DOI: 10.14260/jemds/2014/3874

ORIGINAL ARTICLE

DETECTION OF RESIDUAL FRAGMENTS DURING PERCUTANEOUS NEPHROLITHOTOMY: ROLE OF INTRA-OPERATIVE ULTRASOUND

Rajanna B[1], Harshavardhan[2], Ramalingaiah[3], Girish N[4], Manjunath C. S[5]

HOW TO CITE THIS ARTICLE:
Rajanna B, Harshavardhan, Ramalingaiah, Girish N, Manjunath C. S. "Detection of Residual Fragments during Percutaneous Nephrolithotomy: Role of Intra-Operative Ultrasound". Journal of Evolution of Medical and Dental Sciences 2014; Vol. 3, Issue 64, November 24; Page: 14006-14012, DOI: 10.14260/jemds/2014/3874

ABSTRACT: AIMS: To prospectively evaluate the efficacy of ultrasound and fluoroscopy for detection residual stones during percutaneous nephrolithotomy (PCNL). **MATERIAL AND METHODS:** We prospectively evaluated 49 patients (55 renal units) undergoing percutaneous nephrolithotomy for renal calculi greater than2cms, in 38 renal units or staghorn calculus in 17 renal units, from May 2011 to Sep 2011. In 35 renal units patients underwent standard fluoroscopic guided PCNL and in 20 renal units patients underwent standard fluoroscopic guided PCNL followed by ultrasound of kidney was done before concluding the procedure. The size and location of residual fragments determined fluoroscopically and identified by ultrasound were compared. **RESULTS:** Stone free status was achieved in 27 of the 35 renal units using fluoroscopy alone, of the 27 renal units significant residual fragment were detected postoperatively by CT kidney in 8 false negative rate of 29.6% renal units, 4(14.8%) of them required ESWL/ relook PCNL. Clinically insignificant residual fragments (≤4mm) not observed in 4 (14.8%) renal units by fluoroscopy were confirmed by post-operative CT scan. Stone free status was achieved in 14 of the 20 renal units and stone clearance was ensured by intra-operative ultrasound alone. Clinically significant residual stones were detected in 3 (21%) of 14 renal units by post-operative CT, managed conservatively**.** Clinically insignificant residual fragments (≤4mm) observed in 3 (21%) patients which were confirmed by post-operative CT scan. **CONCLUSION:** Routine intra-operative ultrasound after standard PCNL helps in detecting CIRF and significant residual calculi. There were significant false positive and false negative rate of detection of residual stones which can be overcome by further experience in use of intra-operative ultrasound.

KEYWORDS: Renal calculi; percutaneous nephrolithotomy; clinically insignificant residual calculi (CIRF).

INTRODUCTION: Percutaneous nephrolithotomy (PCNL) effectively treats large volume renal calculi but relies on postoperative imaging to judge its success.[1,2] Residual stone fragments can occur in up to 8% of patients who are treated with percutaneous nephrolithotomy. Retained calculi generated by intracorporeal lithotripsy remain a concern because of their potential for growth and future symptoms. The ability to detect residual fragments is dependent on the imaging modality and this gives different outcomes when different modalities used to assess the stone free rate.[3,4,5]

Residual stones worth to be more studied because it gives rise to two major problems namely regrowth and recurrent urinary tract infection (2) Although, Computerized Tomography (CT) is the ideal investigation to detect these residual fragments, but detection with this cannot be done intra-operatively, and patients detected to have residual fragments will require a second procedure. So accurate intra-operative detection of these residual fragments is very important to avoid a second procedure and give 100% clearance in a single surgery. Although in traditional PCNL fluoroscopy has been used to detect intraoperative residual fragments, but it has got its own limitations.

DOI: 10.14260/jemds/2014/3874

Besides increased radiation exposure, fluoroscopy may not detect small residual fragments (according to recent literature CIRF < 2 mm) and especially non-opaque stones.[6]

Also contrast material is used during PCNL and it may mask many residual fragments.

So intraoperative USG (Ultrasonography) may supplement fluoroscopy in accurate detection of residual fragments during PCNL.

AIM: To prospectively evaluate the efficacy of ultrasound and fluoroscopy for detecting residual stones during percutaneous nephrolithotomy (PCNL).

Patients and Methods: This is a prospective study conducted in Institute of Nephro-urology Bangalore.

Inclusion Criteria: All patients who underwent PCNL for radio-opaque renal calculi (Greater than 2 cms. or staghorn (Total 55renal units of 49 patients) from May 2011 to October 2011 were included in this study. Our institutional review board approved the study, and informed consent was obtained from all patients before surgery.

Exclusion Criteria: Patients were excluded if they had a history of open renal stone surgery or if they had impaired renal function, with an ectopic kidney and urosepsis from the study.

All patients were evaluated by thorough medical history, physical examination, urine analysis, urine culture, renal function test, a coagulation test and thesel patients underwent unenhanced CT or i.v. urography to clarify the size, location of the calculi and the grade of hydronephrosis, before undergoing surgery. During their hospital stay, all patients were prescribed parenteral antibiotics, according to their urine culture results.

Our surgical team and sonologist with more than ten years' experience performed these procedures under general anesthesia. Standard PCNL with conventional fluoroscopy was performed in 35 renal units and standard PCNL by fluoroscopy, followed by an ultrasonography (USG) of same kidney was done intra-operatively to look for any residual calculus in 20 renal units. The size and location of residual fragments determined fluoroscopically and identified by ultrasound were compared.

Stone-free status was defined as the absence of visible fragments on CT. Clinically insignificant residual fragments (CIRFs) were defined as those that were ≤4 mm in diameter, non-obstructive, and asymptomatic. All patients were assessed for stone clearance between 3-4 weeks after surgery using CT before removal of double J stent.

Characteristics Number (%)

Mean age in years	**38.6 years(18- 58 years)**
Gender Male Female	 29 (59.1) 20(40.8)
Laterality Left Right Bilateral	 30(54.5) 25(45.5) 06(10.9)

DOI: 10.14260/jemds/2014/3874

Stone type	
Pelvic & Calyceal	38(69.1)
Staghorn	17(30.9)
Mean stone burden in mm2 (range)	375.5 (300-450)
Grade of hydronephrosis	
None	05(9.1)
Mild	17(30.9)
Moderate	22(40)
Severe	11(20)

Table no. 1: Demographic and clinical characteristics of the 49 patients (55 Renal units) in the study

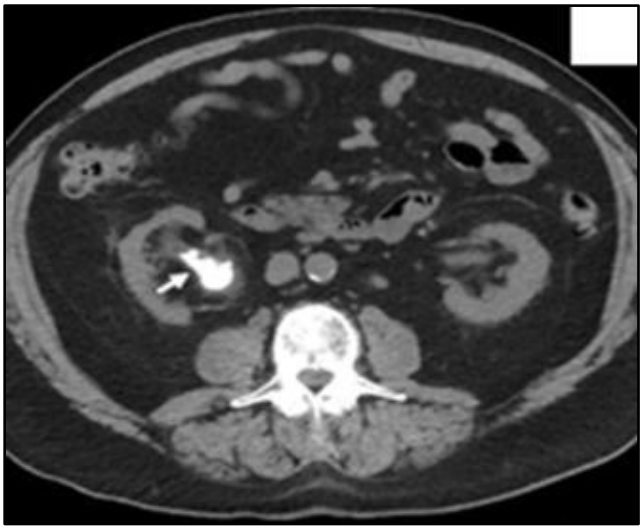
RESULTS: Patients with 35 renal units underwent standard fluoroscopic guided PCNL and concluded the procedure by fluoroscopy only. Patients with underwent 20 renal units underwent standard fluoroscopic guided PCNL followed by ultrasound of kidney was done before concluding the procedure.

Stone-free status was achieved in 27 of the 35 renal units using fluoroscopy alone. Of the 27 renal units significant residual fragments were detected postoperatively by CT in 8 (false negative-29.6%) renal units, 4 of them required ESWL/re-look PCNL. Clinically insignificant residual fragments (≤4mm) not observed in 4 (14.8%) patients by fluoroscopy were detected by post-operative CT scan.

Stone free status was achieved in 14 of the 20 renal units and stone clearance was ensured by intra-operative ultrasound alone. Clinically significant residual stones were detected in 3 (21%) of 14 renal units by post-operative CT, managed conservatively**.** Clinically insignificant residual fragments (≤4mm) observed in 3 (21%) patients which were confirmed by post-operative CT scan.

Stone-free rates according to AGP, KUB film, and non-contrast CT were 73.6% (39/53), 62.3% (33/53), and 20.8% (11/53), respectively. However, if clinically insignificant residual fragments are included in the success rates, these rates increased to 84.9% (45/53), 83.0% (44/53), and 41.5% (22/53), respectively.

Pre-operative CT Scan showing Rt staghorn calculus

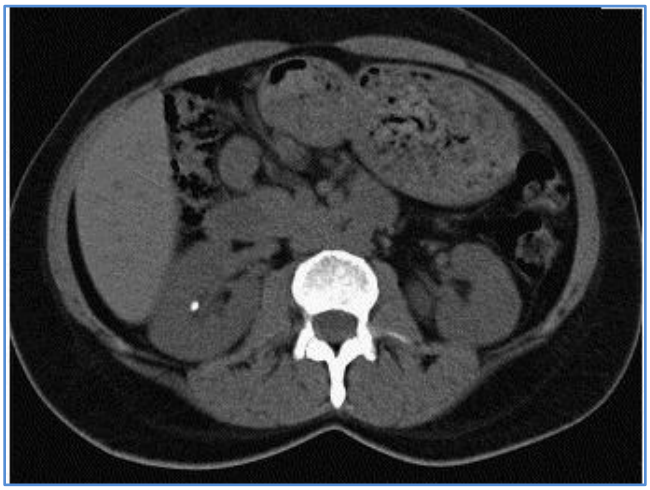


DOI: 10.14260/jemds/2014/3874

KUB Xray: Showing Stag horn calculus.

Intra-operative ultrsonogram of kidney for detection of stone fragments.

Post PCNL- USG and CT KUB: Showing residual calculi.



DOI: 10.14260/jemds/2014/3874

DISCUSSION: Percutaneous nephrolithotomy (PCNL) constitutes first line therapy for large and complex renal calculi. It has been proved to be a less morbid procedure compared to open stone surgery & better stone clearance than ESWL. Multiple investigators have showed that modification to standard technique may be accompanied by decreasing the length of hospital stay or promoting patient outcome.[1,3,4] The sensitivity of intraoperative imaging with reference to the gold standard of postoperative CT was 40%, 38% and 100% at thresholds of 0, 2 and 4 mm, respectively. Specificity was 100%, 94% and 95%, respectively.[7,8]

Flexible nephroscopy combined with high magnification rotational fluoroscopy allows sensitive and specific intraoperative detection of residual fragments, enabling immediate removal or planning for necessary second look nephroscopy.

Conventional CT, plain film radiography, nephrotomography and renal sonography were compared by Lehtoranta et al.[9] in detecting residual stones after PCNL 12 to 36 months post-surgery. In a comparison for different modalities, residual fragments were detected by CT in 53%, by plain film in 44%, by nephrotomograms in 42% and by sonography in 28%.

Pires et al.[10] compared the sensitivity of residual stones detection after PCNL between plain abdominal x-ray and computed tomography and found that sensitivity was 87% and 100% respectively especially in diagnosis of small residual fragments <5mm concluding that spiral CT is justified to confirm the absence of residual fragments in patients after percutaneous nephrolithotomy despite the higher cost and irradiation compared to plain abdominal x-ray.[10]

In an attempt to increase the intraoperative detection of residual stones high magnification rotational fluoroscopy was used by Portis et al.[11] in conjunction with flexible nephroscopy. Despite these measures only 60% of patients were stone-free on postoperative day 1 CT. However 40 % of patients who were endoscopically and fluoroscopically stone-free had residual stones 4 mm or smaller.

A KUB has a sensitivity and specificity of 45% and 77%, respectively, as reported in the literature. An excretory urogram has 94% to 100% sensitivity and 64% to 97% specificity [12, 13].The sensitivity, specificity and accuracy of ultrasound for detecting calculi are 40%, 84% and 53%, respectively.

Intraoperative ultrasound of the kidney could able to detect 2 mm residual fragments & can be complementary to fluoroscopy during PCNL to obtain complete stone clearance.

In our experience differentiating residual fragments with artifacts produced by air, blood clots & Amplatz sheath inside the kidney was difficult, but may be overcome by experience. Finally, plain CT KUB is essential to define success or failure of the procedure.

References	Total no. of patients.	No. risk for re surgery (%)	No. risk for stone growth (%)	No. risk for pain (%)	No. overall risk (%)
Park et al51	160				69(43)
Raman et al59	42	11(26)	6(14)	12(28)	18(48)
Altunrende et al[8]	38		8(21)	10(26)	
Our study	55	04 (7.3)	07 (12.7)	07 (12.7)	11 (20)
Fluoroscopy	35	04 (11.4)	04(11.4)	04(11.4)	08 (22.8)
Ultrasound	20	00	03 (15)	03 (15)	03 (15)

Table no. 2: Post PCNL: Summary of residual fragments

DOI: 10.14260/jemds/2014/3874

Our study	Stone clearance	% of stone clearance	False negative	% of false negative
Intra-operative fluoroscopy.	27/35	77	8/27	29
Intra-operative ultrasonography	14/20	70	3/14	21
Lehtoranta et al				
Plain KUB	NA	56	NA	--
Sonography	NA	72	NA	--
CT- KUB	--	42	--	--

Table no. 3: Post PCNL: Comparison of stone clearence

CONCLUSION: Routine intra-operative ultrasound after standard PCNL helps in detecting CIRF and significant residual calculi.

There were significant false positive & false negatives rate of detection of residual stones which can be overcome by further experience in use of intra-operative ultrasound.

Improved intraoperative imaging also has the potential to further localize fragments and improve surgical outcome during the initial PCNL.

REFERENCES:

1. Andrew J Portis, Mark A Laliberte, Stephanie Drake, Cindy Holtz, Michael S Rosenberg, Carl A Bretzke J Urol 2006 Jan;175(1):162-5; discussion 165-6,
2. Abdelhafez M F (2013) Residual Stones after Percutaneous Nephrolithotomy. Med Surg Urol 2: 115. doi:10.4172/2168-9857.1000115.
3. Feng MI, Tamaddon K, Mikhail A, Kaptein JS, Bellman GC (2001) Prospective randomized study of various techniques of percutaneous nephrolithotomy. Urology 58: 345-350.
4. Lim JK HJ, Chung KH (2002) Cost and Effectiveness of Different Treatment Options for Renal Calculi Larger than 2 cm. Korean J Urol 43:454-458.
5. Lojanapiwat B (2006) Previous open nephrolithotomy: does it affect percutaneous nephrolithotomy techniques and outcome? J Endourol 20: 17-20.
6. Mohamed F Abdelhafez* Department of Urology, University Hospital Tübingen, Eberhard-Karls University, Tübingen, Germany. Med Surg Urol 2013, 2:2
7. Karin E. Westesson, M. D. and Manoj Monga, M. D. Streem Center for Endourology & Stone Disease Glickman Urological & Kidney Institute Cleveland Clinic Foundation Cleveland, Ohio AUA Update Series Lesson 36 Volume 31 2012.
8. Song Yan, Fei Xiang and Song Yongsheng, BJU Int 2013; 112: 965–971, Division of Urology, Sheng Jing Hospital, China Medical University, Shenyang, China.
9. Lehtoranta K, Mankinen P, Taari K, Rannikko S, Lehtonen T, et al. (1995) Residual stones after percutaneous nephrolithotomy; sensitivities of different imaging methods in renal stone detection. Ann Chir Gynaecol 84: 43-49.

DOI: 10.14260/jemds/2014/3874

10. Pires C, Machet F, Dahmani L, Irani J, Dore B Sensitivity of abdominal radiography without preparation compared with computed tomography in the assessment of residual fragments after percutaneous nephrolithotomy. Prog Urol 13:581-584.
11. Portis AJ, Laliberte MA, Drake S, Holtz C, Rosenberg MS, et al. (2006) Intraoperative fragment detection during percutaneous nephrolithotomy: evaluation of high magnification rotational fluoroscopy combined with aggressive nephroscopy. J Urol 175:162-165.
12. Tamm EP, Silverman PM and Shuman WP: Evaluation of the patient with flank pain and possible ureteral calculus. Radiology 2003; 228: 319.
13. Smith RC, Rosenfield AT, Choe KA et al: Acute flank pain: comparison of non-contrast-enhanced CT and intravenous urography. Radiology 1995; 194: 789.

AUTHORS:

1. Rajanna B.
2. Harshavardhan
3. Ramalingaiah
4. Girish N.
5. Manjunath C. S.

PARTICULARS OF CONTRIBUTORS:

1. Associate Professor, Department of Surgery, HIMS, Hassan.
2. Assistant Professor, Department of Medicine, HIMS, Hassan.
3. Associate Professor, Department of Radiology, Institute of Nephro Urology, Bangalore.
4. Associate Professor, Department of Urology, Institute of Nephro Urology, Bangalore.
5. Assistant Professor, Department of Anatomy, HIMS, Hassan.

NAME ADDRESS EMAIL ID OF THE CORRESPONDING AUTHOR:

Dr. Rajanna B,
Associate Professor & HOD,
Department of General Surgery,
Hassan Institute of Medical Sciences, Hassan.
Email: drrajannab@gmail.com

Date of Submission: 15/11/2014.
Date of Peer Review: 16/11/2014.
Date of Acceptance: 21/11/2014.
Date of Publishing: 22/11/2014.