EPIDEMIOLOGY AND CLINICAL EVOLUTION OF CONGENITAL ANOMALIES OF THE KIDNEY AND URINARY TRACT

Raluca Isac[1,2], Gafencu M[1,2], Cristina Olariu[2], Simona Cerbu[1,2], Ligescu A[2], Boia ES[1,3]

Abstract

Congenital anomalies of the kidney and urinary tract (CAKUT) are characterized by structural and functional abnormalities of kidney, collecting system, bladder, and urethra. These anomalies are the most commonly diagnosed malformations in the prenatal and postnatal period and constitute the leading cause of Chronic Kidney Disease (CKD) in children, worldwide. CAKUT can be identified as single malformation or it can be part of a complex malformation. Classification of CAKUT on embryological basis consists of: abnormalities in the renal parenchymal development, aberrant embryonic migration and abnormalities of the collecting system. We analyzed 20,326 children admitted in Children Emergency Hospital Timisoara between January 2015 and March 2016 for different pathologies in a cross-sectional study. The prevalence of children with CAKUT was high in our study 5.3‰, with an incidence of 1.5‰ per year. CAKUT is difficult to detect since there is no significant clinical manifestations in early ages. Clinically, CAKUT are silent most of the time, UTI is the most frequent initial distress clue as it was present in 54.12% of cases by the time of diagnosis. Abdominal ultrasound is the preferred method of screening for CAKUT and it should be recommended as a routine of children`s physical examination.

Keywords: CAKUT, Pelviureteric junction obstruction, Hydronephrosis, renal agenesis, multi cystic dysplastic kidney, vesico-ureteric reflux

Introduction

Congenital anomalies of the kidney and urinary tract (CAKUT) represent an important cause of morbidity in children and at the same time they are the most common cause of Chronic Kidney Disease (CKD) in children1,2. The prevalence of CAKUT reaches 3-6 per 1000 live births 3, can appear as solo malformation or in association with other organ involvement.

Barakat and Douglas analyzed 13775 autopsies in 1991 and 636 patients were found with reno-ureteral malformations (4,61%). Higher incidence was found in pediatric population4.

Antenatal ultrasonography after 28 weeks' gestation can identify renal tract abnormalities with an incidence of 1% to 5% of all pregnancies and 14.3 per 1000 births, permitting early treatment of the asymptomatic newborn and reducing later renal damage5,6.

Embryologic development of kidneys and urinary tract take place during the third and fourth week of gestation7. At birth each kidney contains about 1million nephrons7. Structural development of these nephrons completed by the end of the 34th gestation week, anyhow maturation of kidney function will continue until completion 6 months after birth. Most of prenatal diagnosed hydronephrosis are transient or physiological up to 74%5, resolution occurring within the first three years; therefore most patients will not need surgical intervention8. Overall, children with any degree of antenatal hydronephrosis are at greater risk of postnatal pathology as compared with the normal population6.

CAKUT can be identified as single malformation or it can be part of a complex malformation including muscular abdominal wall defect (Prune-Belly Syndrome), abdominal mass (50% of neonates with abdominal mass have a urinary malformation underneath9), undescended testicle, minor genital alterations, limbs alterations or ear malformations10. Regarding clinical manifestations, most CAKUT are asymptomatic, in other cases though, repeated or recurrent Urinary Tract Infections (UTIs) can be a leading sign. Clinical features vary widely depending on the type, severity and laterality of renal anomaly11. Kidney hypoplasia, ectopic kidneys, and anomalies in shape are mainly asymptomatic, detected by ultrasound, accidentally. Renal agenesis, multi cystic dysplastic kidneys (MCDK), bilateral Pelvi-ureteric junction obstruction (PUJO) and cystic renal diseases can present early either antenatally with oligohydramnios or in newborn with UTI, hypertension, proteinuria, renal impairment, abdominal mass, hematuria or stones12.

[1] "Victor Babeş" University of Medicine and Pharmacy Timişoara
[2] "Louis Ţurcanu" Emergency Hospital for Children Timişoara, Pediatrics
[3] "Louis Ţurcanu" Emergency Hospital for Children Timişoara, Pediatric Surgery

E-mail: ralu_isac@yahoo.com, mgafencu@umft.ro, olariu.ioanacristina@yahoo.com, cerbusimona@yahoo.com , adreealigescu@yahoo.com, boiaeugen@yahoo.com, gdoros@gmail.com

	Cases	Bilateral	Right
Total	**109**		
Renal abnormalities	**27**		
- Unilateral Renal agenesis	9	-	7
- Kidney hypoplasia	7	-	3
- Kidney dysplasia	9	3	2
Aberrant embryonic migration			
- Pelvic kidney	4		
- Fused pelvic kidney	1		
Collecting system abnormalities	**92**		
- Double collecting system	9	4	3
- Hydronephrosys	86	26	23
o Grade I	5	-	-
o Grade II	32	-	-
o Grade III	20	-	-
o Grade IV	22	-	-
o Grade V	4	-	-
- Pelvi-ureteric junction obstruction (PUJO)	36	6	9
- Hydroureter	13	7	2
Urethral malformation	**3**		
- Posterior urethral valves	**0**	NA	NA
- Cloaca	**2**	NA	NA
- Vezical diverticulum	**1**	NA	NA

Table 1: Overview of CAKUT classification with patient group information

Despite recent improvements in prenatal diagnosis and early surgical intervention, these anomalies still remain the primary cause of kidney failure in infants13. Ultrasonography evaluation has enhanced early diagnosis of CAKUT14 and is considered to be "gold standard" of identification of these malformations. CT urography can confirm the ultrasound detected abnormality, complex malformations, demonstration of collecting system and vascular anatomy and also can bring supplemental images and 3D reconstruction of the urinary tract and can be used for CAKUT evaluation both before surgery and post-surgery11. Voiding cystourethrography is needed to evaluate vesico-ureteric reflux (VUR)15.

CAKUT can be classified on embryological basis, in: abnormalities in the renal parenchymal development (MCDK, renal hypoplasia, agenesis or supernumerary kidney, and cystic renal diseases), aberrant embryonic migration (ectopic kidney, fusion anomalies - horse shoe kidney) and abnormalities of the collecting system (double collecting system or PUJO)11.

CAKUT are one of the leading causes of CKD in children13.

Purpose

To describe CAKUT in a cohort of children in the west part of Romania, presented in Children Emergency Hospital Timisoara, aged between 2 weeks and 18 years of age admitted in our hospital, and to compare prevalence with literature data. To highlight about the easy and usefulness of performing abdominal ultrasound in children which should be recommended as part of physical examination.

Material and method

We analyzed 20,326 children admitted in Children Emergency Hospital Timisoara between January 2015 and March 2016 for different pathologies in a cross-sectional study. We included patients having Hydronephrosis grade I to V, renal anomalies regarding number, position of kidneys or structural defects, hypoplastic kidney or renal agenesis and MCDK. Children with urinary tract dilatation due to lithiasis were excluded from the group. We analyzed data about family, sex, living environment, age, type of CAKUT, presence/absence of UTI, number of UTIs, Antibioprophylaxis for UTI, age at the time of diagnosis, presence/absence of surgery treatment and renal impairment.

Data was analyzed using Microsoft Excel, SPSS 2.0 for statistical analysis.

Results

The prevalence of CAKUT was 5.3‰ (109 cases out of 20.326) and the male: female ratio was 1.36:1. Prenatal diagnosis of CAKUT (hydronephrosis in particular) was established only in 9.2% by ultrasound. Incidence of CAKUT was 1.5‰ per year (2015), while the most part of patients were diagnosed before January 2015 and presented in hospital for an acutization or for control.

The prevalence of UTI was 54.12%, meaning more than half of patients presented at least one UTI by the time of diagnosis, while more than half presented for other reasons or CAKUT diagnosis was accidental. Sex distribution of patients with CAKUT and UTI shows a ratio male: female of 1.36:1. Age and sex analysis of patients with CAKUT and UTI reveal that patients at risk for UTI are female toddlers (0 to 12 months) and boys over 6 years. Higher frequency of UTI events was reported in children with neurogenic bladder, collecting system anomalies or associated VUR. About 5.1% of children had over 5 episodes of UTI by the time of diagnosis, even though; almost 70% of children had no more than one UTI. Escherichia Coli and Klebsiella pneumoniae were the commonest isolated bacteria (63%).

Prophylactic antibiotic was used in patients with CAKUT and VUR that presented at least three episodes of UTI.

Trying to establish a classification of CAKUT and the prevalence in our study, we took into consideration dividing CAKUT in: renal abnormalities (kidney agenesis, kidney hypoplasia, kidney dysplasia, position or structural anomalies), collecting system abnormalities (duplicated collecting system, hydronephrosis, congenital PUJO, obstructive megaureter) and urethral malformations. Table 1 shows a list of encountered CAKUT.

Incidence of UTI was reduced with the use of pediatric surgery, consequently it led to reduction in the number of UTIs after surgery also. Corrective surgery was performed in 41 cases (37,6%) mostly in those with severe malformations or recurrent and aggressive UTIs. Prophylactic antibiotics were given to 9 patients (8.3%) in other to reduce the frequency of UTIs.

Discussion

Renal parenchymal abnormalities include renal agenesis, renal hypoplasia, MCDK, , and cystic renal disease. Unilateral renal agenesis is not uncommon; its prevalence is 0.7‰12, often asymptomatic and associating compensatory hypertrophy of the existing kidney. In our study unilateral renal agenesis was found in 9 patients representing 0.44‰ of all patients and 8.25% of patients with CAKUT, 2 of them having also CKD due to abnormalities on the remaining kidney (renal dysplasia or hydronephrosis).

Renal hypoplasia refers to small congenital kidneys due to incomplete renal development. Children with renal dysplasia (MCDK) have renal parenchyma replaced by non-communicating cysts of various sizes with very little functional renal parenchyma12. Incidence is in general population about 0.23‰16, slightly more frequent in males and on the left side. In our study incidence was 0.44‰ (9 patients), with the same slightly increased incidence in males having the left side predominantly affected (male: female ratio 5:4, left: right ratio 4:2). More than half of them (5 patients) had impaired renal function at the time of diagnosis and must be kept under close surveillance.

Abnormal migration anomalies include ectopic kidneys (abnormal location of kidneys) and fusion anomalies (horse-shoe kidney). Both types of malformation are inoffensive unless associated with other CAKUT13.

CAKUT referring to abnormal collecting system will actually talk about duplex collecting system and PUJO. Duplex collecting system is characterized by incomplete fusion of upper and lower pole moieties resulting in a variety of complete or incomplete duplication of the collected system. Based on the degree of fusion, it can present as bifid renal pelvis, partial ureteric duplication (Y-shaped ureter), incomplete ureteric duplication with ureters joining near or in bladder wall (V-shaped ureter) and complete ureteric duplication with separate ureteric orifices11. This is often asymptomatic and incidentally detected. We have found 9 cases of different variants.

PUJO is definitely one of the most common types of CAKUT with the highest prevalence of 2‰ in general population11. In our study, hydronephrosis was at a high prevalence 4.2‰, while PUJO was encountered in 1.77‰ of the cohort group with left: right ratio of 18:9. PUJO represented 33% of CAKUT.

VUR is a common finding in pediatric practice that occurs in about 1% of children and is often familial15. In our group VUR prevalence was 0.73‰, representing 13% of CAKUT patients, with a left: right ratio of 8:2. The majority of low-grade cases have a tendency to resolve spontaneously during childhood. However, VUR has been identified as a risk factor for the development of urinary tract infections (UTI). In addition, some children with high-grade VUR have already renal lesions before the advent of any UTI15.

Conclusions

The proportion of children with CAKUT was high. CAKUT is difficult to detect since there is no significant clinical manifestations in early ages, anyhow abdominal ultrasound is the preferred method of screening, as it should be recommended as a routine of children`s physical examination.

Abbreviations:

CAKUT – Congenital Anomalies of the Kidney and urinary tract
UTI – Urinary Tract Infection
PUJO – Pelvi-ureteric junction obstruction
VUR – Vesico-ureteric reflux
CKD- Chronic Kidney Disease
MCKD – Multi cystic dysplastic kidne

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Correspondence to:

Mihai Gafencu
I. Nemoianu Street, no.2
Timisoara, Romania
e-mail: mgafencu@umft.ro