Ultrasonographic Screening of Newborns for Congenital Anomalies of the Kidney and the Urinary Tracts

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Purpose: To search for the efficiency of scanning the newborns with routine urinary system ultrasonography.

Materials and Methods: Urinary ultrasonography has been carried out on 721 infants born in or brought to our hospital. During the study, name, sex, week of birth, presence of antenatal diagnosis or urinary tract infections, and pathologies in examinations of the babies were recorded. Ultrasonography analysis was done with a scanner by a radiologist. Patients identified to have pathologhy, were watched closely in pediatric nephrology clinic, and advanced visualizations and treatments were carried out.

Results: Seventy-six infants (10.5%) had congenital anomalies of the kidney and the urinary tracts that prompted medical and/or surgical intervention. Of whom, 32 were diagnosed with antenatal ultrasonography and 44 during their initial postnatal ultrasonography screening. The most frequent identified pathology was hydronephrosis, in particular physiologic hydronephrosis (35.8%). The most frequent congenital urinary anomaly which caused hydronephrosis was ureteropelvic obstruction.

Conclusion: It is suggested to apply the urinary ultrasonography scanning to all the infants that are born or brought to the university hospital. If possible, it is to be considered to include urinary ultrasonography scanning in newborn scanning programs.

Keywords: ultrasonography, newborns, congenital abnormalities, urinary tract

Urol J. 2010;7:161-7.
www.uj.unrc.ir

INTRODUCTION

Congenital anomalies of the kidney and the urinary tracts constitute major causes of renal insufficiency. In Turkey, these disorders are found in upto 38.8% of pediatric cases requiring dialysis. Among them, vesicoureteral reflux plays the major role (24%), whereas other congenital urological disorders (8%) and renal hypoplasia/dysplasia (7%) constitute remaining causes.[1] The prevalence of congenital urologic abnormalities is roughly the same in various geographical locations, being 45% in Japan and 33% in North America.[2,3] The incidence of renal insufficiency exhibits a decline in developed countries. The unchanged incidence of congenital anomalies puts them on top of the differential list for disorders that cause renal insufficiency.[4]

Congenital anomalies of the kidney and the urinary tracts may be detected with a variety of screening techniques and diagnostic

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Received October 2009
Accepted March 2010

methods, including antenatal and postnatal ultrasonography, urinary analysis, and renal biopsy.[5] Ultrasonography, an easily accessible, non-invasive, and real-time method, has been used since many years ago to determine renal and urinary tract anomalies.[1,6,7] In the absence of any systemic disease, the prevalence of congenital anomalies of the kidney and the urinary tracts is found to be around 0.1% with antenatal ultrasonography[8] and over 1% with postnatal ultrasonography.[9] However, not the incidence, but the severity of the clinical picture and the presence of the bilateral disease govern the clinical importance.

In this study, descriptive statistics of newborns screened for renal and urinary tract anomalies are presented. Furthermore, postnatal ultrasonography screening findings and their follow-ups are given. This study is the initial large-scale screening for congenital anomalies of the kidney and the urinary tracts in Turkey.

MATERIALS AND METHODS

This study was conducted at Turgut Ozal Medical Center, Inonu University during a period of 18 months. Subjects were 3 to 28-day-old infants that were delivered in our institution, admitted to our premature and neonatal intensive care units, or admitted to our outpatient clinic of pediatric nephrology. The sampling method of this study was representative.

Sample consisted of 721 newborns. One hundred and twenty (16.6%) subjects were screened antenatally with ultrasonography, and found to have renal and/or urinary anomalies. They were subsequently sent to our department for postnatal work-up.

Subjects were investigated using color Doppler ultrasonography (ATL HDI 5000, Philips Medical Systems, Bothell, WA) and 4-7 MHz linear array transducer with 38 mm footpath. Investigations were performed in department of diagnostic radiology, always by the same radiologist and the same equipment.

The kidneys were assessed for following features: Their presence or absence, dimensional abnormality (length $\leq$ 35 mm, $\geq$ 65 mm) and asymmetry in the left or right kidney (difference $\geq$ 10 mm), presence of central echogenic complex with a grade of 2 or higher according to the Society of Fetal Urology criteria,[10] presence or absence of normal renal echogenicity, and accompanying abnormalities such as cysts or tumors. The urinary bladder was checked for abnormalities in shape and wall. The ureters were checked for any ureteral dilation. The complete list of renal or urinary anomalies that can be diagnosed by ultrasonography in antenatal and/or postnatal period is given in Table 1.

Subjects with abnormal findings in initial work-up underwent 12-month follow-up examination with ultrasonography. The persistence of abnormal findings mandated further examinations, including voiding cystourethrography, intravenous urography, renal scintigraphy with 99mTc-dimercaptosuccinic acid, diuretic renal scintigraphy with 99mTc-diethylenetriamine pentaacetic acid or 99mTc-mercaptoacetyltriglycine, abdominal computed tomography, and abdominal magnetic resonance imaging, including magnetic resonance urography. Patients were then treated and/or referred to appropriate clinics, including pediatric surgery.

The procedures were in accordance with the ethical standard for human experimentations established by Declaration of Helsinki in 1975, revised in 1983. The study was approved by the Ethics Committee of Inonu University and

Table 1. The list of congenital anomalies of the kidney and the urinary tracts that can be detected during ultrasonography screening (in alphabetical order)

Prenatal period	Postnatal period
Dysplastic kidney	Aplastic kidney
Hydronephrosis	Double ureter
Multicystic dysplastic kidney	Dysplastic kidney
Posterior urethral valve	Horseshoe kidney
Potter's syndrome	Hydronephrosis
Prune–Belly syndrome	Hypoplastic kidney
Simple renal cyst	Multicystic dysplastic kidney
Ureterocele	Posterior urethral valve
Ureteropelvic junction obstruction	Simple renal cyst
Ureterovesical junction obstruction	Ureterocele
Vesicoureteral reflux	Vesicoureteral reflux

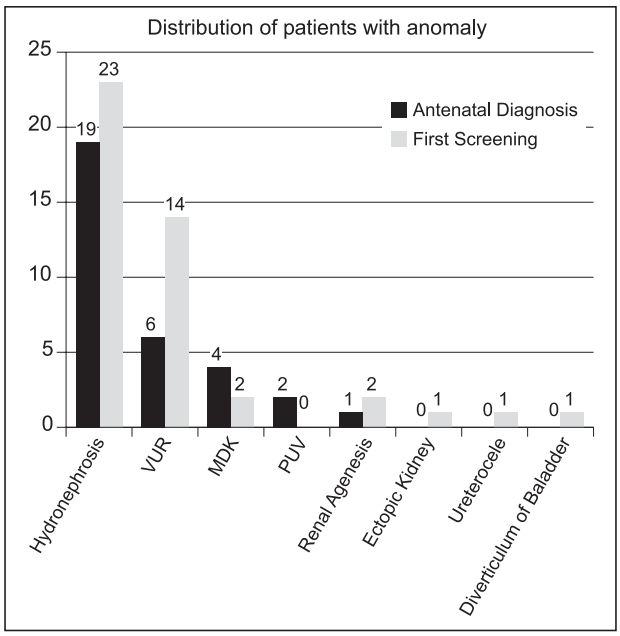
detailed consent forms were signed by the families of all the patients, before participating in the study.

Data were analyzed using the SPSS software (Statistical Package for the Social Sciences, version 13.0, SPSS Inc, Chicago, Illinois, USA). Pearson's chi-square and Fisher's exact tests were used. *P* values less than .05 were considered statistically significant.

RESULTS

Of 721 infants that were screened with ultrasonography, 253 (35.1%) were preterm and 468 (64.9%) were term babies, with female predominance (58.7%). Seventy-six infants (10.5%) had congenital anomalies of the kidney and the urinary tracts that prompted medical and/or surgical intervention. Of whom, 32 were diagnosed with antenatal ultrasonography, whereas 44 were diagnosed during their initial postnatal ultrasonography screening. Demographic and clinical characteristics of the patients are presented in Table 2. Distributions of anomalies according to their frequency in sample group are presented in Figure.

The most frequent anomaly that was seen in



Numbers of positive cases at antenatal and postnatal screening

*VUR, indicates vesicoureteral reflux; MDK, multicystic dysplastic kidney; and PUV, posterior urethral valve.

120 subjects that were found to have a urinary anomaly in antenatal ultrasonography was hydronephrosis. Postnatal follow-ups of these subjects revealed transient hydronephrosis in 27.5%, physiological hydronephrosis in 35.8%, ureteropelvic junction obstruction in 15%, vesicoureteral reflux in 5%, multicystic dysplastic kidney in 3.3%, and posterior urethral valve in 1.6% of the patients. Etiologies of antenatal hydronephrosis and postnatal first screening patients are given in Table 3.

In infants with antenatally diagnosed hydronephrosis, the subsequent physiological

Table 2. Demographic and clinical characteristics of patients

	n (%)
Total patients (male/female)	721 (58.7/41.3)
Preterm/term	253 (35.1)/468 (64.9)
Antenatal ultrasonography (yes/no)	120 (16.6)/601 (83.4)
CAKUT (yes/no)	76 (10.5)/645 (89.5)
CAKUT (antenatal group/first screening)	32 (42.1)/44 (57.9)

*CAKUT, indicates congenital anomaly of the kidney and the urinary tracts.

Table 3. Etiological classification of antenatal hydronephrosis and postnatal first screening

Etiology	first Postnatal screening n (%)	Antenatal abnormal Ultrasonography (+) n (%)
Physiological hydronephrosis*	17 (2.8)	43 (35.8)
Transient hydronephrosis*	0	33 (27.5)
Ureteropelvic stenosis	24 (3.4)	20 (16.6)
Vesicoureteral reflux	14 (2.3)	6 (5)
Multicystic displastic kidney	2 (0.3)	4 (3.3)
Posterior urethral valve	0	2 (1.6)
Renal agenesis	3 (0.4)	0
Ektopik böbrek	1 (0.1)	0
Normal	557 (92.6)	88 (73.3)
Total	601	120

*Physiologic and transient hydronephrosis were considered as normal group

improvement was significantly poorer than the infants with postnatally diagnosed hydronephrosis (27.5% versus 35.8%, $P < .05$). In infants with persistent hydronephrosis, the frequency of left kidney involvement was significantly higher than the frequency of right kidney involvement (31% versus 13%, $P < .0001$). Males were significantly more frequently affected than females (31.2% versus 10%, $P < .01$). Physiological improvement of hydronephrosis in the left kidney was significantly higher than the physiological improvement of the right kidney (26.9% versus 12.1%, $P < .01$).

Increased parenchymal echogenity of the kidneys was observed in 23 subjects (3.1%), of whom 9, 10, and 4 also had acute renal failure, urinary tract infection (UTI), and multicystic dysplastic kidneys, respectively. The presence of ureteropelvic junction obstruction and/or vesicoureteral reflux had statistically significant association with UTIs ($P < .001$).

In 18 infants (2.4%) with congenital anomalies of the kidney and the urinary tracts, physical examinations and other diagnostic investigations detected additional extra-renal congenital anomalies. These anomalies and accompanying congenital anomalies of the kidney and the urinary tracts are listed in Table 4.

Table 4. Congenital anomalies other than urinary disorders and accompanying congenital anomalies of the kidney and the urinary tracts

Anomaly	n	Anomaly of the kidney and/or the urinary tracts
Congenital heart disease	9	
VSD	4	2 Vesicoureteral reflux, 2 hydronephrosis
PDA	3	1 Vesicoureteral reflux, 2 hydronephrosis
ASD	1	Vesicoureteral reflux
Dextrocardia	1	Hydronephrosis
Gastrointestinal anomaly	4	
Omphalocele	1	Hydronephrosis
Anal atresia	1	Hydronephrosis
Pyloric stenosis	1	Hydronephrosis
Cleft palate	1	Hydronephrosis
CNS anomaly	3	
Myelomeningocele	2	1 Vesicoureteral reflux, 1 hydronephrosis
Diastematomyelia	1	Hydronephrosis
Genital anomaly	2	
Ambiguous genitalia	1	Renal agenesis
Urogenitale sinus	1	Hydronephrosis

*VSD, indicates ventricular septal defect; PDA, patent ductus arteriosus; ASD, atrial septal defect; and CNS, central nervous system.

During the study period, 49 infants with congenital anomalies of the kidney and the urinary tracts have been treated medically with antibiotics and/or antihypertensive agents. Twenty-three patients with ureteropelvic junction obstruction, 2 patients with posterior ureteral valve, and 2 patients with high grade vesicoureteral reflux underwent surgery.

DISCUSSION

Due to the advent of preventive measures and modern treatment strategies, the incidence of chronic renal failure in pediatric population has decreased in many countries. Congenital factors being mostly unpreventable became, therefore, primary causative factors. In pediatric end-stage renal disease, congenital factors are encountered in 39% of the patients in Turkey, 45% of the patients in Japan, and 33% of the patients in the USA.[1-3]

Ultrasonography is the first imaging method of choice to evaluate urinary assessment of infants both antenatally and postnatally.[11] Ultrasonography has many advantages such as non-invasiveness, cost efficiency, and easy accessibility. In screening studies using ultrasonography, the frequency of urinary anomalies are usually found between 0.1% and 1%.[12,13] In the present study, the frequency of congenital anomalies of the kidney and the urinary tracts was 10.5%, which was much higher than the ones reported in other studies, such as studies by Riccipetitoni and colleagues (1.04%),[9] Sakuma and Ogawa (3.7%),[14] Tsuchiya and associates (3.5%),[2] and Himmetoglu and coworkers (0.27%).[15]

The higher figure was thought to be caused by the study design and the sample of the present study. The study was conducted in a tertiary institution to which many complicated pregnancies and sick newborns were referred, and also included samples from pediatric nephrology department. In addition to the above mentioned factors, the people that live in the geographical area (East Anatolia) that was represented by the study have low socioeconomic level and endogamy. The

study, therefore, cannot represent the general situation in Turkey, but is, nevertheless, a good indicator of the status in its eastern parts.

The antenatal diagnosis of congenital anomalies of the kidney and the urinary tracts or their discovery in postnatal screening has also major impact on the prevalence of the anomaly. Even the screening policy that was used to detect the anomaly may be a contributing factor as shown in a very large study on 709 030 live births, stillbirths, and induced abortions that was performed to evaluate the prevalence of antenatal ultrasonography diagnoses for renal anomalies in 20 registries of 12 European countries. In that study, detection rates varied in different countries of the European community due to diverse policies or ethical and religious background. Countries with no routine ultrasonography showed the lowest rates of detection.[16]

However, there are also some studies in which the above mentioned factors were not found to have a significant effect on the prevalence of congenital anomalies of the kidney and the urinary tracts. In a study by Raboei and colleagues on 23 000 babies, an antenatal ultrasonography examination has been performed on 19 400 newborns and the incidence of significant urinary tract malformations were found to be similar in antenatally and postnatally diagnosed infants. However, more complications occurred in the unscreened group, implicating the value of a population-screening test based on antenatal ultrasonography examination.[17]

But it should be kept in mind that the antenatal discovery of urinary abnormalities does not always implicate a better prognosis. To comply with that statement, we have found that in infants with antenatally diagnosed hydronephrosis, the subsequent physiological improvement was significantly poorer than the infants with postnatally diagnosed hydronephrosis, possibly due to higher damage in former infants.

In the present study, the prevalence of congenital anomalies of the kidney and the urinary tracts was higher in infants with antenatal diagnosis than ones without such diagnosis. Although this is an expected finding, it still shows the efficacy of antenatal screening. Of interest was the reconfirmation of pathological findings in only a fraction (32 out of 120) of these infants. This finding implicates the necessity to repeat ultrasonography in postnatal period to establish a firm diagnosis and to plan an appropriate therapeutic management.

Hydronephrosis, with a prevalence of 1/100 to 1/500, constitutes 2/3 of all the intrauterine urinary abnormalities,[18] with the rate of 0.6%.[19] Woodward and Frank had evaluated postnatal findings of antenatally diagnosed hydronephrosis and reported transitory hydronephrosis in 48%, physiological hydronephrosis in 15%, ureteropelvic junction obstruction in 11%, vesicoureteral reflux in 9%, megaureter in 4%, multicystic dysplastic kidney in 2%, and ureterocele in 2% of their subjects.[20] The results of our study are in accordance with that study regarding the order of frequency, albeit with different prevalence. Of notice was the lower prevalence of transient hydronephrosis (27.5%) and the higher prevalence of physiological hydronephrosis (35.8%), possibly due to classification mismatch between two studies.

This study additionally described some novel features of infantile hydronephrosis. Accordingly, (i) in infants with antenatally diagnosed hydronephrosis, the subsequent physiological improvement was significantly poorer than the infants with postnatally diagnosed hydronephrosis, as stated above; (ii) in persistent hydronephrosis, left kidney was much more frequently affected than its right counterpart, but was more frequently normalized during the follow-up; and (iii) males were more frequently affected than females.

Congenital anomalies of the kidney and the urinary tracts in general, and vesicoureteral reflux in particular, frequently accompany with the relapsing UTIs in pediatric population.[21] The present study also points to the association of congenital anomalies and UTI by showing higher incidence of infection in infants with ureteropelvic junction obstruction and vesicoureteral reflux. When the renal pelvis has a diameter of 10 mm or less, risk of significant UTI is also known to be lower.[22] However,

in our study group, the prevalence of UTI was also significantly high in infants without hydronephrosis. This contradictory result may be attributed to the violation of rules for general hygiene and rules to prevent such infections both due to low socioeconomic status.

Medullary hyperechogenity is an ultrasonographic finding that may be observed in early stages of life. According to Khoory and colleagues,[23] the prevalence of this abnormality is 3.9% in healthy newborns. Medullary hyperechogenity may also be observed in pathological states such as hypernatremic dehydration.[24] In this study, the prevalence of medullary hyperechogenity was 3.1% (23 infants). It was accompanied by acute renal failure in 9, UTI in 10, and multicystic dysplastic kidney in 4 of these patients. Medullary hyperechogenity is known to spontaneously regress during the first 7 to 10 days or following the treatment of underlying causative disorder.

Two to 5% of live births are accompanied by some kind of major congenital abnormalities. Likewise, using a multimodal approach, we observed congenital cardiac, gastrointestinal, and/or other genitourinary anomalies in 18 infants (2.4%) that were found to have congenital anomalies of the kidney and the urinary tracts. Any congenital anomaly, therefore, mandates a careful investigation toward the detection of additional anomalies.

CONCLUSION

This study reveals the rationale of providing ultrasonography screening of urinary system to infants that are born in tertiary medical institutions and those that are admitted to such centers for any cause. This policy may help to establish prompt diagnosis of any urinary abnormality that may get further complicated without timely treatment and/or intervention.

CONFLICT OF INTEREST

None declared.

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