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RESEARCH ARTICLE

Ultrasound Screening for Early Detection of Congenital Kidney and Urinary Tract Abnormalities in Neonates

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Abstract

Objective: To determine the incidence of urinary tract congenital abnormalities in apparently healthy newborns by postnatal ultrasound screening, also, to detect the accuracy of prenatal ultrasound screening in excluding thoseabnormalities.

Method: Renal ultrasound screening was performed on300 apparently healthy newborns, aged > 3 days and < 7 days. In case of renal pelvis dilatation (RPD), the anteroposterior diameter (APD) was determined and follow-up protocol was set.

Results: The incidence of renal abnormalities was 5.3% (16/300). One case was right renal agenesis. The other 15 cases were RPD (5%); 12 caseswere mild (APD of 5-9.9 mm) and 3 cases were moderate (APD 10-14.9 mm). Eleven cases out of those 15 cases completed the follow-up. Eight casesshowed resolution within 6 months follow-up. In one case with mild RPD and other case with moderate RPD, there were persistence of RPD at 6th month and right vesicoureteral reflux (VUR) grade II and left VUR grade II were diagnosed respectively. In one case with moderate RPD, follow-up at 1st month revealed progression of RPD and ureteropelvic junction obstruction (UPJO) was diagnosed.

Conclusions: Congenital renal abnormalities are not uncommon in apparently healthy newborns and can be missed during the prenatal ultrasound screening**.**

Introduction

Congenital urinary tract anomalies are relatively frequent and may be found in about 3% to 4% of the population [1]. Also they account for 20 to 30 percent of all anomalies identified in the prenatal period [2].

Many cases of renal insufficiency in childhood are attributed to congenital anomalies of the urinary tract [1]. They account for 30% of childhood cases of chronic renal failure in Japan [3]. Furthermore, they are well known causes of urinary tract infections (UTIs) in children, as about 40% of infants and children with symptomatic UTI are reported to have vesicoureteric reflux (VUR) and 20% have other associated abnormalities in the urinary tract [4].

Therefore, early diagnosis of congenital anomalies of the urinary tract is crucial, as potential early therapy might prevent irreversible damage of the renal parenchyma [5]. Ultrasound study has a fundamental role in the investigation for detecting renal anomalies, since it is an accessible method without the use of ionizing radiation, which is an important factor, especially in the pediatric age [1].

METHOD

This cross sectional study was conducted on 300 apparently healthy newborns, after 72 h of life (72–144 h), randomly selected from Gynecology and ObstetricsHospital, AinShamsUniversity over a period of 9 months from September 2010 to May 2011. Males were 157 and females were 143. An informed verbal consent was taken from the parents of the neonates. The study was approved by the ethical committee of AinShamsUniversity.

The inclusion criteria were: gestational age ≥ 35 weeks, birth weight ≥ 1.800 kg, and postnatal age >3 and < 7 days

The exclusion criteria were: sick neonates, neonates with congenital abnormalities, and neonates with congenital abnormalities detected on prenatal ultrasound screening.

Renal ultrasound (US) screening (GE Logic, pro series, 400 and GE Logiq pro 3 with linear array transducer 6-10 MHz) was performed on the studied neonates.

In case of renal pelvis dilatation (RPD), the anteroposterior diameter (APD) of the renal pelvis by a transverse sonogram was determined and recorded. We classified hydronephrosis into 3 grades using APD of renal pelvis, mild 5-9.9 mm, moderate 10-14.9mm, and severe ≥15mm [6,5].

We set a protocol for follow-up of cases of RPD (figure I), modified from both Halek et al., 2010 [5] and Chein et al., 1999 [7].

For further analysis, the diameter of screening result was relevant. The analyzed data were from the number of children, not renal units, in bilateral dilatations; only the side with greater dilatation was taken into account.

RESULTS

The study was done on 300 newborns. Males were 159 and females were 141 were. The mean birth weight was 3.15 kg (range 1.8 – 4.8 kg). The mean maternal age was 27.24 yr. Out of the studied neonates, 228 were normal vaginal delivery, and 72 were cesarean section. The mean postnatal age was 4.66 days (range 4 – 6 days).

The total incidence of renal abnormalities on initial renal ultrasound screening was 5.3% (16/300) (table I). There was male predominance, 10 males and 6 females (male:female = 5:3). One case out of the 16 cases found on our initial ultrasound screening, was right renal agenesis with an incidence of 1/300 (0.3%). The other 15 cases were RPD with an incidence of 15/300 (5%), 12 cases (4%) with mild (APD of 5-9.9 mm), 3 cases (1%) with moderate (APD 10-14.9 mm), and no case with severe RPD (APD ≥ 15 mm). Four cases out of the 15 cases with RPD were bilateral, and 11 cases were unilateral, 7 cases were left and 4 cases were right.

Of those 15 cases with RPD, 2 cases were lost, and in 2 cases, it was still too short to complete the follow-up. Eleven cases out of those 15 cases completed the follow-up. Follow-up showed resolution of RPD in 8 cases out of those 11 cases (73%) and persistence or progression in the remaining 3 cases (27%) within the 6 months follow-up period (table II). Out of those 11 cases, 8 cases were mild and 3 cases were moderate. Resolution occurred in 7 cases out of those 8 cases with mild RPD, while in moderate RPD, only one case out of the 3 cases showed resolution during the 6 months follow-up period. Out of those 11 cases, 3 cases were bilateral and 8 cases were unilateral. There was resolution of all bilateral RPD, while only 5 cases out of those 8 cases with unilateral RPD showed resolution during the 6 months follow-up period. In 5 cases; resolution was at 1st month, in 1 case at 4th month, and in 2 cases at 6th month.

The 3 cases with persistence or progressive RPD were followed by further investigations. In one case with mild RPD, there was persistence of RPD at 6th month and so VCUG was done and right VUR grade II was diagnosed. In one case with moderate RPD, also, there was persistence of RPD at 6th month, so VCUG was done and left VUR grade II was diagnosed. In one case with moderate RPD, follow up at 1st month revealed progressive dilatation of renal pelvis so 99mTc-Diethylenetriaminepentaacetate (DTPA) was done and ureteropelvic junction obstruction (UPJO) was diagnosed.

Table I: The 16 cases detected by initial postnatal ultrasound, their perinatal data and final diagnosis

	Diagnosis	**n**	**%**	**Gender**	**GA (wk)**	**BW (kg)**	**MOD**	**Maternal age (yr)**	**Final diagnosis**
1	**R kidney agenesis**	**1**	0.3%	Male	37	2.6	NVD	32 yr	R kidney agenesis
	Renal pelvis dilatation	**15**	5%						
	≥5 &<10	**12**							
2	**L = 5**			Male	37	2.3	NVD	22	Normal
3	**L = 5.2**			Male	40	3.4	NVD	27	Lost follow-up
4	**L = 5.4**			Female	36	1.8	NVD	24	Normal
5	**L = 5.5**			Female	41	3.3	NVD	37	Normal

6	**L = 6.1 (bilateral)**	Male	40	3.6	CS	42	Normal
7	**L = 6.1**	Female	37	3.2	CS	33	Lost follow-up
8	**R = 6.4 (bilateral)**	Female	36	2.4	NVD	19	Normal
9	**L = 6.9**	Male	40	3.8	NVD	29	Normal
10	**R = 7.2**	Male	41	3.5	NVD	26	Short follow-up
11	**R = 8 (bilateral)**	Male	39	4.2	NVD	27	Short follow-up
12	**R = 9.1**	Male	40	3.8	NVD	20	R VUR II
13	**R = 9.5**	Female	38	2.8	NVD	28	Normal
	≥10 **3**						
14	**L = 10**	Male	38	3.3	CS	23	L VUR II
15	**L = 11.2 (bilateral)**	Female	38	3.7	NVD	18	Normal
16	**R = 14**	Male	39	3	NVD	25	R UPJO

GA gestational age, BW birth weight, MOD mode of delivery, VUR Vesicoureteral reflux, UPJO Ureteropelvic junction obstruction

Table II: The 15 cases with renal pelvis dilatation, their initial APD, follow-up and final diagnosis*

Case	Initial APD (mm)*	At 1 month	At 4 months	At 6 months	Final diagnosis
1	**L = 5**	Normal	-	-	Normal at 1 mo
2	**L = 5.2**	Lost	-	-	Lost follow-up
3	**L = 5.4**	Normal	-	-	Normal at 1 mo
4	**L = 5.5**	Normal	-	-	Normal at 1 mo
5	**L = 6.1 (bilateral)**	Normal	-	-	Normal at 1 mo
6	**L = 6.1**	Lost	-	-	Lost follow-up
7	**R = 6.4 (bilateral)**	R = 5.7	Normal	-	Normal at 4 mo
8	**L = 6.9**	Normal	-	-	Normal at 1 mo
9	**R = 7.2**	R = 6.6	Short	-	Short follow-up
10	**R = 8 (bilateral)**	R = 6.9	Short	-	Short follow-up
11	**R = 9.1**	R = 7.8	R = 8.4	R = 8.1, so VCUG done	Persistence of pelvis dilatation at 6 mo, VCUG done, R VUR II diagnosed
12	**R = 9.5**	R =7.8	R = 6.5	Normal	Normal at 6 m
13	**L = 10**	L = 9.1	L = 7.8	L = 8.6, so VCUG done	Persistence of pelvis dilatation at 6 mo, VCUG done, L VUR II diagnosed
14	**L = 11.2 (bilateral)**	L = 9.4, R = 5.3	L = 7.2	Normal	Normal at 6 mo
15	**R = 14**	R = 24, so DTPA done	-	-	Progressive pelvis dilatation at 1 month, DTPA done, R UPJO diagnosed

*In bilateral dilatations, only the side with greater dilatation was taken into account. The analyzed data were from the number of children, not renal units.

VCUG Voiding cystourethrogram, DTPA Diethylenetetrapentaacetic acid, VUR Vesicoureteral reflux, UPJO Ureteropelvic junction

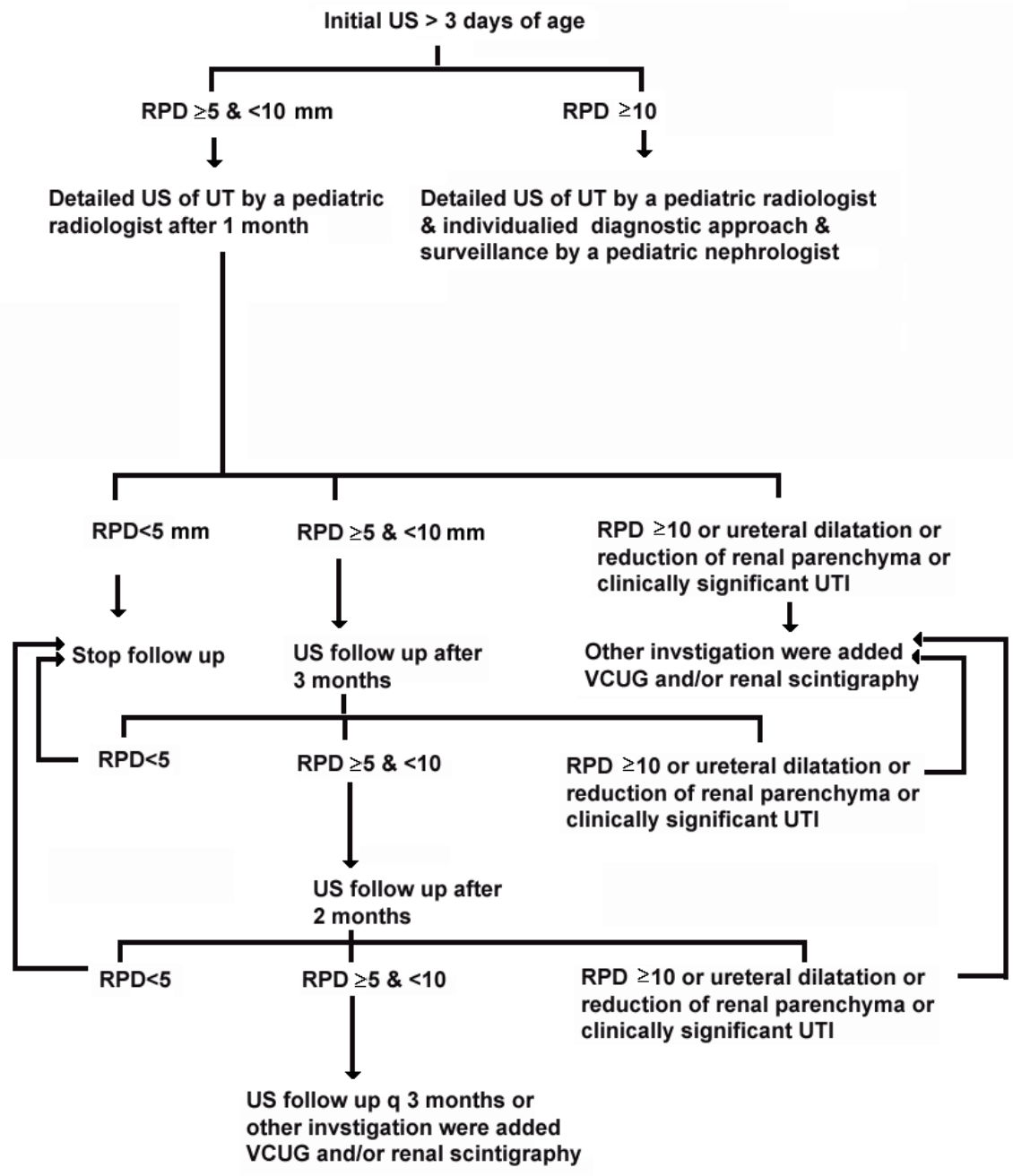

Figure I: Protocol for management of postnatal renal pelvis dilatation (modified from both Halek et al., 2010 [5] and Chein et al., 1999 [7])

DISCUSSION

In our study, we screened 300 apparently healthy newborns, using renal ultrasound for detection of renal abnormalities. Screening was performed after 72 h of life to prevent underestimating the incidence of hydronephrosis as there is a relative state of dehydration and decreased glomerular filtration rate immediately after delivery of newborns.

In our study we excluded those with renal abnormalities on prenatal ultrasound. So, all the detected cases postnatally were missed during routine antenatal ultrasound screening. The results of our study revealed that the incidence of renal abnormalities on initial renal ultrasound screening in healthy asymptomatic newborns was 5.3% with male predominance (male:female = 5:3). The incidence of congenital renal abnormalities varies greatly among different studies. Some studies excluded those with antenatally detected abnormalities, as that done by Tsai et al., 1998 [8] in Taiwan with an incidence of 17.7% with male predominance and that done by Tabel et al., 2010 [9] in Turkey with an incidence of 7.3%. Similar studies done on healthy newborns or infants include Chein et al., 1999 [7] in Taiwan with an incidence of 17.6 % with male predominance and that done by Yoshida et al., 2003 [10] in Japan, Tsuchiya et al., 2003 [3] also in Japan, and Steinhart et al., 1988 [11] in USA with renal abnormalities incidence of 4%, 3.5%, and 2.8% respectively. Also in the study done by Halek et al., 2010 [5] in CzechRepublic, the incidence was 4.1% with male predominance, also only 9.6% of those cases detected postnatally was detected prenatally. In the study done by Riccipetitoniet al., 1992 [12] in Italy, pronounced anomalies were found in 1.04% and mild RPD in 4.60%. Only 19.4% of those cases with severe renal anomalies detected postnatallywas detected prenatally. Many other studies concluded the low sensitivity of prenatal ultrasound in detecting renal abnormalities. The study done by Stolz et al., 2002 [13] in Germany, revealed that the incidence of renal abnormalities was 1.2% and the sensitivity of prenatal ultrasound was 36%.

In our study, one case out of the 16 cases found was right renal agenesis with an incidence of 1/300 (0.3%). This incidence is higher than that in the literatures which ranges from 1 in 450 -1000 live births [14,15]. Also, this incidence is higher than that of the study done by Halek et al., 2010 [5] which was 0.1%, none was detected antenatally. In the study done by Chein et al., 1999 [7], the incidence of unilateral renal agenesis was 0.22, slightly lower than that of us. In the study done by Tabel et al., 2010 [9], the incidence of renal agenesis was 0.5%.

In our study, the most common abnormality was RPD with an incidence of 15/300 (5%), 12 cases (4%) with mild RPD (APD of 5-9.9 mm), 3 cases (1%) with moderate RPD (APD 10-14.9 mm). Our results are close to that revealed by Halek et al., 2010 [5] with an incidence of RPD of 3.8% (mild, moderate and severe RPD were 3.5%, 0.21%, and 0.082% respectively), only about 8% of those detected postnatally was detected prenatally. The results revealed by Chein et al., 1999 [7], show much higher incidence than that of our results, that was 16.9% (mild with APD 5-15 mm was 16.2% and severe with APD >15 mm was 0.7%). Also the results of the study done by Tsai et al., 1998 [8], showed very close high incidence of 17.7% (9.6% was mild RPD and 8.1% was mild, moderate, and severe hydronephrosis). The incidence of hydronephrosis in the study done by Tsuchiya et al., 2003 [3] was 2.3%.

In our study, we set a protocol for follow up of cases of RPD [5,7], which revealed resolution of most of cases within the 6months follow-up. In follow-up of the 15 cases of RPD, 11 cases completed the follow-up. Eight cases of them (73%) showed resolution within the 6 months follow-up period. In one case with mild RPD, there was persistence of RPD at 6^{th} month and so VCUG was done and right VUR grade II was diagnosed. In one case with moderate RPD, also, there was persistence of RPD at 6^{th} month, so VCUG was done and left VUR grade II was diagnosed. In one case with moderate RPD, follow-up at 1^{st} month revealed progressive dilatation so DTPA was done and PUJO was diagnosed, and VUR was excluded with VCUG. So the follow-up of RPD showed 2 cases of VUR (both grade II) with a total incidence of 0.66% and one case of UPJO with an incidence of 0.33% of those initially screened with renal US. This was in agreement with other studies as that done by Chein et al., 1999 [7], in which most of cases with mild RPD showed improvement on follow-up, and further investigations for those with severe, persistence or progresssive RPD diagnosed VUR in about 0.55% and UPJO in 0.99% of the initially screened with renal US. In the study done by Tsai et al., 1998 [8], VCUG was done on the cases who had moderate to severe hydronephrosis or persistent mild hydronephrosis, and VUR was diagnosed in about 1.3% of the initially screened with renal US.

From our study, we concluded that congenital renal abnormalities are not uncommon in apparently healthy newborns and can be missed during the prenatal ultrasound screening. Postnatal ultrasound renal screening is reliable and non-invasive method, enabling the early detection of these subclinical abnormalities missed by the prenatal ultrasound screening and hence the early management. Also, we concluded that mild renal pelvis dilatation detected postnatally is usually benign condition, and most regress during six months follow-up by ultrasound.

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DECLARATION OF INTEREST SECTION

The authors report no declarations of interest.

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