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ORIGINAL ARTICLE

A Retrospective Analysis to Evaluate Role of the New UTD Classification System in Prenatal Prediction of Severity and Postnatal Outcome in Antenatally Diagnosed Urinary Tract Dilatation Abnormalities

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Abstracts

Background/Purpose of the Study Foetal urinary tract dilation (UTD) abnormalities affect 1–5% of all pregnancies. However, exact incidence is difficult to estimate because of different terminologies used to define the condition and different grading systems to define its severity antenatally as well as postnatally worldwide. In order to overcome this problem, the new UTD classification system has been introduced in the year 2014 so as to have universal approach for diagnosis and management of UTD globally. Indian data about clinical utility of the UTD classification system and its role in prenatal prediction of severity of renal disease are lacking. The present study aims to investigate clinical utility of new UTD classification system in foetal UTD abnormalities and to evaluate the role of UTD classification system in antenatal prediction/prognostication of severity of UTD abnormalities.

Methods We conducted a single-centre retrospective study between April 2014 and January 2017, which included 70 infants with antenatally diagnosed UTD delivered in our hospital and managed in our paediatric unit postnatally. Pre- and postnatal ultrasound findings were noted, and UTD-A and UTD-P classification were applied retrospectively in all cases as per criteria defined in the new UTD classification. Postnatal outcome in all cases was evaluated in terms of need for immediate postnatal urosurgical intervention, presence of persistent UTD pathology and severity of renal impairment in relation to their pre- and postnatal UTD A and P risk categories.

Results None from UTD A1 risk group in the last prenatal scan showed significant postnatal UTD abnormality. In contrast to this, UTD A2–3 risk group in the last prenatal scan had persistent postnatal UTD pathology in 70% cases. All infants with abnormal postnatal UTD diagnosis were identified prenatally as UTD A2–3 (high risk). Nine infants (12.8%, $n = 70$) who needed urosurgical intervention postnatally were categorised as UTD A2–3 prenatally and UTD P3 postnatally.

Conclusion We found increased frequency of complications and urosurgical interventions in all infants with antenatal UTD A2–3 grades in the last prenatal scan in comparison with those with UTD A1 grades who showed complete resolution (100%)

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postnatally. Antenatal UTD classification may be useful in antenatal prediction and prognostication of postnatal severity, especially in high-risk cases (i.e. UTD A2–3).

Keywords Urinary tract dilation · Antenatal hydronephrosis · Foetal pelvicalyceal dilation · Foetal hydroureteronephrosis · Oligohydramnios · Congenital abnormalities of the kidneys and urinary tract · UTD classification

Introduction

Congenital abnormalities of the kidneys and urinary tract (CAKUT) affect 1 in 500 live births and are the leading cause of end-stage renal disease (ESRD) in children [1]. Urinary tract dilation (UTD) is one of the most common prenatal ultrasound diagnoses affecting 1–5% of all pregnancies. The exact incidence of this condition is difficult to estimate as it is confounded by different terminologies used to describe it, including hydronephrosis, pyelectasis, pelviectasis and pelvicaliectasis [2]. Common aetiologies for UTD include transient dilation (41–88%), ureteropelvic junction obstruction (10–30%), vesicoureteric reflux (10–20%), ureterovesical junction obstruction (5–10%), duplex collecting system/ureterocele (5–7%), multicystic dysplastic kidney (4–6%) and lower urinary tract obstruction (1–2%) [3]. Due to the lack of consensus in defining and classifying severity of antenatal urinary tract dilation worldwide, prognostication and prediction based upon antenatal ultrasound findings and correlation with postnatal findings remained difficult. In the year 2014, an attempt was made to develop a standard grading system for urinary tract dilation and follow-up evaluation by eight societies from urology and foetal medicine specialities to overcome the above-mentioned problem [4].

There is no Indian study in our knowledge till date to evaluate the validity/clinical utility of this new classification in our population and its efficacy in antenatal prediction and prognostication of postnatal outcome. Therefore, we aimed to perform a retrospective analysis to investigate clinical utility of new UTD classification system in foetal UTD abnormalities and to evaluate the role of UTD A classification in antenatal prediction/prognostication of severity of renal disease.

Subjects and Methods

This was a single-centre retrospective study, which was done between April 2014 and January 2017 after obtaining the approval from institutional ethics committee. We included 70 pregnant women with foetal urinary tract dilation detected prenatally, followed up, delivered and whose babies were postnatally managed in our hospital's paediatric care unit. Data were collected from the antenatal and postnatal case records, and pre- and postnatal US features (e.g. anteroposterior renal pelvic diameter, renal parenchymal abnormalities like parenchymal thinning, echogenicity, cortical cysts, bladder, ureter, etc.) were noted. All cases with major structural or chromosomal anomalies, intrauterine foetal demise or non-availability of detailed anomaly scan or cases where couple opted for medical termination of pregnancy were excluded from this study. Based upon findings in pre- and postnatal ultrasound, all cases were assigned UTD A (Normal, A1, A2–3) and P (Normal, P1, P2, P3) risk categories retrospectively as per criteria defined in UTD classification. As per the new UTD classification, antenatal presentation of UTD has been divided into normal, A1 and A2–3 and postnatal UTD is divided into normal, P1, P2, and P3 risk groups [4] (Refer Table 1 and Fig. 1).

Antenatal UTD risk categories in the first prenatal scan (usually performed in the second trimester) and in the last prenatal scan (performed in third trimester before delivery) were observed for any transition during antenatal period (e.g. progression, regression or no change in risk category). Thereafter, UTD A risk category was compared with postnatal risk category for every infant in order to understand its usefulness in antenatal prediction of postnatal severity of renal disease.

Effectiveness of UTD classification in identification of UTD abnormalities was assessed (after having considered antenatally/postnatally resolved UTD/transient dilation cases as Normal). Postnatal outcome was evaluated in terms of severity of renal impairment, perinatal morbidity and mortality, duration of NICU stay and need for urosurgical intervention in neonates in relation to UTD risk categories assigned as per UTD classification. The data collection and compilation were done in Microsoft excel 2017 version. Analysis was done through Microsoft excel and Dx test software. The quantitative variables are presented as frequencies.

Results

Seventy cases satisfying the inclusion criteria were included in our study with prenatal and postnatal characteristics listed in Table 2. The overall prevalence of UTD noted in our population was 4.5 per 1000 births per year. There was no significant difference in occurrence of UTD among various age groups and parity. 42.8% (30, $n = 70$) participants

Table 1 UTD A and P classification [4]

UTD A Classification system for antenatal presentation of UTD	
Risk category	Criteria
UTD A Normal	A *Normal* urinary tract is described as the one with no urinary tract abnormalities and anteroposterior renal pelvic diameter (APRPD) measuring *less than 4 mm between 16 and 27 weeks'* gestation and *less than 7 mm* pelvic dilation *at 28 or more weeks* of gestation.
UTD A1(*low risk)*	A normal urinary tract with 4 to less than 7 mm pelvic dilation at 16–27 weeks' gestation or 7 to less than 10 mm at 28 or more weeks of gestation with or without central calyceal dilation.
UTD A2–3 (*increased risk)*	Includes foetuses with APRPD of 7 mm or more between 16 and 27 weeks' gestation or 10 mm or greater at 28 weeks of gestation, peripheral calyceal dilation, ureteral dilation, renal parenchymal, or bladder abnormalities.
UTD P Classification system for postnatal presentation of UTD	
Risk category	Criteria
UTD P Normal	A normal urinary tract is described as the one with no urinary tract abnormalities and APRPD less than 10 mm.
UTD P1 (*low risk)*	Describes a normal urinary tract with APRPD 10 to less than 15 mm or central calyceal dilation.
UTD P2 (*intermediate risk)*	Describes APRPD 15 mm or more or peripheral calyceal dilation.
UTD P3 (*high risk*)	Describes additional ureteral dilation, abnormal renal echogenicity, or cysts or bladder abnormalities regardless of APRPD measurement.

were referred from outside hospitals with diagnosis of UTD abnormalities in the third trimester for further antenatal management and delivery and paediatric surgery opinion without any standard protocol for follow-up prior to referral. Fifty-eight percentage (41, $n = 70$) had vaginal delivery, whereas 41% (29, $n = 70$) had caesarean section for various obstetric indications. None of them required premature delivery due to UTD abnormalities and its effects. Only one patient with PUV was delivered by LSCS in view of severe oligohydramnios at 37.3 weeks' gestation. 24.2% infants had low birth weight either due to preterm birth or due to intrauterine growth restriction. All infants with abnormal postnatal UTD diagnosis were identified prenatally as UTD A2–3/high risk. Most frequent causes of UTD noted antenatally were UTD of undetermined aetiology in 30 (42.8%) followed by pelviureteric junction obstruction in 13 (18.5%), transient dilation in 9 (12.8%), posterior urethral valve in 5 (7.1%), vesicoureteric reflux in 5 (7.1%) and ureterovesical junction obstruction in 2 (2.8%). Various postnatal UTD diagnoses are shown in Fig. 2. Table 3 shows the distribution of participants according to change in UTD A risk category between first and last prenatal scan. Thirty-one (83.7%) of the 37 foetuses diagnosed as UTD A2–3 in their first scan, continued to be in the same risk category in their last scan before delivery. Correlation of UTD A risk category in the last antenatal scan with postnatal UTD P risk category is shown in Table 4. Out of 70 prenatally detected UTD, 30 (42.8%, n =70) were diagnosed with postnatal abnormal UTD condition. All of them were identified prenatally as UTD A2–3 in their last prenatal scan. Table 5 shows the correlation of UTD A risk category in the first antenatal scan with postnatal UTD P risk category.

When compared with postnatal UTD P category, 20 (54%) out of 37 foetuses in UTD A2–3 category in *the first antenatal scan* were observed to be in UTD P3 postnatally (Refer Table 5). Twenty-two (51.1%) out of 43 foetuses in A2–3 category in the *last antenatal scan* were categorised as UTD P3 in postnatally (Refer Table 4). Hence, it can be concluded that UTD A categorisation under "increased risk UTD A2–3" in the first antenatal scan has higher predictive value for abnormal postnatal outcome, i.e. persistent UTD abnormalities.

ROC curves for the validity of UTD A risk-based classification in the first and last prenatal scan in relation to abnormal postnatal outcome for the cut-off value of 2 (UTD A1) revealed that the sensitivity and specificity in the first scan were 67.5% and 80%, respectively, whereas the sensitivity and specificity in the last scan were 67.5% and 100%, respectively (Figs 3, 4).

For UTD A2–3 risk category, both the prenatal scans showed sensitivity of 100% for the abnormal postnatal outcome. Area under the curve was found to be slightly higher for the last antenatal scan (0.7 for the first antenatal scan and 0.8 for the late antenatal scan). This suggests that the last antenatal scan had a higher predictive value for abnormal postnatal outcome. Therefore, it can be concluded that UTD A classification can be considered as a valid risk stratification tool for antenatal prediction of abnormal postnatal outcome.

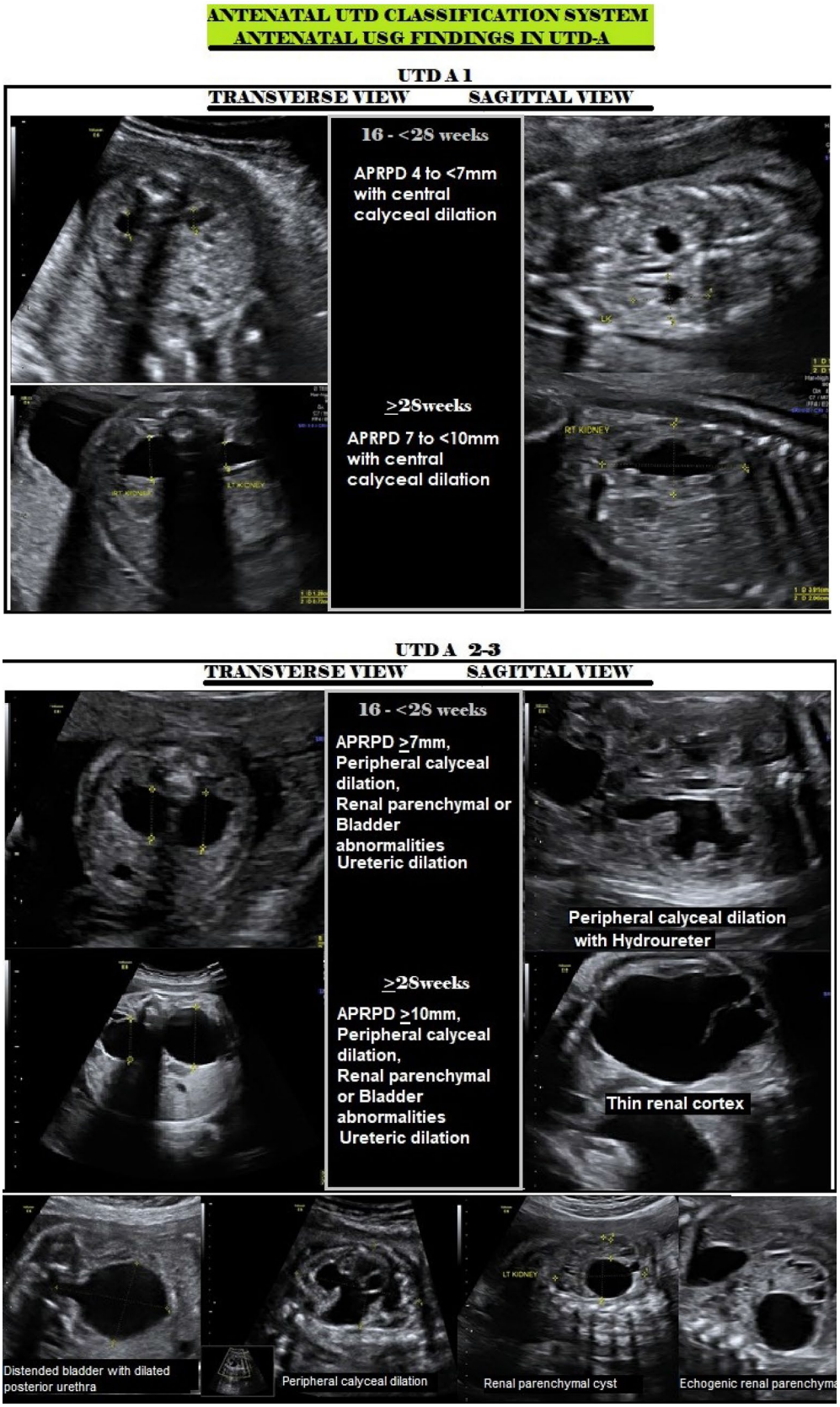

Fig. 1 Ultrasonographic appearance of urinary tract in UTD A risk categories (antenatal presentation) as per the urinary tract dilation (UTD) classification system.

Table 2 Prenatal and postnatal characteristics

Prenatal characteristics	
Total participants, *n*	70
Maternal age at birth (in years), mean	27
Primiparous women, *n* (%)	38 (54%)
Gestational age at antenatal registration in weeks	26
Gestational age at diagnosis in weeks, mean	26.4
Oligohydramnios, *n* (%)	8 (11.4%)
Gestational age at delivery in weeks, mean	38.6
Preterm birth*, *n* (%)	4 (%)
Caesarean delivery, *n* (%)	29 (41%)
Postnatal characteristics	
Male infants, *n* (%)	53 (75%)
Birth weight in kg, mean	2.82
Duration of NICU stay in days, mean	7.2
Neonatal deaths, *n* (%)	1 (1.4%)
Neonatal UTI, *n* (%)	10 (14.2%)
Neonatal urosurgical intervention, *n* (%)	9 (12.8%)
Postnatal renal profile available/documented, *n* (%)	45 (64%)
Neonatal age at discharge from paediatric unit in days, mean	7.4

*none due to complications of UTD

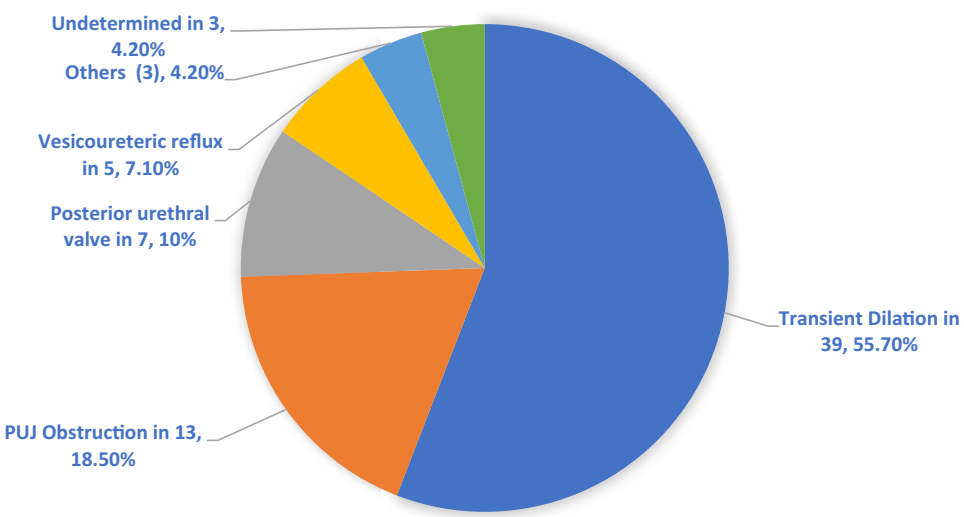

Fig. 2 Distribution of postnatal diagnoses of UTD

Table 3 Distribution of participants according to change in UTD risk category between first and last scans

	Last UTD Normal	Last UTD A1	Last UTD A2–3	Total (*n* = 70)
First UTD normal	0	2 (66.6%)	1(33.3%)	3
First UTD A1	10 (33.3%)	9 (30%)	11(36.6%)	30
First UTD A2–3	2 (5.4%)	4(10.8%)	31 (83.7%)	37

All babies were admitted in neonatal intensive care unit for various indications with majority being admitted for observation and postnatal evaluation of antenatal UTD. Majority of infants (61, *n* = 70) (81%) did not have any postnatal complications or any intervention in immediate postnatal period. Urinary tract infection was noted in 10

Table 4 Correlation of UTD A risk category in the last antenatal scan with postnatal UTD P risk category

Last UTD A	UTD P normal	UTD P1	UTD P2	UTD P3	Total ($n = 70$)
UTD A Normal	12 (100%)	0	0	0	12
UTD A1	15 (100%)	0	0	0	15
UTD A2–3	13 (30.2%)	3 (6.9%)	5 (11.6%)	22 (51.1%)	43

Table 5 Correlation of UTD A risk category in the first antenatal scan with postnatal UTD P risk category

First UTD A	UTD P normal	UTD P1	UTD P2	UTD P3	Total ($n = 70$)
UTD A Normal	2 (66.6%)	0	0	1 (33.3%)	3
UTD A1	25 (83.3%)	1 (3.3%)	2 (6.6%)	2 (6.6%)	30
UTD A2–3	12 (32.4%)	2 (5.4%)	3 (8.1%)	(54%)	37

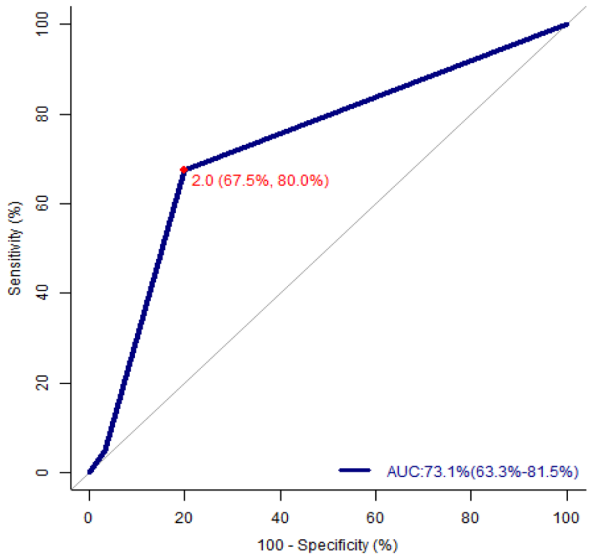

Fig. 3 ROC curve for UTD A at the first testing with postnatal outcome

Area under the ROC curve (AUC)	
Area under the ROC curve (AUC):	0.731 (0.633, 0.815)
Youden index J:	0.475
Cut off:	2
Prob > Z (P - Value):	<0.01
Sensitivity (%):	67.5
Specificity (%):	80

(14.2%) participants. All cases with UTI were categorised as UTD A2–3 in the last prenatal scan. Three infants (4.2%) developed sepsis in postnatal period, and one of 3 infants succumbed to death on day 17th of life due to septic shock. Renal failure was noted in one infant with posterior urethral valve with bilateral dysplastic kidneys and required loop ureterostomy on day 9 of life. Nine (12.8%) infants needed urosurgical intervention in their immediate postnatal period. All these infants who required urinary tract surgeries were classified as high-risk UTD A prenatally (UTD A2–3) in the first and last antenatal scan, as well as postnatally (UTD P3).

Discussion

To our knowledge, this is the first Indian study to evaluate clinical utility of the new UTD classification system in prenatal as well as postnatal UTD. Although the present study

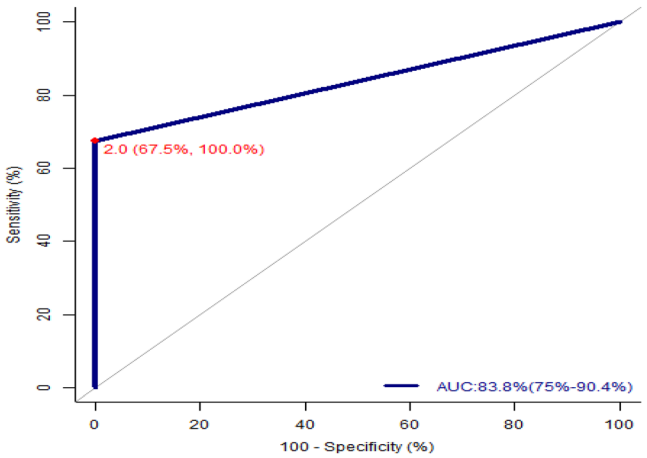

Fig. 4 ROC curve for UTDA in the last visit with postnatal outcome

Area under the ROC curve (AUC)	
Area under the ROC curve (AUC):	0.838 (0.75, 0.904)
Prob > Z (P - Value):	<0.001
Youden index J:	0.675
Cut off:	2
Sensitivity (%):	67.5
Specificity (%):	100

is limited by being single-centre retrospective design with small sample size, most of the findings were found to be consistent with other studies done on antenatal UTD in past.

Our study reported the incidence of 4.5 per 1000 births per year (after having excluded all cases where pregnancy was terminated due to severe disease or other associated major congenital abnormalities). Most frequent cause of UTD noted antenatally was UTD of undetermined aetiology (42.8%). In a prospective cohort study by Mallik et al. [5], the incidence of antenatally detected urinary tract abnormalities was 7.6 per 1000 live births and of the 350 infants, 48.6% had nonspecific dilation. In a 3-year prospective Indian study by Sanghvi et al. [6], they identified sixty-five foetuses (0.2%) with congenital renal malformation prenatally at mean gestational age of 28.4 weeks.

Retrospectively, when all prenatal cases (70) were assigned a risk category after application of criteria defined in UTD classification system, we found 3 (4.2%) as UTD A normal, 30 (42.8%) as UTD A1 and 37 (52.8%) as UTD A2–3 in their first prenatal scan.

Of 3 cases classified as UTD A normal in the first scan, 2 progressed to UTD A1 and one progressed to UTD A2–3 risk groups in their last prenatal scan. However, significance of this fact could not be assessed due to small number of cases and lack of uniform approach for reporting US findings by radiologists' till date to describe UTD abnormality. Among UTD A1 cases ($n = 30$) on the first prenatal scan, 10 (33.3%) had antenatal resolution, whereas 9 (30 %) remained same as UTD A1 and 11(36.6%) progressed to high-risk grade (i.e. UTD A2–3) in their last scan, whereas among UTD A2–3 cases ($n = 37$), only 2 (5.4%) had antenatal resolution, 4 (10.8%) regressed to low-risk grade and 31 (83.7%) remained same as UTD A2–3. These findings are in contrast to the study by Kaspar et al. [7] who found consistency in the UTD A classification between first and last prenatal scan as they found 93.3% of all patients to be at same classification throughout the prenatal period. However, they noted worsening in 3.3% UTD A normal cases and in 14.3% UTD A-1 cases between first and last prenatal US.

Based on our observations, it can be said that low-risk UTD A1 grade may have equal chances of either progression, regression or being static on subsequent scan prenatally, whereas high-risk UTD A2–3 group in majority may remain the same throughout the antenatal course from the time of diagnosis. This fact is important in counselling prospective parents presenting before 20 weeks' gestation (legal gestational age of termination in our country) who may opt for termination in view of higher renal morbidity associated with the high-risk UTD A2–3 group.

Many studies have found that the degree of antenatal hydronephrosis may change antenatally. A decrease in renal pelvic dilatation that sets off in the antenatal period is predictive of spontaneous resolution in the early neonatal period. On the other hand, progression of hydronephrosis is directly related to poor outcome. However, a short-term postnatal follow-up in postnatal period is recommended to

avoid a delay in medical or surgical treatment, even in cases where antenatal resolution has taken place before birth [8].

Most frequent postnatal UTD diagnoses found in our study was transient dilation (55.7%). UTD A risk groups assigned as per last prenatal US findings correlated better with postnatal UTD P risk grades than UTD A risk grades in the first scan. UTD A normal group ($n = 12$) in the last prenatal scan did not have any significant postnatal UTD abnormality, therefore showing consistency with prenatal diagnosis. UTD A1 group ($n = 15$) showed 100% resolution postnatally. Those with UTD A2–3 grade ($n = 43$) on the last prenatal scan, 13 (30.2%) had postnatal resolution, whereas 30 infants (69.7%) were diagnosed with significant persistent urinary tract abnormality with abnormal UTD P grades and 22 (51%) were classified as high-risk UTD P-3. All of abnormal UTD P cases were graded as UTD A2–3 in their last prenatal scan, showing good consistency with prenatal diagnosis and prenatal risk categorisation. Kaspar et al. [7] also found that UTD A1 yielded a majority of postnatally resolving UTD, whereas UTD A2–3 yielded a majority of the obstructive uropathies with postnatal resolution in 30% of UTD A2–3 cases.

These differences in postnatal outcome based on UTD A risk-based classification system need to be discussed during prenatal counselling of parents and explaining them about postnatal prognosis, risk of severe renal impairment and management.

In the present study, 9 (12.8%) infants who needed urosurgical intervention postnatally were categorised as UTD P3 and UTD A2–3. In a retrospective study by Hodhod et al., they found that 12% cases of UTD required surgical intervention. They concluded that UTD classification system is reliable for evaluation of postnatal hydronephrosis and valid in predicting surgical intervention [9]. Kaspar et al. [7] also reported a notable trend towards more UT surgeries, UTI, and positive VUR among UTD A2–3 patients.

The major limitations of this study were single-centre retrospective design with small sample size, non-availability of long-term postnatal follow-up, improper or non-uniform reporting of USG findings by different sonologists due to using different terminologies to describe the abnormalities and different classifications to define severity. To overcome these limitations, there is a strong need to perform long-term prospective study with larger sample size involving single sonologist or a team of expert radiologist/s with good knowledge of foetal urinary tract scanning to perform prenatal and postnatal scans to avoid inter-observer variation and bias.

There was no universal consensus about terminology for defining UTD and no universal grading system to define severity and subsequent management of the condition before introduction of UTD classification system. This classification will replace the confusing terms used to define and/or grade UTD by radiologists. This will also help in standardising USG reporting using six imaging parameters as defined in UTD classification system. Implementation of UTD classification and recommendations will ensure a unified approach for clinical management of such cases prenatally as well as postnatally globally. This classification should be utilised in our routine clinical practice to evaluate its validity further and for future research purpose."

Conclusion

It is obvious from our study findings that low-risk UTD A1 at first scan may have equal chances of progression or regression or remaining same in the last prenatal scan, whereas UTD A2–3 is less likely to undergo antenatal resolution. This is an important point to discuss during prenatal counselling and prognostication.

Antenatal UTD A classification may be useful in antenatal prediction of postnatal severity especially in high-risk cases (i.e. UTD A2–3) and helpful in prognostication and prenatal counselling of prospective parents. It is evident from observations in this study that there is lack of systematic documentation of USG findings to describe UTD abnormalities by radiologists with the lack of unified approach to immediate postnatal evaluation and management by clinicians. Larger prospective studies with long-term follow-up for long-term renal function are urgently needed to evaluate the efficacy and validity of the UTD classification in antenatal prediction of postnatal outcome and renal morbidity.

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Compliance with Ethical Standards

Conflict of interest The authors declare that they have no conflict of interest.

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