Tubeless PCNL in Macrotract for Multiple and Staghorn Calculus with More Than One Tract- A Single Centre Experience and Literature Review

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ABSTRACT

BACKGROUND

Percutaneous nephrolithotomy (PCNL) has gradually become a preferred method of treatment modality for kidney stones in adults as well as in paediatric patients. The primary objective of this study was to evaluate the outcomes and complications in patients having multiple and staghorn calculi and of different sizes, who underwent tubeless PCNL at a single, tertiary care hospital.

METHODS

A retrospective study was conducted at IGIMS, Patna from January 2017 to February 2018. Patients who underwent conventional PCNL with one or two access for single, multiple or staghorn calculus without nephrostomy tube were included in the study. Patients having solitary kidney with stones are excluded from this study. The primary outcomes of the study were haemoglobin, pain score, and duration of hospital stay.

RESULTS

A total of 96 patients underwent conventional PCNL with a mean age of 34 years and male:female ratio of 1.3:1. Majority of the patients had a single stone (n=54) followed by 28 patients with multiple stones. Medical comorbidities including hypertension, diabetes mellitus and chronic obstructive pulmonary disease were observed in patients of single (n=8), multiple (n=3) and staghorn (n=2) groups, respectively. Postoperative complications such as haematuria and pleural effusion were developed by the patients. Seventy-six patients were treated with single-tract and 20 by double tract PCNL.

CONCLUSIONS

PCNL is safe and efficient with limited post-operative complications. The number of residual stones were nil in single stone group while in multiple and staghorn groups insignificant number of renal stones was seen.

KEY WORDS

Comorbidities, Haematuria, Nephrostomy, Kidney Stones, Pleural Effusion

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BACKGROUND

Renal calculi or kidney stones have been showing an increasing trend in their relapse rate and prevalence in all ages, genders and races. Renal calculi formation is multifactorial and patients with renal diseases,^[1] cardiovascular diseases, diabetes, and hypertension have greater risk of developing renal calculi.^[2,3,4] The risk of renal stone varies from 1-5% in Asia and about 12% Indian population shows its presence.^[5,6]

Availability of limited drugs for the treatment of renal calculi has led to the advances of surgical technology with nominal modality invasive treatment such as Percutaneous nephrolithotomy (PCNL).^[7] PCNL has advanced gradually over the years and according to the European Association of Urology (EAU) guidelines (2017), is now a first-line of treatment for kidney and upper ureteral calculi.^[8] Untreated renal calculi especially staghorn type causes further complications increasing the risk of morbidity and mortality thus, PCNL or a combination of multimodality treatments are used. PCNL was associated with morbidities such as bleeding, pyrexia, incomplete stone removal, pleural injury, and adjacent organ injury.^[9] Refinements in the technique and better lithotripsy technologies have led to a reduction in these morbidities. In the standard PCNL procedure, after stone removal, a nephrostomy is placed. In the later years, tubeless PCNL was introduced with the insertion of a double J ureteric stent following PCNL. However, the presence of double-J stent in tubeless PCNL is often associated with stent-related problems such as frequency, urgency, nocturia, pain, and hematuria.^[10] Recently, a more advanced technique called totally tubeless PCNL was introduced in which a nephrostomy catheter, a double J stent, or a ureteral catheter are not inserted after surgery.^[11]

Studies reveal significantly lowered hospital stay, pain profiles, and use of analgesics in patients undergoing the tubeless PCNL technique. Percutaneous method is beneficial in terms of tolerance, recovery and expenses.^[12,13] The residual stone rate after PCNL (13.3–16.2%) is comparable to open surgery (0–24%).^[14–16] Studies have been conducted to determine the safety and efficacy of tubeless, totally tubeless and conventional PCNL.^[17]

The primary objective of this study was to evaluate the outcomes and complications in patients having multiple and staghorn calculi and of different sizes, who underwent tubeless PCNL at a single, tertiary care hospital.

METHODS

This was a retrospective study conducted at IGIMS, Patna. The study protocol was approved by Institutional Review Board and Ethics Committee. Written informed consent was obtained from all the patients before undergoing percutaneous nephrolithotomy (PCNL).

The patients who underwent conventional PCNL with one or two access for single, multiple or staghorn calculus without nephrostomy tube from January 2017 to February 2018 were included in the study. All preoperative investigations like complete blood count (CBC), kidney function tests (KFT), random blood sugar (RBS), intravenous

urogram (IVU) and computed tomography (CT) urography were completed. Postoperatively CBC, KFT, and X ray KUB were done in all the patients. The medical records of all the included patients were reviewed and clinical data was recorded.

The procedure was performed under aseptic condition. A ureteral catheter was introduced into the renal pelvis. The patient was inclined to access percutaneously into the corresponding pelvicalyceal system by image intensification using an 18-gauge needle. The tract was dilated using a single-step 30 F dilator. Renal stones were fragmented using ballistic lithotripsy. Post-operative stone clearance was checked with X-ray.

The patients having solitary kidney with stones are excluded from this study. The primary outcomes of the study were haemoglobin, pain score, duration of hospital stay. Data analysis included stone size and number, number of access tracts, medical comorbidities, post-operative complications and stone-free status.

RESULTS

A total of 96 patients who underwent conventional PCNL with a mean age of 34 years were included for analysis. Of 96 patients, the male: female ratio was 1.3:1. The patients were examined clinically and investigated post operatively on POD (post-operative day)

In this study one patient became serious and was shifted to surgical intensive care unit for septicaemic shock but patient revived and then discharged from hospital. The demographic characteristics of the study are listed in Table. The post-operative complications and the main outcomes of the study are listed in Table 1. Majority of the patients had single stone (n=54) followed by 28 patients with multiple stones and 14 patients. Medical comorbidities including hypertension, diabetes mellitus and chronic obstructive pulmonary disease were observed in eight, three and two patients of single, multiple and staghorn groups respectively. Postoperative complications such as haematuria and pleural effusion were developed by the patients. Among the total patients six patients developed haematuria and only one patient in multiple stone group developed pleural effusion.

Stone Size and Patient Number	Medical Comorbidities (HTN, DM, COPD)	Side		Number of Tracts		Postoperative Complications		Residual Stones
		Left	Right	Single	Double	Haematuria	Pleural Effusion	
Single (n=54)	8 (14.8)	30 (55.6)	24 (44.4)	50 (92.6)	4 (7.4)	2 (3.7)	-	Nil
Multiple (n=28)	3 (10.7)	16 (57.1)	12 (42.9)	20 (71.4)	8 (28.6)	3 (10.7)	1 (3.5)	2 (7.1)
Staghorn (n=14)	2 (14.3)	4 (28.6)	10 (71.4)	6 (42.9)	8 (57.1)	1 (7.1)	-	1 (7.1)

Table 1. Characteristics of Kidney Stones, Medical Comorbidities and Post-Operative Complications

Data is presented as n (%). COPD, chronic obstructive pulmonary disease; DM, diabetes mellitus; HTN, hypertension

Author	Year	Number of tracts	Medical comorbidities	Postoperative complications	Stone clearance rate	References
Wu et al	2019	Single, multiple	-	Fever, hematuria with blood clot, hypokalaemia, urine leakage	89.7,100	[28]
Zhao et al	2019	Single, multiple	HTN, DM	Fever, obvious hematuria with blood clot, hypokalaemia, urine leakage	89.7,100	[29]
Raharja et al	2019	-	-	Urine leakage		[30]
Ichaoui et al	2019	-	HTN, DM, CAD, Renal failure	Pyelonephritis, urinary fistula, urinoma, fever, pleural breach, digestive breach, arteriovenous fistula, blood transfusion	72.5	[31]
Gupta et al	2019	Single	-	Fever, perinephric collection, blood transfusion	92.4	[32]
Kim et al	2019	-	-	Hematoma or urinoma	91.1	[33]
Bryniarski et al	2019	-	HTN, DM	Fever, leucocyturia	-	[34]
Sourial et al	2019	-	-	Thoracic complications pneumothorax, and pleural effusion, bleeding requiring transfusion, fever, urinary retention and syncope	68.5	[35]
Iqbal et al	2018	-	-	Urinary leakage, fever, UTI	96	[36]
Keshavamurthy et al	2018	-	-	Fever, paralytic ileus, urinary leakage	-	[37]
Sofer et al	2017	-	-	Blood transfusion, Hb drop	89	[38]
Bhat et al	2017	-	-	Blood transfusion, fever, urinary leakage, haemorrhage	-	[17]
Ming et al	2017	-	-	Blood transfusion, fever, pleural effusion, HB drop	96.7	[39]
Terao et al	2015	Single, multiple	-	Fever, blood transfusion	90.2	[40]
Jou et al	2015	-	-	Fever, UTI	75.7	[41]
Zhang et al	2015	-	-	Fever, blood transfusion,	96.3	[42]
Zhao et al	2015	-	-	Haemorrhage with bleeding, pleural injury, thoracentesis	98.3	[43]
Kara-koyunlu et al	2014	-	-	Fever, blood transfusion, urinary leakage, perirenal hematoma, neighbouring organ injury, toxic hepatitis	97.5	[44]
Joo et al	2014	-	-	Bleeding, fever	76.5	[45]
Gonen et al	2014	-	-	Bleeding	95	[46]
Rifaioğlu et al		Single, multiple	-	Bleeding	93.5	[47]
Agrawal et al		-	-	Fever, blood transfusion, urinary leakage,	-	[27]
Pillai et al	2014	Single	-	Blood transfusion, pneumonia, hydrothorax, urosepsis	95	[48]
Lee et al	2013	-	-	Bleeding, angioembolization, fever, wound infection	78	[49]
Ziaee et al	2013	-	-	Bleeding, fever, urinary leakage	98	[50]
Xiong et al	2013	-	-	HB decrease, fever	99.1	[51]
Garofalo et al	2013	-	-	Fever, bleeding	-	[52]
Gonulalan et al	2013	-	-	Fever, bleeding	90	[53]
Nalbant et al	2012	-	HTN, DM, chronic respiratory disease	Haemorrhage	91.6	[54]
Samad et al	2012	-	-	Pain, urine leakage	93.3	[55]
Gudeman et al	2012	-	-	Bleeding, pseudoaneurysm, urine leakage	90	[56]
Etemadian et al	2012	-	-	Fever	83.3	[57]
Zilberman et al	2010	-	-	Pulmonary embolus, hydrothorax, pseudoaneurysm or arteriovenous fistula	89	[58]
Sofer et al	2010	-	-	Bleeding, hydrothorax, extravasation	91	[59]
Lojanapiwat	2010	-	-	Haemorrhage, pleural complication, Intercoastal drainage	86.7	[60]
Jun-Ou et al	2010	-	-	Pleural complication	90.7	[61]

Table 2. Studies of Tubeless PCNL Reported in Literature of Last 10 Years

DM, diabetes mellitus; HB, haemoglobin; UTI, urinary tract infection.

Figure 1. (A) Right Side Renal Calculi with DJ Stent with Left Side Total Clearance (B) in Situ with Two Tracts

Figure 2. Both Side Renal Calculi with Left Side Staghorn Calculi

DISCUSSION

PCNL is although an ideal procedure for management of renal calculi whether single, multiple or staghorn, is a very challenging endourologic measure of treatment. Medical literature has reported excellent stones free rates with this procedure. In this study the outcomes of the tubeless PCNL for a series of patients with single, multiple or staghorn calculi of varying sizes and multiple tracts was evaluated.

The response to this to this procedure was very well with nil residual stones in patients with single calculi and 7% in multiple and staghorn renal calculi. Medical comorbidities like hypertension, diabetes melitis and COPD in 13 among 96 patients. Similar comorbidities were reported by Soucy et al. along with cardiac, neurologic and in few renal failures.

Placing more than 2-3 tracts during PCNL increases the risk of complications, hence urologists hesitant to use multi

tracts. Studies have been carried out to support multi-tract PCNL for large staghorn calculi. Aron et al. reported less morbidity with usage of multiple tracts with a clearance rate of 84% that improved to 94% with adjunctive shockwave lithotripsy (SWL). It was observed that 81% patients with double tracts did not require transfusion.^[18] In the present study single and double tracts were used and majority patients were fitted with single tract in all the groups including single stone, 92.6%, multiple, stones, 71.4% and staghorn 42.9%. Double tract was placed in 7.4% patients of single stone group and 28.6% and 57.1% of patients in multiple and staghorn. In another study by Soucy et al. wherein 1338 patients with staghorn calculi underwent PCNL were evaluated for outcomes and major complications of PCNL. The study reported 16% of the cases requiring multiple access tracts with 78 stone free rates during hospital discharge. In an Indian study by Gupta et al. observed post-operative complications like fever (7.5%) perinephric collection (5.6%) and blood transfusion (3.7%).

The efficacy of intercostal nerve block and nephrostomy tract infiltration (NTI) with ropivacaine in patients undergoing tubeless PCNL was found to be safe.^[19]

A meta-analysis by Zhong et al. showed that totally tubeless PCNL is an ideal method of treatment that significantly condenses the hospital stay, analgesic requirement, and the time to return to normal activity without increased complications. Because this series consists of our early experiences with tubeless PCNL, we routinely placed a ureteral stent during tubeless PCNL due to safety concerns.^[20] A meta-analysis conducted by Wang et al. indicated that the haemostatic agents in tubeless PCNL are expected to be expensive rather than unsafe and not mandatory to be used whereas another study by Yu et al. revealed that haemostatic agents exhibited a short hospital stay.^[21,22]

PCNL procedure requires patients routinely to be hospitalized postoperatively. To lessen the constant rising healthcare costs, efforts are made to move PCNL to outpatient surgery.^[23-25] Outpatient surgery would be beneficial in providing a more rapid patient recovery, and decreased postoperative nosocomial infections, hence less morbidity. Our initial experience with outpatient PCNL has been favourable and warrants further investigation in a larger patient population.^[26] Agrawal et al. reported a study wherein advantages of tubeless PCNL with tethered DJ stent was evaluated that was found to overcome its main drawback i.e. the need for cystoscopy for stent removal.^[27] Various studies of tubeless PCNL are conducted in regards to its safety, efficacy, cost, hospital stay and stone clearance in comparison to standard PCNL. Table 2 depicts the clinical studies of tubeless PCNL conducted in patients having renal calculi of different types, and with single or multiple tracts.

The main limitation of this study was the retrospective nature of our study. The other factor was the limited selection of patients in this study. The tubeless method has been reported in challenging cases such as staghorn stones, horseshoe or ectopic kidneys. Promising outcomes have been demonstrated in elderly patients and circumstances requiring a supracostal approach. Multi-centre randomised controlled trials are desired to fully establish the success of the tubeless method.^[28]

CONCLUSIONS

PCNL using multiple tracts is safe and effective with limited post-operative complications and should be the first option for massive renal staghorn calculi. The number of residual stones with tubeless PCNL were nil in single stone group while in multiple and staghorn groups, minimal number of renal stones was seen.

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