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Clinico-demographic profile and comparative assessment of ultrasonography and computed tomography examination in the diagnosis of urinary tract infections

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Abstract
Background and Objective: Urinary tract infections (UTIs) are one of the most commonly reported infections worldwide. The diagnosis of these infections is primarily based on clinical symptoms and biochemical data. Diagnostic imaging plays an important role in the management of UTIs. The main objective of this prospective study was to evaluate and compare of sensitivity and specificity of ultrasonography and computed tomography examination in the diagnosis of UTIs.
Patients and Methods: In this study, we examined 100 cases (48 males and 52 females of varying age groups) referred with clinical suspicion of urinary tract infection to the department of radiodiagnosis, KIMS Hospital, Bangalore. After history taking and clinical examination all patients underwent urine analysis, ultrasound, and computed tomography (CT) examination.
Results: Uncomplicated cystitis followed by acute pyelonephritis (APN) was the most common type of UTI as per the results. The sensitivity and specificity of ultrasound in diagnosing uncomplicated cystitis were 88.57% and 100%, respectively, whereas, that of CT was 74.29% and 100%. The sensitivity and specificity of ultrasound in diagnosing APN were 64.51% and 100%, respectively, whereas, that of CT were 90.32% and 100%. Sensitivity and specificity of CT in diagnosing chronic pyelonephritis, renal abscess, and emphysematous pyelonephritis remained 100% throughout.
Conclusion: Ultrasound was found to be a more sensitive investigation in cases of uncomplicated cystitis than CT. CT on the other hand was found to be more sensitive and specific in the diagnosis of UTI and its complications other than uncomplicated cystitis.

Keywords: USG, CT scan, UTI, sensitivity, specificity

Introduction
Urinary tract infections (UTIs) are the most commonly reported Infection worldwide.[1] UTIs affect men and women of all ages, and vary dramatically in their presentation and sequelae UTIs range from mild-to-severe, acute-to-chronic and may be associated with predisposing risk factors such as diabetes mellitus, human immunodeficiency virus (HIV), leukemia, and vesicoureteric reflux [1].

UTIs are a result of interactions between uropathogens and the host. Successful infection of the urinary tract is determined partly by the virulence factors of the bacteria, the inoculum size, and the inadequacy of host defense mechanisms. The diagnosis of UTI is primarily based on the typical patient symptomatology and urinary evaluation for the presence of bacteria and white blood cells [2].

Diagnostic imaging is reserved for doubtful cases or evaluation of pyelonephritis in patients who fail to respond to treatment or at high risk of complications, such as diabetic and immunocompromised patients. The role played by diagnostic imaging regards both the identification of the lesion and evaluation of its intra- and extrarenal extension and follow-up during treatment. Intravenous pyelogram and ultrasonography (USG) have been traditionally used in the detection of predisposing factors for recurrent UTIs like calculi, obstruction, and incomplete bladder emptying [3].

Ultrasound is an important imaging technique because it is noninvasive, easy to perform, rapid, and offers no radiation or contrast agent risk to the patient.

It is particularly useful in identifying calculi and hydronephrosis, pyonephrosis, and perirenal abscesses. Computed tomography has now become accepted as a more sensitive modality for diagnosis and follow-up of complicated renal tract infections [4]. Usually, the correct diagnosis is made in a relatively early phase and targeted therapy can resolve infection without the development of complications. Hence, this study was undertaken to assess the effectiveness of radiological investigation in diagnosing UTIs and their correlation with clinical and biochemical findings.

Patients and Methods

The present study was conducted at KIMS HOSPITAL using GE Volusion Ultrasound machine using a curvilinear probe and 16 slice GE CT among clinically suspected patients of urinary tract infections referred to the Radiology Department for USG and CT evaluation and the study was carried out for the period of 18 months.

Inclusion criteria

- Patients of both sexes and all age groups with the clinical diagnosis of UTIs
- Informed consent was taken from patients above 18 years of age and the parents of patients less than 18 years of age
- Patients who could and were willing to undergo both ultrasound and CT imaging modalities

Exclusion criteria

- Pregnant patients
- Patients with previous urinary tract surgery status
- Post renal transplant patients
- Patients not willing to participate in the study

Patient preparation and scanning technique

Informed consent was taken before the ultrasound and CT examination, followed by a detailed history and brief clinical examination.

Ultrasound scanning technique

Acoustic jelly was thoroughly applied over the skin to act as a coupling agent. In adults 3.5-5 MHz curvilinear probe was typically used to scan the kidneys, ureters, and bladder, in the pediatric population 5.0- 7.5MHz high-frequency linear probe was used.

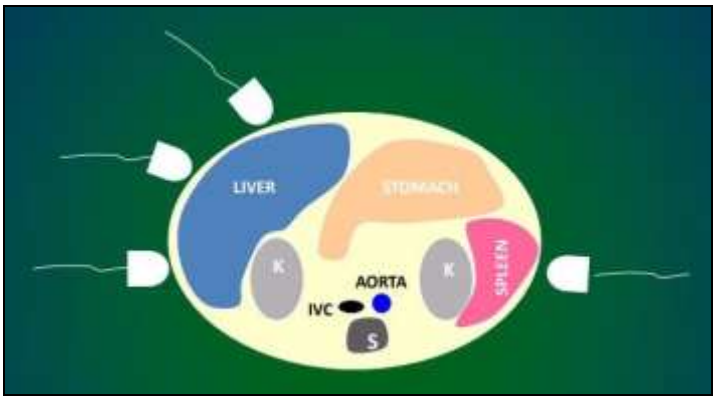

Fig 1: Image showing approach to scanning

Right kidney technique: For the right kidney, patients were made to lie supine and the probe was placed in the right lower intercostal space in the midaxillary line. The liver was used as an "acoustic window" and longitudinal (long axis) & transverse (short axis) views were obtained.

Left kidney-technique: For the left kidney the patients were made to lie supine or in the right lateral decubitus position. The probe was placed in the lower intercostal space on the posterior axillary line. The placement was more cephaled and posterior to the entire kidney. Longitudinal and transverse views are obtained.

Ureters

- Normal ureter was not seen on USG. If dilated, it could be traced from renal pelvis to level of obstruction. Decubitus, tracing along the dilated ureter, longitudinally
- Ureters were seen as tubular hypoechoic structure with echogenic wall. Dilated distal ureter can be traced into the bladder

Urinary bladder

- For bladder evaluation the patient was presented with full bladder
- Patient was made to lie in supine position, suprapubic area was exposed, and scanning was done in axial (transverse) and sagittal planes. Pre-void and post-void volumes are taken.
- Comprehensive scanning of other abdominal parts was done

CT Technique of KUB

- CT KUB was done with 16 slice GE VOLUSION machine.
- CT protocol for evaluation of urinary tract consisted of non-enhanced CT and contrast was done wherever required.
- Contrast CT was done in the following phases
  - Cortical nephrographic phase (20–45 seconds after intravenous injection)
  - Nephrographic phase (45–120 seconds after intravenous injection)
  - Excretory phase (>2 min after intravenous injection)

Urine analysis technique

1. **Specimen collection:** Cleansing of skin and mucous membranes adjacent to the urethral orifice was done and then the clean-catch midstream of urine sample was

collected.

2. Detection of bacteriuria and pyuria was done by using urine microscopy

Results

In this study, the patient's age ranged from 12-82 years and the mean age was 40.03 years.

Table 1: Age and gender distribution of the study population

Age	Total	Percentage
11-20	02	02.00
21-30	32	32.00
31-40	26	26.00
41-50	15	15.00
51-60	12	12.00
>61	13	13.00
TOTAL	100	100.00
The mean age was 40.03 ± 15.80 and Range 12-82		
SEX		
Male	42	42.00
Female	58	58.00
Total	100	100.00

Table 2: Distribution of cases in the study population

Diagnosis	No. of Cases
Uncomplicated cystitis	35
Acute pyelonephritis	31
Chronic pyelonephritis	12
Emphysematous pyelonephritis	07
Renal abscess	06
Pyonephrosis	01
Clinically suspected UTI	08
Total	100

Table 3: Distribution of clinical symptoms in the study population

Clinical Symptoms	Number of Patients	Percentage
Burning micturition	24	24.00
Increased frequency of micturition	28	28.00
Fever	44	44.00
Pain abdomen	54	54.00

Table 4: Gender wise distribution of the co-morbidities in the study population

Co-Morbidity	Gender		Total
	Female	Male	
Diabetes mellitus	14	11	25
Hypertension	05	05	10

Table 5: Comparison of Clinical Features, Urine Analysis, and Imaging Findings in Diagnosing UTI

Parameters	CF	UA	USG	CT
Uncomplicated cystitis	35	35	31	26
Acute pyelonephritis	31	31	20	28
Chronic pyelonephritis	12	11	07	12
Emphysematous pyelonephritis	07	07	01	07
Renal abscess	06	06	03	06
Pyonephrosis	01	01	01	01
Clinically diagnosed UTI	08	-	-	-
Total	100	91	63	80

Table 6: Comparison of Sensitivity and specificity of USG and CT

Parameters	USG		CT	
	Sn (%)	Sp (%)	Sn (%)	Sp (%)
Uncomplicated cystitis	88.57	100	74.29	100
Acute pyelonephritis	64.51	100	90.32	100
Renal abscess	50.0	100	100	100
Chronic pyelonephritis	63.64	100	100	100
Emphysematous pyelonephritis	14.29	100	100	100
Pyonephrosis	11.11	100	100	100

Discussion

In our study, 100 cases with clinically suspected UTIs were examined, which were further evaluated with urine analysis, ultrasound, and computed tomography. Data were tabulated and the results were analyzed statistically.

This study was directed to evaluate the role of ultrasound and computed tomography in patients with UTIs and the correlation of imaging findings with clinical features and biochemical findings.

The various types of UTIs observed in this study were uncomplicated cystitis, acute pyelonephritis, chronic pyelonephritis, renal abscess, emphysematous pyelonephritis, and pyonephrosis.

In our study, the mean age of the patients was 40.03 years. Maximum numbers of cases were noted in the 21-30 years patients. This observation was similar to that of Thattil SJ *et al*. [5] who had reported a similar age group of 26-35 years L Paudel *et al*. [6] who reported the most common age group of UTI in females to be 15-30 years.

Amongst 100 cases, 42 were males and 58 were females. Slight female preponderance was noted in our study. This correlated with the observations made by Sewify M *et al*. [7] and Magliano E *et al*. [8]

There are various risk factors for the UTIs. In our study, the common risk factor associated was diabetes mellitus (25%). This observation was correlated closely with Khalid *et al*. [9] study. Chita T *et al*. [10] and He K *et al*. [11] also reported similar findings. Strikingly, the incidence of diabetes mellitus was found to be higher in our study group. In our study increased urinary bladder wall thickness, internal echoes, and significant post-void residue (suggestive of cystitis) measured on ultrasound had the sensitivity of 88.57%. This observation of ours was similar to the observations by the aforementioned researchers.

Mitterberger *et al*. [12] reported that the CT has 84% sensitivity in diagnosing acute pyelonephritis. A study conducted by Yoo *et al*. [13] CT showed a sensitivity of 81% in the diagnosis of APN.

As per Venkatesh L *et al*. [14], USG features were suggestive of APN in 66% of cases. Majd *et al*. [15] reported a sensitivity and specificity of 74.3 and 56.7% for ultrasound diagnosis of APN. In our study, the sensitivity of CT in diagnosing the APN was 90.32% which is closely correlated with the Mitterberger *et al*. and Yoo *et al*. observations. In our study, the sensitivity of ultrasound in APN diagnosis was 64.51%, which is similar to Venkatesh L *et al*. [14] and Majd *et al*. [15] observations.

Conclusion

This study is an analysis of the epidemiological trends, risk factors, and type of UTI. The results of our study could be well correlated with the observations made by other researchers. Ultrasound is found to be a more sensitive investigation in cases of uncomplicated cystitis than CT, as it allows for additional dynamic evaluation with pre and post-void assessment. CT is more sensitive and specific in the diagnosis of UTI and its complications other than uncomplicated cystitis. Based on the observations from our study we suggest that combining USG and imaging helps to increase the diagnostic yield of UTI, especially in cases of chronic infections where urine routine may be negative.

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