

Role of CT in Evaluation of Pyelonephritis

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Abstract: *CT is the imaging modality of choice for the diagnosis of acute pyelonephritis and its associated complications due to its wide availability and accurate depiction of the features, extent and severity of the disease. Unenhanced CT is mostly sufficient to rule out some of the causes and extent of the disease such as the presence of calculi, perinephric fat stranding, presence of hydronephrosis, presence of air foci within the renal parenchyma or the collecting system or the presence of fluid collections around the kidney. Contrast enhanced CT scan is required in all cases of suspected pyelonephritis, to look for hypoenhancing areas of renal parenchyma or striations within the renal parenchyma. It helps in the early detection of suspected pyelonephritis leading to early management and decreased morbidity and decreased incidence of complications, limiting the extent of progression of the disease. Contrast enhanced CT scan is confirmatory to assess the diffuse/focal extent of the disease. CT is particularly useful for evaluating the complications of pyelonephritis such as abscesses and emphysematous pyelonephritis. It helps in defining the extent and severity of these complications. It also plays an important role not only in the diagnosis of these complications but also in the management, wherein CT guided procedures. CT plays a critical role in patient management by suggesting the correct diagnosis based on characteristic imaging findings, identifying the complications especially in critically ill patients and reducing the morbidity and mortality by immediate percutaneous nephrostomy or nephrectomy in cases of complications of pyelonephritis.*

Keywords: pyelonephritis, contrast CT, calculi, diabetismellitis, hydronephrosis

1. Introduction

Acute pyelonephritis is defined as an infection of the upper urinary tract, specifically the renal parenchyma and renal pelvis. Misdiagnosis or delayed diagnosis and treatment may result in complications such as shock, septicaemia, renal abscess, emphysematous pyelonephritis and chronic pyelonephritis that may cause secondary hypertension and renal failure. Classic symptoms and signs include flank or abdominal pain, fever and chills, nausea or vomiting, and costovertebral angle tenderness. Symptoms Suggestive of cystitis such as urinary frequency, dysuria may also be present. Computed Tomography (CT) is considered the imaging modality of choice in the evaluation of patients with pyelonephritis and is superior to ultrasonography in providing comprehensive anatomic and physiologic information that accurately characterizes both intra- and extra-renal pathologic conditions. Most patients with acute pyelonephritis show bulky or enlarged kidneys.. A sign widely regarded as a characteristic finding of acute pyelonephritis perinephric fat stranding and thickening of the pararenal fasciae with obliteration of perinephric fat planes. After administration of contrast material, acute bacterial nephritis most commonly manifests as one or more wedge-shaped areas or streaky zones of lesser enhancement that extend from the papilla to the renal cortex

2. Literature Survey

Lee CY et al from Hong Kong in 2012, studied to identify which imaging features of acute pyelonephritis in contrast CT may be used as predictors of need . They found that in patients with acute pyelonephritis who required intervention, significant CT imaging findings that were predictors of need for intervention included 1. Presence of hydronephrosis, 2. Renal pelvic or ureteric stone on same side and 3. Focal infection or abscess formation for intervention. In 2007, Mitterberger M et al examined 100 patients to

assess the value of contrast-enhanced ultrasonography for detecting renal parenchymal changes in acute pyelonephritis, compared with contrast-enhanced computed tomography (CT) as the reference standard. Of the 100 patients, 82 were women and 18 were men, with a mean age of 30.2 years. 90% of patients had unilateral and 10% had bilateral acute pyelonephritis. On contrast CT, 84 patients (84%) had renal parenchymal changes suggestive of acute pyelonephritis. They concluded that conventional ultrasonography has a very low sensitivity for detecting lesions of acute pyelonephritis while contrast enhanced ultrasonography has a high sensitivity and specificity for detecting acute pyelonephritis, comparable to contrast enhanced CT scans.

Venkatesh L and Hanumegowda RK studied 100 patients diagnosed with pyelonephritis at Institute of Nephrology Hospital, Bengaluru, to compare the clinical and biochemical parameters with radiological findings. Clinical and radiological criteria were set for the diagnosis of pyelonephritis and descriptive studies were performed with Fischer Exact test performed for significance. Mean age of patient was 48.7 years, with majority of them being more than 40 years (70%) with female (62%) preponderance. Urine cultures were positive in 24% of patients and diabetes mellitus was the most common comorbidity (69%). CT showed a sensitivity of 86.8% and specificity of 87.5% in diagnosing pyelonephritis, compared with 74.3% and 56.7% for ultrasonography. Emphysematous pyelonephritis was found in 4% and renal abscess in 3% of patients. They concluded that the detection of pyelonephritis was better and earlier with CT when compared to ultrasound and that early diagnosis helps prevent complications.

3. Methods/ Approach

3.1 Aim

The aim of this research is to describe and analyse the role of CT in evaluation of acute pyelonephritis and its complications.

3.2 Objectives

- 1) To identify and describe the Computed Tomography imaging appearances of pyelonephritis
- 2) To compare the Computed Tomography features of pyelonephritis with the clinical findings.
- 3) To identify and describe the Computed Tomography findings of complications associated with acute pyelonephritis and the extent of involvement, for planning of the management.

3.3 Study

Department of Radiodiagnosis, Government General Hospital, Guntur, Our hospital is 1000 bedded multi-specialty (including super-specialties) tertiary care and post graduate training hospital with round the clock services.

This study was conducted for a period of 13 months i.e., from Jan 2019 to Dec 2019. This is a prospective observational study conducted over a period of 12 months. All patients who are referred to the department of Radiodiagnosis for Computed Tomography (CT) scan with clinical suspicion / diagnosis of acute pyelonephritis were consecutively inducted into the study after receiving informed consent

50 subjects were enrolled for the study.

Inclusion Criteria

The study included –

- 1) Patients with clinical features such as fever with chills, flank pain, nausea, vomiting, costovertebral angle tenderness
- 2) Patients with laboratory findings such as pyuria, bacteriuria, leucocytosis, and positive urine culture
- 3) Patients who needed computed tomography scan as a further investigation to rule out complications.

3.4 Methodology

This study was conducted as a prospective observational study. The study was approved by the ethical committee of the hospital for human studies. Patients were scanned with a dedicated imaging protocol.

3.5 Scanning Protocol

CT machine- GE 16 slice multidetector CT used section headings come in several varieties

Sections - From above the level of diaphragm to pubic symphysis.

Series – Plain and IV contrast – corticomedullary and nephrogram phases.

Excretory phase if needed.

kVp – 120 and mA – 300 (varies)

Collimation – 64 x 0.6 mm

Slice Thickness – 3 mm

Increment – 0.6 mm

Contrast – Non Ionic Contrast media – OMNIPAQUE 350

Flow Rate – 4 ml/sec by an Injection Pump and about 1.5 ml / Kg Bodywt.

Technique - Plain Study is done first and findings noted.

Scan

Sections redesigned for minimizing radiation.

Contrast Studies in both corticomedullary phase (20-45s) and nephrogram phase (60-100s). Excretory/urogram phase (5-15mins) if needed.

4. Results

Table 1: Gender wise distribution of pyelonephritis

Gender	No. of Cases	Percentage
Female	25	50
Male	25	50

Table 2: Age wise distribution of pyelonephritis

Age (in years)	No. of Cases	Percentage
11-20 Years	1	2
21-30 Years	5	10
31-40 Years	0	0
41-50 Years	16	32
51-60 Years	11	22
61-70 Years	9	18
71-80 Years	8	16

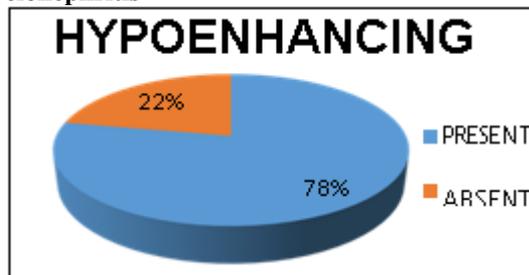
Table 3: Presence or absence of bulky kidneys

Bulky Kidneys	No. of Cases	Percentage
Present	40	80%
Absent	10	20%

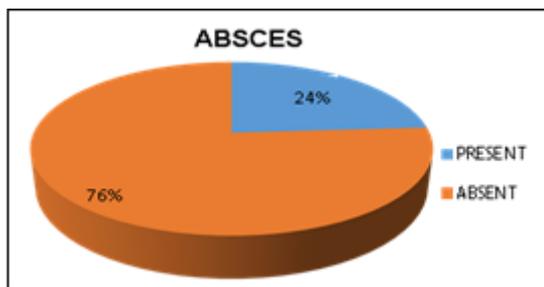
Table 4: Presence or absence of perinephric fat stranding / thickening of perirenal fasciae

	No. of Cases	Percentage
Present	47	94%
Absent	3	6%

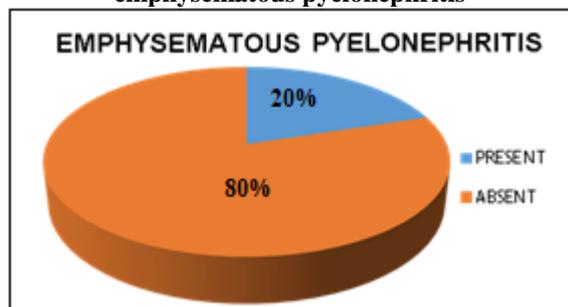
Pie chart representing the presence or absence of hypoenhancing areas within renal parenchyma in cases of pyelonephritis



Pie chart representing the presence or absence of renal / perirenal abscesses in cases of pyelonephritis



Pie chart representing the presence or absence of emphysematous pyelonephritis



Pie chart representing the presence or absence of diabetes mellitus in cases of pyelonephritis

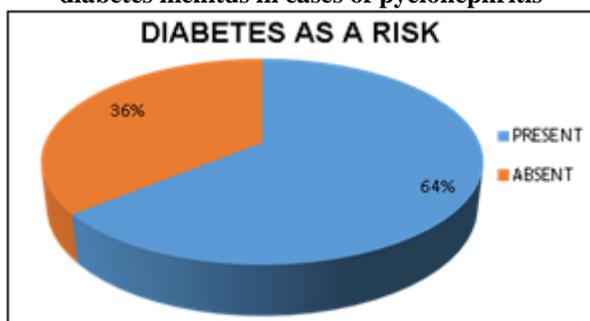


Table 4: Presence or absence of dilatation of pelvicalyceal system

	No. of Cases	Percentage
Present	24	48%
Absent	26	52%

5. Discussion

Age Distribution

Fifty patients were evaluated, whose age group ranged from 13 to 80 years. The highest incidence of acute pyelonephritis in my study was found in 41-50 years age group accounting for 32% of cases and least was seen in age group of 31-40 years constituting 0%.

Sex Distribution

Out of the 50 patients evaluated for acute pyelonephritis, 25 (50%) were males and 25 (50%) were females. This differed from the literature wherein acute pyelonephritis was more common in males than in females due to increased incidence of obstructive pathologies including benign prostatic hyperplasia

Renal Involvement

Fifty patients were evaluated, out of which 46 cases (92%) had unilateral pyelonephritis, while 4 cases (8%) had

bilateral pyelonephritis. Of the 46 cases that had unilateral pyelonephritis, right kidney was involved in 48% of cases and left kidney was involved in 52% of cases. This finding coincided with previous studies wherein the left kidney involvement in pyelonephritis was marginally higher when compared to the right renal involvement.

Renal Enlargement

Enlarged kidneys or bulky kidneys are found in 40 (80%) cases with pyelonephritis, while normal sized kidneys were found in 10 (20%) cases.

Perinephric Fat Stranding

Perinephric fat stranding or thickening of the anterior perirenal fascia (Gerota's fascia), posterior perirenal fascia (Zuckerkandl's fascia) and lateroconal fascia was found in 47 (94%) cases, while these features were absent in 3 (6%) cases. Perinephric fat stranding was the most common finding in this study.

Hypoenhancing Areas

Hypoenhancing or non-enhancing areas of renal parenchyma were found in 39 cases (78%) out of the total 50 cases. According to several studies in the literature, this is the most definitive sign in the diagnosis of acute pyelonephritis. The distinction between focal or diffuse involvement of the kidneys is based on the amount of renal parenchyma showing hypoenhancement. These hypoenhancing areas represent early evolving abscesses and microabscesses and if left untreated, develop into renal abscesses. In a few cases, these hypoenhancing areas gave rise to a striated nephrogram appearance.

Complicated Pyelonephritis

The two common complications of acute pyelonephritis that were observed in this study are renal and perirenal abscesses, and emphysematous pyelonephritis. Of the 50 cases, 3 patients had both complications simultaneously i.e., they had both renal/perirenal abscess formation and emphysematous pyelonephritis.

Renal Abscesses

Out of the 50 cases evaluated, 12 cases (24%) showed abscess formation, while the remaining 38 cases (76%) did not show abscess. Intrarenal abscesses were found in 9 cases out of the 12 patients, while the remaining 3 had perirenal abscesses. One patient out of the 3 had a perirenal abscess extending along the psoas muscle into the pelvis. 3 of the 12 cases of renal/perirenal abscesses had air foci within them, suggesting secondary infection or emphysematous changes.

Emphysematous Pyelonephritis

10 cases (20%) out of the total 50 cases evaluated, showed features of emphysematous pyelonephritis, a severe necrotizing complication of acute pyelonephritis. All the 10 patients were diabetics. There was 100% association between emphysematous pyelonephritis and diabetes mellitus in this study. Emphysematous pyelonephritis was identified by the presence of air foci in renal parenchyma, collecting system and/or in the perirenal areas depending on the severity of the infection. Of the 10 cases, one patient had bilateral emphysematous pyelonephritis. 3 out of 10 cases

showed renal or perirenal collections (type 2 emphysematous pyelonephritis). The other 7 cases did not have associated collections (type 1 emphysematous pyelonephritis)

6. Conclusion

CT is the imaging modality of choice for the diagnosis of acute pyelonephritis and its associated complications due to its wide availability and accurate depiction of the features, extent and severity of the disease.

Unenhanced CT is mostly sufficient to rule out some of the causes and extent of the disease such as the presence of calculi, perinephric fat stranding, presence of hydronephrosis, presence of air foci within the renal parenchyma or the collecting system or the presence of fluid collections around the kidneys. However, early stages of the disease process as in the acute nephritic stage are not visualized on unenhanced CT scan. Therefore, contrast enhanced CT scan is required in all cases of suspected pyelonephritis, to look for hypoenhancing areas of renal parenchyma or striations within the renal parenchyma. It helps in the early detection of suspected pyelonephritis leading to early management and decreased morbidity and decreased incidence of complications, limiting the extent of progression of the disease. Contrast enhanced CT scan is confirmatory to assess the diffuse/focal extent of the disease. Other features of pyelonephritis that are usually appreciated on unenhanced CT such as renal enlargement or perinephric fat stranding or thickening of Gerota's fascia are not specific to the diagnosis of acute pyelonephritis. Although perinephric fat stranding was the most common imaging finding in this study, it alone cannot be used as the characteristic finding for pyelonephritis. The experience of the researchers has shown that although perinephric fat stranding is present in most of the cases of pyelonephritis as seen in this study, it is also seen in many other renal diseases such obstructive uropathy, previous infections, following trauma and in chronic pyelonephritis.

CT is particularly useful for evaluating the complications of pyelonephritis such as abscesses and emphysematous pyelonephritis. It helps in defining the

extent and severity of these complications. It also plays an important role not only in the diagnosis of these complications but also in the management, wherein CT guided procedures are recommended for the drainage of collections or abscesses.

CT also provides additional information as to the cause of the pyelonephritis such as the presence of calculi, renal or ureteric abnormalities, and prostatic hyperplasia.

CT imaging findings that correlate with presence of acute pyelonephritis include renal enlargement, dilation of pelvicalyceal system, perinephric fat stranding, thickening of perirenal fasciae, urothelial thickening, and hypoenhancing areas of renal parenchyma. The most specific and early imaging feature that aids in the diagnosis of acute pyelonephritis among all the above features is the visualization of focal or diffuse hypoenhancing areas of renal parenchyma. Therefore, contrast enhanced CT scan is

superior to unenhanced CT for the early detection of acute pyelonephritis and limiting the associated morbidity.

In the present study, males and females were equally affected, with 41-50 years age group as the most commonly involved group and a 20-25% incidence of complications such as abscesses and emphysematous pyelonephritis. The incidence of pyelonephritis and its complications had a strong association with the presence of diabetes mellitus in patients and as such careful evaluation of these patients is required to reduce the risk of complications in such patients.

CT plays a critical role in patient management by suggesting the correct diagnosis based on characteristic imaging findings, identifying the complications especially in critically ill patients and reducing the morbidity and mortality by immediate percutaneous nephrostomy or nephrectomy in cases of complications of pyelonephritis.

7. Future Scope

Another modality which can be used to diagnose and evaluate patients with pyelonephritis is MRI. Though gadolinium enhanced contrast MRI gives a thorough evaluation of the disease process and extent, non-contrast MRI also has a useful role in the early diagnosis of pyelonephritis and its complications. The sensitivity of diagnosing pyelonephritis and complications with plain MRI is higher than that by unenhanced CT scan and therefore MRI studies can be a part of the routine workup of suspected pyelonephritis in tertiary centers, especially in patients in whom contrast administration is contraindicated or those who are pregnant

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