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Dimension of Foetal Kidneys & Gestational Age Estimation

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ABSTRACT Reliable gestational age assessment of the fetus is usually done by ultrasonography. The various parameters which have been used for gestational age measurements are: Crown rump length (CRL), Biparietal diameter (BPD), Head circumference, Abdominal circumference, Femur length, Hand and Foot length, Time of appearance of ossification centers of bones. Gestational age estimation is usually the primary characteristic for identification and is often the only means of identification for fetuses since they do not usually have any other type of identification with them. Gestational age estimation can also play an important role in the prosecution of forensic cases. There are lots of studies reported in literature showing the relation of length of kidneys and gestational age estimation.

KEYWORDS :

Introduction

Gestational age is the age of unborn baby. Proper assessment of foetal well-being requires an accurate knowledge of gestational age of the fetus. Developmental status can be assessed by noting out the progressive differentiation, growth and maturation of the organ system of the body. Almost any organ system in the body may be used to assess developmental status, providing that it manifests progressive differentiation, growth and maturation.

Estimation of age in the foetus and newborn infants.

The approach to fetal or perinatal autopsy is very different from the approach to adult autopsy. Fetal development is, in part, dependent on maternal health and intrauterine environment.

The major objectives of the fetal or perinatal autopsy are to determine gestational age, document growth and development, detect congenital abnormalities, analyze clinical diagnosis and treatment, and determine the cause of death. In addition, the diseases and conditions considered in the fetus are not the same as in adults. Genetic syndromes must be identified if present.

KIDNEY LENGTH

Lawson etal[1] analyzed the normal size and frequency of visualization by ultrasonography. In their study 177 fetuses were evaluated from 15 weeks onwards till term. They concluded that the identification of either one or both kidneys is possible in 90% of cases in the 17th week of gestation and in 95% of cases after the 20th week. However, advanced echosonographic techniques have enabled the study of fetal kidney development in early gestation and this is possible as early as at 12 weeks[2].

Grannum et al[3] says that kidneys can be identified by ultrasonography in fetuses from as early as 12 – 14 weeks by a study done on 89 patients not at risk for fetal kidney disease.

Development of the human fetal kidney runs through a series of continual and mutually dependent changes during which the kidney obtains its morphological and functional maturity. A study was created in 2006 by Vlajkovic et al [4] to estimate the changes in kidney size during gestation in fetuses from the 4th to the 10th lunar month, to evaluate the dynamics of their growth, as well as to establish the validity of the volume calculated from these dimensions. Serial measurements of kidney dimensions (length, width, thickness) were performed in 110 fetuses. Photomicrographs of kidneys from the 4th, 6th, 8th and 10th lunar months were also presented. On the basis of the results obtained by the examination, it was concluded that the period from the 14th to 16th week of intrauterine life is the fastest period of kidney growth during fetal development. While organogenesis of most organs is finished by the 12th week of gestation, fetal nephrogenesis continues until 36 weeks when the increase of nephron number ceases[5].

In a study done by Osman Sulak et al[6] with aim to determine the morphometric development and location of the kidneys during the fetal period, three hundred and forty-four fetal kidneys, obtained from 172 human fetuses and aged between 9 and 40 weeks, were used. Fetuses were divided into four groups according to the gestational weeks: first trimester, second trimester, third trimester, and full-term gestation. First, the anterior abdominal wall was dissected. Topographic localization of the kidneys in the abdominal cavity was then assessed. The distance between the inferior pole of the kidney and iliac crest was measured. The vertebral levels of the superior and the inferior poles and relations to ribs of the kidneys were determined. The distances between hilum of the kidneys and inferior vena cava, abdominal aorta, and midline of the vertebral column were determined. The dimensions (width, length, and thickness), weight, and volume of kidneys were measured.

The results showed that the distance between the inferior poles of the kidneys and the iliac crest increases with gestational age. The vertebral levels of the superior and inferior poles of the kidneys increased during the fetal period. The level of the left kidney was higher than the level of the right kidney in the fetal period. The posterior surface relations to the ribs showed certain ascendance during gestation, corresponding to vertebral levels. However, fetal kidneys do not reach the same level as adults at full term. The kidneys move farther apart from the midline of the body during the fetal period. The dimensions, weight, and volume of the kidneys increased with gestational age during the fetal period. The ratio between kidney weights and fetal body weights were determined, and it was observed that the ratio decreased during the fetal period. There were no sex or laterality differences in any parameter.

In order to determine gestational age, it is important to know the kidney's length. During gestational weeks 24–38, kidney length is a more accurate parameter for predicting gestational age than other parameters[7].

In a study by Konje JC et al[8] they determined whether there are differences in kidney size and shape in small and appropriate for gestational age fetuses at different gestation. The kidney lengths at different gestational ages were similar in the two groups. The circumference, transverse and anterior-posterior diameters were significantly greater in the appropriate for gestational age fetuses from 28 weeks. They concluded that differences in fetal kidney size with gestation manifest from as early as 26 –28 weeks. The fetal kidney length at different gestational ages does not alter even in small for gestational age fetuses.

Cohen et al[9], evaluated the fetal renal length in 397 obstetric patients. They found that there was no difference between the mean length of right and left kidneys, which were highly correlated. In their study it

was also found that fetal renal length has no correlation with paternal height and pre – pregnancy weight. They concluded that gestational age is related to renal length and could be used in confirming other questionable biometric measurements of gestational age.

Pandey et al[10] proposed the use of kidney parameters for estimating gestational age. In their study 98 obstetric patients were subjected to routine ultrasound along with measurements of renal parameters. They found 0.98 correlation coefficient between gestational age and renal length with prediction of 1.5 weeks by renal parameters after 30 weeks of pregnancy.

A prospective study was done by Yusuf et al[11] in102 pregnant women after 30 weeks of pregnancy whose gestational ages were confirmed by early ultrasonography (<24 weeks). The aim of this study was to establish a correlation between the fetal kidney length & gestational age in 3rd trimester. The mean length of fetal kidneys showed a linear correlation with gestational age. The mean fetal kidney length in mm approximates the gestational age in weeks in 3rd trimester as predicated by biparietal diameter, femur length, abdominal circumference & head circumference (P<0.001). Maternal height, weight & socioeconomic status did not show any effect on growth of fetal kidneys. The result obtained confirmed that measurement of fetal kidney length in mm can be used as an additional parameter.

Toosi and Delui[12] did a study aimed to evaluate the normal fetal kidney length (KL) and its correlation with gestational Age. A cross-sectional study on 92 pregnant women between 8th and 10th week of gestation with normal singleton pregnancy underwent standard ultrasound fetal biometry and kidney length measurement. Univariate and multivariate linear regression analysis was used to create a predictive equation to estimate gestational age on the kidney length and feto biometry parameters. A significant correlation was found between Gestational Age and kidney length (r=0.83, P<0.002). The best gestational age predictor was obtained by combining head circumference, fetal biparietal diameter, femur length and kidney length with a standard error (SE) of about 14.2 days.

Kansaria and Parulekar[13] did a study to evaluate the application and accuracy of fetal kidney length measurement in determining the gestational age of the fetus in 70 pregnant women. Serial study of fetal biometry at 2 weekly intervals between 22 weeks and 38 weeks of gestation was performed to measure fetal kidney parameters and biparietal diameter, femur length, abdominal circumference & head circumference. They concluded that fetal kidney length grows at the rate of 1.7 mm fortnightly. Kidney length predicted gestational age with better precision than the model with biometric indices of Biparietal Diameter (BPD), Abdominal Circumference (AC) and Femur Length (FL).

Abbas et al[14] did a cross-sectional study to assess the reliability of fetal renal length obtained by ultrasonography with the manual measurement, in 100 pregnant ladies of 2nd & 3rd trimester who were selected for sonographic renal length study on weekly basis. Thirty dead born fetuses of 2nd and 3rd trimester were studied. Their kidneys were dissected out and measured manually. Measurement of both samples was compared. Insignificant differences were observed between the sonographically and manually measured renal length at each gestational week of pregnancy. They concluded that sonographically measured fetal renal length is accurate and useful tool for assessment of fetal renal growth.

Kaul et al [15] evaluated role of fetal kidney length in estimation of gestational age (GA) in late 2nd & 3rd trimester. A total of 98 pregnant women with singleton pregnancy underwent serial biometric & fetal kidney length measurements ultrasonographically at 24, 28, 32, 36 and 38 weeks of gestation. These measurements were used to date the pregnancies relative to dating by last menstrual period. Linear regression models for estimation of gestational age were derived from the biometric indices and fetal kidney length. New models were constructed by combining different biometric indices and kidney length in various combinations. Comparison of accuracy in prediction of gestational age was made between individual parameters and these models to obtain best individual parameter and the best model in prediction of gestational age. Left was slightly, but significantly longer than right fetal kidney length at each gestational period observed in the study. Standard error of prediction of gestational age was least for fetal kidney length (±8.56 days), closely followed by femur length (±8.9 days), and maximum for abdominal circumference (±11.72 days). The best model in estimating gestational age included all the five variables (femur length, fetal kidney length, biparietal diameter, head and abdominal circumference) with a standard error of ±7.41 days. According to Kaul et al [15] Fetal kidney length is the most accurate single parameter for estimating gestational age than other biometric indices in late 2nd and 3rd trimester and could be easily incorporated into the models for estimating gestational age.

Conclusion

Various non-traditional sonographic parameters for estimating gestational age are being studied like transverse cerebellar diameter, fetal foot length, epiphyseal ossification centers, amniotic fluid volume and placental grading. Fetal kidney length is one such nontraditional parameter for estimating gestational age under study. It is easy to identify and measure. It is strongly correlated to gestational age and its linear growth during gestation has been demonstrated. It is more accurate method of gestational age estimation than Biparietal diameter, Femur length, Head circumference and head circumference after 24th week of gestation.

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