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ORIGINAL ARTICLE

Centile Charts of Fetal Kidney and Adrenal Gland Length: A Prospective Study in Indian Population in the State of Bihar

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Abstract Normal development of the fetal kidneys and adrenal glands is essential for a good crucial neonatal outcome. There is, however, paucity of data on normal fetal adrenal gland and renal length in populations of North India and this poses a not infrequent dilemma when an anomaly is suspected during the anomaly scan. The objective of this study was to obtain gestation wise data of fetal renal length and adrenal length for 18, 19, 20 and 21 weeks of gestation and construct a gestation age wise size chart. This was a cross sectional study of 128 consecutive normal pregnancies after exclusion of multiple gestations, maternal complications, congenital anomalies and a family history of congenial adrenal hyperplasia. Gestational age of the fetus was calculated from fetal biometry. Measurements were made in the sagittal plane as length including renal and adrenal, longest pole to pole length of kidney and adrenal gland length calculated as the difference between the values. The values were analysed to yield the 95% confidence interval along with the 50th centile for gestational age groups of 18–21 weeks.

Keywords Fetal renal length · Fetal adrenal gland length · Size charts

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Introduction

Nuchal renal and adrenal development is critical for normal neonatal outcomes [1]. Knowledge of the kidney maturation process remains controversial in perinatal medicine [2]. The human kidney develops through three successive embryonic stages of pronephros, mesonephros and metanephros. Transient development and regression of the pronephros and the mesonephric kidney occurs between day 23 and 112 [3].

These primitive stages regress and the final functional kidneys develop from the metanephros which starts development from day 23. It starts its development in the upper sacral area during the fourth week of gestation, but with the rapid growth of the lumbar and sacral regions of foetus, it migrates cephalad into the retroperitoneum of the upper abdomen. Concomitant with the ascent, it also undergoes a medial rotation such that ureteropelvic junction has a medial position relative to the kidney. Maximum cell proliferation of the kidney occurs in the third trimester.

During 26-34 weeks of gestation growth of the kidney reaches the maximum [4]. Approximately 60% of nephrons are formed in the third trimester and growth of the kidneys continues up until 34-36 gestational weeks [5].

Renal length does not change significantly from 35 weeks of gestational age until term [6].

Fetal kidneys show a steady growth of 1.7 mm per fortnight during the entire pregnancy and is not affected by growth abnormalities.

During antenatal visualization, the fetal kidney shows varying texture with gestational age. It is echogenic in the first trimester and shows decreasing echogenicity as the pregnancy progresses [4].

The kidneys can be visualized by transvaginal ultrasound as early as 9 weeks of gestation and can be seen in all cases from 12 weeks [20]. Sonographic corticomedullary

differentiation starts at 15 weeks and becomes clearer as gestational age advances [4]. It is most easily visualized within fetuses after 18 weeks. Its ultrasonographic appearance is a sonolucent halo of tissue surrounding the somewhat more echogenic pyelocaliceal sinus [10].The outer more hyperechogenic renal cortex can be clearly distinguished from the inner hypoechogenic medulla at 20 weeks of gestation [12–19].

Renal echogenicity decreases compared to liver and spleen after 17 weeks.

At about 28 weeks, renal pyramids can be demonstrated. Visualization of fetal renal arteries by color doppler can facilitate the identification of the kidneys [4, 6, 9, 10].

Fetal adrenal cortex arises from the intermediate mesoderm and the medulla from ectoderm. The earliest recognizable structure of the adrenal gland is called the adrenal blastema or the adrenal primordium which appears distinct from surrounding structures at 33 days post conception and lies posteromedial to the urogenital ridge. At 6–7 weeks of gestation the cortex consists of an outer cortical zone (adult cortex) and an inner fetal zone.

Before birth, the bulk of the fetal adrenal, about 80%, comprises of the cortical zone. The weight of the developing human adrenal gland increases almost 10 fold from 8 to 10 week post-conception.

At the end of the first trimester, the normal adrenal glands appear as pyramid shaped hypoechoic structures on the superior aspect of the kidneys.

By 20 weeks of gestation, the gland becomes as large as the fetal kidney and by 30 weeks achieves a relative size 10–20 fold that of the adult adrenal.

During the second and third trimesters, corticomedullary differentiation is apparent with a hyperechoic medulla and hypoechoic cortex. On a longitudinal sonogram, the adrenals are seen as V or Y shaped structures superior to the kidneys [12–14].

Imaging the fetal adrenal glands is not a part of routine obstetric ultrasonographic examination guidelines [2].

There is paucity of available data on prenatal imaging of normal and abnormal fetal adrenal gland and, therefore whenever fetal adrenal gland pathology is suspected during an ultrasound examination, it often poses a confusing situation [3].

Due to ethnicity, racial, physiological and environmental differences amongst populations worldwide, regional nomograms become necessary [2].

Materials and Methods

This was a hospital based prospective cross-sectional study in a tertiary care hospital (AIIMS) in North India in the state of Bihar which was conducted from November 2019 to March 2021. The study included 128 consecutive normal pregnant women after exclusion of those with maternal diseases that could lead to a significant alteration of kidney size and adrenal gland size of the fetus. Exclusion criteria also included abnormal fetuses, fetal growth abnormalities, multiple gestations, abnormal renal morphology and unclear adrenal / renal borders. All pregnancies from 18 to 21 gestational weeks by ultrasound (based on fetal biometry). The study was approved by the institutional ethical committee.

Method

Conventional ultrasound examination was done using ultrasound systems LOGIQ S9, LOGIQ S8 or SAMSUNG RS80A systems equipped with curvilinear probe of 3.5–5 MHz.

For antenatal ultrasound examination, the parameters studied were: Gestational age from BPD, HC, AC and FL, measurements of kidney length, measurement of adrenal gland closest to the probe including length of the fetal adrenal gland.

The measurement of kidney length was done as distance BC (Fig. 1).

The longest distance including adrenal gland and kidney length was measured as AC and the adrenal gland length was calculated as AC-BC= AB (Fig. 1).

Results

Our study was conducted in 128 fetuses at 18 to 21 weeks of gestation because most expectant mothers were referred during 18–22 weeks for the targeted fetal anomaly scan to our department. In our study each gestational age group 18 weeks, 19 weeks, 20 weeks and 21 weeks included 40, 36, 34 and 18 samples respectively.

Using Statistical Package for the Social Sciences software (version 25 SPSS), statistical analysis was performed and the following results were obtained:

- There was no significant difference between the ipsilateral kidney length and contralateral kidney length after applying the paired T test (p value = 0.5988).
- In our study the 5th, 50th, 95th centiles were obtained for the renal length and ipsilateral adrenal gland length.

There was a significant correlation between the renal length and gestational age (Figs. 2, 3).

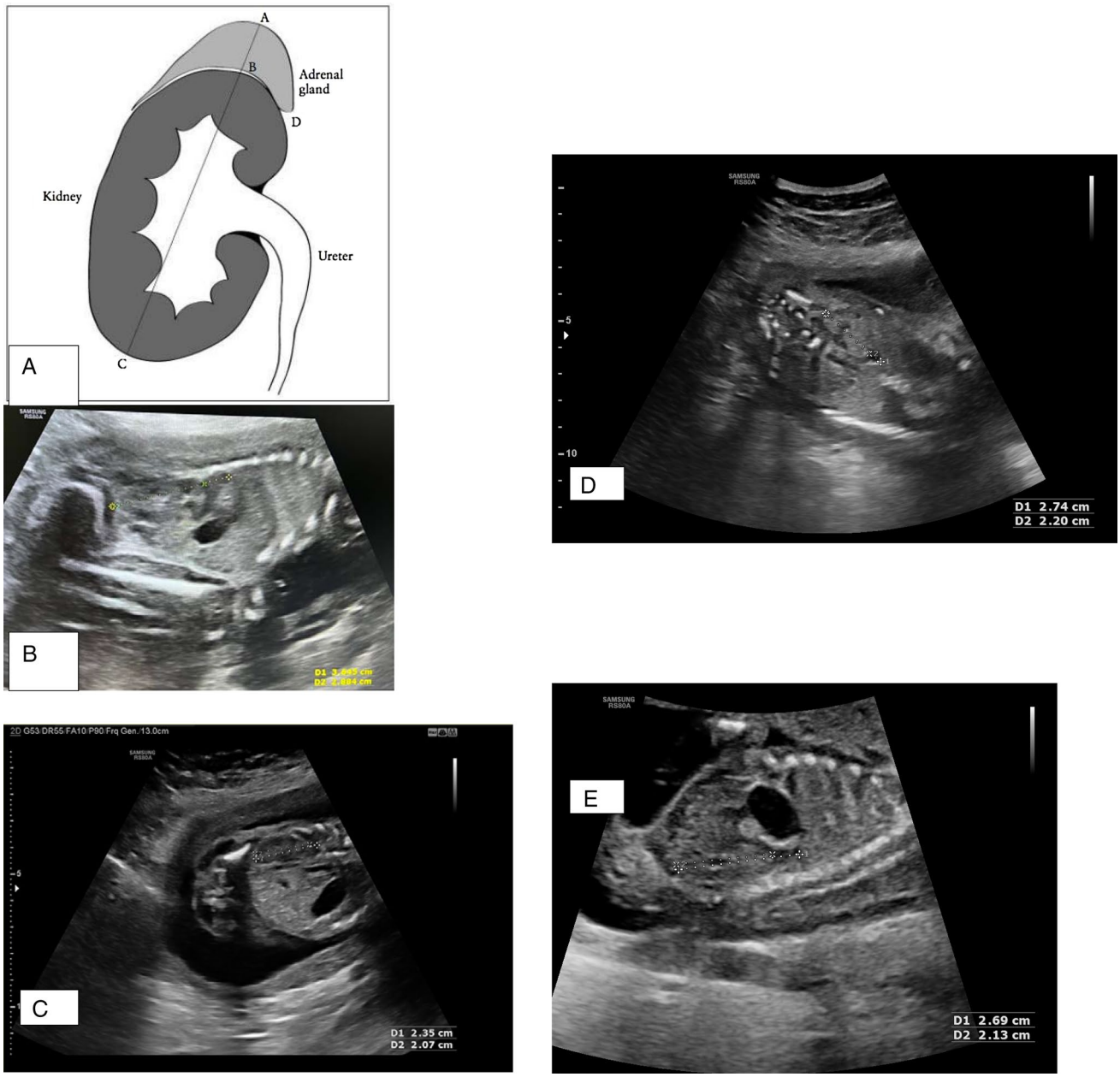

Fig. 1 **A–G**: Sagittal plane showing measurement for renal length (upper pole to lower pole), adrenal gland length

Fetal adrenal gland length also showed strong correlation with gestational age of the fetus.

The regression analysis of renal length with reference to gestational age was done and the correlation coefficient was 0.72.

The correlation coefficient for adrenal gland length was 0.36

The predictive models derived after regression analysis for kidney length and adrenal length are as follows:

- Renal length (Y) = -0.4538 + 0.130(gestational age)
- Adrenal gland length (y) = -0.5655 + 0.055 (gestational age)

Discussion

Our study provides indigenous and regional nomograms that account for possible racial, ethnic and environmental variations in size parameters of fetal development. A similar study has been available in the south Indian population [2]. This, however, included adrenal gland only and

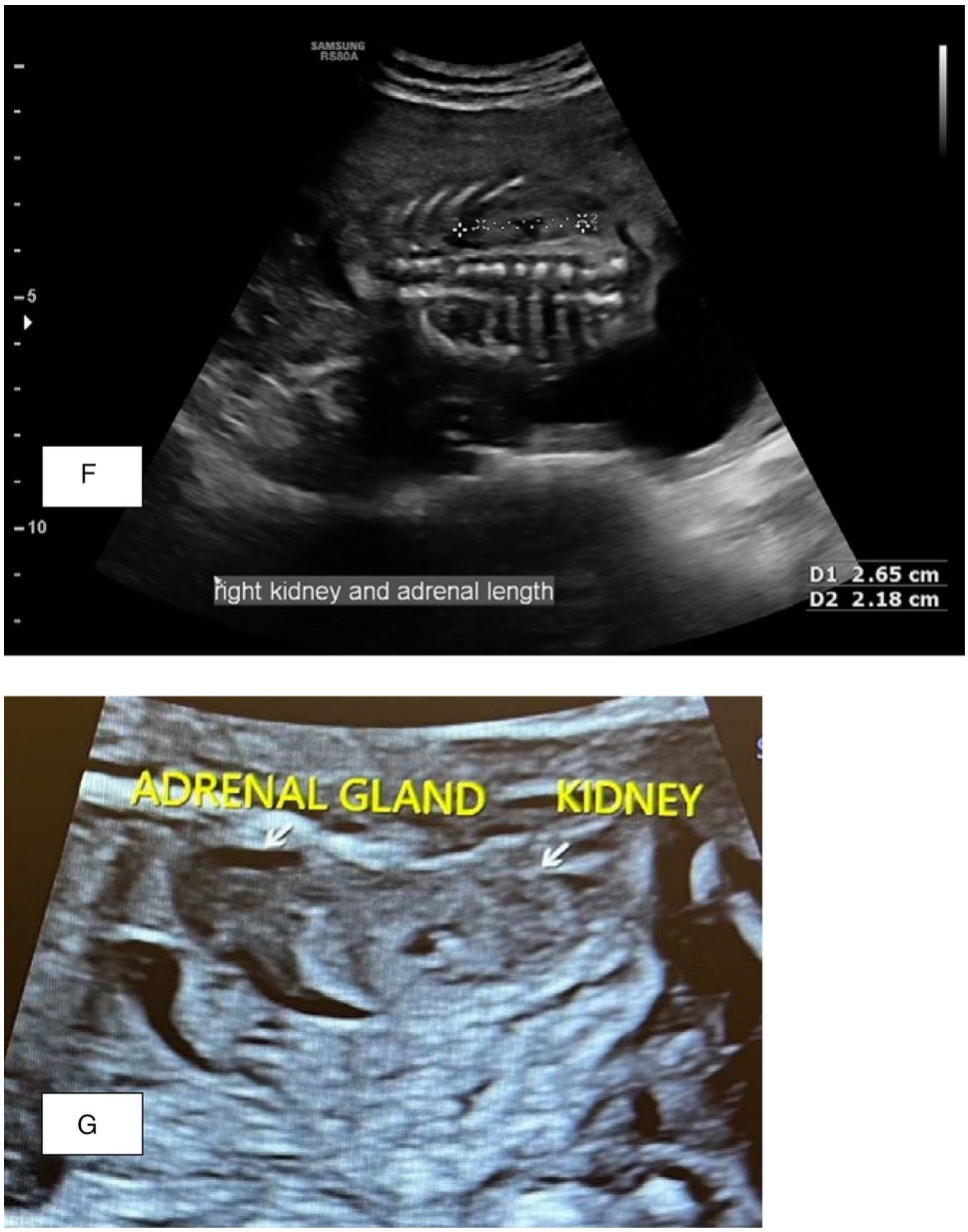

Fig. 1 (continued)

could not get the minimum 15 cases in each sample gestational age. The relation of fetal kidney and adrenal gland length in the sagittal plane is the best reproducible and repeatable plane for assessment of length. This method originally described by Van Vuuren et al. in 2012 [1], was also followed by Jeanty et al. [4]. Despite previous studies which failed to identify the adrenal gland at a gestational age less than 26 weeks (Rosenberg et al. 1980), Jeanty et al. 1983 described adrenal gland sizes in 20–40 weeks with only 70% cases showing adequate visualization. The current era of high resolution imaging as in our study, has 100% identification of adrenal gland morphology. In our study an attempt has been made to provide nomograms of fetal renal length and adrenal gland with reasonable sample size in the gestational age group where detection of anomaly is the prime objective (Tables 1 and 2).

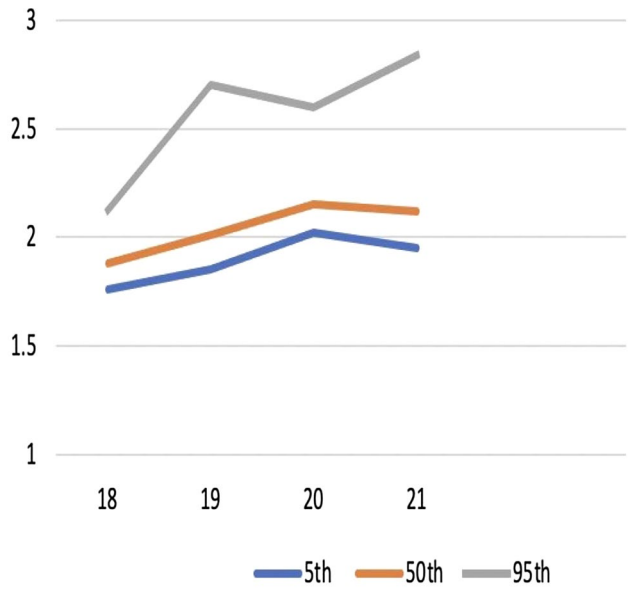

Fig. 2 The 5th, 50th, 95th centiles for the kidney length (in cm) for gestational age of 18 weeks to 21 weeks

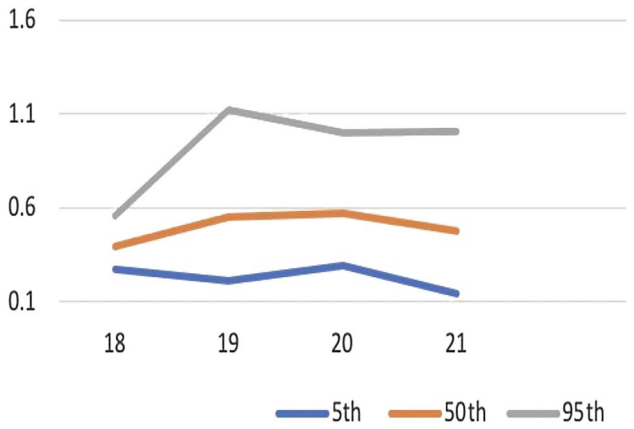

Fig. 3 The 5th, 50th, 95th centiles for the ipsilateral adrenal gland length (in cm) for gestational age of 18 to 21 weeks

Table 1 The 5th, 50th, 95th centiles for the kidney length (in cm) for gestational age of 18 weeks to 21 weeks

Gestational age in weeks	5th centile	50th centile	95th centile	Number of samples
18	1.76 cm	1.88 cm	2.12 cm	40
19	1.85 cm	2.01 cm	2.7 cm	36
20	2.02 cm	2.15 cm	2.6 cm	34
21	1.95 cm	2.12 cm	2.84 cm	18

Table 2 The 5th, 50th, 95th centiles for the ipsilateral adrenal gland length (in cm) for gestational age of 18 to 21 weeks

Gestational age in weeks	5th centile	50th centile	95th centile	Number of samples
18	0.275 cm	0.375 cm	0.555 cm	40
19	0.21 cm	0.555 cm	1.12 cm	36
20	0.29 cm	0.57 cm	1.0 cm	34
21	0.14 cm	0.48 cm	1.01 cm	18

Conclusions

Our study proposes future prospect of regular monitoring of fetal adrenal gland and fetal kidney side by side so that the unchartered territories of adrenal gland could be less challenging.

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