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Ultrasonographic Measurement of Dimensions of Adult Human Kidney in Odisha And Its Variations

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Abstract: *The present piece of work was studied in the population of Odisha to determine the ultrasonographic kidney dimensions in subjects without known renal disease. We studied weather age, sex, side, body mass index(BMI) and presence or absence of diabetes mellitus, hypertension and chronic kidney disease affect the renal size.* ***Material and Methods :*** *295 individuals were included in the study. After exclusion of diseased, 289 subjects were finally selected for this study.All ultrasounds were performed by an experienced facultyto exclude inter- observer variation. The effect of gender, age, side, height, weight, BMI, hypertension, diabetes mellitus and chronic kidney disease was statistically analyzed.****Results :****The mean renal length of right side (9.64 cm) was significantly smaller than that of left side (9.97 cm).The mean renal length, breadth and cortical thickness of right side was greater in male and no significant difference was found in mean left renal length with gender.The mean renal dimensions of subjects decreased after the age of 61 years. The mean renal length of both sides were directly proportional with body mass index, weight and height.In multivariate analysis, diabetes mellitus and chronic kidney disease shows significant correlation with mean renal dimensions.* ***Conclusion :****The length and volume of kidneys are considered as very important parameters for clinical assessment and follow up. Ultrasonography is a noninvasive procedure and there is no risk of radiation hazards. So there is definite advantage of this procedure in clinical field.*

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I. Introduction

The changes in renal dimensions and/or morphology are manifested by many renal pathologies and are important parameters in clinical evaluation and management of patients with diabetes, hypertension, renal artery stenosis, chronic kidney diseases and for assessment of renal transplant candidates.[5,9] Renal ultrasonography provides a non-invasive, reliable, broadly accessible and affordable way of imaging the kidneys.

Renal sonography is currently in use for the evaluation and follow-up of patients with congenital anomalies of the kidney, renal cystic diseases, kidney stones, renal arterial stenosis, recurrent urinary tract infections, vesicoureteral reflux, chronic kidney disease, kidney tumors and kidney transplants, both in all age group of population. [3,6,20,22] Renal size estimation by ultrasonography can be performed by measuring renal length, breadth and cortical thickness. Renal length measurement along the longitudinal plane parallel to the longest renal axis is the most frequently used clinical parameter because of its low interobsever variation and better reproducibility. [6] Renal length and cortical thickness are closely related parameters in patients with chronic kidney disease. [20]

To recognize anatomical deviations in individuals with renal diseases, it is important to have a set of standard sonographic measurements for appropriate comparison. There are limited statistical data on renal measurements in adult population. Among the first such studies conducted on fifty-two patients with normal renal function was by Brandt et.al in 1982.[2] Since then countries with multiple ethnic backgrounds have sought after finding the average normal ultrasonographic renal length in their populations, looking for potential associations with age, gender, height, weight and BMI of individuals.[14,15]

The primary aim of our study was to observe the variations in ultrasonographic renal dimensions in the normal population of Odisha in reference to age, gender, side, height, weight and BMI.In addition we also assessed the effects of hypertension, diabetes mellitus and chronic kidney disease in a subgroup of our study population on renal dimensions and correlated the findings with available literatures.

II. Aims And Objective

• To study the ultrasonographic anatomic dimensions of adult human kidney in Odisha.

• To study the anatomic variations of adult human kidney in reference to age, gender, height, weight, BMI, hypertension, diabetes mellitus and chronic kidney disease (CKD).

III. Materials & Methods

The present study was conducted in the S.C.B. Medical college, cuttack and Hospital. For this prospective study,289 consecutive patients between13 to 80 years of age were selected and had undergone an abdominal diagnostic ultrasound in the Department of Radiology of S.C.B. medical college , Cuttack over a period of 24 months and had an additional screening and measurements of the kidneys.

PROCEDURE

Kidney dimensions measured included length (distance from pole to pole),width(transverse axis) and cortical thickness in centimeters . Additional data recorded at presentation include age, gender, height, weight and BMI (Weight [kg]/ Height[meter]^2) and history of established hypertension, diabetes mellitus and chronic kidney disease.

All ultrasounds were performed by an experienced faculty duly guided by Professor & Head of Department of Radiology,S.C.B. Medical College, Cuttack to exclude inter- observer variation. Renal ultrasound scans were done by using a single real time ultrasound scanner of the Department using 3.5-5 MHz curvilinear probe in supine and lateral positions with deep inspiration and full bladder.

EXCLUSION CRITERIA

Pregnant patients, patients having congenital kidney diseases, malignancy and renal stone were not included in this study.

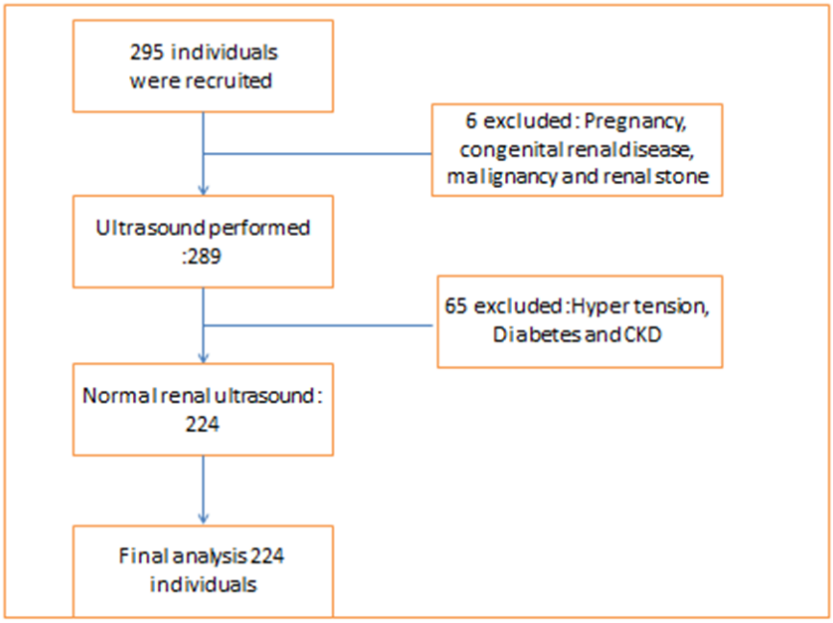
IV. Data Collection & Analysis

All the data were entered in Microsoft Excel data base and statistical analyses were done in SPSS version -19. Descriptive statistics were used to look at the spread of the data with respect to age, gender, height, weight, BMI, side. Proportions and percentages were computed for categorical variables. With symmetric distribution of the outcome variable of renal sonographic dimensions mean and corresponding 95% confidence interval for continuous variables was computed. The Pearson correlation was used to highlight any significant correlations between renal length and anthropometric parameters of subjects.Parametric tests of independent sample t-test and ANOVA were used to find any significant difference in renal dimensions between different sexes and age groups. A multivariate regression model was applied to identify various factors predicting renal length in our study population. . A p- value < 0.05 was regarded as statistically significant.

ETHIC STATEMENT

Study procedure was approved by the Institutional Ethics Committee of S.C.B. Medical College, Cuttack, Odisha, (Regd. No. ECR/84/Inst/OR/2013) while grant for the study was approved by the Institutional Review Board vide Ref. No. 166/7.9.2015. Written consent was sorted prior to participation from respondents by means of an informed consent. Participants were informed regarding their ultrasound results with appropriate format.

OBSERVATION Flow chart: To demonstrate selection methods of study sample



In this prospective study 295 cases were recruited. Out of which six cases were excluded for having pregnancy, congenital renal diseases, malignancy and renal stone. 65 subjects were clustered for having history of hypertension, diabetes mellitus and chronic kidney disease for separate analysis and finally 224 normal individuals were selected for normal ultrasonographic analysis.

(TABLE-1) ANTHROPOMETRIC ANALYSIS WITH RESPECT TO GENDER

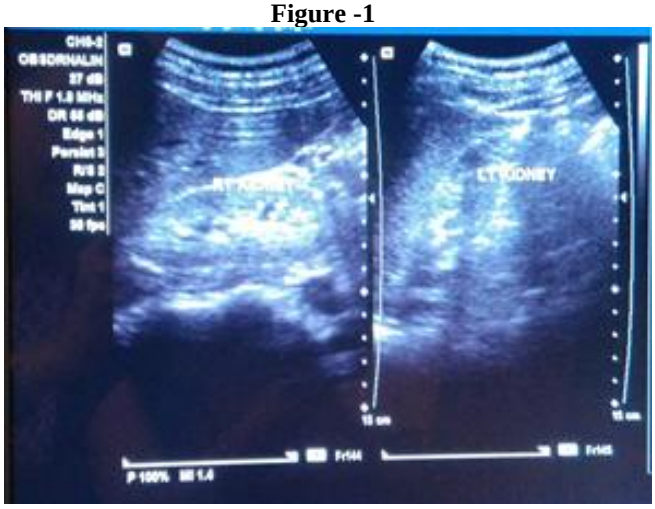
Gender	Age(years)	Height(cm)	Weight(Kg)	Body mass index(Kg/m^2)
Male(n=106)	42.22	116	63.56	22.86
Female(n=118)	34.67	153.6	56.66	23.85

Table-1 depicts the anthropometric analysis of our normal study population with respect to gender. It was observed that the mean age of our study population was 42.22 years in male which was greater than the female mean age (34.67years). The mean height and weight of male was 166cm and 63.56kg respectively which was greater than female subjects(height: 153.6cm, weight: 56.66kg) in contrast to mean body mass index(BMI) which was more in female($23.85kg/m^2$) than mean BMI of male($22.86kg/m^2$).

(TABLE-2)COMPARISION OF AVERAGE ULTRASONOGRAPHIC RENAL DIMENSIONSOF BOTH SIDE (N=224)

RENAL DIMENSIONS	**AVERAGE VALUE(cm)**
Right kidney length	9.64
Right kidney breadth	3.89
Right kidney cortical thickness	1.09
Left kidney length	9.97
Left kidney breadth	4.51
Left kidney cortical thickness	1.11

Figure -1

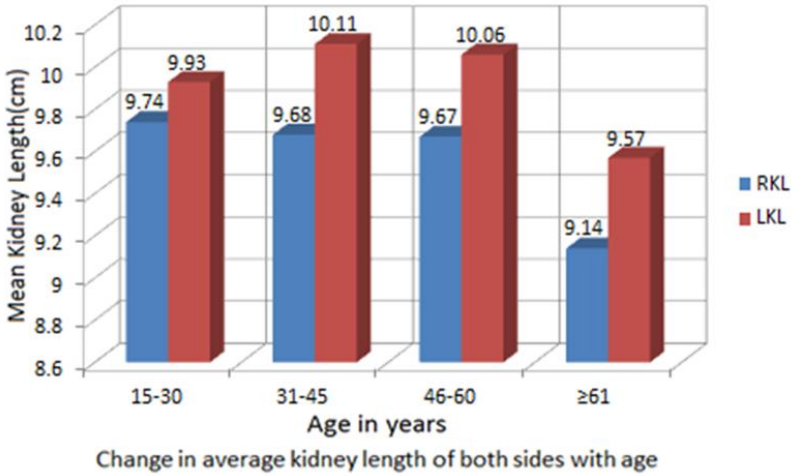


In table-2 of our study average renal length of right side was smaller than that of left side which is supported by Niels-Peter Buchholz et.al.[12] , Raza M. et.al.[17] , Zeb Saeed et.al.[23] Similarly the average renal breadth and cortical thickness of left side was greater than right side in our study which is supported by Raza M. et.al.[17]

(TABLE-3) ULTRASONOGRAPHIC DETERMINATION OF RENAL DIMENSIONS ACCORDING TO AGE(n=224)

Right Kidney (Mean ± SD)				**Left Kidney (Mean ± SD)**		
Age in years	Length (cm)	Breadth (cm)	Cortical thickness (cm)	Length (cm)	Breadth (cm)	Cortical thickness (cm)
15-30	9.74±0.72	4.03±0.60	1.08±0.21	9.93±0.72	4.43±0.54	1.18±0.28
31-45	9.68±0.78	3.84±0.55	1.03±0.24	10.11±0.61	4.40±0.45	1.09±0.16
46-60	9.67±0.56	4.06±0.39	1.04±0.16	10.06±0.62	4.75±0.38	1.05±0.13
≥61	9.14±0.61	4.04±0.39	0.96±0.22	9.57±0.74	4.60±0.60	1.08±0.33

(Figure-2) change in average kidney length of both sides with age



Change in average kidney length of both sides with age

The mean renal renal length of right side in our study (table-3,figure-2) was larger amongst 15-30 years age group and that of left side was larger amongst 31-45 years age group. It is also observed that renal dimensions remained essentiallyunchanged in our study group between the 30 to 60 years. A statistically significant decrease in all renal dimensions was observed in individuals over 61 years which is supported by Zeb Saeed et.al.[23] and AdeelaArooj et.al.[1]

(TABLE-4)CORRELATION OF AGE WITH RENAL DIMENSIONS

Renal dimensions	Pearson correlation	'P' value
Right kidney length	-0.182	0.006 S
Right kidney breadth	+0.017	0.008 S
Right kidney Cortical thickness	-0.178	0.568 NS
Left kidney length	-0.069	0.004 S
Left kidney breadth	0.193	0.004 S
Left kidney cortical thickness	-0.225	0.934N S

Figure-3

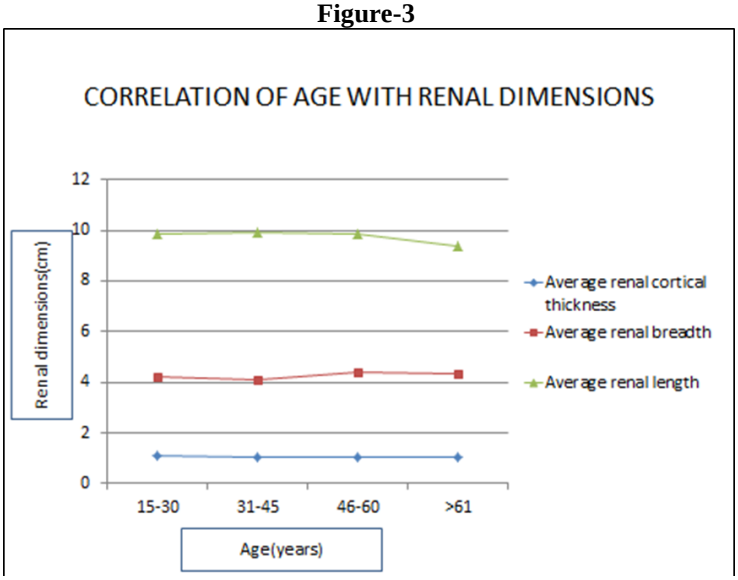


Table -4 and figure-3 shows correlation of age with renal dimensions.Both right and left kidney length and breadth showed significant correlation with age where as cortical thickness has no significant correlation with age (p value>0.05). It is supported by Raza M. et.al.[17] and Zeb Saeed et.al.[23]

(TABLE -5)CORRELATION OF BODY MASS INDEX WITH RENAL DIMENSIONS

Renal dimensions	Pearson correlation	'P' value
Right kidney length	0.329	0.000 ES
Right kidney breadth	0.373	0.000 ES
Right kidney Cortical thickness	0.103	0.123 NS
Left kidney length	0.344	0.000 ES
Left kidney breadth	0.350	0.000 ES
Left kidney cortical thickness	-0.003	0.966 NS

Figure-4

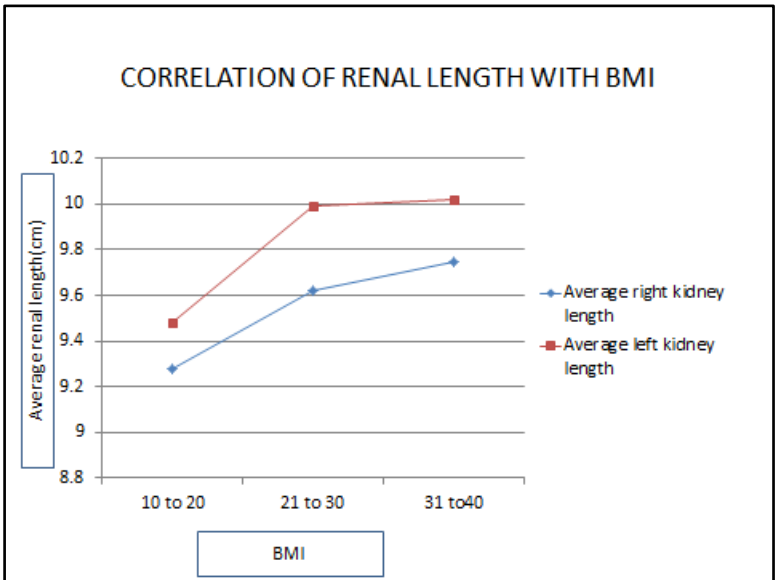


Figure-5

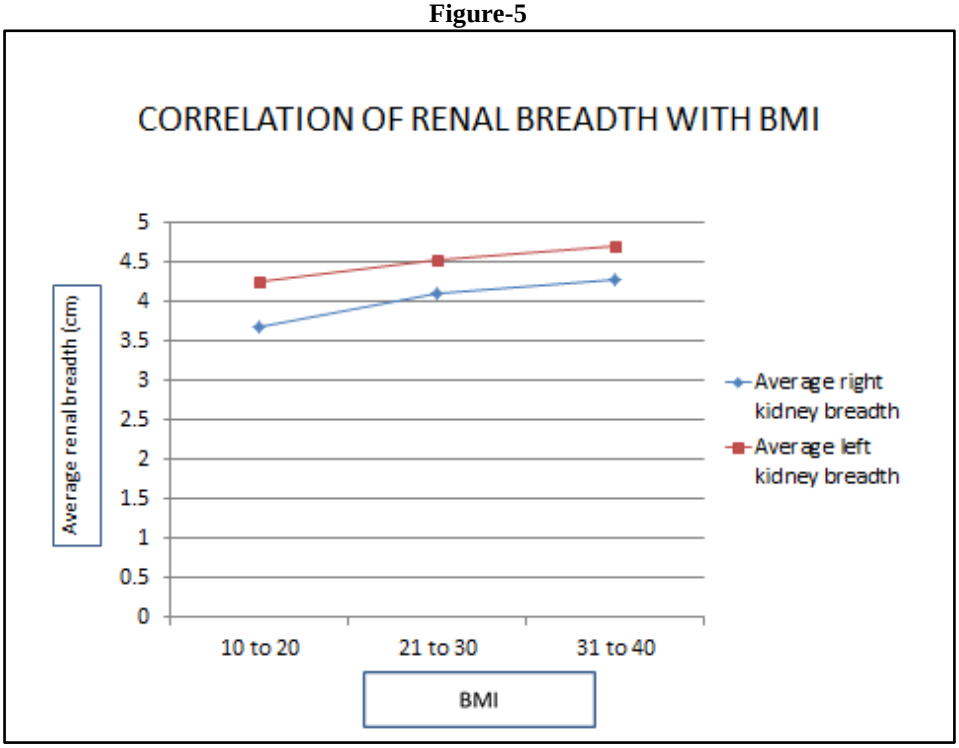


Table-5, figure-4 and figure-5, showsrenal length and breadth of both sides have extremely significant correlation with BMI i.e. with increase in BMI renal length and breadth increases.But cortical thickness has no significant correlation with BMI. It is supported by Naglaa M. Elsayed et.al.[11], J. Oyuela-Carrasco et.al.[10]and Raza M. et.al.[17]

(TABLE-6)CORRELATION OF WEIGHT WITH RENAL DIMENSIONS

Renal dimension	Pearson correlation	'P' value
Right kidney length	0.461	0.000 ES
Right kidney breadth	0.522	0.000 ES
Right kidney cortical thickness	0.186	0.785 S
Left kidney length	0.513	0.000 ES
Left kidney breadth	0.457	0.000 ES
Left kidney cortical thickness	0.000	0.614 S

Table-6 depicted that all the renal dimensions except cortical thickness showed significant correlation with weight.With increase in weight all renal dimensions except cortical thickness increase and vice versa which is supported by J. Oyuela-Carrasco et.al.[10]

(TABLE-7) CORRELATION OF HEIGHT WITH RENAL DIMENSIONS

Renal dimension	Pearson correlation	'P' value
Right kidney length	**0.335**	**0.000 ES**
Right kidney breadth	**0.385**	**0.000 ES**
Right kidney cortical thickness	**0.188**	**0.645 NS**
Left kidney length	**0.427**	**0.000 ES**
Left kidney breadth	**0.357**	**0.000 ES**
Left kidney cortical thickness	**0.040**	**0.554 NS**

Table -7 revealed both right and left kidney length and breadth had extremely significant correlation with height of individuals which is supported by Wael El-Reshaid et.al.[21] and Zeb Saeed et.al.[23] whereas cortical thickness has no significant correlation with height of the individual.

In our study population 40 subjects were hypertensive, 33 having diabetes and 34 chronic kidney disease. Four subjects had both diabetes and hypertension, 15 had both diabetes and chronic kidney disease and 23 had hypertension and chronic kidney disease.

(TABLE-8)MULTIVARIATE REGRESSION SHOWING PREDICTOR OF AVERAGE RENAL DIMENSIONS(N=65)

Predictors	B	SE	Df	Odds ratio	P-value
Gender	0.163	0.116	1	1.177	0.162(NS)
Hypertension	0.726	0.106	1	2.067	0.368
Diabetes	2.959	0.736	1	19.270	0.000
CKD	1.621	0.231	1	5.058	0.000

B:constant
SE:standard error
df:degree of freedom

Table-8 depicts the multivariate regression of average renal dimensions in relation to gender and diseased conditions (Hypertension, Diabetes mellitus and Chronic kidney disease). Diabetes and Chronic kidney disease shows significant correlation with mean renal length and breadth.Renal dimensions increase with established long term diabetes.But renal dimensions decrease with established chronic kidney disease and this observation is supported by Butorovic-Ponikvar J.et.al.[3] In multivariate analysis hypertension and mean renal dimensions are not statistically significant which is supported by Niels Peter Buchholz et.al.[12]

V. Discussion

In this prospective study 295 individuals were included.After exclusion of cases having pregnancy, chronic kidney disease, malignancy and renal stone, 289 subjects were finally selected for this study.The mean renal lenghth of right side was significantly smaller than that of left side.The mean renal length, breadth and cortical thickness of right side was greater in male and no significant difference was found in mean left renal length with gender.The mean renal dimensions of subjects decreased after the age of 61years.The mean renal length of both sides were directly proportional with body mass index(BMI).With increase in weight all renal dimensions except cortical thickness increased and vice versa.With increase in height all renal dimensions increased and vice versa.In established chronic kidney disease all renal dimensions decreased.Hypertension and mean renal dimensions had no significant correlation in multivariate analysis.In long term diabetes mellitus renal dimensions increased.

The mean renal dimensions in the ethnic subgroup of Odisha is smaller than reference value of America and European population.Left kidney is significantly larger than right kidney.The mean renal size is larger in male. The BMI and mean renal size bear a direct relationship in population of Odisha.Subjects with diabetes mellitus and chronic kidney disease show significant correlation with renal dimension.

VI. Conclusion

The length and volume of kidneys are considered as very important parameters for clinical assessment and follow up of patients with diabetes, chronic kidney disease, hypertension secondary to renal artery stenosis and for assessment of renal transplant cases. A change in kidney dimensions from one examination to the next may be an important indicator for the presence or progress of the disease. It is also useful in younger patients with vesico ureteric reflux which alters the morphometric profile of kidney. Ultrasonographic measurement of

kidney can help to determine an irreversible kidney disease, assess prognosis and avoid unnecessary diagnostic or therapeutic procedures. Ultrasonography is a noninvasive procedure and there is no risk of radiation hazards. So there is definite advantage of this procedure in clinical field.

Bibliography

[1]. AdeelaArooj, Jostinah Lam, Yeoh J. Wui, EkoSupriyanto.et.al."Comparison of renal size among different ethnicities". International journal of biology and biomedical engineering. Issue 4, vol.5, 2011.
[2]. Brandt TD, Neiman HL, Dragowski MJ, Bulawa W, Claykamp G. Ultrasound assessment of normal renal dimensions. J Ultrasound Med. 1982; 1: 49-52.
[3]. Buturovic-Ponikvar J, Visnar-Perovic A. Ultrasonography in chronic renal failure. Eur J Radiol. 2003; 46: 115-22.
[4]. Emamian SA, Nielsen MB, Pedersen JF. Intraobserver and interobserver variations in sonographic measurements of kidney size in adult volunteers. A comparison of linear measurements and volumetric estimates. ActaRadiol. 1995; 36: 399-401.
[5]. Ferrer FA, McKenna PH, Bauer MB, Miller SF. Accuracy of renal ultrasound measurements for predicting actual kidney size. J Urol. 1997;157:2278–81.[PubMed]
[6]. Fundamentals of Diagnostic Radiology, Lippincott, Williams & Wilkins, 4th edition, chapter 36, page 886.
[7]. Gheissari A. The place of ultrasound in renal medicine. Saudi J Kidney Dis Transpl. 2006; 17: 540-8.
[8]. Gray's Anatomy 40th edition, Churchill Livingstone, chapter 74, page 1225-1233.
[9]. Hederstrom E, Forsberg L. Kidney size in children assessed by ultrasonography and urography. ActaRadiolDiagn (Stockh) 1985;26:85–91.[PubMed]
[10]. J. Oyuela-Carrasco, F. Rodríguez-Castellanos et al: "Renal length by ultrasound in Mexican adults" .Nefrología 2009;29(1):30-34.
[11]. Naglaa M. Elsayed et.al. "Renal dimensions at ultrasound in adult Saudi population''., JKAU: Med . Sci. Vol 19, No.3, pp: 47-61(2012 A.D./ 1433 A.H.)
[12]. Niels-Peter Buchholz, Farhat Abbas et al: "Ultrasonographic renal size in individuals without renal disease ". JPMA 50:12, 2000.
[13]. Nyengaard JR: The quantitative development of glomerular capillaries in rats with special reference to unbiased stereological estimates of their number and sizes. MicrovascRes 1993; 45:243.
[14]. Okoye IJ, Agwu KK, Idigo FU. Normal sonographic renal length in adult southeast Nigerians. Afr J Med Med Sci. 2005; 34: 129-31.
[15]. Oyuela-Carrasco J, Rodriguez-Castellanos F, Kimura E, Delgado-Hernandez R, Herrera-Felix JP. [Renal length measured by ultrasound in adult mexican population]. Nefrologia. 2009; 29: 30-4.
[16]. Rasmussen SN, Haase L, Kjeldsen H, Hancke S. Determinationof renal volume by ultrasound scanning. J Clin Ultrasound1978;6:160–4.
[17]. Raza M, Hameed A and Khan I et al: "Ultrasonographic assessment of renal size and its correlation with body mass index in adults without known renal disease'' . J Ayub Med Coll Abbottabad 2011;23(3).
[18]. Sanusi AA, Arogundade FA, Famurewa OC, Akintomide AO, Soyinka FO, Ojo OE, et al. Relationship of ultrasonographically determined kidney volume with measured GFR, calculated creatinine clearance and other parameters in chronic kidney disease (CKD). Nephrology Dialysis Transplantation. 2009; 24: 1690-94.
[19]. Troell S, Berg U, Johansson B, Wikstad I. Ultrasonographic renal parenchymal volume related to kidney function an d renal parenchymal area in children with recurrent urinary tract infections and asymptomatic bacteriuria. ActaRadiolDiagn (Stockh). 1984; 25: 411-6.
[20]. Ultrasound in Medicine & Biology, chapter 39 volume (2): page 210.
[21]. Wael El-Reshaid, Husam Abdul-Fattah: "Sonographic assessment of renal size in healthy adults " .Med PrincPract 2014; 23: 432-436, DOI: 10.1159/00364876.
[22]. Wong IY, Copp HL, Clark CJ, Wu HY, Shortliffe LD. Quantitative ultrasound renal parenchymal area correlates with renal volume and identifies reflux nephropathy. J Urol. 2009; 182: 1683-7.
[23]. Zeb Saeed, WaseemMirza, RazaSayani, Adil Sheikh, IffatYazdani, Syed AtherHussain et al: "Sonographic measurement of renal dimensions in adults and its correlates ". International Journal of collaborative research on internal medicine and public health; (09/2012); 4(9).

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