The Morphometric study of human fetal suprarenal glands at various gestational ages

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Abstract

Background: Suprarenal glands are unique endocrine glands that undergo structural modifications both in prenatal and postnatal life to reach the adult status. In recent years, studies were done on the morphology of fetal organs in various gestational ages in assessing the fetal growth.

Objectives: The present study aims to study the morphometry of the suprarenal glands in human fetuses of various gestational age groups.

Methods: Sixty suprarenal glands from 30 human fetuses of gestational age (14 to 36 weeks) of both sexes were studied. The parameters like shape, length, width, thickness and weight of the suprarenal glands were measured. The fetuses were divided into 6 groups (Group I to VI) based on their gestational age. The mean, standard deviation and range of each parameter were calculated. Correlation between the studied variables and gestational age was also done.

Results: The mean, standard deviation and range of all the parameters in all groups and on both sides were determined and their difference in mean was found to be statistically significant. Pearson's correlation between the gestational age and weight of the fetal suprarenal gland showed a significant positive correlation ($p < 0.001$).

Conclusion: The results of this study may be useful to the obstetricians, perinatologists, nenatologists and radiologists to assess the age of the fetus based on the weight of the suprarenal glands. The knowledge of variations in the morphology of fetal suprarenal glands is important in the diagnosis of abnormalities of suprarenal glands and also in predicting the outcome of pregnancy.

Keywords: Gestational age, Adrenal gland, Regression analysis, Correlation

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Introduction

The suprarenal glands are the paired endocrine glands lying on the upper pole of the kidneys[1]**.** They play an important role in the coordination of mammalian stress response and metabolism. The morphological, maturational and functional aspects of the human suprarenal gland are distinctive[2]. The development of suprarenal gland has a prominent role in the development and maturation of the respiratory tract, digestive tract, liver of the fetus and also in regulation of parturition. The uniqueness of this gland is that it undergoes structural modifications both pre-natally and post-natally to reach the adult form[3].

In adults, the right and left suprarenal glands are pyramidal and crescentic in shape respectively[1]. During development in early foetal life, the shape of both right and left suprarenal glands are tetrahedron and later, left becomes crescentic while right is highly variable in shape i.e. triangular, tetrahedral or inverted Y/V-shaped.[4-6]

The information on the rate of growth of suprarenal gland during prenatal life is highly controversial. The gland showed a steady increase in weight throughout fetal life[7] or rapid growth in the beginning and later attaining a relatively large size around fourth fetal month[8] or slow growth in the beginning followed by rapid growth[9].

With increasing interest on fetal growth and development, certain fetal morphometric parameters like crown-rump length (CRL), head circumference, bi-parietal diameter (BPD) and the individual organs like renal and adrenal growth parameters have gained importance[10]. More over the studies on fetal suprarenal glands will facilitate the better understanding of their development on the outcome of pregnancies, birth asphyxia and prematurity[11]. Hence this study aims to measure the normal dimensions of the human fetal suprarenal gland of various gestational age groups, so that it will be of immense help in perinatology and fetal pathology.

Materials and Methods

The present study was approved by the institutional ethical committee. After getting informed consent, 30 spontaneously aborted fetuses of both sexes (18 males and 12 females) of gestational age 14 – 36 weeks, collected from the Department of Obstetrics and Gynecology, were included in the study. The prenatal and the natal history were also carefully collected. The fetuses were observed astutely for external physical abnormalities. Fetuses with gross external anomalies were excluded from the study. These fetuses were then fixed in neutral buffered formalin for two weeks and divided into 7 groups based on their gestational age as follows, group **I** - 14 – 16 wks, **II** - 17 -20 wks, **III** - 21 – 24 wks, **IV** - 25 – 28 wks, **V** - 29 – 32 wks and **VI** - 33 – 36 wks. 60 suprarenal glands were dissected and the parameters namely shape, length, height, thickness and weight of the suprarenal glands were measured. The length of the suprarenal glands was measured using a thread and ruler (Fig. 1), height and thickness of the suprarenal glands were measured using a digital vernier caliper and weight by weighing scale (ASAHI). The mean, standard deviation and range of all the parameters were calculated. Pearson's correlation between all the study variables and gestational age was also done. Data obtained were statistically analyzed using data analysis software, SPSS version 16.0.

Results

During early fetal period until 16 weeks, suprarenal glands were seen as retroperitoneal yellowish tongue shaped mass, obliquely oriented and disposed overlapping the supero-medial poles of the corresponding kidneys up to their hila. The commonly observed shape of the gland on the right side was tetrahedral (Fig. 2A & B), followed by pyramidal (Fig. 2E) and tongue shape (Fig. 2D). On the left side, the commonly observed shape was elongated tetrahedral (Fig. 2C) to crescentic (Fig. 2F) followed by flattened tongue shape.

The mean and standard deviation of all the measured parameters namely length, height, thickness and weight of the suprarenal gland in various groups of fetuses were tabulated (Table 1). All the parameters were found to increase with gestational age. Multiple comparison tests showed that there was a significant increase in the weight of the right supra renal gland from 14 – 32 weeks ($p < 0.001$) after which there was no significant increase during 33 – 36 weeks of gestation. Whereas on the left side, a significant increase in the weight was observed from 14 – 29 weeks ($p < 0.001$) after which there was no significant increase during 30 – 36 weeks. Weight of the left suprarenal gland was significantly higher than that of the right side ($p < 0.001$).

Significant positive correlation exist between all the parameters namely height, length and thickness with the gestational age ($p<0.001$). Pearson's correlation showed a significant positive correlation between the weight of the suprarenal glands and the gestation age ($p < 0.001$) (Fig. 3). Simple linear regression analysis was also done which showed that the weight of the suprarenal gland regressed with the gestational age of the fetus. It was also observed that from 14 to 36 weeks of gestational age, for every 1 week increase in the gestational age, the weight of the suprarenal gland increased by a factor of 0.125 gm (Table 2).

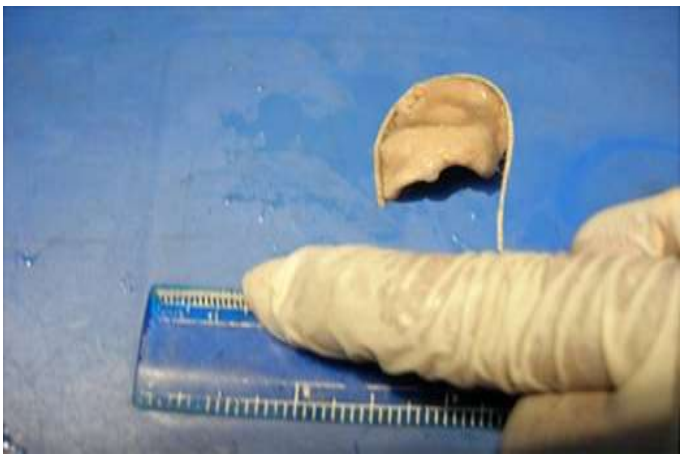

Fig. 1: Measurement of the length of the adrenal gland using a thread and ruler

Fig. 2: Dissected fetal abdomen showing the suprarenal glands (*) in various gestational ages. A–14weeks, B–16weeks, C–20weeks, D–24weeks, E–26weeks, F–30weeks. Note the predominant tetrahedral shape of the right and crescentic shape of the left suprarenal glands

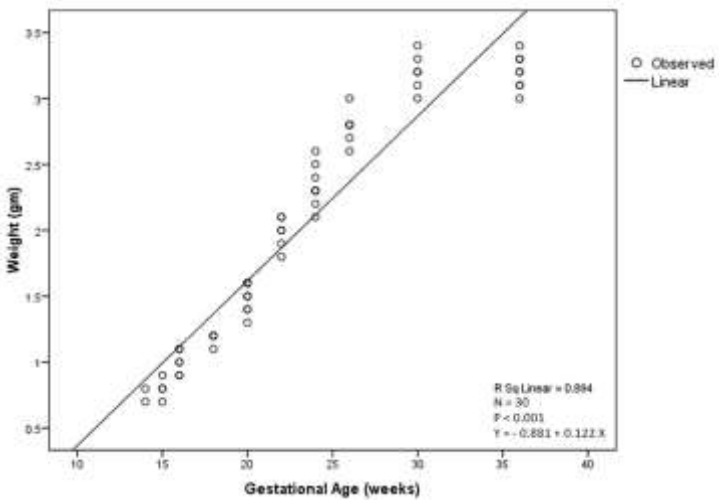

Fig. 3: Scatter plot showing the positive correlation between the weight of the suprarenal gland and gestational age of the fetuses

Table 1: The mean and standard deviation of all the parameters studied in the fetal suprarenal gland on both sides

Groups	Gestational age (weeks)	Length (cm)		Height (cm)		Thickness (cm)		Weight (cm)	
		Right	Left	Right	Left	Right	Left	Right	Left
I	14 – 16 (n = 6)	0.88 ± 0.75	1.17 ± 0.05	1.10 ± 0.15	0.86 ± 0.05	0.52 ± 0.08	0.63 ± 0.15	0.85 ± 0.10	0.93 ± 0.16
II	17 – 20 (n = 7)	1.19 ± 0.11	1.49 ± 0.13	1.07 ± 0.17	1.14 ± 0.17	0.94 ± 0.15	0.93 ± 0.11	1.37 ± 0.18	1.44 ± 0.18
III	21 – 24 (n = 7)	1.50 ± 0.10	1.61 ± 0.11	1.51 ± 0.23	1.61 ± 0.11	0.94 ± 0.10	0.96 ± 0.15	2.10 ± 0.22	2.27 ± 0.22
IV	25 – 28 (n = 3)	1.70 ± 0.26	1.60 ± 0.10	1.47 ± 0.12	1.60 ± 0.10	0.90 ± 0.10	0.97 ± 0.06	2.70 ± 0.10	2.87 ± 0.12
V	29 – 32 (n = 3)	1.60 ± 0.10	1.70 ± 0.10	1.60 ± 0.10	1.70 ± 0.10	1.10 ± 0.10	1.07 ± 0.06	3.17 ± 0.15	3.23 ± 0.15
VI	33 – 36 (n = 3)	1.60 ± 0.08	1.78 ± 0.09	1.38 ± 0.10	1.78 ± 0.09	0.95 ±0.17	0.95 ± 0.13	3.10 ± 0.08	3.30 ± 0.82
Mean		1.44 ± 0.28		1.22 ± 0.24		2.04 ± 0.88		0.88 ± 0.20	

Table 2: Simple regression analysis of the weight of the fetal suprarenal gland against the gestational age of the fetus

Regression coefficient	Standard error (β)	Constant (a)	Standard error (α)	R - square	P - value	95% confidence interval
0.125	0.006	- 0.881	0.137	0.894	< 0.001	0.114 – 0.136
Weight of fetal suprarenal gland (gm) = - 0.881 + 0.125 Gestational age (weeks)						

Table 3: Comparison of the mean length, width, thickness and weight of the suprarenal gland of various studies

No	Study	Gestational age studied	Mean Length (cm)	Mean Height (cm)	Mean Thickness (cm)	Weight [Range] (gm)
1	Anand et al. 1998	9 – 36 weeks	1.4	1	0.45	-
2	Gangulappa & Somasekhar 2015	20 weeks to term	1.6	1.81	0.80	0.28 – 1.96
3	Present study 2016	14 – 36 weeks	1.44	1.22	2.04	0.70 – 3.40

Discussion

Suprarenal glands develop from two different sources. The outer cortex develops from the proliferation of the coelomic epithelium close to the root of dorsal mesentery opposite the sixth to twelfth thoracic segments into the underlying mesenchyme. The migrating sympatho-chromaffin cells from the neural crest give rise to the inner medulla[3,12].

During development, the shapes of both right and left suprarenal glands were tetrahedron till 18thweek, thereafter the left became semilunar or crescentic by 26th week[4–6,13]. On the right side, it was highly variable in shape - triangle, tetrahedral or inverted Y- shaped or V-shaped[4,6]. In the present study, the commonly observed shape on the right side was tetrahedral, next common was pyramidal to tongue shaped. On the left side, the commonly observed shape was elongated tetrahedron to crescentic and the next common shape was flattened tongue shape. In the present study, the observations made are conforming to Singh et al. and Damayanti et al[5,6].

The rate of growth of suprarenal gland during prenatal life was very variable. The gland showed a steady increase in weight throughout fetal life[7]. The glands have also shown a gradually uniform growth throughout except a slight increase in the rate of growth between 18 - 24 weeks and 34 - 40 weeks[5] or rapid growth in the beginning thereby attaining a relatively large size in the fourth fetal month after which the growth is slow[8]. Suprarenal glands also showed a slow increase in the weight between 6-12 weeks of gestation, thereafter the rate of increase was rapid[9]. In the present study, there is a uniform and significant increase in growth from 14 – 32 weeks that is consistent with Salmi et al. except for the fact that the increase is minimal at 33 – 36 weeks of gestation.

The left gland was found to be consistently heavier than the right throughout the fetal period[5,13]. The mass and volume of the left suprarenal gland were higher than the right side during 5th-7th month of gestation to term[14]. The current study is also consistent with the fact that the weight of the left suprarenal glands was significantly higher than the right side ($p < 0.001$). This study showed a steady increase in weight of the adrenal glands throughout the gestational age and the findings in this study conform to the observations of most of the earlier studies[7,9,13-14].

In the present study, the mean length and height of the fetal suprarenal glands on both sides were consistent with the studies Anand et al. and Gangulappa & Somasekhar, whereas the mean thickness of the gland is higher[4,15] (Table 3). The mean weight of the gland was higher when compared to the earlier study done by Gangulappa & Somasekhar[15] (Table 3).

Though, the significant positive linear correlation between the weight of the fetal suprarenal gland and the gestational age shown in this study is consistent with most of the earlier studies, here the regression analysis have shown that for every 1 week increase in the gestational age, the weight of the gland increased by a factor of 0.125. This might be useful in calculating the gestational age of the fetus based on the weight of the suprarenal gland as given by the regression equation. (Table 2)

Conclusion

Fetal adrenal glands showed commonly a tetrahedral or an elongated tetrahedral shape. The weight and all dimensions of the suprarenal glands are gradually increasing in the advancing gestational age. The knowledge of the morphometry, the changing dimensions and the weight of fetal adrenal glands will throw light on the study of fetus in-utero by 3D ultrasound which could be an important factor deciding the outcome of pregnancy. These criteria may help in the anticipation of problems and management of pregnancies.

Conflict of interest: Nil

References

1. Standring, S. Gray's Anatomy: The Anatomical Basis of Clinical Practice. (Elsevier, 2008).
2. Sant ram, K., Sharma, M. & Sharma, A. Morphometrical Assessment of Suprarenal Gland in Fetuses of Different Gestational Age Groups. IJSR 2,1–8(2012).
3. Schoenwolf, G. C. Larsen's Human Embryology. (Churchill Livingstone/Elsevier, 2009).
4. Anand, M. K., Anand, C., Choudhry, R. & Sabharwal, A. Morphology of human suprarenal glands: a parameter for comparison. Surg. Radiol. Anat. SRA 20,345–349 (1998).
5. Damayanti, N., Tempy, G. & Singh, Y. I. Development and maturation of suprarenal glands in human fetuses. J. ASI 54,1–3(2005).
6. Singh, P. R. Dimension and shape of human suprarenal gland. J. Anat Soc. India 51,202–15(2002).
7. Tanimura, T., Nelson, T., Hollingsworth, R. R. & Shepard, T. H. Weight standards for organs from early human fetuses. Anat. Rec. 171,227–236(1971).
8. Salmi, H. A., Pulkkinen M. & Sovala P. The preponderal growth of human organs in early Fetal life. Act Paediatr. 51,375–79(1962).
9. Carr, B. R. & Casey, M. L. Growth of the adrenal gland of the normal human fetus during early gestation. Early Hum. Dev. 6,121–124 (1982).
10. Maruti, R. A., Subadhra, D. V. Gestational Age Related Study on Morphology and Morphometry of Human Foetal Suprarenal Gland. Int. J. Med. Health Sci. 4,82–89(2015).
11. Rumińska, M., Welc-Dobies, J., Lange, M., Maciejewska, J., Pyrzak, B. & Brzewski, M. [Adrenal haemorrhage in neonates: risk factors and diagnostic and clinical procedure]. Med. Wieku Rozwoj. 12,457–462(2008).
12. Datta, A. K. Essentials of Human Embryology. (Current Distributors, 1991).
13. Sangma, G. T. N., lbochouba, Y. & Damayanti, N. Development and Maturation of supra renal glands in human fetuses. J Anat Soc India 2008,1–7 (2008).
14. Nowak, D., Góralczyk, K., Zurada, A. & Gielecki, J. Morphometrical analysis of the human suprarenal gland between the 4th and 7th months of gestation. Ann. Anat. Anat. Anz. Off. Organ Anat. Ges. 189,575–582(2007).
15. Gangulappa, D. & Somasekhar, R. Macroscopic Study of Suprarenal glands in Human Fetuses. J Evol. Med Dent Sci 4,4293–4298(2015).