The Journal of Obstetrics and Gynecology of India (May-June 2020) 70(3):202–207
https://doi.org/10.1007/s13224-020-01318-4

ORIGINAL ARTICLE

Correlation of Antenatal Ultrasound Parameters with the Postnatal Outcome of Bilateral Fetal Hydronephrosis

Priyanka Shukla[1] · Manisha Kumar[1] · Archana Puri[2] · P. M. Siva[3]

Received: 24 January 2020 / Accepted: 17 April 2020 / Published online: 6 May 2020

Abstract

Aim To determine the role of antenatal parameters in predicting the outcome of bilateral fetal hydronephrosis.

Methodology Total 50 antenatal women with bilateral antenatal fetal hydronephrosis (ANH) were included. On ultrasound, amount of liquor, kidney size, pelvic anteroposterior diameter, degree of caliectasis, bladder size, and thickness were observed at 28 and 32 weeks of gestation. For 3 months post-delivery, the babies were evaluated in terms of ultrasound renal parameters, serum creatinine levels, and need for surgery.

Results The mean gestational age at delivery was 37.4 ± 1.7. All babies were alive at birth, 48 were alive after 3 months. Surgery was done in 10/50 cases; cystoscopic fulguration was the most common procedure. There was a resolution of bilateral ANH in 27/50 cases, in 5/50 cases there was pylectasis with normal serum creatinine, and in 18/50 cases there was adverse outcome. Most of the parameters had better sensitivity and specificity at 32 weeks than at 28 weeks. At 32-week gestation, the renal pylectasis between 10 and 15 mm had the highest sensitivity (88.9%), and the presence of caliectasis had the highest specificity (90.6%) for adverse outcome.

Conclusion Resolution of hydronephrosis took place in the majority of cases, and there was an adverse outcome in only one-third of them. Renal caliectasis was the best marker for the prediction of adverse outcome.

Keywords Pylectasis · Bilateral renal anomaly · India · Survival after birth · Hydronephrosis · Caliectasis · Prospective study

Introduction

With the advent of good-quality ultrasound (US) screening during pregnancy, there has been an increase in the recognition of fetal hydronephrosis in recent years. The prevalence of antenatally detected hydronephrosis (ADH) ranges from 0.6 to 5.4% [1], bilateral affection is seen in 17–54% cases and are occasionally associated with additional abnormalities also [2]. It has been observed in previous studies that in the majority of cases, fetal hydronephrosis reverts back to normal in due course, and hence, excessive concern regarding the ultrasound finding often leads to parental anxiety and unnecessary testing of the newborn. The prenatal management should be directed toward identifying those in which fetal hydronephrosis may adversely affect the health of the infant and require antenatal and postnatal evaluation, timely referral to a pediatric urologist if required, and possible intervention to minimize adverse outcomes, while limiting testing in those cases that are due to a benign, transient condition. This prediction would be of help to fetal medicine specialists and obstetricians who deal with these cases antenatally.

There is reasonably large body of existing medical literature on prenatal hydronephrosis [3, 4, 5] but, most of these studies include fetuses with both bilateral and unilateral

Priyanka Shukla, Resident, Department of Obstetrics and Gynecology, LHMC, New Delhi; Manisha Kumar, Professor, Department of Obstetrics and Gynecology, LHMC, New Delhi; Archana Puri, Professor, Pediatric surgery, KSCH, New Delhi; Siva PM, Assistant Professor, Dept of community medicine, TVMCH, Tirunelveli.

✉ Manisha Kumar
manishaonly@gmail.com

[1] Department of Obstetrics and Gynecology, Lady Hardinge Medical College, Shahid Bhagat Singh Marg, New Delhi 110001, India

[2] Pediatric Surgery, KSCH, New Delhi, India

[3] Department of Community Medicine, TVMCH, Tirunelveli, India

hydronephrosis. The bilateral hydronephrosis is different from unilateral as it has worse prognosis due to involvement of both kidneys and because of the presence of lung hypoplasia as sequelae of oligohydramnios. There is paucity of data on outcome of bilateral ANH. Although there is a relatively robust body of work on the retrospective analysis of prenatal hydronephrosis and its postnatal correlates [3, 4, 5], but there is paucity of prospective research on the subject. A prospective study provides a true picture of natural course of the disease, and this is especially true for pylectasis as there is a high probability of reverting to normal after delivery.

A prospective study on bilateral ANH was therefore undertaken to observe the natural course of bilateral fetal hydronephrosis antenatally and to track its postnatal progression till 3 months of age. The study also intended to evaluate the role of antenatal ultrasound parameters to predict the outcome of bilateral ANH.

Material and Method

This Prospective observational study was done at from November 2016 to April 2019 after ethical clearance from institute's ethical committee (IEC). The study included pregnant women with bilateral fetal hydronephrosis on antenatal ultrasound (US) at or before 28 weeks of gestation after obtaining a written informed consent. Hydronephrosis was defined as the renal APD diameter was more than 7 mm in the bilateral kidneys at 28 weeks ultrasound [5]. All women with unilateral hydronephrosis or with other associated non-urinary structural anomalies were excluded as it would impact on the amount of liquor and the outcome.

All US was done by single person, using US machine Nemio XG (Toshiba, Japan), with 3–5 MHz probe. The parameters amniotic fluid index (AFI), kidney length and width, anteroposterior pelvic diameter, and caliectasis were observed at 28 weeks and 32 weeks in all women. An amniotic fluid index, less than the 2.5th percentile for that gestational age was considered to be oligohydramnios [4]. The APD was measured in transverse axial image of the renal pelvis at level of the renal hilum. The dilatation of secondary renal calyces was termed as caliectasis. The length of bladder, thickness of bladder wall, dilatation of ureter was noted. The women were followed up till delivery. At delivery, the baby's birth weight, APGAR were observed.

All live babies were evaluated by a team of pediatric surgeons, the management was provided as per hospital protocol. It included postnatal kidney and bladder US, serum creatinine level for kidney function and urine culture tests at the end of first week, first month and at 3 months. Other conditions such as PUV, VUR, and UPJ obstruction were diagnosed on voiding cystourethrogram (VCUG) and DMSA. Serum creatinine was used to find out the status of kidney function. At the postnatal age of 3 months, all babies with either raised serum creatinine (more than 1.1 gm/dl) or those who underwent surgery or who died were considered as having adverse outcome. The antenatal ultrasound parameters in those with adverse outcome were compared with normal outcome.

Statistical Analysis

The data were entered into MS excel and analyzed using the SPSS version 17. Descriptive statistics in the form of mean and standard deviations or proportions were used to characterize the study sample. For quantitative data, difference between the means of the two groups were compared by *t* test (for normal distribution) or Mann Whitney test (non-normal distribution). For qualitative data, Chi-square or Fischer's exact test were used to observe difference between proportions for independent groups. *p* value of less than 0.05 was considered statistically significant. The antenatal factors of those with poor outcome were compared to good outcome using multivariate analysis. The sensitivity, specificity, negative predictive value (NPV), and positive predictive value (PPV) were calculated.

Results

Total 50 cases with antenatal diagnosed bilateral hydronephrosis were fully followed from 28 weeks of gestation till 3 months after birth and were therefore included in the study group.

Most of the cases were in the age-group of 19–23 years (48%) and were nulliparous (46%) (Table 1). Among the antenatal ultrasound parameters, the mean AFI was

Table 1 Maternal epidemiological profile and fetal details of cases with bilateral fetal hydronephrosis

	28 weeks		32 weeks	
	n = 50	%	*n* = 50	%
Ultrasound parameters				
Oligohydramnios	6	12	16	32
Bilateral renal parameters				
Kidney size > 95th centile	8	16	18	36
Renal pylectasis				
10–15 mm	1	2	10	20
> 15 mm	7	14	10	20
Caliectasis	2	4	4	8
Bilateral ureter and bladder parameters				
Ureteric dilatation	1	2	3	6
Bladder size > 4 cm	6	12	17	34
Bladder thickness > 3 mm	4	8	17	34

11.2 ± 3.1 cm at 28 weeks, but decreased to 7.8 ± 3.4 cm at 32 weeks. The mean renal size of bilateral kidney was more than 95th centile in 16% and 36% cases at 28 and 32 weeks, respectively. The mean renal pelvic diameter was 9.7 ± 4.4 mm at 28 weeks, but rose to 11.3 ± 4.7 mm at 32 weeks. Caliectasis was present in 4% and 8% cases at 28 and 32 weeks respectively. The bladder size was more than 4 cm in 34% subjects at 32 weeks, and ureteric dilatation was observed in 6% of them. (Table 2).

Table 2 Antenatal ultrasound parameters at 28 weeks and 32 weeks of gestation of cases with antenatal bilateral fetal hydronephrosis

Parameters	Number—*n*
Maternal	
Age in years	
19–23	24 (48%)
24–28	19 (38%)
29–33	6 (12%)
> 33	1 (2%)
Parity	
0	23 (46%)
1	15 (30%)
2	10 (20%)
3	2 (4%)
Fetal	
Mean gestational age at delivery in weeks	37.4 ± 1.7
Mean birth weight in Kg	2.6 ± 0.5
Mean APGAR at birth	7.1 ± 1.4
Alive at birth	50 (100%)
Male	35 (70%)
Female	15 (30%)
Delivery by LSCS	5 (10%)
Alive at 1 week	50 (100%)
Alive at 4 weeks	48 (96%)
Alive at 12 weeks	48 (96%)

The mean gestational age at delivery was 37.4 ± 1.7 weeks, and Cesarean section was performed in 5/50(10%) cases. All babies were alive at birth with the mean Apgar score of 7, the male/female ratio was 2:1. The details of postnatal outcome and management of babies are given in Table 3.

The flowchart of the outcome of the cases is given in Fig. 1. The bilateral pylectasis resolved in 8 cases at 32 weeks (16%), it was < 7 mm at postnatal one week in further 6 (12%) cases, and it came back to normal at the end of 3 months in 13 (26%) more cases. In 5 (10%) cases, it persisted in one or both kidneys; however, the serum creatinine was normal. Therefore, there was no adverse outcome in total 32 (64%) cases.

Surgical intervention was required in 10 (20%) cases. Cystoscopic fulguration was done in 5 (10%) cases of PUV, and these cases were stable but had poor urinary stream and were diagnosed as PUV on DMSA scan and VCUG. In 3 (6%) cases of severe, intractable VUR and deranged kidney function, the ureteric reimplantation was performed within the study period. Two cases having high-grade UPJ obstruction underwent pyloplasty. In 5 cases, there was persistent hydronephrosis with raised serum creatinine, but surgery was not done as there was improvement in hydronephrosis and serum creatinine levels on follow-up. Two cases with PUV died.

Table 3 Postnatal investigations and management after delivery among cases with antenatal bilateral fetal hydronephrosis

Parameters	1st week		4 weeks		12 weeks	
	N = 50	%	*N* = 48	%	*N* = 48	%
(A) Investigations						
Raised creatinine (> 1.1 mg/dl)	20	40	13	26	11	22
Raised Na/K	6	12	9	18	8	16
Organism on urine culture	4	8	7	14	3	6
E coli	2		5		2	
Klebsella	1		1		1	
Pseudomonas	1		1		0	
(B) Ultrasound findings						
Bilateral renal pelvis						
10–15 mm	10	20	5	10	3	6
> 15 mm	3	6	1	2	2	4
Bladder > 4 cm	6	12	2	4	2	4
(C) Surgery done – 10						
Cystoscopic fulguration	4	8	0	0	1	2
Ureteric reimplantation	0	0	1	2	2	4.0
Pyeloplasty	0	0	0	0	2	4.0

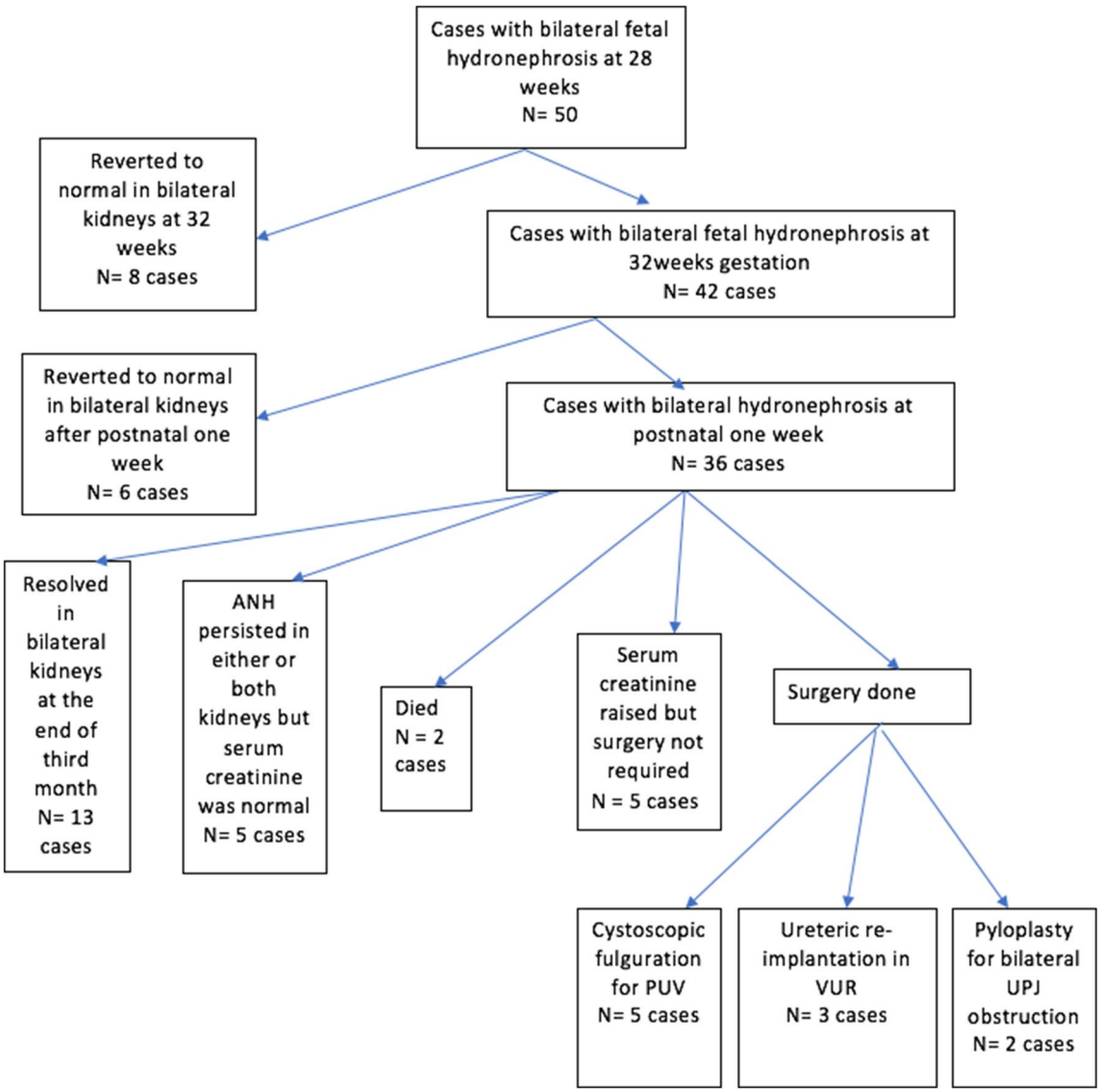

Fig. 1 The flowchart showing the outcome of 50 cases of antenatally detected bilateral fetal pylectasis

When we correlated the antenatal ultrasound parameters and the outcome, oligohydramnios had significant correlation with electrolyte abnormality ($p = 0.049$), chances of surgery ($p = 0.012$) and mortality ($p = 0.041$). Similarly, the increased renal size and degree of renal pelvic dilatation correlated significantly with the persistence of hydronephrosis ($p = 0.030$) and the requirement of surgery ($p = 0.048$). The presence of caliectasis was associated significantly with the need for surgery and mortality. None of the ultrasound parameters correlated significantly with raised serum creatinine levels. The increased bladder size and thickness did not correlate with adverse postnatal outcome (Table 4).

To assess how much each parameter contributed to the outcome, the multivariate regression analysis along with ROC curves were plotted. The sensitivity, specificity, negative predictive value, and positive predictive value of these parameters are given in Table 5. Most of the parameters had better sensitivity and specificity at 32 weeks than at 28 weeks. At 32-week gestation, the renal pylectasis between 10 and 15 mm had highest sensitivity (88.9%), and the presence of caliectasis had the highest specificity (90.6%) for predicting adverse outcome. The presence of caliectasis was the best predictor of adverse outcome with 66.7% sensitivity and 89.4% specificity.

Discussion

This prospective study provides a good data on features on ultrasound that would predict normal outcome in cases with fetal renal pylectasis and therefore reduce the unnecessary

Table 4 The *p* values of analysis of prediction of postnatal outcome by antenatal ultrasound parameters in cases with antenatal bilateral fetal hydronephrosis

Antenatal	Fetal							
	HDN	Blood urea	Serum creatinine	Serum sodium	Serum potassium	UTI	Surgery	Mortality
AFI	0.960	0.832	0.7	0.03	0.049	0.13	0.012	0.041
Kidney length	0.030	0.451	0.4	0.5	0.5	0.6	0.041	0.520
Kidney breadth	0.530	0.502	0.2	0.5	0.48	0.32	0.26	0.322
Pelvis dilatation	0.039	0.110	0.5	0.7	0.9	0.26	0.048	0.411
Change in pelvis dilatation	0.010	0.821	1.0	0.2	0.97	0.5	0.84	0.940
Caliectasis	0.150	< 0.010	0.12	0.6	0.9	0.28	0.023	< 0.014
Bladder size	0.730	0.95	0.17	0.25	0.06	0.59	0.31	0.673

Table 5 The cutoff sensitivity, specificity, PPV, and NPV of antenatal factors at 28 weeks and 32 weeks in predicting the adverse outcome of babies till 3 months of age cases with antenatal Bilateral fetal hydronephrosis

Antenatal ultrasound parameters	28 weeks				32 weeks			
	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)
Oligohydramnios								
	38.9	75	46.7	68.6	77.8	56.3	50.0	81.8
Increased kidney size	44.4	77.8	53.3	71.4	66.7	77.8	63.2	80.6
Pelvis								
> 10–15 mm	77.8	53.1	48.3	81.0	88.9	37.5	44.4	75
> 15 mm	16.7	84.4	37.5	64.3	33.3	87.5	40.0	70.0
Caliectasis	5.6	100	100	65.3	66.7	90.6	80.0	82.9

anxiety of the couple. All babies were alive at birth, and most of them recovered during the 3 months of follow-up; surgery was required in one-fifth of them only. The parameters such as amount of liquor, degree of pylectasis, and the presence of caliectasis had better sensitivity and specificity at 32 weeks than at 28 weeks. Renal caliectasis emerged as the best marker for prediction of abnormal outcome.

The classification of ANH has been controversial due to wide spectrum of causes and anomalies associated with it [6, 7, 8]. The anterior–posterior diameter (APD) measurement system is believed to lack the descriptive detail of the part of renal system involved [6]. The society of fetal urinary tract (SFU) grading system is a five-point grading system based on renal anatomic characteristics [7]. The urinary tract dilatation (UTD) classification system was developed to standardize the description of hydronephrosis across specialties and provide unified recommendations for perinatal evaluation. It is based on six categories in US findings such as anterior–posterior renal pelvic diameter; calyceal dilation; renal parenchymal thickness; renal parenchymal appearance; bladder abnormalities; and ureteral abnormalities. The classification system is stratified based on gestational age and whether the ANH is detected prenatally or postnatally [8]. In the study by Chalmer et al. UTD was found to have better inter- rater reliability than SFU system [5]. In the present study, we evaluated the kidney size, pylectasis, caliectasis, bladder and ureteral abnormalities. Our classification was measurement based, and hence, we omitted renal parenchymal appearance component of UTD classification.

In the present study, after delivery, there was decrease in pylectasis, bladder size, caliectasis along with regression of serum creatinine levels towards normal with advancement of age. Therefore, the natural progression after birth was in favor of recovery in most of the cases. Similar findings have been observed in previous studies also [1, 10, 11]. In the present study, the resolution of ANH took place in 54% of cases. Previous studies have shown that ANH resolves by birth or during infancy in 41–88% patients [9, 10, 11, 12]. Surgery was performed in 10/50 (20%) cases in the present study. This was akin to previous studies by Klener et al. and Darwish et al., in which the surgical intervention was required in 17.9% and 20.2% cases respectively [12, 13].

On multivariate analysis, the antenatal factors such as oligohydramnios, kidney size, degree of pylectasis and caliectasis were significant predictors of postnatal outcome whereas the bladder size and the bladder thickness were not. When all significant parameter was analyzed, it was found that prediction by all markers were better at 32 weeks

compared to 28 weeks. In the study by Klener et al., at APD cutoff of 8.3 mm, the sensitivity and specificity for possibility of surgery were 77.8% and 85.7% respectively [12]. In the present study, at APD cutoff of 10 mm the sensitivity was the highest (89%), whereas at the cutoff of 15 mm, the specificity was the highest (87.5%). The parameters such as oligohydramnios, increased kidney size and caliectasis had NPV of over 80%, suggesting that if the above values were below the cutoff, the chances of having good outcome was more than 80%. In the study by Santos et al., it was similarly concluded that caliectasis was an important marker of adverse outcome after birth [14].

The major limitation of the study could be the limited sample size and only 3 months of follow-up, but the strength of the study was that it was a prospective study done from antenatal to postnatal period and only bilateral fetal hydronephrosis was studied, as prospective studies are required to know the natural progression of the disease and bilateral hydronephrosis is a different entity than unilateral affection.

The study provides data regarding the course and outcome of bilateral hydronephrosis. Ultrasound features at 32 weeks was better in predicting the outcome; there was resolution of hydronephrosis in half of the cases, and there was adverse outcome in only one third of them. Renal caliectasis emerged as the best marker for prediction of abnormal outcome.

Funding There is no funding from any source for the study.

Compliance with Ethical Standards

Conflict of interest There is no conflict of interest among authors to disclose.

Ethical Statement The research involved human participants and informed consent was taken before enrolment in the study.

References

1. Plevani C, Locatelli A, Paterlini G, et al. Fetal hydronephrosis: natural history and risk factors for postnatal surgery. J Perinat Med. 2014;42(3):385–91.
2. Kumar M, Thakur S, Puri A, Shukla S, et al. Fetal renal anomaly: factors that predict survival. J Pediatr Urol. 2014;10(6):1001–7.
3. De Paula PG, Bunduki V, Hase EA, et al. Prenatal natural history of isolated fetal mild bilateral pyelectasis. Clinics (Sao Paulo). 2016;71(9):511–6.
4. Kaspar CDW, Lo M, Bunchman TE, et al. The antenatal urinary tract dilation classification system accurately predicts severity of kidney and urinary tract abnormalities. J Pediatr Urol. 2017;13(5):485.e1–.e7.
5. Chalmers DJ, Meyers ML, Brodie KE, et al. Inter-rater reliability of the APD, SFU and UTD grading systems in fetal sonography and MRI. J Pediatr Urol. 2016;12:305.
6. Fernbach SK, Maizels M, Conway JJ. Ultrasound grading of hydronephrosis: introduction to the system used by the Society for Fetal Urology. Pediatr Radiol. 1993;23:478e80.
7. Zanetta VC, Rosman BM, Bromley B, et al. Variations in management of mild prenatal hydronephrosis among maternal-fetal medicine obstetricians, and pediatric urologists and radiologists. J Urol. 1935e;188:1935e9.
8. Nguyen HT, Benson CB, Bromley B, et al. Multidisciplinary consensus on the classification of prenatal and postnatal urinary tract dilation (UTD classification system). J Pediatr Urol. 2014;10(6):982–98.
9. Nguyen HT, Herndon CD, Cooper C, et al. The Society for Fetal urology consensus statement on the evaluation and management of antenatal hydronephrosis. J Pediatr Urol. 2010;6:212–31.
10. Bondagji NS. Antenatal diagnosis, prevalence and outcome of congenital anomalies of the kidney and urinary tract in Saudi Arabia. Urol Ann. 2014;6(1):36–40.
11. Afroz R, Shakoor S, Salat MS, et al. Antenatal renal pelvic dilatation and foetal outcomes—review of cases from a tertiary care center in Karachi, Pakistan. J Pak Med Assoc. 2016;66(12):1597–601.
12. Klener TA, Wohlmuth C, Schimke C, et al. Ultrasound Markers in Fetal Hydronephrosis to Predict Postnatal Surgery. Ultraschall Med 2018 Jul 5
13. Darwish HS, Habash YH, AlMardawi EA, et al. Postnatal outcome of isolated antenatal hydronephrosis. Saudi Med J. 2014;35(5):477–81.
14. Dos Santos J, Parekh RS, Piscione TD, et al.. A new grading system for the management of antenatal hydronephrosis. Clin J Am Soc Nephrol. 2015;10(10):1783–90.

About the Author

Dr. Priyanka Shukla has done M.B.B.S from Kanyakumari Govt. Medical College and M.S in Obstetrics and Gynaecology from Lady Harding Medical College. She has received various distinctions and gold medals in her academic career. She also received best outgoing postgraduate student award in LHMC. This research paper is a part of her thesis dissertation with Professor Manisha Kumar as her guide.