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Normal Adrenal Gland Thickness On Computerized Tomography In A South Indian Adult Population

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Abstract

Background:

The size of the adrenal glands varies with age, gender and sex. Various pathological conditions of adrenal origin are presents with change in the size of the gland itself on day today imaging techniques. We would establish a baseline range for normal adrenal gland thickness in the south Indian adult population which can be used for clinical care and future research.

Methods of Data Collection:

Informed consent will be taken from all patients. All patients subjected to CECT abdomen including the adrenal regions. Measurements will be made in late arterial or early portal venous phase CT on the axial image in an abdominal soft tissue window setting. Maximum thickness of the body, the medial and the lateral limbs will be measured perpendicular to their long axis in adrenal glands.

Results: The thickness of the body, medial and lateral limb of adrenal glands were calculated in males and females, predominantly of age group of 18-60 years.

Interpretation and conclusion: Maximum thickness of body, medial and lateral limb of both adrenal glands were calculated and baseline reference range for the gender and age group was setup. These values help in early detection of the various pathological conditions presenting with change in the gland size and hence guiding appropriate treatment.

Keywords: maximum thickness; Adrenal gland

Introduction

Adrenal glands are paired gland located in the suprarenal region which forms the vital role in the body metabolism by secreting various steroid hormones and neurotransmitters. In day today imaging various incidentilomas are identified which may be functioning or non-functioning. Few of the adrenal gland pathological conditions presents with derangement in the biochemical parameters / clinical illness and few are found to be fatal. Many of the possible etiologies ranging from the genetic to neoplastic have found to resulting in variation of size. So imaging plays a critical role in determining the normal baseline reference range of adrenal gland, to differentiate normal from abnormal. This becomes important in evaluation of patients with inconclusive biochemical parameters and subclinical presentation. Although majority of the adrenal gland pathologies are detected by their typical clinical presentation and deranged biochemical parameters. Imaging plays a critical role in detection in their identification and characterization. Ultrasonography, CT , MRI and

PET CT being widely used imaging techniques , CT is the modality of choice for any suspected adrenal gland pathologies, which are diagnosed with their characteristic imaging features and also helps in follow-up due to their wide availability.

Embryology: Adrenal glands are consists of two different embryonic tissues. a. Adrenal cortex b. Adrenal medulla Adrenal cortex is derived from coelomic mesoderm of the urogenital ridge. By the 5th week of gestation, the mesothelial cells in the posterior abdominal wall proliferate to form primitive cortex in between the root of mesentery and urogenital ridge. Definative cortex is formed by the second wave of proliferation by mesothelial cells around the primitive cortex in the 6thweek. At 8th week of fetal development the functioning cortical tissue separates from the mesothelial cells forming a surrounding connective tissue. Adrenal medulla is formed by neural crest cells in the region of coeliac plexus within the sympathetic ganglion. The medullary cells migrate along the central vein to locate centrally in the cortical tissue. Encapsulation of medulla by cortex occurs completely in the later weeks of gestation. Differentiation of adrenal cortex into zona glomerulosa and zona fasciculata occurs by birth. Development of Zona reticularis occurs later[4] .

Blood Supply:

Arterial supply: Three main arterial feeders are present namely a) superior adrenal artery from the inferior phrenic artery b) median adrenal artery from the descending abdominal aorta c) inferior adrenal artery from the renal artery. The cortex and medulla includes multiple arterial and venous capillaries within , which facilitates the formation of epinephrine and nor-epinephrine from steroid hormones.

Venous drainage: The left adrenal vein measures 30 mm and drains into the inferior phrenic vein which course obliquely downwards to enter left renal vein. Right adrenal vein drains directly into the inferior venacava in its posterior aspect. Accessory adrenal veins follow the arteries and may drain into the posterior gastric vein/azygos vein which can represent the pathology like in large tumours. The venous anatomy is of significance, the excess hormone producing tumours are treated with adrenelectomy and by adrenal venous drainage cut-off. Left adreneclectomy carries good prognosis than on right due to long course of left adrenal vein and risk of torrential haemorrhage on right side[5].

Lymphatic drainage : On the right side, there are three pathways-

1. drains into the right lateral aortic nodes, in front of the right crus of the diaphragm and proximal to the celiac trunk
2. ends in the right lateral aortic nodes, proximal to the junction between the left renal vein and the vena cava.
3. ends in the thoracic duct or in the posterior mediastinal nodes after the lymphatic vessels pierce the crura of the diaphragm, which explains the arrival of distant and early metastases of cortical malignant tumors.

On the left side, the first two pathways end in the left lateral aortic nodes proximal to the celiac trunk and left renal vein. The third pathway is through the diaphragm, as on the right side. Lymphatic vessels drain the cortex, not the medulla; corticoids can be found in the thoracic duct.

Nerve innervation: Sympathetic visceral nervous system forms the main source numerous nerves. Direct secretory/indirect vasomotor innervation are derived from the visceral afferent fibers from the celiac ganglia through posterior vagus nerve and greater splanchnic nerves are seen traversing the cortex. The medulla is a presynaptic sympathetic nerve forming a major component of sympathetic nervous system in body[5].

IMAGING TECHNIQUES:

Imaging and management of adrenal gland pathology has been the subject of intense research and controversy in the past 25 years, in tandem with the increasing use of cross-sectional imaging as a fundamental component of modern medical care.There are various imaging techniques available for specific characterization of the adrenal gland pathologies like Ultrasonography,CT and MRI. Recent advances have also included dual CT, FDG – PET, contrast enhanced ultrasound and nuclear medicine imaging.

Normal adrenal glands are seen as inverted V- or Y-shaped structures lying anterosuperior to the kidneys in the retroperitoneum .Paucity of retroperitoneal fat

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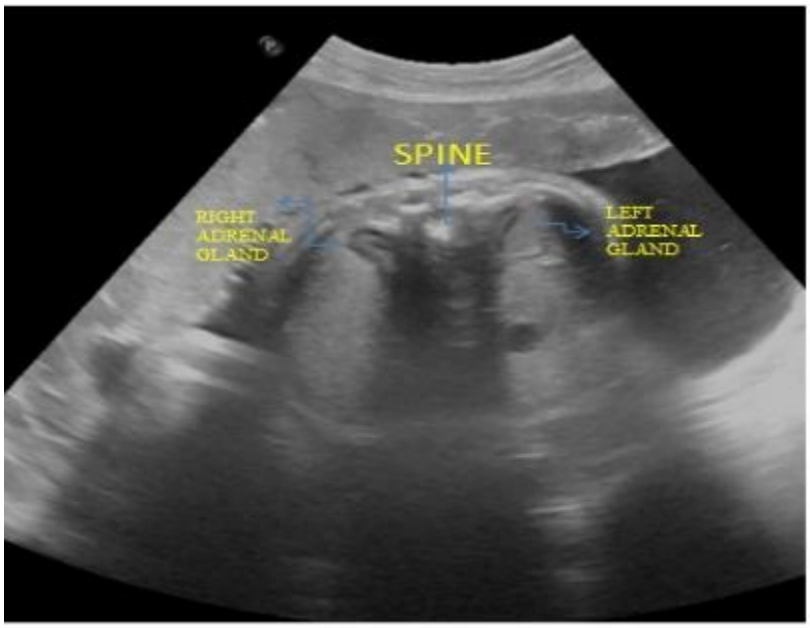
may render visualization of adrenals difficult due to overlap of surrounding structures.Ultrasonography (USG) has a major role in the evaluation of the neonatal patients in which the adrenal glands are larger than the kidney and helps in evaluating the most common abnormal conditions like adrenal hemorrhage/calcification. In adults, it helps in differentiating the solid from a cystic mass. In fetus, the adrenal gland hyperplasia imaged as glandular enlargement with maintained cortico-medullary zone differentiation[18].

Ultrasonography (USG) is a readily available technique for evaluation of abdominal pathologies. Though the visualization of retroperitoneal structures like adrenals is difficult on USG, it still has a role in incidentally detecting adrenal masses, in monitoring the changes during treatment of already established pathology and enables visualization of other abdominal organs at the same setting without any risk of radiation exposure and is cost effective.

USG shows adrenal glands quite accurately in infants and children as compared to adults where they may be obscured due to bowel gas and obesity. On USG, if no mass is seen with or without visualization of normal adrenals, it is considered to be specific for the absence of malignancy.

Figure No 1 : Axial sonogram through upper abdomen of a fetus of gestational age 36 weeks showing two adrenal glands on each side of the spine appearing as a peripheral anechoic cortex and central echogenic medulla.



Why To Choose Computed Tomography As A Imaging Technique:

CT plays a pivotal role in imaging the adrenal gland . Many incidentiloma's are found in the day today reporting where most of them are hypofunctioning and benign. CT provides a advantage of fast acquisition time , high spatial resolution and accuracy in differentiation of the benign from malignant conditions to achieve a correct diagnosis.Multiphase CT (MPCT) protocols in adrenal imaging is based on the fact that while both adenoma and malignant lesions show rapid contrast enhancement, adenomas show rapid washout of contrast as well while malignant masses show slower washout[20].

Magnetic Resonance Imaging (MRI) remains as a second non-invasive imaging option with added advantages of multiparametricity, multiplanarity, higher contrast resolution and imaging using chemical shift imaging (CSI) which is non-invasive and helps in imaging the paediatric population and pregnant patients[20]

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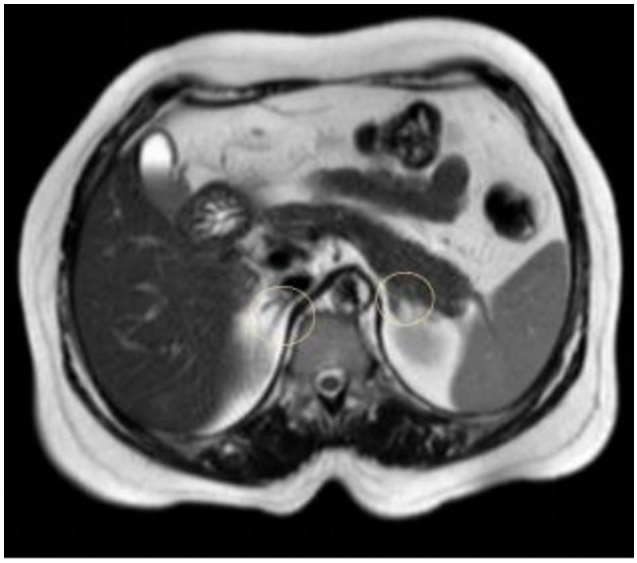
Figure No 2 : Axial MRI ultrafast spin echo sequence(Philip SSh TE 80) of abdomen at the level of pancreas showing Y shaped hypoechoic structures in both suprarenal region representing adrenal glands.



Aims and Objectives:

To study the normal thickness of adrenal gland on computed tomography in south Indian adult population.

To correlate adrenal gland size with age and sex.

To establish the baseline reference range for normal adrenal gland thickness in south Indian adult population.

Materials and Methods:

The present study was carried out in a tertiary care teaching hospital in Bengaluru. The hospital consists of highly qualified teaching staff with appropriate referral super-speciality units and also oncology care. All patients in the revelant age groups (>18 years) who underwent CT abdomen for non-adrenal diseases over a period of 18 months between January 2020-June 2021 and subsequently found to have normal study were included in the study.

Study design : Cross sectional study.

Inclusion criteria :

1. All patients referred to the department of radio-diagnosis VIMS & RC for CECT abdomen with clinically diagnosed or suspected of pathology, with or without systemic disease.
2. Adults between 18 to 60 years of age(ensuring minimum 100 cases per decade).
3. Stable patients

Exclusion criteria:

1. Patients not willing to enroll for the study.
2. Pregnant patients
3. All patients with clinical, biochemical, or radiological evidence of adrenal disease (Including those with nodular thickening).
4. Patients with history of chronic steroid use.
5. Elderly debilitating patients

Method:

After taking informed consent, MDCT of the abdomen was performed using Siemens Somatom Definition AS 128 slice Multi-detector CT scanner with 5 mm collimation and a gantry speed of 0.05 sec and pitch of 1.2 sec, 120kvP and 345 effective mAs First a non- contrast axial cuts were obtained, thereafter contrast was administered (Omnipaque (Iohexol) -350 mg I/ml), typical doses of 1.5 mg/kg (60-90 ml) through pressure injector (Imaxeon, SW version- 1.5-.12) using smart prep software (RCU manager) and arterial, venous and delayed phase were obtained. The typical scan parameters involved 5 mm and 1 mm slice thickness , coronal, axial and sagittal reconstruction , with 120 MA and 60-80 Kvp.The CT examinations were analyzed on dedicated work stations, this included Aquarius systems (Aquaris Nutrition Edition Ver.4.4 TERARECON Protected by U.S Patent 6,826,297 @1998-2009 TeraRecon, Inc. All rights reserved) or Syngovia (127.0.0.1@ 2009-2016 Siemens

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Healhcare) dedicated work station. The analysis was performed using the axial cuts (5 mm), thin section reconstructions (1 mm) and multiplanar technique is used to obtain coronal images if necessary.

Technique : Axial images of the MDCT in arterial/porto venous phases were further studied in detailed evaluation of the adrenal glands. Images are well analyzed to visualized the both adrenal glands separately for in relation to other structures.Maximum thickness of the adrenal glands are measured separately perpendicular to its long axis involving the body, medial limb and lateral limb.Maximum thickness of the body is taken at the level of junction of body and both limbs and maximum thickness of the limbs are measured perpendicular to the long axis of gland.

Figure No 3 : Schematic diagram of an adrenal gland demonstrating our measurement technique. No. I indicates the maximum thickness of the body of adrenal gland, and No. 2 & 3 indicates the maximum thickness of the limbs of the adrenal gland.

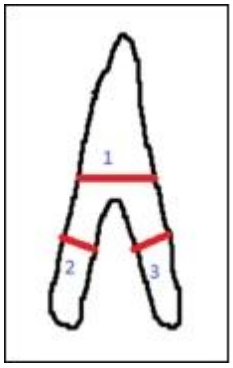

Figure No 4 : Illustrative case of a 24 years male patient with clinical history of tuberculosis and non-compliant with the ATT treatment is subjected to CECT abdomen demonstrating the maximum thickness of body,and limbs in both adrenal glands.

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Observation and Result:

In our study we included 1410 subjects out of which 894 patients (63.4 %) of male population and 516 (36.6 %) of female population.Majority of the study population involve the age groups 41-50, 51-60 followed by 31-40 and 21-30 & 61-70 years ensuring minimum 100 cases per decade.Majority of the study population are found to be males (63.4 % with 894 subjects) in comparison to females(forming 36.6 % i.e 516 subjects).In all the decade wise survey, majority of the subjects are males.

Figure No 5: Bar diagram representing the age distribution of subjects included in the study

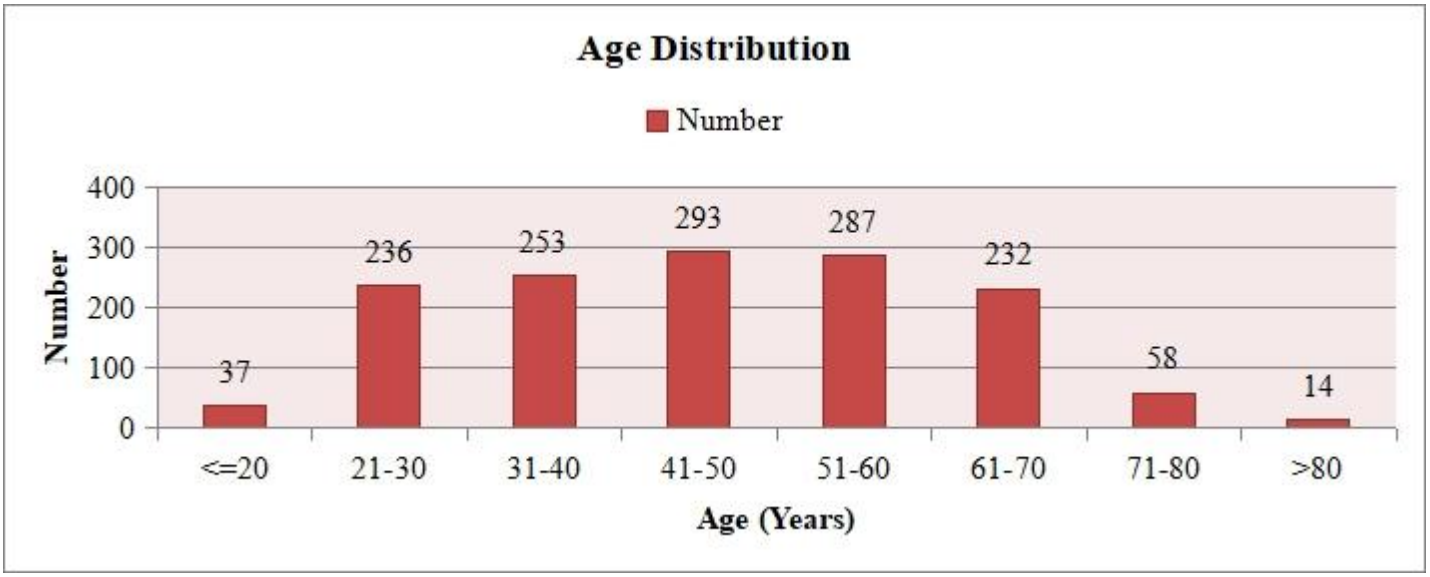

Figure No 6: Pie chart demonstrating the gender distribution of the study population

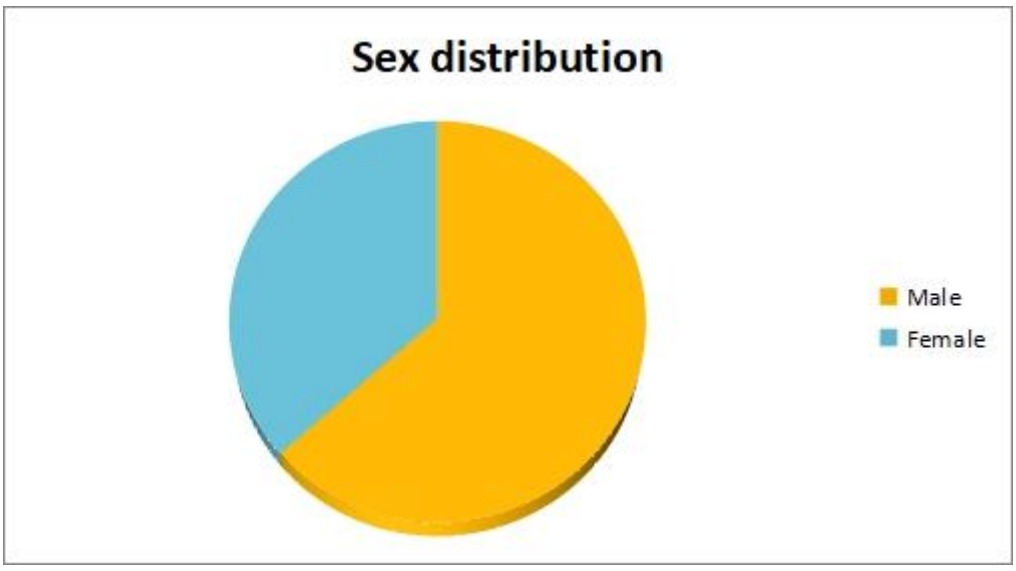

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Table No 1: Sex wise Distribution of Measurements

Variable	Males (n = 894)				Females (n = 516)			
	Mean	± SD	Minimum	Maximum	Mean	± SD	Minimum	Maximum
Body (a1)	8.3610	0.97409	5.70	9.90	8.3615	0.99069	5.50	9.80
Medial Limb (a2)	4.711	0.43384	3.50	5.40	4.6442	0.41593	3.50	5.40
Lateral Limb (a3)	4.5844	0.40416	3.60	5.40	4.5801	0.40338	3.70	5.40
Body (b1)	8.5266	0.71005	7.00	11.00	8.5691	0.75897	7.10	11.00
Medial Limb (b2)	4.6422	0.42301	3.80	5.90	4.6594	0.38701	3.80	5.70
Lateral Limb (b3)	4.5729	0.47297	3.80	6.20	4.6360	0.48458	3.80	6.30

Figure No 7: Bar diagram demonstrating the gender wise distribution of both adrenal gland thickness (mm).

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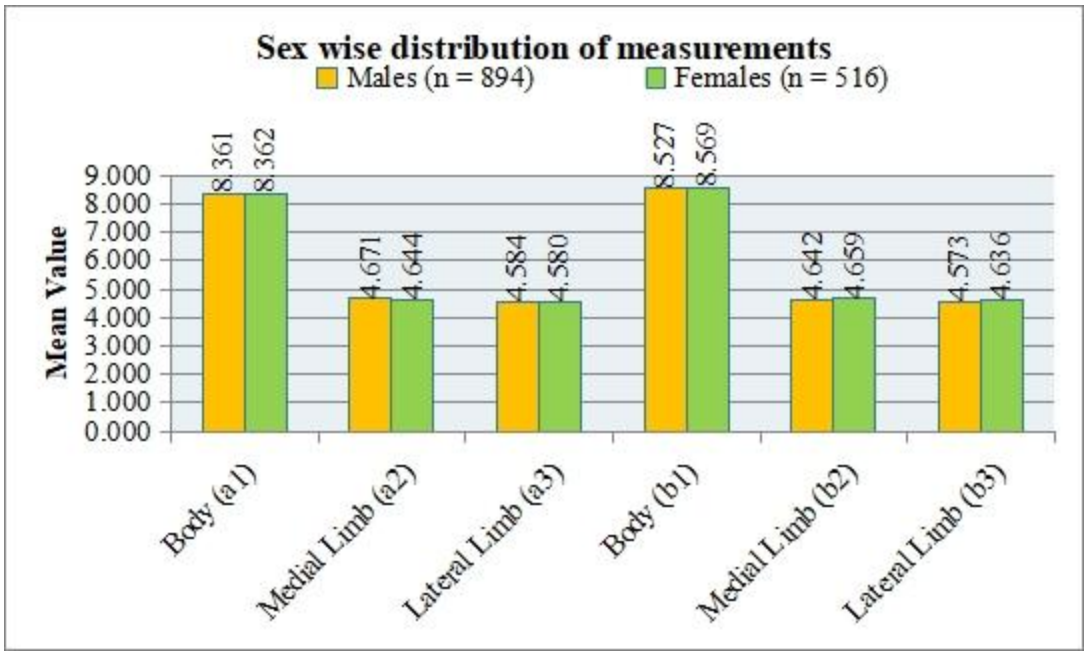

Left adrenal gland found to be larger than right. Maximum thickness of the adrenal gland is noted in the after 30 years of age. The overall thickness of the right adrenal gland is found to be highest in the females and the left adrenal gland in the male. Mean thickness of body, medial limb and lateral limb of the right adrenal gland is 8.3 ± 0.97, 4.7 ± 0.43 and 4.58 ± 0.40. Mean thickness of body, medial limb and lateral limb of the left adrenal gland is 8.52 ± 0.71, 4.64 ± 0.42 and 4.57 ± 0.47.

Maximum mean thickness of adrenal glands	Reetu John et al	Neeti Aggarwal et al	**Our study**
RIGHT			
Body	7.2 ± 1.8	6.9±0.31	**8.3±0.97**
Medial limb	4.1 ± 1.1	3.9±0.09	**4.7±0.43**
Lateral limb	4.3 ± 1.1	3.4±0.10	**4.58±0.40**
LEFT			
Body	8.8 ± 1.9	5.4±0.24	**8.52±0.71**
Medial limb	4.7 ± 1.1	4.2±0.06	**4.64±0.42**
Lateral limb	4.9 ± 1.3	3.8±0.07	**4.57±0.47**

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Discussion:

The present study was carried out as a cross sectional study among patients who underwent CECT abdomen for various complains excluding and subsequently found to have normal adrenal gland on scan.In the current practice , assessing the adrenal gland size is mostly a subjective attempt with lack of objectivity due to lack of sufficient data and studies on the Indian population. Development of normometry of adrenal gland thickness in Indian adult population with the help of CECT will be beneficial for the identification of abnormal adrenal size in borderline cases and their management.

During the lifespan of an individual , the size and shape of the normal adrenal gland seem to be dynamic . Age and gender play a pivotal role in the same. It is important to know the normal. range of adrenal gland thickness to distinguish between the normal and abnormal adrenal gland thickness. Hence the above study was conducted to establish adrenal gland size of normal Indian subjects aged >18 years.

Here we have systematically compared our study results with similar studies done.

Akin et al have taken a sample of 420 subjects (220 males , 200 females) in 50-84 years age group and concluded that VAG were observed lower in males compared to females in age groups and VAG was observed increasing with age in males; decreased in 60-69 age group of females and increased again in 70 and plus age group.

In our study the overall thickness of the adrenal glands tend to be raise in the after 30 years of age and significant difference noted after 60 years[12].

Julia Schnelle et al included 105 patients in their study conducted in 2014 and demonstrated larger left adrenal gland volume 4.84 (1.67) cm3 in comparision to right 3.62 (1.23) cm3 on the right side. It is heavier in the women . The total width of the adrenal gland was 15.80 (3.05) mm on the right side and 18.96 (3.37) mm on the left side. In our study we found that the females have a larger gland and found mean thickness of body, medial limb and lateral limb of the right adrenal gland is 7.92±1.63, 4.77±1.04 and 4.17±2.94. Mean thickness of body, medial limb and lateral limb of the left adrenal gland is 8.66±1.72, 4.85±1 and 4.32±1.02 respectively[14].

Xuan Wang et al in 2012 included 81 patients (49 males, 32 females) in china and stated that there is no significant different in the adrenal gland volume with respect to gender. They demonstrated there is significant difference in the adrenal gland volume with respect to patient height, weight and body surface area[16].

Reetu John et al conducted a retrospective study in 2018 including 586 adults in a teritiary care hospital of south India and concluded that the median maximum thickness of the adrenal body, medial, and lateral limbs were 7.2 ± 1.8, 4.1 ± 1.1, and 4.3 ± 1.1 mm on the right side and 8.8 ± 1.9, 4.7 ± 1.1, and 4.9 ± 1.3 mm on the left. They have involved the 18-85 age group participants in their study. Adrenal gland is found to be larger in male($p< 0.05$). Among 27 % of the study population showed > 10 mm in thickness of atleast one adrenal gland[13].

Neeti Aggarwal et al in 2019 included 1250 patients showed that maximum width of the both adrenal gland reached not more than 11 mm and limbs not more than 5 mm. Average width of right and left adrenal glands is 6.9 ± 0.31 mm and 5.4 ± 0.24 mm, respectively[17].

In comparison to the studies conducted by Reetu et al and Neha Aggarwal et al in Indian population concluded that adrenal gland body thickness > 11 mm and limb thickness > 5 mm is considered abnormal. Our study also showed same inference in regards to the incidental adrenal gland enlargement. 22 % of the participants showed body thickness greater than 10 mm and 8 % of the participants showed > 5 mm thickness of the limbs. Larger thickness is noted in age group > 30 years.

In our study we included 1410 patients with beyond 18 years age and attempt is made to set a baseline reference range for the normal adult population in south India. Hence total of 2820 adrenal glands are studied in our study. Due to limited literature found in regards to this topic, we have contributed to the future research.

The limitation of the study being majority of the male population in the study and due to the COVID -19 pandemic , the selection of cases were randomly selected who have undergone CECT abdomen for various reasons.

Conclusion

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The present study conducted over 1410 participants with a normal study of CECT abdomen and no obvious adrenal pathology detected clinically/imaging led to the following important conclusions:

1. Females, in general have larger adrenal gland than male across all age groups , Although ,difference is marked after 30 years
2. Adrenal gland thickness was the most reliable and consistent individual morphoetric parameter for assessing adrenal gland.
3. In any gland, body thickness greater than 10 mm and > 5 mm thickness of the limbs to consider as incidental adrenal gland enlargement.
4. Findings of the present study matched with most of the previous similar studies in the same age group.
5. The difference of adrenal gland size across different age groups in males and females can further help in formulating age group specific nomograms for Indian adults. This study can form the base for further studies that include a larger number of healthy volunteers in regards to weight, height and body surface area.

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