

A STUDY ON MORPHOMETRIC CHANGES OF THE SUPRARENAL GLAND AT VARIOUS STAGES OF DEVELOPMENT

Sushma Korukonda¹, Jami Sagar Prusti², Purna Chandra Maharana³

¹Assistant Professor, Department of Anatomy, Gayatri Vidya Parishad Institute of Healthcare and Medical Technology, Visakhapatnam, Andhra Pradesh.

²Associate Professor, Department of Anatomy, M.K.C.G. Medical College, Berhampur, Odisha.

³Professor and HOD, Department of Anatomy, Gayatri Vidya Parishad Institute of Healthcare and Medical Technology, Visakhapatnam, Andhra Pradesh.

ABSTRACT

BACKGROUND

The suprarenal glands are located just above the kidneys from their position the name is derived. They have no other relation to the kidneys, either functionally or developmentally. Their development is taken up at this place because of their intimate embryological relation to the autonomic nervous system. The relative prominence of the foetal adrenal in comparison to other abdominal viscera is accounted for by a mass of cells called the foetal zone between the area, which is later to become the adult cortex and the medulla. The aim of the study is to evaluate the morphometric parameters of human foetal suprarenal gland - shape, length, breadth, thickness and weight and to compare these parameters between the right and left sides to study the relation between the foetal adrenal gland size and kidney size and the relation between the foetal adrenal weight and body weight.

MATERIALS AND METHODS

The material for the study consisted of 50 human foetal specimens from 9th to 38th week of gestational age. Morphometric measurements including length, breadth, thickness, weight were taken from the right and left suprarenal glands in each specimen and to the results obtained Student's unpaired t-test was applied and data was analysed using GraphPad Prism 5.0 (free trial version).

RESULTS

In the 18th week foetus, the right suprarenal gland acquired pyramidal and left suprarenal gland assumed semilunar shape and were yellowish in colour. There was a steady increase in the parameters from 9th to 38th week. A statistically significant difference was obtained for the length, breadth and weight between the right and left suprarenal glands with a 'p' value less than 0.05.

CONCLUSION

It was observed in the present study that the left gland measured more weight than the right throughout the gestational ages from 9th week to 38th week confirming the reports of earlier authors. The suprarenal glands at term weighed 1/3rd the weight of the kidney. The suprarenal glands are relatively very large at birth and constitute 0.2% of the entire body weight compared with 0.01% in the adult.

KEYWORDS

Foetal Adrenal Gland, Length, Breadth, Thickness, Weight.

HOW TO CITE THIS ARTICLE: Korukonda S, Prusti JS, Maharana PC. A study on morphometric changes of the suprarenal gland at various stages of development. J. Evid. Based Med. Healthc. 2017; 4(12), 642-649. DOI: 10.18410/jebmh/2017/125

BACKGROUND

The adrenal glands are derived from two sources and like the hypophysis and pancreas are actually two glands combined in a single capsule. The shape of the adrenal

glands is largely a result of their proximity to the kidneys. If a kidney is not present to push the lower pole of the adrenal gland upward and give it a characteristic triangular shape, it remains a round flat disk against the posterior abdominal wall. Position varies in relation to the size and location of the kidneys with polycystic or hydronephrotic kidneys, the adrenal glands lie higher and often more anterior than usual. The foetal suprarenals are relatively large. At four months, the glands are larger than the foetal kidney.

At birth, they are approximately 0.2% of the total body weight and therefore, about twenty times their relative size in the adult. The cortical portion of the gland develops rapidly and is relatively more advanced during the first half

*Financial or Other, Competing Interest: None.
Submission 30-01-2017, Peer Review 02-02-2017,
Acceptance 04-02-2017, Published 07-02-2017.*

Corresponding Author:

Dr. Jami Sagar Prusti,

*Associate Professor, Department of Anatomy,
M.K.C.G. Medical College, Berhampur, Odisha-760004.*

E-mail: sagarprusti72@gmail.com

DOI: 10.18410/jebmh/2017/125



of pregnancy than the other abdominal or thoracic organs. The cortex of the foetal adrenal gland is much thicker than the adult gland and consists of at least two histologically distinct layers. The inner provisional cortex continues to grow as long as the foetus remains in the uterus, but immediately after delivery it begins to retrogress. No other organ in the body except the uterus and mammary gland grow in this manner.¹ The bulk of the foetal adrenal gland is largely due to the presence of the foetal adrenal cortex that produces Dehydroepiandrosterone (DHEA) and DHEA-sulphate. These weak androgens are important precursors of placental oestrogens. Later in gestation, the foetal adrenal gland will also produce aldosterone and cortisol. Therefore, the foetal adrenal gland is an organ of immense importance for maintenance of pregnancy and foetal homeostasis. The hormone production also promotes organ maturation late in gestation and may assist in the timing of labour. After birth, the foetal zone of the adrenal gland involutes and the adrenal weight is markedly reduced.² Recently, it has been observed that there is a decrease in the serum cortisol levels among children born to mothers who were smokers either active or passive, this being a cause of difficulty among these children to face stress of any kind. The most common abnormality of suprarenal gland development is 'congenital adrenal hyperplasia', which occurs in 1:5,000-1:15,000 births. Thus, in view of the various interesting changes found in the morphology and in the developmental and functional aspects of adrenal glands in the embryonic life and their further development in adult form of a human has prompted me to undertake the present study. The emphasis on the development of foetal adrenals aids in the understanding of the adult structure. There is no adequate literature on the foetal adrenals. In the present study, the existing literature on the foetal adrenals has been thoroughly reviewed and observations are made after study of 50 foetal adrenals of different gestations (9 weeks to 38 weeks). The aim of this study is to study the morphometric parameters of human foetal suprarenal gland- shape, length, breadth, thickness and weight to compare these parameters between the right and left suprarenal glands and to study the relation between the foetal adrenal gland weight and kidney weight and that between the foetal adrenal weight and body weight.

MATERIALS AND METHODS

The present study was carried out in the Department of Anatomy, GVP Medical College, Visakhapatnam. The material for study consisted of 50 human foetuses from 9th week to 38th week of gestational age. The foetuses were obtained from the Department of Obstetrics and Gynaecology, King George Hospital, Visakhapatnam, GVP IHC and MT, Visakhapatnam and VGH, Visakhapatnam. All the foetal specimens obtained were the result of intrauterine death and spontaneous abortions. In all cases, the maternal history was collected. The foetuses were numbered appropriately. Foetuses with gross anomalies are omitted from the study.

Inclusion Criteria

The foetal specimens obtained were the result of intrauterine death and spontaneous abortions. Foetuses, which appeared normal in appearance were only included.

Exclusion Criteria

Foetuses with gross malformations and of mothers suggestive of endocrine disturbances, hypertension and with a past history of neural tube defects and with a family history of neural tube defects and polycystic kidney disorders were excluded from the study.

The age of the foetuses were calculated from the crown-rump length measured by using thread and scale, weight measured using weighing scale and by the external features. The reference values were taken from Langman's Textbook of Embryology (Table 1). The foetuses were divided into eight groups according to the gestational age.

Group	Gestational Age in Weeks	Sample size
A	9-12	6
B	13-16	6
C	17-20	6
D	21-24	6
E	25-28	6
F	29-32	6
G	32-36	6
H	37-40	8

The foetuses were embalmed, fixed in 10% formalin, dissected, abdomen opened and the suprarenals were viewed in their natural location for proper recording. The length and breadth of the right and left suprarenal glands were measured in situ using thread and scale. The suprarenal glands were dissected out and removed. The thickness was measured using Vernier calipers.

The weight of the gland was measured using "volume displacement method."

Statistical Analysis

The data was analysed using GraphPad Prism 5.0 (free trial version). For comparing the continuous variables, i.e. the mean length, breadth, thickness and weight in the groups A-H between the right and left suprarenal glands, the Student's unpaired t-test was used. The mean weights of the left and right suprarenal gland and respective kidney were compared for all the eight groups. The ratio of the body weight to the suprarenal glands of either side was compared using the unpaired t-test. A p value <0.05 was taken to be statistically significant.

RESULTS

The gross morphology of both the suprarenals appeared as tongue-shaped, pale-coloured masses before 16 wks. of IUL. There was a clear differentiation between the suprarenals of right and left side in group C. Right suprarenal was pyramidal and left one was semilunar in

shape. In the present study, the mean length of right suprarenal was more than that of the left before 20 weeks and beyond 20 weeks (group D, E, F, G, H) the mean length of left gland was more than that of the right. The mean difference was found to be statistically significant ($p < 0.05$) (Table 3). The difference in the mean breadth between the right and left suprarenals beyond 25 wks. (Group C, E, F and H) was observed to be significant (Table 4). The comparison of the thickness between the right and left glands in all the groups was not significant (Table 5). In the present study, left suprarenal weighed heavier than the right gland throughout the gestational period. There was a steady increase in the weight of the gland with increasing gestational age. The difference in the mean weight was significant in groups E, G and H (Table 6). The weight of the suprarenal gland expressed as percentage to the weight of kidney of respective sides increased along with the increasing gestational age and this was significant (Table 7 and 8). All throughout the increasing gestational age, there was no uniformity in the weight of the SRG expressed as percentage to the body weight of kidney of respective sides (Table 9 and 10) and this was significant statistically.

Age (wks.)	CRL (cm)	Wt. (gm)
9-12	5-8	10-45
13-16	9-14	60-200
17-20	15-19	250-450
21-24	20-23	500-820
25-28	24-27	900-1300
29-32	28-30	1400-2100
33-36	31-34	2200-2900
37-38	35-36	3000-3400

Table 1. Langman's 8th Edition Growth in 'l' and 'wt.' During the Foetal Period

Group	Length (cm)		Breadth (cm)		Thickness (cm)		Weight (gm)	
	R	L	R	L	R	L	R	L
A	0.8	0.7	0.65	0.7	0.2	0.2	0.08	0.08
B	1.3	1.3	1.15	1.3	0.3	0.3	0.25	0.3
C	1.7	1.4	1.35	1.4	0.4	0.5	0.65	0.7
D	1.7	1.8	1.5	1.8	0.5	0.6	1.2	1.3
E	1.75	2.2	1.6	2.2	0.5	0.5	1.5	1.7
F	1.9	3.0	1.6	3.0	0.6	0.5	2.1	2.3
G	2.3	3.2	1.8	3.2	0.6	0.4	2.5	3.1
H	3.0	3.4	2.6	3.4	0.6	0.5	3.0	3.4

Table 2. Morphology of Right (R) and Left (L) Suprarenal Glands (SRGs)

Group	Mean Length (cm) ± SD		'P' Value
	Right	Left	
A	0.800 ± 0.076	0.675 ± 0.158	0.0633
B	1.3 ± 0.200	1.275 ± 0.116	0.7645
C	1.662 ± 0.052	1.400 ± 0.000	0.0001
D	1.700 ± 0.000	1.825 ± 0.046	0.0001
E	1.750 ± 0.053	2.200 ± 0.093	0.0008
F	1.875 ± 0.046	3.000 ± 0.200	0.0001
G	2.275 ± 0.255	3.200 ± 0.000	0.0001
H	2.850 ± 0.160	3.350 ± 0.053	0.0001

Table 3. Comparison between the Mean 'Length' of the Right and Left Suprarenal Glands

Group	Mean Breadth (cm) ± SD		'P' Value
	Right	Left	
A	0.650 ± 0.053	0.700 ± 0.076	0.1489
B	1.150 ± 0.053	1.200 ± 0.000	0.0192
C	1.350 ± 0.053	1.250 ± 0.053	0.0022
D	1.525 ± 0.046	1.500 ± 0.107	0.5536
E	1.575 ± 0.046	1.775 ± 0.089	0.0001
F	1.600 ± 0.000	2.000 ± 0.131	0.0001
G	1.875 ± 0.287	2.175 ± 0.089	0.0134
H	2.550 ± 0.053	2.450 ± 0.053	0.0022

Table 4. Comparison in the Mean 'Breadth' between Right and Left Suprarenal Glands

Group	Mean Thickness (cm) ± SD		'P' Value
	Right	Left	
A	0.188 ± 0.083	0.213 ± 0.083	0.5586
B	0.350 ± 0.053	0.350 ± 0.053	1.0000
C	0.413 ± 0.083	0.488 ± 0.083	0.0939
D	0.500 ± 0.076	0.550 ± 0.120	0.3343
E	0.4225 ± 0.0757	0.4688 ± 0.1132	0.3531
F	0.563 ± 0.052	0.538 ± 0.052	0.3504
G	0.550 ± 0.120	0.525 ± 0.128	0.6927
H	0.4675 ± 0.0396	0.4675 ± 0.0396	1.0000

Table 5. Comparison of Mean 'Thickness' of Right and Left Suprarenal Glands

Group	Mean Weight (gm) ± SD		'P' Value
	Right	Left	
A	0.0725 ± 0.0089	0.0825 ± 0.0139	0.1080
B	0.2525 ± 0.1617	0.3250 ± 0.1102	0.3123
C	0.6500 ± 0.1195	0.7250 ± 0.1102	0.2130
D	1.1750 ± 0.1389	1.2750 ± 0.1389	0.1718
E	1.5500 ± 0.1195	1.7250 ± 0.1439	0.0192
F	2.0250 ± 0.2053	2.3375 ± 0.3148	0.0338
G	2.450 ± 0.160	3.125 ± 0.089	0.0001
H	3.050 ± 0.1604	3.3750 ± 0.0267	0.0001

Table 6. Comparison between the Mean Weights of Right and Left Suprarenal Glands

Group	Mean Weight (gm) ± SD		'p' Value	% SRG to Kidney Weight
	Right SRG	Right Kidney		
A	0.0688 ± 0.0083	0.5750 ± 0.0886	0.0001	11.96
B	0.2525 ± 0.1617	1.1625 ± 0.2825	0.0001	21.72
C	0.650 ± 0.120	2.463 ± 0.311	0.0001	26.39
D	1.150 ± 0.120	3.813 ± 0.331	0.0001	30.15
E	1.550 ± 0.120	4.813 ± 0.196	0.0001	32.20
F	2.000 ± 0.185	5.750 ± 0.207	0.0001	34.78
G	2.475 ± 0.128	7.063 ± 0.657	0.0001	35.04
H	3.038 ± 0.130	9.500 ± 0.334	0.0001	31.97

Table 7. Ratio of Weight of Right Suprarenal Gland and Right Kidney

Group	Mean Weight (gm) ± SD		'p' Value	% SRG to Kidney Weight
	Left SRG	Left Kidney		
A	0.0825 ± 0.0139	0.5750 ± 0.0886	0.0001	14.34
B	0.3250 ± 0.1102	1.1250 ± 0.2435	0.0001	28.88
C	0.7250 ± 0.1102	2.3250 ± 0.4234	0.0001	31.18
D	1.275 ± 0.139	3.675 ± 0.396	0.0001	34.69
E	1.7250 ± 0.1439	4.8000 ± 0.2000	0.0001	35.93
F	2.3375 ± 0.3148	5.7250 ± 0.4234	0.0001	40.82
G	3.125 ± 0.089	6.875 ± 0.443	0.0001	45.45
H	3.3750 ± 0.0267	8.500 ± 0.5345	0.0001	39.70

Table 8. Ratio of Weights of Left Suprarenal Gland and Left Kidney

Group	Mean Weight (gm) ± SD		'p' Value	% of SRG to Body Weight
	Right SRG	Body Weight		
A	0.0725 ± 0.0089	27.500 ± 11.0195	0.0001	0.263
B	0.2525 ± 0.1617	112.500 ± 55.6135	0.0001	0.224
C	0.6500 ± 0.1195	350.00 ± 84.5154	0.0001	0.1857
D	1.1750 ± 0.1389	662.50 ± 148.2035	0.0001	0.1774
E	1.5500 ± 0.1195	1175.0000 ± 205.2873	0.0001	0.1319
F	2.0250 ± 0.2053	2050.000 ± 220.3893	0.0001	0.098
G	2.4500 ± 0.1604	2700.00 ± 169.0309	0.0001	0.0907
H	3.0500 ± 0.1604	3100.00 ± 106.9045	0.0001	0.098

Table 9. Ratio of Right Suprarenal Gland to Body Weight

Group	Mean Weight (gm) ± SD		'p' Value	% of SRG to Body Weight
	Left SRG	Body Weight		
A	0.0825 ± 0.0139	27.50 ± 11.019	0.0001	0.3
B	0.3250 ± 0.1102	112.50 ± 55.61	0.0001	0.288
C	0.7250 ± 0.1102	350.00 ± 84.51	0.0001	0.207
D	1.275 ± 0.1389	662.5 ± 148.2035	0.0001	0.1924
E	1.725 ± 0.1439	1175.00 ± 205.2873	0.0001	0.985
F	2.3375 ± 0.3148	2050.00 ± 220.3893	0.0001	0.114
G	3.1125 ± 0.0886	2700.00 ± 169.0309	0.0001	0.115
H	3.375 ± 0.0267	3100.00 ± 106.9045	0.0001	0.108

Table 10. Ratio of Weight of Left Suprarenal Gland with Body Weight

Group	WT of Both SRG (gm)	Body Weight (gm)	% SRG and Body Weight
A	0.16	27.5	0.58
B	0.55	112.5	0.49
C	1.35	350	0.39
D	2.5	662.5	0.37
E	3.2	1175	0.27
F	4.4	2050	0.21
G	5.6	2700	0.20
H	6.4	3500	0.18

Table 11. Percentage of Weight of Suprarenal Gland to the Body Weight

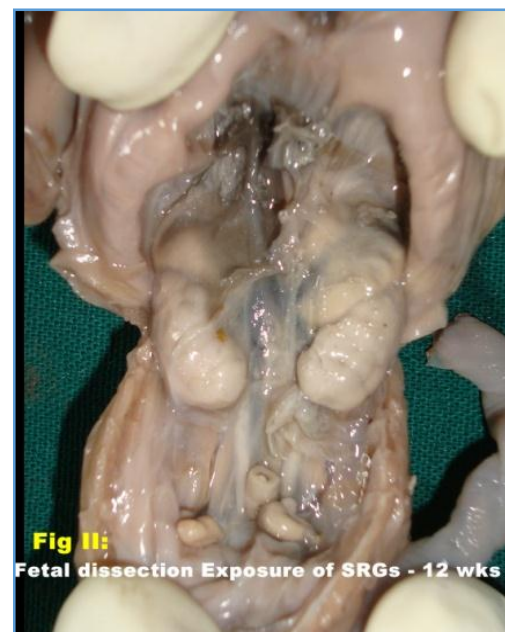




Fig III: SRGs at (A) - 16 wks; (B) - 18 wks



Fig IV:
SRGs at different gestational ages



Fig VI : SRG s at 30 wks
Right SRG - Pyramidal; Left SRG - semilunar



Fig VII : SRGs - Polycystic Kidney



Fig V:
Measuring length of left SRG

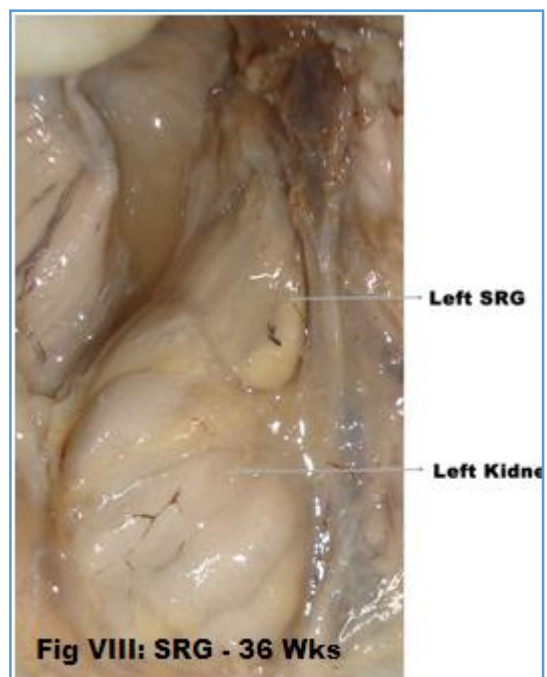


Fig VIII: SRG - 36 Wks

DISCUSSION

Appearance

According to Jackson³ (1909), the suprarenal glands become definitely outlined during the second month. Lanman⁴ (1953) highlighted that suprarenal glands become apparent at 5 weeks. GTN Sangma et al⁵ (2008) in their study revealed that both suprarenal glands are identifiable by naked eye as an oblong tongue-shaped structure by 9th week of gestation. They further maintained that the size and shape of both glands are same and not much difference has been noted. In the present study, at 9 weeks both suprarenal glands were well identifiable. These findings are in similar with the above authors.

Shape

According to 'Pathology of the Foetus and the Newborn' - Edith L. Potter⁶ (1952), the shape of the adrenal gland is largely a result of their proximity to the kidneys. According to Sangma, Ibochouba and Damayanti,⁵ there was no differentiation up to 18 weeks between 9 to 16 weeks, both the suprarenal glands were tongue shaped and at 16 to 22 weeks the difference in the shape of the gland was noted, the right becoming tetrahedron and left assuming crescent-shaped gradually. According to Anand, Choudhary, Sabharwal et al,⁷ the shapes of right-sided suprarenals were 50% triangular and 50% tetrahedral. Indarjit and Bang⁸ (1987) described the shape of right suprarenal as pyramidal or tetrahedron and left as cock hat. They observed the right suprarenal is pyramidal in 56% of males and 44% of females and some variable shapes are also seen in the rest.

In the present study, the gross morphology of both the suprarenal glands appeared as tongue-shaped, pale-coloured masses before 16 weeks of gestational age. There was a clear differentiation between the suprarenals of right and left side in group C. Right gland was pyramidal and left one was semilunar in shape. The findings in this study are similar with those of Sangma et al⁵ and Indrajit and Bang.⁸

Length

Few studies are available in the literature regarding dimensions of foetal suprarenals for comparison with the data of the present study. According to the study done by Anand et al⁷ (1998), the fetuses grouped under group A (12-15 wks.) mean 'l' was 10 mm, group B (15-20 wks.) mean 'l' 12 mm, Group C (20-25 wks.) mean 'l' is 15 mm and Group D (25-30 wks.) mean 'l' was 19 mm. According to the study done by Nowak et al (2007), the fetuses grouped under Group B (15-20 wks.) mean 'l' was 8.3 mm, Group C (20-25 wks.) mean 'l' was 13.55 mm and Group D (25-30 wks.) mean 'l' was 16.7 mm. According to the study done by Khyati Sant Ram, Mahesh Sharma and Anshu Sharma⁹ (2011), the fetuses grouped under Group A (12-15 wks.), mean 'l' was 6.93, Group B (15-20 wks.) mean 'l' was 8.29, Group C (20-25 wks.) 'l' 13.53 and Group D (25-30 wks.) 'l' is 13.58 mm. In group A, the right suprarenal measured more than left gland. In group D, the left suprarenal measured more than the right one. According to

Rakh Rajendra S, Pakhale Sandeep V, Kulkarni Pramod R¹⁰ (2014), the mean 'l' of suprarenal gland was 0.95 cm at 12 wks. and 3 cm at 38 wks. Before 20 wks., the value of mean 'l' of right suprarenal is more compared to that of left gland and after 20 wks. mean 'l' of left gland was more than that of right suprarenal.

In the present study, the mean length of right suprarenal was more than that of the left before 20 weeks and beyond 20 weeks (group D, E, F, G, H) the mean length of left SRG was more than that of right SRG. The mean difference was found to be statistically significant ($p < 0.05$). The values obtained are similar with those of Rakh Rajendra et al.¹⁰ The values are more than those obtained by Anand et al,⁷ Nowak et al and Khyati Sant Ram et al.⁹ These findings are also similar with the studies of Khyati Sant Ram et al and Rakh Rajendra et al.

Breadth

In the study done by Anand et al⁷ (1998), mean breadth of Group A (11-15 wks.) was 0.89 cm, Group B (15-20 wks.) was 1.23 cm, Group C (20-25 wks.) was 1.03 cm and Group D (>25 wks.) was 1.03 cm. In the study done by Nowak et al (2007), the mean breadth obtained in group B (15-20 wks.) -1 cm, Group C (20-25 wks.) -1.5 cm and Group D (>25 wks.) -1.8 cm. According to the study of Khyati Sant Ram et al⁹ (2011), mean breadth in Group A - 0.6 cm; Group B - 0.73 cm, Group C - 1.3 cm and Group D - 1.5 cm. In the study done by Rakh Rajendra et al¹⁰ (2014), mean breadth obtained at 12 wks. 0.8 cm and that at 38 wks. was 2.55 cm.

This study observed that the difference in the mean breadth between the right and left SRGs beyond 25 wks. (Group C, E, F and H) was observed to be significant. The findings are similar to those of Rakh Rajendra et al (2014). The values obtained are all more than those obtained in the studies done by Anand et al, Nowak et al and Khyati Sant Ram et al.

Thickness

In the study done by Anand et al⁷ (1998), the value of thickness (t) obtained in Group A (11-15 wks.) - 0.3 cm, Group B (15-20 wks.) - 0.45 cm, Group C (20-25 wks.) - 0.5 cm and Group D (>25 wks.) - 0.6 cm. In the study done by Nowak et al (2007), the 't' of Group B (15-20 wks.) - 0.58 cm, C (20-25 wks.) - 0.8 cm and D (>25 wks.) - 0.9 cm. According to the study of Khyati et al⁹ (2011), the values of 't' obtained in their study were Group A (11-15 wks.) - 0.3 cm; Group B (15-20 wks.) - 0.32 cm, Group C (20-25 wks.) - 0.5 cm and Group D (>25 wks.) - 0.57 cm.

In the present study, the comparison of the thickness of suprarenals in all the groups was not significant. The values obtained in the present study were similar with those of Anand et al⁷ and Khyati Sant Ram et al. The values obtained in the study by Nowak et al are more than those of the present study.

Weight

According to the study of Rakh Rajendra S, Pakhale Sandeep V, Kulkarni Pramod,¹⁰ the combined mean weight of suprarenal gland at 12th week is 0.2 g and at 38th wk. it is 6.66 gm. Ekholm and Niemineva¹¹ (1950) observed that the suprarenals grow quickly in the beginning and attained their relatively large size in the third month. According to Crowder, the foetal adrenal grows rapidly attaining its maximum size in relation to the kidney at four months of gestation at which time it is larger than the foetal kidney. During the ensuing months, the relative size decreases in relation to the kidney until at birth it is one-third the size of the kidney. Salmi et al¹² (1962) stated that the weight of suprarenal gland increased faster until the fourth month where after the growth became slower. According to 'Developmental Anatomy' by Leslie Brainerd Arey¹ (1965), at birth each suprarenal gland is one-third the weight of a kidney.' According to Hamilton and Mosman Boyd,¹³ at birth, the glands are approximately 0.2% of the total body weight and therefore about twenty times their relative size in the adult. According to 'Intrauterine Development' - Allan C. Barnes¹⁴ (1968) at 16-20 wks. of pregnancy, the foetal adrenal weighed 0.5 g; at 21-24 wks. - it weighed 1 g; at 25-28 wks. - it weighed 1.7 g; at 29-32 wks. - it weighed 2.2 g; at 33-39 wks. - it weighed 3.0 g and at term the right suprarenal measured 4.47 g and left measured 4.64 g. Tanimura et al¹⁵ (1971) observed that increase in suprarenal weight was gradual suggesting a steady growth. Carr and Casey¹⁶ (1982) reported that there were slow increase in the adrenal weight between 6-12 wks. of gestation, there after the rate of increase was rapid. According to Color Atlas of Foetal and Neonatal Histology (2011), the combined adrenal weight at 12 wks. of gestation is 0.1 g and at 38 wks. it is 7.1 g. At 12 wks., the suprarenal gland measures 62.5% of the kidney weight. At 38 wks., it measures about 28.6% of the kidney weight. The combined weight of adrenals measured 0.3% of the body weight at 38 wks.

According to Gray's Anatomy,¹⁷ 40th edition (2012), at term each gland usually weighs 4 g; the average weight of the two glands is 9 g (average in the adult is 7-12 g). The left gland is heavier and larger than the right as it is in the adult. At birth, the suprarenals are relatively large at birth and constitute 0.2% of the entire body weight compared with 0.01% in the adult. They are approximately one-third size of the ipsilateral kidney.

In the present study, left suprarenal weighed heavier than the right throughout the increasing gestational period. There was a steady increase in the weight of the gland with increasing gestational age. The difference in the mean weight was significant in groups E, G and H. These findings were similar to the study of Rakh Rajendra et al.¹⁰ The observations in this study are in concurrence with Allan C Barnes,¹⁴ Tanimura, et al.¹⁵ The weight of the suprarenal expressed as percentage to the weight of kidney, of respective sides increases all along the gestational age and this was significant. This finding is in concurrence with that of Crowder, Leslie Brainerd Arey and Gray. Throughout the

increasing gestational age, there was no uniformity in the weight of the gland expressed as percentage to the body weight of kidney of respective sides and this was significant statistically. The percentage of combined adrenal weight to body weight was 0.2%. The findings in the study are in concurrence with Leslie Brainerd Arey,¹ Hamilton Mossman and Boyd¹³ and Gray.¹⁷

CONCLUSION

The difference in the length and breadth between the right and left SRGs could be because of the change in dimensions during the shaping of the gland with the increasing gestational age. Relative to body weight, the suprarenals of the human foetus are 10-20 times larger than in the adult and are large compared to kidneys. These large glands result from the extensive size of the foetal cortex, which produces steroid precursors that are used by the placenta for the synthesis of oestrogen. The results of the present study showed a high ratio between the suprarenal weight and kidney weight and also to that of the body weight compared to that in the adult. This could be as a result of the inner provisional or foetal cortex inner to the definitive or adult cortex in the adrenal gland. To confirm this, the present study need to be continued further to study the microscopic structure of the suprarenal gland, especially the adrenal cortex to understand the histogenesis of the suprarenal gland and correlate the increase in size of the gland with the increase in thickness of the cortex.

REFERENCES

- [1] Arey LB. Developmental anatomy-A text book & laboratory manual of embryology. Philadelphia & London: WB Saunders company 1925.
- [2] Linda EM, Eduardo RD, Dale HS. Color atlas of fetal and neonatal histology. New York: Springer 2011.
- [3] Jackson CM. On the prenatal growth of the human body and the relative growth of the various organs and parts. American Journal of Anatomy 1909;9(1):119-165.
- [4] Lanman JT. The fetal zone of the adrenal gland: its developmental course, comparative anatomy and possible physiologic functions. Medicine 1953;32(4):389-430.
- [5] Sangma GTN, Ibochouba Y, Damayanti N. Development and maturation of suprarenal glands in human fetuses. Journal of Anatomical Society of India 2008;57(1):1-7.
- [6] Potter EL. Pathology of the fetus & the new-born. Chicago, Illinois: Year Book Publishers 1952.
- [7] Anand MK, Anand C, Choudhry R, et al. Morphology of human suprarenal glands: a parameter for comparison. Surg Radiol Anat 1998;20(5):345-349.
- [8] Indrajit, Banga N. Shape, size weight and relations of the human right suprarenal gland. Journal of Anatomical Society of India 1987;36(2):73-81.
- [9] Ram KS, Sharma M, Sharma A. Morphometric assessment of suprarenal gland in fetuses of different

- gestational age groups. *International Journal of Scientific & Research Publications* 2012;2(12):1-8.
- [10] Rajendra RS, Sandeep PV, Pramod K. Morphology of suprarenal gland in human fetuses. *International Journal of recent trends in Science & Technology* 2014;10(1):158-160.
- [11] Ekholm E, Neimineva K. On prenatal changes in the relative weights of the human adrenal, the thymus and the thyroid gland. *Acta Paediatrica* 1950;39(1-2):67-86.
- [12] Salmi HA, Martti P, Petter S. The ponderal growth of human organs in early fetal life. *Acta Paediatrica* 1962;51(3):375-379.
- [13] Hamilton WJ, Mossman HW. Hamilton, Boyd and Mossman's human embryology: prenatal development of form and function. 4th edn. Cambridge: Heffer 1972.
- [14] Barnes AC. Intrauterine development. Philadelphia: Lea & Febiger 1968:273-277.
- [15] Tanimura T, Nelson T, Hollingsworth RR, et al. Weight standards for organs from early human fetuses. *Anatomical Record* 1971;171(2):227-236.
- [16] Carr BR, Casey ML. Growth of the adrenal gland of the normal human fetus during early gestation. *Early Hum Dev* 1982;6(2):121-124.
- [17] Stranding S. Gray's anatomy: the anatomical basis of clinical practice. 40th edn. Philadelphia: Elsevier 2008:1218-1219.