Mini-PCNL - A Single Centre Experience of 5 Years

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ABSTRACT

Introduction and Objectives. According to the European Association of Urology (EAU) guidelines, percutaneous nephrolithotomy (PCNL) is reserved for stones larger than 1 cm, or localized in the lower renal pole, but may also constitute a great alternative for public health care services, due to cost effectiveness. This study aims to demonstrate that mini-PCNL is sometimes complementary to standard PCNL, while also constituting a great alternative to shock wave lithotripsy (SWL) or retrograde intrarenal surgery (RIRS), with a relatively short learning curve.

Materials and Methods. This is a single centre, retrospective study. We analysed 112 patients, undergoing mini-PCNL between 2017 and 2022. For each case, we documented the intervention time; history of previous renal interventions (open / percutaneous); number of access tracts; stone free rate, as quantified by ultrasonography; hospitalization period; haemoglobin variation (pre and postoperatively); visual analogic scale of pain scores and the use of a postoperative tube (JJ / nephrostomy tube / tubeless).

Results. Our study population included 112 patients, which underwent mini-PCNL, during the previous five years within our clinic. We stratified our cohort in two subpopulations, namely: an early, first subgroup of 47 patients, treated within the first three years; and a second subgroup of 75 patients, treated later on (last two years). This distinction was made due to the consideration that, within the first two years, at the beginning of the transition from standard PCNL to mini, our clinic was inexperienced and still trying to get comfortable with this novel procedure. Moreover, 2020 was a peak COVID-19 pandemic year, during which we only performed a small number of interventions for urolithiasis.

Conclusions. Mini-PCNL is a safe and reliable procedure, with a very high level of cost effectiveness, which can be used to treat complex renal stones, with quite large volumes.

Key-words: less pain, mini-PCNL, urolithiasis

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INTRODUCTION AND OBJECTIVES

The prevalence and incidence of the urinary stones in Romania are increasing. In the Banat region, the incidence and prevalence of urinary stone formers is very high (245 new cases per 100000 individuals).

Mini-PCNL was firstly implemented in Timișoara almost five years, and within this timeframe, we performed a total of 112 interventions.

PCNL is one of the most important minimally invasive treatment methods for renal stones and, concomitantly, the procedure with the highest stone free rates reported. In time, this technique has evolved, reducing the calibre of dilatation from 30 Fr to 15 Fr. This miniaturization, of both equipment and renal access tracts, offered significant clinical benefits, reflected by the shorter hospitalization periods and the reduced perioperative haemoglobin loss, with blood transfusions becoming unnecessary and rarely utilized [1].

Contemporary guidelines recommend standard PCNL for larger renal stones (> 2 cm in maximum diameter), or in case of previous failure of other procedures (SWL / RIRS) [2].

PCNL is a very cost effective procedure, due to the fact that the nephroscope and the dilatation sheets used are very resistant and durable, as compared to the instruments used for RIRS. Equipment maintenance costs are also much lower for PCNL, as compared to SWL [3, 4, 5].

The aim of the current study is to assess the clinical role of the emerging mini-PCNL technique, within the context of a urology centre with a rich tradition of standard PCNL.

MATERIALS AND METHODS

This is a single centre, retrospective study. We analysed 112 patients, undergoing mini-PCNL between 2017 and 2022. For each case, we documented the intervention time; history of previous renal interventions (open/percutaneous); number of access tracts; stone free rate, as quantified by ultrasonography; hospitalization period; haemoglobin variation (pre and postoperatively); visual analogic scale of pain scores and the use of a postoperative tube (JJ / nephrostomy tube / tubeless).

Preoperatively, for all patients, a sterile urine culture was mandatory and had to be obtained. For prophylaxis, we administered only two doses of 3rd generation Cephalosporin (one intraoperative dose and another 12 hours postoperatively).

The mini-PCNL procedure is quite standardized. A 6 Fr ureteral catheter is advanced towards the renal pelvis, under fluoroscopic control, using a rigid cystoscope. A Foley catheter is inserted and used to secure the mounted ureteral catheter. Afterwards, the patient is repositioned, in either prone or supine position - depending on patient particularities and/or surgeon preference [6].

For most cases, the renal puncture is usually performed in an ultrasound-guided manner. After the placement of a Lunderquist guidewire in the renal pelvis, a fluoroscopy-guided, three step dilatation of the access tract is performed.

In our centre, for most cases, we usually perform this access tract dilatation to 16 Fr, yet, in a few particular situations, we prefer to achieve a greater access tract diameter. In order to achieve the lithotripsy, we used either a 12 W laser from EMS or a 15 W laser from Storz. The nephroscope and the sheets used are manufactured by Karl Storz. The stone fragments were retrieved, in most cases, through direct exteriorization, based on the Bernouli effect, or by using a grasper and/or different types of Dormia baskets [7, 8].

Commonly, in most cases, after the lithotripsy procedure was finalized, we placed a small nephrostomy tube for 12 hours, and, in some specific situations, an additional JJ stent.

RESULTS

Our study population included 112 patients, which underwent mini-PCNL, during the previous five years within our clinic (2017 - 2022). We stratified our cohort in two subpopulations, namely: an early,

first subgroup of 47 patients, treated within the first three years; and a second subgroup of 75 patients, treated later on (last two years). This distinction was made due to the consideration that, chronologically, within the first two years, at the beginning of the transition from standard PCNL to mini, our clinic was inexperienced and still trying to get comfortable with this novel procedure. Moreover, 2020 was a peak COVID-19 pandemic year, during which we only performed a small number of interventions for urolithiasis.

For the first subgroup, we report an overall mean value for maximum individual stone diameter of 12 mm (-2 mm / +4 mm), while for the second group, this mean value increased to 18 mm (-2 mm / +15 mm). In other words, as a result of the amounting procedural experience within our clinic, we started to use mini-PCNL to treat increasingly larger stones, while also utilizing multiple renal access tracts (in 10 cases from the second subgroup).

The main intraoperative complications which we encountered were the following: loss of the dilatation tract (in one case); small perforation during lithotripsy (4 cases in the first subgroup and 7 in the second subgroup); and perforation of the renal pelvis during the dilatation procedure (2 in the first subgroup and 1 in the second subgroup), yet without important contrast extravasation, i.e. the procedure was continued and finalized for all cases.

The mean duration of hospital stay in the first subgroup was 3.4 days, while in the second subgroup only 2.7 days. In light of our amounting experience, we started to extract the Foley catheter and the nephrostomy tube in the first day after surgery, which allowed for this decrease in overall hospitalization periods for the second subgroup.

The mean blood loss was comparable between these two subgroups, as all postoperative haemoglobin values were contained within the same interval (0.7 +/- 0.5 g). No patient needed embolization after the procedure.

Furthermore, the decision to place a JJ stent was much more prevalent within the first subgroup (20 cases belong to the first subgroup, out of the total of 27 cases - this included only per primam JJ stenting).

Another parameter that we followed in our study was the operation time. For the first subgroup, the average total intervention time was 140 minutes, while in the second subgroup this average decreased, i.e. 125 minutes. Noteworthy, in the second subgroup we also have more patients with previous renal interventions (24 cases from the second subgroup out of the 36 in total).

Overall, 75% of the interventions were performed in the supine position. In the first subgroup, there was an increased tendency to use the larger access sheets (17.5 or 21 Fr - in 30 patients), whereas in the second subgroup we mostly used the 16 Fr sheet (in 60 patients). The stone free rates were similar in both subgroups (90%).

Postoperatively, the most common complication was haematuria, seen in 72 cases, 34 from the first subgroup and 38 from the second, ranging from mild to severe. Five patients developed fever postoperatively as well. Regarding postoperative pain quantification, we used the standard 10 tier visual analogic pain scale, and we found relatively similar scores between the two subgroups (4 +/- 1), as overall, most patients experienced mild to moderate levels of postoperative pain.

DISCUSSIONS

Since the first PCNL was performed in 1976, and with the development of mini-PCNL later on, in 2001, this lithotripsy technique has been greatly and continuously improved. Nowadays, PCNL is still evolving constantly, mainly through the development of superior technical instruments (i.e. different renal access sheets with aspiration), reflected in the steadily increasing stone free rates, further nuanced therapeutic indications and significant gains in patient outcomes [9]. Current urological guidelines unequivocally recommend standard PCNL only for the treatment of larger renal stones (> 2 cm). Even so, mini-PCNL has proven to be a viable option, which can be safely used for calyceal stones, in obese patients, in centres which cannot afford flexible ureteroscopy and/or when previous SWL attempts have failed [10]. Moreover, mini-PCNL can be used in a complementary

manner to standard PCNL, particularly in staghorn stones, for obtaining a second or third simultaneous renal access tract [11]. Furthermore, when dealing with renal stones which fully occupy a particular calix, direct dilatation of the renal access tract to a 26 Fr calibre may prove to be quite difficult to achieved. Thus, mini-PCNL can be used, to initially obtain a smaller calibre renal access tract (16 Fr), allowing for the preliminary assessment of overall intra-renal anatomy and the identification of an alternative, more favourable calix, i.e. that can be safely dilated to a larger calibre [12].

A preoperative computed tomography (CT) scan is generally regarded as mandatory prior to PCNL, in order to further explore the relationship between the kidney and its surrounding organs, but also the complexity of the intrinsic pyelocalyceal system and its morphological relationship to the renal stone. Conversely, Lahme et al. have reported that ultrasonography and retrograde pyelography are generally sufficient for the preoperative assessment of patients undergoing PCNL [13].

Notwithstanding the original technique described by Lahme for mini-PCNL, i.e. a single step dilatation of the renal access tract, we prefer the more precautious three step dilatation protocol, even for the smaller access sheet [14].

Even though the necessity of nephrostomy tube placement at the end of the PCNL procedure has been highly debated, the currently available data remain contradictory. A recent investigation by Desai et al. has reported that a totally tubeless approach is feasible in 16 Fr dilatation [15]. In corroboration with this report, we must note that a smaller nephrostomy tube will usually become obstructed and will thus have a greatly limited renal drainage capacity, while also failing to offer a proper haemostatic compression of the renal access tract post-dilatation [16, 17].

In order to avoid thermal damage during mini-PCNL, Traxer et al. recommend not to use laser power higher than 15 Watts within the kidney [18].

Lastly, from a technical perspective, a suction apparatus connected to the renal access sheet represents a significant improvement to the mini-PCNL procedure, allowing for the achievement of higher stone free rates, while also providing an improved capacity to treat larger renal stones [19]. However, when dealing with these larger renal stones, it is important to keep in mind that mini-PCNL operative time, i.e. actual laser lithotripsy and stone fragment retrieval, should not exceed one hour [20].

CONCLUSIONS

In the current study, we report our experience and emerging therapeutic results regarding the use of mini-PCNL in clinical practice. All in all, we conclude that, after a period of time, necessary for experience gathering and proper procedural assimilation (i.e. obtaining more accurate renal punctures, overcoming the lack of aspiration, adjusting to the much slower laser lithotripsy, as opposed to ultrasonic), mini-PCNL can be safely performed for the treatment of different types of renal stones, even in the more complex scenarios of staghorn stones, with lower complication rates, shorter hospitalization intervals, and faster recovery times than the standard PCNL technique.

REFERENCES

1. Lahme S, Zimmermanns V, Hochmuth A, Janitzki V Minimally invasive PCNL (mini-perc). Alternative treatment modality or replacement of conventional PCNL?] Urologe A 2008 May;47(5):563-8. doi: 10.1007/s00120-008-1708-3.
2. Lahme S-Miniaturisation of PCNL Urolithiasis 2018 Feb;46(1):99-106. doi: 10.1007/s00240-017-1029-3.
3. Chung DY, Kang DH, Cho KS, et al. Comparison of stone-free rates following shock wave lithotripsy, percutaneous nephrolithotomy, and retrograde intrarenal surgery for treatment of renal stones: A systematic review and network meta-analysis PLoS One 2019 Feb 21;14(2):e0211316. doi: 10.1371/journal.pone.0211316. eCollection 2019.
4. Wymer KM, Sharma V, Juvet T, et al. Cost-effectiveness of Retrograde Intrarenal Surgery, Standard and Mini Percutaneous Nephrolithotomy, and Shock Wave Lithotripsy for the Management of

1-2cm Renal Stones-Urology 2021 Oct;156:71-77. doi: 10.1016/j.urology.2021.06.030. Epub 2021 Jul 15.
5. Nagele U, Schilling D, Anastasiadis AG, et al. A Stenzl-Minimally invasive percutaneous nephrolitholapaxy (MIP)]- Urologe A 2008 Sep;47(9):1066, 1068-73. doi: 10.1007/s00120-008-1814-2.
6. Nicklas AP, Schilling D, Bader MJ, Herrmann TRW, Nagele U; Training and Research in Urological Surgery and Technology (T.R.U.S.T.)-Group World J Urol 2015 Nov;33(11):1847-53. doi: 10.1007/s00345-015-1541-4. Epub 2015 Apr 2.
7. Lin, CH, Lin, YC, Chiang HC, et al. Totally tubeless single access tract mini-percutaneous nephrolithotripsy in treatment of large burden > 2-cm and/or complex renal stones: a case series of 62 patients. BMC Urol 22, 61 (2022).
8. 8.Aarthy, P., Thangarasu, M., Prakash, J.S. et al. Safety and efficacy of mini-percutaneous nephrolithotomy as daycare procedure: a prospective observational study. Afr J Urol 27, 9 (2021).
9. Khadgi S, El-Nahas AR, El-Shazly M, Al-Terki A Comparison of standard- and mini-percutaneous nephrolithotomy for staghorn stones, Arab Journal of Urology, 19:2, 147-151, DOI: 10.1080/2090598X.2021.1878670
10. Jackman SV, Docimo SG, Cadeddu JA, et al. The 'mini-perc' technique: a less invasive alternative to percutaneous nephrolithotomy. World J Urol 1998; 16:371–374.
11. Schilling D, Husch T, Bader M, et al. Nomenclature in PCNL or the Tower of Babel: a proposal for a uniform terminology. World J Urol 2015; 33:1905–1907.
12. Alken P, Hutschenreiter G, Gunther R, Marberger M. Percutaneous stone manipulation. J Urol 1981; 125:463.
13. Kukreja R A. Should mini percutaneous nephrolithotomy (MiniPNL/Miniperc) be the ideal tract for medium-sized renal calculi (15-30 mm)? World J Urol. 2018;36(02):285–291.
14. Güler A, Erbin A, Ucpinar B, Savun M, Sarilar O, Akbulut M F. Comparison of miniaturized percutaneous nephrolithotomy and standard percutaneous nephrolithotomy for the treatment of large kidney stones: a randomized prospective study. Urolithiasis. 2019;47(03):289–295
15. Haghighi R, Zeraati H, Zade MG Ultra-mini-percutaneous nephrolithotomy (PCNL) versus standard PCNL: A randomised clinical trial, Arab Journal of Urology, 15:4, 294-298, DOI: 10.1016/j.aju.2017.10.003
16. Giusti G, Piccinelli A, Taverna G, et al.: Miniperc? No, thank you. Eur Urol. 51:810–815. 2007.
17. Higgins JP, Altman DG, Gøtzsche PC, et al: The Cochrane collaboration's tool for assessing risk of bias in randomised trials. BMJ. 343(d5928)2011
18. De la Rosette J, Assimos D, Desai M, Gutierrez J, Lingeman J, Scarpa R and Tefekli A: CROES PCNL Study Group. The clinical research office of the endourological society percutaneous nephrolithotomy global study: Indications, complications, and outcomes in 5803 patients. J Endourol. 25:11–17. 2011
19. Somani BK, Desai M, Traxer O and Lahme S: Stone-free rate (SFR): A new proposal for defining levels of SFR. Urolithiasis. 42(95)2014.
20. Akman T, Sari E, Binbay M, et al.: Comparison of outcomes after percutaneous nephrolithotomy of staghorn calculi in those with single and multiple accesses. J Endourol. 24:955–960. 2010