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FETAL ULTRASOUND IN DIAGNOSING CONGENITAL RENAL ANOMALIES: A CASE SERIES

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Abstract
This case series evaluates the accuracy of fetal ultrasound in diagnosing congenital renal anomalies through the examination of seven cases, comparing prenatal findings with postnatal outcomes. Case 1, at 23 weeks gestation, showed mild urinary tract dilation (UTD A1) with a renal pelvic diameter (RPD) of 5.0 mm, which resolved spontaneously by the follow-up growth scan. Case 2 presented at 31 weeks with an RPD of 9.8 mm (UTD A1), and postnatal scans confirmed persistent dilation (UTD P1), necessitating ongoing monitoring. In Case 3, a 28-week scan revealed a significant left kidney PUJ obstruction with an RPD of 26 mm (UTD A2-3), confirmed postnatally as severe urinary tract dilation (UTD P3) requiring intervention. Case 4, detected at 18 weeks, involved an ectopic right kidney adjacent to the bladder, with the absence of the right renal artery confirmed postnatally. Case 5, identified at 18 weeks, showed bilateral enlarged echogenic kidneys, leading to pregnancy termination at 21 weeks due to a poor prognosis, consistent with similar findings in a previous pregnancy. Case 6, at 20 weeks, showed anhydramnios and bilateral renal agenesis, confirmed by the absence of renal arteries and kidneys on imaging, resulting in pregnancy termination at 21 weeks. Case 7, at 12 weeks, revealed a dilated bladder, distended posterior urethra, and bilaterally enlarged echogenic kidneys, indicating a posterior urethral valve, leading to termination at 14 weeks due to the severity. These cases highlight the crucial role of fetal ultrasound in early detection and management of congenital renal anomalies, demonstrating its capabilities and the necessity for confirmatory postnatal diagnostics.

Keywords: Urinary tract dilation, Congenital renal anomalies, Fetal ultrasound, Ectopic kidney, Renal agenesis, Posterior urethral valve

Introduction

Congenital renal anomalies are among the most frequently detected fetal abnormalities during routine prenatal ultrasounds.(1) These anomalies can range from mild conditions that resolve spontaneously to severe malformations requiring immediate postnatal intervention.(2) The timely and accurate diagnosis of these anomalies is crucial for prenatal management and planning for postnatal care. Early detection allows healthcare providers to offer appropriate counseling to expectant parents, manage the pregnancy more effectively, and prepare for any necessary treatments or interventions after birth.(3)

Fetal ultrasound has become the primary modality for prenatal screening and diagnosis of congenital renal anomalies due to its non-invasive nature, accessibility, and ability to provide detailed images of the fetal anatomy.(4) Despite its widespread use, the accuracy of fetal ultrasound in diagnosing these anomalies can vary. Factors influencing this accuracy include the gestational age at the time of the scan, the experience of the sonographer, and the resolution of the ultrasound equipment.(5) Previous studies have highlighted the efficacy of fetal ultrasound in detecting various renal anomalies,(6, 7) yet there remains a need for further evaluation to understand its limitations and strengths comprehensively. This is particularly important as some anomalies detected prenatally may resolve spontaneously, while others may persist or even worsen, necessitating close monitoring and early intervention.

The Urinary Tract Dilatation (UTD) classification system aims to provide a unified approach for assessing urinary tract dilation both prenatally and postnatally. Recently updated in 2021 by Nguyen et al.,(8) this system utilizes six key ultrasound findings to categorize cases: anteroposterior renal pelvic diameter (APRPD), calyceal dilatation (central vs. peripheral), renal parenchymal abnormalities, bladder abnormalities, and ureteric abnormalities. For antenatal assessment, it defines UTD A1 as APRPD between 4 mm to <7 mm before 28 weeks and 7 mm to <10 mm thereafter, while UTD A2-3 includes broader criteria involving APRPD ≥7 mm, calyceal or ureteric dilatation, or other noted abnormalities. Postnatally, it classifies cases into UTD P1 (low risk) for APRPD 10 mm to <15 mm with central calyceal dilatation, UTD P2 (intermediate risk) for APRPD ≥15 mm, peripheral calyceal dilatation, or significant ureteric dilatation, and UTD P3 (high risk) for the presence of parenchymal or bladder abnormalities, oligohydramnios, along with APRPD ≥15 mm or any calyceal dilatation.(9-12)

Against this background, the aim of the present case series was to demonstrate the accuracy of fetal ultrasound in diagnosing congenital renal anomalies.

Methodology

This is a case series conducted in the Department of Radiodiagnosis, Meenakshi Medical College Hospital and Research Institute, Kanchipuram, Tamil Nadu, India between July 2023 and December 2023. The study was approved by the Institutional Human Ethics Committee (IHEC). The Participant Information Sheet was translated into the local language and given to the participants and their attendants. The information was also verbally explained to them in their

native language until they fully understood it. Participants were included in the study after they provided written consent.

Case Series

This case series included a total of seven cases presenting to the Department of Radiodiagnosis between July 2023 and December 2023 for routine antenatal scans. The distribution of these anomalies showed that of the seven cases, six cases (85.7%) had upper urinary tract anomalies and one case (14.3%) had lower urinary tract anomalies. Looking at the outcomes of these seven cases, four cases (57.1%) were followed up postnatally for confirmation, and three cases (42.9%) had termination of pregnancy (TOP).

Case 1: At 23 weeks of gestation, the antenatal ultrasound revealed anteroposterior renal pelvic diameter (RPD) of 5.0 mm, classified as UTD A1, indicating mild urinary tract dilation. A follow-up growth scan showed no evidence of pelviectasis, suggesting that the initial finding was transient or resolved spontaneously. This case demonstrates the potential for mild renal pelvic dilation detected in utero to resolve by the time of follow-up without any intervention.

Case 2: An antenatal ultrasound performed at 31 weeks gestation detected an anteroposterior RPD of 9.8 mm, classified as UTD A1. The postnatal follow-up scan showed RPD of 10.5 mm and was classified as UTD P1. This underscores the importance of postnatal evaluation for cases identified with mild to moderate antenatal urinary tract dilation to monitor for persistent abnormalities that may require further clinical management.

Case 3: The antenatal ultrasound at 28 weeks revealed a normal right kidney and pelvi-ureteric junction (PUJ) obstruction with RPD of 26 mm in left kidney which was classified as UTD A2-3. The postnatal scan confirmed the persistence of significant urinary tract dilation and was classified as UTD P3. This case illustrates a severe congenital renal anomaly that was accurately detected antenatally, emphasizing the role of prenatal ultrasound in identifying significant urological issues that require early postnatal intervention.

Case 4: Patient assessed at 18 weeks of gestation, presented with an ectopic right kidney located adjacent to the bladder at the level of bifurcation which was confirmed postnatally. This case highlights the capability of fetal ultrasound to detect renal ectopy and providing critical information for postnatal management planning.

Case 5: At 18 weeks of gestation, the ultrasound for this patient showed bilaterally enlarged kidneys with echogenic cortexes, suggesting bilateral echogenic kidneys. Given a similar history in a previous pregnancy, the parents opted for termination at 21 weeks. In view of similar history in previous baby, the couple were advised for amniocentesis and chromosomal microarray to look for genetic abnormalities. But the couple opted for termination. This emphasizes the significance of prenatal ultrasound in detecting renal pathology early in pregnancy.

Case 6: The antenatal scan at 20 weeks for this patient identified anhydramnios. The fetus showed empty renal fossa on both sides, suggestive of bilateral renal agenesis. This severe congenital anomaly led to the decision for pregnancy termination at 21 weeks. The case demonstrates the

crucial role of prenatal ultrasound in diagnosing lethal conditions and thereby facilitating timely counseling and decision-making.

Case 7: Case 7 presented at 12 weeks with a dilated bladder and distended posterior urethra, along with bilaterally enlarged kidneys with an echogenic cortex, indicative of a posterior urethral valve. The pregnancy was terminated at 14 weeks due to the severity of the findings. This early detection of a severe obstructive uropathy showcases the value of early ultrasounds in identifying critical urological anomalies, enabling parents to make informed decisions regarding the pregnancy.

Discussion

The cases presented in this series highlight the pivotal role of fetal ultrasound in diagnosing congenital renal anomalies, underscoring both its strengths and limitations. The detailed prenatal imaging allowed for the identification of a spectrum of renal conditions, from mild urinary tract dilation to severe structural abnormalities such as renal agenesis and posterior urethral valves.

Case 1 demonstrated the transient nature of mild urinary tract dilation. The initial antenatal finding of a 5.0 mm renal pelvic diameter (RPD) was no longer present on the follow-up growth scan. This aligns with studies indicating that mild hydronephrosis detected in utero often resolves spontaneously without intervention.(13, 14) In Case 2, the persistence of moderate urinary tract dilation postnatally (UTD P1) highlights the need for ongoing monitoring of such conditions identified prenatally. Research supports the observation that antenatal hydronephrosis with an RPD greater than 7 mm often persists and may require postnatal follow-up.(15) Case 3 involved a severe pelvi-ureteric junction (PUJ) obstruction, accurately detected by prenatal ultrasound, with an RPD of 26 mm, classified as UTD A2-3. The postnatal confirmation (UTD P3) underscores the accuracy of fetal ultrasound in identifying significant obstructive uropathies. Severe cases like this typically necessitate early postnatal intervention, which can significantly improve outcomes. Case 4 presented an ectopic kidney detected at 18 weeks gestation; a condition confirmed postnatally. The ability of prenatal ultrasound to accurately diagnose ectopic kidneys, including associated vascular anomalies, is well-documented in the literature.(16) Such early detection is crucial for planning postnatal surgical or medical management. Case 5 and Case 6 involved severe anomalies detected early in pregnancy, leading to pregnancy termination. Bilaterally enlarged echogenic kidneys in Case 5 and bilateral renal agenesis in Case 6 are both conditions with poor prognoses. Early diagnosis allows for critical decision-making regarding the pregnancy, as supported by studies that emphasize the importance of early and accurate detection of lethal anomalies. Case 7 featured a posterior urethral valve detected at 12 weeks; a condition often associated with significant morbidity. The early gestational identification of this condition facilitated an informed decision for pregnancy termination. Early diagnosis of posterior urethral valves can significantly impact management decisions and outcomes, as highlighted by various studies.

The overall efficacy of fetal ultrasound in diagnosing congenital renal anomalies, as evidenced by these cases, is corroborated by numerous studies.(6) Fetal ultrasound's sensitivity and specificity for detecting renal anomalies have been reported to be high, though dependent on factors such as the gestational age at the time of the scan and the experience of the sonographer.(17) Accurate

early detection allows for appropriate prenatal counseling, planning for potential interventions, and, in some cases, decisions regarding the continuation of the pregnancy.

In cases of mild anomalies, monitoring is typically sufficient, with many conditions resolving spontaneously. However, for severe anomalies, early detection is critical for planning immediate postnatal interventions or making informed decisions about the pregnancy. Despite its high diagnostic accuracy, fetal ultrasound has limitations, including potential variability in detection rates based on the skill of the operator and the quality of the equipment used. Additionally, some anomalies may not be detectable until later in gestation or may evolve as the pregnancy progresses. Therefore, serial ultrasounds and postnatal confirmation remain essential components of comprehensive prenatal care.(18, 19)

Future research should focus on improving the resolution of ultrasound technology and training programs for sonographers to further enhance the accuracy and reliability of prenatal renal anomaly detection. Integrating advanced imaging modalities, such as fetal MRI, may also provide complementary information in complex cases.

Conclusion

The cases presented in this series reaffirm the critical role of fetal ultrasound in the early detection and management of congenital renal anomalies. While prenatal ultrasound provides invaluable information that can significantly impact clinical outcomes, continuous advancements in technology and practice are necessary to further improve diagnostic accuracy and patient care.

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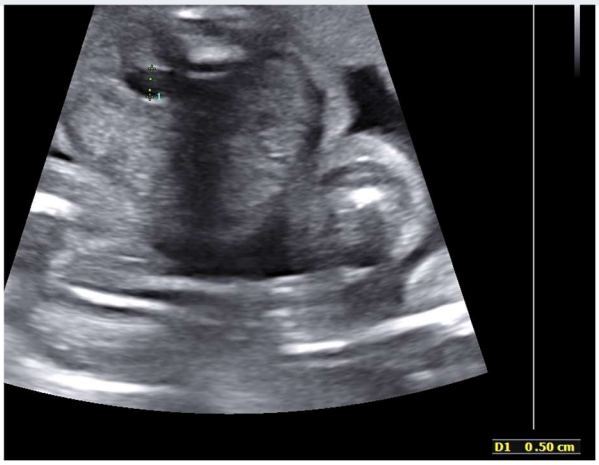
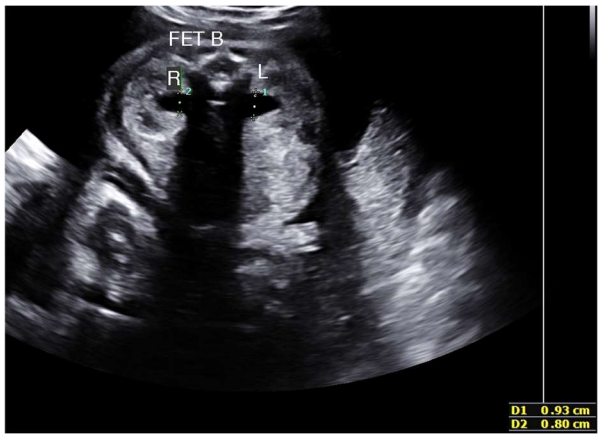
Case 1



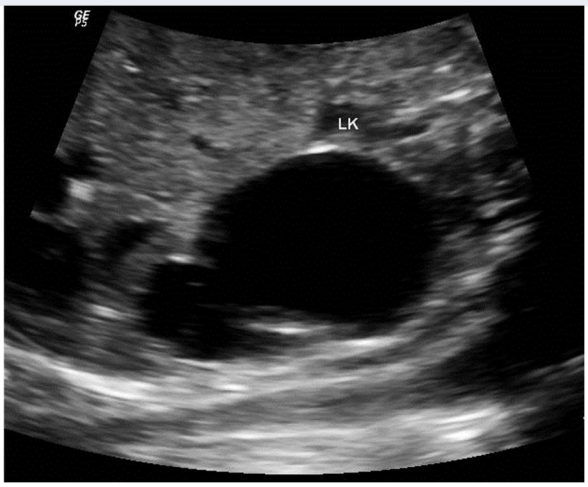
Antenatal ultrasound obtained at 23 weeks gestation shows anteroposterior renal pelvic diameter 5.0 mm

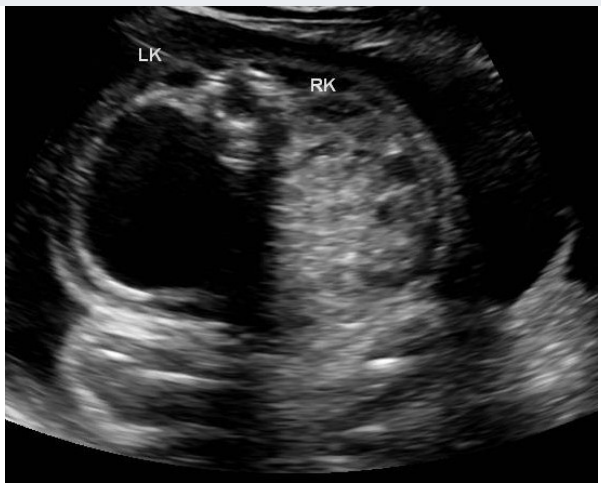
Case 2



Antenatal ultrasound obtained at 31 weeks gestation shows anteroposterior renal pelvic diameter 9.8 mm

Case 3

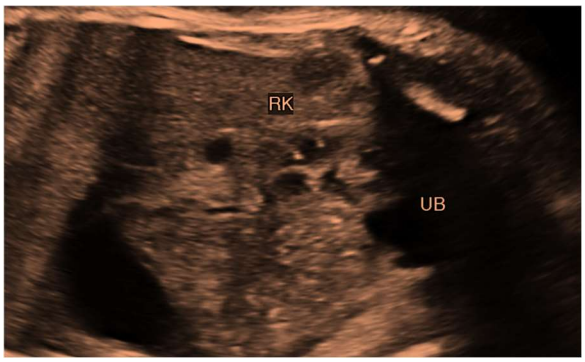


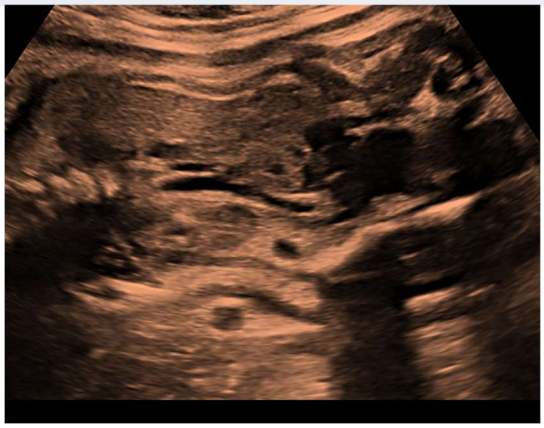


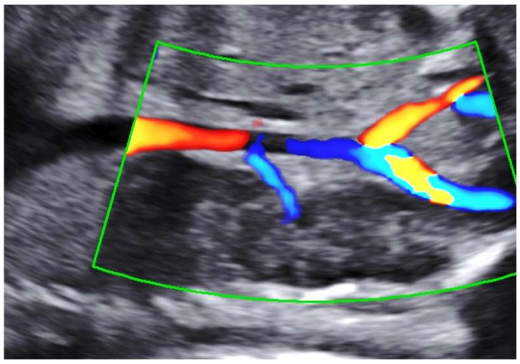
Extended renal sonogram at 28 week – Right kidney appears normal; Left kidney – PUJ obstruction (RPD – 26 mm (UTD A2-3)

Figure 1: Sonographic images of cases 1 to 3

Case 4





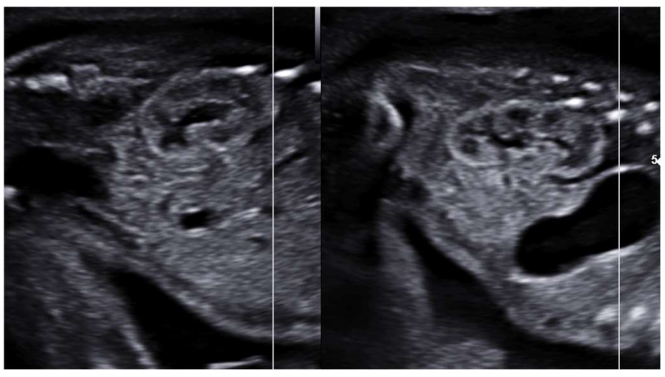


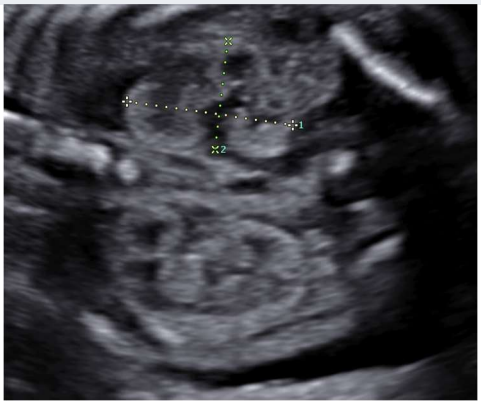
Antenatal ultrasound shows right kidney visualized adjacent to the bladder at the level of bifurcation.

Antenatal ultrasound shows lying down right renal adrenal gland.

Colour flow mapping shows absent right renal artery

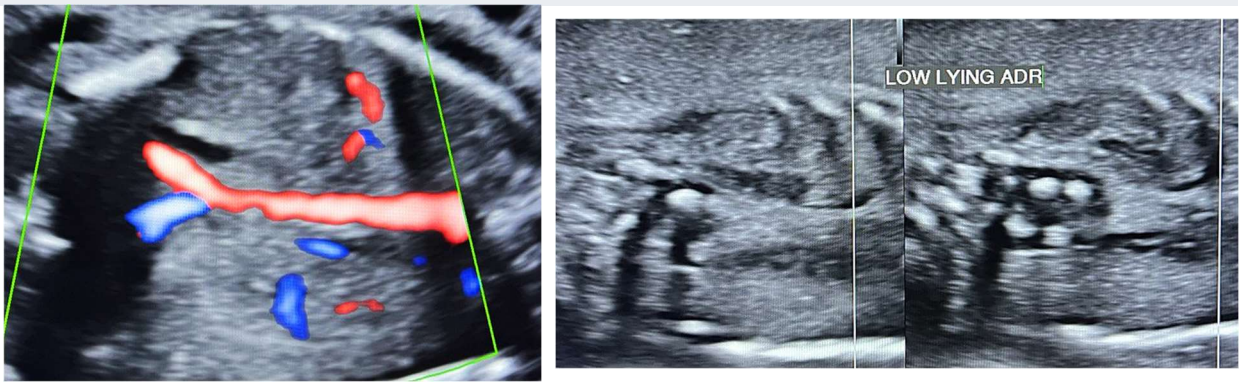
Case 5





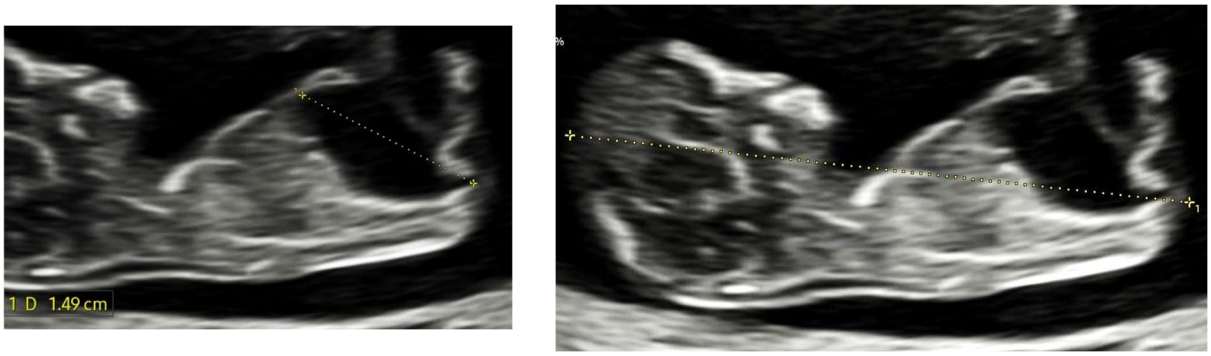
Extended renal sonogram done – Both kidneys enlarged; Cortex appear echogenic

Case 6



Anhydramnios; Colour flow imaging shows agenesis of both renal arteries; Gray-s cale image in 20 weeks gestation shows absence of both kidneys with low lying adrenal glands

Case 7



Bladder appear dilated with distended posterior urethra; Bilateral kidneys appears enlarged with echogenic cortex

Figure 2: Sonographic images of cases 4 to 7Table 1: Summary of patient characteristics

Case	**Antenatal USG – GA**	**Antenatal USG – Findings**	**UTD classification**	**Follow-up scan**	**Follow-up scan – Findings**	**Remarks**
Case 1	23 weeks	Anteroposterior RPD – 5.0mm	UTD A1	Growth scan	No pelviectasis	
Case 2	31 weeks	Anteroposterior RPD – 9.8mm	UTD A1	Postnatal scan	UTD P1	
Case 3	28 weeks*	Right Kidney – Normal Left Kidney – PUJ obstruction; RPD – 26mm	UTD A2-3	Postnatal scan	UTD P3	

Case 4	18 weeks	Right ectopic kidney – adjacent to the bladder at the level of bifurcation; Lying down renal adrenal gland in the right side; Color flow mapping shows absent right renal artery	Right ectopic kidney	Postnatal scan	Findings were confirmed	
Case 5	18 weeks*	Both kidneys enlarged; Cortex appear echogenic	Bilateral echogenic kidneys			Similar history in previous pregnancy; Termination of pregnancy at 21 weeks
Case 6	20 weeks	Anhydraminos; Color flow mapping shows agenesis of both renal arteries; Gray scale imaging shows absence of both kidneys with low lying adrenal glands	Renal agenesis			Termination of pregnancy at 21 weeks
Case 7	12 weeks	Bladder appears dilated with distended posterior urethra; Bilateral kidneys appear enlarged with echogenic cortex	Posterior urethral valve			Termination of pregnancy at 14 weeks

GA, Gestational age; USG, Ultrasonography; RPD, Renal pelvic diameter; UTD, Urinary tract dilation

*Extended renal sonogram