RESEARCH PAPER

Diagnostic Accuracy of Ultrasonography in Urinary Tract Pathologies

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ABSTRACT

BACKGROUND: The most frequent instances, which are more likely to affect men than women, are those involving the urinary system. Ultrasonography (US) is a crucial imaging technique in these situations. The quick and harmless imaging technique that is ultrasonography (US) is used to diagnose disorders of the urinary system.

OBJECTIVES:

To evaluate the sensitivity and specificity of ultrasonography in the diagnosis of illnesses affecting the urinary system.
To ascertain the age range most frequently exposed to urinary tract illnesses and its localisation.

METHODS: From 10 February to 13 May 2025, a 3-month period, 100 patients requested and reported having USG abdominal scans. This study was retrospective and cross-sectional in nature. The data collected was entered onto a self-created data capture sheet. With the aid of Microsoft Excel 2014, data was examined.

RESULTS: The department of radio diagnostics received a referral for a USG scan of the abdomen from a total of one hundred (100) patients, ranging in age from 18 to 60, with a clinical suspicion of urinary tract disorders. Of the patients, fifty-two (52) were men and forty-eight (48) were women. The majority of patients who belong to the patient-total age range of 18 to 30 years.

Conclusion: Renal ultrasonography (US) is a flexible and helpful test. For patients who have urinary or renal symptoms or who need guidance during a renal intervention, ultrasonography (US) is a quick, affordable, and easily accessible tool. However, due to its limitations, renal ultrasonography (US) should always be viewed as an additional imaging modality when evaluating renal or urinary tract disease.

Keywords Add keywords here:

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INTRODUCTION

The kidneys, ureters, bladder, and urethra make up the urinary system. The system that eliminates urine from the body, which is composed of wastes and surplus fluid, is known as the urinary tract. All body parts must function properly together for normal urination.

The body's urinary system is a collection of organs responsible for filtering extra fluid and other contaminants from the bloodstream. Urine, a liquid waste product created by the kidneys, serves as a filter for the compounds that are removed from the body. The bladder stores pee, which is then expelled through the urethra. Blood cells and excessive minerals are both removed from the body through urine. For the body to maintain water and electrolyte equilibrium, the urinary system collaborates with the other systems. Since they keep the blood's acid-base balance in check, the kidneys are important for maintaining homeostasis.

ANATOMY OF KIDNEY

The kidneys are paired retroperitoneal structures that are typically positioned somewhat higher on the left kidney than the right, between the transverse processes of the T12 and L3 vertebrae. In contrast to the lower poles, the upper poles are often placed more posteriorly and medially.

The filtration and excretion of metabolic waste products (urea and ammonium), the maintenance of the proper electrolyte, fluid, and acid-base balance, and the encouragement of red blood cell synthesis are all crucial kidney processes. They also serve to regulate blood pressure through the renin-angiotensin-aldosterone system,

controlling reabsorption of water and maintaining intravascular volume. The kidneys also reabsorb amino acids, gulucose and have hormonal functions through erythropoietin, calcitriol, and vitamin D activation.

Ureters

A pair of tubes known as ureters transport urine from the kidney to the bladder. The ureters of an adult are typically 25–30 cm (10–12 in) length and 3– 4 mm (0.12–0.16 in) in diameter. The ureter's upper and lower halves are located in the abdomen and the pelvis, respectively. The ureter has thick, contractible walls made of fibrous, muscular, and mucus-coated fibers.

25-30 cm in length and 4mm in diameter

Parts of Ureter

The ureter consists mostly of three components.

1. The ureter's pelvis.
2. The ureter's abdominal section.
3. The ureter's pelvic portion.

Bladder

The urinary bladder is a muscular sac that serves as a urine storage. The urinary bladder is a hollow organ that resembles a sac that is used to store Urine. Urination is the term for bladder emptying. Until the user finds a suitable time and location to urinate, the bladder retains urine.

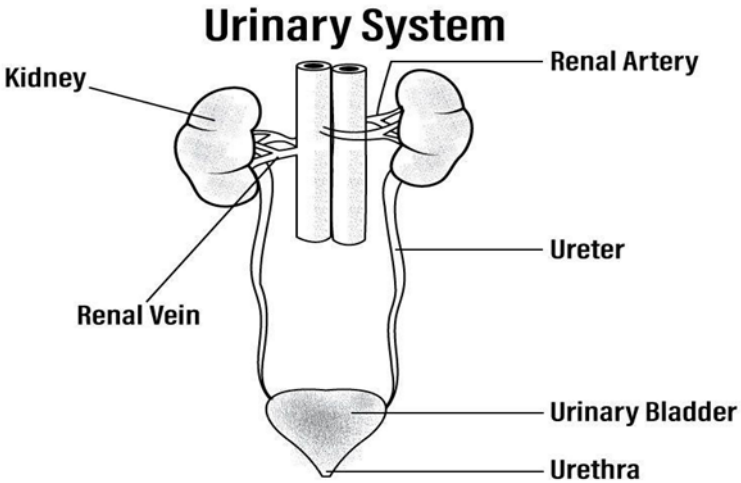
Capacity

1000 ml, anatomical capacity.

450 ml is the physiological capacity

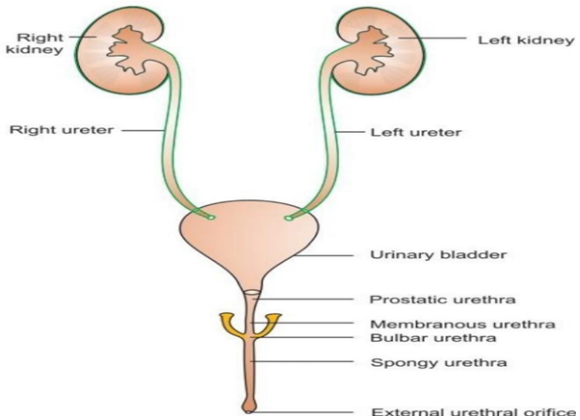
Urethra

The urethra is a tube that connects the bladder to the outside of the body for the passage of urine. Urine is transported from the bladder to the exterior by the distal-most portion of the urinary system.



Male urethra

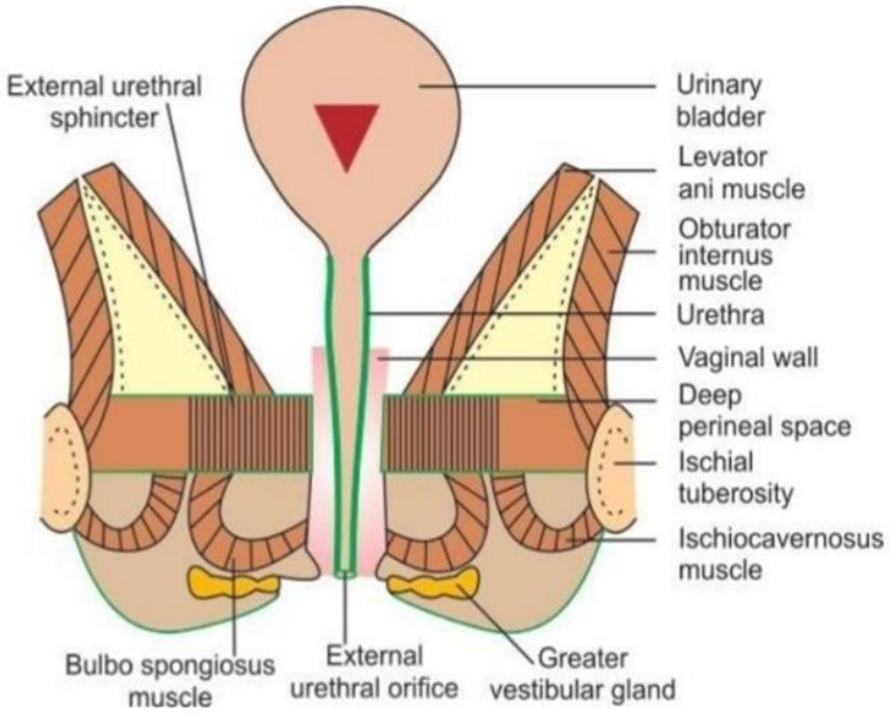
In men, it measures 8 to 10 inches in length and connects the bladder neck to the tip of the penis. Another component of the male reproductive system is the urethra. In a flaccid penis, it has a S shape, while an erected penis has a J shape.



Female urethra

The female urethra measures around 2 inches in length and terminates superior to the vaginal entrance and inferior to the clitoris. It is enmeshed in the vagina's front wall. The

urethral mucosa is heavily folded internally and is home to numerous mucus glands.



IMPORTANCE OF THE URINARY SYSTEM

The urinary system plays a vital role in a human body as eliminates waste and surplus fluid present in a human body.

- Stops the accumulation of wastes and excess fluid in the body.
- Maintains stable electrolyte levels.
- Produces hormones that control blood pressure.
- Producing red blood cells.
- Keeps bones healthy.

Urine is transported from the kidneys to the urinary bladder by the ureters, bladder, and urethra, where it is stored until it is expelled from the body. The abdominal cavity's rear wall is where the kidneys, two bean-shaped organs, are situated. To create urine, the kidney filters metabolic wastes, extra ions, and chemicals from the blood. Urine transport from the kidneys to the bladder is carried out by a thin pair of tubes known as ureters

A renal ultrasound employs sound waves to produce images of the kidneys, ureters, and bladder. It is a painless, safe, and effective test. An ultrasound machine creates sound waves that are sent to the kidney area during the exam, forming images that are then captured on a computer. The interior structure of the organs is depicted in the monitor's black and white visuals. An examination that is frequently carried out and has been done for years is ultrasound (US).It is simple to assess the anatomy of the kidneys using a linear array transducer for (B mode imaging), and US is also utilized as image guidance for renal therapies. Additionally, fusion imaging and contrast-enhanced ultrasonography (CEUS) have been used in applications for renal US. I'll focus on the most typical US results in my discussion of the urinary system.

Radiology department patients frequently complain of abdominal pain, severe flank pain, and hematuria. Although kidney stones, cystitis, and urinary blockage are possible diagnoses in these patients, the differential diagnosis also includes potentially fatal disease processes, most notably chronic kidney disease (CKD) and rupture.A technology called emergency bedside solography can quickly identify the presence of acute urinary blockage.

The common medical words used to describe the pathophysiology should be understood. Obstructive uropathy refers to the structural obstruction of urine flow. This obstruction, known as renal colic, usually causes pain unless it develops gradually. Ureterolithiasis is a kidney stone that has become dislodged and trapped in the ureter. The stone blocks urine flow, causing a backup and enlargement of the proximal ureter (hydroureter).

Ureterolithiasis, as previously established, is a prevalent cause of renal colic and hydronephrosis. However, anything that obstructs the collecting system's inner lumen can stop urine flow and cause renal colic.

Patients who present to the emergency room with reduced urination or anuria, acute renal insufficiency, or pyelonephritis may also benefit from bedside renal solography. Similar to a patient with renal colic, this patient's retroperitoneal anatomical structures can be examined for abnormalities to help the doctor restrict the differential diagnosis, but it only provides a few hints about the functioning status of the urinary system.

The following are the indications for urinary system

Sonography:

- Kidney presence or absence
- Ectopic kidney is the location.
- Renal cysts.
- Calculus
- Hydronephrosis
- Renal cystic disease
- Solid renal masses
- Kidney that is not functioning on IVP.
- Chronic and acute renal failure as well as renal hypertension.
- Renal transplantation
- Post-operative complication
- Renal injury
- Hematoma/perinephric abscess
- Bladder calculi
- Chronic interstitial cystitis with reduced bladder capacity
- Post-operative complications

AIMS AND OBJECTIVES

- To assess the sensitivity and specificity of USG in the evaluation of disorders of the urinary tract.
- To assess the different abnormal signs in the urinary system.
- To distinguish between different urinary tract problems utilising the USG.

MATERIALS AND METHODS

Study Design

A retrospective cross sectional design was used in this study.

Source of Data

Data used in this study was from secondary sources. This data was collected from multiple research papers, journals and radiology books.

Study Population

This study consists of record of 100 patients with request for renal scan and had signs of urinary tract diseases.

Inclusion Criteria

The inclusion criteria were:

- case-control or cohort studies involving participants.
- 18 years or older provided the multivariate- adjusted odds ratio (OR), risk ratio (RR).
- Hazard ratio (HR), or standardized incidence ratio (SIR) with 95% confidence interval.
- (CI), or sufficient information to calculate these, and a comparison group made up of participants without kidney stones history were used.

Exclusion Criteria

The exclusion criteria were: non- human studies, reviews, comments, editorials, case reports and cross- sectional studies. If a cohort study was reported in more than one publication, we choose the latest article.

Instrument of Data Collection

GE Ultrasound machine of the department of radio-diagnosis and imaging IVY Hospital was used for this study.

Methods of Data Collection

- A data capture sheet will be used.
- Data collected will be analyzed thus

- Subjects were classified according to age group and sex
- Data will be presented in charts tables
- Data will be analyzed using descriptive statistical tools, frequencies, mean and percentages.

Standard Imaging Protocol

- Scanning technique, normal findings and common variants.
- A 3.5 - 7 MHz probe is typically used to scan the urinary tract.

TYPES OF KIDNEY STONES

Knowing what sort of kidney stone you have will help you locate its origin and perhaps provide you advice on how to reduce your risk of getting more stones in the future. If possible, try to save any kidney stones you pass so you may deliver them to your doctor for analysis.

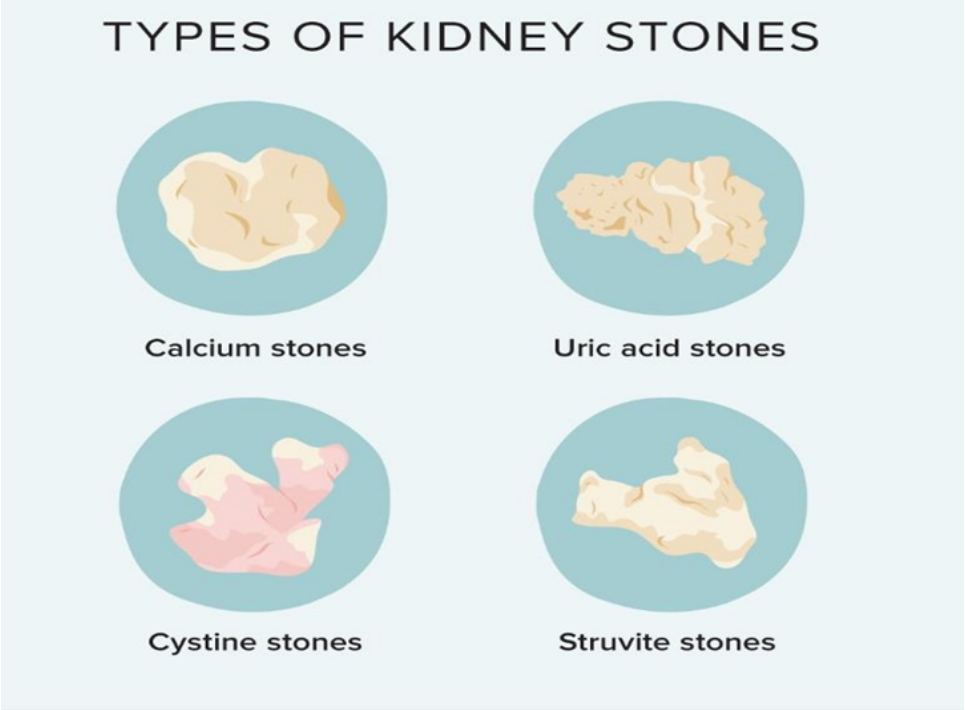
1. Calcium Stones:

Calcium stones, typically in the form of calcium oxalate, make up the majority of kidney stones. Each day, your liver generates oxalate, which you can also receive from meals. The oxalate level of some fruits, vegetables, nuts, and foods like chocolate is high.

Another type of calcium stone that might form is calcium phosphate stone. This kind of stone occurs more frequently in metabolic disorders such renal tubular acidosis. It might possibly be related to topiramate (Topamax, Trokendi XR, Qudexy XR), a medication used to treat migraines or seizures.

2. Struvite Stones:

Urinary tract infections can cause the formation of struvite stones. These stones have the ability to develop quickly and are quite big, sometimes with minimal signs or warning.



1. Uric Acid Stones

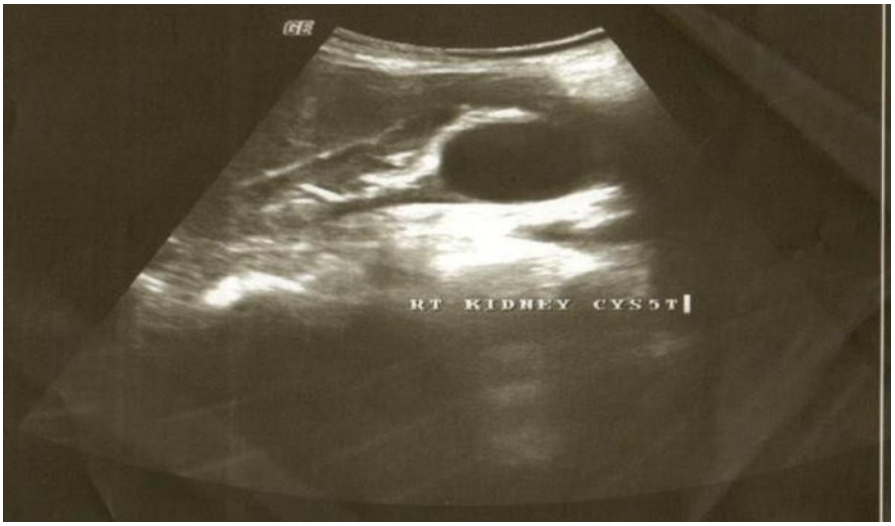
People with chronic diarrhoea or malabsorption, those who consume a high protein diet, those who have diabetes or metabolic syndrome, and those who lose too much fluid can all develop uric acid stones. Your risk of uric acid stones may also be increased by specific genetic variables.

2. Cystine Stones:

People who have a hereditary condition called cystinuria, in which the kidneys expel an excessive amount of a certain amino acid, develop these stones.

Renal cysts:

Fluid-filled sacs called renal cysts develop in the kidney. They are frequently referred to as "simple cysts," which refers to their thin wall and fluid composition. Older adults frequently develop renal cysts, which typically do not hurt or create any symptoms



Hydronephrosis:

The enlargement of a kidney caused by an obstruction in the ureters or bladder is known as hydronephrosis .It occurs when a blockage or obstruction in the ureters prevents urine from going without any obstruction to bladder from kidney. It expands or contracts within the kidney's collecting system.

An ultrasonography (USG) scan will reveal a buildup of urine in the kidney in a foetus or unborn child with hydronephrosis. It is referred to as "antenatal hydronephrosis". After birth, hydronephrosis can also be discovered. For instance, an ultrasonographic examination of a baby's kidneys and bladder during a urinary tract infection (UTI) may reveal hydronephrosis.

Chronic kidney disease (CKD) :

A form of kidney disease known as chronic kidney disease (CKD) sees a slow decline of kidney function over months or years. Initially, there are frequently no symptoms. Leg swelling, nausea, fatigue, disorientation, or loss of appetite could appear later. Heart disease, bone disease, anaemia, and high blood pressure are examples of complications.

High blood pressure, diabetes, and polycystic kidney disease are some of the factors that contribute to chronic kidney disease. A family history of the illness is one of the risk factors.

The steady decrease of kidney function is referred to as chronic kidney disease, often known as chronic kidney failure. Urine is the excretion of wastes and extra fluids from your body that have been filtered by your kidney.

Cystitis:

The medical name for bladder irritation is called cystitis (sis-TIE-tis).Urinary tract infections (UTIs) are bacterial infections that most frequently result in inflammation. A urinary tract infection can be uncomfortable, and if it spreads to the kidneys, it could become a major issue. The short tube (urethra) connecting the bladder to the outside frequently becomes clogged with bacteria that ordinarily reside in the intestine. These bacteria multiply swiftly once they're inside the bladder.

Women of all ages frequently develop cystitis. At some point in their life, between 30 and 50 percent of women will get cystitis. When a woman is sexually active, during pregnancy, and after menopause, she is most prone to develop cystitis. During sex, the infection cannot spread to other people.

RESULTS AND OBSERVATIONS

Observation

A total of 100 patients (age 18-60) were subjected to undergo Ultra Sonography, out of which 34 patients were normal, 41 patients had one disease and 25 were observed to have more than one disease. This data is shown in table 4.1 below.

Table 4.1 Classification of Patients

Diagnosis	No. of Patients	Male	Female
Normal	34	14	20
Patients with one disease	41	24	17
Patients with multiple diseases	25	14	11
Total	100	52	48

From the able above we can also confirm that renal stone disease is more common in men than that of women. From the data of table 4.1 we can confirm that out of 66 effected people 58% were men and 42% were women. This data is also being depicted in figure 4.1 pie chart. Blue chart indicates men and orange chart indicates women.

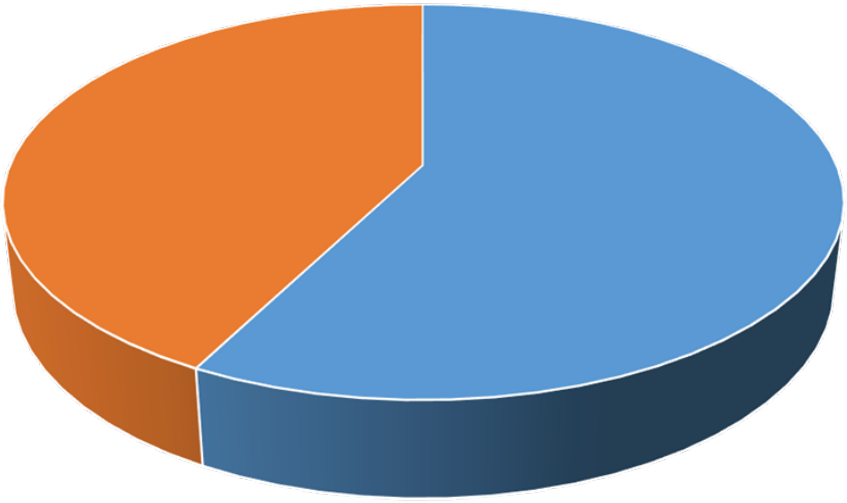
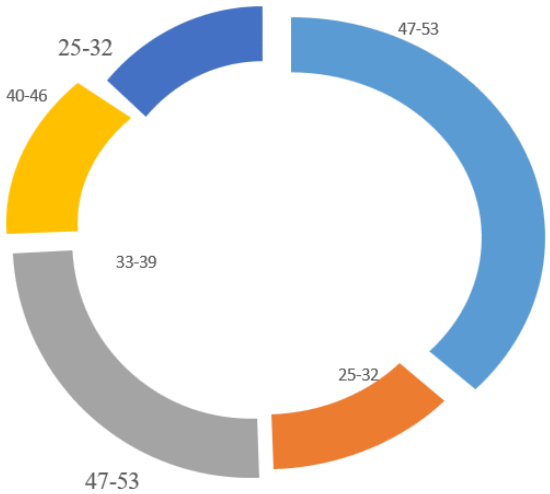


Table 4.2 Age and Gender distribution of patients

Age	No. of Cases	Male	Female
18-24	33	14	19
25-32	11	5	6
33-39	22	12	10
40-46	11	6	5
47-53	12	9	3
54-60	11	6	5
Total	**100**	**52**	**48**



Age distribution of patients

The present study included a total of 100 patients who underwent ultrasonographic evaluation for urinary tract disorders. Among these patients, 52 were males and 48 were females, indicating a slightly higher prevalence of urinary tract abnormalities among males.

The age group of 18–24 years constituted the highest number of cases, with 33 patients, including 14 males and 19 females. This finding suggests that urinary tract disorders were more common among young adults in the present study. The second highest number of cases was observed in the age group of 33–39 years, which included 22 patients, comprising 12 males and 10 females.

The age groups of 25–32 years, 40–46 years, and 54–60 years each showed 11 cases. In the 25–32 years age group,

5 were males and 6 were females. Similarly, the 40–46 years group included 6 males and 5 females, while the 54–60 years group also consisted of 6 males and 5 females. The age group of 47–53 years accounted for 12 cases, with a higher predominance among males, including 9 males and 3 females.

Overall, the study findings indicate that urinary tract disorders affected individuals across all age groups; however, the highest prevalence was observed in younger adults between 18 and 24 years of age. Male patients showed a slightly greater frequency of urinary tract abnormalities compared to females. These observations highlight the importance of ultrasonography as an effective diagnostic tool for evaluating urinary tract disorders across different age groups and genders.

Patients that were diagnosed during this study after USG

diagnosis	No. of patients	Male	Female
B/L Increased Echogencity	7	2	5
B/L Renal Calculus	4	0	4
B/L Renal Cyst	8	5	3
CKD	5	3	2
RT Ectopic Kidney	3	3	0
LT Renal Calculus	13	5	8
LT Renal Cyst	6	3	3
Prostatonegaly	10	10	0
UB Mass	4	4	0
RT Horseshoe Kidney	6	3	3
Total	66	38	28

Out of a total of 66 patients diagnosed with urinary tract abnormalities through ultrasonography, 38 were males and 28 were females, indicating a higher prevalence of urinary tract disorders among males. The most common finding observed in the present study was left renal calculus, detected in 13 patients, including 5 males and 8 females. Prostatomegaly was the second most common abnormality, identified exclusively in males, affecting 10 patients. Bilateral renal cysts were found in 8 patients, with a higher occurrence in males (5 cases) compared to females (3 cases). Bilateral increased echogenicity was observed in 7 patients, predominantly among females, with 5 female and 2 male patients affected.

Left renal cysts and right horseshoe kidney were each diagnosed in 6 patients, showing an equal distribution between males and females in both conditions. Chronic kidney disease (CKD) was identified in 5 patients, including 3 males and 2 females. Bilateral renal calculus and urinary bladder (UB) mass were detected in 4 patients each. Bilateral renal calculus was found only in females, while urinary bladder mass was observed exclusively in males. Right ectopic kidney was diagnosed in 3 male patients and was not observed in females.

The findings of the study demonstrate that renal calculi, renal cysts, and prostatomegaly were among the most frequently encountered urinary tract abnormalities. The study also highlights a greater susceptibility of males to urinary tract disorders compared to females. Ultrasonography proved to be highly effective in detecting various urinary tract pathologies, thereby supporting its importance as a reliable first-line imaging modality for urinary system evaluation.

CONCLUSION

An accessible, affordable, and quick tool for decision-making in patients with urinary symptoms as well as for directing subsequent care is ultrasound. In the early identification of urinary system abnormalities, ultrasonography is crucial. Renal calculus and Renal cyst were found to be the major diseases in the patients that were made to undergo USG. The current study also demonstrates that women are less prone to urinary tract disorders than males are.

Although renal ultrasonography (US) has several limitations, it should always be used in conjunction with other imaging modalities when evaluating renal or urinary tract diseases. Overall, we can state that ultrasonography is the most significant and preferred method of imaging the urinary system. In evaluating the urinary system, ultrasonography has a 96% accuracy rate.

LIMITATIONS

USG has following limitations in case of Urinary Tract Disorder:

- It is an operator-dependent approach that calls for expertise.
- It is challenging to inspect because of respiratory movement.
- Arduous to carry out on unwilling patients.
- The kidneys may be obscured and difficult to conduct due to bowel gas.

It might be challenging to conduct in obese persons as well.

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