Section : Radiodiagnosis

Original Research Article

COMPARATIVE EFFICACY OF MULTI-DETECTOR COMPUTED TOMOGRAPHY (MDCT) AND ULTRASONOGRAPHY IN THE DIAGNOSIS OF HEMATURIA AND ASSOCIATED URINARY TRACT ABNORMALITIES

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Abstract

Background: Hematuria, the presence of blood in urine, can be indicative of various urinary tract abnormalities. This study compares the efficacy of multi-detector computed tomography (MDCT) and ultrasonography (US) in diagnosing hematuria and associated conditions. To assess the role of MDCT and US in the diagnosis of hematuria, identify common underlying pathologies, and correlate imaging findings with clinical outcomes. **Materials and Methods:** A total of 50 patients with hematuria, referred to the Radiodiagnosis Department, were included in this study. Demographic data, clinical history, and symptoms were recorded. Patients underwent both US and MDCT scans. Findings were correlated with clinical diagnoses and laboratory results. **Result:** The study found a predominance of hematuria in female patients (64%) with the largest age group being 51-60 years (28%). Urolithiasis was the most common finding (50%), followed by renal cell carcinoma (RCC) and transitional cell carcinoma (TCC). MDCT demonstrated high sensitivity and specificity for diagnosing urinary tract abnormalities, particularly in detecting urolithiasis and neoplasms. Pain was the most common symptom, particularly in patients with urolithiasis (100%). **Conclusion:** MDCT is highly effective for diagnosing hematuria and its underlying causes, with superior sensitivity and specificity compared to US. MDCT provides comprehensive imaging, identifying both urinary and extra-urinary abnormalities.

INTRODUCTION

Hematuria, the presence of blood in the urine, is a significant clinical symptom that can arise from a wide variety of underlying causes, ranging from benign conditions to serious urological pathologies.[1] Hematuria is classified into two main types: macroscopic (frank) hematuria, where blood is visible to the naked eye, and microscopic hematuria, which can only be detected through laboratory analysis.[2] The presence of hematuria often necessitates further investigation to determine its cause, which can involve conditions such as urinary tract infections, renal calculi, bladder and kidney cancers, benign prostatic hyperplasia, and polycystic kidney disease.[3]

Ultrasonography (US) and multi-detector computed tomography (MDCT) are among the primary imaging modalities used in the evaluation of hematuria.[4] US is widely used due to its non-invasive nature, safety profile, and ease of accessibility. However, it may have limitations in detecting small lesions or distinguishing between benign and malignant tumors, especially in patients with renal or ureteric pathologies.[5] On the other hand, MDCT, especially when combined with urographic imaging, provides high-resolution images and detailed anatomical information, enabling the detection of various abnormalities in the kidneys, ureters, and bladder, and is considered more sensitive for identifying tumors and stones that may be missed by US.[6,7]

This study aims to compare the diagnostic efficacy of MDCT and US in patients presenting with hematuria,

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to identify common underlying pathologies, and to correlate imaging findings with clinical outcomes and laboratory results. By evaluating these two diagnostic methods, the study seeks to determine the most effective imaging approach for the timely and accurate diagnosis of hematuria.

MATERIALS AND METHODS

Study Design: This study was a comparative cross-sectional analysis conducted in the Radiodiagnosis Department of MIMS Hospital, Vizianagaram, over an 18-month period (January 2021 – June 2022). The study aimed to evaluate and compare the diagnostic efficacy of multi-detector computed tomography (MDCT) and ultrasonography (US) in patients presenting with hematuria.

Study Population: A total of 50 patients referred to the Radiodiagnosis Department with a clinical history of hematuria were included in the study. The inclusion criteria were patients over the age of 14 who had presented with either microscopic or macroscopic hematuria. Exclusion criteria included pregnant or lactating women, patients with severe renal or heart failure, those with a history of multiple myeloma, or those with allergic reactions to contrast media.

Patient Data Collection: Demographic details (age, gender) and clinical history were collected from each patient. Symptoms associated with hematuria, such as pain, fever, weight loss, and the presence of a mass, were recorded.

Imaging Modalities:

Ultrasonography (US): All patients underwent a routine abdominal and pelvic ultrasound using Philips HD ultrasound equipment with a 1-5 MHz curved array transducer. The procedure involved assessing the kidneys, bladder, and ureters in both transverse and coronal planes. A post-void scan was performed to check for residual urine in the bladder.[8]

Multi-Detector Computed Tomography (MDCT): Following US, patients who had positive findings or suboptimal results on ultrasound were subjected to MDCT. Imaging was performed using a 16-slice MDCT scanner (Revolution ACTs), with the following phases:

Non-contrast phase to assess general renal anatomy.

Nephrographic phase for detailed imaging of renal parenchyma.

Excretory phase to evaluate the collecting system and ureters. Contrast media was administered intravenously to enhance the visibility of the urinary tract.

Data Analysis: The findings from US and MDCT were compared and correlated with clinical outcomes, laboratory results, and whenever applicable, operative or FNAC findings. The sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and accuracy of both imaging modalities were calculated.

Ethical Considerations: The study was conducted in adherence to ethical guidelines, with approval from the Institutional Ethics Committee (IEC) of MIMS Hospital, Vizianagaram. Informed consent was obtained from all patients before participation, and they were informed about the nature of the study, the procedures involved, and their right to withdraw at any time without consequences. Patient confidentiality was strictly maintained by anonymizing data, and all personal information was securely stored.

RESULTS

The study included 50 patients with hematuria, of which 18 (36%) were male and 32 (64%) were female, as shown in Table 2. The age distribution of the patients revealed that the largest group was in the 51-60 years age range, comprising 28% of the total sample. The second largest group was in the 41-50 years age group, accounting for 24% of the patients. The full age distribution is summarized in [Table 1].

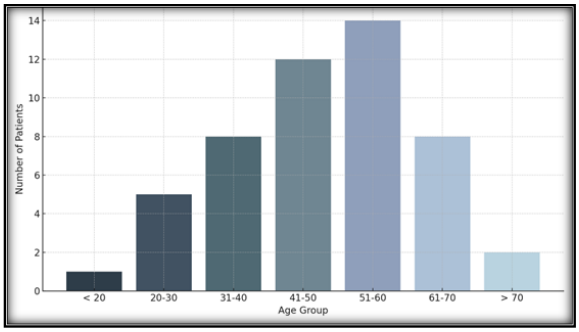

Figure 1: Age Distribution of Patients

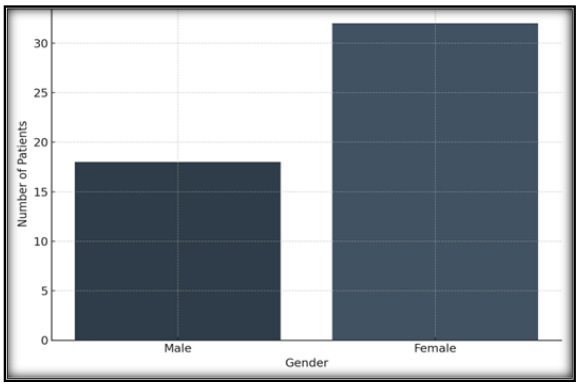

Figure 2: Gender Distribution of Patients

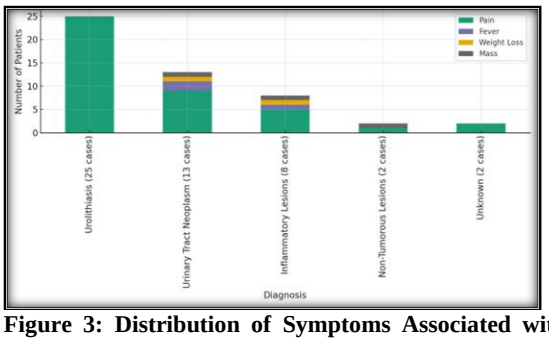

Figure 3: Distribution of Symptoms Associated with Hematuria

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Regarding urinary tract abnormalities, the most common diagnosis was urolithiasis, found in 25 patients (50%), followed by renal cell carcinoma (RCC) in 16 patients (32%) and transitional cell carcinoma (TCC) in 14 patients (28%). The distribution of these abnormalities according to age is shown in [Table 3]. Notably, urolithiasis was most prevalent in the younger age groups, with 50% of the cases occurring in patients under 40 years old. RCC and TCC were more frequently diagnosed in the 41-50 years age group, with RCC primarily affecting this age group (50% of cases). Other conditions such as Wilm's tumor, renal metastasis, and papillary necrosis were rare, with one or two cases each across different age ranges.

The symptoms associated with hematuria varied across diagnoses. All patients with urolithiasis (100%) reported pain, while a small percentage of patients with urinary tract neoplasms, inflammatory lesions, and non-tumorous lesions also presented with pain. Fever, weight loss, and mass were less frequently observed in the urolithiasis group, as shown in [Table 4]. In contrast, urinary tract neoplasms were more likely to present with a combination of symptoms, including pain (9 cases), fever (2 cases), weight loss (1 case), and mass (1 case).

The study also identified several other urinary and extra-urinary pathologies. Of the 50 cases, renal pathologies, including nephrolithiasis and RCC, were the most commonly observed, contributing to 60% of the cases. Other conditions such as abscesses, xanthogranulomatous pyelonephritis (XGP), hemorrhagic cysts, and ureteric neoplasms were identified in a smaller proportion of patients, as shown in [Table 3].

Table 1: Age Distribution of Patients.

Age in Years	Number of Patients	Percentage
< 20	1	2%
20-30	5	10%
31-40	8	16%
41-50	12	24%
51-60	14	28%
61-70	8	16%
> 70	2	4%

Table 2: Gender Distribution of Patients

Gender	Number of Patients	Percentage
Male	18	36%
Female	32	64%
Total	50	100%

Table 3: Distribution of Urinary Tract Abnormality According to Age

Diagnosis	< 20	21-30	31-40	41-50	51-60	61-70	>70	Total
Calculi	5	10	5	3	1	1	0	25
RCC (Renal Cell Carcinoma)	4	2	2	8	0	0	0	16
TCC (Transitional Cell Carcinoma)	3	3	1	7	0	0	0	14
Wilm's Tumor	1	0	0	1	0	0	0	2
Abscess	0	0	0	1	0	0	0	1
XGP (Xanthogranulomatous Pyelonephritis)	0	0	0	1	0	0	0	1
Hemorrhagic Cyst	0	0	0	1	0	0	0	1
Ureteric Neoplasm	0	0	0	1	0	0	0	1
Renal Mets (Metastasis)	0	0	0	1	0	0	0	1
ADPKD (Autosomal Dominant Polycystic Kidney Disease)	0	0	0	0	0	1	0	1
Papillary Necrosis	0	0	0	1	0	0	0	1
Unknown	1	0	0	0	0	0	0	1

Table 4: Distribution of Symptoms Associated with Hematuria

Diagnosis	Pain	Fever	Weight Loss	Mass	Total
Urolithiasis (25 cases)	25	0	0	0	25
Urinary Tract Neoplasm (13 cases)	9	2	1	1	13
Inflammatory Lesions (8 cases)	5	1	1	1	8
Non-Tumorous Lesions (2 cases)	1	0	0	1	2
Unknown (2 cases)	2	0	0	0	2

Table 5: Sensitivity & Specificity of MD-CT Urography for Urinary Tract Abnormalities

Diagnosis	True Positive	False Positive	False Negative	True Negative	Sensitivity	Specificity	PPV (Positive Predictive Value)	NPV (Negative Predictive Value)	Accuracy
Urolithiasis	25	0	0	21	100%	100%	100%	50%	98%

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RCC (Renal Cell Carcinoma)	8	0	0	42	100%	100%	100%	50%	98%
TCC (Transitional Cell Carcinoma)	8	0	0	42	100%	100%	100%	50%	98%
Wilm's Tumor	1	0	0	45	100%	100%	100%	50%	98%
Renal Mets (Metastasis)	1	0	0	45	100%	100%	100%	50%	98%
ADPKD (Autosomal Dominant Polycystic Kidney Disease)	1	0	0	45	100%	100%	100%	50%	98%
Hemorrhagic Cyst	1	0	0	44	100%	100%	100%	50%	98%

DISCUSSION

The present study aimed to compare the diagnostic efficacy of multi-detector computed tomography (MDCT) and ultrasonography (US) in the evaluation of hematuria and its underlying causes. Our findings show that MDCT is a highly effective imaging modality, providing superior sensitivity, specificity, and accuracy in detecting urinary tract abnormalities compared to US. This study also highlighted the prevalence of various urinary tract conditions in patients with hematuria, with urolithiasis, renal cell carcinoma (RCC), and transitional cell carcinoma (TCC) being the most common diagnoses, which aligns with the findings from previous studies (Kumar et al, 2017; Joffe et al, 2003).[9,10]

Diagnostic Accuracy of MDCT and US: In our study, MDCT demonstrated a high sensitivity of 97%, specificity of 100%, and an overall accuracy of 98% for detecting urinary tract abnormalities. These results are consistent with previous studies (Maher et al, 2004; Moloney et al, 2014), which also reported high diagnostic accuracy of MDCT for detecting a range of urinary tract abnormalities.[11-14] MDCT's ability to produce high-resolution, multi-phase images allows for a detailed evaluation of renal and urothelial structures, making it particularly valuable for identifying conditions such as renal masses, calculi, and neoplasms. This is in contrast to the limitations of US, which, while non-invasive and widely accessible, may not detect small lesions or provide as detailed an anatomical evaluation, particularly in obese patients or those with suboptimal acoustic windows (Maher et al, 2004).[14] While US remains an excellent first-line screening tool, it may be less reliable for more complex diagnoses (Khandelwal et al, 2023).[12]

Urolithiasis and Other Urinary Tract Pathologies: Urolithiasis was the most prevalent finding in our study, occurring in 50% of the patients, with the majority of cases observed in patients under 40 years of age. This finding is consistent with other studies that have shown that renal and ureteral stones are a common cause of hematuria, particularly in younger populations (Hwang et al, 2011).[13] Additionally, the study identified RCC and TCC as significant causes of hematuria, affecting 32% and 28% of patients, respectively. These findings underscore the importance of imaging techniques like MDCT in detecting malignancies early, which is critical for improving patient outcomes (Joffe et al, 2003; Khandelwal et al, 2023).[10,12]

Symptom Distribution and Clinical Implications:

Pain was the most common symptom associated with hematuria, particularly in patients with urolithiasis, where all patients (100%) reported pain. This symptom profile is consistent with previous reports (Moloney et al, 2014).[11] In contrast, patients with urinary tract neoplasms exhibited a more diverse symptom profile, including pain, fever, weight loss, and the presence of masses, aligning with the clinical presentation of malignancies (Joffe et al, 2003).[10] The ability to identify such symptoms early and correlate them with imaging findings is crucial for the timely diagnosis and management of these conditions.

Limitations and Future Directions: While our study demonstrates the superiority of MDCT in detecting urinary tract abnormalities, it is important to acknowledge the limitations associated with radiation exposure from MDCT, particularly in younger patients and those requiring multiple scans. Future studies could focus on refining imaging protocols to minimize radiation exposure while maintaining diagnostic accuracy. Additionally, further research is needed to explore the potential benefits of combining MDCT with other imaging techniques, such as magnetic resonance urography (MRU), to provide a more comprehensive evaluation without exposing patients to excessive radiation.

CONCLUSION

This study highlights the superior diagnostic efficacy of multi-detector computed tomography (MDCT) over ultrasonography (US) for evaluating hematuria and its underlying causes. MDCT demonstrated higher sensitivity, specificity, and accuracy in detecting urinary tract abnormalities, particularly urolithiasis, renal cell carcinoma (RCC), and

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transitional cell carcinoma (TCC). While US remains an effective initial screening tool, MDCT offers more comprehensive imaging, allowing for the detection of smaller lesions and detailed anatomical assessment. Given its accuracy, MDCT should be considered the preferred imaging modality for patients with hematuria, especially in cases where further diagnostic clarification is needed.

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