International Journal of Anatomy and Research,
Int J Anat Res 2021, Vol 9(4):8139-44. ISSN 2321-4287
DOI: https://dx.doi.org/10.16965/ijar.2021.170

Original Research Article

Study on Morphometry of Adrenal Glands in live fetuses by Ultrasonography

Maruti ram Annamraju *[1], Alka Prasad [2], Srihari Rao Battalapalli [3], Subhadra Devi Velichety [4], B Ravindra Kumar [5].

*[1] Associate Professor, Department of Anatomy, ACSR Govt. Medical College, Nellore, Andhra Pradesh, India.

[2] Consultant Radiologist, Alka scan Centre, Hyderabad, Telangana, India.

[3] Professor, Department of Surgery, Sri Venkateswara Institute of Medical Sciences, SPMC(W), Tirupati, Andhra Pradesh, India.

[4] Professor, Department of Anatomy, Apollo Institute of Medical Sciences, Chittoor, Andhra Pradesh, India.

[5] Assistant Professor, Department Anatomy, Parul Institute of Medical Sciences & Research, Parul University, Post Limda, Waghodia, Vadodara, Gujarat, India.

ABSTRACT

Introduction: Development of adrenal gland is always peculiar as it involves the complex process. It has an intriguing role in the harmonious development of fetus. Ultrasonographic Studies on fetal suprarenal glands help in understanding the embryology of Suprarenal glands and are also useful in obstetrics, perinatology and fetopathology. Risk factors associated with the pregnancy like maternal diabetes and hypertension could impair the growth of adrenal glands. The nomograms of adrenal glands observed by ultrasonography are of clinical importance and help us in planning prevention and management of a fetus in high-risk pregnancies. This requires a feasible and repeatable screening test.

Objective: To estimate various suprarenal gland measurements such as length, width, thickness, volume, surface area, circumference, thickness of cortex and medulla.

Materials and methods: Present study conducted with 62 live normal human fetuses of different gestational ages ranging from 20 – 40 weeks, through ultrasonographic study using real time 4D and B mode Ge Voluson 730 pro ultra sound macine. Probes used were AB-2-7 Convex 2d abdominal Probe and RABA 4-8 Convex 4D abdominal probe, This study was undertaken after obtaining prior permission from the institutional ethics committee, and consent from pregnant woman. Sex of the fetus was not revealed during ultrasonographic study. Fetal parameters of supra-renal gland were recorded and documented.

Results: Suprarenal gland length, width, thickness, cortico-medullary thickness, surface area and circumference of both right and left side revealed significant difference ($p<0.01$). The detailed data analysis was presented in the subsequent headings.

Conclusion: The data obtained from this study, may be useful to understand the suprarenal morphometry in live fetuses thus, the database is useful in obstetrics, perinatology and fetopathology.

KEYWORDS: Morphometry, Suprarenal gland, Adrenal gland, Antenatal, Ultrasonography.

Corresponding Author: Dr. Maruti ram Annamraju, Associate Professor, Department of Anatomy, ACSR Govt. Medical College, Nellore, Andhra Pradesh, India. **E-Mail:** marutiramannamraju@gmail.com

Access this Article online	Journal Information
Quick Response code	**International Journal of Anatomy and Research** ISSN (E) 2321-4287 | ISSN (P) 2321-8967 **https://www.ijmhr.org/ijar.htm** **DOI-Prefix:** https://dx.doi.org/10.16965/ijar
DOI: 10.16965/ijar.2021.170	**Article Information**
	Received: 15 Sep 2021 | Accepted: 05 Oct 2021 Peer Review: 16 Sep 2021 | Published (O): 05 Dec 2021 Revised: 29 Sep 2021 | Published (P): 05 Dec 2021

INTRODUCTION

The adrenal gland development is interesting and peculiar. It has an intriguing role in the harmonious development of fetus. Studies on fetal supra renal glands help in understanding the embryology of Suprarenal glands and are also useful in obstetrics, perinatology and fetopathology [1].

Risk factors in pregnancy like maternal diabetes and hypertension could impair the growth of adrenal glands. The nomograms of adrenal glands observed by ultrasonography are of clinical importance and facilitates in planning prevention and management of a fetus in high-risk pregnancies.This requires a feasible and repeatable screening test.

The first reported study of ultrasonographic observations on fetal suprarenal glands was that of Rosenberg et.al (1982) [2] to recognize its sonographic appearance. According to Lewis et.al (1982) [3] fetal adrenal glands can be recognized routinely by ultrasonography after 30 weeks of gestation and reported the values on length of adrenal glands in normal fetuses based on real time ultrasonographic evaluation in 31 out of 34 cases.

Turan et.al., (2011) [4] and Hofman et.al., (2016) [5] conducted studies on the use of fetal adrenal ultrasonographic measurements in predicting pregnancy outcome.Zhang et.al (2013) [6] reported MRI based morphometric analysis of adrenal glands of foetal cadavers in second half of gestation.Flores et.al., (2017) [7] reported ultrasound measurements of 3rd trimester fetal adrenal glands in gestational diabetes. Shigeo Iijima (2018) [8] reported developmental pattern of fetal adrenal gland based on ultrasonographic evaluation in neonates.

Anand et.al (1998) [9] observed 20 prenatal glands of 9-36 weeks gestational age in North Indian population. The mean length, breadth and thickness were 1.4 cm, 1 cm and 0.45 cm respectively. They compared their data on gross measurements with available ultrasound and CT scan data and concluded that both the length and thickness in the population studied were greater than reported in the literature.

MATERIALS AND METHODS

This includes ultrasonographic study of 62 live normal human fetuses of different gestational ages ranging from 20 – 40 weeks that was conducted in the department of Radiology, S.V.R.R.GOVT Hospital, Tirupati. Sex of the fetus was not revealed during ultrasonographic study. The consent from pregnant woman was taken. By using real time 4D and B mode Voluson ultra sound, the fetal parameters of supra-renal gland were recorded.

After determining fetal lie, scan planes were aligned relative to the fetal body in a sagittal / coronal plane (Fig.1). Long axis of the of kidney is identified. The kidney was first identified as an oval structure with prominent medullary spaces and its measurements and volume were recorded. The scan plane was then moved slightly medially towards the spine in sagittal plane or anteriorly in coronal plane to identify Adrenals. Both organs together were imaged best in coronal plane. The adrenal gland was identified superior and medial to the same side kidney, revealing a typical pattern of an anechoic limb with a distinct echogenic core. The image was frozen and calipers of the ultra sound machine were used to obtain following measurements.

1. Suprarenal gland parameters of both sides like Length, Width, Antero-posterior thickness (Fig.2 and 6). Volume, surface area, circumference (Fig.3) and Cortex-medulla thickness (Fig.4 and 7). Length was measured in transverse plane. Width was measured in coronal plane. Antero-posterior thickness was measured in sagittal plane.

2. Data were recorded on a photograph and stored in a Data base. The volume of the adrenal gland was calculated, according to limb model assuming each limb cylindrical by using the sagittal, axial and coronal dimensions in cubic cms.

In all cases mid sagittal view of the fetal trunk was obtained by trans- abdominal sonography.

RESULTS

Suprarenal parameters of live fetuses were observed by the fetal ultrasonograms. Mean

standard deviation, one way ANOVA and Duncan's multiple range tests were calculated and represented in table 1. The supra renal volume, surface area and circumference were estimated and analyzed and represented in table 2. Table 1 shows results of one way ANOVA & Duncan's multiple range test (DMRT) carried out for external and internal parameters of suprarenal gland by week wise age groups(A to E) of live fetuses. This revealed significant difference at 0.01 levels in Suprarenal gland length, width, thickness, cortex and medulla of both right and left side. Further DMRT revealed significant increase after 28 weeks in suprarenal gland length, width, Thickness of cortex and medulla thickness on both right and left sides. The suprarenal gland thickness significantly increased after 24 weeks on right side and after 20 weeks on left side. In live fetuses, the mean of Cortico-medullary thickness ratio on the right side is 1.17:1 and on the left side it is 1.23:1.

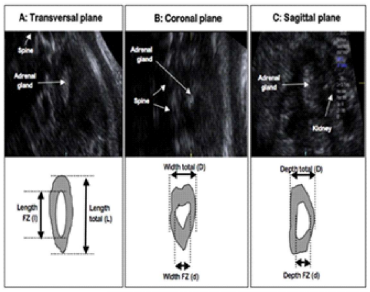

Fig. 1: Planes of Ultrasonographic Morphometry of Adrenal gland in live fetus (Turan et al., 2011) [4]

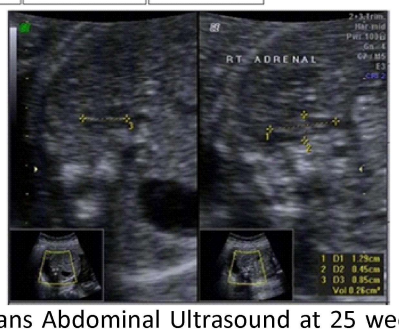

Fig. 2: Trans Abdominal Ultrasound at 25 weeks in live fetus showing measurement of length, width antero – posterior thickness of Right adrenal gland.

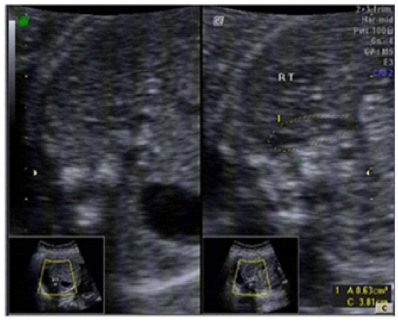

Fig. 3: Trans Abdominal Ultrasound at 25 weeks in live fetus showing measurement of Area and Circumference of Right adrenal gland.

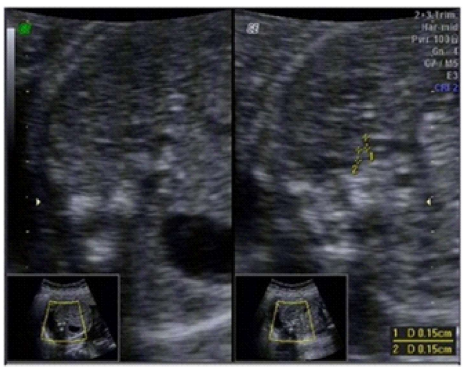

Fig. 4: Trans Abdominal Ultrasound at 25 weeks live foetus showing measurement of thickness of Cortex and medulla of Right adrenal gland.

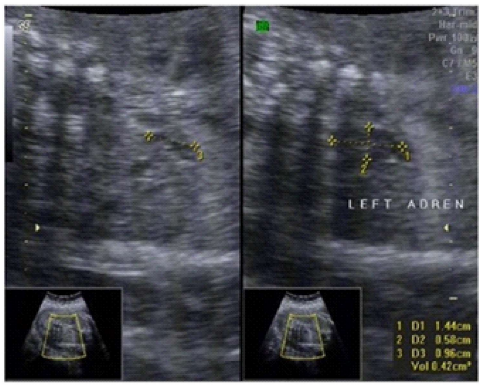

Fig 5: Trans Abdominal Ultrasound at 25 weeks in live fetus showing measurement of length, width antero-posterior thickness of Left Adrenal gland.

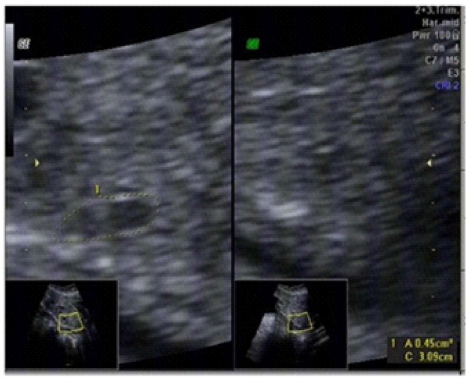

Fig. 6: Trans Abdominal Ultrasound at 25 weeks in live fetus showing measurement of Area and Circumference of left Adrenal gland.

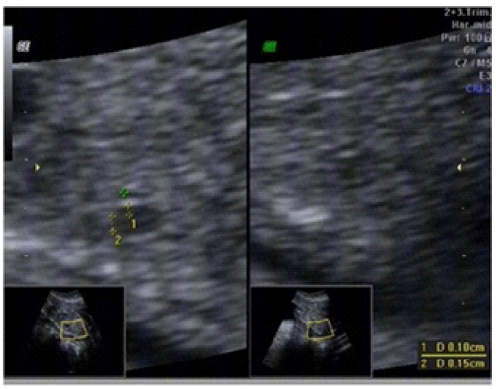

Fig. 7: Trans Abdominal Ultrasound at 25 weeks in live fetus showing measurement of thickness of Cortex and Medulla of left Adrenal gland.

Table.1: One way ANOVA and DMRT by gestational age for external and internal parameters of suprarenal glands (SRG) of live fetuses.

Parameters	Age (wks.)	N	Mean	Std. Deviation	F-value	p-value
SRG Length (cms) Right	17 - 20 (A)	2	1.57 a	0.325	20.517**	0
	21 - 24 (B)	12	1.51 a	0.239		
	25 - 28 (C)	4	1.43 a	0.05		
	29 - 32 (D)	9	2.10 b	0.206		
	> 33 (E)	36	2.28 b	0.344		
	Total	63	2.03	0.451		
SRG Length (cms) Left	17 - 20 (A)	2	1.730 a	0.2687	25.373**	0
	21 - 24 (B)	12	1.651 a	0.3768		
	25 - 28 (C)	4	1.640 a	0.0883		
	29 - 32 (D)	9	2.397 b	0.2386		
	> 33 (E)	36	2.454 b	0.2642		
	Total	63	2.218	0.4495		
SRG Width (cms) Right	17 - 20 (A)	2	0.85 a	0.007	9.899**	0
	21 - 24 (B)	12	0.61 a	0.114		
	25 - 28 (C)	4	0.77 a	0.459		
	29 - 32 (D)	9	1.34 b	0.292		
	> 33 (E)	36	1.30 b	0.427		
	Total	63	1.12	0.462		
SRG Width (cms) Left	17 - 20 (A)	2	0.845 a	0.1909	9.565**	0
	21 - 24 (B)	12	0.653 a	0.1235		
	25 - 28 (C)	4	0.768 a	0.2405		
	29 - 32 (D)	9	1.429 b	0.4024		
	> 33 (E)	36	1.347 b	0.4511		
	Total	63	1.174	0.4853		
SRG Thickness (cms) Right	17 - 20 (A)	2	0.425 a	0.1061	3.152*	0.021
	21 - 24 (B)	12	0.742 a	0.2787		
	25 - 28 (C)	4	1.110 b	0.268		
	29 - 32 (D)	9	0.889 b	0.2977		
	> 33 (E)	36	0.971 b	0.3069		
	Total	63	0.907	0.316		
SRG Thickness (cms) Left	17 - 20 (A)	2	0.385 a	0.0212	1.517	0.209
	21 - 24 (B)	12	0.935 b	0.3509		
	25 - 28 (C)	4	1.028 b	0.0574		
	29 - 32 (D)	9	0.922 b	0.2949		
	> 33 (E)	36	0.991 b	0.3758		
	Total	63	0.954	0.3532		
Cortex (mm) Right	17 - 20 (A)	2	1.550 a	0.0707	7.616**	0
	21 - 24 (B)	12	1.571 a	0.7782		
	25 - 28 (C)	4	1.825 a	0.4349		
	29 - 32 (D)	9	3.178 b	1.0426		
	> 33 (E)	36	3.341 b	1.2444		
	Total	63	2.827	1.3135		
Cortex (mm) Left	17 - 20 (A)	2	1.325 a	0.1768	12.646**	0
	21 - 24 (B)	12	1.492 a	0.6317		
	25 - 28 (C)	4	2.550 a	0.3416		
	29 - 32 (D)	9	3.400 b	0.755		
	> 33 (E)	36	3.545 b	1.1114		
	Total	63	2.999	1.2599		
Medulla (mm) Right	17 - 20 (A)	2	1.550 a	0.3536	7.666**	0
	21 - 24 (B)	12	1.492 a	0.7573		
	25 - 28 (C)	4	1.825 a	0.556		
	29 - 32 (D)	9	3.378 b	0.8348		
	> 33 (E)	36	2.807 b	1.0197		
	Total	63	2.536	1.1029		
Medulla (mm) Left	17 - 20 (A)	2	1.375 a	0.5303	13.119**	0
	21 - 24 (B)	12	1.333 a	0.3447		
	25 - 28 (C)	4	1.925 a	0.2872		
	29 - 32 (D)	9	3.478 b	0.2682		
	> 33 (E)	36	2.853 b	0.9886		
	Total	63	2.547	1.0607		

Table. 2 is showing the results of one way ANOVA with Duncan's multiple range test carried out for gestational age for external parameters of suprarenal glands of live fetuses. This revealed significant difference in parameters of suprarenal gland relative to its surface area and circumference on both right and left sides at 0.01 levels.Right suprarenal volume showed significant difference at 0.05 levels and left suprarenal volume is not significant.

Further DMRT suggests significant increase in right and left suprarenal volume after 20 weeks of age. Suprarenal surface area on left side significantly increased after 28 wks. Suprarenal circumference on right side is significantly less below 24 wks and increased significantly after 29 wks. Suprarenal circumference on left side showed significant increase at 20 wks and at 28 wks.

Table2: One way ANOVA with DMRT by gestational age for external parameters of suprarenal glands of live fetuses.

Parameters	Age	N	Mean	Std. Deviation	F-value	p-value
Suprarenal Volume (CM^3) Right	17 - 20 (A)	2	0.1500 a	0.01414	3.354*	0.015
	21 - 24 (B)	12	0.8125 b	0.31906		
	25 - 28 (C)	4	0.5175 b	0.0685		
	29 - 32 (D)	9	1.1467 b	0.40376		
	> 33 (E)	36	1.1433 b	0.6249		
	Total	63	1.0095	0.56556		
Suprarenal Volume (CM^3) Left	17 - 20 (A)	2	0.1950a	0.02121	1.719	0.158
	21 - 24 (B)	12	1.305 b	0.53281		
	25 - 28 (C)	4	0.8600 b	0.44699		
	29 - 32 (D)	9	1.4556 b	0.59237		
	> 33 (E)	36	1.4019 b	0.85216		
	Total	63	1.3184	0.75917		
Suprarenal Surface area (CM^2) Right	17 - 20 (A)	2	0.820 a	0.233	20.508**	0
	21 - 24 (B)	12	0.670 a	0.169		
	25 - 28 (C)	4	0.720 a	0.094		
	29 - 32 (D)	9	2.36 b	0.669		
	> 33 (E)	36	2.450 b	0.816		
	Total	63	1.93	1.032		
Suprarenal Surface area (CM^2) Left	17 - 20 (A)	2	0.9200 a	0.11314	15.188**	0
	21 - 24 (B)	12	0.7753 a	0.22137		
	25 - 28 (C)	4	0.8150 a	0.11121		
	29 - 32 (D)	9	2.7389 b	0.59688		
	> 33 (E)	36	2.8722 b	1.17197		
	Total	63	2.2612	1.30425		
Suprarenal Circumference (CM) Right	17 - 20 (A)	2	2.580 a	0.0566	24.278**	0
	21 - 24 (B)	12	3.410 a	0.4929		
	25 - 28 (C)	4	3.918 b	0.4051		
	29 - 32 (D)	9	6.274 c	0.7097		
	> 33 (E)	36	6.116 c	1.2075		
	Total	63	5.371	1.5848		
Suprarenal Circumference (CM) Left	17 - 20 (A)	2	2.7800 a	0.08485	40.131**	0
	21 - 24 (B)	12	3.7117 b	0.6735		
	25 - 28 (C)	4	4.0525 b	0.32877		
	29 - 32 (D)	9	6.6800 c	0.5174		
	> 33 (E)	36	6.6622 c	0.99476		
	Total	63	5.8138	1.59943		

* Significant at 0.05 level.
** Significant at 0.01 level.

DISCUSSION

Observations in Live fetuses:

According to Rosenberg et. al., (1982) [2], Lewis et. al., (1982) [3] and Turan et. al., (2011) [4] the fetal adrenal gland size is positively correlated with gestational age.

Suprarenal gland length, width, thickness, cortico-medullary thickness, surface area and circumference of both right and left side revealed significant difference ($p<0.01$). In the present study results are in agreement with those reported by Ozhan M et.al. (2011)[4] between gestational age and total gland measurements of length, width and depth. According to Bronsthtein *et. al.*, (1993) [10] adrenal gland length is 4.5 mm at 17 weeks in their study. Where as in the present study it is 2.2 mm.

Significant Correlation of suprarenal length, surface area and circumference of right and left with gestational age was reported by Hataet.al. (1985) [11] and Ljubitsh et.al., (2002)[12].

DMRT revealed significant increase after 28 weeks in suprarenal gland length, width, cortex and medulla thickness on both sides but thickness on left side only. Suprarenal gland thickness significantly increased after 24 weeks on right side and after 20 weeks on left side. Suprarenal circumference increased significantly after 29 wks on right side and it showed significant increase at 20 wks and at 28 wks age on left side.

Right suprarenal volume showed significant difference ($p<0.05$). Significant increase in right and left suprarenal volume after 20 weeks of age was observed in the present study. Ljubitshet.al, (2002) [12] reported significant correlation between gestational age and supra renal volume.

In live fetuses, the mean of Cortico-medullary thickness ratio on the right side is 1.17:1 and on the left side it is 1.23:1.The mean of Renal-Suprarenal volume ratio on right side is 9.60:1 and on left side it is 8.14:1. These values indicate a left sided higher value for cortico - medullary thickness and right sided higher value for renal-supra renal volume.

Right suprarenal gland thickness and cortex and medulla thickness correlated strongly ($p<0.01$) than corresponding parameters of the left side ($p<0.05$). Cortex and Medulla of each side are correlated ($p<0.01$).

CONCLUSION

in live foetuses ultrasonographic observations are bilaterally significant for various paraments viz., Length and width, Cortical and Medullary thickness, Surface area & Circumference in all the Suprarenal glands. Unilateral significance also observed in the Right side for thickness and Volume of the Suprarenal gland.

Conflicts of Interests: None

REFERENCES

[1]. Ozgüner G, Sulak O, Koyuncu E. A morphometric study of suprarenal gland development in the fetal period. SurgRadiol Anat.2012;34(7):581-7.

[2]. Rosenberg ER, Bowie JD, Andreoti RF, Fields SI.Sonographic evaluation of fetal adrenal glands. AJAR1982;139:1145-47.

[3]. Lewis E, Kurtz AB, Dubbins PA, Wapner RJ, Goldberg BB. Real TimeUltrasonographic evaluation of normal fetal adrenal glands.J.Ultrasound Med. 1982;1:265-270.

[4]. Turan OM; Turan S, Funai ES et.al Ultrasound measurement of fetal adrenal gland enlargement: an accurate predictor of preterm birth. Am J ObstetGynecol2011;204:311.e1-10.

[5]. Hoffman MK, Turan OM, Parker CB ,Wapner RJ, Wing DA, Haas DM, Esplin MS et.al. Ultrasound Measurement of the Fetal Adrenal Gland as a Predictor of Spontaneous Preterm Birth.Obstet Gynecol. 2016;127(4):726–734. doi:10.1097/AOG.0000000000001342.

[6]. Zhang Z, Meng H, Hou Z, Ma J, Feng L, et al. Fetal Adrenal Gland in the Second Half of Gestation: Morphometrical Assessment with 3.0T PostMortem MRI. PLoS ONE 2013;8(10):e75511. doi:10.1371/journal.pone.0075511

[7]. Flores JG, Cruceyra M, Ca˜namares M, et.al. Sonographic Evaluation of Fetal Adrenal Gland in GestationalDiabetes Relation to Fetal Growth and Maternal Biochemical Markers. J Ultrasound Med 2017; 36:999–1007.

[8]. Shigeo Iijima. Sonographic evaluation of adrenal size in neonates (23 to 41 weeks of gestation). BMC Pediatrics 2018;18:60 https://doi.org/10.1186/s12887-018-1056-4

[9]. Anand MK, Anand C, ChoudhryR,Sabharwal A. Morphology of human suprarenal glands: a parameter for comparison. Surg Radiol Anat. 1999;20(5): 345-9.

[10]. Bronshtein M, Tzidony D, Dimant M, Hajos J, Jaeger M, Blumenfeld Z. Transvaginal Ultrasonographic Measurements of the Fetal Adrenal Glands at 12 to 17 Weeksof Gestation. Am J ObstetGynecol 1993; 169(5):1205-10.

[11]. Hata K, Hata T, Kitao M.Ultrasonographic identification and measurement of the human fetal adrenal gland in utero. Int J Gynaecol Obstet. 1985;23(5):355-9.

[12]. Ljubiæ V, Petkoviæ S, Radunoviæ N. The fetal adrenal gland in risk pregnancy. SrpArhCelok Lek. 2002;130(5-6):198-200.

How to cite this article: Maruti ram Annamraju, Alka Prasad, Srihari Rao Battalapalli, Subhadra Devi Velichety, B Ravindra Kumar. Study on Morphometry of Adrenal Glands in live fetuses by Ultrasonography. Int J Anat Res 2021;9(4):8139-8144. **DOI:** 10.16965/ijar.2021.170