

Computed Tomography Measurements of Normal Adrenal Glands in Indian Population

Abstract

Introduction: Evaluating the adrenal glands for size is fundamental in their imaging and to ascertain its normality or abnormality. Awareness of the range of normal size and shape is useful for adequate interpretation of computed tomography (CT) scans in patients with suspected adrenal pathology. **Material and Methods:** CT body scans of 1250 patients without evidence of adrenal disease were reviewed to determine the shape and size of normal adrenal glands. Patients with conditions that are known to affect the adrenal glands or any known malignancy were excluded from the study. Furthermore, patients with any evidence of focal adrenal enlargement or malignancy on imaging were not included in the study. All measurements were made on 64-slice contrast-enhanced CT axial sections and only those images were selected in which the adrenals were adequately visualized. Three measurements were made: maximum width of the body of the gland and maximum width of both the limbs (medial and lateral); all measurements were taken perpendicular to the long axis of the body/limb. **Results:** Based on our study, we came to the conclusion that the average width of the body of the right and left adrenal glands is 6.9 ± 0.31 mm and 5.4 ± 0.24 mm, respectively (though maximum width of the body may reach up to 11 mm) and that normal adrenal limbs should not measure >5 mm. **Discussion and Conclusion:** The most common shape of the adrenal glands was found to be Y shape, followed by the V and triangular shapes. The values provided in the present study may be used as a reference standard for the CT evaluation of the adrenal glands in the Indian population in particular.

Keywords: Adrenal anatomy, adrenal measurement, computed tomography

Introduction

Evaluating the adrenal glands for size is fundamental in their imaging and to ascertain its normality or abnormality (defined as enlargement of the gland which may be focal or generalized).^[1] Awareness of the range of normal size and shape is useful for adequate interpretation of computed tomography (CT) scans in patients with suspected adrenal pathology. Most of the previous studies performed for evaluating the size of the adrenal glands were performed on early-generation CT scan systems employing prolonged data acquisition times that yielded low-resolution images.^[2,3] The relatively limited studies about the normal adrenal anatomy published so far have been carried out in Western population,^[2-8] and no such study has been done on the Indian population up till now. We carried out a retrospective analysis of adrenal anatomy in 1250 patients and aimed to ascertain the normal adrenal size by considering the maximum width of

the body of the gland and maximum width of each limb.

The aim of this study was to establish the size of normal adrenal glands in the Indian population, providing measurements of the width of the gland and the normal width of adrenal limbs.

Material and Methods

Measurements of the adrenal glands were obtained retrospectively from CT images in 1250 patients (age range: 21–76 years; male:female ratio of 1.14:1) who underwent CT examinations for routine clinical indications. Patients with conditions that are known to affect the adrenal glands or any known malignancy were excluded from the study. Furthermore, patients with any evidence of focal adrenal enlargement or malignancy on imaging were not included in the study. Both the adrenal glands were evaluated for their shape and size.

Continuous 6-mm thick sections were obtained using a General Electric 64-slice

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CT scanner machine. Window width and window level (WW = 400; WL = 40) were kept the same in all cases while recording the measurements. All measurements were made on contrast-enhanced axial sections and only those images were selected in which the adrenals were adequately visualized. Selected images were magnified, and the following measurements were taken for each gland: maximum width of the body of the gland and maximum width of both the limbs (medial and lateral); all measurements were taken perpendicular to the long axis of the body/limb [Figure 1]. Patients in whom both the glands could not be adequately visualized and measured due to the suboptimal delineation of the gland(s) were not considered. For the purpose of measurements, only glands with Y or V shaped were considered, as either the long axis could not be defined (triangular shape) or there was an absence of the medial and lateral limbs (linear or variable shape). This method of measurement was standardized at the beginning of the study and followed in all cases. All the measurements [Figures 2 and 3] were made by the same author to avoid any interobserver variation. Figure 4 depicts a V-shaped right adrenal gland. Descriptive statistics were used for analyzing the data.

Results

The age of the patients ranged between 21 and 76 years, with a median age of 38.00 + 7.22 years. There were 665 male and 585 female patients with the male: female ratio being 1.14:1.

Shape of adrenal glands

Most commonly seen was Y-shaped adrenals (having a body and two limbs) in 53% of cases followed by the V shape (having two limbs and no appreciable body) in 30% of cases. Rest had triangular, linear, or variable shapes [Table 1 and Figure 5]. No significant difference was seen regarding the shape of the adrenal gland and gender of the patient. In 84% of cases, the superior most part of the right adrenal was higher as compared to the left one, while in 14% of cases, both the glands were at the

same level, and in rest 2% of cases, the superior most part of the left gland was seen earlier than the right gland on proceeding craniocaudally on axial sections.

Measurement of normal adrenal glands

For the purpose of measurement, only Y- and V-shaped glands (1030 cases) were considered due to either inability to define the long axis (triangular shape) or due to the absence of the medial and lateral limbs (linear or variable shape) of the glands. Among the Y- and V-shaped glands, the body was measured in Y shape only (660 patients) as the same could not be identified in the V-shaped glands.

Table 2 depicts the average and the range of measurements of normal adrenal glands.

Table 1: The distribution of the shape of the normal adrenal glands in 1250 patients

Shape	Number of patients (%)	Males	Females	P
Y shape	660 (52.8)	405	255	>0.5
V shape	370 (29.6)	170	200	>0.5
Triangular shape	150 (12)	60	90	>0.5
Others	70 (5.6)	30	40	>0.5

Table 2: Average and range of measurements for normal adrenal glands (mm)

	Body*	Medial limb#	Lateral limb#
Right	6.9±0.31 (3.7-11.4)	3.9±0.09 (3.1-4.5)	3.4±0.10 (2.9-4.3)
Left	5.4±0.24 (3.6-10.6)	4.2±0.06 (3.0-4.2)	3.8±0.07 (2.9-3.9)

*Only in case of Y-shaped glands, #Only in case of Y- and V-shaped glands

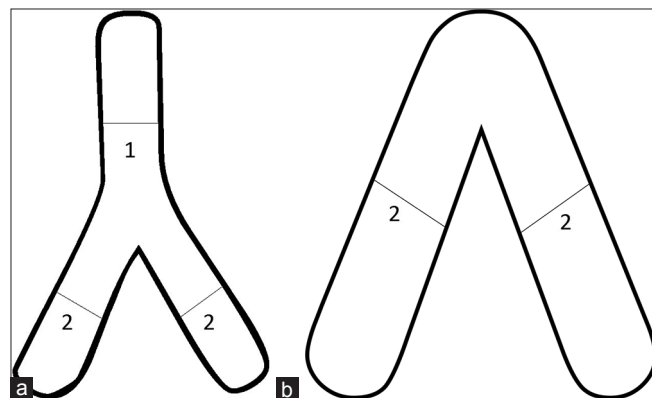


Figure 1: Pictorial representation illustrating the method for measuring the (a) inverted Y-shaped and (b) inverted V-shaped adrenal gland. Number 1 indicates the maximum width of the body of the adrenal gland; number 2 indicates the maximum width of the limbs of the adrenal gland

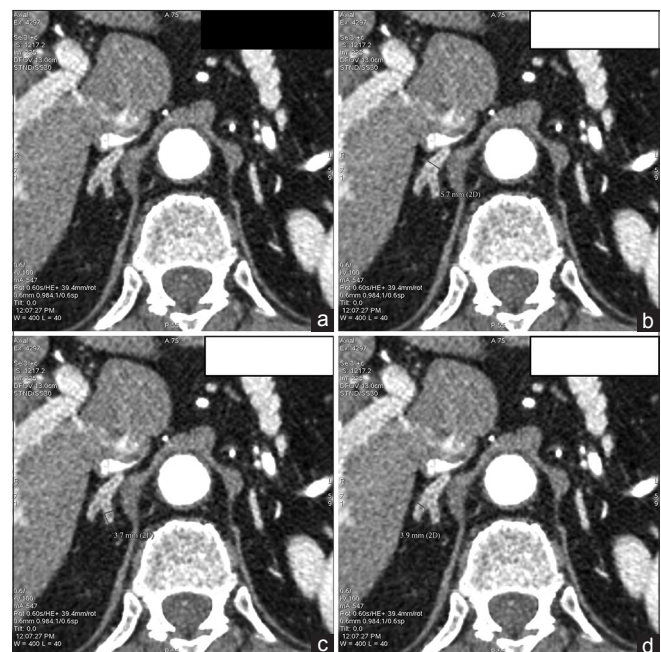


Figure 2: Axial 64 slice CECT images showing the measurement of (a) right adrenal gland in a 39 year old female with an inverted Y shaped gland. (b) body (c) medial limb (d) lateral limb

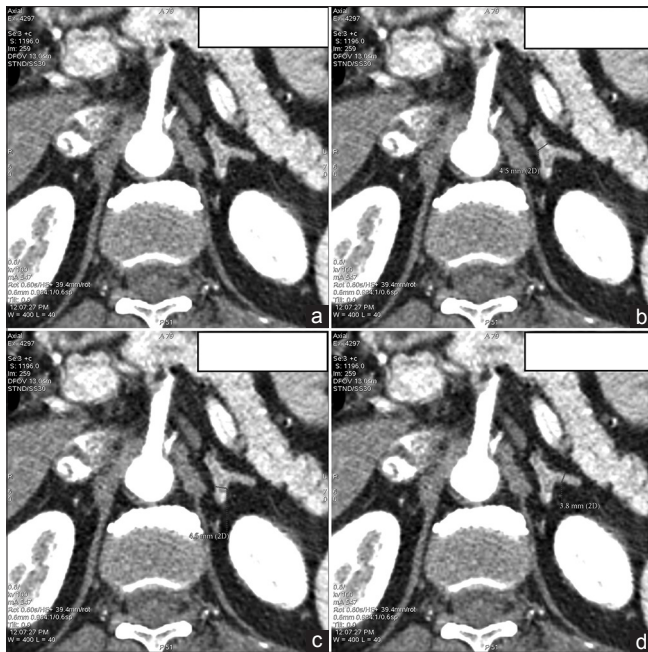


Figure 3: Axial 64 slice CECT images showing the measurement of (a) left adrenal gland in a 39 year old female with an inverted Y shaped gland. (b) body (c) medial limb (d) lateral limb

We found that the right gland was slightly larger than the left one in majority of the cases (970 out of 1250) although it was not significant statistically. Although not included in the study, we found that it was easier to identify/delineate the right gland as compared to the left one in certain cases (due to poor definition of the margins of the gland or due to sparsely distributed retroperitoneal fat and/or contiguity with adjoining normal structures and the variable configuration of the adrenal glands). A slight decrease in the size of the adrenal glands with age was noted, though it was statistically insignificant.

Discussion

The adrenal gland is so called because of its location adjacent to the kidney (adrenal). The normal gland weighs 5 g and has a characteristic inverted Y (most common) and inverted V or T (triangular) shape.^[3,5-7] The gland is composed of the outer cortex and inner medulla. The cortex is derived from mesoderm and secretes cortisol, aldosterone, and androgens. The inner medulla is derived from the neural crest and secretes epinephrine and norepinephrine.^[5-8]

Most of the previous studies performed for evaluating the size of the adrenal glands were performed on early-generation CT scan systems employing prolonged data acquisition times that yielded low-resolution images.^[2-3,6-8] The relatively limited studies about the normal adrenal anatomy which have been published so far in English medical literature have been carried out in Western population,^[2-8] and no such study has been done on the Indian population up till now.

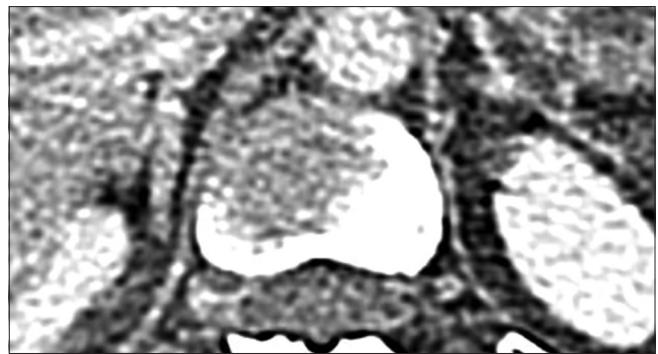


Figure 4: Axial 64-slice contrast-enhanced computed tomography images showing an inverted V-shaped right adrenal gland

In this study, an attempt was made to establish the size of normal adrenal glands in the Indian population, providing measurements of the width of the gland and the normal width of adrenal limbs.

Although plain radiographs can be useful in characterizing old adrenal hemorrhage or calcified adrenal neoplasms, these are unable to demonstrate the normal adrenal gland.^[9] Ultrasound can identify the gland only if it is enlarged.^[10] The adrenal gland is routinely identified at abdominal CT and magnetic resonance imaging examinations.

Dobbie and Symington reported that the limbs of the gland consist mainly of adrenal cortical tissue with little or no medullary tissue, which is seen predominantly in the body of the gland.^[11] CT measurements of the limbs will provide an assessment of adrenal cortical tissue and may be more useful in the assessment of adrenal cortical hyperplasia.^[1]

Montagne *et al.*^[2] and Karstaedt *et al.*^[3] measured the maximum width or thickness of the adrenal glands perpendicular to the long axis of the gland or one of its limbs. 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 always larger than the width of the individual limbs. According to Montagne *et al.*,^[2] CT was able to demonstrate the normal gland in 85% of the patients evaluated, but with new and modern CT scanners, this figure has increased, and in our study, we were able to demonstrate the normal adrenal gland in 97% of patients. This is possible because of the small amount of fat present in the retroperitoneal space which allows sharp delineation of its borders as well as 64-slice CT scan machine which allows thin sections of as little as 0.65 mm.

In our study, the average width of the medial and lateral limbs was 3.9 mm and 3.4 mm, respectively, on the right side, and in case of the left adrenal gland, the average width of the medial and lateral limbs was 4.2 mm and 3.8 mm, respectively, while the maximum width of the medial and lateral limbs in the study done by Vincent *et al.*^[4] was 0.28 mm and 0.28 mm on the right side and 0.33 mm and 0.30 mm on the left side, respectively.

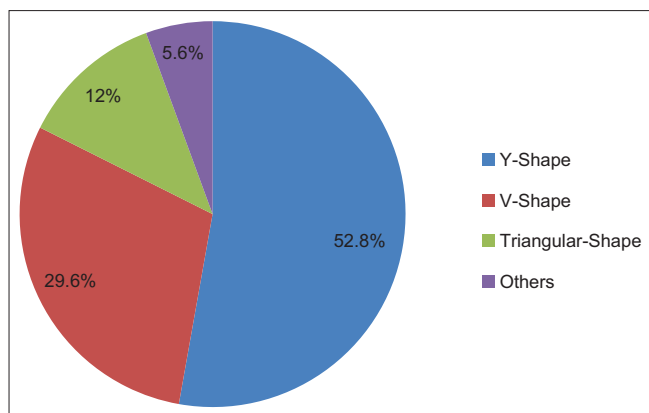


Figure 5: Graphical representation of the distribution of the shape of the normal adrenal glands in 1250 patients

The measurements were more in our case which may be due to the different study populations in both the studies and it may also be partly due to the fact the present study was done on 64-slice CT scanner where section thickness of 0.625 mm could be achieved and measurements could be made more accurately.

In our study, we found the most common shape to be Y shape, followed by the V and triangular shapes. This is in contrast to findings of Montagne *et al.*^[2] who found the V shape to be more common as compared to Y shape. This difference in observation may be attributed to the different population groups in both the studies. Due to these variable configurations of the gland, the body could be measured only in Y-shaped glands and the limbs in Y- and V-shaped glands.

Limitations of the study

The morphometric data were not analyzed with respect to the gender and age of the patients and also we did not note the different shapes of the adrenal gland separately on the right and left sides.

Therefore, further studies are required in this regard taking into account the age- and sex-specific analysis of the morphometric data and shape of the gland with respect to laterality for better estimation of its morphology.

Conclusion

Based on our study, we come to the conclusion that the average width of the body of the right and left adrenal glands is 6.9 ± 0.31 mm and 5.4 ± 0.24 mm, respectively (though maximum width of the body may reach up to 11 mm) and that normal adrenal limbs should not measure >5 mm. These values may be used as a

reference standard for the CT evaluation of the adrenal glands in the Indian population in particular.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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