ORIGINAL RESEARCH PAPER

Radiology

SPECTRUM OF CONGENITAL ANOMALIES OF THE KIDNEY AND URINARY TRACT (CAKUT) AS EVIDENCED ON MULTIDETECTOR CT IN TERTIARY CARE HOSPITAL .

KEY WORDS: CAKUT, congenital, kidney, lower urinary tract

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ABSTRACT

Background: Congenital anomalies of the kidneys and lower urinary tract (CAKUT) are the primary causes of renal failure in children and account for 25% of end-stage renal disease in adults. **Objective:** This study aimed to evaluate the incidence of congenital kidney anomalies in adults at a tertiary care hospital. **Materials and Methods:** A descriptive analysis was conducted on the records of 1,037 participants who underwent CT abdomen and pelvis examinations February 2023 to January 2024 at Mandya Institute Of Medical Sciences to identify CAKUT. **Results:** The overall incidence of CAKUT was 5.3%. A duplex collecting system was found in 1.15% of participants, while pelviureteric junction obstruction (PUJO) was seen in 0.96%. Malrotated and ectopic kidneys occurred in 0.28% and 0.48%, respectively. Renal agenesis and horseshoe kidneys each accounted for 0.38% each. **Conclusion:** CAKUT are often identified through abdominal CT scans. Early recognition and diagnosis can prevent complications such as renal failure and hypertension.

INTRODUCTION:

Congenital anomalies of the kidney and urinary tract (CAKUT) encompass a range of congenital conditions, including renal, pelviureteric, vesicoureteric junction, bladder, and urethral anomalies [1]. CAKUT is the primary cause of end-stage renal disease (ESRD) in children [2].These abnormalities occur in approximately 3 to 6 per 1000 live births and may lead to ESRD in childhood.They can also cause renal complications in adulthood, such as stone formation, infections, hypertension, and renal failure. CAKUT affects about 0.5% of all pregnancies and accounts for nearly 50% of abdominal masses detected in infants [3,4].

From an embryological perspective, CAKUT can be classified into three categories: abnormalities in renal parenchymal development, aberrant embryonic migration, and collecting system anomalies. Renal parenchymal abnormalities include multicystic dysplastic kidneys, renal hypoplasia, and variations in number (agenesis or supernumerary), shape, and cystic renal diseases. Aberrant embryonic migration involves unusual locations and fusion anomalies, while collecting system abnormalities encompass duplex kidneys and pelviureteric junction obstruction [4,5].

Historically, plain abdominal radiography and excretory urography (EU) were the preferred imaging techniques for diagnosing kidney and urinary tract conditions. However, the advent of computed tomography (CT) and magnetic resonance imaging (MRI) has significantly transformed the approach to imaging in these cases. In the past decade, CT has largely supplanted EU for evaluating the genitourinary tract [6, 7]. While CT had limitations regarding the evaluation of the mucosal surface of the renal collecting system and ureters, advancements in multidetector computed tomography (MDCT) have addressed these issues. MDCT enables the acquisition of thinner slices rapidly, albeit with higher radiation doses. The multiplanar reconstructions and advanced post-processing capabilities of MDCT enhance diagnostic accuracy [6,8].

The present study aimed to evaluate the incidence of congenital kidney anomalies in adults at a tertiary care hospital.

Aims And Objective Of The Study

- To evaluate the role of CT in assessing CAKUT and to determine the incidence and patterns of CAKUT in adulthood.

Methodology And Materials:

- **Study Design:** Descriptive study
- **Period:** The study retrospectively evaluated 1,037 abdominal CT studies conducted between February 2023 and January 2024.
- **Sample Size:** 1037
- **Sampling Method:** Purposive sampling
- Records of 1037 participants of who underwent CT KUB, CECT KUB and CECT abdomen examination from February 2023 to January 2024 at Department of Radio-Diagnosis, MIMS, Mandya were studied for CAKUT
- **Inclusion Criteria:** All patients in the age group of 18-90 years who have undergone CT abdomen at our hospital during the study period.
- **Exclusion Criteria:** Age<18 years.

Method of Data Collection :

- The CT of the patients who underwent CT scan of the abdomen during the study period were selected from the PACS dataset.
- The clinical details of these patients were retrieved from the HIS.
- Data of individuals included in present study were
- Age
- Sex
- The pattern of CAKUT anomaly.

Data Analysis:

Data were entered and analysed through epi info 7. Categorical variables were expressed with percentages

RESULTS :

In present study, overall incidence of congenital anomalies of kidney and urinary track (CAKUT) was 5.3%.The incidence of duplex collecting system in our study was 1.15%.Among males it was 0.7% and among females it was 1.47%. Pelviureteric junction obstruction was seen more among females (1.2%) as compared to males (0.7%). Overall PUJO was seen among 0.96% of the study participants. Mal-rotated and ectopic kidneys were seen among 0.86% and 0.76% of the study participants respectively. Renal Agenesis and Horse

.Cross fused ectopia seen among 0.38% of the study participants. As per table 2, Left sided PUJO was much more common than right PUJO and B/L PUJO.

Table 1.Incidence of congenital anomalies (n=1037)

Anomalies	Total (n-1037)	Male (n-565)	Female (n-475)
	n-%	n-%	n-%
Duplex Collecting system	12-(1.15%)	5-(0.80%)	7-(1.47)
PUJO	10-(0.96%)	4-(0.70%)	6-(1.26%)
Mal rotated kidneys	3-(0.28%)	3-(0.53%)	N/A
Ectopic kidney	5-(0.48%)	4-(0.70%)	1-(0.21%)
Renal agenesis	4-(0.38%)	3-(0.53%)	1-(0.21%)
Supernumerary kidney	1-(0.09%)	1-(0.17%)	N/A
Horse shoe kidney	11-(1.06%)	9-(1.94%)	2-(0.42%)
Cross fused ectopia	4-(0.38%)	2-(0.35%)	2-(0.42%)
Retrocaval ureter	1-(0.09%)	1-(0.17%)	N/A
Ureterocele	4-(0.38%)	2-(0.35%)	2-(0.42%)
Total	55-(5.30%)	34-(6.0%)	21-(4.42%)

Table 2 Congenital anomalies of the kidneys among study participants

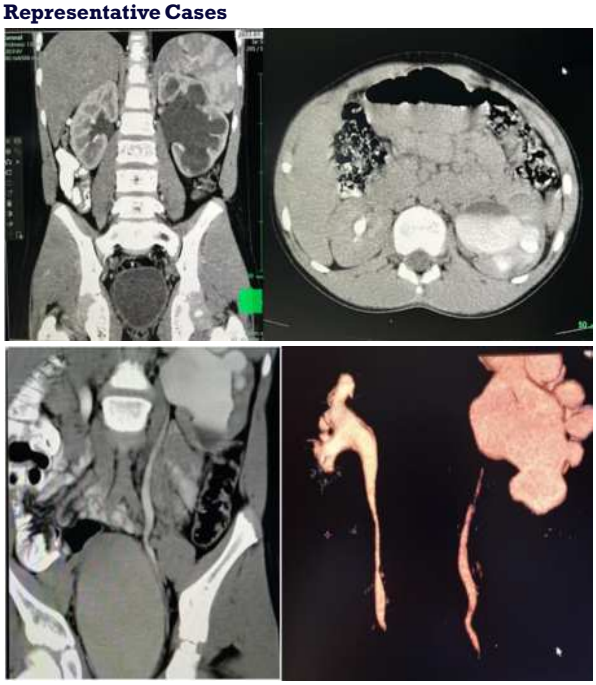
Anomalies	Total (n=55)	Male (n=34)	Female (n=21)
Partial Duplex	**8**	**3**	**5**
Right partial Duplex	5-(62.5%)	2-(66.6%)	3-(60%)
Left Partial duplex	3-(37.5%)	1-(33.3%)	2-(40%)
Complete duplex	**4**	**2**	**2**
Right complete duplex	2-(50%)	1-(50%)	1-(50%)
Left complete duplex	2-(50%)	1-(50%)	1-(50%)
Cross fused ectopia	**4**	**2**	**2**
Right Cross fused ectopia	3-(75%)	2-(66.6%)	1-(100%)
Left Cross fused ectopia	1-(100%)	0	1-(100%)
Horse shoe kidney	**11**	**9**	**2**
Ectopic kidney	**5**	**4**	**1**
PUJO	**10**	**4**	**6**
B/L PUJO	2-(20%)	1-(50%)	1-(50%)
Right PUJO	3-(30%)	2-(66%)	1-(33%)
Left POJJO	5-(50%)	2-(40%)	3-(60.0%)
Renal agenesis	**4**	**3**	**1**
Right Renal agenesis	1-(100%)	2-(66.6%)	0-(00%)
Left Renal agenesis	0-(00%)	0-(00%)	1-(100%)
Supernumerary kidney	**1**	**1**	**0**
Left side	1-(100%)	1-100%	0
Mal-rotated kidneys	**3**	**3**	**0**
Right side	2-(66.6%)	2-(66.6%)	0-(00%)
Left side	1-(33.3%)	0-(00%)	0-(00%)
Retrocaval ureter	**1**	**1**	**0**
Right side	1-(100%)	1-(100%)	0-(00%)
Left side	0-(00%)	0-(00%)	0-(00%)
Ureterocele	**4**	**2**	**2**
Right side	2-(50%)	1-(50%)	1-(50%)
Left side	2-(50%)	1-(50%)	1-(50%)

DISCUSSION:

Present study was carried out to find the incidence and pattern of congenital abnormalities of kidney among the adults attending tertiary care hospitals.

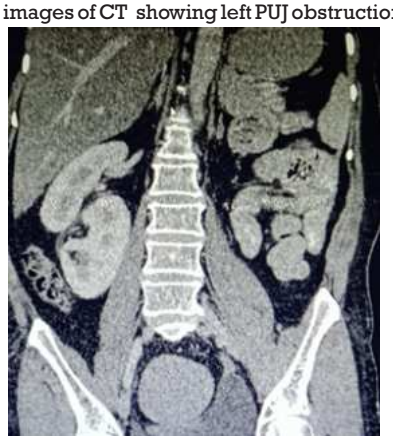
In present study the overall incidence of CAKUT was 5.3%. In our study, Duplex collecting system in our study was 1.15%. Among males it was 0.7% and among females it was 1.47%. Duplications of the renal collecting system and ureter are the most common congenital renal anomalies and can be classified as incomplete versus complete, depending on whether two ureters drain into the bladder via a single common ureter or separately. Many conditions, such as ureterocele, ectopic insertion of ureter, vesicoureteric reflux, renal dysplasia, and PUJO, occur more frequently with a complete duplex collecting system compared with a single collecting system[9,10]. In present study, Overall PUJO was seen among 0.96% of the study participants. Pelviureteric junction obstruction was seen more among females (1.26%) as compared to males (0.8 %).PUJO is a common condition that affects adults and children. Potential causes for PUJO include intrinsic stenosis, insertional abnormalities, and extrinsic compression from crossing vessels[11]. CT and MR urogram findings of PUJO include hydronephrosis with abrupt transition from a dilated collecting system to a non-dilated ureter associated with decreased relative renal nephrogram. Crossing vessels could be accurately identified on the contrast- enhanced phase of a CT or MR urogram[12].In present study, renal agenesis was seen among 0.38% of the study participants. Renal agenesis thought to result from a lack of induction of the metanephric blastema by the ureteral bud. Bilateral agenesis is incompatible with life and is associated with pulmonary hypoplasia and limb defects. Unilateral renal agenesis is not uncommon, seen in 1/1300 pregnancies[13]. It is often asymptomatic and compensatory hypertrophy in other kidney may cause glomerulosclerosis in adults. Unilateral renal agenesis is often incidentally detected in adults in US or CT performed for other reasons[14,5].In our study, horse shoe kidney was seen among 1.06% of the study participants Horseshoe kidney is the most common renal fusion anomaly, accounting for 90% of all renal fusion anomalies, and occurs in approximately 1 in 400 births[5]. Pancake kidney is associated with the absence of a renal capsule and fusion at both the upper and lower poles, whereas crossed-fused ectopia is associated with fusion at only one pole14. Horseshoe kidney is twice as common among men as among women[5]. It may occur as an isolated entity, but in approximately one third of cases, it is associated with other congenital anomalies of the urogenital, gastrointestinal, skeletal, and neurologic systems. Renal fusion anomalies can lead to a variety of complications, such as stone disease, infections (secondary to urinary stasis resulting from abnormal ureteric locations and consequent altered urodynamics), and a variety of both benign and malignant tumors14. Knowledge about CAKUT and their radiological findings helps to diagnose it and permit optimal patient management and thorough workup to prevent hypertension and progression from CAKUT to renal failure.

Representative Cases

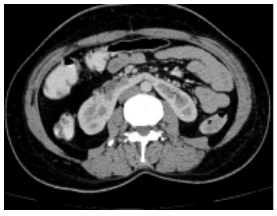


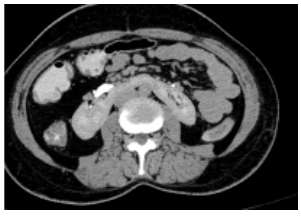
CECT coronal and axial images of a patient showing markedly dilated, ballooned renal pelvis and calyces with abrupt termination at the left pelvi-ureteric junction. No intraluminal/mural cause for obstruction detected.

Curved MPR and volume rendering maximum intensity projection images of CT showing left PUJ obstruction .

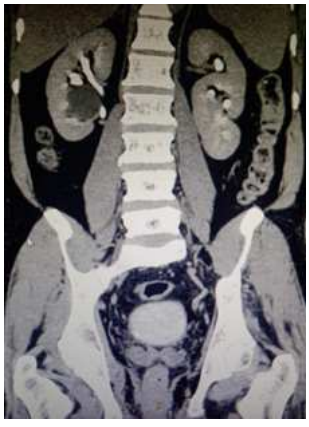


CECT coronal images of a study showing ectopic left kidney seen right to the midline and fused to the medial aspect of the right kidney

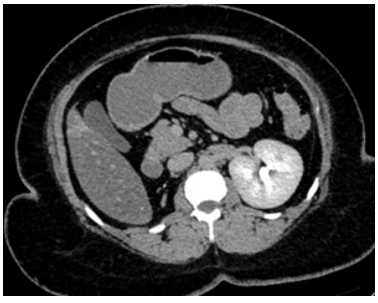




CECT abdomen axial images in arterial and delayed phase shows horse show kidney



CECT abdomen coronal images in delayed phase shows supernumerary kidney fused to the lower pole of the left kidney.



CECT abdomen axial images in delayed phase shows right renal agenesis .

CONCLUSION:

This study highlights the significance of multidetector CT (MDCT) in diagnosing congenital anomalies of the kidney and urinary tract (CAKUT) in adults. With an overall incidence of 5.3%, the study underscores that conditions such as duplex collecting systems, pelviureteric junction obstruction (PUJO), and horseshoe kidneys can be detected and evaluated effectively through advanced imaging. Early detection and accurate diagnosis are crucial to prevent complications such as renal failure and hypertension. As imaging technology continues to evolve, MDCT remains a vital tool in the early recognition and management of CAKUT, ultimately improving patient outcomes in both pediatric and adult populations. Further research may focus on refining imaging techniques and exploring treatment strategies to address these anomalies more comprehensively.

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