

ORIGINAL RESEARCH

Assessment of Normal Adrenal Gland Thickness on Computerized Tomography in a Tertiary Care Hospital of Karnataka, India

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ABSTRACT

Background: Adrenal glands are vital part of endocrine system but very little has been described in literature about normalcy of the glands. CT (computerized tomography) is a very good modality to describe the morphology of the glands. Many conditions can be diagnosed by knowing the radiological anatomy of the glands. The objectives is to assess the normal adrenal gland thickness in adult population and to evaluate the relationship of thickness with age and gender.

Materials and Methods: It is a hospital based cross-sectional study for a period of 1 year in which the adult patients who underwent CT angiogram of the upper abdomen for clinical indications other than adrenals were included. 1000 scans were included in the study. The maximum thickness of the body, the medial and the lateral limbs were measured at right angles to their long axis, in both adrenal glands.

Results: The mean age of the study participants was 54 ± 7.5 years and total of 700 males and 300 females were included. Mean maximum thickness of the right adrenal gland body, medial limb, and lateral limb were 7.16 ± 1.67 mm, 4.23 ± 1.45 mm and 4.45 ± 1.19 mm respectively. The difference in all the measurements of the right and left sides in which, left being larger than the right was statistically significant ($P < 0.001$). The differences between the measurements among males and females were statistically significant. There was positive correlation between the patient age and all the adrenal gland measurements.

Conclusion: We recommend the use of our data as a useful baseline reference range for the Indian adult population, and a guide for radiologists who can use this in their routine cross-sectional reporting practice when they encounter a doubtful “bulky” or “diffuse smoothly enlarged” adrenal gland.

Keywords: Adrenal Gland Thickness, Computed Tomography, Body, Medial and Lateral Limb of Adrenal Gland.

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INTRODUCTION

The adrenal glands play most important role in endocrine and physiological functions of the human body. The scientist, Eustacius described them first in 1563. They are triangular like endocrine glands located suprarenally at L1 vertebral level and on antero-superior aspect of the superior end of each kidney. The shape of the right adrenal gland is like an inverted V or Y and that of the left is inverted V or Y, an inverted or reverse letter L or it may be triangular. The normal adult adrenal gland weighs about 4 grams in both genders. The superoinferior dimension of the adrenal gland is varying but can extend from 2 to 6 cm. The overall

thickness of normal adrenal gland 5 to 6mm or rarely 10mm.^[1] A variety of physiological states and pathological conditions, including hemorrhage, neoplasms, tuberculosis and other infections, noninfectious granulomatous diseases and various endocrine disorders will have influence on size and morphology of the adrenal glands.^[2]

However, there is minimal recent literature that asserts the normal adrenal gland thickness on CT images in a larger population. Hence, through this study, a baseline reference range for normal adrenal gland thickness in Indian adult population may be established which can be used as baseline for upcoming research.

Newer technologies like CT, MRI, PET/CT etc. have been developed in recent years which are helping in imaging characterization of adrenal lesions. These technologies are efficient to differentiate benign from malignant adrenal lesions also. Advances in adrenal imaging, like spectroscopy, are also potentially helpful. It is important to be aware about the imaging manifestations of pathology that can influence the adrenal gland. The tiny size of the adrenal gland contradicts its pivotal importance in medicine, and imaging now plays a very critical role in adrenal pathology recognition and characterization.^[3] CT is an excellent screening and often decisive radiologic test of assessing the adrenal gland. The measurements offer a baseline for determining adrenal normality or enlargement on CT examination of the adrenal glands in the clinical or research setting.^[4]

Montagne et al and Karstaedt et al measured the maximum width or thickness of the adrenal glands at right angles to the long axis of the gland or one of its limbs.^[5,6] Due to the anatomical configuration of the gland the maximum width usually occurs at the junction of the medial and lateral limbs. The maximum width is almost at all times greater than the width of the individual limbs. Unfortunately, the measurement for the maximum width has been incorrectly applied: it has been used as the upper limit of normal for the adrenal limb width.^{[7-}

^{9]} With this background the study was conducted with the objectives of assessment of normal adrenal gland thickness in adult population and evaluating the relationship of thickness with age and gender.

MATERIALS & METHODS

It is a hospital based cross-sectional study in which all the adult patients who underwent CT angiogram of the upper abdomen for clinical indications other than adrenals were included. CT angiograms were used in order to confirm uniformity in slice thickness and quality of the images across all the study cases. All patients with evidence of adrenal disease based on clinical, biochemical, or radiological reports and the patients having history of chronic steroid use were excluded from the study. The study was conducted for a period of 1 year. On an average 5 to 7 CT angiogram of the upper abdomen are done in RIMS teaching hospital every day. Over the period of 1 year, 1000 scans were included in the study according to inclusion criteria. Thin slice axial images of CT were included where the slice thickness was less than 2.5 mm. The maximum thickness of the body, the medial and the lateral limbs were measured at right angles to their long axis, in both adrenal glands. These measurements were done in each late arterial or early portal venous phase CT on the axial image in an abdominal soft tissue window setting (window level 40–60, window width 400) using a standard defined method.^[10] The measurements were recorded in millimetres (mm) to the nearest single decimal point.

Data were entered in Microsoft excel sheet. The mean and standard deviation for each of the measurements were calculated. Statistical Package for the Social Sciences software trial version 26.0 was used for statistical analysis.

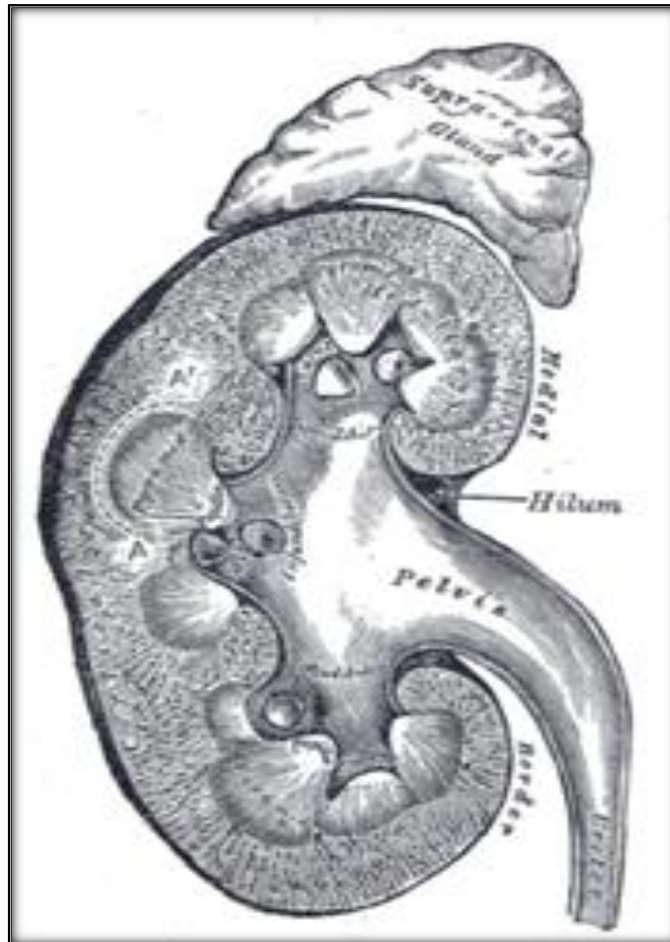


Figure 1: Kidney and adrenal gland anatomy (Case courtesy of Gray's Illustrations, Radiopaedia.org, rID: 26448).



Figure 2: Normal adrenal glands on CT (Case courtesy of Dr Omar Bashir, Radiopaedia.org, rID: 16570)

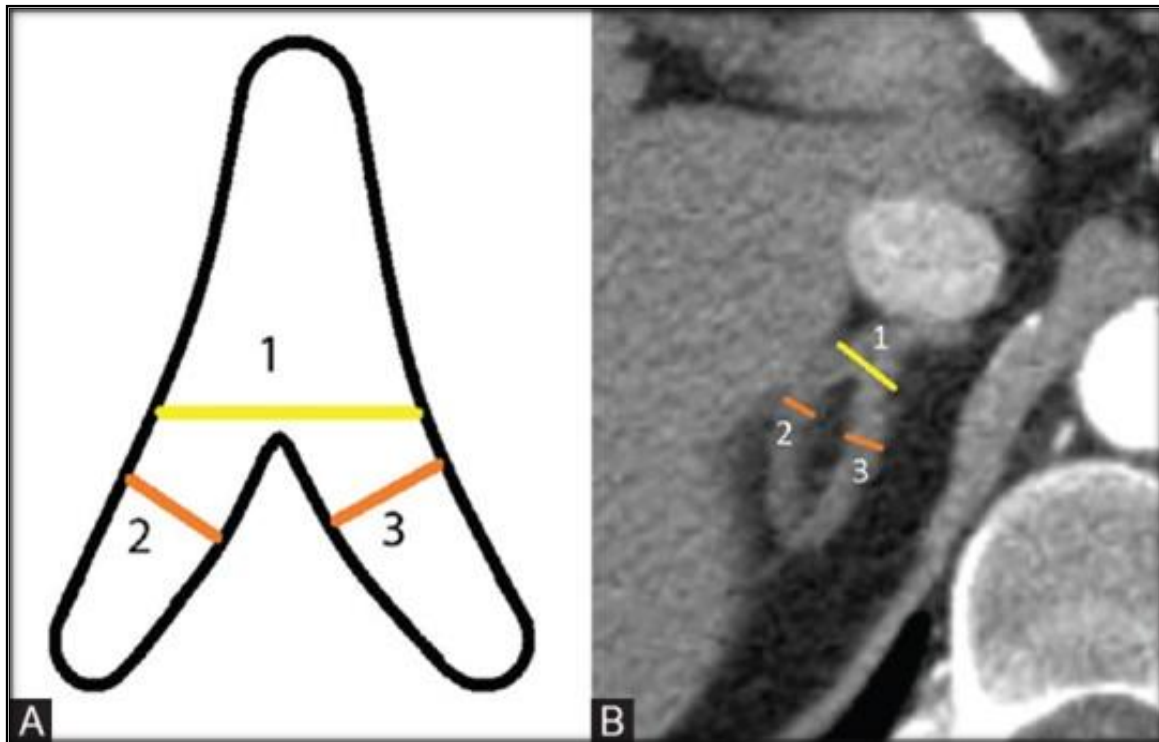


Figure 3: Schematic diagram (A) and axial CT image (B) demonstrating the measurement technique of adrenal gland: 1- maximum thickness of the body, 2 and 3- maximum thickness of the lateral and medial limbs.^[2]

RESULTS

The mean age of the study participants was 54 ± 7.5 years and the range was 18 to 78 years. A total of 700 males and 300 females were included in the study. As a whole, the mean and standard deviation for various measurements of adrenal glands on CT scan are summarized in Table 1. The total maximum thickness of the right adrenal gland was 15.84 ± 3.49 mm. The mean maximum thickness of the right adrenal gland body, medial limb, and lateral limb were 7.16 ± 1.67 mm, 4.23 ± 1.45 mm and 4.45 ± 1.19 mm respectively. The total maximum thickness of the left adrenal was 18.99 ± 4.13 mm. The mean maximum thickness of the left adrenal gland body, medial limb, and lateral limb were 8.67 ± 1.82 mm, 5.11 ± 1.24 mm and 5.21 ± 1.19 mm respectively.

There was difference in all the measurements of the right and left sides in which, left being larger than the right and this difference was statistically significant (P values < 0.001). The left adrenal body was larger than the right adrenal body by 1.5 mm and the cumulative left adrenal size was larger than the right side by 3.15 mm.

The measurements of mean cumulative right adrenal gland in males and females were 17.27 ± 4.11 and 13.33 ± 3.54 mm, respectively and the mean cumulative left adrenal gland size in males and females were 20.24 ± 4.21 and 16.4 ± 3.57 mm, respectively. The cumulative adrenal gland thickness of right side is 3.93 mm more in males when compared to females and that of left side is 3.84mm bigger in males than females. The differences between the measurements among males and females were statistically significant.

There was medium positive correlation between the patient age and all the adrenal gland measurements with the exception of left medial limb thickness, which showed a weak positive correlation.

Table 1: The different adrenal gland measurements on CT in all study subjects (n=1000)

Thickness of adrenal gland	Right adrenal gland			Left adrenal gland			P value
	Mean thickness in mm	Standard deviation	CI (95%)	Mean thickness in mm	Standard deviation	CI (95%)	
Body	7.16	1.67	3.5-11	8.67	1.82	4.7-12.9	<0.001
Medial limb	4.23	1.45	2.1-5.9	5.11	1.24	2.6-7.2	
Lateral limb	4.45	1.19	1.8-5.9	5.21	1.19	1.8-7.7	
Total	15.84	3.49	7.6-22.7	18.99	4.13	10.2-26.4	

Table 2: The adrenal gland measurements in males (n=700) and females (n=300)

Thickness of adrenal gland	Right adrenal gland			Left adrenal gland			P value
	Mean thickness in mm	Standard deviation	CI (95%)	Mean thickness in mm	Standard deviation	CI (95%)	
Males							
Body	7.44	1.82	3.6-10.8	9.44	1.76	6.1-12.8	<0.001
Medial limb	4.67	1.48	2.4-5.7	5.31	1.22	2.5-6.8	
Lateral limb	5.16	1.33	2.1-7.3	5.49	1.85	2.4-8.1	
Total	17.27	4.11	8.8-24.1	20.24	4.21	10.9-25.1	
Females							
Body	5.98	1.71	2.8-9.4	7.83	1.81	4.7-12.1	<0.001
Medial limb	3.12	1.56	2.1-5.2	4.17	1.29	2.5-6.2	
Lateral limb	4.23	1.49	1.8-6.1	4.40	1.31	2.0-6.7	
Total	13.33	3.54	7.3-19.5	16.40	3.57	10.4-23.7	

DISCUSSION

The adrenal glands enhance after contrast administration to approximately 50-60 HU. Hyperenhancement of the adrenal gland is concerning for hypovolemic shock. The baseline investigations for adrenal enlargement are serum 8 AM cortisol, serum electrolytes, 24-h urine-free cortisol, and 24-h urinary catecholamine levels and also other investigations like dexamethasone suppression test.^[11] Adrenals are often difficult to visualize on ultrasound. CT scan is a better mode of visualization of adrenal glands.^[12] Knowledge of the range of imaging appearances of the adrenal glands in primary may allow definitive diagnosis in most cases. The CT studies done in the previous have measured various thicknesses of the adrenal glands like the cephalocaudal extent, the greatest dimension of the gland on a single axial image, the length of the long axis of the body of the gland, the length of the long axis of the limbs and the maximum thickness of the gland perpendicular to the long axis of the body,

usually occurring at the junction of the body and the limbs.^[13] Measurements of the adrenal glands are affected by the variety of configurations of the adrenal gland seen on axial imaging. They may be linear, V-shaped, Y-shaped or triangular. To overcome the influence of gland structure on measurement, the adrenal gland volume was considered. But this method is time consuming and therefore not appropriate to regular clinical settings and a possible drawback with this technique could arise due to erratic inspiratory effect on sequential scans. CT dimensions of the adrenal limbs will offer an evaluation of adrenal cortical tissue and may be more sensitive in the assessment of adrenal cortical hyperplasia. Our measurements of the maximum width of the right and left adrenal gland correlate well with the previous CT studies.^[2-4] In our study we have described the size of normal adrenal glands. We have also recorded the width of the particular adrenal limbs.

It has been attempted in the past to calculate the normal size of adrenal glands^[5,6]. But it was done 3 to 4 decades ago and there were many drawbacks like multislice CT machines were not available, CT slice thickness was not optimal and sample sizes were less. Since the study was not prospective, biochemical screening could not be done.

CONCLUSION

We, through this study, recommend the use of our data as a useful baseline reference range for the Indian adult population, and a guide for radiologists who can use this in their routine cross-sectional reporting practice when they encounter a doubtful “bulky” or “diffuse smoothly enlarged” adrenal gland.

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