



# 'Microperc' micro percutaneous nephrolithotomy: evidence to practice

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## Purpose of review

Miniaturization of instruments in percutaneous nephrolithotomy (PCNL) has spawned an interest in so-called 'microperc' in which the procedure is carried out through 16-gauge needle.

## Recent findings

The greatest limitation of extracorporeal shock wave lithotripsy is its unpredictable results. The main limitation of retrograde intrarenal surgery is high sustainable cost and poor durability. The main limitation of PCNL is its invasiveness and associated morbidity. The interest in reducing the tract size was to potentially reduce the invasiveness of the procedure, and, therefore, attending complications. In a historical study, postrenal biopsy bleeding was found to be significant only after the tract of the needle was less than 16 gauge. Microperc extended the concept of 'All-seeing needle' to perform PCNL through a 4.85-Fr (16 gauge) tract. The working hypothesis of the 'All-seeing needle' is that if the initial tract is perfect, then the tract-related morbidity could be reduced. The optical needle helps to avoid any traversing viscera and confirms the visual cues of a correct papilla. The other advantage of microperc is that it is a novel single-step renal access procedure, resulting in a shorter insertion to lithotripsy time. This may provide a new standard of obtaining renal access.

## Summary

Only a few published studies have documented efficacy and safety. Till further prospective and multicentric articles are published, it is still an experimental procedure requiring further research.

## Keywords

All-seeing needle, microperc, percutaneous nephrolithotomy

## INTRODUCTION

Minimal-access surgery has revolutionized the entire field of urological surgery over the past 50 years. Fundamental advances in optics, illumination, television application, instrumentation, and operative radiology have resulted in the advanced state of the technology [1]. Further to the miniaturization of surgical instruments, we are progressing to a state of futuristic surgical applications.

In percutaneous renal access surgery, Bader *et al.* [2<sup>\*</sup>] described their initial experience of using a microoptical system through a specific puncture needle to confirm the quality of the chosen access prior to dilatation of the operating tract using microoptics of 0.9 and 0.6 mm diameter. The microoptic with integrated light lead was inserted through the working sheath of the puncture needle. The modified needle had a 1.6 mm (4.85-Fr) outer diameter. The optical fiber was connected via a zoom ocular and light adapter to a standard endoscopic camera system. The optical puncture needle was used in

15 patients for renal access prior to standard percutaneous nephrolithotomy (PCNL) procedures. They concluded that optical puncture needle for PCNL was most helpful for confirming the optimal percutaneous access to the kidney prior to dilation of the nephrostomy tract, improving the safety of the technique. Later on, Desai *et al.* [3<sup>\*\*</sup>] reported the first technical feasibility and safety study of one-step percutaneous nephrolithotomy using the previously described 4.85 Fr All-seeing needle. They defined 'microperc' as modified PCNL in which renal access and PCNL was done in one step using the all-seeing needle. The purpose of this review is to

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**Curr Opin Urol** 2012, 22:134–138

DOI:10.1097/MOU.0b013e32834fc3bb

## KEY POINTS

- Microperc is the only documented miniaturized percutaneous nephrolithotomy procedure.
- Efficacy of microperc has been demonstrated in a few initial studies.
- Till further articles are published, it is still an experimental technique.
- It may fill the void for retrograde intrarenal surgery and extracorporeal shock wave lithotripsy (ESWL) failure cases.

gather evidence for its possible role in endourology in future.

## MATERIAL AND METHODS

A MEDLINE search was done on articles printed in the last 10 years keeping key words of microperc and All-seeing needle. This retrieved only two abstracts. A further search was done keeping the limits of PCNL, tract size, complications, miniperc, flexible ureteroscopy, retrograde intrarenal surgery (RIRS), ESWL, and renal stone 1–2 cm size. The abstracts retrieved were in all languages, age groups, and consisted of reviews, meta-analysis, randomized controlled trials (RCTs), prospective study, clinical trials, consensus meetings, and guidelines. A total of 590 abstracts were then selected for the relevant manuscript and 90 were shortlisted. This was further reduced to 40 abstracts relevant for the review.

## RESULTS

The greatest limitation of ESWL is its unpredictable results. The lower pole anatomy has always been an area of dispute for SWL. Prognostic variables affecting the results are patient characteristics, stone characteristics, and the spatial anatomy of the lower pole, as defined by infundibular length, diameter, infundibulopelvic, and infundibuloureteropelvic angles as well as the pattern of dynamic urinary transport [4–8]. Srisubat *et al.* [9<sup>¶</sup>] did a Cochrane database meta-analysis between the three treatment modalities currently available for small bulk renal urolithiasis. The authors concluded that a clearance rate with PCNL was the highest, whereas ESWL compared equivocal with RIRS. Also, other comparative trials have yielded better results with PCNL than either RIRS or ESWL [10–12].

The main limitation of RIRS is recurring cost. van Hove *et al.* [13<sup>¶</sup>] did an economic evaluation of RIRS and found it to be an expensive modality, being sustainable only in cases of high-stone

workload. Monga *et al.* [14] did a durability study of the flexible ureteroscopes and found requirement of frequent repairs depending on the frequency of use, minutes of use with an instrument in the working channel, and lower pole lithotripsy deflection. Even with the newer generation flexible scopes, durability in ex-vivo trials is high but still remains the primary one in in-vivo trials [15]. There is a concern that after RIRS, lower calyceal fragment reaccumulation occurs, which is a cause of recurrence and suboptimal stone-free rate [12]. RIRS is likely to result in remarkable infectious complications and less satisfying stone-free rates if performed in the presence of pre-existing tubes or prior urinary tract infections [16].

The main limitation of PCNL is its invasiveness and associated morbidity. CROES global data on PCNL [17] showed the probability of bleeding complications was higher with larger sheath size [18]. The interest in reducing the tract size was to potentially reduce the invasiveness of the procedure and, therefore, attending complications. Three prospective comparative studies addressed the issues of efficacy and enhanced safety of reducing the tract size [19–21]. These studies demonstrated significant advantages of the miniperc procedure in terms of reduced bleeding and hospital stay while maintaining similar stone-free rates.

There are many different constructs for acquiring the necessary skills for a standard PCNL. These different constructs after making the patient prone with an appropriate sized ureteric catheter are initial ultrasound or fluoroscopic access, placement of a guide wire in the system preferably ureter, removal of initial puncture needle keeping guide wire, serial dilation of the tract with resultant tract bleeding during the maneuvers, and finally placing amplatz sheath after removing the tract dilators. These individual constructs in addition to being time-consuming often also have the disadvantages like fluoroscopic time and radiation, tract bleeding, and inadvertent complications such as calyceal infundibular tear and pelvic perforation during tract dilation. One of the solutions to this problem could be devising the PCNL in such a way that the entire procedure is performed in a single step without dilation and without the need for multiple maneuvers for access, tract dilation, and nephroscopy [22,23]. A novel single-step renal access device is well tolerated resulting in less blood loss and efficacious resulting in a shorter insertion time for PCNL [24]. This may provide a new standard of obtaining renal access. The 'All-seeing needle' was described and presented by Bader *et al.* [2<sup>¶</sup>] at the American Urological Association Annual Meeting, San Francisco, 2010. The 'All-seeing needle' permits

visualization of the entire tract during percutaneous access including the successful and correct calyceal entry into the pelvicalyceal system. They used the 'All-seeing needle' in 15 patients during PCNL procedures. In all cases, they were able to visualize the punctured kidney calyces and thus confirm the presence of calculi prior to dilating the tract to 30 Fr for standard PCNL.

The concept of 'All-seeing needle' came through a similar use in laparoscopic surgery. In laparoscopic surgery, serious complications caused by the blind insertion of the first trocar have been reported even after the pneumoperitoneum is established by means of a Veress needle. As a consequence, some techniques to safely insert the first port have been developed. The introduction of optical-access laparoscopic trocars was met with enthusiasm and the impression that these devices provide safer access with decreased complication rates [25,26]. Identification of distinct layers of the abdominal wall was always possible with optical trocars. The working hypothesis of the 'All-seeing needle' is that if the initial tract is perfect, then the tract-related morbidity can certainly be reduced. The perfect tract or the tract that causes the least amount of bleeding is the one that provides access to the kidney in the shortest possible distance through the cup of the calyx. The optical needle can be passed with ultrasound as well as fluoro assistance. One of coarse benefits from the initial assistance of an ultrasound, which make the window for ideal, puncture line. The microoptics of this needle will help to avoid any traversing viscera, confirming the visual cues of a correct papilla. The needle then confirms the correct entry from the cup of the planned calyx. If the tract is not perfect, the surgeon just needs to withdraw the needle and enter in the correct plane and angle. In the initial series of the authors [2<sup>o</sup>,3<sup>o</sup>], the visual cue of the correct papillary cup was not mentioned. However, as the experience grows, as has happened in flexible ureteroscopy, the cues would definitely be of particular importance.

In an experimental study [27], multiple biopsy procedures were performed on the livers and kidneys of anesthetized pigs with 14–22 gauge Chiba-type needles. The procedures were performed under direct vision at laparotomy, and blood loss was measured. Although larger needles generally produced more bleeding, the differences were statistically significant only when comparing 14-gauge with 16-gauge needle. In this study, the authors found that postrenal biopsy bleeding was significant only till the tract of the needle was less than 16 gauge. Therefore, the initial puncture from the 16 gauge needle is unlikely to cause bleeding. Desai *et al.* [3<sup>o</sup>] further extended the concept of 'All-

seeing needle' to assess the technical feasibility of performing a one-step PCNL through a 4.85-Fr tract. This could potentially avert the morbidity related to tract dilations during a standard PCNL with the obvious disadvantage of performing a small tract size of 16-gauge needle. They selected small stones, which were otherwise amenable for shock wave lithotripsy or flexible ureteroscopy. The microoptics with integrated light lead was inserted in the working sheath of the puncture needle. The highly flexible fiber-optic telescope contains 10000 fiber-optic bundles and can be bent over itself without causing any damage. The optic is relayed through a multi-joint mounting arm with attached camera and light cable. There is an outlet from the connector to an irrigation pump. Once the access is achieved, the inner sharp beveled needle housing the telescope is removed. A three-way connector is then attached to the proximal end of the 4.85 Fr sheath. The three ends of the connector allow the use of a 200  $\mu$ m laser fiber from the central port, irrigation connection to one side port, and telescope through another side port. Mean calculous size was 14.3 mm. Two of the 10 patients were of pediatric age, and each had an ectopic pelvic kidney, chronic kidney disease, and obesity. Microperc was feasible in all cases with mean  $\pm$  SD surgeon visual analog score for access of  $3.1 \pm 1.2$ , a mean  $1.4 \pm 1.0$  gm/dl hemoglobin decrease, and a mean hospital stay of  $2.3 \pm 1.2$  days. The stone-free rate at 1 month was 88.9%. In one patient, intraoperative bleeding occurred, requiring conversion to mini PCNL. There were no postoperative complications and no auxiliary procedures were required.

Desai *et al.* [3<sup>o</sup>] cautioned against elevated intrarenal pressures that could cause intravasation of irrigant fluid and resultant sepsis methods [4] they were working on to reduce the pressures. The same problem was associated with fluid irrigation in RIRS. The irrigation pressures generated within the collecting system can be significantly elevated, as evidenced by pyelovenous and pyelolymphatic backflow seen during retrograde pyelography [28]. Auge *et al.* [28] sought to determine whether the ureteral access sheath can offer protection from high intrarenal pressures attained during routine ureteroscopic stone surgery. The access sheath is potentially protective against pyelovenous and pyelolymphatic backflow, with clinical implications for the ureteroscopic management of upper-tract endoscopy and may be even for microperc. This remains to be proven and can only be gauged by pressure-reducing maneuvers that the authors will publish in future.

The authors postulated that microperc would provide direct access to the lower pole calyx;

microoptics would confirm stone location and holmium laser lithotripsy would assure stone fragmentation in a single step. The pressurized irrigation would also theoretically help in clearance of fragments in the lower pole.

## CONCLUSION

Microperc would be of interest in selected cases of renal calculus disease. For the microperc to be an appealing alternative to shock wave lithotripsy or flexible ureteroscopy, it must be fully effective in one step with acceptable morbidity. In our opinion, only a stone-free rate that approximates 100% would outweigh the drawbacks of a surgical procedure requiring general anesthesia. Microperc would provide direct access to the lower pole calyx; microoptics would confirm stone location and holmium laser lithotripsy would assure stone fragmentation in a single step. The pressurized irrigation would also theoretically help in clearance of fragments in the lower pole. Perhaps, percutaneous access through the 'All-seeing needle' may be helpful in ectopic kidneys wherein it can provide optical visualization while accessing the pelvi-calyceal system, to know with surety that no bowel structure has been traversed. Other areas of interest would be failed RIRS cases, lower calyceal diverticular stone, narrow infundibular width and awkward lower calyceal anatomy, and horseshoe kidney isthmus stone. It may also prove to be efficacious in pediatric patients. Currently, there is paucity of data related to this procedure. More efficacy and safety studies are warranted. It requires extensive multiple center surgeon operative case studies. Furthermore, only properly conducted RCTs can identify which category of patient with small bulk urolithiasis would benefit from this upcoming technology. It is a step to a futuristic realization. Maybe one day, as we observe today in brain surgery, there would be a navigation system that would increase operation safety for lesions that are deep seated or difficult to access and on the other, endourology that would enable the surgeon to recognize discrepancies and mistakes of the navigation due to optical control.

## Acknowledgements

Markus Bader of University Hospital Grosshadern, Ludwig-Maximilians-University Munich, Munich, Germany, who first demonstrated the 'All-seeing' needle and started the interest in microperc technique.

## Conflicts of interest

There are no conflicts of interest.

## REFERENCES AND RECOMMENDED READING

Papers of particular interest, published within the annual period of review, have been highlighted as:

- of special interest
- of outstanding interest

Additional references related to this topic can also be found in the Current World Literature section in this issue (p. 164).

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