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EVALUATION AND PREVALENCE OF RENAL SYSTEM PATHOLOGIES ON COMPUTED TOMOGRAPHY KIDNEY, URETER AND BLADDER (CT KUB) AT HAYATABAD MEDICAL COMPLEX PESHAWAR

Original Research

Muhammad Zeeshan[1], Sehrish Malghalara[2], Aleena Khan[3], Sapna Mumtaz[4], Abdul Salam[5], Abdul Wadood[6]*
[1]Radiology Technologist, Peshawar Institute of Medical Sciences (PIMS), Peshawar, Pakistan.
[2]Department of Radiology Technology, NCS University System, Peshawar, Pakistan.
[3]Demonstrator Radiology Technology, International College of Health Sciences (ICHS), Peshawar, Pakistan.
[4]Radiology Technologist, Alkhidmat Hospital, Peshawar, Pakistan.
[5]Lecturer Medical Imaging Technology, WMIAHS – Gandhara University, Peshawar, Pakistan.
[6]Assistant Professor Radiology, NCS University System, Peshawar, Pakistan.
Corresponding Author: Abdul Wadood, Assistant Professor Radiology, NCS University System Peshawar, Pakistan, abdulwadoodafridi686@gmail.com
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ABSTRACT

Background: Hydronephrosis, hydroureter, and urolithiasis are among the most frequently encountered renal pathologies presenting with overlapping symptoms but requiring distinct management approaches. Conventional imaging methods such as ultrasonography and intravenous pyelography, although useful, often fail to precisely distinguish between obstructive and non-obstructive causes of hydronephrosis. Computed Tomography of the Kidneys, Ureters, and Bladder (CT KUB) offers superior sensitivity, specificity, and anatomical detail, making it the preferred diagnostic tool for evaluating urinary tract calculi and obstruction with enhanced clinical accuracy.

Objective: To assess renal system pathologies using CT KUB and determine its diagnostic value in differentiating obstructive from non-obstructive hydronephrosis and related urinary tract abnormalities.

Methods: A retrospective study was conducted at the Radiology Department of Hayatabad Medical Complex, Peshawar, analyzing CT KUB reports obtained between July 2022 and July 2023. Data were retrieved from 5,180 patient records and included demographic characteristics (age, gender) and radiological findings related to hydronephrosis, hydroureter, and urinary calculi. Imaging was performed using a 128-slice GE CT scanner, and findings were reviewed through the Picture Archiving and Communication System (PACS). Statistical analysis was performed using SPSS version 26.0, applying descriptive and inferential statistics with significance set at $p < 0.05$.

Results: Out of 5,180 patients, 8.63% of males and 6.24% of females had obstructive hydronephrosis, while 25.08% of males and 16.37% of females exhibited non-obstructive hydronephrosis. Hydroureter was observed in 27.03% of males and 18.68% of females, confirming a clear male predominance. Renal calculi were identified in 60.64% of all cases, most commonly located within the kidneys, followed by the pelvic ureteric junction and proximal ureter. CT KUB effectively detected and classified urinary tract stones and obstructions with high precision.

Conclusion: CT KUB proved to be a highly reliable and accurate imaging modality for evaluating renal system pathologies. It effectively differentiated obstructive from non-obstructive hydronephrosis and precisely identified the presence and location of urolithiasis. The observed male predominance underscores the need for preventive strategies and timely imaging evaluation to reduce disease burden and complications.

Keywords: Computed Tomography, Hydronephrosis, Hydroureter, Kidney Calculi, Prevalence, Renal Pathology, Urolithiasis.

INTRODUCTION

The kidneys are a pair of bean-shaped excretory organs located in the retroperitoneal space between the twelfth thoracic and the third lumbar vertebrae, positioned on either side of the vertebral column, with the right kidney slightly lower than the left due to hepatic displacement (1). They play a vital role in maintaining homeostasis by filtering blood, regulating electrolyte balance, and excreting metabolic waste. Structural or functional disruptions in this system, such as hydronephrosis, can significantly impair renal function. Hydronephrosis refers to the dilatation of the renal pelvis and calyces due to an increased volume within the renal collecting system (2). When this dilation extends into the ureter, the condition is termed hydroureteronephrosis (3). The pathology can be classified as obstructive or non-obstructive depending on the presence or absence of urinary outflow obstruction (4,5). Among the leading causes of obstructive hydronephrosis is urolithiasis, commonly known as kidney stone disease, which remains one of the most frequent urological emergencies encountered globally (6). Urolithiasis is defined as the formation of calculi within the urinary tract, including the kidneys, ureters, bladder, or urethra (7). It affects nearly 12% of the world's population during their lifetime, posing a major health and economic burden (8). Patients typically present with acute flank pain, often accompanied by nausea, vomiting, anorexia, and malaise, while hematuria is a common clinical finding (9). Modern imaging modalities have revolutionized the diagnosis of urinary stones, with non-contrast computed tomography of the kidneys, ureters, and bladder (CT KUB) now considered the gold standard for detecting urolithiasis (10). CT imaging not only identifies the presence of calculi but also provides precise information regarding their size, number, and anatomical location (11). Furthermore, non-contrast CT has demonstrated high sensitivity and specificity—ranging from 96–100% and 95.5–100%, respectively—making it superior to conventional imaging techniques for detecting obstructive pathology (12,13).

Recent studies further emphasize CT's diagnostic value in symptomatic patients presenting with hydronephrosis or urolithiasis. A study identified flank pain and hematuria as the predominant presenting symptoms (14), while a study reported additional manifestations such as burning micturition, fever, vomiting, and abdominal lumps, with imaging confirming ureteric calculi as a leading cause of unilateral hydronephrosis (15). Similarly, another study highlighted the comparative diagnostic role of CT in differentiating obstructive from non-obstructive hydronephrosis (16). While a study expanded on the technological advancement of multidetector computed tomography (MDCT), enabling multiplanar and three-dimensional reconstructions that enhance visualization, quantify stone burden, and estimate stone composition through Hounsfield Unit (HU) measurement (17). Comparative analyses have also shown CT's superiority over ultrasonography, with ultrasound demonstrating 69.79% sensitivity and 100% specificity relative to CT findings ($p<0.001$) in detecting urinary tract calculi (18). Given the high diagnostic accuracy and comprehensive anatomical assessment provided by CT KUB, the present study aims to assess renal system pathologies using computed tomography of the kidneys, ureters, and bladder. The objective is to establish its diagnostic utility in evaluating both obstructive and non-obstructive pathologies, thereby supporting evidence-based clinical decision-making.

METHODS

This study was conducted at the Department of Radiology, Medical Teaching Institute, Hayatabad Medical Complex (MTI-HMC), Peshawar, and included patients who were diagnosed with hydroureteronephrosis and urolithiasis. The study employed a retrospective chart review design, utilizing secondary data obtained from the hospital's radiology records for the period between July 2022 and July 2023. The study population comprised all patients, irrespective of age or gender, who had undergone non-contrast computed tomography of the kidneys, ureters, and bladder (CT KUB) for the evaluation of suspected renal pathologies during the defined period. The inclusion criteria encompassed all CT KUB scans performed for patients with complete medical records available in the radiology database. Patients who had undergone nephrectomy, had a history of renal or urological surgery, or were diagnosed with carcinoma of the urinary tract were excluded to avoid confounding interpretations of structural abnormalities unrelated to calculi or obstruction. This ensured that the findings represented renal pathologies arising independently of surgical alterations or malignant processes. All imaging was performed using a GE 128-slice CT scanner (Japan), following standard institutional imaging protocols for renal evaluation. The scanner's high-resolution capability allowed for detailed visualization of the kidneys, ureters, and bladder. The data were retrieved from the Picture Archiving and Communication System (PACS) and corresponding medical records. A structured data extraction form was utilized to record demographic information (age and gender), clinical indications for the CT scan, imaging findings (such as the presence,

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size, and location of calculi or degree of hydronephrosis), and any relevant coexisting medical conditions. Where available, details regarding management plans or therapeutic interventions, including medical or surgical treatments, were also documented. Ethical approval for the study was obtained from the Institutional Review Board (IRB) of Hayatabad Medical Complex, Peshawar, prior to data collection to ensure adherence to ethical standards and patient confidentiality. As this was a retrospective study based on existing hospital records, the requirement for informed consent was waived by the IRB. All data were anonymized prior to analysis to maintain patient privacy and uphold ethical integrity. Data analysis was performed using Statistical Package for the Social Sciences (SPSS) version 26.0. Descriptive statistics, including means and standard deviations, were computed for continuous variables, while categorical data were expressed as frequencies and percentages. The chi-square test was applied to determine associations between categorical variables, and a p-value of less than 0.05 was considered statistically significant. The results were presented in tables and graphs for clarity and ease of interpretation.

RESULTS

A total of 5180 computed tomography kidney, ureter, and bladder (CT KUB) reports were retrospectively analyzed. Among these, 3073 (59.3%) patients were male and 2107 (40.7%) were female, indicating a predominance of males. Age distribution revealed that most patients were younger than 35 years (41.0%), followed by those aged 35–45 years (22.1%), 46–56 years (18.4%), 57–65 years (12.4%), and those 66 years or older (6.0%), suggesting that renal and ureteric calculi were more prevalent in younger and middle-aged adults. Out of 5180 reports, 4761 (91.91%) patients had kidneys of normal size, while 419 (8.09%) exhibited abnormal kidney size. Similarly, a smooth kidney outline was noted in 4761 (91.91%) cases, whereas 419 (8.09%) had an undefined kidney outline, reflecting that most patients maintained normal renal morphology. In terms of calculi distribution, 3141 (60.64%) patients had stones located within the kidneys, 732 (14.13%) at the pelvic ureteric junction, 538 (10.39%) in the proximal ureter, 345 (6.66%) in the mid ureter, 170 (3.28%) in the distal ureter, 180 (3.47%) at the vesicoureteral junction, 60 (1.16%) in the urinary bladder, and 4 (0.08%) in the urethra. Only 10 (0.19%) individuals showed no evidence of stones. Within the kidney itself, stones were predominantly located in the lower pole (36.51%), followed by the mid pole (21.70%) and upper pole (8.49%). Gender-wise analysis showed that obstructive hydronephrosis was more common in males (447, 8.63%) compared to females (323, 6.12%). Similarly, non-obstructive hydronephrosis affected 1299 (25.08%) males and 848 (16.37%) females. Hydroureter was also more frequent among males (1400, 26.08%) than females (968, 18.91%). Unilateral hydroureter was seen in 1000 (19.3%) males and 697 (13.46%) females, whereas bilateral hydroureter occurred in 416 (8.03%) males and 269 (5.19%) females, confirming male predominance across all categories. Regarding stone characteristics, the stone size ranged from 2.00 mm to 17.89 mm, with a mean size of 8.61 ± 3.10 mm. The stone density varied from 159.00 to 1601.00 Hounsfield Units (HU), with a mean of 899.21 ± 335.08 HU. Most patients (3427) had solitary calculi, while 1753 presented with multiple stones, suggesting that single stones were more prevalent in this population.

Overall, 3141 (60.64%) individuals had renal calculi, and a substantial number also presented with hydronephrosis or hydroureter, indicating that obstructive uropathy due to stones was a major clinical finding. The analysis revealed clear gender and age differences in stone burden and hydronephrotic changes, reinforcing the diagnostic value of CT KUB for accurate localization and quantification of urinary tract pathology. Statistical correlation and chi-square analysis were performed to determine the relationships between patient demographics (age and gender) and renal pathologies, including stone location and hydronephrosis type. The chi-square test revealed no statistically significant association between age group and the occurrence of hydronephrosis ($p = 0.196$), indicating that both obstructive and non-obstructive hydronephrosis were distributed across all age groups without notable variation. However, gender was found to have a significant relationship with both hydronephrosis and hydroureter ($p < 0.05$), with males showing a higher prevalence of obstructive and non-obstructive hydronephrosis as well as hydroureter compared to females. Further correlation analysis demonstrated that the presence of renal stones was significantly associated with the occurrence of obstructive hydronephrosis ($p < 0.001$), confirming that ureteric or renal calculi contributed to urine flow obstruction and renal pelvis dilatation. Moreover, stone location had a strong influence on hydronephrosis type—stones located in the pelvic ureteric junction and proximal ureter were most frequently associated with obstructive hydronephrosis, whereas stones confined to the lower calyces and mid-ureter showed a greater tendency toward non-obstructive dilatation. These relationships underscore the diagnostic role of CT KUB in differentiating between obstructive and non-obstructive causes of renal dilatation, as well as in characterizing gender and anatomical variations in disease presentation.

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Table 1: Showing Age of the Patients

Age Group	Frequency	Percentage	P-Value
Less than 35	2126	(41.0%)	0.196
35 to 45	1146	(22.1%)	
46 to 56	953	(18.4%)	
57 to 65	644	(12.4%)	
66 years and above	**311**	**(6.0%)**	

Table 2: Association Between Gender and Hydronephrosis Type

Gender	Obstructive Hydronephrosis	Non-Obstructive Hydronephrosis	Hydroureter	Chi-Square p-Value
Male (n=3073)	447 (8.63%)	1299 (25.08%)	1400 (26.08%)	<0.05 (S)
Female (n=2107)	323 (6.12%)	848 (16.37%)	968 (18.91%)	<0.05 (S)

S = Significant at $p < 0.05$

Table 3: Correlation Between Stone Location and Type of Hydronephrosis

Stone Location	Associated Condition	Statistical Relationship
Pelvic Ureteric Junction (14.13%)	Predominantly Obstructive Hydronephrosis	$p < 0.001$ (S)
Proximal Ureter (10.39%)	Obstructive Hydronephrosis	$p < 0.001$ (S)
Mid and Distal Ureter (9.94%)	Mixed or Non-Obstructive Hydronephrosis	$p < 0.05$ (S)
Kidney Calyces (60.64%)	Non-Obstructive Hydronephrosis	$p < 0.05$ (S)

S = Significant at $p < 0.05$

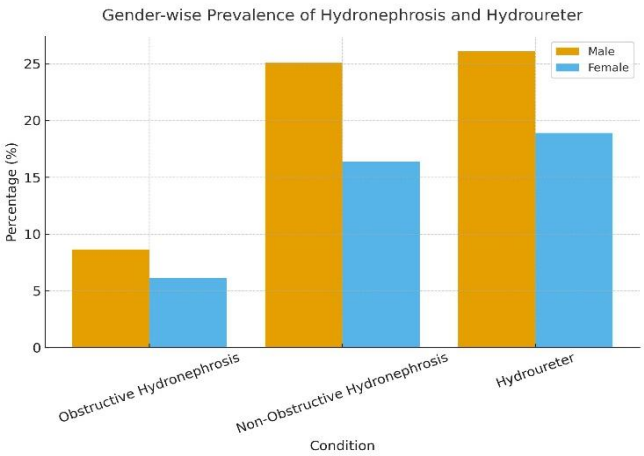

Figure 2 Gender-wise Prevalence of Hydronephrosis and Hydroureter

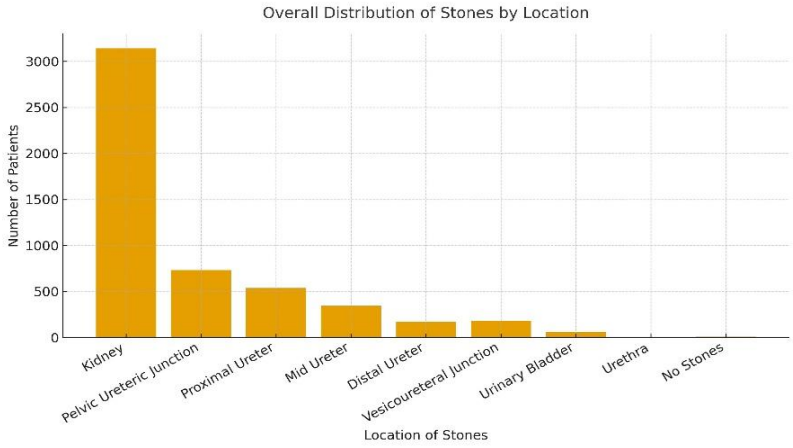

Figure 2 Overall Distribution of Stones by Location

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DISCUSSION

The findings of the present retrospective analysis demonstrated a clear predominance of obstructive and non-obstructive hydronephrosis, hydroureter, and urolithiasis among male patients compared to females. Out of 5,180 reviewed CT KUB reports, 8.63% of males exhibited obstructive hydronephrosis, 25.08% had non-obstructive hydronephrosis, and 27.03% showed evidence of hydroureter, whereas the corresponding values among females were 6.24%, 16.37%, and 18.68%, respectively. These results reinforce the existing evidence that urological pathologies, particularly those associated with urinary calculi, occur more frequently in males. Previous literature similarly reports a higher incidence of urinary tract calculi and related obstructive pathologies among men, suggesting that anatomical and lifestyle-related factors contribute to this gender disparity (19-21). The predominance of male cases in the present study may be attributed to hormonal influences, dietary habits, occupational exposure to heat, and differences in hydration practices. Males are more likely to engage in physically demanding outdoor occupations, which predispose them to dehydration and higher urinary concentration, facilitating crystallization and stone formation. In contrast, females are relatively protected due to estrogen-mediated modulation of calcium and oxalate metabolism, which reduces urinary supersaturation. The current study also supports the observation that obstruction-related hydronephrosis, particularly when associated with stones in the pelvic ureteric junction or proximal ureter, is a major contributor to renal dilatation and functional impairment detected on CT scans (22). The use of non-contrast CT KUB as the imaging modality in this study allowed for precise localization, measurement, and characterization of stones, as well as accurate differentiation between obstructive and non-obstructive causes of hydronephrosis. This imaging approach aligns with global diagnostic standards, which recognize CT as the most sensitive and specific method for detecting urolithiasis and its complications. The large sample size of 5,180 reports strengthens the generalizability of the findings, making it one of the more comprehensive institutional assessments of renal system pathologies conducted within a South Asian context (23).

Despite these strengths, several limitations were noted. Being a retrospective study, it relied on secondary data, limiting the ability to assess clinical correlations such as biochemical markers, treatment outcomes, or recurrence rates. The absence of patient follow-up data prevented evaluation of long-term renal outcomes after diagnosis. Moreover, while CT findings were detailed, interobserver variability in image interpretation may have introduced minor diagnostic bias. Another limitation was the lack of direct comparison with other imaging modalities, such as ultrasonography or MRI, which could have validated CT's superiority in detecting subtle or early lesions. The results have important clinical and public health implications. The higher prevalence of urological conditions in males underscores the need for targeted screening and preventive education, particularly focusing on hydration, dietary control, and early symptom recognition. From a diagnostic standpoint, CT KUB should remain the primary imaging modality for accurate identification of hydronephrosis, hydroureter, and urolithiasis. Expanding CT scanner availability in high-volume centers and standardizing reporting protocols across institutions could enhance diagnostic accuracy and ensure timely management. Future research should focus on prospective, multicentric studies comparing CT with other imaging modalities to validate its diagnostic performance and cost-effectiveness in diverse clinical settings (24). Additionally, studies exploring the metabolic, environmental, and genetic determinants of gender-specific urolithiasis patterns could help formulate preventive strategies tailored to regional risk factors. Overall, the current study highlights the significant diagnostic and epidemiological role of CT KUB in evaluating renal system pathologies while emphasizing the ongoing need for early detection and standardized diagnostic practices.

CONCLUSION

This retrospective study established computed tomography as the gold standard imaging modality for the evaluation of renal pathologies, offering superior diagnostic precision in identifying hydronephrosis, hydroureter, and urolithiasis. The findings demonstrated that CT KUB effectively differentiated between obstructive and non-obstructive causes of renal dilatation and accurately localized urinary stones throughout the urinary tract. The study also highlighted a consistent male predominance across all renal pathologies, reflecting possible anatomical, hormonal, and lifestyle influences. Overall, the research underscores the essential role of CT in guiding clinical decision-making, enhancing diagnostic accuracy, and supporting timely management of renal system disorders.

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AUTHOR CONTRIBUTION

Author	Contribution
Muhammad Zeeshan	Substantial Contribution to study design, analysis, acquisition of Data Manuscript Writing Has given Final Approval of the version to be published
Sehrish Malghalara	Substantial Contribution to study design, acquisition and interpretation of Data Critical Review and Manuscript Writing Has given Final Approval of the version to be published
Aleena Khan	Substantial Contribution to acquisition and interpretation of Data Has given Final Approval of the version to be published
Sapna Mumtaz	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Abdul Salam	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Abdul Wadood*	Substantial Contribution to study design and Data Analysis Has given Final Approval of the version to be published

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