Supine percutaneous nephrolithotomy with the “mini-perc” technique: an initial experience

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KEYWORDS
Mini-percutaneous nephrolithotomy; Valdivia position; Kidney stones

Abstract
Background: The mini-percutaneous nephrolithotomy technique has been used as an alternative to conventional percutaneous nephrolithotomy for the treatment of small-volume kidney stones. There are few descriptions of this technique and even fewer in the supine position.
Aims: To evaluate the safety and efficacy of the “mini-perc” technique in the supine position for the treatment of small-volume stones.
Methods: A retrospective study reviewing the case records of patients that underwent supine mini-percutaneous nephrolithotomy within the time frame of December 2012 to January 2014 was conducted. Patients underwent the procedure as initial or second-line treatment if they had a single stone smaller than 1.5 cm with a calyceal anatomy that did not lend itself to flexible ureterorenoscopy. A 15 Fr operating tube was employed, and either the Valdivia or the Valdivia/Galdakao positions were used. The variables of surgery duration, stone-free rate, and complications were evaluated.
Results: The series included 10 cases. Mean patient age was 37.7 years (range: 20-59), 4 patients were men and 6 were women, and the mean body mass index was 27.4 kg/m² (range: 24-30). The previous failed therapies were: 4 extracorporeal lithotripsies, and 1 ureteroscopy. The mean cumulative area was 227 mm² (range: 180-250). Intrarenal stone location was: 6 lower calyx, 2 middle calyx, and 2 upper calyx; mean surgery duration was 70.5 min (range: 40-100); and the stone-free rate was 90%. In relation to residual lithiasis management, one patient was treated with conventional percutaneous nephrolithotomy.
Conclusions: This technique has been in use for 16 years; it is effective in treating small-volume stones and is a good alternative when other therapies have failed. The procedure is versatile and safe, with the known advantages of the supine position. In addition, the one-shot tract creation results in less radiation exposure for the surgeon.

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Introduction

Urolithiasis management requires a balance between stone elimination and procedure-related morbidity. For example, a low-risk procedure with a high-risk for re-treatment (such as extracorporeal shock wave lithotripsy [ESWL]) results in residual lithiasis. The development of retrograde intrarenal surgery (RIRS) may minimize the risks associated with blood loss and visceral damage, but the poor durability of the flexible instruments can have a negative impact on its success and applications.

Of the minimally invasive therapies, percutaneous nephrolithotomy (PCNL) is the prototype for treating lithiasis. It can be performed safely and has a high short-term stone-free rate. However, its possible complications keep it from being the first treatment option for many patients.

Minimal invasion techniques and instrument miniaturization are constantly being developed in urology and PCNL is no exception. Even though interest in mini-perc PCNL (m-PCNL) and micro-perc PCNL has recently grown, they are not new techniques. The mini-perc technique was first described in 1997 in the prone position; there are very few reports on it in the supine position. Desai et al. recently developed the “all-seeing needle” called micro-perc.

Perhaps the re-emergence of the mini-perc and the recent interest in the micro-perc techniques are due to the fact that ESWL and RIRS have not provided the expected results in cases of low-volume kidney stones. PCNL has a higher success rate, but its complications, especially blood loss requiring transfusion reported at up to 23% of the cases, have kept it from attaining its anticipated success. The efforts to lower the risk for this complication are focused on reducing the caliber of the tract, and consequently decreasing trauma to the renal parenchyma.

This technique was first developed by Helal et al. in pediatric patients and one year later the first reports on adult populations appeared. The term “mini-perc” was coined by Jackman et al. as a percutaneous nephrolithotomy performed through a small operating tube for positioning a standard rigid nephroscope.

The aim of the present study was to present our preliminary experience with the mini-perc technique in the supine position.

Methods

A retrospective study was carried out from the database and case records of patients that underwent supine m-PCNL (s-m-PCNL) within the time frame of December 2012 and January 2014. The patients that underwent s-m-PCNL fit the following criteria: stone volume under 250 mm³, body mass index (BMI) under 30, a single stone, a pyelocaliceal system anatomically unsuitable for flexible ureterorenoscopy, and mini-perc therapy as initial treatment or second-line
treatment. Patients that underwent percutaneous surgery for other pathologies (conventional supine and prone PCNL, derivative nephrostomy, anterograde endopyelotomy) were excluded from the study. Preoperative evaluation included medical history, anesthesia evaluation (American Society of Anesthesiologists), routine laboratory work-up, negative urine culture, noncontrast computed tomography (evaluating the number and size of the stone, Hounsfield units, and topography and location of the stone, ruling out retrorenal colon). All the patients were given general anesthesia. Either the Valdivia or the Valdivia/Galdakao positions were used. Only a descriptive analysis of the variables was carried out.

Surgical technique
An open-tip 6 Fr catheter was introduced with the help of a 19 Fr cystoscope and was placed at the ureteropelvic junction under fluoroscopic control. The puncture site was planned through retrograde pyelography. A 16 Fr transurethral catheter and a 3-liter bag were placed below the flank, according the technique previously described by Valdivia et al.3 (fig. 1). The posterior axillary line was identified as the puncture limit. In some cases, another urologist, a urology resident, or a surgical nurse simultaneously carried out pyelography. The calyx selected for puncture was the one that best allowed stone clearance. Ultrasound-fluoroscopy-assisted puncture was carried out in only one patient. An 18 G (Cook™) needle was used. A 0.038 hydrophilic guidewire (Roadrunner Cook™) was inserted after successful calyx puncture and its positioning into the ureter was attempted. Fascial dilators were employed, followed by a 15 Fr Storz™ sheath and obturator. A safety guidewire was not used in all the cases and we introduced a second guidewire through the nephroscope, toward the ureter, in some of the cases. Afterwards we removed the operating tube, leaving the second guidewire outside of it. When possible, the guidewire was exteriorized through the urethra. Dilation was carried out with a 15 Fr sheath from the Storz™ Mini-perc Set with the one-shot technique. Rigid nephroscopy was initially performed. Pneumatic lithotripsy (EMS Lithoclast) or Holmium laser lithotripsy (Dornier 20 W) were then carried out. Litholapaxy was performed with a 2,9 Fr Nitinol basket, with no incidents. Calyces were checked in 2 cases with a Storz™ X2 flexible ureterorenoscope through the operating tube.

Finally, a double-J catheter was placed in all the patients and the majority of the cases had nephrostomy catheter placement (7/10). The patients were released on the third postoperative day and the double-J catheter was removed at one month, on average.

Result analysis
Patients that underwent s-m-PCNL as primary treatment or that had some other prior failed therapy (extracorporeal shock wave lithotripsy or flexible ureterorenoscopy) and that met the abovementioned inclusion criteria were evaluated. Symptomatic patients were those that presented with pain or urinary infection. Surgery time began with cystoscopy and ended with nephrostomy catheter placement. Radiologic study the following day consisted of a plain abdominal x-ray and a noncontrast computed axial tomography scan. The surgery was considered a success if there were no stones larger than 4 mm. Perioperative complications were classified in accordance with the modified Clavien grading system.

Results
A total of 10 patients and 10 kidney units were treated (table 1). All 10 patients (100%) had general anesthesia. Four of the patients (40%) were men and 6 (60%) were women and the mean age was 37.7 years (range: 20-59). The mean BMI was 27.4 kg/m² (range: 24-30); 3 patients (20%) had normal weight and 7 (70%) had overweight. The right/left stone site was 5 (50%)/5 (50%). There were 7 symptomatic patients (70%). ASA 1: 8 (80%), ASA 2: 2 (20%).

Four patients (40%) underwent prior failed extracorporeal shock wave lithotripsy and one (10%) underwent prior failed ureteroscopy. Calyceal system stone topography was: 6 patients (60%), the lower calyx; 2 (20%) patients, the middle calyx, and 2 (20%) patients, the upper calyx. The mean stone size was 227 mm² (range:180-250). One patient (10%) had ultrasound assistance for creating the tract. Percutaneous access by calyx was: 6 patients (60%) with lower calyx access and 4 (40%) with middle calyx access. A 15 Fr operating tube was used in 100% of the cases. However,
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Table 1  Preoperative characteristics of the patients that underwent surgery

<table>
<thead>
<tr>
<th>No. of patients</th>
<th>Age (years)</th>
<th>Sex</th>
<th>ASA</th>
<th>BMI</th>
<th>Symptoms yes/no</th>
<th>Previous therapy</th>
<th>Stone vol. (mm)</th>
<th>Topography (Calyx)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>45</td>
<td>Man</td>
<td>1</td>
<td>28</td>
<td>Yes</td>
<td>ESWL</td>
<td>230</td>
<td>Lower</td>
</tr>
<tr>
<td>2</td>
<td>34</td>
<td>Man</td>
<td>1</td>
<td>25</td>
<td>No</td>
<td>ESWL</td>
<td>250</td>
<td>Lower</td>
</tr>
<tr>
<td>3</td>
<td>59</td>
<td>Woman</td>
<td>2</td>
<td>26</td>
<td>Yes</td>
<td>ESWL</td>
<td>180</td>
<td>Lower</td>
</tr>
<tr>
<td>4</td>
<td>20</td>
<td>Man</td>
<td>1</td>
<td>26</td>
<td>Yes</td>
<td>ESWL</td>
<td>190</td>
<td>Lower</td>
</tr>
<tr>
<td>5</td>
<td>26</td>
<td>Man</td>
<td>1</td>
<td>29</td>
<td>No</td>
<td>ESWL</td>
<td>180</td>
<td>Lower</td>
</tr>
<tr>
<td>6</td>
<td>25</td>
<td>Woman</td>
<td>1</td>
<td>30</td>
<td>No</td>
<td>ESWL</td>
<td>190</td>
<td>Lower</td>
</tr>
<tr>
<td>7</td>
<td>34</td>
<td>Woman</td>
<td>1</td>
<td>30</td>
<td>Yes</td>
<td>0</td>
<td>200</td>
<td>Upper</td>
</tr>
<tr>
<td>8</td>
<td>37</td>
<td>Woman</td>
<td>2</td>
<td>24</td>
<td>Yes</td>
<td>0</td>
<td>220</td>
<td>Middle</td>
</tr>
<tr>
<td>9</td>
<td>50</td>
<td>Woman</td>
<td>1</td>
<td>25</td>
<td>Yes</td>
<td>0</td>
<td>210</td>
<td>Upper</td>
</tr>
<tr>
<td>10</td>
<td>47</td>
<td>Woman</td>
<td>1</td>
<td>27</td>
<td>Yes</td>
<td>URS</td>
<td>220</td>
<td>Middle</td>
</tr>
</tbody>
</table>

ESWL: Extracorporeal shock wave lithotripsy; URS: Flexible ureterorenoscopy

one case (10%) with a tract from the middle calyx was converted to conventional PCNL (24 Fr) due to a stone in the upper calyx. The double-J catheter was left in 100% of the patients and the nephrostomy in only 2 patients (20%) - the patient with the conversion to conventional PCNL and another in whom there was doubt in regard to residual lithiasis that was later ruled out in the noncontrast computed tomography scan. Mean surgery duration was 120 min (range: 70-160). Three patients (70%) underwent laser lithotripsy. Nine patients (90%) had procedure success or a stone-free rate. Mean hospital stay was 3 days (range: 3-4). Two patients (20%) presented with complications and 2 (20%) with Clavien I urosepsis.

Discussion

PCNL was introduced in 1976, later becoming the treatment method for large-volume stones. With the advent of ESWL, PCNL has taken a backseat due to the complications it can present with. However, as a surgical technique it has always had excellent results in relation to stone clearance or success rate. Treatments with PCNL-ESWL were later approved for the management of staghorn stones. The disadvantages of ESWL are made up for by PCNL in regard to a high stone-free rate, shorter surgery duration, reduced symptoms from stone passage, and less frequent UTI-related events. However, the main risk involved in PCNL is bleeding, and according to some articles, presents in up to 23% of the cases.

One of the aspects concerning the risk for bleeding is the size of the operating tube. In the majority of the published case series a 30 Fr operating tube is used. Theoretically, reducing the caliber of the operating tube would reduce the damage to the renal parenchyma and, in turn, the risk for bleeding that is one of the complications related to access creation. Lahme et al. used a 15 Fr access sheath with results similar to ours, but in pelvic stones.

ESWL and RIRS are acceptably safe and successful treatment methods indicated for small-volume kidney stones. However, ESWL has the disadvantages of high re-treatment rates, risk for obstructive pyelonephritis, and the time in which the patient is stone-free is unpredictable. Stone location and hardness, as well as patient BMI, are determinants of its success. On the other hand, RIRS has become an excellent option for kidney stones under 1.5 cm. Nevertheless, the costs of flexible ureterorenoscopy and Holmium laser, together with the learning curve for this technique, play important roles in its being adopted as treatment in Mexico. Another significant point that can interfere with the success of the RIRS technique is the calyceal anatomy; specifically, long infundibula or an obtuse angle of the calyceal infundibulum.

A high stone-free rate, shorter surgery duration, and less risk for urinary tract infection are undeniable advantages of s-m-PCNL, but because of the greater risk for bleeding, along with reports of isolated cases of organ loss, it is not the first treatment option for many.

There are few reports on s-m-PCNL in the supine position. Regarding access creation, we found no difference in the comparison of conventional and supine PCNL, surgery duration was similar, and there were few complications. Perhaps an important point is the fact that we meticulously selected the patients for this technique. However, there are published case series of patients with a greater stone burden than our patients, including staghorn stones, whereas we excluded patients with large-volume stones. Likewise, patients with a pyelocaliceal system contraindicated for flexible ureterorenoscopy were treated with the mini-perc technique.

We determined a stone size no greater than 2.4 cm², based on a published article by Lahme et al. They had a 100% stone-free rate applying this selection criterion. All the punctures and dilations for creating the percutaneous tract were made with the one-shot technique, which has the advantage of reducing radiation exposure for the urologist and the surgical team.

The supine position is very versatile for the percutaneous approach and the advantages in regard to anesthesiology,
the reduced risk for lesions for the patient, and the possibility of both an anterograde and retrograde approach to the urinary tract are undeniable. In contrast to what was published 10 years ago, today the Holmium laser has become important in mini-perc lithotripsy. The pulverization and vaporization capacity of this laser should be taken full advantage of, and the mini-perc technique is the prototype for that.9

With respect to complications, we had only one patient that required conversion to conventional PCNL because of poor visualization of the lithotripsy procedure. In some case series utilizing the mini-perc technique, a 1.4% risk for transfusion and complications (Clavien i and ii) in 0.5% of the patients has been reported. In our study group, one patient (10%) presented with pyelonephritis. We owe our success rate to 2 factors: the selection of patients with medium-volume stones and patients with acceptable BMI. Unlike the micro-perc technique, the mini-perc technique does not sacrifice irrigation or image vision quality, flexible instruments can be used, and litholapaxy can be performed.

With regard to terminology, the external diameter of the operating tube, measured using the French scale, determines the technique and its correct name:10

- Mini-perc: 15-18 Fr.
- Ultra mini-perc 11-13 Fr.
- Micro-perc 4.85 Fr.

In our opinion, the mini-perc technique could have the following indications:

- Primary treatment for non-staghorn, large-volume stones.
- As an alternative to ESWL and RIRS for stones in the lower pole.
- When there are probabilities of failure with ESWL and RIRS (very hard stone, adverse pyelocaliceal anatomy).
- When there is failed RIRS and post-ESWL residual stones.
- Upper third stone management in which ESWL or flexible ureterorenoscopy have failed or will fail.
- Lithiasis in calyceal diverticula.

Conclusions

S-m-PCNL broadens the indications for PCNL, but it does not substitute it. The advantages of the supine position are also reflected in this technique, which has been in use for almost 15 years and is routinely performed in many hospital centers. The patient selection criteria may increase as greater experience is acquired. This is a small case series, but we believe the results are good and that this technique can be reproducible in our medical environment.

Data confidentiality. The authors declare that they followed their work center protocols in relation to the publication of patient data.

Right to privacy and informed consent. The authors obtained the informed consent of the patients and/or subjects referred to in the article. This document is in the possession of the corresponding author.

Financial disclosure

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Conflict of interest

The authors declare that there is no conflict of interest.

References


Ethical responsibilities

The protection of persons and animals. The authors declare that no experiments on humans or on animals were conducted for this study.