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Kidney Dimensions In TC-99m DMSA Scan Compared To Morphometric Parameters In Normal Children

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Abstract

In this study it was aimed to examine morphometrical measurements of the kidney with consideration of its clinical importance. Chosen subjects were 83 male and 147 female children from 230. In the scope of the study age group of children was between 7-11. Height, weight, and width, length and thickness of both kidneys of the children have been measured in the Department of Nuclear Medicine of Necmettin Erbakan University Meram Faculty of Medicine. Dimensions of kidneys have been examined proportionally to their height and weight. Results have been examined with Pearson analysis and t-test. On average, 69,21±13,8 mm as length, 32,66±6 mm as width, 18,59±3,5 mm as thickness of right kidney and on average 70,97 ±14,2 mm as length, 33,51 ±6 mm as width,18,97±3,6 mm as thickness of left kidney, and 109,40±31,1 cm as length, as 23,32 ±15,7 kg as weight of the children were measured. When the correlation of the parameters with each other was examined it has been observed that width, length, thickness of right kidney on average were higher than width, length, thickness of left kidney, and that kidney dimensions were higher in females (p>0.05). Considering clinical importance of the kidney and issues seen in its surgical practices, it has been noticed that to be aware of its morphometrical measurements would benefit clinical experience significantly.

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Introduction

Kidneys are the most important excretion organs in our body and provide electrolyte, acid-base and water equilibrium by filtration, reabsorption, excretion functions. As urine is the excrete material as a result of these regulation functions kidneys are called uropoetica, meaning organ that creates urine. Kidneys are retroperitoneally located on the right and left of the of columna vertebralis as two, leaned to abdominal wall, skeletotopically right kidney is located on T_{12} – L_3 and left kidney is located on T_{11} – L_2 levels (Leonhardt, 1984; Moore, 1988; Tamgaç et al., 1997).

Ultrasound (US) is a non invasive technique widely used in the investigation of renal disorders and Tc-99m DMSA scan is a valuable alternative imaging method in patients with upper urinary tract infection (Tamgaç et al., 1997; McBiles et al., 1995; McBiles, 1994; Gordon, 1990 ; Merric et al., 1995; Wallin and Bajc, 1993; Famsworth

et al., 1991; Arnold et al.,1990). In classical text books; fresh adult kidney dimensions are given as about 10-11 cm in length, 5-6 cm in width and 2.5-4 cm in thickness. In clinical practice, measurement of renal length (RL) in a child is a useful method in the assessment of renal disorders (Effmann et al., 1997; Eklöf and Ringertz, 1976). Both imaging techniques, ultrasound and Tc-99m DMSA scan can be used to determine RL in routine clinical practice (Rosenbaum et al., 1984; Hederström and Försberg, 1985; Sisayan et al., 1992; Bajc and Wallin, 1995).

Some kidney diseases could be result in morphological and morphometrical changes in kidneys and cause increase and decrease in kidney size (Dinkel et al., 1985).

A number of authors have described normal values for kidney size in infancy and childhood in the last few years. The measurements included morphometric data such as length, width, depth, parenchymal thickness and a calculated volüme (Dinkel et al.,1985; Haughstuedt and Lundberg, 1980; Rosenbaum et al., 1984; Vries, Levene, 1983; Fitzsimons, 1983; Blane et al.,1985; Lawson et al.,1981; Weitzel et al., 1984; Peters et al., 1982; Holloway et al., 1983; Han, Babcock, 1985). These parameters were correlated to age, body length (BL), body weight (BW) bodysurface. Close correlation was noted between kidney length and BL as well as between kidney volume and BW (Dinkel et al., 1985; Peters et al., 1982; Rasmussen et al., 1978). In the present study we have tried to define the renal size by some other body measurements.

In this study it has been examined morphometrical growth of kidney depending on gender and lateralisation. It was aimed to compare the findings derived from the statistical analysis of collected data to the results existed in literature which were available from former studies.

Method

The study has been done between years 2016-2017 on 213 patients (7-11 ages) who were scanned with scintigraphy in the Department of Nuclear Medicine of Necmettin Erbakan University Meram Faculty of Medicine and was approved by ethical committee of Meram Faculty of Medicine of Necmettin Erbakan University according to Copenhagen criteria (2008/211). As a beginning study forms were prepared. Personal data such as age, gender has been recorded, weight and height were measured. For height measurement it has been measured from ground to

vertex. Collected values were recorded as cm. For the weight measurement children has been undressed until they only had thin clothes with them and 0.5 kg differences were round up to 1 higher value. Weight was measured with legged platform scale by resetting the pointer on each child.

Later on it was time for scintigraphy scanning. Length on longitudinal (sagittal) plane and back diameter (width) on axial (transverse) and thickness of parenchyma have been examined. It was asked from the patients to be hungry and with an empty bladder. These measurements have been done by giving contrast matter and while the patients were on supine position. Our study has been done with 462 kidneys which had been scanned with scintigraphy separately. Scintigraphy scans have been done equally in number as 231 right and 231 left kidneys from males and females.

Collected datas have been recorded in previously prepared forms for each subject. Later on these forms were gathered. Datas have been transferred to computer environment and analyzed statistically with SPSS program (10.0 for Windows). Summary of datas have been expressed as mean± standard deviation and percent. t test has been done. Correlation between variables was examined with Pearson correlation test ($p<0.05$) value was accepted as a relevant statistically. With these tests gender (male, female), age, lateralisation (right-left) comparison has been done and shown in tables.

Findings

Table 1: Comparison of measured parameters in kidney in terms of gender (male-female) (mm) (Mean+Standard Deviation) (n=84 male, n=147 female)

Parameters	**Male**	**Female**	**P**
	Mean±SD	**Mean±SD**	
Height	106.48 ± 35.06	110. 7±28.600.	0.281
Weight	22.20±19.01	22.38±13.66	0.934
Right length	68.56±14.84	69.58±13.29	0.592
Rightwidth	32.60±6.45	32.70±5.89	0.900
Right thickness	18.43±3.68	18.69±3.54	0.596
Left length	70.19±15.35	71.41±13.66	0.532
Left width	33.32±6.53	33.62±5.78	0.720
Left thickness	18.70±3.57	19.12±3.62	0.401

Table 2: Comparison of measured parameters in kidney in terms of lateralisation (right-left) (mm) (Mean±Standard deviation) (n=231 right, n=231 left)

Parameters	**Right**	**Left**	**P**
	Mean±SD	**Mean±SD**	
Kid length	69.21±13.85	70.97±14.28	0.179
Kidney width	32.66±6.09	33.51±6.05	0.134
Kidney thickness	18.59±3.59	18.97±3.60	0.261

Table 3: Comparison of measured parameters of kidney in terms of gender (male-female) (mm) (Mean±Standard deviation) (n=84 male, n=147 female)

	Right			**Left**		
	Male	**Female**		**Male**	**Female**	
	Mean ± SD	**Mean ± SD**	**P**	**Mean ± SD**	**Mean ± SD**	**P**
Length	68,56 ± 14.84	69,58±13,29	0.592	70.19 ±15.35	71.41 ±13.66	0.532
Width	32.60 ±6.45	32.70 ±5.89	0.900	33.32 ±6.53	33.62 ±5.78	0.720
Thickness	18.43 ±3.68	18.69 ±3.54	0.596	18.70 ±0.39	19.12 ±3.62	0.401

Result

460 kidneys totally on 230 children (147 female, 83 male) have been examined dual sided measurement. Morphometry of kidney has been examined in the study. Data collected from length, width and thickness measurements of kidneys has been examined statistically ± SS and P values of these parameters have been calculated according to gender (male-female) and lateralisation (right-left) and the data has been organized in tables.

Length, width and thickness values belonging to each kidney have been examined in terms of gender. It is has been noticed a significant difference between genders in these parameters (Table 1,3). All values in these parameters were determined lower in male children ($p<0.05$). collected data has been examined in terms of right and left kidney and it has been noticed a significant difference as for lateralisation (Table 2, 3). All values were determined higher in left kidney ($p<0.05$).

Discussion

The evaluation of renal growth plays an important role in the follow-up control of children with kidney disease. A great number of these disorder are accompanied by reduction or enlargement of the total organ volume (Wallin and Bajc, 1993). Such disorder are urinary tract infection, vesicoureteral reflux, hypoplasia and dysplasia, polycystic disease, leukemia, renal vein thrombosis, compensatory hypertrophy, trauma, tumors etc. Close correlation between parenchymal mass and kidney function are desribed (Aperia et al., 1978; Troell, 1984).

US as a sensitive and non invasive method is generally used as the first method of choice in investiation of urinary tract infection with the disadvantage that the normal US does not exclude a renal scar (Famsworth et al., 1991). Tc-99m DMSA scan is an alternative imaging method to these techniqes with its high sensitivity in detection and assessment of upper urinary infection (Wallin,Bajc,1993; Arnold et al.,1990; Monsour et al.,1987; Tamgaç et al.,1993). Additionally,the simplicity of measuring the kidney length, which is the ideal parameter for assessment, increases the role of Tc-99m DMSA scan in routine practice. In the study of Tamgaç et al. (1997) mean kidney sizes measured by scintigraphy were 6 mm larger than those measured by US. This difference can be explained by the physiological movement of the kidneys due to respiration during Tcm DMSA scan whereas US uses a breath holding image (Sisayan et al., 1992). Other than these difference, the two techniqes showed excellent correlation. Tamgaç et al result support the previous studies (Rosenbaum et al.,1984; Sisayan et al., 1992; Currarino et al., 1984). In which it was shown that, in growing children, renal lengths have good correlation with choronological age, body weight and height of the children.

Observer related variations in the measurements are also significant. Schlesinger et al. (1996) evaluated the variations in repeated measuements of renal length by three experienced pediatric sonographers. They showed that both intra- and inter-observer variations in the measurements can equal or even exceed the expected annual rate of growth in older infants and children. The mean inter- and intra-observer variations in their sudy were 3.9-5.5 mm and 0.9-3.6 mm, respectively. Carrico et al. (1996) the mean inter-observer variation was 3.1-3.6 mm depending on patient position. The mean intra-observer variation was 1.7-2.9 mm.The mean difference in renal length in various positions was-0.3 to 2.1 mm.

One of our measurements was renal width. Hederström et al. (1985) measured renal width as 214 percentil. In our measurements these values were 32.66±6.09 mm for right kidney and 33.51±6.05 mm for left kidney.

The parenchymal thickness at the upper pole showed slight changes with age and between sexes (Emamian et al.,1993). Measurement of parenchymal thickness is less feasible because the built in calipers on the sonographic unit allow measurements in increments of 1mm only and because accurate definition of the border between renal parenchyma and the central echogenic area may be difficult. However, measurements of parenchymal thickness may be useful in pathologic conditions. In our study thickness of kidney was determined 18.59±3.59 mm as right and 18.97±3.60 mm as left.

As with findings of other authors (Holloway et al., 1983; Rasmussen et al., 1978; Klare et al., 1980; Stolpe et al., 1967). We did not find a sex-related difference in size. The left kidneys were slightly greater in median length and median volume, e.g. 0.9mm in kidney and 2.5ml in kidney volume. Longer left kidneys predominate. The kidney was found to be longer on the left in 51.7 %, on the right in 34.1%, and of equal size in 14.2%.Renal volume was greater on the left in 51.7 %,on the rigth in 29.5 % and of equal size in18.8%. Some authors report no difference.

In the last decade various reports on renal ultrasonography of children have been published. These reports were also related to kidney position as they were related to pathological changes and morphology. Kidney measurement with ultrasonography was emphasized, and especially renal length was included (Haughstuedt, Lundberg, 1980; Hasch, 1974; Littlewood, 1977; Lyons, 1972; Moskowitz et al. 1972; Sanders, 1975; Tay et al., 1977; Taylor and Hill,1975).

In our measurements renal length was determined 69,21± 13,85 as right and 70.97 ± 14,28 as left. Hederström et al (Hederström and Forsberg, 1985) measured renal length as 218 percentil.

Also renal width was a part of our measurements. Hederström et al. (1985) measured renal width as 218 percentil. In our measurements renal width was 32,66 ±6,09 mm as right and 33,51 ± 6,05 mm as left.

Fitzsimons (1983) has determined the left kidney significantly longer than the right kidney. Our measurements comply with those values. Kidney dimensions and growth are parameters in various renal diseases. Deviations from standard values are important diagnostic criteria for renal diseases.

In the end of the study morphometrical examination of kidney in children has been done. And all gathered data was compared with the results of former studies. It has been thought that knowing morphometry and morphological variations of kidney would be considerably important to diagnosis, follow-up and treat for internal diseases, urological surgery and uroradiology.

References

Aperia A, Broberger O, Ekengren K, Wigstad I. (1978). Relationship between area and function of the kidney in well defined childhood nephropaties. Acta Radiol [Diagn]. 19:186.

Arnold AJ, Brownless SM, Carty HM, Rickwood AMK.(1990). Detection of renal scanning-An experimental study. J Pediatr Surg. 25:391-3.

Bajc M, Wallin L.(1995). Tc-99m DMSA renal scintigraphy during kidney maturation. Clin Nucl Med. 20:211-4.

McBiles M, Lambert AT, Cote MG, Solano RK. (1995). Diuretic scintirenography: past, present and future. Nuclear Medicine Annual. Raven Pres.New York. pp:185,216.

McBiles M. (1994). Correlative imaging of the kidney Seminars in nuclear Medicine 24: 219-33

Blane CE, Bookstein FL, DiPietro MA, Kelsch RC. (1985). Sonographic standarts for normal kidney length. AJR.145:1289.

Carrico CWT, Zerin JM. (1996). Sonographic measurement of renal length in children: does the position of the patient matter? Pediatr Radiol. 26:553-555.

Currarino G,Williams B,Dana K.(1984).Kidney length correlated with age: normal values in children. Radiology. 150: 703-4.

Dinkel E, Ertel M, Dittrich M, Peters H, Berres M.Schulte-Wisserman H. (1985). Kidney size in childhood-Sonographical growth charts for kidney length and volume. Pediatr Radiol.15-38.

Effmann EL, Ablow RC, Siegel NJ. (1977). Renal growth.Radiol Clin North Am.15:3.

Eklöf O, Ringertz H. (1976). Kidney size in children:A method of assessment: Acta Radiol Diag. 17: 617-25.

Emamian SA, Nielsen MB, Pedersen JF, Ytte L. (1993). Kidney dimensions at sonography: correlation with age, sex and habitus in 665 adult volunteers. AJR. 160: 83-86.

Famsworth RH, Roshleigh MA, Leighton DM, Bass SJ, Rosenberg AR. (1991). The detection of reflux nephropathy in infants by 99m Technetium dimercaptosuccinic acid studies. J Urol. 145:524-6.

Fitzsimons RB. (1983). Kidney length in the newborn measured by ultaround. Acta Peadiatr Scand. 72: 885-88.

Gordon I. (1990). Urinary tract infection in paediatric: the role diagnostic imaging. Br J Radiol.

Han BR, Babcock DS. (1985). Sonographic measurements and appearance of normal kidneys in children. AJR.145:611, 63: 507-11.

Hasch E.(1974). Ultrasound in the ınvestıgation of dısease of the kidney and urinary tract in children. Acta Paediatr Scand, 63: 424.

Haugstvedt S, Lundberg J. (1980).Kidney size in normal children measured by sonography.Scand J Urol Nephrol. 14: 251.

Hederström E,Försberg L. (1985). Kidney size in children assessed by ultrasonography and urography. Acta Radiol Diag. 26:85-91.

Hederström E, Forsberg L.(1985). Accuracy of repeated kidney size estımation by ultrasonography and urography in chıldren. Acta Radiologica Diagnosis. 26:5.

Holloway H, Jones TB, Robinson AE, Harpen MD, Wiseman HJ. (1983). Sonographic determination of renal volumes in normal neonates. Pediatr Radiol. 13:212.

Klare B, Geiselhardt B, Wesch H, Scharer K, Immich H, Willich E. (1980). Radiological kidney size in childhood.Pediatr Radiol. 9:153.

Lawson TL, Foley WD, Berland LL, Clark KE. (1981). Ultrasonic evaluation of fetal kidneys. Radiology, 138:153.

Leonhardt H.(1984). Taschenatlas der Anatomic. New York. 244,247.

Lıttlewood R.(1977).Ultrasonography of the genitourinary tract in children. Radiol Clin N Amer. 15: 109.

Lyons EA, Flemingj GG, Arnell GC, Murphy AV, Sweet EM, Donald I. (1972). Nephrosonography in infants and children. A new technigue Birt Med J. 689.

Merric MV, Nothgi A,Chalmers N, Wilkinson AG, Uttley WS. (1995). Long term follow up to determine the prognostic value of imaging after urinary tract infections, Part 2: scarring. Arch Dis Child. 72:393-6.

Moore K.L. (1988). The developing Human, Clinically Oriented Embryology. FourthEdition, W.B. Saunders Company, Phıladelphia, London, Toronto. 246-257.

Monsour M, Azmy AF, MacKenzie. (1987). Renal scarring secondary to vesicoureteric reflux. Critical assessment and new grading. Br J Radiol. 60: 320-4.

Moskowitz PS, Caroll BA, MC coysj M. (1980). Ultrasonic renal volumetry in children Radiology. 134: 61.

Peters H, Dinkel E, Dittrich M, Alzen G, Weitzel D. (1982). Sonographically determined renal volumetry as a diagnostic aid in neonates and infants.J Ulrasound Med 1[Suppl]: 200.

Rasmussen SN, Haase L, Kjeldsen H, Hancke S. (1978). Determination of renal volume by ultrasound scanning. J Clin Ultrasound, 6:160.

Rosenbaum DM, Korngold E, Tele RF. (1984). Sonographic assessment of renal length in normal children. AJR.142-467.

Sanders RC. (1975). Renal Ultrasound. Radiol Clin N Amer. 8: 417.

Schlesinger AE, Hernandez RJ, Zerin JM, Marks TI, Kelsch RC. (1991). Interobserver and intraobserver variations in sonographic renal length measurements in children. AJR. 156:1029-1032.

Sisayan RM, Rossleigh MA, Mackey DWJ. (1992). Normograms of renal length in children obtained from DMSA scintigraphy. Clin Nucl Med. 18:970-3.

Stolpe Y, King LR, White H. (1967). The normal range of renal size in children.Invest Urol. 4:600.

Tamgaç F, Moretti JL, Rocchisani JL, Baillet G, Weinmann P. (1993). Tc-99m MAG3 and Tc-99m DMSA in the detection and assessment of pyelonephritis.J Nucl Med Biol.37:62:4.

Tamgaç F, Savcı G, Cankur NŞ, Alper E. (1997). Renal length in childhood measured by Tc-99m DMSA scan and ultrasonography. Turk J Med Sci. 27:569-572.

Tay JS, Vellayapan K, Tan L,et al. (1977). The accuracy of the ultrasound scan in the estimation of renal size in children.J Singapore Paediatr Soc.19:234.

Taylor KJW, Hill CR. (1975). Technical notes. Scanning techniques in grey-scale ultrasonography.Brit J Radiol.48:918.

Troell S, Berg U, Johannson B, Wickstad I. (1984).Ultrasonographic renal parenchymal volume related to kidney function and renal parenchymal area in children with recurrent urinary tract infections and asymtomatic bacteriuria.Acta Radiol[Diagn]. 25:411.

De Vries L, Levene MI. (1983).Measurement of renal size in preterm and term infants by real-time ultrasound. Arc Dis Child. 58:145.

Wallin L, Bajc M.(1993).Typical technetium dimercaptosuccinic acid distribution patterns in acute pyelonephritis. Acta Paediatr. 82: 1061-5.

Weitzel D, Dinkel E, Dittrich M, Peters H. (1984). Padiatrische ultraschall diagnostik. Springer, Berlin Heidelberg New York Tokyo. p 295.