

COMPUTED TOMOGRAPHY VERSUS PLAIN RADIOGRAM IN EVALUATION OF RESIDUAL STONES AFTER PERCUTANEOUS NEPHROLITHOTOMY OR PYELONEPHROLITHOTOMY FOR COMPLEX MULTIPLE AND BRANCHED KIDNEY STONES

By

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Abstract

This study compared the efficacy of computed tomography of the urinary tract (CT urography) versus plain X-ray of the urinary tract (KUB) in detection and evaluation of the significance of residual stone after percutaneous nephrolithotripsy (PCNL) or surgical pyelonephrolithotomy (SPNL) for complex branching or multiple stones in the kidney.

A retrospective prospective archival cohort of 168 patients underwent PCNL or SPNL for large stag horn or multiple stones in the kidney were evaluated, they were 113 patients who underwent SPNL, and 55 patients underwent PCNL. In all patients they had KUB second day of the operation, those who had multiple kidney punctures in the PCNL procedure for multiple stones, or multiple nephrotomies in the SPNL procedure, or had a radiolucent stones had an additional imaging with CT urography. Indications for the CT urography were cases of radiolucent stones and multiple small calyceal stones detected pre-operatively. The study was conducted between March 2010 and December 2014, data were retrospectively analyzed. Preoperatively multiple or branching stones were diagnosed with intravenous urography and CT urography. Stone size and location were mapped pre-operatively on a real-size drawing, and three dimensional computed construction images in multiple planes. All patients were informed about the advantages, disadvantages and probable complications of both PCNL and SPNL before the selection of the procedure. Patients decided the type of the surgery type by themselves and written informed consent was obtained from all patients prior to the surgery. Patients were in two groups according to the patient's preference of surgery type. Group 1 consisted of 113 patients who underwent SPNL and Group 2 consisted of 55 patients treated with PCNL. Detection of residual stones stone postoperatively using KUB and CT urography was evaluated in both groups.

There was statistical significance between the two imaging methodology in detection of residual stones after PCNL and/or SPNL. CT urography detected stones of 2 mm and up to 5mm which was not visualized with KUB. CT urography was statistically significant and precise in detecting the radiolucent stones of uric acid, urate, and phostate stones which were not detected by KUB.

Keywords: Kidney stones; Percutaneous nephrolithotripsy; Pyelonephrolithotomy; residual stones; surgical procedures, operative; computed tomography; imaging.

Introduction

Kidney stones which are multiple and branching and located in different calyces, in different anatomical plane, are challenge for urologist to achieve a stone free status. In either case of intervention to completely remove the stone whether with percutaneous nephrolithotripsy (PCNL) or open surgical procedure of pyelonephrolithotomy (SPNL), in either procedure the target

is to achieve a stone free status and no residual stones. In case of the residual stones a complementary procedure of second look PCNL would be done, or another procedure of extracorporeal shock wave lithotripsy (ESWL). Decision of which procedure will be chosen depends on precise detection of residual stoned. Plain radiogram of the urinary tract (KUB) often misses diagnosis of radiolucent stones or stones hid-

den behind a nephrostomy tube and infected stones. Ignoring a residual stone after PCNL or SPNL will lead to obstructed kidney, pyelonephritis, urinary fistula, and fast regrowth of the kidney stone. PCNL is recommended as a primary treatment in the management of renal stones ≥ 2 cm (Preminger *et al*, 2005; Gupta *et al*, 2007; Miler *et al*, 2007; Deem *et al*, 2011). Although PCNL has stone-free rates higher than 90% regardless of stone size and location, PCNL may leave behind an unrecognized residual stone that may lead to various complications. Early detection of the residual stone may indicate second look PCNL or ESWL that will avoid future several disadvantages such as infection, urinary extravasation and long hospitalization (Osman *et al*, 2008; Sountoulides *et al*, 2013). In patients with Large branching stones that of stag horn type that had multiple stones distributed in multiple calyces in different anatomical location, PCNL is not advisable as open surgical procedure of pyelonephrolithotomy combined with multiple nephrotomies and intra-operative fluorescence imaging and ultrasound would offer a favorable stone free status rather PCNL. These limitations of PCNL had offered the choice for urologists to choose between PCNL and SPNL in complex large multiple renal stones.

Retrograde intrarenal surgery (RIRS) has recently become popular in the management of renal stones; RIRS provides an alternative way to PCNL by minimizing the risks related to PNL. Studies reported stone-free rates from 77% to >90% for RIRS of renal stones and 62%-85% for the management of lower pole stones and in management of large renal stones (Grosso *et al*, 1999), but this procedure of RIRS was not feasible for complex renal stones.

Several reports indicated that CT urography was superior to plain X-ray radiogram or ultrasound in evaluation of residual fragments after PCNL (Lehtorant *et al*, 1995; Gaucher *et al*, 1998; Park *et al*,

2007; Osman *et al*, 2008, Sountoulides *et al*, 2013,).

To the authors' knowledge, none compared the efficacy of CT urography versus plain urography to assess residual stones following PCNL and SPNL in large complex multiple branching radio-opaque and radiolucent stones. The present study aimed at surgical treatment for urinary calculi is achieving stone free status.

Patients, Materials and Methods

Patients (166) underwent PCNL (55) or SPNL (111) for large complex multiple branching renal stones between March 2010 and December 2014, Department of Urology Theodor Bilharz research Institute and in Private Hospitals in Giza, Suhag, Qena and Aswan Governorates. They were followed prospectively and evaluated with intravenous urography preoperatively.

All patients were examined within 24-48 hours after the procedure by plain radiogram of the urinary tract (KUB), and CT urography. KUB and CT urography images were investigated by two radiologists and urologist, the presence of residual stone along with size and location were recorded. For stone size, less than 3 mm was accepted as cut off level of significance. Unenhanced helical scanning was performed; images were obtained from the upper border of 10th rib to the lower border of the symphysis pubis using 4 mm slice thickness.

CT urography was used as the gold standard for detection of residual stones, compared to KUB. Sensitivity of KUB was defined as number of positive results divided by the overall number of positive cases using the CT urography standard.

Statistical significance was determined by use of Pearson chi-square test and P value of <0.05 was accepted for significance.

Results

Total of 55 PCNL cases were performed and one stage procedure was performed in all of the cases. Access through one cali-

ceal puncture was performed in 32 patients (58.1.5%), and multiple access was performed in 13 cases (23.6%). Mean age of the patients was 38.6 ± 5 , 38 patients (69%) were males.

Stone free status without or with residual stones less than 3 mm was achieved in 41 patients (75.5%) using CT urography as the gold standard test. The 14 patients with significant residual stones were diagnosed with CT urography in 100%, and 5 out of 14 by KUB (35.7%). When cut off value of 3 mm for residual stone was considered, stone free status was achieved in 44 patients (75.5%). Sensitivity was 35.7% (5 of 14 cases) for KUB. CT urography was shown to be significantly more efficient for detection of residual stones compared to KUB ($p=0.01$). Considering specificity, KUB did not result in any false positive results. Therefore specificity of CT urography and KUB were calculated aequal.

Patients underwent surgery for complex renal stones were 113 cases, surgical procedure was pyelonephrolithotomy via eleventh rib access, pyelotomy incision was done to extract the main bulk of the stone either in Toto or fragmented into medium size pieces. Multiple radial nephrotomies are done to access stones in closed calyx or a multiple stone in anterior or lower calyx, no pedicle clamping was applied to the 113 cases. The procedure was completed with insertion of nephrostomy tube and double J ureteric stent. On the second postoperative day imaging was done with KUB and CT urography.

Significant residual stones over 3 mm was detected in 21 patients using CT urography, KUB detected 13 cases of these significant residual stones (62%). Patients having residual stones, were kept with their double J stent to follow passage of the stones, and to be subjected to ESWL. CT urography was shown to be significantly more efficient for detection of residual stones compared to KUB ($p=0.01$).

Regarding ancillary procedures following detection of residual stones by CT urography, ESWL was employed in 10 patients after PCNL, the other 4 patients with residual stones has passed the stones. Patients whom had SPNL were 113, 21 of them had residual stones, 14 received ESWL, where the other 7 patients passed the residual stone in the presence of the double J ureteric stent.

Discussion

Complete stone removal after PCNL or SPNL is crucial for preventing recurrence and regrowth of stones and further need for additional procedures (Preminger *et al*, 2005; Gupta *et al*, 2007; Miler *et al*, 2007; Deem *et al*, 2011). This makes postoperative imaging for Residual stone necessary. KUB is one of the most commonly used imaging modality for detection of residual stone following SPNL and PNL. Main advantages of KUB are its low cost.

Most of urinary stones are radiopaque, following PCNL and SPNL the residual stones are in certain cases difficult to be seen on plain abdominal radiographs because of their size, location, and also to the presence of stents and tubes. However, routine follow-up with only KUB for the detection of residual stone after PCNL and SPNL is not advised, because its sensitivity is directly affected from the presence of a nephrostomy tube.

CT urography is currently the imaging modality of choice for evaluation of residual stones after PCNL (Osman *et al*, 2008; Sountoulides *et al*, 2013). Sensitivity and specificity of CT urography exceeded 90%, for all stones whether radiopaque or translucent. The superiority of CT urography over KUB for detection of residual stones was shown (Lehtorant *et al*, 1995; Gaucher *et al*, 1998; Park *et al*, 2007).

Sensitivity of to detect residual stones of radiopaque stones was 100% and 62% for CT urography and KUB and US respectively, these results are comparable to the

result of (Osman *et al*, 2008; Sountoulides *et al*, 2013).

In the present study only radiopaque stones were considered and sensitivity of KUB was applied to stones of 3mm and more that was accepted as the cut off value and for detection of residual stones above this cut off level, sensitivity of KUB in radiolucent stones was 0%. Sensitivity of CT urography in both radio-opaque and radiolucent stones was significantly greater than KUB and reached 100%. Previous studies, utilized KUB, or CT urography for detection of residual stones following PCNL is still controversial indicating that CT urography is the best method for detection of RFs, but the superiority is especially prominent for smaller stones less than 3 mm of the radio-opaque stones. Small stones of 2-3 mm can cause significant obstruction or act as a nidus for further stone regrowth especially in infection stones, so detection of residual stones are of significance to plan further treatment and anticipate possible side effects, and to inform the patient of possible events in the follow-up period.

In the present study, an imaging is performed routinely at postoperative day 1, for KUB and in doubtful cases UT urography is done on day 2 postoperatively, this timing is crucial to plan further treatment options as leaving double stent for longer time, second look in cases of PCNL, or ESWL. The imaging modalities by CT urography are mandatory in radiolucent stones, and would be optional in radio-opaque stones with sensitivity and specificity of 100%. KUB was done routinely in the 1st day postoperatively with less sensitivity to CT urography.

Conclusion

Kidney imaging by CT urography for residual stones proved accurate in cases of SPNL or PCNL for multiple and branching kidney stones, emphasis in cases of multiple small stones, uric acid stones, urate stones, and phosphate stones with

most sensitive in imaging residual stones after percutaneous nephrolithotripsy and surgical pyelonephrolithotomy in early postoperative period. It is sensitive than plain radiogram with best specificity to diagnose radiolucent stone.

References

- Deem, S, Defade, B, Modak, A, Emmett, M, Martinez, F, et al, 2011:** Percutaneous nephrolithotomy versus extracorporeal shock wave lithotripsy for moderate sized kidney stones. *Urology* 78:439-43.
- Gaucher, O, Cormier, L, Deneuille, M, Régent, D, et al, 1998:** Which is the best performing imaging method for demonstrating residual renal calculi? *Prog. Urol.* 8: 493-5
- Grasso, M, Ficazzola, M, 1999:** Retrograde ureteropyeloscopy for lower pole caliceal calculi. *J. Urol.* 162:1904-8.
- Gupta, M, Oct, MC, Shah, JB, 2007:** Percutaneous Management of Upper Urinary Tract. *Campbell-Walsh Urology*, 9th edition; Philadelphia, PA: Saunders Elsevier.
- Lehtoranta, K, Mankinen, P, Taari, K, Rannikko, S, et al, 1995:** Residual stones after percutaneous nephrolithotomy; sensitivities of different imaging methods in renal stone detection. *Ann. Chir. Gynaecol.* 84:43-9
- Miller, NL, Lingeman, JE, 2007:** Management of kidney stones. *BMJ* 334:468-72.
- Osman, Y, El-Tabey, N, Refai, H, Elnahas, A, Shoma, A, et al, 2008:** Detection of residual stones after percutaneous nephrolithotomy: role of nonenhanced spiral computerized tomography. *J. Urol.* 179:198-200.
- Park, J, Hong, B, Park, T, et al, 2007:** Effectiveness of noncontrast computed tomography in evaluation of residual stones after percutaneous nephrolithotomy. *J. Endourol.* 21:684-7
- Pevzner, M, Stisser, BC, Luskin, J, Yeamans, JC, Chend-Lucey, M, et al, 2011:** Alternative management of complex renal stones. *Int. Urol. Nephrol.* 43:631-8
- Preminger, G, Assimos, D, Lingeman, J, 2005:** AUA guideline on management of staghorn calculi: diagnosis and treatment recommendations. *J. Urol.* 173:1991-2000.
- Sountoulides, P, Metaxa, L, Cindolo, L, 2013:** Is computed tomography mandatory for the detection of residual stone fragments after percutaneous nephrolithotomy? *J. Endourol.* 27:1341-8.