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SINGLE VERSUS MULTIPLE-TRACT PERCUTANEOUS NEPHROLITHOTOMY IN THE SURGICAL MANAGEMENT OF SINGLE LARGE STONE: PROSPECTIVE STUDY OF 50 CASES AT SINGLE CENTRE (OUR INSTITUTE).

Urology

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ABSTRACT

Purpose: Renal calculi are a common urological disorder characterized by a high recurrence rate. Single large calculus still represents an intractable challenge for urologists. Percutaneous nephrolithotomy (PCNL) is the gold standard procedure used for large kidney stones, and multiple tracts of PCNL are applied to achieve better stone clearance if not cleared by single tract PCNL. However, the creation of multiple tracts may have the potential risk of bleeding and higher complication rates compared with single-tract procedures. The purpose of this study is to assess the safety and efficacy of single tract access for single large renal calculi in comparison to multiple tract access. **Materials and Methods**: Records of 50 patients with single large calculi who underwent PCNL at our institution between January 2021 and Dec 2022 were studied prospectively. twenty-five patients were managed by single-tract access (Group 1), and 25 patients underwent multiple-tract access (Group 2). Mean age was (42.84 years) Both groups were compared in terms of perioperative findings and postoperative outcomes and complication like postoperative bleeding, post op fever, sepsis, pulmonary complication, necessitated blood transfusion and selective angio-embolization. **Results**: In group 1 the initial access were either superior, or middle, or inferior. In group 2 The mean number of percutaneous accesses in the multiple-tract group was (2.5), with most patients requiring two tracts. The mean duration of fluoroscopy screening time is 3.22±0.85 in group 1 and 6.05±1.18 in group 2 which is higher compared to group 1. The operative time was 72.60±15.55 minutes in group 1 and group 2 it is 109.80±13.03 minutes which is longer in Group 2. Stone-free rates (in a view of with no residual stone) were 80% and 60% in Groups 1 and 2, respectively. The mean hospital stay was higher in group 2 compare to group 1. Complications included blood transfusion, resulting from a haemoglobin drop of 0.74±0.81 and 1.96±1.51 g/dL in Groups 1 and 2, respectively. Mean pre- and post-operative creatinine change were 0.26 mg/dL in Group 1 and 0.26 mg/dL in Group 2. Mean changes in creatinine values were not statistically was likely to fail significant between the groups. Clavien–Dindo Classification Grade II complications included blood transfusion, which occurred in one patient in Group 1 and five in Group 2, urosepsis occurred in two patients in group 2. Pseudoaneurysm attributed to Grade III complications occurred in one patient in Group 2. **Conclusion.** This study indicated that STPCNL is the only best an effective method for treating single large calculi. Compared with MTPCNL, STPCNL is associated with many advantages, less blood loss, fewer blood transfusions, fewer pulmonary complications without an increase in other complications and less hospital stay.

KEYWORDS

single tract percutaneous nephrolithotomy- STPCNL, Multiple tract percutaneous nephrolithotomy-MTPCNL.

1. INTRODUCTION

As similar to Staghorn or complex caliceal calculi, a single large renal stone also constitutes one of the most challenging problems in urology especially in our locality and are likely to destroy the function of the kidney and cause life-threatening sepsis and recurrence. The goal of stone treatment is to use a less morbid, minimally invasive and effective modality [1] The management of stone disease has witnessed a revolution since the introduction of shock wave lithotripsy (SWL) and percutaneous nephrolithotomy (PCNL) [2,3]. The refinement of nephroscopes, the introduction of simple, commercially available nephrostomy sets and development of stone disintegration techniques have paved the way of PCNL [4).

However, longer operation times, higher irrigation pump pressure, and multiple tracts become necessary methods for achieving complete stone removal as the size and complexity of renal stones increase.[5] Controversy remains whether creating multiple percutaneous tracts can cause more bleeding and higher complication rates than procedures requiring a single tract.[6] Moreover, MTPCNL has been questioned in treating patients with large complex staghorn stones due to the smaller access sheath, leading to comparatively reduced visibility and stone-free rate (SFR).[7] This study reviewed the experience of managing single large calculi with multiple-tract PCNL and evaluates that multiple-tract PCNL approaches are appropriate and effective in achieving stone-free status in more complex staghorn stone.

Table no-1 showing inclusion and exclusion criteria in between two groups

Inclusion criteria	Exclusion criteria
-Single large renal calculi	-Partial or complete staghorn calculi
	-uncorrectable coagulation disorders
-stone burden < 7.5 cm3.	-Azotaemia -patients <18 yrs.
-haemoglobin level > 10 g/dl preop	-extreme obesity (body weight > 130 Kg.)
-All procedures were performed by the same urologic team.	-Horse shoe, ectopic kidney, polycystic kidney, -Transplant kidney.

2.Patients and Methods

In this study patients who underwent PCNL for specifically single large calculi at our centre between Jan 2021 to Dec 2022 were reviewed. 50 renal units of 50 patients (26men, 24 women) with total stone burden of >3,000 mm2 but <7.5 cm in size, occupying single major calyceal system or pelvis or infundibulum, were treated. All patients were evaluated for a past or family history of urolithiasis, SWL, and percutaneous or open renal surgery.

In addition to brief history-taking, Preoperative preparation like patient demographics, including age, gender, height, weight, body mass index (BMI), preoperative blood analysis like haemoglobin (Hb), serum creatinine, estimated glomerular filtration rate,

coagulation profile, urine pH, previous procedures, stone size (cm3) were done. Stone surface area measurements were accomplished manually using graph paper, with a grid of 1-mm squares, and stone burden (cm3), were recorded. Infection and anaemia were treated pre-operatively. Prophylactic antibiotics were administered to all patients.

Radiological evaluation included plain radiography of the kidney, ureter, and bladder (KUB) and ultrasonography. Furthermore, noncontrast abdominal CT was performed to identify the anatomy of the renal collecting system and stone location, size, and hardness.

Clinical outcomes included SFRs, operation time, hospital stay length, complications, postoperative Hb and creatinine levels, and pain control dosages.

Technique

Procedure was done as a single tract PCNL and multiple tract pcnl procedure under general endotracheal anaesthesia. In addition, 25 patients who underwent the single tract (24F sheath) percutaneous method (Group 1) were prospectively compared with 25 patients who required multiple (≥2) tracts (Group 2) in a single surgical setting.

A 6-french external ureteral catheter was inserted retrograde into the PCS retrograde pyelography done and the patient was then turned prone. The appropriate calyx for puncture was selected after injection of iodinated contrast medium and (sometimes) air through the ureteric catheter. In all patients the initial puncture was in either superior-posterior, middle posterior, inferior calyx. For a supracostal access, the needle puncture was placed immediately above the upper border of the lower rib to avoid damage to the intercostal vessels. Once the PCS was entered a guide wire was manipulated down the ureter if possible, or coiled in a distant calyx. Subsequently the tract was dilated with polytetrafl uoroethylene dilators (cook) to accept a 24-french Amplatz sheath. The stones were fragmented with a pneumatic lithotriptor through a -19.5french nephroscope, and removed with grasping forceps. Smaller fragments and stone debris resulting from intracorporeal lithotripsy were evacuated under direct vision using a tri prong forceps through the working channel of the nephroscope. Since these were single large calculi, we often anticipated the need of secondary tracts, and these secondary punctures (sited at the basis of the stone and PCS configuration) were made at the outset, and guidewires were 'parked' in the PCS, although the secondary tracts were not dilated initially.

The second pre-placed puncture was dilated for stones not easily retrievable through the upper polar access. If, midway through the procedure, it was felt that the pre-placed second wire was not at an ideal site for dilation to remove the remaining stones, it was removed and a fresh puncture made. Flexible nephroscopy was used, when necessary, as an adjunct to retrieve smaller fragments from peripheral calyces, and also to confirm complete clearance if the fluoroscopy screen was doubtful. A JJ stent was used selectively in the event of mucosal injury at the ureteropelvic junction along with all cases. The procedure was terminated by placement of a 20-french nephrostomy tube into the tract(s). If on-table fluoroscopy revealed complete clearance, only a single nephrostomy tube was placed regardless of the number of tracts. If there was doubt about complete clearance or there was bleeding from other tracts, additional nephrostomy tubes were placed in those tracts. For patients with a supracostal access, the chest was screened, on table, before the patient was extubated, and an additional plain chest X-ray obtained in the recovery room.

Postoperative KUB was performed 24–48 h after the operation to evaluate the JJ stent position and residual stone size and calculate the SFR in each case. The JJ stent was placed for approximately 2–4 weeks. Notably, the stone-free status was defined as no residual stone (100 % clearance) on the KUB after JJ stent removal. Hb, creatinine, and urine analysis were also performed within 48 h after the operation. The need for blood transfusion was decided on the basis of postoperative haemoglobin. Another ESWL and ureterorenoscopic stone manipulation were performed if the residual stone was >0.4 cm.

All patients were followed up with KUB, urinalysis, and renal function tests within at least 3 months. In each visit, a thorough clinical examination, urinalysis, urine culture and sensitivity, renal ultrasonography and KUB film were performed. Excretory urography was carried out when indicated.

RESULTS:

Statistical analysis was done by the Microsoft Excel version 2019. Correlations were tested using Spearman or Pearson correlation coefficients. P value of ≤ 0.05 was considered significant, ≤ 0.001 was considered highly significant and (R) = Correlation coefficient.

Mean age was (42.84 years) Both groups 1 and 2 compared **(table no.2)** in between two in term of pre-op-post op Hb, s. creatinine, no of drains, post op pain, various post op of

Table no.2 showing mean age between groups

	TOTAL PATIENTS(n)	STPCNL 25	MTPCNL 25	P VALUE
AGE(YRS)	MEAN	41.04	44.64	0.454
	SD	18.29	15.37	
OVER ALL AGE (YEARS)	MEAN	42.84		
	SD	16.82		
SEX (%)	MALE	80%	80%	1.000
	FEMALE	20%	20%	

complications. (**Table no.3&4**) The stone free rate (in view of without residual stone rate) was 80% for STPCNL and 60% for MTPCNL. Residual stone burden ranged from 0.0 to 0.51 cm for STPCNL and 0.0 to 0.71 cm for MTPCNL and there was a statistically significant positive correlation between stone size and presence of residual stones as with increased stone burden there was an increase in the residual stones (r = 0.297).

Mean pre- and post-operative creatinine change were 0.26 mg/dL in Group 1 and 0.26 mg/dL in Group 2. Mean changes in creatinine values were not statistically was likely to fail significant between the groups. **(Figure no.1)**

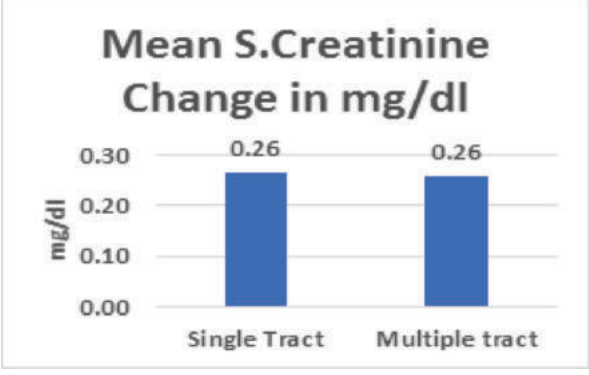

Figure-1. showing mean s.creatinine changes between two groups.

Operative time ranged from 45 to 95 minutes for STPCNL (mean 72.60 ± 15.55 minutes) and 65 to 130 minutes (mean 109.80 ± 13.03 minutes) for MTPCNL.

There was a statistically significant association between stone burden and operative time in both groups as with increased stone burden there was an increase in the operative time (P < 0.01). The mean duration of fluoroscopy screening time is 3.22±0.85 in group 1 and 6.05±1.18 in group 2 which is higher compared to group 1. (**Figure no.2**).

Difference in haemoglobin levels in pre and immediate postoperative blood counts were considered as indicator of intra-operative blood loss. Blood transfusion requirement was defined as postoperative symptomatic anaemia (Hb level, <8g/dl). The estimated intra-operative drop in haemoglobin (Hb) level ranged from 0.1–3.2 g/dl (mean 0.74±0.81 g/dl) for STPCNL and from 0.1–5.0 g/dl (mean 1.96±1.51 g/dl) for MTPCNL. **(Figure no-3)**.

There were statistically significant association between multiple tract puncture and haemoglobin drop. (P = 0.008) There is positive correlation between both the stone burden and operative time, as with increased the amplitude of operative time there was increase in haemoglobin drop (r = 0.419 and r = 0.593 respectively).

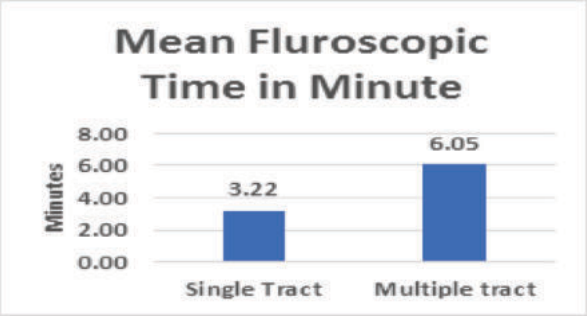

Figure .2 showing mean fluoroscopic time in between two groups.

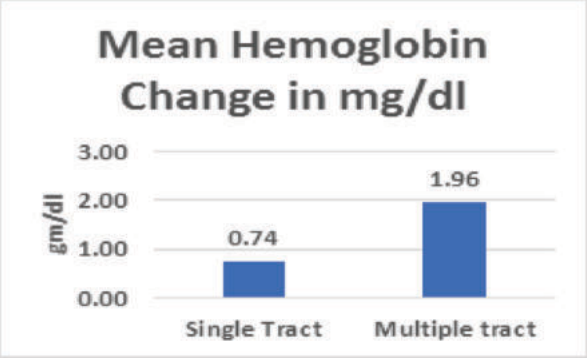

Figure -3 showing mean haemoglobin changes in between two groups.

Minor intra-operative complications occurred in 3 patients: perforation of the pelvicalyceal system occurred in 2 patients (among the group with multiple tracts). Hypotension occurred in 1 patient with a branched stone and was managed conservatively without blood transfusion. There were statistically significant positive association between MTPCNL and intra-operative complication as with increased the number of tracts there was an increase in the intra-operative complications ($P < 0.0001$). it was observed that there was an increase in intraoperative complications with increases operative time.

In 15 patients, post-operative complications were reported in the form of: post-operative fever occurred in 3 patients and was managed conservatively secondary haemorrhage in 1 patient with multiple tract puncture with pseudoaneurysm occurred in the fifth post-operative day and was managed successfully by blood transfusion followed by selective angiography and angio-embolization of bleeding lower polar segmental artery. urinary leakage occurs in 6 patients, managed conservatively. pulmonary complication like hydrothorax and pneumothorax develops in 3 patients managed by insertion of ICD tubes. Urosepsis develops in 2 patients and managed with ICU admission with higher antibiotics with strict monitoring vitals, on average 3 days both patients recovered from sepsis. Perioperative complications are summarized in **table 4**.

Percutaneous nephrostomy tube was removed on mean of 3.08 days for MTPCNL (range 2-5 days) and for STPCNL it was removed on mean of 1.2 days (range 1–2 days).

All residual stones divided in to two categories those who have <4 mm size stone (managed conservatively, no need to intervene) in both groups and those who have >4 mm stone size (n = 5) was within the range of 0.4– 0.71 cm and were managed by a single session of SWL, except in 1 patient ureteroscopic retrieval of a lower ureteral stone fragment was needed (a total of 5 ancillary procedure.)

Post operative pain was expressed in form of VAS (visual analogue score) in to four categories like no pain, mild, moderate, severe pain. so, it was observed that as there is increase in tube number of drains (group 2) there was in increase in post operative pain compared to group 1. (**figure -4**)

Total duration of Hospital stays is more for MTPCNL compare to STPCNL. For STPCNL ranges from 3-5 days with mean 3.16±0.47 and MTPCNL ranges from 3-7 days with mean 4.60±0.96 which is statically significant ($p<0.0001$).

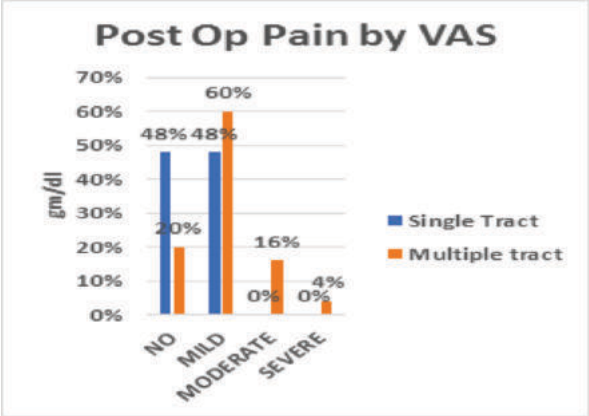

Figure -4 showing comparison between STPCNL and MTPCNL.

Table no 3. Showing comparison between STPCNL and MTPCNL in preop and postop periods.

		STPCNL	MTPCNL	P VALUE
Stone Size (cm3)	Mean	4.95	5.59	0.005
	SD	0.48	0.71	
	Range	3.66 - 5.98	4.18 - 7.01	
Pre op Hb (gm/dl)	Mean	11.72	12.18	0.244
	SD	1.55	1.18	
Pre op S.Creatinine (mg/dl)	Mean	1.74	2.14	0.015
	SD	0.54	0.58	
Fluoroscopic time (min)	Mean	3.22	6.05	<0.0001
	SD	0.85	1.18	
Operative Time (min)	Mean	72.60	109.80	<0.0001
	SD	15.55	13.03	
	Range	45 - 95	65 - 130	
Hb Dropped (gm/dl)	Mean	0.74	1.96	0.008
	SD	0.81	1.51	
	Range	0.1 - 3.2	0.1 - 5	
S.Creatinine Change (mg/dl)	Mean	0.26	0.26	1
	SD	0.34	0.22	
Stone Free Rate	80%	60%		
Hospital stay (days)	Mean	3.16	4.60	<0.0001
	SD	0.47	0.96	
	Range	3 - 5	3 - 7	
VAS	NO	48%	20%	0.027
	MILD	48%	60%	
	MODERATE	0%	16%	
	SEVERE	0%	4%	
Final PCN tube removal (days)	Mean	1.20	3.08	<0.0001
	SD	0.41	0.96	
	Range	1 - 2	2 - 5	

Table no.4 showing post operative complications.

Complications	Grade I: Fever, n (%)	0%	12%
	Grade II: blood transfusion, n (%)	8%	20%
	Grade III: Pseudoaneurysm, n (%)	0%	4%
	Urinary leakage, n (%)	0%	24%
	Urinary tract infection (urosepsis), n (%)	0%	8%
	Pulmonary complication, n (%)	0%	12%
	Perforatin of pelvicalyceal system, n (%)	0%	8%

DISCUSSION

The size of the renal calculi is directly correlated with the overall incidence of complications after PCNL and hence, treatment of large renal calculi is still considered challenging in the majority of the cases. An ideal procedure for the treatment of large renal stones would be the one that helps achieve complete stone-free status and with minimal morbidity and is cost-effective. PCNL is generally considered as a safe

procedure, and there is a lot of literature available supporting its usefulness and cost-effectiveness.

Despite the introduction of ESWL for treatment of renal calculi, PCNL still plays an important role in the treatment of large stone burden, radiolucent stones and stones in patients with anatomic concerns [5]. Improvement of endourologic instruments and lithotripsy devices has yielded greater success rates and lower complications rates for percutaneous renal surgery [5].

Proper access is a prerequisite for complete clearance of renal calculi by PCNL. The ideal tract is one that provides the shortest and straightest access to all calculi [6]. Successful percutaneous removal of such large calculi requires the accurate placement of tracts that provide the least traumatic and most direct access for fragmentation and retrieval of calculi. Time taken for meticulous planning and careful placement of tracts is time well spent and is the most important part of the operation. Verma et al. insisted that pelvicalyceal anatomy variables (e.g., infundibular width, intercalyceal angle, and pelvicalyceal system surface area) affected the number of punctures.[16] As far as possible all initial tracts should be in a posterior calyx. Care should be taken to puncture through the centre of the calyceal papilla, and direct puncture into the pelvis and near the infundibular neck must be avoided. Access through the superior posterior calyx provides a straight tract along the long axis of the kidney [8], with good exposure of superior calyceal, renal pelvis, upper ureteral and lower calyceal contents [9]. Operating along the long axis of the kidney causes minimal torque and ultimately less bleeding and better clearance. The upper calyceal tract is quite often supracostal. This in itself does not significantly increase the morbidity provided certain anatomical concepts are kept in mind. The upper pole of the kidney is more medial than the lower pole and there may, at times, be a tendency to make a more medial puncture than usual. However, the horizontal inferior border of the posterior parietal pleura crosses the upper border of the oblique 12th rib in the vicinity of the lateral border of the erector spinae group of muscles. Therefore, making a puncture through this interspace, well lateral to the erector spinae, and staying close to the upper border of the 12th rib, can minimize pleural complications. Supracostal punctures should never be made with the lung fully inflated, since in this situation the postero-inferior margin of the lung expands to fill the posterior costophrenic recess, and one can potentially puncture the lung. As far as possible, punctures above the 11th rib should be avoided, since they are associated with a significantly higher (16-fold greater than supra-12th access) incidence of chest complications [10]. In our series in some patients supracostal access was made whenever the target upper pole calyx was not easily accessible by triangulated subcostal entry. We also made punctures into middle posterior and inferior posterior calyces at the outset and placed wires in the PCS for use as required, depending on how the stone clearance proceeded with the upper polar access. Many times, fresh tracts were required to retrieve elusive stones from peripheral calyces. These punctures were usually made towards the end of the procedure, since anterior calyceal tracts tend to bleed more as a greater bulk of renal parenchyma is traversed by the dilators and sheath, since the entry into the calyx is side-on and not as end-on as a posterior calyx entry is in a prone patient.

The difference between pre- and post-operative haemoglobin level was used as an indicator of blood loss, in our study no intra-operative blood transfusion was required and the mean decrease in haemoglobin level for STPCNL was 0.74 g/dl and for MTPCNL it was 1.88g/dl. Major complications of PCNL include bleeding. The results of this meta-analysis showed that the use of multiple tracts contributed to a higher haemoglobin drop and a higher frequency of transfusions. These results are consistent with previously published results. Haemorrhage is generally associated with the initial puncture and injury of renal blood vessels and the surrounding organs. Additional tracts during PCNL may increase the risk of injury to major blood vessels and may complicate recovery from puncture injury. Hegarty and Desai noted a mean drop in haemoglobin in patients with multiple tracts similar to that in patients with single tracts [12, 13, 14]. Although an increase in the number of tracts has adverse effects in terms of blood loss, many measures can be implemented to avoid more blood loss. First, direct puncture into the pelvis or near the infundibular neck may be avoided to reduce the risk of severe bleeding [15].

The mean operative time in our study was 72.60 ± 15.55 minutes for STPCNL and 109.80±13.03 for MTPCNL which is shorter than that reported by Kurtulus et al, who reported mean operative time of 2.3 and 2.2 hours [11]. Overall intra-operative complications were 26% in the form of perforation of pelvicalyceal system and hypotension. This compares favourably with that of Lingeman et al., who stated that minor intra-operative complications can be seen in 11 to 25% of patients [19].

Post-operative complication rates ranged between 3.2% as reported by Segura [20], to 12.8% as reported by Singla et al [21]. In this study, secondary haemorrhage necessitating a haemostatic manoeuvre occurred in 1 patient (3.8%) and was managed by selective angio-embolization for pseudoanurysm. This is comparable to what was reported by Gremmo et al. (2.3%) [22] and less than that reported by Jones et al (5.8%) [23].

In this study, there were 3 patients having complications involving the chest cavity. Such complications are reported by almost every study in literature investigating the safety of upper calyceal approach. Singla et al. reported occurrence of hydrothorax in 7 patients and haemothorax in 1[21] while Shaban et al. had one patient who suffered from hydrothorax and another one who developed renopleural fistula [24]. Aron et al. who compared upper to lower calyceal approach in a prospective non randomized fashion, reported 2 incidents of hydrothorax that required chest tube insertion among the group with upper calyceal access compared to non in the group with lower calyceal approach.

Colonic injury after PCNL is a rare complication; in our study, no colonic injury was reported, a rate comparable to Elghoneimy et al., who in 2016 reported colonic injury following PCNL in three patients (0.14%), all of whom were managed conservatively [17]. Also, Ibrahima A et al. reported a low rate of colonic injury, only in 5 patients—3 was managed conservatively, one needed colostomy, and one died from sepsis [18].

When planning to perform multiple tracts, the anatomy of the collecting system, namely the angle, length and width of infundibulum should be considered. In addition, stone burden, complexity and the number of stones is all crucial factors in determining and planning the number of punctures needed.

CONCLUSION -

Our systematic review and meta-analysis demonstrated that STPCNL seems to be a safe and feasible alternative compared to MTPCNL for patients with large renal stones and has many advantages, such as no decreases in the final SFR, fewer blood transfusions, and even fewer complications, such as less blood loss, pulmonary complications and postoperative fever. However, our conclusion should be treated prudently, and further large-sample, prospective, and multicentre studies and RCTs should be undertaken to confirm our findings.

Declaration of patient consent -

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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