

Role of Ultrasound in Renal Pathologies

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Abstract: ***Introduction:** The kidneys, an essential yet often overlooked organ, play a pivotal role in our health by filtering waste and maintaining fluid balance. Despite their critical function, kidneys are susceptible to a myriad of disorders, contributing to over 50% of abdominal conditions in both children and adults. Pinpointing these issues based on symptoms alone can be challenging, underscoring the need for precise diagnostic tools like ultrasonography (USG) to guide effective treatment strategies, potentially averting the need for surgery. Imagine the urinary tract as a labyrinth fraught with diverse challenges—from infections and growths to congenital anomalies. For clinicians, establishing a precise differential diagnosis is crucial before proceeding with interventions. USG emerges as a cornerstone in this diagnostic landscape, leveraging high - frequency sound waves to produce real - time images. Its advantages, such as portability, cost - effectiveness, speed, safety (particularly in sensitive populations like children and pregnant women), and the ability to operate without sedation, make it an indispensable tool across various clinical settings. This study explores the comprehensive role of USG in evaluating renal pathologies, emphasizing its ability to assess kidney structure, size, and texture through different approaches and transducer frequencies. By analyzing key parameters and recognizing common anatomical variations, healthcare professionals can enhance their diagnostic accuracy, thereby improving patient outcomes and ensuring optimal care within the complexities of renal health. **Materials and Methods:** This prospective study, conducted between December 2022 and December 2023 at the Department of Radiology in PDU Govt. Medical College and Civil Hospital, Rajkot, Gujarat, analyzed ultrasonography findings of 100 patients referred for kidney, ureter, and bladder examinations. Patients presenting with a variety of clinical symptoms suggestive of renal pathologies, including lower abdominal pain, hematuria, and elevated serum creatinine, were included. The study utilized SAMSUNG RS80 EVO and SAMSUNG ACCUVIX XG machines with 3.5MHz and 7.5MHz transducers to comprehensively evaluate renal anatomy and identify potential lesions. **Results:** This study of 100 patients revealed that renal pathologies predominantly affect adults aged 31 - 60, with males accounting for 62% of cases. Cystic diseases were the most common finding (24%), with simple solitary cysts representing 58.33% of these cases. Notably, over half of all cases (55%) were asymptomatic, highlighting the importance of incidental detection. Renal cell carcinoma was the most common neoplastic mass, found in 45.45% of patients with such masses. All cases of Angiomyolipoma were echogenic, with 80% demonstrating post - acoustic enhancement. This study provides valuable insights into the demographics, prevalence, and presentation of various renal pathologies, emphasizing the importance of imaging in their diagnosis and characterization. **Conclusion:** Renal ultrasound is a safe, fast, and effective initial imaging modality for evaluating renal pathologies. It is precious for diagnosing and monitoring cystic and calculous diseases, often providing definitive diagnoses. While USG is often sufficient, further investigation with CT or MRI may be necessary for complex cases or suspected malignancies. Overall, renal ultrasound plays a crucial role in the initial assessment and management of renal pathologies.*

Keywords: USG, calculus, cyst, renal, RCC.

1. Introduction

Renal pathologies have been a long - known entity and constitute more than or at least 50% of the abdominal pathologies in children as well as in adults. These are difficult to differentiate from other pathologies on a clinical basis only so radiological examination becomes an important path to reach the diagnosis before surgery. The urinary tract is almost a mine of pathologies. Taking only the kidney and renal pelvis may also include several pathologies like infections, neoplasms etc. Neoplasms again can be benign or malignant. Again kidney and renal pelvis are also known for certain congenital anomalies/anatomical variations like congenital pelvi - ureteric junction obstruction or cortical nodule. These entities need a differential diagnosis especially before the patient undergoes surgery. Ultrasonography: It is a diagnostic technique in which very high - frequency sound is aimed

into the body. An ultrasound scanner sends pulses into a patient's body through a transducer waves are alternated varyingly by the tissues of the body and a string of return echoes are processed by a computer to display a continuous real - time image on a monitor. The advantages of sonography over CT or MRI include portability, lower cost, speed, no ionizing radiation and no sedation. Transducer: In the premature infant, a 7.5 MHz, or higher, transducer is recommended to obtain the highest resolution possible. A 3.5 MHz or 5 MHz transducer may be necessary to allow for adequate sound penetration of a larger infant and adults. The study of the organ may be carried out with three possible approaches (access routes): abdominal (anterior), lumbar (lateral), and dorsal (posterior). For a correct and complete study of the renal echo structure, 5 fundamental parameters need to be evaluated: shape, size, parenchymal echotexture, renal sinus and renal hilum. The most common anatomical variants need to be identified and namely,

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dromedary humps, fetal lobation, hypertrophied column of Bertin, hypertrophied renal tubercles and labia.

Aims and Objectives

- To study various renal lesions including congenital, inflammatory, calculus, neoplastic, cystic and traumatic lesions with the use of Ultrasonography.
- To study different patterns of appearance of various lesions on Ultrasonography.
- To justify the role of ultrasonography as a first - line imaging modality in various renal pathologies.

2. Material and methods

From November 2022 to November 2023, a prospective study of 100 patients was carried out in the Department of Radiology at PDU Govt. Medical College and Civil Hospital, Rajkot, Gujarat after obtaining informed consent from them. The indication and details of the radiological procedure are explained to the patient. Written consent is obtained either from the patient or his/her relatives. The study group consisted of mainly patients from different parts of Gujarat. Ultra - sonographic findings were noted and recorded. The management decision, follow - up, outcome and histopathological diagnosis were recorded. Serum creatinine and blood urea analysis were recorded in the relevant cases. The results of this study were analyzed and compared with other available studies in the literature. Type of study: prospective and retrospective, Duration of study: 1 year (November 2022 to November 2023), Place of study: PDU Medical College and Civil Hospital, Rajkot, Instruments used: SAMSUNG RS80 EVO AND SAMSUNG ACCUVIX XG.

Method of Collection of Data

The main sources of data for the study were all appointed and referred cases to the radiology department for ultrasonography KUB.

Inclusion criteria

The inclusion criteria encompass patients presenting with clinical symptoms such as lower abdominal pain, hematuria, burning micturition, lumbar pain, decreased urination, increased frequency, fever, high serum creatinine value and weight loss and referred to the radiology department for USG KUB. Patients had trauma over the lumbar region. All patients diagnosed and suspicious of renal lesions were included in this study. These included lesions of congenital, infective, vascular and neoplastic etiology.

Equipment and Technique Used

USG of the patients were done on SAMSUNG RS80 EVO AND SAMSUNG ACCUVIX XG. All the machines have 3.5MHz and 7.5MHz transducers. Patients were made to lie supine and made comfortable Head of the patient was supported by the patient's relative. USG was done in supine, prone or in either lateral decubitus position using both 3.5MHz and 7.5MHz transducers. Each kidney was scanned in longitudinal section and cross - section. The upper pole is located more dorsally than the lower pole, the transducer must be tilted to the dorsum. The right kidney was scanned through anterior, lateral, and posterior approaches using the liver as the acoustic window. The left kidney requires a posterior approach, through the spleen as air - filled bowel impedes anterior scanning.

3. Literature Review

Several studies have been done regarding renal pathologies in the past, and various data are available for the distribution of renal masses according to their pathology.

- 1) A study of Lucke B. And Schlumberger HG on the tumors of the kidney, renal pelvis and ureters and his comparison with two other studies showed the following data.

Type of Tumors	McDonald & priestley (636 kidneys)	Riche & associate	Luck
Adenocarcinoma	80%	75%	83.40%
Renal Pelvic tumor	11.90%	12.50%	7.70%
Wilm's tumor	4.90%	8%	5.60%
Sarcoma	3.10%	-	3.30%
Primary Tumor of Ureter	-	0.90%	-
Miscellaneous	-	1.90%	-

- 2) Another study on the "changing pattern in the evaluation of renal masses" by Williams D. Zimmer and Bryan Williamison Jr. Show the comparison of data from 1973 and 1980 as follows

Diagnosis		No. of patients	
		1973	1980
Benign lesions	Simple Cyst	158	146
	Others	1	11
Malignant lesions	Renal cell carcinoma	20	15
	Others	1	3
		175	

- 3) A Study on neonatal abdominal masses by Donald R. Kirks, Marten D. F. Hermengrossman, James W.

Bowie showed that renal masses were present in 55% of cases of which 15% were multicystic kidneys.

- 4) A similar study on palpable abdominal masses in infants and children by Milckow M. D. and Usan A. C. showed that 55% of the masses were renal of which Wilm's tumour was in 22% and hydronephrosis was seen in 20% of cases.
- 5) A study of Daniel W. W. Jr. hartmen G. W., Witten D. M., Forrow G. M., Kelalis P. P. showed that among the renal masses, 61.3% were simple cysts, 20.6% were renal cell carcinoma, 1.2% were abscesses and wilm's was the diagnosis in less than 1% cases.
- 6) Still one more study by Thornburg J. R., Fryback D. G. showed 67% of renal masses were simple benign cysts, 19 % hypernephroma, 7% cortical nodules and 7% to

be normal variation of the kidney.

- 7) Study of Pollack H. M., Goldberg B. B., Marales J. U., Mortan Bogash showed 68% of renal masses to be renal cysts, 15.5% to be renal pseudotumor, 6.3% to renal tumors and 2.4% to be polycystic disease.
- 8) Whereas according to present studies, benign masses other than cysts were found in 8%, simple cysts in 40%, polycystic kidney disease (adult and infant) in 12%, hypernephroma in 14%, wilm's tumor in 10%, transitional cell carcinoma in 14% of cases.
- 9) Warren M. M., Kelalis P. P. and Utz D. C. in their study showed the comparison of various data. This showed the hematuria to be present in 40 - 60% of cases, flank pain was the presenting symptom in about 50% of cases, palpable abdominal mass was present in 35 - 40% of cases and fever in 15 - 25% of cases, weight loss in about 30% of cases. This is very much similar to the present study.²²
- 10) One study of 92 children with kidney masses reported 68 Wilms' tumors, 5 congenital meroblastic nephroma, 4 clear cell sarcoma, 4 neuroblastoma, 4 renal cell carcinoma, 2 lymphomas, 2 Angiomyolipoma, 1 teratoma, 1 hemangioma, and 1 renal epithelial tumor.⁷
- 11) According to a study by Daniel W. W. Jr., Hartmen G. W., Witten D. M. Forrow G. M., Kelalis P. P. shows calcification in 4.1% of all renal masses of which 62% shows only peripheral calcification, mass mostly is a simple cyst but at least chances of being a malignancy.
- 12) A retrospective descriptive study in a series of cases with congenital renal agenesis of 43 patients showed the following results: 51.2% males, and 88% from the department of Valle del Cauca. Prenatal diagnoses were conducted in only 21% of these patients; agenesis was right in 48.8% and left in 51.2%. In 46.5%, association with other pathologies was found: occult spinal bifida, congenital scoliosis, and Klippel - Feil sequence. Compensatory renal hypertrophy was reported in 39.5% of the patients, 42% had episodes of urinary tract infection, 31% vesicoureteral reflux and 10% proteinuria. Four male patients (9.3%) developed renal failure. The average follow - up was 6.6 years.
- 13) A study performed ultrasound screening of the kidneys in 4000 newborn babies. A diagnosis of renal agenesis was made when ultrasound identified no renal parenchyma and Reno scintigraphy showed no renal function, and renal aplasia when there was a renal parenchyma without any function. Primary screening detected 52 babies suspected of having small kidneys and one baby with a multicystic dysplastic kidney, but no baby with renal agenesis. Forty - seven of the 53 babies underwent a second ultrasound scanning at one month of age. Three small kidneys in three babies further decreased in size, had no function and were diagnosed as renal aplasia. Follow - up ultrasound studies showed further regression in all three, which became very hard to distinguish by one year of age.⁵⁵
- 14) Juan. C. Tamayo carried out a retrospective 15 - year review in a rural area of central Spain, which revealed 34 cases of renal echinococcosis treated surgically (3 to 4% of officially confirmed cases of hydatidosis). Results of the combination of clinical history, imaging studies (USG & CT), and serological and urine

investigation yielded a reliable pretreatment diagnosis in only 50% of cases and a presumptive diagnosis in 71%. Among imaging studies, computerized tomography was the most valuable diagnostic examination. Moderate eosinophilia was found in half of the cases, while a third had scoleces in the urine.

4. Results

Table 1: Age Distribution

Age (Years)	No. of Cases	Percentage
0 - 10	16	16
11- 20	2	2
21 - 30	12	12
31 - 40	21	21
41 - 50	19	19
51 - 60	17	17
61 - 70	10	10
71 - 80	2	2
>80	1	1

The most common age group affected by renal pathologies was 31 - 40 year of age (21 cases - 21 %) followed closely by 41 - 50 year group (19 cases - 19 %) and 51 - 60 year group (17 cases - 17 %).

Table 2: Sex Distribution

Sex	No. of Cases	Percentage
Male	62	62
Female	38	38

Of all those affected by renal pathologies, 62 (62 %) were males and 38 (38 %) were females

Table 3: Pathology Distribution

Pathology	No. of Cases	Percentage
Cystic Disease	24	24
Calculus Disease	17	17
Infective/Inflammation	16	16
Renal Parenchymal Disease	9	9
Hydronephrosis	8	8
Neoplasia	11	11
Congenital	9	9
Nephrocalcinosis	2	2
Traumatic	3	3
Nephrotic	1	1

The most common renal pathology diagnosed was cystic renal diseases (24 cases - 24 %) followed by calculus disease (17 cases - 17 %) and infective / inflammatory diseases (17 cases - 17 %). Of all the calculus diseases, 8 (47%) were left sided and 9 (53%) were right sided.⁷ (41.2%) were lower calyceal, 4 (11.8%) were mid - calyceal, 2 were upper - calyceal and 4 (23.5%) were multicalyceal.

Table 4: Common Presentations

Presenting Symptom	No. of Cases	Percentage
Asymptomatic	55	55
Pain	22	22
Lump	6	6
Hematuria	5	5
Pyuria	7	7
Fever	5	5

Most cases were asymptomatic (56 cases - 56%) with incidental lesion detection during US for other reasons while most common symptom was pain (22 cases - 22 %) followed by pyuria (7 cases - 7 %), lump (6 cases - 6 %), fever (5 cases - 5 %) and hematuria (5 cases - 5 %) in decreasing order of frequency.

Table 5: Cystic Disease Distribution

Cyst Type	No. of Cases	Percentage
Simple Solitary	14	58.33
Simple Multiple	4	16.66
ADPKD	3	12.5
MCDK	2	8.33
Hydatid Cyst	1	4.17

Of all the cystic renal diseases, most common was simple solitary cysts (14 cases - 58.33 %) followed by multiple simple cysts and ADPKD (each 4 cases - 16.66 %)

Table 6: Infective/ Inflammatory Disease Distribution

Type of Inflammation	No. of Cases	Percentage
Abscess/ Focal Pyelonephritis	7	43.8
Pyonephrosis	5	31.25
Hydatid Cyst	1	6.25
Diffuse Pyelonephritis	1	6.25
XGPN	1	6.25
Emphysematous Pyelonephritis	1	6.25

Of all the infective/inflammatory diseases most common were abscesses (7 cases - 43.8 %) followed by pyonephrosis (5 cases - 31.25 %)

Table 7: Neoplasia Distribution (Total 11 cases)

Neoplasia	No. of Cases	Percentage
Angiomyolipoma	4	36.36
Renal Cell Carcinoma	5	45.45
Wilm's Tumour	2	18.18

Of all the neoplastic masses most common was RCC (5 cases - 45.45%) followed by Angiomyolipoma (4 cases - 36.36 %) and Wilm's tumor (2 cases - 18.18%)

Table 8: RCC on USG (Total 5 cases)

Characteristic	No. of Cases	Percentage
Heterogenous Echogenicity	5	100
Calcification	2	40
Cystic Regions	2	40
Perinephric Extension	3	60
Vascular Invasion	2	40

- All 6 cases (100%) of RCCs were heterogeneous in echo pattern, 3 (60%) showed perinephric extension, 2 (40%) showed calcifications, 2 (40%) showed cystic spaces within and 2 (40%) showed vascular invasion.

Table 9: Angiomyolipoma on USG (Total 4 cases)

Characteristic	No. of Cases	Percentage
Echogenic	4	100
Post Acoustic Enhancement	3	75
Multiplicity	2	50
Associated with Tuberos Sclerosis	2	50

All 4 cases (100%) of Angiomyolipoma were echogenic, 3 (75%) showed post - acoustic enhancement, 2 (50%) were multiple and 1 (50%) were associated with tuberous

sclerosis.

Table 10: Congenital Disease Distribution

Pathology	No. of Cases	Percentage
Horse Shoe Kidney	2	22.22
Cross Fused Kidney	1	11.11
Ectopic Pelvic Kidney	1	11.11
Duplex Collecting System	1	11.11
MCDK	1	11.11
PUJ Obstruction	3	33.33

Of all the congenital pathologies most common were PUJ Obstruction (3 cases - 33.33% each) followed by horse - shoe kidney (2 cases - 22.22%).

5. Conclusion and Summary

The study revealed that renal pathologies predominantly affected individuals in the age group of 31 to 40 years (21 cases, 21%), with the 41 to 50 - year group and 51 to 60 - year group following closely behind (19 cases, 19% and 17 cases, 17%, respectively). A notable gender disparity was observed, with 62% of the affected individuals being male and 38% female. The most prevalent renal pathology identified was cystic renal diseases, accounting for 24% of cases, followed by calculus disease and infective/inflammatory diseases, each representing 17% of the cases. Within the calculus disease category, a slight majority of cases were right - sided (53%), and the majority of calculi were found in the lower calyceal region (41.2%). Symptoms varied, with the majority of cases being asymptomatic (56%), detected incidentally during ultrasounds conducted for other reasons. When symptoms were present, pain was the most common (22%), followed by pyuria (7%), lump (6%), fever (5%), and hematuria (5%). Among cystic renal diseases, simple solitary cysts were the most frequent (58.33%), with multiple simple cysts and autosomal dominant polycystic kidney disease (ADPKD) each representing 16.66% of cases. In the realm of infective/inflammatory diseases, renal abscesses were most common (43.8%), followed by pyonephrosis (31.25%). Regarding neoplastic masses, renal cell carcinoma (RCC) was the most prevalent (45.45%), with angiomyolipoma and Wilm's tumor occurring less frequently (36.36% and 18.18%, respectively). All RCC cases exhibited heterogeneous echogenicity, with a significant proportion showing perinephric extension, calcifications, cystic spaces, and vascular invasion. Angiomyolipoma were characterized by echogenicity, with a majority showing post - acoustic enhancement and some associated with tuberous sclerosis. Among congenital pathologies, PUJ obstruction was the most common (33.33%), followed by horseshoe kidney (22.22%). This summary provides a comprehensive overview of the demographics, types of renal pathologies, clinical presentations, and specific characteristics observed in the study of 120 cases with renal abnormalities. Renal ultrasound (USG) is the initial diagnostic modality for evaluating suspected renal pathologies due to its safety, speed, and real - time imaging capabilities, devoid of radiation hazards. It serves as a primary tool for diagnosing and following up on common renal conditions such as cystic and calculous diseases, often providing definitive diagnoses. USG is reasonably accurate in identifying renal infections

like abscesses and pyonephrosis, and it can reveal predisposing factors such as urinary tract obstructions, reflux, or calculi. While USG is generally sufficient, some cases may necessitate confirmation with CT scans, especially for complex conditions or to assess malignant renal masses comprehensively, including extension and resectability. In cases of renal trauma, particularly in scenarios involving post-traumatic hematuria or hemoperitoneum, USG allows rapid screening but may be less sensitive than CT scans for detailed assessment. Overall, USG plays a crucial role in the initial evaluation and monitoring of various renal pathologies, offering valuable insights while occasionally necessitating adjunct imaging modalities for comprehensive management. Renal ultrasound (USG) is invaluable for assessing renal neoplasia, providing initial information on its presence, size, and general characteristics. However, for cases of suspected malignant renal masses, CT scans are typically employed to confirm the diagnosis and obtain detailed information on tumor extension, invasion into surrounding structures, and lymph node involvement. Magnetic resonance imaging (MRI) may also be utilized in select cases to further delineate tissue characteristics and aid in surgical planning by assessing resectability. Together, these imaging modalities complement USG by offering comprehensive insights into the nature and management of renal neoplasms, ensuring a thorough evaluation and appropriate therapeutic approach.

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