Original Article

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USG Changes in Different Kidney Diseases of Children

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Abstract

Background: The kidney disease is one of the major causes of morbidity and mortality in paediatric age group around the world and its laboratory evaluation cost is also very high. **Objective:** This study was aim to determine ultrasonographic (USG) changes of kidney in any renal diseases in children and to correlate between USG findings with the clinical features as well as with biochemical parameter (serum creatinine). *Methods:* A total 200 cases irrespective of sex and age ranging from birth to 12 years were enrolled in this study which was done in tertiary care hospital from July 2003 to June 2004, 100 of wtich were clinically presented with kidney diseases and 100 were non renal cases as control. Clinical parameters were noted as per pre-prepared questionnaire of the studied group who fulfilled the inclusion criteria. All the studied populations were undergone of USG of KUB regions by expert radiology and imaging specialist in a modern suitable machine and biochemical parameters specially serum creatinine level were done in all the cases for correlation. **Results:** Among 100 renal cases, acute glomerulonephritis and nephrotic syndrome were most frequently presenting renal diseases followed by chronic renal failure, hydronephrosis, pyelonephritis, renal stone, nephroblastoma and polycystic kidney diseases less than 12 years of age. In renal cases 64 (64%) were USG positive (p value <0.001). The various USG changes of kidney diseases were the highest of abnormal echo-structure (96.8%) and second highest were enlarged kidney (81.25%). Poor or loss of corticomedullary differentiation were 43.75% and 21.8% cases showed dilated pelvi-calyces and ureter. Atrophied kidney was 12.5% and only 6.25% cases showed bladder abnormality. Total 35 (35%) renal cases showed high serum creatinine level among those 28 (80%) were USG positive and 7 (20%) were USG negative (p value<0.001). **Conclusion:** USG can be used as an important diagnostic tool to evaluate the kidney diseases in children. The sensitivity of USG changes of renal cases was 64% and specificity was 97%.

Key words: USG Changes of Kidney Diseases in Children, correlation with serum creatinine level.

Introduction

The kidney disease is one of the major health problems throughout the world causing significant morbidity and mortality in paediatric age group. Early diagnosis and treatment are predominant factor which determine its outcome[1,2]. Different categories of diseases are found in different age groups[3]. Ultrasonography (USG) is an accepted primary imaging modality for evaluating paediatric urinary tract diseases[4]. It is the first imaging technique to be employed in patient presented with renal colic, suspected renal mass, haematuria, renal failure, recurrent urinary tract infection, trauma to the kidney, polycystic kidney diseases, non-functioning kidney, pyelonephritis and renal tuberculosis[5].

It also considered as first choice of imaging for diagnosis urinary tract disease in new born[6]. The method of USG examination is portable, non invasive and inexpensive[7]. So it can be done easily. Its specificity and sensitivity are about 90% for hydronephrosis, 98% for pelvicalycal dilation and 70% for VUR (Vesico Ureteric Reflux) [8,9,10].

The mortality rate of bacteraemia and septic shock due to pyonephrosis is 25% and 50% respectively[11]. Fifteen percent of patient of pyonephrosis will be asymptomatic at presentation[12]. USG help in early diagnosis of pyonephrosis which showed mobile collecting debris with or with out a fluid-debris level in a dilated collecting system of the kidney[13]. It also helps to diagnose an asymptomatic CRF and 85% CRF patients had hyper-echoic thin cortex[14,15]. Renal tuberculosis is rare in children because the incubation period of tubercle bacilli is several years[16]. In 51% patient of Nephrotic syndrome showed kidney changes of sonogram in the form of nephromegally 42% and increased renal echogenicity 35%[17]. The degree of increased echogenicity of renal cortex is directly related with the severity of renal diseases[18]. USG examination delineated renal swelling as well as parenchyma changes

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consistent with acute pyelonephritis and marked enlargement of kidney with defused hyper-echogenicity in the cortex suggesting the tubule-interstitial nephritis (TIN)[19, 20]. It is an excellent diagnostic tool in the investigations of the mass suspected in renal origin, urinary tract obstruction, renal and perirenal infection and nephroblastoma in infant and children[21].

The objectives of this study was to determine USG changes in any renal diseases in children and to correlate between the clinical features with USG findings and to compare between the USG findings with serum creatinine level.

Methodology

A analytical cross-sectional study was carried out in the department of paediatric in Sir Salimullah Medical College & Mitford Hospital from July 2003 to June 2004. A total 200 cases of age group ranging from birth (0 day) to 12 years were enrolled in this study of which 100 were clinically presented with kidney diseases and 100 were non renal cases. Detailed history taking was taken and physical examination were done according to preplanned questionnaires. All the cases were recorded in a check list form with personal information. Critically ill patient were excluded from this study. The clinical features were recorded in questionnaire included puffy face, generalized swelling, oliguria, macroscopic haematuria, dysuria, abdominal pain, abdominal mass, anaemia, hypertension, history of kidney disease of other sibs and bed side urine test. The common investigations such as urine R/E, UTP, serum creatinine, serum total protein and serum albumin were done by skilled biochemist and pathologist with the help of modern instrument, analyzer and medical kits. The USG examination were done by a postgraduate radiologist and imaging specialist. A two dimensional (B-mode) ultrasound machine were used. The scanning were done by 5.0 MHz transducer & a coupling agent were used for scanning to prevent air trapped between the skin and transducer. During scanning, size of the kidney was measured correctly then it plotted over the normal size chart of this particular age group to evaluate the size. Corticomedullary differentiations were assessed and echogenicity of the cortex were measured and compared with the echogenicity of liver and renal pyramid. Normally, the cortex is less echogenic than the liver but more echogenic than the adjacent renal pyramids & subsequently any abnormality or dilatation of the pelvi-calyceal system and ureters were searched and finally condition of the urinary bladder was assessed. All the data were entered carefully in the computer and statistical analysis was done with the help of SPPS version 17.

Result

Among 100 clinically presented with renal diseases, minimum age of the patient was 1 month and maximum 12 years. Acute glomerulonephritis and nephrotic syndrome were most frequently presenting renal disease followed by chronic renal failure, hydronephrosis, pyelonephritis, renal stone, nephroblastoma and polycystic kidney diseases under 12 years of age. Eighty two percent renal diseases were present in between the age of 3-12 years and 18% were under the age of 3 years (Table 1).

Table 1: Distribution of children by age and renal diseases (n-100)

Name of the disease	0-<3yrs	3-<6yrs	6-12yrs	Total (n)
AGN	3	15	24	42
NS	10	17	09	36
CRF	01	03	03	07
HN	02	03	02	07
PN	0	01	02	03
RS	0	0	02	02
NB	01	01	0	02
PCKD	01	0	0	01
Total	18	40	42	100
Percentage	18%	40%	42%	100%

Note: AGN = Acute Glomerulonephritis; NS=Nephrotic Syndrome, CRF=Chronic Renal Failure, HN=Hydronephrosis, PN=Pyelonephritis, RS=Renal Stone; NB=Nephroblastoma, PCKD=Polycystic Kidney Diseases.

Total 200 studied patients, among which 100 were clinically presented renal and 100 were non-renal cases and ultrasonogram of KUB region were done among all the studied population. It revealed in renal cases USG positive were 64% and non renal cases USG positive were only 03%. Out of 100 renal case, 64 (64%) were USG positive and 36 (36%) were USG negative. So, in renal cases, USG positivity is highly significant (p value <0.001) than the non-renal cases. The sensitivity of USG changes of renal cases was 64% and specificity was 97% (Table 2).

Table 2: Number and percentage of renal and non-renal cases by ultrasonographic status.

USG findings	Number renal cases	Number non-renal cases
USG positive	64(64%)	03 (03%)
USG negative	36 (36%)	97 (97%)

Chi square at df. 1 at 0.001 levels is 10.83 and P value <0.001

Out of 100 clinically presented renal cases 64 cases were showed abnormal USG finding. The USG changes were enlarged or atrophied kidney, poor or loss of

differentiation, abnormal echo-structure, dilatation of pelvi-calyces and ureters, and urinary bladder abnormality. Among the various changes maximum kidney showed abnormal echo-structure (96.8%). The second highest were enlarged kidney (81.25%), poor or loss of cortico-medullary differentiation were 43.75% and 21.8% cases showed dilated pelvi-calyces and ureter. Atrophied kidney was 12.5% and only 6.25% cases showed bladder abnormality (Table 3). USG positive findings were found in chronic renal failure, hydronephrosis, renal stone, nephroblastoma and polycystic kidney diseases in cent percent cases. Renal diseases were present clinically as puffy face, generalized oedema, macroscopic hematuria, oliguria, hypertension (HTN) and positive heat coagulation at bed side. Acute glomerulonephritis, nephrotic syndrome and chronic renal failure were present multiple clinical parameters but hydronephrosis, pyelonephritis, renal stone, nephroblastoma and polycystic kidney diseases were present single clinical parameter. Positive USG findings were found frequently of all the clinical parameter in different kidney diseases (Table 4).

Table 3: Distribution of children by USG changes in various kidney diseases (n-64)

Name of the disease	No of cases					
	Abnormal echo-structure	Enlarged kidney	Poor/loss of cortico-medullary differentiation	Dilatation of the pelvi-calyces and ureters.	Atrophid kidney	Abnormality in in bladder wall
AGN	30	29	07	01	0	0
NS	12	10	03	01	01	0
CRF	07	0	07	02	07	1
HN	06	07	05	07	0	02
PN	03	03	02	01	0	0
RS	01	0	01	02	0	1
NB	02	02	02	0	0	0
PCKD	01	01	01	0	0	0
Total	62(96.8%)	52(81.25%)	28(43.75%)	14(21.8%)	08(12.5%)	04(6.25%)

Note: AGN = Acute Glomerulonephritis; NS=Nephrotic Syndrome, CRF=Chronic Renal Failure, HN=Hydronephrosis, PN=Pyelonephritis, RS=Renal Stone; NB=Nephroblastoma, PCKD=Polycystic Kidney Diseases.

Most common laboratory finding is routine urine examination which showed abnormal findings in different kidney diseases among the studied group. Nephrotic range of protienuria, hypoprotienemia and hypoalbuminemia were found in nephrotic syndrome and chronic renal failure. Total 35 (35%) renal cases were showed high serum creatinine level among these 28 (80%) were USG positive and 7 (20%) were USG negative. This indicated that high serum creatinine level in kidney diseases were associated with USG changes of kidney which was highly significant (p value<0.001) (Table 5).

Acute glomerulonephritis, nephrotic syndrome and chronic renal failure were about fifteen days, seventeen days and twenty days at hospital respectively who were positive findings in sonogram but without sonographic findings their hospital stay were less. It revealed that the mean duration of USG positive stayed more days in hospital than USG negative case in maximum renal diseases (Table 6). The outcomes were divided into 3 types such as improved, discharged on risk bond (DORB) and death. In USG negative patient 88.8% were improved where as USG positive patient 68.7% were improved. DORB in USG negative cases were 11.11%, USG positive case 25%.

Table 4 : Distribution of children with different kidney diseases by USG findings and clinical presentation

Diseases		Puffy face	Generalized Oedema	Macroscopic hematuria	Oliguria	HTN	Positive heat coagulation
AGN	USG (+)	31	15	21	31	23	30
	USG (-)	11	02	05	11	05	10
NS	USG (+)	13	13	01	10	01	13
	USG (-)	23	21	0	11	0	23
CRF	USG (+)	05	03	01	01	06	02
	USG (-)	0	0	0	0	0	0
HN	USG (+)	21	0	0	0	0	0
	USG (-)	05	0	0	0	0	0
PN	USG (+)	01	0	0	0	0	0
	USG (-)	01	0	0	0	0	0
RS	USG (+)	0	0	01	0	0	0
	USG (-)	0	0	0	0	0	0
NB	USG (+)	0	0	0	0	01	0
	USG (-)	0	0	0	0	0	0
PCKD	USG (+)	0	0	0	0	01	0
	USG (-)	0	0	0	0	0	0

Note: AGN = Acute Glomerulonephritis; NS=Nephrotic Syndrome, CRF=Chronic Renal Failure, HN=Hydronephrosis, PN=Pyelonephritis, RS=Renal Stone; NB=Nephroblastoma, PCKD=Polycystic Kidney Diseases.

Table 5 : Correlation between Renal function (Serum creatinine) and USG finding.

Creatinine level	USG Positive No. (%)	USG Negative No. (%)
High serum creatinine (n-35)	28 (80%)	7 (20%)
Normal serum creatinine (n-65)	36(55%)	29(45%)

Table value of chi square at df. 1 at 0.001 level, P value <0.001

Death in USG negative cases 0%, but in USG positive case were 4.6%. This indicated that the outcome of USG negative cases were better than USG positive case (Table 7).

Discussion

Among 100 hospitalized patients clinically presented with renal diseases were evaluated to find out the USG changes in different kidney diseases of children. In present study total 200 cases were selected. Out of 200 cases, 100 patients were clinically presented with renal diseases as case and other 100 cases were non-renal as control. Among them 42 (42%) cases were AGN, 36 (36%) cases of NS, 07 (7%) cases CRF, 07 (7%) cases were HN, 03 (3%) cases PN, 02 (2%) cases RS, 02 (2%) cases NB and 01 (2%) cases were PCKD. AGN and NS were the most common renal diseases in paediatric age group[22]. Incidence of AGN in 5 years to 12 years and Nephrotic syndrome was 2 years to 6 years was very high and <3 years AGN was uncommon[23]. In the present study it was found that high incidence of AGN in 6 to 12 years and NS within first 6 years of life and AGN was uncommon in <3 years of age. A study in USA showed that 85% of clinically presented renal disease was USG positive[24] and another study at Taiwan showed 79.4% USG changes of renal cases[25]. Present series, we found USG changes in 64% renal cases and in control group it was found in only 3% population. USG finding of individual renal cases were found as follows AGN 73.8%, in NS 36. 1%, in CRF 100%, in HN 100% and in PN 33.3%.

Table 6 : Mean duration of hospital stay (days) by positive and negative USG findings in different types of kidney diseases of children

Name of the diseases	USG positive (Days)	USG negative
AGN	15.19	13.0
NS	17.46	16.0
CRF	20.0	0
HN	7.42	0
PN	8.0	12
RS	6.0	0
NB	24.0	0
PCKD	3.0	0

Note: AGN = Acute Glomerulonephritis; NS=Nephrotic Syndrome, CRF=Chronic Renal Failure, HN=Hydronephrosis, PN=Pyelonephritis, RS=Renal Stone; NB=Nephroblastoma, PCKD=Polycystic Kidney Diseases.

The present study showed positive correlation between positive USG finding and presence of important clinical feature like generalized oedema, macroscopic haematuria and hypertension. A study at Paediatric Nephrology Department in University Medal Centre, Slovenia, observed a positive correlation between positive USG finding and clinical features[26]. In the present study different types of USG changes were found in renal cases such as enlarged kidney in 81.25%, reduced size of the kidney in 12.5%, poor or loss of cortico-medullary differentiation in 43.75%, abnormal echo-structure (Hyper or hypechoic) 96.8%, dilatation of pelvi-calyces and ureter 21.8% and abnormal bladder 6.25%. Similar findings were observed in other studies[27]. Cent percent different form of USG positive findings were found in chronic renal failure, hydronephrosis, renal stone, nephroblastoma and polycystic kidney diseases which also stated in an study at department of paediatrics in national Taiwan university

Table 7 : Outcome of both USG positive and USG negative cases in different types of kidney diseases of children.

Diseases	USG positive			USG Negative		
	Improved	DORB	Death	Improved	DORB	Death
AGN	26	04	01	10	01	0
NS	11	02	0	20	03	0
CRF	02	03	02	0	0	0
HN	01	06	0	0	0	0
PN	01	0	0	02	0	0
RS	02	0	0	0	0	0
NB	01	01	0	0	0	0
PCKD	0	01	0	0	0	0
Total	**44(68.7%)**	**17(26.6%)**	**03(4.6%)**	**32(88.8%)**	**4(11.2%)**	**0(0%)**

Note: AGN = Acute Glomerulonephritis; NS=Nephrotic Syndrome, CRF=Chronic Renal Failure, HN=Hydronephrosis, PN=Pyelonephritis, RS=Renal Stone; NB=Nephroblastoma, PCKD=Polycystic Kidney Diseases.

hospital[28,29].

The present study also showed a positive relation between abnormal USG finding and serum creatinine level. Out of 100 renal cases high serum creatinine were found in 35 cases, out of them 80% were USG positive and 20% were USG negative. A study in Taipei in a national hospital under department of paediatrics show a positive relation between the increase echogenicity of cortex and high serum creatinine and similar finding was also observed in other study[18,26]. Present study showed that the mean duration of hospital stay (days) was higher in USG positive than USG negative patients. A study in the department of paediatrics, Fukui Medical School, Matsuaka, Japan showed mean duration of hospital stay (days) of USG positive patient were higher than USG negative patient[30]. Present study also showed the outcome of the USG negative patient was better than the outcome of USG positive cases, improvement occur 88.8% of cases in USG negative, 68.7% cases in USG positive cases. Death was 0% in USG negative cases but 4.6% in USG positive cases and similar findings were stated in another study[30].

Conclusion

In this study various types of USG changes were found in different renal diseases of children which were nephromegally, reduced size of the kidney, abnormal echogenicity, poor or loss of cortico-medullary differentiation, pelvicalyceal dilatation and bladder abnormality. The sensitivity of USG positive cases was 64% and specificity was 97%. High serum creatinine in kidney diseases were highly associated USG changes of kidney. The outcome of the USG negative cases was better than USG positive cases. These indicate that USG can be used as an important diagnostic tool to evaluate the kidney diseases in children.

References

1. Jequier S, Jequier JC, Hanquinet S. Acute Childhood Pyelonephritis: Predictive value of positive sonographic finding in regard to later parenchyma scarring. J Urol 1996; 156 (2): 725-9

2. Key Serling HF, Fielding JR. Mittel Stacdt CA. Renal sonography in the intensive care unit; when is it necessary? Zhonghua Min Guo Xiao Er Ke Yi Xue Hui Za Zhi 1997; 38(4); 276-81

3. Suraj Guple, RM Shore, Paediatric Nephrology. The short text book of peadiatrics, 10th ediction, 427, 437

4. Wingberg B, Yeung N. Sonographic sign of intermittent dilation of the renal collectinjg system in 10 patients with vesicoureteric reflux. Scand J Urol Nephrol 2003; 37(1): 28-30

5. P.E.S. Palmer.: Basics of Ultrasound. Manual of diognosic ultrasound, WHO, Geneva: 1995

6. Neil MC Intosh, Peter Helms, Rosalind smyth. Forfar and Armeil's Text book of Pediatrics, The new born. 5th edition, 1998 (242)

7. Avni EF, Ayadi K, Rypens F, Hall M Schulman CC. Can careful ultrasound examination of urinary tract exclude vesicoureteric reflux in neonate? Arc Dis Child 2002; 86(6): 419-20

8. Julian L. Seifter, Barry M. Brenner. Urinary tract obstruction. Harrison's Principles of Internal Medicine, 14th edition, 1575

9. Hugh R. Brady, Barry M. Brenner. Acute renal failure. Harrison's Principles of Internal Medicine, 14th education, 1510

10. Mathant S, Friedman J, Mac Arthur C. Renal ultrasound findings and vesicoureteric reflux in children hospitilized with urinary tract infection. J Clin Ultrasound 1998; 26(2); 65-8

11. Carol M. Rumack, Stephanic R. Wilson, J. William Charbo neou.: The Urinary Tract. Diagnostic ultrasound. 2nd edition

12. Patel NP Laveitgoud RW, Frunade SM et al. Gas-foriniting infection in the genituurinary tract. Ito/ogy 1992;39:34 1-345

13. Nlichaeli 1. Mugle P, Perlberg S et al: Euphysematous pyelonephritis. JUR, 1984; 131:203-208

14. Pastor-Pots E, Martinez-Lon Nl, Alvarez-Bustos C et al: Isolateth renal nucortycosis in two patients with AIDS. Mr 1996; 166:1 282-1284

15. Torora M, Coldblumn LE, hutchins CM et al. Renal involveinent in: sonographic-MR 1988; 150:1321-1325

16. Behrman RE, Kliegman RM, Nenson HB, Nelson Text book of paedialtrics, 17th edition, WB Saunders company, 2004

17. Gershen R S, Brody A S, Duffy LC, Springate JE. Prognostic value of sonography in childhood nephrotic syndrome. Child Nephrol Urol 1991; 11(4): 209-11

18. Tsau YK, Lee Pl, Chang LY, Chen CH. Correlation of quantitative renal cortical echogenicity with renal function in pediatric renal diseases. AJR Am J Roeutgenol 1999; 173(4): 1075-7

19. Sommerville AJ. Ultrasound in the investigation of renal disease infanst and children Nephron 2002; 92(1)244-5

20. Hiraoka M, Hori C, Tsuchida S, Tsukhara H, Sudo M. Ultrasonographic finding of acute tubulo interstitial nephritis. Pediatr Rediol 1999;29(10): 736-40

21. Sommerville AJ. Ultrasound in the investigation of renal disease in infants and children Nephron 2002; 92(1)244-6

22. Sommerville AJ. Ultrasound in the investigation of renal disease in infants and children. Nephron 2002;92(1)192

23. Chen CH. Correlation of quantitative renal cortical echogenicity with renal function in pediatric renal diseases. AJR AM J Roeutgenol 1999; 173(4):108

24. Yassa NA, Peng M, Ralls PW. Perirenal lucency ("kidney sweat"): a new sign of renal failure. Am J Nephrol. 1996; 16(2): 154-4

25. Tain VL. Vesicoureteral reflux. Clin Radiol. 2001; 56(12): 979-83

26. Lerart Tk, Kenig A, Fettich JJ, Sensitivity of Ultrasonography in detecting renal parenchymal defects in children. J Urol. 2002;168(2): 1821-5

27. Kraus RA, Gaisie G, Young LW. Increased renal parencymal echogenicity: Causes in pediatric patients. Z Urol Nephrol 1986; 79(8); 459-64

28. Trappe BO, Von Rohden L, Kleinhans f, Wiemann D, Knittle b, Koditaz H. Kidney sonography in glomerulopathies in childhood. Radiology 1984; 152(2) 413-7

29. Kenig A, Fettich JJ, Sensitivity of ultrasonography in detecting renal parenchymal defects in children. J Urol. 2002; 168(2): 1821

30. Hiraoka M, Hori C. Ultrasographic finding of acute tubulointerstitial nephritis. Pediatr Radiol. 1999; 29(10): 736-40