

Role of CT to Evaluate Renal Imaging Features of Acute Pyelonephritis and it's Complications

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Abstract

Background: Acute pyelonephritis is infection of the renal parenchyma and its collecting system. It can present as complicated pyelonephritis especially when associated with risk factors such as diabetes, sickle cell anemia, immunocompromised patients, etc. Complications manifest as renal abscess, pyonephrosis, lobar nephronia, emphysematous pyelonephritis and renal papillary necrosis.¹

CT is the most sensitive modality for early diagnosis of acute pyelonephritis, to distinguish between complicated and uncomplicated pyelonephritis and assess the complications.

Materials & Methods: A retrospective analysis of 100 patients who presented with clinical symptoms and urinalysis of acute pyelonephritis had undergone contrasted enhanced computed tomography of the Abdomen for assessing renal imaging features of acute pyelonephritis, its manifestations and complications.

Results & Discussion: Out of 100 cases of acute pyelonephritis, the imaging findings were diffuse renal enlargement (96%), perinephric & perirenal fascial thickening (95%), streaky nephrogram (53%), urothelial thickening of renal pelvis (17%), Gas in renal parenchyma or collecting suggestive of emphysematous pyelonephritis (13 %), renal abscess (11 %), filling defects in the calyceal system on excretory phased imaging suggestive of papillary necrosis (4 %), hyperdense dependent contents within the pelvic calyceal system suggestive of pyonephrosis (2 %) and well defined hypoenhancing focal area within renal parenchyma without cortical rim sign suggestive of lobar nephronia (1 %).

Out of 100 cases 69 cases were diagnosed as uncomplicated acute pyelonephritis and 31 cases were diagnosed as complicated pyelonephritis.

Conclusions: CT is the modality of choice for early diagnosis of acute pyelonephritis, assessment of its

complications and serial follow ups for progression of complications.

Keywords: Acute pyelonephritis, Emphysematous pyelonephritis, Lobar nephronia, Pyonephrosis, Renal abscess, Renal papillary necrosis.

Introduction

Acute pyelonephritis is bacterial infection of the renal parenchyma and its collecting system. It's primary diagnosis is based on typical clinical features of dysuria, flank pain, fever and with urinalysis suggestive of bacterial infection.

Complicated pyelonephritis is more associated with patients with risk factors such as uncontrolled diabetes, sickle cell anemia, pregnancy, kidney transplants, urinary tract anomalies, acute or chronic kidney failure, as well as immunocompromised patients, and those with hospital-acquired bacterial infections.

These complications include renal or perinephric abscess, pyonephrosis, lobar nephronia, emphysematous pyelonephritis and renal papillary necrosis.²

CT is the most sensitive modality for diagnosis of acute pyelonephritis and assessment of complications.

Role of imaging is to confirm the clinical diagnosis, early diagnosis, to help identify complications such as abscess formation or to evaluate for potential complications and therapeutic interventions if needed. It is essential to distinguish between complicated and uncomplicated pyelonephritis, as patient management depends on it and complicated pyelonephritis can lead to damage to the organ, scarring and can be life threatening.³

Aims and Objectives

Role of CT to evaluate renal imaging features of acute pyelonephritis and it's complications.

By illustrative examples of various manifestations of acute pyelonephritis and its complications, this article

attempts to assess the role of CT in evaluation of imaging features of acute pyelonephritis and it's complications.

Materials & Methods

100 patients who presented with clinical symptoms and urinalysis of acute pyelonephritis were retrospectively evaluated for the presence of renal imaging features of its manifestations and complications.

Study Type - Retrospective study

Study Period – 1 year

Sample Size – 100

Study Population – All suspected patients who presenting to hospital with clinical symptoms and urinalysis of acute pyelonephritis, fulfilling the inclusion criteria and undergoing contrasted enhanced computed tomography of the Abdomen.

Inclusion Criteria

- 1) Patients presenting with clinical symptoms and urinalysis of renal bacterial infection.
- 2) Patients in whom contrast enhanced computed tomography of the Abdomen and Pelvis can be performed.
- 3) Patients of all sexes and age group above 18 years.

Exclusion Criteria

- 1) Patients with known allergy to iodinated contrast agents.
- 2) Pregnant patients.
- 3) Patients not willing for examination/ study.
- 4) Patients below 18 years of age.
- 5) Patients with systemic cause of pyelonephritis other than infection.

Materials

Computed Tomography of the Abdomen were performed on Fujifilm 128 Slice MDCT machine.

Axial thick cuts 5x5 mm and thin cuts 1x1mm will be taken from domes of diaphragm to pubic symphysis. Intravenous contrast Omnipaque 350mg% (Ioxehol)

70ml will be injected by pressure injector through venous cannula with a flow rate of 4ml/sec. 4 phases will be taken.

1. Plain Unenhanced CT
2. Arterial phase – 20 sec scan delay
3. Portal venous/ Nephrographic phase – 60 sec scan delay
4. Delayed/ Excretory phase – 5 mins scan delay

Results & Discussion

Imaging Findings of Acute Pyelonephritis

A. Diffuse renal enlargement

Diffuse renal enlargement and swelling is best assessed by comparison rather than measurement. Areas of kidney appear swollen, i.e. oedematous and of low attenuation. (Fig.1). Though, it is a common feature of acute pyelonephritis, kidneys may appear normal.⁴

B. Perinephric & Perirenal fascial thickening

Perinephric fat stranding implies oedema within the fat of the perirenal space seen on CT images.

Perinephric fat stranding and perirenal fascial thickening are common, contributory but nonspecific findings. (Fig. 2).

C. Streaky Nephrogram

Another common CT finding of striated or streaky nephrogram seen as alternating linear bands of high and low attenuation orientated parallel to the axis of the tubules and collecting ducts, i.e. in radial pattern on contrast enhanced CT images. This is best depicted in the excretory phase images.

Striations result from stasis and prolonged accumulation of contrast in edematous or necrosed tubules. It demonstrates increasing attenuation over time⁵. (Figs. 3a & b).

Urothelial Thickening of Renal Pelvis

Urothelial thickening and increased enhancement in the walls of the renal pelvis seen on CT are contributory findings of acute pyelonephritis. (Fig. 4).

Imaging Findings of Complicated Pyelonephritis:

A. Lobar Nephronia

Formation of renal abscess is preceded by a focal inflammatory process without liquefaction. Lobar nephronia or acute focal nephritis is this intermediate stage between acute pyelonephritis and renal abscess.

CT is the modality of choice for diagnosis. It shows a wedge shaped non-enhancing solid lesion with ill-defined borders within renal parenchyma without cortical rim sign (seen in renal infarcts)⁶. (Fig. 5).

The defect represents vascular ischemia, usually affecting a wedge-shaped portion of the renal parenchyma due to a locally intense kidney infection without gas, liquefaction, or abscess formation.

This can quickly progress (in 3 days or less) to the typical walled-off cavity with central tissue necrosis consistent with a frank renal abscess⁷.

B. Renal Abscess

Renal abscesses begin as smaller microabscesses that coalesce to form large collections. In poorly treated cases, diabetic and immunocompromised cases renal abscesses are frequent seen.

CT is the modality of choice for diagnosis and follow ups. It shows intrarenal and extrarenal extent.

On contrast enhanced scans, it appears as a well-defined low attenuation collection with a thick, irregular wall or pseudo capsule. Due to inflammatory changes and edema adjacent renal parenchyma around the abscess may appear hypoenhancing in nephrogram phase and hyperattenuating in delayed images excluding necrosis. (Figs. 6a & b).

Sometimes abscess may rupture and spread to various spaces,

Pelvicalyceal system - pyonephrosis

Perinephric space - perinephric abscess

beyond the perirenal fascia into the anterior or posterior

Pararenal space - paranephric abscess

Peritoneal cavity - subdiaphragmatic or pelvic abscess. ⁸

C. Pyonephrosis

Pus in the upper collecting system which can progress to its obstruction and dilatation.

In addition to features of obstruction as hydronephrosis, CT may demonstrate, thickened walls of the renal pelvis and ureter, perinephric fat stranding and hyperdense urine within the renal collecting system suggestive of debris, fluid-fluid levels (pus-urine, urine-debris, or contrast-debris levels). Fig. 7). ⁹

D. Emphysematous pyelonephritis

Gas in renal parenchyma or collecting system is suggestive of emphysematous infection. Commonly seen in females, patients with uncontrolled diabetes mellitus and in immunocompromised individuals.

CT depicts presence of air as small bubbly or linear streaks of gas within the abscesses, collecting system, and the parenchyma and fluid collections with gas-fluid levels. (Fig. 8a & b). ¹⁰

E. Papillary Necrosis

Renal papillary necrosis is associated with conditions like diabetes, analgesic overuse, sickle cell disease, renal vein thrombosis, tuberculosis, and obstructive uropathy.

It is best seen in Contrast enhanced CT in excretory phase where the contrast fills a necrotic cavity located centrally or peripherally in the papillae within the renal medulla. (Fig. 9). Even the entire papilla may become necrotic. Later, these papillary defects become peripherally calcified. Sloughed off papillae when seen in the renal pelvis or ureter cause obstruction.

Classical features may appear as: ball on tee, lobster claw sign of forniceal excavation, signet ring and sloughed papilla with clubbed calyx. ¹¹

Result of the Illustrative Cases

This retrospective analysis of 100 cases of acute pyelonephritis, the imaging findings were diffuse renal enlargement (96%), perinephric & perirenal fascial thickening (95%), streaky nephrogram (53%), urothelial thickening of renal pelvis (17%), Gas in renal parenchyma or collecting suggestive of emphysematous pyelonephritis (13 %), renal abscess (11 %), filling defects in the calyceal system on excretory phased imaging suggestive of papillary necrosis (4 %), hyperdense dependent contents within the pelvic calyceal system suggestive of pyonephrosis (2 %) and well defined hypoenhancing focal area within renal parenchyma without cortical rim sign suggestive of lobar nephronia (1 %).

Out of 100 cases 69 cases were diagnosed as uncomplicated acute pyelonephritis and 31 cases were diagnosed as complicated pyelonephritis.

Figures & Tables



Figure 1: Bilateral diffuse renal enlargement noted



Figure 2: Bilateral perinephric fat stranding and perirenal fascial thickening noted.



Figure 3a:

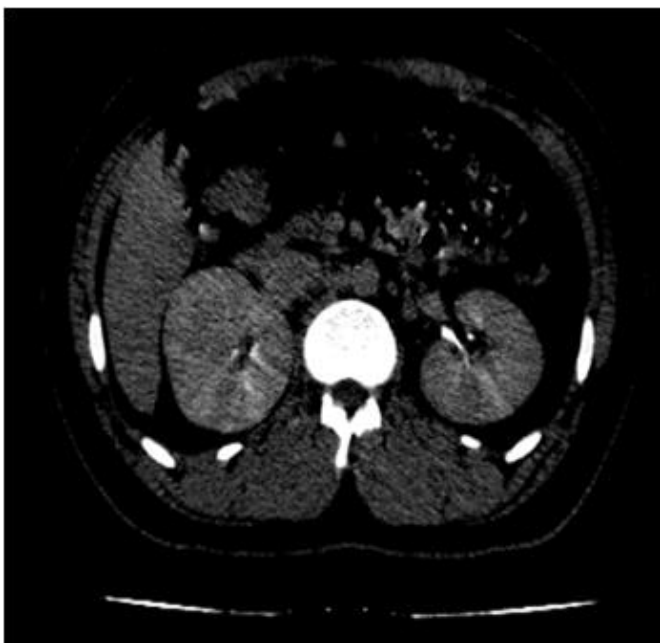


Figure 3b:

Bilateral kidneys appear bulky and show alternating linear bands of high and low attenuation orientated in

radial pattern on sagittal (a) and axial (b) images of contrast enhanced CT images suggestive of striated nephrogram.



Figure 4: Right renal pelvis walls appear thickening and show increased enhancement suggestive of urothelial thickening.



Figure 5: There is a well-defined wedge shaped non-enhancing area solid lesion with ill-defined borders within renal parenchyma without cortical rim sign noted involving the upper pole of left kidney with striated nephrogram suggestive of focal pyelonephritis with lobar nephronia.



Figure 6a:



Figure 6b:

Multiple variable sized hypodense wedge shaped poorly enhancing areas are seen scattered throughout the left renal parenchyma with few small non enhancing necrotic areas and peripherally enhancing collections within at lower pole of left kidney on sagittal (a) and axial (b) contrast enhanced images suggestive of left pyelonephritis with renal abscess showing small areas of liquefaction/ necrosis.

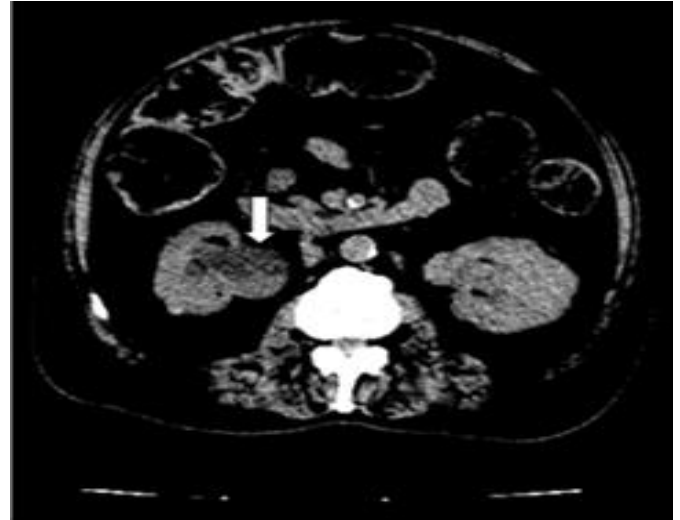


Figure 7: Moderate right sided hydronephrosis and upstream hydroureter with mildly hyperdense dependent contents are noted within the dilated and thick walled right pelvicalyceal system. It is associated with perinephric and fat stranding. Findings are suggestive of Pyonephrosis.

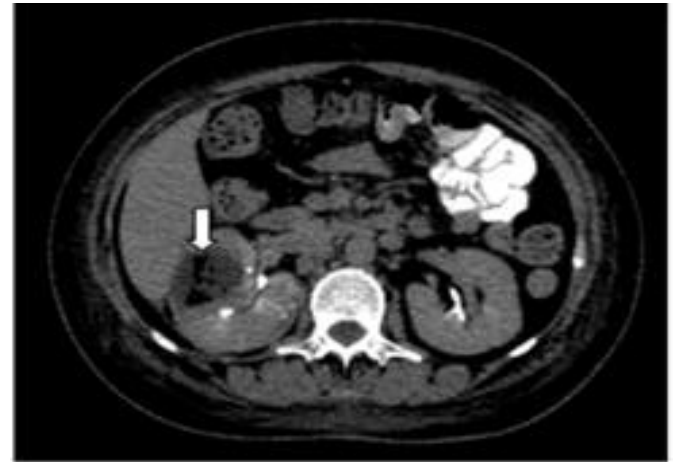


Figure 8a:



Figure 8b:

Multiple air foci are noted involving the upper and midpole calyces and the cortex of right kidney on axial (a) and sagittal (b) contrast enhanced images with mild perinephric fat stranding suggestive of emphysematous pyelonephritis.

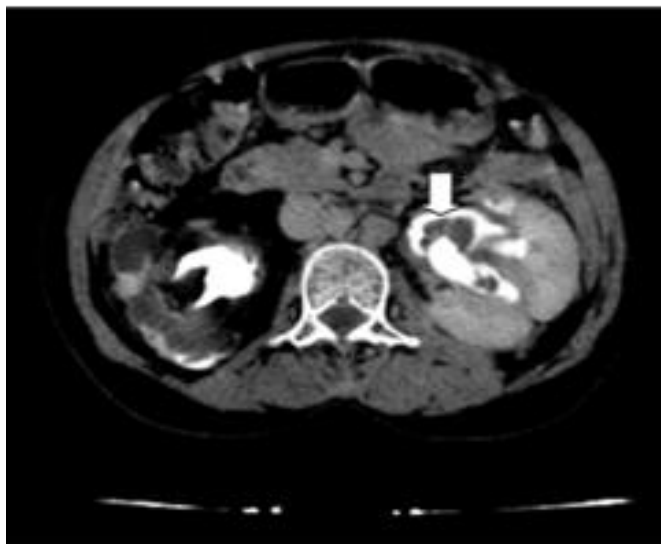


Figure 9: Multiple variable sized filling defects are noted within the left renal pelvicalyceal system on axial image of excretory phase suggestive of renal papillary necrosis.

Table 1: CT imaging findings of Acute Pyelonephritis and its complications

No.	Renal imaging findings	Total No. of cases	Percentage %
1	Diffuse renal enlargement	96	96
2	Perinephric & perirenal fascial thickening	95	95
3	Streaky nephrogram	53	53
4	Urothelial thickening of renal pelvis	17	17
5	Emphysematous pyelonephritis	13	13
6	Renal abscess	11	11
7	Renal papillary	4	4

	necrosis		
8	Pyonephrosis	2	2
9	Lobar nephronia	1	1

Table 2: CT Diagnosis of uncomplicated and complicated pyelonephritis

Diagnosis	Total No. of Cases	Percentage %
Uncomplicated acute pyelonephritis	69	69
Complicated pyelonephritis	31	31

Conclusion

Early detection of acute pyelonephritis is important to avoid complications especially in vulnerable groups of patients. CT helps in diagnosis and serial follow ups for progression of complications in patients who have complicated acute pyelonephritis, have not responded to treatment, or are very sick.¹²

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