International Journal of Medical Research Professionals
P-ISSN: 2454-6356; E-ISSN: 2454-6364
DOI: 10.21276/ijmrp

*Original Research Article.*

# Role of Non-Contrast CT Scan in the Diagnosis of Urolithiasis and Incidental Findings

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## ABSTRACT

**Background:** Urolithiasis is one of the most common urinary tract diseases worldwide, with a wide range of affected age groups. Non-contrast enhanced computed tomography (NECT), has been considered as gold standard for the initial as well as follow-up assessment of patients with suspected urolithiasis. Aside from detection of stones, non-contrast CT examination also offers a valuable overlook upon the other pathologies of which may simulate a stone disease or accompany stone disease and can be detected incidentally.

**Methods:** Descriptive observational study done at Department of Radiology and Imaging of Sylhet MAG Osmani medical college Hospital, Sylhet from October 2019 to February 2020. 75 patients who presented with symptoms and signs of urolithiasis referred for computerized tomography (CT) were enrolled. CT scan were performed without oral or intravenous contrast with respect to size and CT attenuation value of the calculus, secondary signs of obstruction, CT diagnosis of urolithiasis, genitourinary or other diseases.

**Results:** Out of 75 patients, 60 patients diagnosed as urolithiasis, 93 stones detected by NECT. Most of patients presented solitary stone which appear 73.4%, followed by double stone in 11.6% of patients and 3.45% had 5 or more stone at investigation. 10.8% of stones lie in ureter, 7.6% of stones in renal pelvis, rest within the calyceal system, according to size of stones, most belongs to range 3–5 mm (35.4%). The range of CT attenuation value of calculus was from 60 to 1100 HU (Hounsfield Unit) with median value of 311 HU. Hydronephrosis (84%) and hydroureter (82%) were the most common secondary signs of obstruction followed by fat stranding (51%) and renomegaly (26%). We have observed incidental diagnosis related to genito-urinary tract in 15 (20%) cases and not related to genito-urinary tract in 6 (0.8%) cases.

**Conclusions:** NECT scan evaluation helped in diagnosis of urolithiasis and secondary obstruction. It also provided very useful information regarding genitourinary as well as other than genitourinary pathology.

**Keywords:** Non-Contrast Enhanced CT (NECT), Stone, Hydronephrosis, Incidental Findings.

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**Article History:**

**Received:** 09-04-2020, **Revised:** 05-05-2020, **Accepted:** 28-05-2020

| Access this article online | |
|---|---|
| Website: www.ijmrp.com | Quick Response code |
| DOI: 10.21276/ijmrp.2020.6.3.013 | |

## INTRODUCTION

Computed tomography (CT) is recommended by several authors at present as the initial diagnostic imaging technique in patients with suspected renal colic because of its high sensitivity and specificity for the detection of calculus.[1-4]

The initial use of CT reveals the presence of a calculus, its size and location[5], these give us a useful information for selecting the most appropriate therapeutic approach.[6]

The major determinants of treatment options are the calculus number, site, size, attenuation, as well as the presence or absence of obstruction.[7] Multiple radiological techniques can be used to detect and characterize urinary tract calculi, including plain X-ray, intra- venous urography, ultrasonography and computed tomography.[8]

Non- contrast enhanced computed tomography (NECT) has been considered as gold standard for the initial as well as follow-up assessment of patients with suspected urolithiasis. It has several advantages like a high sensitivity and specificity for stone detection, characterization of composition of stone, ease of availability and avoidance of intravenous administration of contrast.[9]

Another advantage in NECT is that it gives an overview of the other abdominal organs and of the peritoneal cavity with possible detection of other incidental pathological processes that may gain a priority in its management over the urinary tract stones, with early detection and hence early management, resulting in better prognosis. NECT also enables detection of other pathologies that mimic urinary tract stone in its symptoms and signs, and so redirecting the management plan to its correct path.[10]

## METHODOLOGY

This is a prospective cross-sectional observational study done at Department of Radiology and Imaging, Sylhet MAG Osmani Medical college hospital, Sylhet, Bangladesh. Study duration was October 2019 to February 2020. 75 patients who presented with symptoms and signs of urolithiasis referred for non-contrast enhanced computerized tomography (NECT) with provisional diagnosis of urolithiasis were enrolled. Informed consent was obtained from the subjects prior to enrolment in the study. NECT study was done with respect to size, location and CT attenuation value of the calculus, secondary signs of obstruction, CT diagnosis of genitourinary or other incidental diseases.

CT Machine: TOSHIBA Aquilion PRIME 160 slice MDCT scanner.

Axial sections were taken from dome of diaphragm to pubic symphysis with slice thickness of 7 mm and recon index of three with pitch of 1.5. The images were viewed in abdominal window and bone window. The coronal and sagittal post scans reconstruction done for proper visualization of renal calculus.

## RESULTS

This cross-sectional study enrolled 75 patients had renal colic symptoms and signs. Among them 60 patients diagnosed as urolithiasis having 93 calculi.21 patients had incidental findings on NECT.

Male constitute 57% (34) and Female 43% (26). Male to Female ration 1.3. About 65% of the patient in the age group of 40–59 years, 26% in the age group of 20–39 years, 6.6%of them had age less of 20 years and 1.4% with age more than 59 years.

Table 1 reveal 46.6% of patients had calculus in the left side and 53.4% show in the right side, solitary calculus which appears 73.4%, 11.6% of patients had double calculi, 5% had triple calculi, 6.6% had four calculi and 3.45 of the patients had 5 or more calculi.

Other results for the location of calculi for 93 stones reveal 10.8% located in ureter,7.6% in renal pelvis, 13.9%in upper calyx,28% in lower calyx and39.7% in middle calyx as shown in Table 2. (Fig 1 shows left renal two calculi in upper and lower calyx)

In Table 3, appeared size of calculus in mm, which shown 11.9% had size<3mm,35.4% of calculus range 3–5 mm,34.5% range 6–10 mm, 12.9% for 11–15 mm in size, 3.25% had size range 16–20 mm and only 2.1% of calculi had size >20mm.

Out of 93 calculi found in 60 patients diagnosed as urolithiasis on NECT, the range of CT attenuation value of calculus was from 60 to 1100 HU (Hounsfield Unit) with median value of 311 HU. The largest group (47.8%) was found having less than 300 HU value (Table 4).

51 patients (68%) had urinary tract stones only with no other associated pathologies detected by NECT and 9 patients (12%) had incidental finding beside urinary tract stones, 12 patients (16%) had an incidental finding with no urinary tract stones and 3 patients (4%) had neither stones nor incidental findings seen in non-contrast CT study (Table 5).

Among the 60 patients of urolithiasis, hydronephrosis (70%) and hydroureter (60%) were the most common secondary signs of obstruction (Fig:2) followed by fat stranding (53%) (Fig:3) and renomegaly (33%) (Table 6).

We have observed additional diagnosis related to genito-urinary tract in 15 (20%) cases and not related to genito- urinary tract in 6 (8%) cases (Table 7 and Table 8).

A total number of 21 patients (28% of total patients) had incidental findings and these incidental findings were divided into two groups: group 1 with incidental findings related to the urinary system (71.42%) and group 2 related to organs other than the urinary system (28.57%);

Considering the patients with extra-urinary incidental findings (group 2), the most of the incidental findings were cholelithiasis (33.3%) (Fig: 4) and acute appendicitis (33.3%)

On the other hand, renal cysts were the urinary tract related incidental finding most commonly encountered in 4 patients (66.66%) (Fig: 4), followed by renal infections in 3 patients (50%) and PUJ obstruction in 2 patients (33.33%).

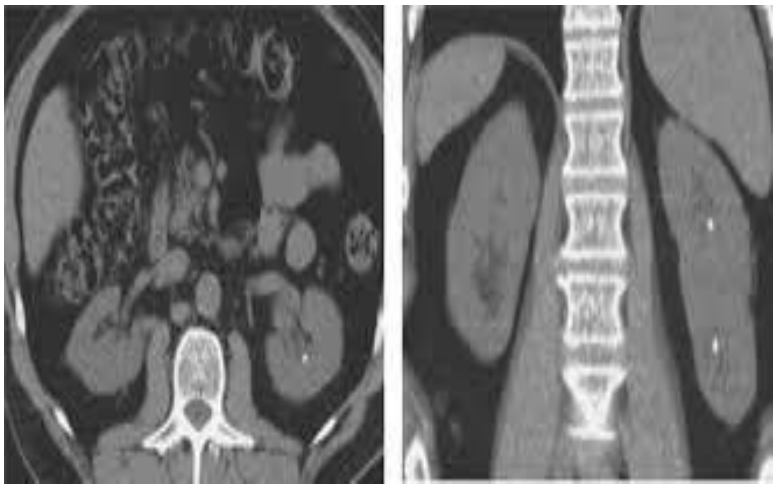

**Figure 1: Sixty-one-year-old female patient with left flank pain. NECT in axial and coronal planes shows stones in left upper and lower calyx.**

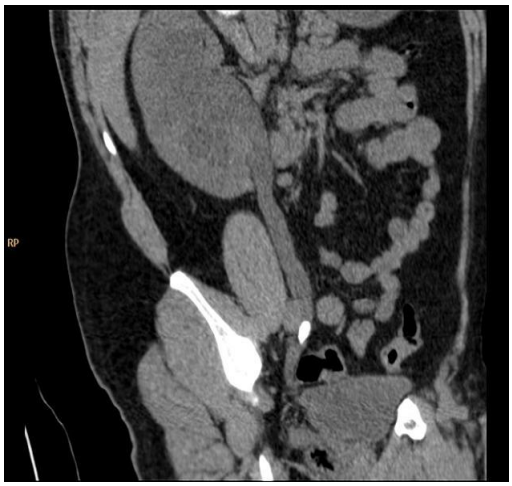

**Figure 2: NECT of KUB of 33-year-old female patient having right ureteric calculus with hydrouretero-nephrosis.**

**Figure 3: NECT of 60-year-old male patient having perinephric fat stranding.**

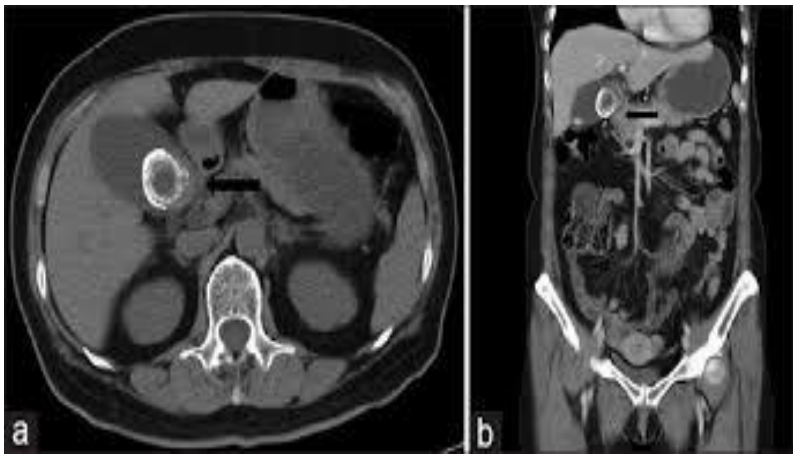


**Figure 4: Axial and reconstructed coronal NECT of Fifty-two years old female patients showing gall bladder stones (arrow).**

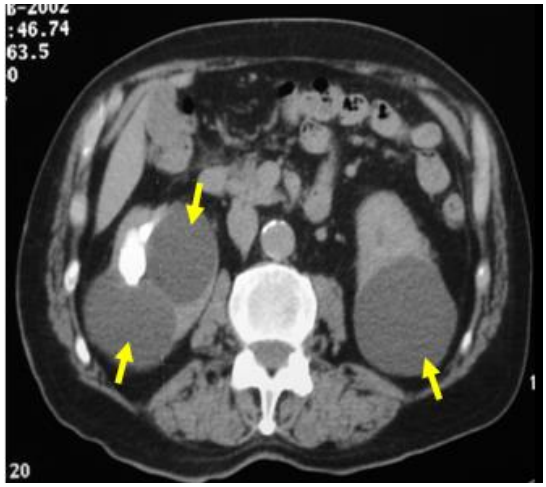


**Figure 5: 34 year old female patient with right flank pain. NECT shows renal calculi with hydronephrosis on right and renal cyst on left kidney.**

**Table 1: Side and number of calculus.**

| | | |
|---|---|---|
| **Side** | **Left** | 28 (46.6) |
| | **Right** | 32 (53.4) |
| **Number of stone** | **One** | 44 (73.4) |
| | **Two** | 7 (11.6) |
| | **Three** | 3 (5) |
| | **Four** | 4 (6.6) |
| | **≥5** | 2 (3.4) |

**Table 2: Location of renal calculi.**

| Location of stone | n (%) |
|---|---|
| **Ureter** | 10 (10.8) |
| **Renal pelvis** | 7 (7.6) |
| **Upper calyx** | 13 (13.9) |
| **Lower calyx** | 26 (28) |
| **Middle calyx** | 37 (39.7) |
| **Total** | 93 |

**Table 3: Size of renal calculus**

| Stone size (mm) | Stone, n (%) |
|---|---|
| **<3** | 11 (11.9) |
| **3-5** | 33 (35.4) |
| **6-10** | 32 (34.5) |
| **11-15** | 12 (12.9) |
| **16-20** | 3 (3.2) |
| **>20** | 2 (2.1) |
| **Total of stone** | 93 |

**Table 4: CT attenuation value of calculus(n=93)**

| HU Value | Number | % |
|---|---|---|
| **<300** | 36 | 38.70 |
| **301-600** | 33 | 35.48% |
| **601-700** | 14 | 15.05% |
| **> 1000** | 10 | 10.75% |
| **Total** | 93 | 100 |

**Table 5: Distribution of all cases**

| Distribution of all cases | Number | % |
|---|---|---|
| **Cases with stones only** | 51 | 68% |
| **Cases with stones and incidental finding** | 9 | 12% |
| **Cases of incidental finding with no stones** | 12 | 16% |
| **Cases with no stones or incidental finding** | 3 | 4% |
| **Total cases** | 75 | |

**Table 6: Secondary signs of obstruction in urolithiasis (n=60).**

| Variables | Number | % |
|---|---|---|
| **Hydronephrosis** | 42 | 70% |
| **Hydroureter** | 36 | 60% |
| **Fat stranding** | 32 | 53.33% |
| **Renomegaly** | 20 | 33.33% |
| **Periureteric edema** | 11 | 18.33% |
| **Parenchymal thinning** | 4 | 6.66% |

**Table 7: Additional diagnosis related to genito - urinary tract.**

| Diagnosis | Number |
|---|---|
| **Renal cyst** | 4 |
| **Pyelonephritis** | 3 |
| **PUJ obstruction** | 2 |
| **Parenchymal calcification** | 1 |
| **Polycystic kidney** | 1 |
| **horse-shoe kidney** | 1 |
| **Hypoplastic kidney** | 1 |
| **Ureterocoele** | 1 |
| **Crossed fused ectopia** | 1 |
| **Renal tumor** | 1 |
| **Total** | 15 |

**Table 8: Additional diagnosis not related to genito- urinary tract.**

| Diagnosis | Number |
|---|---|
| **Gall bladder calculi** | 2 |
| **acute appendicitis** | 2 |
| **Chronic calcific pancreatitis** | 1 |
| **Umbilical hernia** | 1 |
| **Total** | 6 |

## DISCUSSION

In our study, the mean age was 44.2 ± 7.3 and most patients in age groups 40–59 years, similar to study in the USA by Moore et al.[11] in 2015 reported mean age 44 ± 2.6. Poletti et al.[12] reported in 2006 age range from 19 to 80 years and mean age 45 ± 5.1. Park et al.[13] reported mean patient age was 49.9 years (range19–77years) while other study by Sharma et al.[14] patients had mean age of 33.01 ± 10 years (range 19–62 years) and by Fracchia et al.[15] reported 53 years mean age.

Male to Female ratio in study equal to 1.3:1, as male constitute 56.6% of sample. Other studies reported high male percentage Hamm et al. had 74%.[16] Fracchia et al. reported 69%,[15] and Moore et al.[11] study recorded male predominant as constitute 52% of sample

Our result reveals 10.8% of stone located in ureter, 7.6% of stone lie at renal pelvis, 13.9% in upper calyx, 28% in lower calyx, 39.7% lie in middle calyx. Other study reported stone location as 50% of the stones were in the kidney,30% within the distal ureter and 20% within the proximal ureter.[17] Another study by William Sohn demonstrated that ureteral stones were presented in 38 (36%) of 106 patients.[18]

Zilberman[19] 2011 revealed the most frequent location for stone detection was the kidney (58.5%), followed by the distal ureter (21.7%) and upper ureter (13.2%).

In sixty patients diagnosed as urolithiasis on NECT, 93 calculi were found. The mean calculus size was 4.65 mm±7.03 with a range of 1 to 70 mm. Out of 93 calculi the range of CT attenuation value of calculus was from 60 to 1100 HU with median value of 311 HU. The largest group (47.8%) was found having less than 300 HU value.

Calculus size measurement is a method for burden assessment which can be reliably done on NECT. It determines the decisions regarding selection of urological treatment plan like need of endoscopic or percutaneous interventions or management by medical expulsive therapy.[20,21] Several studies have reported the significance of stone size assessment and CT attenuation value of stones in making treatment decisions in patients. Sasane et al. studied 61 patients with urolithiasis diagnosed by unenhanced spiral Computed Tomography and 145 calculi were noticed. The mean calculus size was 5.71 mm and range were 2 to 78 mm.[22] Fowler KA et al reported mean size of calculus as 4.2 mm with range from 0.5-26 mm.[23]

Among the 60 patients of urolithiasis, hydronephrosis (84%) and hydroureter (82%) were the most common secondary signs of obstruction followed by fat stranding (51%), and renomegaly (26%). Smith et al. study determined the value of secondary signs of ureteral obstruction on helical unenhanced CT.[24] Over a 19-month interval, 312 patients with acute flank pain were imaged with helical unenhanced CT. Ureteral stone disease was confirmed to be present in 109 patients and confirmed to be absent in 111 patients. The sensitivity of each secondary sign was ureteral dilatation, 90%, perinephric stranding 82%, collecting system dilatation, 83% and renal enlargement 71%. The specificity of each secondary sign was ureteral dilatation, 93%, perinephric stranding 93%, collecting system dilatation 94% and renal enlargement 89%.

We have observed incidental diagnosis 21(28%). Among the incidental findings related to genito - urinary tract in 15 (20%) cases and not related to genito-urinary tract in 6(8%).

Ather et al.[25] studied 4000 patients suspected to have urinary tract stone and found an alternate diagnosis in 398 patients (9.9%), which is different than our finding of 20% stone-free patients.

In a study conducted by Hoppe et al.[26] 1500 patients underwent unenhanced CT due to acute flank pain. 1035 (69%) had urinary tract calculi. Stones alone were found in 331 of these patients (32%) and additional pathological conditions were noted in 704 (68%). Of all patients 1064 (71%) had other or additional CT findings. Of all patients 207 (14%) had non-stone related CT findings requiring immediate or referred treatment, 464 (31%) had pathological conditions of little clinical importance and 393 (26%) had pathological conditions of no clinical relevance. CT was normal in 105 of all patients (7%).

## CONCLUSION

NECT examination of the urinary tract offers the highest sensitivity and specificity in the detection and characterization of urinary tract stones and is also valuable in the detection of both incidental and alternate pathologies with great impact on patient diagnosis and management.

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**Source of Support:** Nil.

**Conflict of Interest:** None Declared.



**Cite this article as:** Mostaque Ahmed Bhuiyan, Shafiqul Islam, Nahid Sultana, Swajal Chandra Das, Tariqul Islam. Role of Non-Contrast CT Scan in the Diagnosis of Urolithiasis and Incidental Findings. Int J Med Res Prof. 2020 May; 6(3): 58-62.
DOI:10.21276/ijmrp.2020.6.3.013