# Microperc versus miniperc for the management of medium-sized renal stones: a comparative two-center clinical study

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**Objective**
To date, there is very little evidence directly comparing the outcomes between Mini-percutaneous nephrolithotomy and Micro-percutaneous nephrolithotomy. Because of this evidence gap, we wanted to compare miniperc and microperc with an ultimate purpose to determine which modality is preferred for different stone characteristics. Our hope is that these findings may help guide which technique is most suitable for a given renal stone burden.

**Patients and methods**
This is a retrospective collaborative multi-institutional study between Dortmund Teaching Hospital (Germany) and Modena University Hospital (Italy) in which we compared two matched groups of patients. The first group (32 patients) underwent miniperc for medium-sized renal stones in Dortmund, and the second group (19 patients) underwent microperc in Modena. Both groups were matched according to age, sex, BMI, and maximum stone diameter according to preoperative plain KUB films.

**Results**
The primary stone-free rates in the miniperc and microperc groups were similar (93.8 vs. 84.2%, $P = 0.262$). Mean operative time for miniperc was significantly shorter than that of microperc (45.6 ± 18.9 vs. 68.7 ± 35.2 min, $P = 0.004$). The overall complication rate was 11.7%, with no significant difference between the two groups (12.5% for miniperc vs. 10.5% for microperc, $P = 0.604$). Mean hospital stay in miniperc was significantly longer than that of microperc (4.7 ± 1.6 vs. 3 ± 1.5 days, $P < 0.001$).

**Conclusion**
Our current data show that microperc is emerging as an effective and safe treatment option for intermediate-sized kidney stones, with outcomes comparable even to miniperc, which is already a well-established treatment with high safety profile in experienced hands.

**Keywords:**
Micro-percutaneous nephrolithotomy, Mini-percutaneous nephrolithotomy, nephrolithiasis, percutaneous nephrolithotomy, renal stones

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## Introduction

Extracorporeal shockwave lithotripsy (ESWL), ureteroscopic retrograde intrarenal surgery (RIRS), and percutaneous nephrolithotomy (PCNL) may all be used to treat small kidney stones [1]. The urological community has attempted to define the specific indications for these different minimally invasive and endourological techniques, but with stones between 10 and 20 mm in size, the preferred approach remains controversial, with all techniques demonstrating reasonable success [1,2]. It has been suggested that tract size reduction in PCNL procedures could decrease bleeding risk and other complications [3].

With this aim, advances in PCNL technology have led to miniaturization of the instruments. To date, many reports exist describing PCNL through tracts smaller than 30 Fr [4,5]. Micro-PCNL or microperc (5–8 Fr) and Mini-PCNL or miniperc (12–18 Fr) are two minimally invasive percutaneous techniques that have demonstrated feasibility and efficacy with small renal stones [6–9]. As reported by Ganpule *et al*. [10], Micro-PCNL and Ultramini-PCNL may be suitable for stones less than 1.5 cm, but they have never been directly compared. Recently, Micro-PCNL has demonstrated acceptable stone clearance and complication rates in small-sized and intermediate-sized stones when compared with RIRS [11,12].

To date, there is very little evidence directly comparing the outcomes between Mini-PCNL and Micro-PCNL.

Because of this evidence gap, we wanted to compare microperc and miniperc with an ultimate purpose to determine which modality is preferred for different stone characteristics. Our hope is that these findings may help guide which technique is most suitable for a given renal stone burden.

## Patients and methods

Upon approval of the Institutional Ethics and Research Committee, this study was conducted as a retrospective collaborative multi-institutional study between Dortmund Teaching Hospital (Germany) and Modena University Hospital (Italy). The investigators explained the steps and value of the research to all eligible participants and obtained an informed consent from all patients. We compared two matched groups of patients: the first group (32 patients) underwent miniperc for renal stones in Dortmund Teaching Hospital, and the second group (19 patients) underwent microperc in Modena University Hospital. Both groups were matched according to age, sex, BMI, and maximum stone diameter according to preoperative plain KUB films. Patients' demographics and preoperative variables are detailed in Table 1. Our inclusion criteria were (a) stone size between 1.5 and 3 cm, (b) stone size less than 1.5 cm if ESWL failed to clear the stone as a primary treatment, and (c) pelvicalyceal system not favorable for stone clearance after ESWL as in case of lower calyceal stones. Exclusion criteria of the study were (a) pregnancy, (b) uncorrected coagulopathy, and (c) an active untreated urinary tract infection.

### Miniperc

All miniperc cases took place under general intubational anesthesia using a 12-Fr nephroscope (Karl Storz Miniatur Nephroskop, Tuttlingen, Germany). In this procedure, the patient was placed in the lithotomy position, and a 5-Fr open-tip ureteral catheter was placed on the side ipsilateral to the stone, and a retrograde pyelogram was obtained. The patient was then placed prone with all pressure points padded.

The initial percutaneous puncture performed by the urologist was done into the stone carrying calyx or the most appropriate posterior calyx leading to the stone under both sonographic and fluoroscopic guidance. Single-step dilatation was done over a stiff guide wire using a 16-Fr telescopic metal dilator. Then a 16.5-Fr Amplatz sheath was introduced into the pelvicalyeal system over the metal dilator. Stone disintegration took place using the pneumatic LithoClast. Retrieval of stone fragments occurred mainly via suction and to a lesser extent by stone graspers. Intraoperative stone clearance was endoscopically and fluoroscopically assessed. A 16-Fr nephrostomy tube was placed in all cases at the end of the procedure.

**Table 1 Stone criteria and patients demographics of Mini-percutaneous nephrolithotomy and micro-percutaneous nephrolithotomy groups**

| Criteria | Miniperc | Microperc | *P* |
|---|---|---|---|
| Age (mean±SD) | 53.2±12.1 | 51.5±10.7 | 0.622 |
| Sex (male : female) | 25 : 7 | 15 : 4 | 0.945 |
| Laterality (right : left) | 18 : 14 | 10 : 9 | 0.802 |
| BMI (mean±SD) | 27.7±5.1 | 25.4±1.7 | 0.066 |
| Stone size (mean±SD) | 16.5±2.3 | 15.1±3.7 | 0.101 |

### Microperc

The procedure was performed under general anesthesia. A ureteral occlusion balloon catheter was placed with the patient in the lithotomy position. Puncture of the renal calyx was carried out in the prone position. In all procedures, the three-part 4.8-Fr diameter 'all-seeing' needle (Polydiagnost, Pfaffenhofen, Germany) was used, and 8- and 10-Fr sheaths were used as necessary to facilitate navigation within the collecting system, as movement through the 4.8-Fr sheath is limited because of its poor resistance to bending. This was most problematic, and hence access tract sheaths were more commonly employed when the angle of the puncture, and so the axis of the needle, was not directly aligned with the long axis of the calyx–stone tract, which depended on the position of the stone in relation to the anatomy of the renal collecting system. Ultrasound and fluoroscopic guidance were used during calyceal puncture. In addition, puncture precision was enhanced with the use of a high-resolution, 0.9-mm diameter micro-optical probe specifically designed for insertion into the access needle during percutaneous tract creation. Lithotripsy of the stone was performed with a 200-μm fiber and Holmium: YAG laser Versapulse P20 (Lumenis, Santa Clara, California, USA). A three-way adapter was fitted onto the back end of the puncture needle to which irrigation was connected and the laser fiber was introduced. Lithotripsy was started with high-frequency (20 Hz) and low-energy (0.4 J) settings to maximize stone dusting and minimize stone movements, whereas the irrigation pump was used to flush out the stone dust and aid with clear visualization.

All patients were examined with plain radiograph and abdominal ultrasound on the first postoperative day. Non-contrast computed tomography was used in only a few doubtful cases where radiograph and ultrasound imaging were inconclusive. Hemoglobin level and serum creatinine were monitored preoperatively and postoperatively. The data were recorded for the following clinical parameters: operative time (the time from puncture to closure of the tract), length of hospital stay, stone-free rate (absence of any detectable stone upon nephroscopy at the end of the procedure and on postoperative radiograph and ultrasound control), and complications (any adverse event within 30 days of the procedure). Postoperative complications were assessed using the modified Clavien–Dindo classification [13].

Asymptomatic fragments less than 4 mm were considered clinically insignificant residual fragments. Follow-up of patients from both groups consists of renal ultrasound and plain KUB film at one month postoperatively.

Clinical data and outcome measures of the two groups were compared using SPSS, version 19 (SPSS Inc., Chicago, IL, USA). Student's $t$-test was applied for continuous variables, and $\chi^2$ test or Fisher exact test for nominal variables. A $P$ value less than 0.05 was considered statistically significant.

## Results

In total, we identified 51 cases fulfilling the inclusion criteria who underwent percutaneous stone extraction procedures for renal stones. A total of 32 cases (group 1) were treated with miniperc and 19 cases (group 2) with microperc. Table 1 shows the demographic and preoperative characteristics for both groups, confirming matching according to age, sex, laterality, BMI, and stone size.

Mean operative time for group 1 was significantly shorter than that of group 2 (45.6 ± 18.9 vs. 68.7 ± 35.2 min, $P = 0.004$).

In group 1, 30 (93.8%) patients were rendered stone free from a single session, whereas 16 (84.2%) patients became stone free in group 2. There was no significant difference between the two groups in terms of stone-free rate (Table 2).

The mean hemoglobin drop was 0.7 ± 0.6 g/dl, with no significant difference between both groups (Table 2). No single case required blood transfusion or angioembolization.

We experienced only six (11.7%) complications overall. There was no significant difference between group 1 (12.5%) and group 2 (10.5%) ($P = 0.604$). Three complications were modified Clavien grade I, two were grade II, and one was grade IIIB (Table 3). Mean hospital stay for group 1 (4.7 ± 1.6 days) was longer than that of group 2 (3 ± 1.5 days) ($P < 0.001$).

## Discussion

Nephrolithiasis is one of the most common problems in the urological practice, which comprises about one-third of the surgical workload of an active urologic department [14]. First described in 1976 by Fernstrom and Johansson [15], PCNL rapidly became the gold standard in the management of large renal stones. During the past 20 years, PCNL has undergone significant evolution regarding the miniaturization of instrumentation and access tract size [10]. This has been done to such an extent, then one must ask how small is too small and do we actually need to go any smaller?

Much of the morbidity of PCNL is attributed to access formation and tract size in the form of blood loss, postoperative pain, and urine extravasation and leakage [16–19]. To limit the occurrence of such complications, various minimally invasive PCNL techniques have been developed, namely miniperc, ultraminiperc, and microperc.

Since its introduction in 1997, miniperc has been widely and regularly used for treatment of intermediate-sized and large-sized renal stones with high stone-free rates and reduced morbidity in relation to conventional PCNL [9,20,21]. Miniperc is a two-step PCNL, which is preferred by many urologists, where a single-step dilatation takes place instead of gradual dilatation in conventional PCNL, which decreases the shear effect on the renal parenchyma, which in turn minimizes the intraoperative bleeding and the overall morbidity [21].

In continued efforts to decrease the tract size, even further than that used during miniperc, microperc was developed, and also with the goal of minimizing PCNL morbidity such as postoperative pain and length of hospital stay. In comparison with miniperc, microperc is a single-step PCNL using the all-seeing needle to access into the renal collecting system without additional tract dilation. The small tract size and the avoidance of tract dilation in microperc are believed to limit the potential

**Table 2 Comparison of operative and postoperative outcomes between mini-percutaneous nephrolithotomy and micro-percutaneous nephrolithotomy**

| Criteria | Miniperc | Microperc | *P* |
|---|---|---|---|
| Operative time (mean±SD) | 45.6±18.9 | 68.7±35.2 | 0.004 |
| Stone-free rate [*n* (%)] | 30 (93.8) | 16 (84.2) | 0.262 |
| HB drop (mean±SD) | 0.7±0.6 | 0.8±0.7 | 0.514 |
| Complications [*n* (%)] | 4 (12.5) | 2 (10.5) | 0.0.604 |
| Hospital stay(mean±SD) | 4.7±1.6 | 3±1.5 | <0.001 |

**Table 3 Complications occurred according to modified Clavien grading**

| Complications | Microperc | Miniperc | Management | Grade |
|---|---|---|---|---|
| Renal colic | 2 | 1 | Analgesics | I |
| Postoperative bleeding | No | 2 | Fluids, follow-up | II |
| Ureteric obstruction | No | 1 | Ureteroscopy | IIIB |

renal injury and minimize the bleeding complications. Another advantage of the microperc as described is the routine lack of postoperative nephrostomy, which has been shown to improve patient's comfort [2,22].

ESWL is a widely used treatment option for renal stones with variable stone clearance rates depending on stone and patient factors [23,24]. Retrieval of the stone and its fragments is not possible in ESWL, a fact which is similar to microperc; however, the latter is carried out under vision aiming at disintegrating the stone into dust regardless of its hardness, which is then easily washed out, but ESWL results in small fragments where active removal of the stone is not accessible especially in cases of stones located in the unfavorable lower calyx [24]. In addition, ESWL often requires repeated treatment sessions and therefore time and compliance in order to achieve stone clearance. In a large number of patients following ESWL treatment, residual fragments remain within the kidney and are believed to lead to recurrent stone formation [25].

RIRS is another treatment option that is also minimally invasive and uses natural orifices. Palmero *et al.* [26] reported a stone-free rate with RIRS in a series of 106 patients with moderate-sized stones (≥2 cm) to be 79.4% with a single treatment and 94.1% with retreatment, with overall complication rate of 6.7%. In another series of 70 patients, Singh *et al.* [27] reported a primary stone-free rate, with RIRS of 85%. Traxer and Thomas [28] reported 46.5% ureteral wall injury rate in a series that contained 359 patients, who underwent RIRS using ureteral access sheath, which adds more doubt to the safety of the maneuver. There are some limitations to RIRS in the management of lower calyceal stones secondary to an acute infundibulopelvic angle which can hamper stone retrieval by flexible ureteroscopes [29,30]. Other drawbacks of RIRS include high costs and limited life expectancy and durability of the instruments [31].

The objective of this study was to compare the outcomes of two minimally invasive PCNL techniques, namely, miniperc and microperc. In their large multicenter study, Kiremit *et al.* [32] reported a stone-free rate of 88.8% after microperc in comparison with 83.6% after miniperc and an overall complication rate of 3.4% with microperc versus 7.3% with miniperc. In our comparative study, both techniques showed excellent efficacy in the treatment of medium-sized renal stones with a stone-free rate after single treatment of 84.2% with microperc versus 93.8% with miniperc, with no statistically significant difference between both groups ($P = 0.262$).

Given the large working sheath and instruments, it is not surprising that miniperc led to a similar stone clearance in much less operative time ($P = 0.004$). However, our results and those from other studies suggest microperc can achieve comparable efficacy to miniperc, while having a possibly better safety profile. The drawback of reduced sheath diameter in microperc is basically increased operative time owing to reduced irrigation flow, in addition to the need for more extensive stone disintegration. Moreover, higher intrarenal pressures can be generated during microperc, though to date this does not appear to result in any detectable untoward renal functional effects. The need for auxiliary measures was negligible after treatment in both groups. The mean hospital stay was significantly lower in the microperc cases ($P < 0.001$), which may have been attributable to the tubeless nature of the microperc technique.

The retrospective nature of this study is one limitation, as are the low number of included cases, the lack of randomization, and the potential selection bias. Nevertheless, the fact that all surgeries were performed by highly experienced stone surgeons should help to minimize result variation, and excellent operative results were appreciated for both treatment modalities.

## Conclusion

Our current data show that microperc is emerging as an effective and safe treatment option for intermediate-sized kidney stones, with outcomes comparable even to miniperc which is already a well-established treatment with high safety profile in experienced hands. Studies are needed to better evaluate its cost-effectiveness, the need for auxiliary treatments over time, and its possible complementarity with RIRS when working with patients in the supine position.

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### Conflicts of interest

There are no conflicts of interest.

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