The Egyptian Journal of Hospital Medicine (January 2018) Vol. 70 (5), Page 855-858

Sonographic Dimensions of Normal Kidney Among Children

Anas Sulaiman Aloraini[1], Ali Mekbel Aldahmashi[2]
[1]College of Medicine, King Saud University, [2]College of Medicine, Umm Al-Qura University, Saudi Arabia

ABSTRACT

Background: the measurement techniques vary between operators, and there is a lack in standards for measuring either renal length or volume. Individual observation shows that optimal sonographic technique varies with sonography system and transducer combination.
Objectives: the purpose of this review was to combine the sonographic measurements and morphology of normal kidney among children obtained.
Materials and Methods: An electronic search was conducted in CINAHL, EMBASE, and MEDLINE databases. The search resulted in 42 relevant studies, from which 8 studies were met the inclusion criteria. The information was extracted from these studies.
Results: in the included studies, the length of right kidney ranged from 4 cm to 7.9 cm. Three studies from the all eight studies of this review revealed that the mean length of the right kidney was 7.6 cm, the rest five studies was with length ranged between 4.2 cm to 6.8 cm and the length of left kidney ranged between 4 cm to 8.4 cm. There are two studies found that length was equal both in right and left kidneys.
Conclusion: Assessment of kidney size using sonography can be an early screening technique for these conditions especially among children.
Keywords: Sonography; Kidney; Dimensions; Children; Hypertrophy.

INTRODUCTION

Kidney size is an essential parameter for evaluating pediatric renal and genitourinary tract pathologies **(1)**. Measurement of kidney size is important because many current disorders with enlargement or kidney reduction, which means that renal size and function determined the health status of the kidney (2). It can be helpful and facilitate the follow up for the treatment of children with chronic pyelonephritis, obstructive uropathy, and chronic glomerulonephritis in early childhood. Sonography helps in accessing and following the patients of urolithiasis, cystic kidney diseases, malignancies, infections, vesicoureteric reflux and renal transplant in elders as well as in children **(3)**.

Serial volume measurements can be used to track the normal growth pattern of kidneys and to follow the known pathology of kidney in children. The establishment of normal kidney values in routine imaging tests can serve as a baseline for the diagnosis of kidney disease associated with changes in size, such as acute or chronic pyelonephritis **(4)**. There are several methods for measuring renal sizes, including abdominal CT and MRI. However, these approaches have disadvantages such as radiation exposures and high costs. Also, due to the need for sedation in CT or MRI, and the radiation exposure associated with CT, we prefer US evaluation in pediatric patients **(5)**. In comparison, sonography is the preferred method for assessment of renal size in children, because of safety and simplicity in evaluation of renal length and volume **(5)**. It is non-invasive imaging modality and have widespread applications in pediatric urology **(1)**.

Proper body developments and functions are directly related to organ growth rate. The growth rate of renal length will be evaluated in association with distinct measurements like weight, height and anthropometric parameters such as body mass index (5). Measurement techniques vary between operators, and there is a lack in standards for measuring either renal length or volume. Individual observation shows that optimal sonographic technique varies with the used sonography system and transducer combination**(6)**. The purpose of this review was to combine the sonographic measurements and morphology of normal kidney among children obtained by different studies from different population.

METHODS

An electronic search was conducted in CINAHL, EMBASE, and MEDLINE databases using search strategy (Sonography OR Ultrasound OR US) AND (Kidney OR Renal) AND (Size OR Morphology) AND (Children OR Infants OR Newborns). The search resulted in 42 relevant studies, from which 8 studies were met the inclusion criteria. The information was extracted from these studies in the table 1. The

Received: 5/12/2017 DOI: 10.12816/0043994
Accepted: 15/12/2017

protocol of this review was approved by ethical committee of **King Saud University**.

RESULTS

This review included 8 retrospective study studies. The overall sample size ranged from 0 years to 18 years. Sample size ranged from 34 to 794. The number of radiologists who examined the sonography reported in only three included studies. The first study was done by one radiologist in which the subjects were children, with mean age of 6 years, while the second study was done in Korean children with mean of age 4.6 years old and the sonography were diagnosed by two radiologists. The third study was also done by two radiologists; the gestational age of the study subjects was ranged between 35 and 42 weeks.

All studies used a real-time ultrasound, convex, linear, or sector transducer, with high frequency. Only one study used low frequency transducer (2.25 mHz with a diameter of 1.5 cm), the subjects of this study were 46 children,16 females and 30 males with mean age of 6.1 years. Over all weight ranged from 517 g (infants) to 73 kg, while overall height ranged from 6.6 cm (infants) to 191 cm.

In the included studies, the length of right kidney was ranged from 4 cm to 7.9 cm. Three studies from the all eight studies of this review revealed that the mean length of the right kidney was 7.6 cm, the rest five studies was with length ranged between 4.2 cm to 6.8 cm and the length of left kidney ranged between 4 cm to 8.4 cm. There are two studies found that the length was equal in right and left kidneys.

Table (1) Kidneys dimensions reported in the included studies:

Study	Sample size	Mean age and range of children	Technique and software used in sonography	Number of radiologists who review he sonogram	The men height, weight and BMI of the children	Right Kidney Length (cm)	Left Kidney Length (cm)
Kim *et al.* [5]	794	0 to 18 years with a mean of 4.6 ± 4.6 years	IU22 ultrasound unit (Philips Ultrasound, Bothell, WA, USA) with a 5-8 or 1-5 MHz convex transducer	Two Pediatric radiologists	Height 100.5 ± 33.8 cm weight was 19.4 ± 15.0 kg BMI 16.7 ± 2.5 kg/m2	6.89	7.06
Sargent and Gupta[6]	52	2 months to 16 years and mean age= 6 years old	A 5.0-MHz wide-angle sector transducer (Ultramark 9)	One radiologist	Non-reported	Mean length = 7.6 cm (SD, 1 .3 cm)	Mean length = 8.4 cm
Blane *et al.*[7]	34	aged 2-56 weeks (mean, 24.6 weeks	Phillips real-time sector scanner with 3.5-MHz transducer a	Non-reported	Weight 7.4 Length 6.6	Range= 4-6.2cm Mean= 5 cm	Range= 4-6.5cm Mean= 5.2 cm
Dinkel *et al.* [8]	325	3 days- 15 years old	3.5 MHz mechanical sector scanner (Combison 100, Kretz-Company, Zipf, Austria).	Non-reported	Weight 1.8 to 73.8kg Height: 43-191cm	Range= 3.1 to 11.8 cm, mean 7.64 cm.	Range= 3.4 to 13.2 Cm , mean= 7.75 cm
Haugstvedt *et al.*[9]	46	Range= 0 to 16 years, mean= 6.1 years old	The Diasonograph NE 4200, which gives a grey scale image by a scan converter. A 2.25 mHz transducer with a diameter of 1.5 cm	Non-reported	Not-reported	7.9 cm	8.1 cm

Rosenbaum *et al.*[(10)]	203	Age ranged from several hours to 18 years old	Real-time mechanical sector scanner, either a Diasonics Wide-vue using a 3.5, 5, or 7.5 MHz transducer or a Diasonics Neonatal Unit using a 6 MHz transducer. I	Non -reported	Not-reported	4.48 0-10.81 cm	4.48 0-10.81 cm
Fitzsimons[(11)]	115	Range= 35 and 42 weeks of gestational age	Toshiba SAL 30 real-time Ultrasound scanner using a 5 mHz linear phased-array transducer.	2 radiologists	Not-reported	3-5 cm	3-5 cm
Scott *et al.*[(12)]	560	Range= 33-42 weeks of gestational age	A Hewlett Packard 77020A sector scanner with 5 MHz short and medium focus transducers and a 3 5 cm standoff accessory was used	Non-reported	Weight was 3291 g	4.21 cm	4.32 cm

DISCUSSION

Sonography is the method of choice for assessment of renal size in children [(13)]. Sonography allows measurements and provides information without exposing the patient to ionizing radiation [(10)]. Measurement techniques vary between operators, and no standard for measuring either renal length or volume exists. Personal observation shows that optimal sonographic technique varies with the sonography system and transducer combination used. In a previous study at this institution better predictions of renal length have been obtained with a body measurement such as height, weight, or surface area. The children of the same age were with greatly varying overall size of the kidneys [(9)].

Almost all included studies were retrospective analyses of sonography of children performed for medical reasons. Two included studies done by **Fitzsimons *et al.*[(11)]** and Rosenbaum ***et al.*[(10)]** shows the same length for both right and left kidneys, the rest of studies shows that the left kidney is slightly larger than the right kidney. This slightly greater variation in the length of the left kidney may be due to increased noise in the sonograms of the left kidney; also spleen is smaller than the liver, so the left kidney has more space to grow and it does not provide as large an acoustic window as the liver. Three included studies in this review were with smaller sample size [(6, 7, 9)]. Although this sample size was small it was statistically sufficient to develop a morphometric nomogram.

Many authors mentioned above have discussed some aspect of the relation of renal length to factors of body size such as weight, height, body surface area, and age [(10)]. One potential drawback of articulated-arm scanning is that length may be underestimated by failure to image the kidney in its greatest dimension. This is less likely to happen with maneuverable real-time transducer. Sometimes the entire kidney of an older child extends outside the sector of a real-time scanner, leading to an estimation of renal size by extrapolation. This can be avoided by the use of a water bath between the transducer and skin to create a wider arc of view, or by using an articulated-arm scanner [(10, 14)]. Many renal conditions lead to hypertrophy of kidney such as diabetes [15]. However, medical conditions such as simple renal cyst can lead to shrinkage in the kidney size [16, 17].

CONCLUSION

Assessment of kidney size using sonography can be an early screening technique for these conditions especially among children.

REFERENCES

1. **Oswald J, Schwentner C, Lunacek A, Deibl M, Bartsch G, and Radmayr C (2004):** Age and lean body weight related growth curves of kidneys using real-time 3-dimensional ultrasound in pediatric urology. J Urol., 172(5):1991-4.
2. **Bax L, Van Der Graaf Y, Rabelink A, Algra A, Beutler J, and Group M (2003):** Influence of atherosclerosis on age-related changes in renal size and function. Eur J Clin Invest., 33(1):34-40.
3. **Wong IY-Z, Copp HL, Clark CJ, Wu H-Y, and Shortliffe LD (2009):** Quantitative ultrasound renal parenchymal area correlates with renal volume and identifies reflux nephropathy. J Urol., 182(4):1683-7.
4. **Eze C, Agwu K, Ezeasor D, Agwuna K, Aronu A, and Mba E (2014):** Sonographic biometry of normal kidney dimensions among school-age children in Nsukka, Southeast Nigeria. West Indian Med J., 63(1):46-51.
5. **Kim J-H, Kim M-J, Lim SH, Kim J, and Lee M-J (2013):** Length and volume of morphologically normal kidneys in Korean children: ultrasound measurement and estimation using body size. Korean J Radiol., 14(4):677-82.
6. **Sargent M, and Gupta SC (1993):** Sonographic measurement of relative renal volume in children: comparison with scintigraphic determination of relative renal function. Am J Roentgenol., 161(1):157-60.
7. **Blane C, Bookstein FL, DiPietro M, and Kelsch R (1985):** Sonographic standards for normal infant kidney length. Am J Roentgenol., 145(6):1289-91.
8. **Dinkel E, Ertel M, Dittrich M, Peters H, Berres M, and Schulte-Wissermann H (1985):** Kidney size in childhood sonographical growth charts for kidney length and volume. Pediatr Radiol., 15(1):38-43.
9. **Haugstvedt S, and Lundberg J (1980):** Kidney size in normal children measured by sonography. Scand J Urol Nephrol., 14(3):251-5.
10. **Rosenbaum D, Korngold E, and Teele RL (1984):** Sonographic assessment of renal length in normal children. Am J Roentgenol., 142(3):467-9.
11. **Fitzsimons R (1983):** Kidney length in the newborn measured by ultrasound. Acta Paediatr., 72(6):885-7.
12. **Scott J, Hunter E, Lee R, and Matthews J (1990):** Ultrasound measurement of renal size in newborn infants. Arch Dis Child., 65(4):361-4.
13. **Moorthy I, Wheat D, and Gordon I (2004):** Ultrasonography in the evaluation of renal scarring using DMSA scan as the gold standard. Pediatr Nephrol., 19(2):153-6.
14. **Seyer-Hansen K, Hansen J, and Gundersen H (1980):** Renal hypertrophy in experimental diabetes. Diabetologia, 18(6):501-5.
15. **Mogensen C, and Andersen M (1973):** Increased kidney size and glomerular filtration rate in early juvenile diabetes. Diabetes, 22(9):706-12.
16. **Al-Said J, and O'Neill WC (2003):** Reduced kidney size in patients with simple renal cysts. Kidney Int., 64(3):1059-64.
17. **Al-Said J, Brumback MA, Moghazi S, Baumgarten DA, and O'Neill WC (2004):** Reduced renal function in patients with simple renal cysts. Kidney Int., 65(6):2303-8.