

Morphometric Analysis of Human Fetal Kidney

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Abstract

Introduction: Development of human kidney runs through a series of continual and mutually dependent changes during which kidney obtains its morphological and functional maturity.

The evaluation of fetal morphometrical growth parameters have been subject of increased awareness for the assessment of fetal growth and development and prenatal diagnosis of renal anomalies, genetic counseling and treatment of prenatal renal disorders like Wilm's tumor, multicystic renal dysplasia, hydronephrosis.

Objectives: The aim of the study was to determine the morphometric development of the kidneys during the fetal period.

Methods: The present study was carried out in the department of Anatomy, Regional Institute of Medical Sciences, Imphal, Manipur. The material for the study consisted of 60 spontaneously aborted and still born human fetal specimens free from any gross congenital anomalies with gestational age between 11th to 38th weeks were collected from Obstetrics and Gynaecology department, RIMS. The kidneys were taken out from fetal specimens for morphological study. The measurements were done by using compass, scale and vernier caliper, digital weight machine.

Results: A significant and positive correlation between the length, breadth, weight and thickness of kidney with Gestational Age and Crown Rump Length (P-value <0.05) were observed. All the parameters show linear growth from 11-38 weeks of gestation with growth spurts during 18-22 weeks and 24-26 weeks.

Conclusions: From the above observations it is obvious that the growth of kidney was seen to be proportional to gestational age and crown rump length. This will also contribute to imaging of fetal kidneys and detection of kidney abnormalities in intrauterine period and early interventions.

Keywords: Crown rump length, Gestational age, Correlation, Renal dimensions, Linear relationship.

I. Introduction-

Development of human kidney runs through a series of continual and mutually dependent changes during which kidney obtains its morphological and functional maturity^[1]. The evaluation of fetal morphometrical growth parameters have been a subject of increased awareness for the assessment of fetal growth and development. It is very important to know the normal developmental anatomy of kidneys in prenatal diagnosis of renal anomalies, genetic counseling and treatment of prenatal renal disorders like Wilm's tumor, multicystic renal dysplasia and hydronephrosis. Fetal Kidney parameters are most accurate for estimating gestational age than other biometric indices. Accurate gestational age estimation is very important to an obstetrician for diagnosis of growth disorders, in assessment of wrong dates or forgotten dates and timing of delivery either by induction or caesarean section. It is particularly important in high risk pregnancies (severe preeclampsia, chronic hypertension, severe IUGR, central placenta previa, sensitized Rh-negative mother etc) where in some cases early termination may become necessary as soon as fetus becomes mature^[2]. Present study was undertaken to determine the average size (length/breadth/thickness) and weight of kidney in aborted fetuses. A comparison was made between these dimensions with crown rump length and gestational age. The study will establish the macro development of kidney and its correlation with Gestational Age and Crown-Rump Length.

II. Aims And Objectives-

The aim of the study was to determine the morphometric development of the human kidneys during the fetal period.

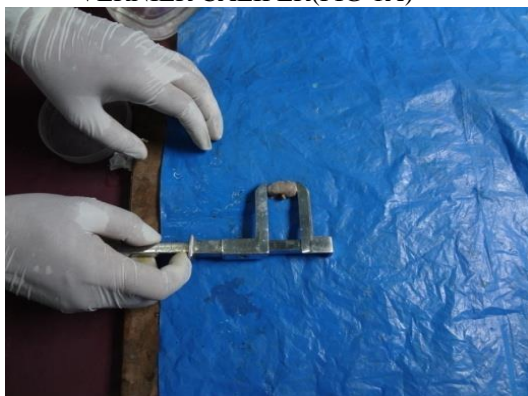
III. Materials And Methods-

The present study was carried out in the department of Anatomy, Regional Institute of Medical Sciences, Imphal, Manipur. The material for the study consisted of 60 spontaneously aborted and still born human fetal specimens free from any gross congenital anomalies with gestational age between 11th to 38th weeks were collected from Obstetrics and Gynaecology department, RIMS after taking permission from the Institutional Ethics Committee. Consent for autopsy and brief antenatal, medical, past history was taken from

the mother to perform the study. The kidneys were taken out from fetal specimens for morphometrical study. The measurements were done by using compass, scale and vernier caliper, digital weight machine.

IV. Measurement Techniques-

VERNIER CALIPER(FIG-1A)



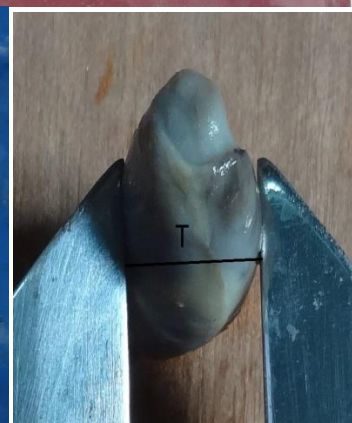
DIGITAL WEIGHT MACHINE(FIG-4)



LENGTH(FIG-1B)



BREADTH(FIG-2)



THICKNESS(FIG-3)

The following morphological measurements were taken on kidney:

- 1) Length (L): The length was measured from the superior pole to inferior pole (Fig: 1A,1B).
- 2) Breadth (B): The breadth was measured as the widest distance at the hilum (Fig: 2).
- 3) Thickness (T): The thickness was measured at the region of maximum anterior and posterior diameter (Fig:3).
- 4) Weight(w) (Fig: 4) : Digital weight machine.

For each gestational age Mean of various measurements of fetal kidney were taken. Graphs were plotted with gestational age on X- axis and measurements of length, breadth and thickness in millimeters and weight in grams on Y- axis. Statistical analysis was carried out using Statistical Package for Social Sciences (SPSS, version 21 for windows). All quantitative variables were estimated using measures of central location (mean, median) and the data were presented in form of figures and tables. Correlation of each parameter with crown rump length and gestational age were calculated using Pearson's correlation coefficient. P value of <0.05 was considered significant.

Type of study-Cross sectional study.

V. Results

A significant and positive correlation were found between the Crown Rump Length(CRL) and Gestational Age with renal dimentions including length, breadth, thickness and weight,(P-value <0.05). All the parameters show linear growth from 11-38 weeks of gestation with growth spurts during 18-22 weeks and 24-26 weeks.

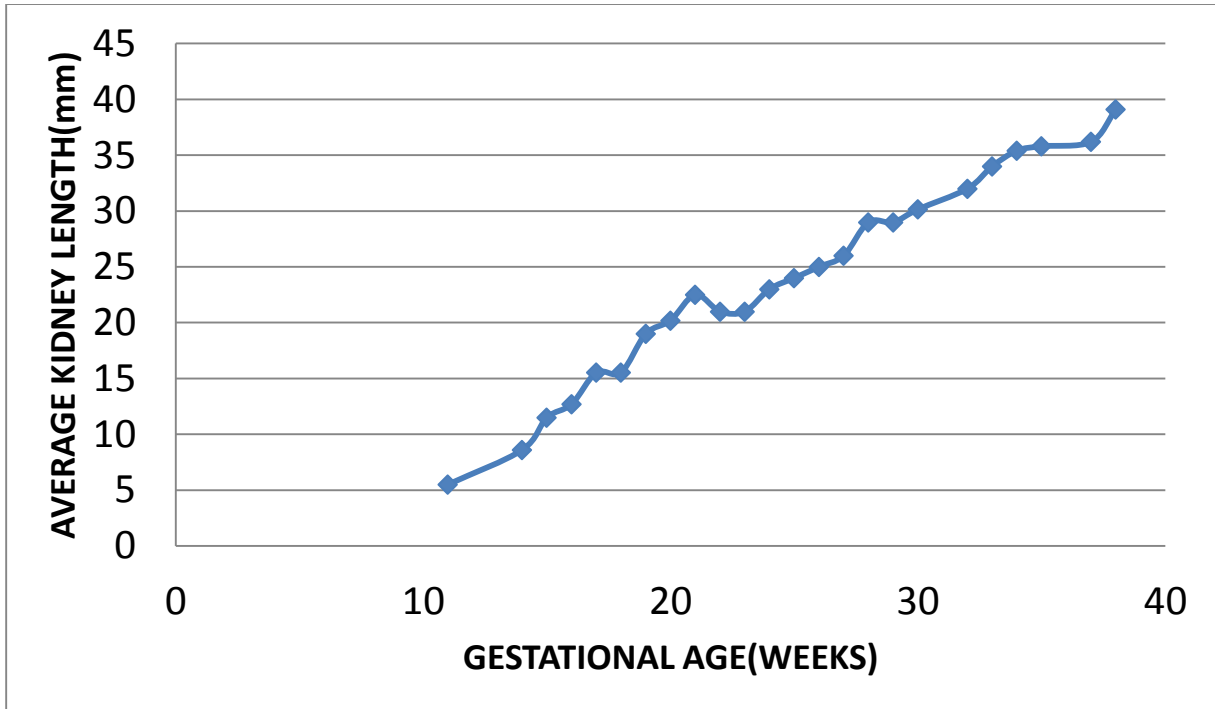


FIGURE-5 : Kidney Length In Relation To Gestational Age

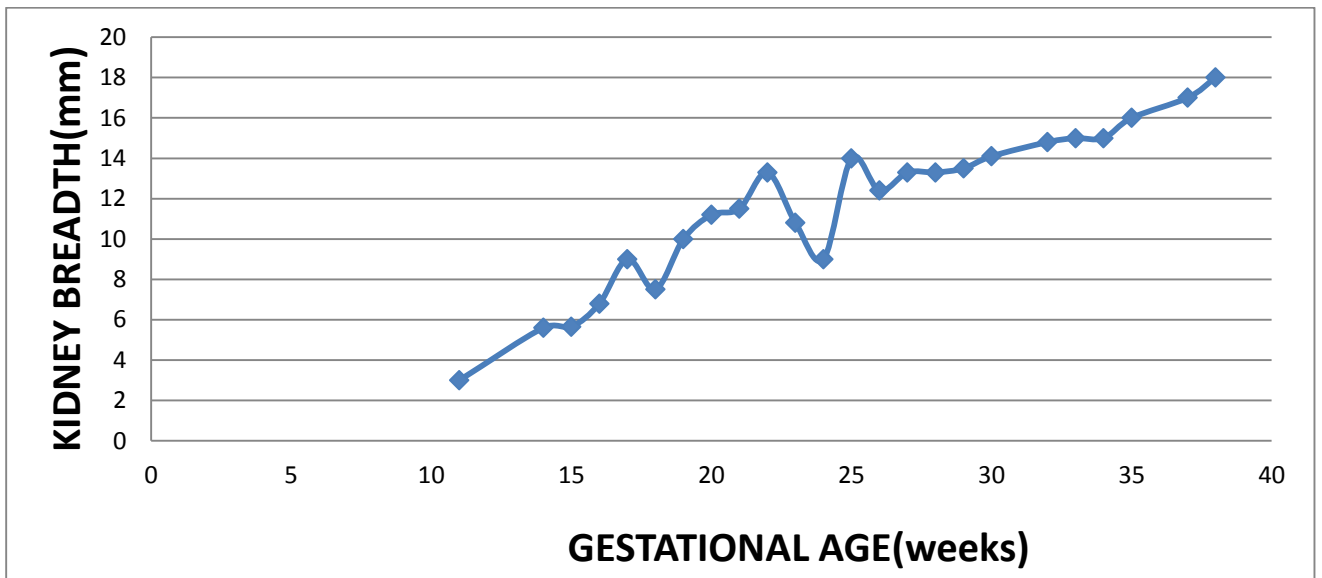


Figure-6 : Kidney Breadth In Relation To Gestational Age

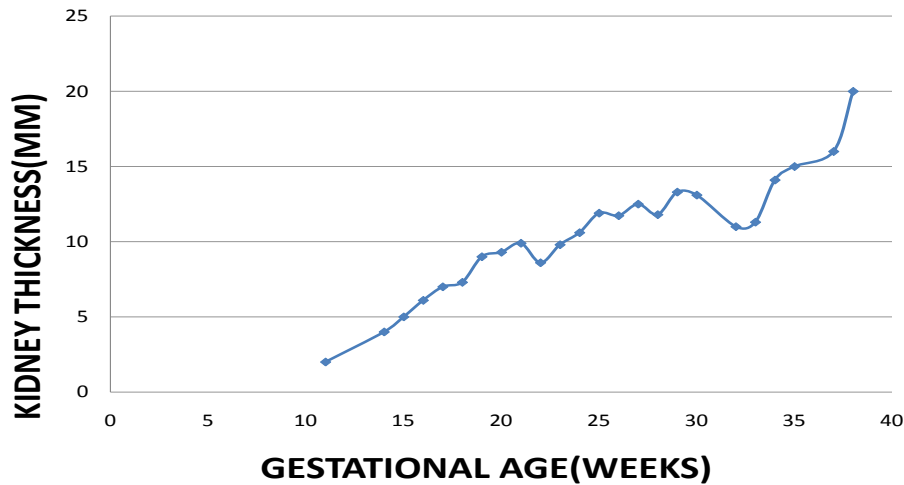


Figure-7: Kidney Thickness In Relation To Gestational Age

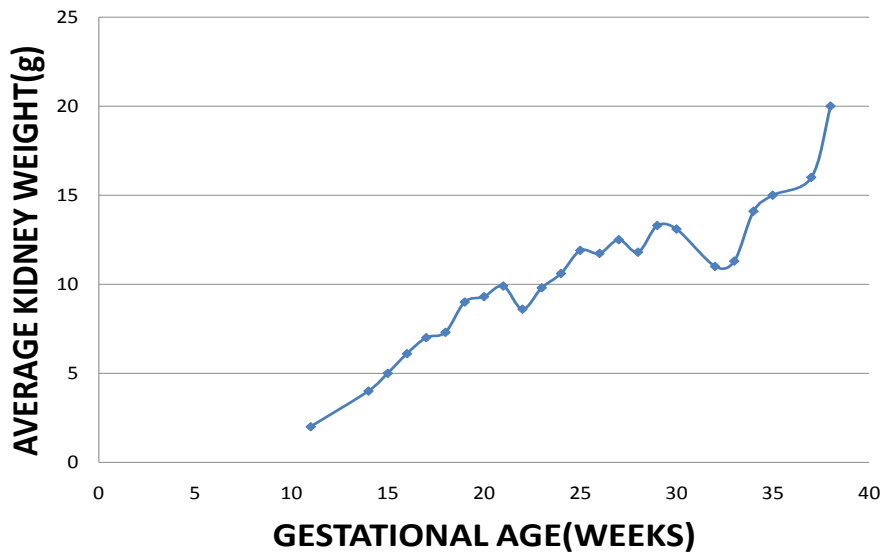


Figure-8 : Kidney Weight In Relation To Gestational Age

Table 1: Relationship for kidney length,breadth,thickness and weight with gestational age and Crown rump length

KIDNEY PARAMETERS	CROWN RUMP LENGTH		GESTATIONAL AGE	
	R	P - VALUE	R	P - VALUE
LENGTH	0.992	<0.0001	0.990	<0.0001
BREADTH	0.886	<0.0001	0.859	<0.0001
THICKNESS	0.958	<0.0001	0.939	<0.0001
WEIGHT	0.921	<0.0001	0.924	<0.0001

VI. Discussion

Most of the studies done by the previous authors are ultrasound based and related to kidney length. Only few studies for direct measurements of kidney parameters other than length have been done earlier. Measurements of kidney length in our study have been compared with studies done by other authors, where it is compare well

with the finding of Konje et al^[3] and Shivalingaiah N et al^[9] but more than Sunita V et al^[7] and Yusuf N et al^[4] and less than Gupta DP et al^[8] and Kumar K et al findings.

Table 2: Comparison between the mean kidney length of present study with other studies.

GESTATIONAL AGE (Weeks)	MEAN KIDNEY LENGTH (mm)						
	PRESENT STUDY	KONJE et al	YUSUF N et al	KUMAR K et al	SHIVALINGAIAH N et al	GUPTA DP et al	SUNITHA V et al
11	5.5						4.5
14	8.6						12
15	11.5						10
16	12.5						10
17	15.3						12.5
18	15.4			12			13.5
20	17			15.3			15.5
22	21			19.3			19
24	23	24.2		21.6	24.1		18.8
26	25	26.3		26.3			20
27	26					30.5	
28	29	29		29.8	28.2	30.5	24.5
29	29					31.4	
30	30	30.9		34.3		32.6	
32	32	33.2	32	36.2	32.8	34.7	28
33	34		33			35.5	
34	35.4	35	34.2	37.2		35.6	
35	35.8		35.1			36.5	
36	36.2	38.2	35.9	38.9	36.5	37.5	35
38	39.1	40.1	37	40.4		39.4	41

Table-3: Comparison between the mean kidney breadth of present study with study of Ahmadi et al.

GESTATIONAL AGE(WEEKS)	MEAN KIDNEY BREADTH (PRESENT STUDY)	MEAN KIDNEY BREADTH (AHMADI F et al)
26	12.4	16.51
28	13.3	17.83
30	14.1	19.44
32	14.8	20.62
34	15	21.44
36	16	21.84
38	18	22.53

Present study shows a significant Pearson’s correlation ($r= 0.99, p<0.05$) for all the dimensions of the kidney including length of kidney which is in accordance with the studies of Konje et al^[3] 2002($r=0.91$) and Shivalingaiah N et al^[9] 2014($r=0.85-0.98, p <0.05$) and Cohen HL et al^[10] 1991($r=0.82$).

Ram KS et al^[5] (2014) measured fetal kidney length, breadth, thickness in 30 spontaneously aborted human fetuses (12th to 28th weeks) and they have observed that the growth of the kidney was proportional to gestational age with spurts of growth during 20-22 and 26-28 weeks which is similar to our study.

Suvarna A et al^[6] (2014) carried out a study on 30 human fetuses (14th to 28th weeks) and found that kidney length, breadth and thickness was to be proportional to Gestational age and Crown-Rump Length, which is similar to our study.

Sulak O et al^[11] (2011) conducted a study on 172 spontaneously aborted human fetuses (9th to 40th weeks) and found that the dimensions of the kidneys increased with gestational age which is similar with our study.

Sunita V et al^[7] in their study with 50 stillborn fetuses (10th to 40th weeks) stated that length, breadth, thickness and weight of the fetal kidney increased gradually with gestational age.

Jovevska S et al^[1] (2008) found a highly significant correlation between renal dimensions and gestational age in his study on macrodissectional measurements of 60 fetuses post mortem with gestational ages from 18 to 31 weeks.

Ahmadi F et al^[12] (2015) carried out a prospective cross-sectional study on 557 fetuses in 26-39 weeks gestational age found a linear relationships between the gestational age and fetal kidneys diameters, including length and width which is in accordance with our study.

Kansaria JJ et al^[13] (2009) in their ultrasound based study on 70 pregnant women found that fetal kidney length,diameter and circumference increases linearly with gestational age of the fetus which is similar to our study.

VII. Conclusion

Growth of kidney was seen to be proportional to gestational age and Crown Rump Length.This information could help in imaging of fetal kidneys, detection of kidney abnormalities in intrauterine period and necessary management will be possible at the earliest.

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