneous access. The need for conversion to miniperc was 10% in the management of moderate sized calculi.[14] Other rare complications include ureteric colic requiring double-J stenting and urinary tract infection.[13] Though urosepsis is a potential complication in view of the closed system irrigation, it has not been reported so far. This is probably due to proper pre-operative preparation and low intra-renal pressure maintained by controlled irrigation and drainage from large bore ureteric catheter. Another potential problem could be stone migration. Since microperc is a rigid instrument, retrieving a migrated stone fragment will be difficult. However, stone migration is low with careful holmium laser lithotrispsy in an undilated pelvicalyceal system. The mean hospital stay is short and ranges from 36 to 56 h.[10,14,15]

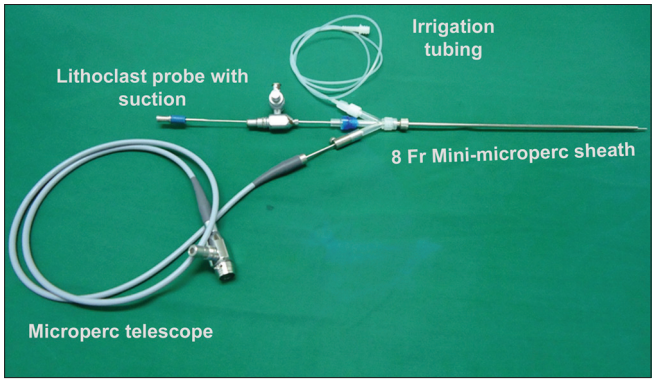

Figure 4b: Mini-microperc setup with lithoclast probe

Microperc versus miniperc

Miniperc is a multistep procedure similar to standard PCNL, except for the smaller tract size. In contrast, microperc is a single step renal access with fragmentation procedure. Thus the complications related to tract size and multiple steps in miniperc can be expected to be lower in microperc. However, there are no studies comparing these procedures. The advantage of miniperc is the ability to retrieve fragments easily. In microperc, this can be achieved using mini-microperc sheath and ultrasonic lithotripter. We prefer microperc for renal calculi less than 1.5 cm in diameter with computed tomography Hounsfield units >1200 and miniperc for renal calculi 1.5-3 cm in diameter.

Microperc versus RIRS

The stone clearance rate achieved with RIRS ranges from 84% to 97% and it has a low risk of complication with small renal stones.[16,17] However, in lower calyceal calculi, the stone clearance rate falls, especially if the lower calyceal infundibulum is narrow with an acute angle. The drawbacks of RIRS include the need do a staged procedure if ureter could not be dilated, higher cost, need for multiple sessions to improve stone clearance, risk of ureteric damage and higher requirement for ureteric stenting.[18,19] In our randomized controlled trial comparing microperc with RIRS, we found similar stone clearance rate and low risk of complications in both the procedures (under publication). RIRS has favorable post-operative pain scores and a lower hemoglobin drop. Microperc is associated with a better surgeon comfort and lower need for double-J stenting. Thus, microperc could be considered as a safe and effective alternative to RIRS in the management of small renal calculi. The advantage of microperc will be especially evident in lower calyceal calculi.

Microperc can be potentially advantageous in the pediatric age group.[20] RIRS is associated with a small but significant risk of injury to the delicate pediatric ureters.[21] In a series of 170 children undergoing flexible ureteroscopy, 57% required passive dilatation of the ureter for 1-2 weeks before ureteroscope could be inserted into the ureter.[22] In comparison, it will be possible to perform a microperc in the first setting in nearly all children. Flexible ureteroscopes have a short life span and high cost of maintenance. Cost comparison between microperc and RIRS has not been performed so far. However, in view of the short and straight telescope without any deflection mechanism, microperc instrument will probably be more economical and long lasting than RIRS. There are important differences in the training of these procedures. While RIRS needs a

structured training program with virtual reality or high fidelity non-virtual reality models, microperc can be more easily mastered by any Urologist who is trained in standard PCNL.[23,24]

Microperc versus SWL

The main drawbacks of SWL are the need for multiple sessions and auxiliary procedures to achieve stone clearance.[25] This aspect is especially relevant in developing countries where patients travel from far off places to get treatment, with no access to emergency healthcare. In contrast, microperc is associated with high stone clearance in a single, short hospital stay.[14] Cochrane review has shown that efficiency quotient of PCNL was higher than SWL for the management of renal calculi.[26] In India, about 75% of renal calculi are composed of calcium oxalate monohydrate.[27] Thus, a significant group of patients have hard stones with high Hounsfield units, which are difficult to fragment with SWL.[28]

Microperc in unusual situations

Microperc has been shown to be safe and efficacious in the pediatric population in case reports and series.[10,20,29] Since this procedure is still in its early stages of development, there are no large series or prospective studies in the pediatric age group. In pre-school children, 14 G angiocath can be used similar to amplatz sheath in PCNL.[12] Since the length of angiocath is limited, it cannot be used in older children or adults. The disadvantages with the use of angiocath is that the initial puncture has to be performed using a larger bore needle and that it is structurally different from the routine PCNL puncture needles the urologists are used to.

Microperc could be advantageous in pelvic ectopic kidneys. We have performed microperc for small renal calculi in pelvic ectopic kidneys in two patients (under publication). One of these patients presented to us after a failed RIRS due to poor vision. In these patients, a sand bag was placed under the ipsilateral hemi-pelvis to move the overlying bowel away from the kidney. Using the ultrasound probe to confirm the absence of any intervening bowel and Doppler to rule out any major vessels, percutaneous renal access was obtained through anterior abdominal wall and complete stone clearance was achieved in both the patients without any complications. In pelvic ectopic kidneys, microperc can also be performed under laparoscopic guidance similar to conventional laparoscopy guided PCNL.[30]

Current role of microperc

Microperc is still in its early stages of development. It is currently used to manage single renal calculus or multiple renal calculi, which can be accessed with a single puncture and cumulative diameter of less than 1.5 cm in diameter. Though it can be used in intermediate sized calculi, it is preferable to use mini-microperc so that the fragments can be removed from pelvicalyceal system. It can be safely used in the pediatric age group, ectopic kidneys, chronic kidney disease and bladder calculi.[10,13,30] Compared with SWL, both PCNL and RIRS have a higher stone clearance rate, albeit with a higher complication rate.[27,29] Microperc can provide the high stone clearance rate associated with PCNL without its morbidity. It is a safe and effective alternative to RIRS in the management of renal calculi less than 1.5 cm. Prospective randomized studies comparing microperc with SWL will help to establish its role relative to SWL.

CONCLUSIONS

Microperc is an emerging minimally invasive PCNL technique. The high stone clearance rate and lower complication rate associated with microperc make it a viable alternative to RIRS. Moreover, it is associated with lower risk of ureteric trauma and lower need for prolonged post-operative ureteric stenting.

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