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Research Article

The Spectrum of Renal Pathologies in Saudi Pediatrics Patients Using Ultrasound

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Abstract

Background and Objective: The Kingdom of Saudi Arabia (KSA) has a high population of children with hereditary renal infections whose factors are linked to the X chromosomes. This study aims to determine the spectrum of renal pathologies in Saudi pediatrics patients as well as to link the genetic aspect to the development of renal diseases in Saudi children by using ultrasound. **Materials and Methods:** The study, hence sought to analyze the outcomes of a cross-sectional retrospective study report at the Radiology department of King Fahad Medical City (KFMC) within 12 months retrogressively. Data was collected using ultrasound machines with B-mode and Doppler modes used to generate results that were later filled in forms. **Results:** Demographic characteristics showed that even though the study incorporated the children between the ages of 1-14 years, renal infection was most prevalent in children between the ages 4-7 years. The study revealed that male children were at a higher risk of getting a hereditary renal infection compared to their female counterparts. Indications for renal ultrasound examination of the study samples indicated that the ectopic renal disease affected 2% of the 50 sample size, while hydronephrosis affected 26% of the sample. **Conclusion:** The current study was able to successfully highlight the role of ultrasound in the detection of a wide range of renal diseases among Saudi children. Additionally, this study attempted to link the genetic aspect to the development of renal diseases in Saudi children, but the use of ultrasound alone was not very helpful in this.

Key words: Color Doppler, Hydronephrosis, multicystic dysplastic kidney, pediatric, polycystic kidney disease, renal ultrasound, vesicoureteric reflux

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Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Children are at a very high risk of various renal diseases, including treatable to long term consequences to life-threatening infections. Acute renal diseases can occur fast and last for a short time, but still, have a long term effect on the child. At times it can also go away in entirety once the root problem has been identified and resolved. However, in the cases where the condition is chronic, it might not go away with treatment and might even get worse over time¹. A chronic renal disease might eventually lead to renal failure that is often seen as the end-stage in any renal disease. From the time of birth to the age of 4-year, heredity, and defect from birth are the primary reasons for the failure of the kidney². From the time the child is aged 4 to 15 years, the heredity issues, in addition to systemic disease and nephritic disease, cause much of the renal abnormalities. Between ages 15 and 19, the glomeruli infections are the most causes of the failure of the kidney, thus making heredity diseases have less prominence in causing a problem.

To examine the kidney, a process known as renal ultrasonography (US) is used. The process is essential in the diagnosis and the management of the various diseases related to the kidney. The ultrasound is a critical process that is inexpensive, accessible, and fast aid in deciding for the patient that can quickly provide a precise examination of the kidney and show most of the pathological changes. In recent times the application of the US with contrast-enhanced ultrasound has helped to make an even more concise analysis of the kidney³.

The Kingdom of Saudi Arabia (KSA) is a vast country that has a massive concentration of the child population. Children that are aged between 0-14 years account for about 29.4% of the country's population. Besides, the child population growth rate is estimated at 1.54%⁴. Moreover, statistics showed that the price to affiliation in the right is high, being at an average of (52-56% of marriages). The statistics on the population of KSA are closely associated with genes that mediate renal infection⁴. However, there are still other factors that lead to a higher incidence of post-infection. Besides, the lack of awareness among the pediatricians on the need for making an early diagnosis of the bladder that is neurogenic with the lesion in the spinal cord or non-neurotic neurogenic bladder makes the chance of chronic renal diseases quite high⁴. The problem is more prevalent in affected children since the conditions might often be only reported at an end-stage. The focus of this article is to study the spectrum of renal pathologies in Saudi pediatric patients using ultrasound.

Genetically transmitted renal disease constitutes a significant portion of the renal abnormalities in childhood.

Some are hereditary that might have a link to the X inheritance, such as the polycystic kidney problem and the Alport's diseases. In KSA, about two-thirds of the marriages are between cousins. Therefore, there is a high possibility of the transmission of renal abnormalities that have autosomal patterns^{5,6}. A study by Kari⁵, tries to look at the prevalence of these conditions in the KSA region. While Al-Homrany⁶ found that, the prevalence of the disease in the areas is high and results in about 8% motility. However, Alsaggaf⁷ argued that genetically mediated renal disease is higher in the KSA region. In another study, it became evident that one of the conditions that are high in the area is post-infection granular pathology⁸. In addition, Jain *et al.*⁹ found that the neurogenic bladder that causes spinal lesions resulting in chronic renal infection is also prevalent in the region. Bearing in mind that in a study about childhood chronic renal disease an experience of a pediatric department, the lack of systematic data on the prevalence of the different conditions has not been effectively explored¹⁰. In the study of Currarino *et al.*¹¹, it becomes apparent that children below the age of 14 are mostly affected by renal diseases that are related to genetic issues. Children that are beyond this age are affected by the condition¹². The lack of genetic variation in the KSA would be one of the significant indicators that need to be explored. Al-Agha *et al.*¹³ stated that about 52-56% of the population comes from consanguinity marriages. These statistics provide an understanding of the reason that many of the renal infections might be passed from one generation to the other¹⁴. The lack of genetic variability that comes from the marriage with cousins means that most of the conditions might remain within the family¹⁵. These studies have thus revealed an essential gap in the linkage between genetic issues and the spectrum of renal infections in the KSA¹¹⁻¹⁵.

The focus of the study is to look at the rate of prevalence for each of the various renal conditions and understand the more prevalent ones. With the analysis of the causes of the infection, it would be possible to understand whether there is a preference for genetically based diseases or other infections. Therefore, this study aimed to determine the spectrum of renal pathologies in Saudi pediatric patients as well as to link the genetic aspect to the development of renal diseases in Saudi children using ultrasound

MATERIALS AND METHODS

Study design and settings: The focus of this study is to use a cross-sectional, retrospective study; therefore, the research seeks to analyze the outcomes of the patients retrospectively within 12 months between May 2019 up to May 2020. There are still specific threats are taking into account, including the

threats to validity and the measurement errors that came from the retrospective assessment. However, these issues are well addressed in the design, making it more suitable for the cross-sectional study of children in the KSA. The choice of using a cross-sectional, retrospective study involves data collected at a definite time that allows the current study to be made at little or no expense. However, this is a major disadvantage over other forms of epidemiological study as routinely collected data does not normally describe which variable is the cause and which the effect¹⁶. As this method allows for the collection of a large amount of data within a short time. The data would be obtained from a self-report survey that will enable us to deal with a large population. The setting of the study explores a retrospective pattern at the Radiology Department of King Fahad Medical City (KFMC).

The population of the study and sample selection: The study population comprises of a total of 50 cases of Saudi pediatrics patients. A convenient sampling method was used to include all referred patients. The sample size of 50 cases with various renal pathologies was selected. The selection criteria only focused on limiting the results to include only Saudi pediatrics patients, as well as from different regions of KSA. The criteria of exclusion were based on the characteristics that children were beyond the age of 14 were not included. Studies have shown that most of the children beyond the age of 14 are not affected by hereditary renal conditions; therefore, they were excluded from the study. The study did not use the background as one of the exclusion criteria; the focus was all the children that met the criteria were included in the study.

Ethical considerations: The ethical considerations involved getting approval from the local ethics committee before starting data collection for this project started. The basic requirements for obtaining approval from the various medical facilities were meeting the standards of the local ethics committee in KFMC. Besides, the participant was given enough information and allowed to give their consent before the start of the study. All patients were informed of the confidentiality of the research and that the findings would only be used for analysis and not any other commercial or social objectives. The participants were required to sign the consent form while participation was voluntarily.

Data collection and data analysis: The data collection instrument included sheets and different ultrasound machines with B-mode and Doppler modes in the area of the study were

utilized to provide the differential results that were later filled with the leaves. Results were analyzed by using the standard Statistical Package for the Social Sciences (SPSS) version 20 for Windows (IBM Corporation, Armonk, NY, USA) and the layout of the results filled tables and graphs. Descriptive analysis was used to describe patients' characteristics and prevalence of renal pathologies.

RESULTS

The first characteristic was the demographics that show sample population was mostly aged between at the age of 6 years. While the community included a sample of children aged from ages 1 to 14 years, most of the children that were infected were aged between 4 to 7 years. The lowest percentages were from ages 12 to 14. There was thus a clear difference in regards to the ages that the children were mostly affected by renal diseases. Most of the children were at the age of 4-7 years. In addition, the males were at a higher risk as compared to females. From the result, about 60% of males were affected as compared to 40% of females. The last characteristics were regions, and the studies show that children in from Central region are more affected as compared to the ones that come from the Western region (Table 1).

The second analysis looks at the ultrasound indication in the study sample. The differential diagnosis shows that there is a significant difference between the various types of infection in the children. Analysis of the indications for renal ultrasound examination of the study sample showed that the ectopic kidney affected only 2% of the sample, while Hydronephrosis affected about 26% of the sample (Table 2).

Table 1: Demographic data and general characteristics of the study samples

Characteristics	n	%
Age		
1-3 years	13	26
4-7 years	22	44
8-11 years	11	22
12-14 years	4	8
Gender		
Male	30	60
Female	20	40
Region		
Central region	37	74
Northern region	4	8
Southern region	6	12
Eastern region	3	6
Western region	0	0
Family history		
Positive for renal disease	8	16
Negative for renal disease	42	84

Table 2: Indications for renal ultrasound examination of the study samples

Indications for renal ultrasound examination	n	%
Ectopic kidney	1	2
Haematuria	1	2
Renal cyst for follow up	1	2
Polycystic kidney disease (PCKD)	1	2
Pelviureteric junction (PUJ) obstruction	1	2
Pyeloplasty	2	4
Bilateral vesicoureteric reflux (VUR)	3	6
Unilateral VUR	3	6
Multicystic dysplastic kidney (MCDK)	4	8
Neurogenic urinary bladder (UB)	5	10
Loin pain	7	14
Recurrent urinary tract infection (UTI)	8	16
Hydronephrosis for follow up	13	26

Table 3: Demonstrate ultrasound findings of the right kidneys in the study samples

Ultrasound findings	n	%
MCDK	1	2
Simple cortical cystic mass	3	6
Renal calculi	1	2
PCKD	1	2
Renal agenesis	2	4
Nephrocalcinosis	3	6
Moderate hydronephrosis	6	12
Mild hydronephrosis	6	12
Normal	27	54

Table 4: Demonstrate ultrasound findings of the left kidneys in the study samples

Ultrasound findings	n	%
PCKD	1	2
Ectopic kidney	2	4
MCDK	3	6
Nephrocalcinosis	3	6
Severe hydronephrosis	5	10
Moderate hydronephrosis	7	14
Mild hydronephrosis	9	18
Normal	20	40

The third analysis looked at the pathologies in the right kidneys of the digitized samples. The results show that in the right kidneys, MCDK, simple cystic mass, renal calculi and PCKD had the lowest pathological result. On the other hand, hydronephrosis was more prevalent in the right kidneys (Table 3). However, in the left kidneys, there was a variation in regards to hydronephrosis, where the mild hydronephrosis was highly detected (Table 4). However, as compared to the right kidneys, it emerged that the left kidneys were more affected. While the right kidneys were 54% normal, the left kidneys were only 40% normal (Table 3 and Table 4).

Regarding the measurement of renal blood flow by color Doppler ultrasound in the study samples, there was normal, blood flow detected in 45 (90%) and 36 (72%) in right and left kidneys of patients, respectively. While the decrease of blood flow perfusion was detected in 2 (4%) of right kidneys and 11 (22%) of the left kidneys of patients. The absence of vascularity for kidneys was seen in 3 (6%) for each (Table 5).

Table 5: Status of renal blood perfusion in the study samples using color Doppler ultrasound

Renal blood perfusion status	Right kidney		Left kidney	
	n	%	n	%
Normal blood flow	45	90	36	72
Decrease blood flow	2	4	11	22
Absence of vascularity	3	6	3	6

DISCUSSION

The demographic characteristics revealed that the age of the child had a severe impact on the prevalence of renal infection. Therefore, the spectrum of renal pathologies is profoundly affected by the age of the children. The children aged between 4 to 7 years, most at risk, while the one aged between 12 to 14 years had the least chance. Besides, the location of the child had an impact on their prevalence of infection. The children from the Central region were at higher chances as compared to the children in the Western region. Lastly, the gender of the children was an important factor in the prevalence. Males were at a higher risk as compared to females. Besides, the family history did not have much impact on the spectrum. The family history had only a 16% positive impact, while 84% of the samples show a negative response (Table 1 and Table 2).

MCDK is a congenital dysplasia of the kidney that is characterized by large nonhomogeneous dilations of the collecting tubules¹⁷. The prevalence rate of MCDK in right and the left kidneys in our study is 1 (2%) and 3 (6%), respectively (Table 3 and Table 4). Which was compatible with the results of Kalyoussef *et al.*¹⁸ and Whittle¹⁹, where they found incidence rates of MCDK ranged from 4.5 to 21%. When further exploring congenital abnormality, ectopic kidneys are displaced from their normal sublumbar location because of abnormal migration during fetal development¹⁹. In the current study, the ectopic kidney was reported only in the left kidneys with an incidence rate of 2 (4%) as presented in Table 4.

In addition, only one case (2%) of simple cystic mass was detected in the right kidneys as shown in Table 3. The incidence of renal stone formation in pediatric patients with suspected renal abnormalities in our study was 1 (2%), which is higher than the rate reported by Wenzl *et al.*²⁰, where the 1 (2%) might be due to that our sample size was higher than the population they investigated.

PCKD is an inherited disorder in which clusters of cysts develop primarily within the kidneys, causing the kidneys to enlarge and lose function over time²¹. PCKD is occurring at an incidence of approximately 1:1000. As its name implies, it is inherited as an autosomal dominant trait. However, there is considerable phenotypic variability, even within the same

family. Males and females are affected equally and ADPKD is present in all races and ethnicities²². In this study the PCKD incidence was equal in both kidneys, the detection rate is 1 (2%) right kidneys and 1 (2%) left kidneys (Table 3 and 4).

Unilateral renal agenesis means that a baby develops only one kidney. Found in roughly one in 1,000 live births (higher in twins), this condition is not fatal and often causes no additional symptoms²³. In the current study renal agenesis was detected in the right upper quadrant (Table 3) and the incidence rate is 2 (4%). Previous reports have shown that the incidence rate of unilateral renal agenesis was 1/1617²³. This difference in incidence rates could be due to the smaller sample size when compared to the previous study.

To the best of our knowledge, renal cysts are benign clinical conditions that may occur well within the kidney or on its surface. Simple cortical renal cysts usually occur in normal kidneys and become more prevalent as people age. They usually have no symptoms and rarely need treatment²⁴. In the study conducted by Kari *et al.*²⁵, the renal cysts were reported in 4 babies (1.2%), while the incidence of a simple renal cortical cystic mass in our study was 6% as presented in Table 3. The difference in incidence rates could be due to smaller sample size when compared to the other studies. Further, nephrocalcinosis is a disorder that occurs when too much calcium is deposited in the kidneys²⁶. In contrast, nephrocalcinosis is mostly asymptomatic, especially during infancy and early childhood. Hence, the diagnosis is often only made when nephrocalcinosis is incidentally noted on an imaging study performed for other reasons or when symptoms of reduced concentrating capacity of the renal tubules are obvious²⁷. The incidence rate of nephrocalcinosis in the current study in the left and right kidneys were 3 (6%) and 3 (6%), retrospectively (Table 3 and Table 4) which is higher than the rate (7.8%) reported by Wenzl *et al.*²⁰. This might be because our sample size is lower than the population they investigated. In addition, Hydronephrosis is the swelling of a kidney due to a build-up of urine. It happens when urine cannot drain out from the kidney to the bladder from a blockage or obstruction²⁸. The study symptoms and indications for renal ultrasound examination of the study samples indicated that the ectopic renal disease affected 2% of the 50 sample size, while hydronephrosis affected 26% of the sample (Table 2).

Doppler ultrasound of the kidneys is essential in the assessment and diagnosis of renal diseases. Using Doppler imaging provides an assessment of vascular changes that are easily evaluated²⁹. As these previous facts were used to obtain

the relevant part of the results of the current study on the measurement of renal blood flow by color Doppler ultrasound (Table 5). Where it was found that the rate of normal blood flow in the kidneys of patients is greater than the decrease of the speed of blood flow or even the complete absence of blood perfusion in the kidneys²⁹.

This study is limited by the unevenness of the population as a result of the randomized selection process, which unfortunately might affect the accuracy of diagnosed renal pathologies in Saudi pediatrics patients using ultrasound and in fact significantly reduce the power of the conclusions because it makes other age groups have lower statistical credibility if applied in future studies. Taking in mind the disadvantages of cross-sectional, retrospective study studies as: i) routine data may not be designed to answer the specific question, ii) routinely collected data does not normally describe which variable is the cause and which the effect, iii) cross-sectional studies using data originally collected for other purposes are often unable to include data on confounding factors, other variables that affect the relationship between the putative cause and effect and iv) cross-sectional studies are very susceptible to recall bias. Despite the above limitations, the importance of the current study lies upon it is one of the few studies that were interested in determining the spectrum of renal pathologies in Saudi pediatrics patients using ultrasound.

In addition, this study attempted to link the genetic aspect to the development of renal diseases in Saudi children, but the use of ultrasound alone was not very useful in this. Therefore, it is one of the future suggestions that the current study offers to interested researchers is that the database is expanded more for this category of patients and work to find additional ways besides ultrasound helps in checking the genetic linkage of the development of these diseases in Saudi children, whereas in KSA, about two-thirds of the marriages are between cousins as the scientific sources used also referred to in this study.

CONCLUSION

In conclusion, the study was able to successfully highlight the role of ultrasound in the detection of a wide range of renal diseases among Saudi children, as the ultrasound examination of the kidneys showed speed, ease, and low cost, as well as the absence of risks to patients during the examination. Additionally, this study attempted to link the genetic aspect to the development of renal diseases in Saudi children, but the use of ultrasound alone was not very helpful in this.

SIGNIFICANCE STATEMENT

This study shows that there are variations in the prevalence of renal pathologies in pediatrics patients using ultrasound. However, no evidence shows that there is a link better genetically linked pathology and renal infections. In fact, most of the genetically related pathologies have a very low incidence, yet the ones that are not genetically linked do not have a high prevalence.

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