



Normal Thickness of the Adrenal Gland in Computed Tomography in the Iranian Adult Population

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Received: 12 November, 2023; Revised: 25 May, 2025; Accepted: 1 June, 2025

Abstract

Background: The morphology and size of the adrenal glands are influenced by various pathological and physiological conditions. Establishing normal gland dimensions is therefore clinically important.

Objectives: This study aimed to determine the normal thickness of the adrenal glands using computed tomography (CT) in an Iranian adult population.

Method: This cross-sectional analytical study was conducted at Imam Khomeini Hospital, Tehran, Iran, in 2020. A total of 500 adult patients undergoing non-contrast abdominal CT scans over the course of one year were included, excluding those with clinical or radiological evidence of adrenal pathology. Measurements included maximum adrenal thickness, lateral and medial limb thickness, and long-axis thickness. An independent samples t-test was used to compare measurements between the left and right adrenal glands.

Results: Among the 500 evaluated cases, the mean \pm standard deviation (SD) thickness of the right adrenal gland was 6.40 ± 1.05 mm, and that of the left adrenal gland was 6.21 ± 1.12 mm ($P=0.001$), indicating that the right gland was significantly larger. The mean thickness of the right lateral limb was 4.23 ± 0.87 mm, compared to 3.61 ± 0.83 mm on the left ($P=0.001$). Similarly, the mean thickness of the right medial limb was 3.91 ± 0.85 mm, greater than the left at 3.68 ± 0.89 mm ($P=0.001$). All measurements were also significantly greater in males than in females.

Conclusions: This study provides reference values for the normal thickness of the right and left adrenal glands in an adult Iranian population. These measurements may serve as a useful comparative standard in the assessment of adrenal abnormalities in clinical practice.

Keywords: Adrenal Gland, Computed Tomography, Iranian Population

1. Background

The adrenal glands are a pair of endocrine organs that produce several essential hormones, including catecholamines such as epinephrine and norepinephrine, as well as steroid hormones like aldosterone and cortisol. Each gland comprises two main parts: The cortex (outer layer) and the medulla (inner core), with the cortex being responsible for steroid hormone production (1).

The adrenal cortex consists of three distinct zones: The zona glomerulosa, zona fasciculata, and zona

reticularis. These zones produce three major classes of steroid hormones – mineralocorticoids, glucocorticoids, and androgens, respectively (2, 3).

Each adrenal gland typically weighs about 5 grams. However, the average weight in adult humans ranges between 7 and 10 grams. The glands are approximately 5 cm in length, 3 cm in width, and about 1 cm in thickness (4, 5).

Numerous endocrine disorders are associated with adrenal dysfunction. Excessive cortisol production results in Cushing's syndrome, whereas insufficient

cortisol secretion causes Addison's disease (6, 7). A genetic disorder known as congenital adrenal hyperplasia (CAH) results from disruptions in normal endocrine function. Additionally, adrenal tumors — benign or malignant — may be identified through medical imaging techniques such as computed tomography (CT) (8-10).

Each of these disorders can lead to structural changes, including alterations in the size and morphology of the adrenal glands. Indeed, diffuse adrenal enlargement is a commonly observed feature in CT reports of various pathological conditions (11, 12). Therefore, establishing normal size references — especially adrenal thickness — is crucial for accurate interpretation of imaging results and diagnosis (13, 14).

2. Objectives

Despite its importance, available data on the normal size of adrenal glands remain limited, and such information has not yet been studied specifically in the Iranian population. Accordingly, the aim of this study is to evaluate and establish the normal thickness of the adrenal glands using computed tomography in healthy Iranian adults.

3. Methods

This study, as a cross-sectional-analytical study, was conducted on healthy people in terms of adrenal glands. Based on this, patients who had undergone abdominal CT as their evaluation were considered as the study group. Cases with the stated exclusion criteria were excluded from the study.

CT studies included thin-slice images (slice thickness ≤ 2.5 mm). The indices evaluated in CT included maximum adrenal thickness and internal and external bases perpendicular to the axis, which were measured in both adrenal glands. Measurements were recorded in millimeters to the nearest decimal point in the checklist.

3.1. Inclusion and Exclusion Criteria

Inclusion criteria: (1) Age > 18 ; (2) Iranian nationality; (3) having a CT scan of the abdomen.

Exclusion criteria: (1) All patients with clinical, biochemical, or radiological evidence of adrenal disease;

(2) patients who had a history of chronic steroid use; (3) incompleteness of file information.

3.2. Ethical Consideration

This study is approved under the ethical approval code [IR.IUMS.FMD.REC.1401.163](#).

3.3. Statistical Evaluation

The information obtained from the evaluated samples was recorded in the checklist. Then, the obtained information was entered into SPSS version 24 software. Quantitative data were checked using mean and standard deviation, and qualitative data using percentage and frequency. Then, an independent sample t-test was used to compare between two sides and gender, and based on this, adrenal size and thickness were compared based on gender and the side of the glands.

4. Results

In this evaluation, 500 healthy cases who met the necessary inclusion criteria were selected, and then the cases were evaluated. Based on the evaluations performed on the population and in accordance with the study objectives, the information obtained regarding adrenal thickness in different parts of the right and left adrenals was assessed.

The mean and standard deviation of the thickness of the right adrenal gland was 6.40 ± 1.05 , and that of the left adrenal was 6.21 ± 1.12 . Based on the statistical evaluation and the independent *t*-test, there was a statistically significant difference between the two sides ($P=0.001$). The size of the adrenal gland was larger on the right side than on the left. The mean and standard deviation of the thickness of the lateral limb of the right adrenal was 4.23 ± 0.87 , and in the left adrenal was 3.61 ± 0.83 . Based on the statistical evaluation, there was a statistically significant difference between the two sides ($P=0.001$), and the size of the lateral limb on the right side was larger than the left. The thickness of the medial adrenal limb was 3.91 ± 0.85 on the right side and 3.68 ± 0.89 in the left adrenal. Based on the statistical evaluation, there was a statistically significant difference between the two sides ($P=0.001$), and the size of the medial adrenal limb was also larger on the right side than on the left side ([Table 1](#)).

Table 1. Mean and Standard Deviation of Thickness in Right and Left Adrenal

Variables	Values		P-Value
	Mean	SD	
Body			0.002
Right	6.40	1.05	
Left	6.21	1.12	
Lateral Limb			0.001
Right	4.23	0.87	
Left	3.61	0.83	
Medial Limb			0.001
Right	3.91	0.85	
Left	3.68	0.89	

Also, the mean and standard deviation of the size of the lateral limb in the right ($P=0.001$) and left ($P=0.001$) adrenals in males were significantly higher than in females. Additionally, the size of the medial limb in the right ($P=0.01$) and left ($P=0.02$) adrenals was significantly greater in males than in females. On the other hand, the size of the adrenal gland in both right ($P=0.04$) and left ($P=0.03$) adrenals was larger in males, and this difference was statistically significant (Table 2).

Table 2. Mean and SD of Adrenal Gland Thickness and Medial and Lateral Right and Left Limbs According to Gender

Adrenal Sizes	Gender		P-Value
	Male	Female	
Lateral Limb			
Right	0.84 ± 4.45	0.84 ± 3.87	0.001
Left	0.85 ± 3.95	0.79 ± 3.58	0.001
Medial Limb			
Right	0.84 ± 4.12	0.79 ± 3.65	0.01
Left	0.75 ± 3.95	0.69 ± 3.55	0.02
Body			
Right	1.09 ± 6.85	0.99 ± 6.38	0.04
Left	1.09 ± 6.45	1.10 ± 6.05	0.03

5. Discussion

Anatomically, adrenal glands are structures that are located bilaterally in the extraperitoneal space around the kidney. Each of these glands is surrounded by a fatty capsule and renal fascia. Functionally, despite their small size, the adrenal glands are vital endocrine glands. Determining adrenal volume has been possible in recent years. Adrenal thickness, rather than volume, is still considered a useful parameter for evaluating suspected adrenal pathology.

Based on the present study, the mean and standard deviation of the thickness of the right adrenal gland was 6.40 ± 1.05 and that of the left adrenal gland was 6.21 ± 1.12 ($P=0.001$); the size of the right adrenal gland was larger than the left. The mean and standard deviation of the thickness of the lateral limb of the right adrenal was 4.23 ± 0.87 and that of the left adrenal was 3.61 ± 0.83 ($P=0.001$), and the size of the lateral limb on the right side was significantly larger than the left. On the other hand, the mean and standard deviation of the thickness of the right medial adrenal limb was 3.91 ± 0.85 and that of the left adrenal was 3.68 ± 0.89 ($P=0.001$), and the size of the medial adrenal limb was larger on the right side than the left. On the other hand, all measured items in the male gender were significantly larger than in the female gender.

Bagheri et al. also stated that visual scores for normal adrenal activity ranged from 0 to 3 and maximum SUVs ranged from 0.95 to 2.46. The visual score of adrenal activity was well correlated with average and maximum SUV (average SUV vs. visual score: 0.96, $r = 0.88$; maximum SUV vs. visual score: 0.99, $r = 0.87$) (15); however, these indices were not examined in the recent evaluation. Devakar et al. also stated that the mean maximum thickness of the right adrenal gland, medial base, and lateral side were 7.16 ± 1.67 , 4.23 ± 1.45 , and 4.45 mm. The difference in all measurements on the left was larger than the right, and this difference was statistically significant ($P<0.001$) (16); however, in the recent evaluation, both right and left sides were compared.

Wang et al. evaluated the normal size of the adrenal gland in healthy cases and observed that the total volume of the left, right, and total size of adrenal glands was 4.23 ± 0.74 (range: 2.85 - 5.83), 0.86 ± 4.26 (6.56 - 2.59), and 8.50 ± 1.40 (5.80 - 11.39) cm^3 , respectively (17); however, some of these indicators have not been evaluated in the recent study, which justifies the difference observed between the two studies. Vincent et al. (1994) also evaluated the size of the normal adrenal gland in a study and observed that the average measurements for the right adrenal gland were: Maximum width 0.61 mm (SD = 0.2), inner base width 0.28 mm (SD = 0.08), and lateral base width 0.28 mm (SD = 0.06) (18); however, in the recent evaluation compared to Vincent et al.'s study, it has been observed that the values in the right adrenal gland were higher. Also, John

et al., by evaluating the normal thickness of the adrenal gland, observed that the average lateral and medial side maximum thickness of the adrenal gland was $3, 4.1 \pm 1.1$, and 7.2 ± 1.8 , respectively. They observed a statistically significant difference ($P = 0.0001$) (19), which, like the recent evaluation, showed that the thickness of the left adrenal gland was greater than the right, and this had a statistically significant difference. In these studies, adrenal thickness has been evaluated in different populations; based on this and according to these results, a resource can be designed to evaluate patients compared to healthy individuals.

5.1. Conclusions

Based on the results observed in this evaluation, the mean and standard deviation of the thickness of the right adrenal gland was 6.40 ± 1.05 and in the left adrenal gland was 6.21 ± 1.12 ($P = 0.001$). The mean and standard deviation of the thickness of the right adrenal gland lateral limb was 4.23 ± 0.87 and 3.61 ± 0.83 in the left adrenal gland ($P = 0.001$), and the size of the right adrenal gland was larger than the left. Also, the mean and standard deviation of the right medial adrenal gland thickness was 3.91 ± 0.85 and in the left adrenal gland was 3.68 ± 0.89 ($P = 0.001$). So, all values in the right adrenal were higher than in the left adrenal. Based on the results of the recent evaluation, the normal value of adrenal thickness in the right and left adrenal glands of adults has been determined, and based on this, it will be possible to compare it with patients.

Footnotes

Authors' Contribution: M. A. contributed in study design, acquisition of data, analysis and interpretation of data and drafting of the manuscript, also M. AK contributed in study design, manuscript revision, data analysis, and study supervision.

Conflict of Interests Statement: The authors declared that they have no conflict of interest.

Data Availability: The dataset presented in the study is available on request from the corresponding author during submission or after its publication. The data are not publicly available due to patients may not be satisfied.

Ethical Approval: This study is approved under the ethical approval code of [IR.IUMS.FMD.REC.1401.163](#).

Funding/Support: This study was supported in part by grant number as 192891 from the Tehran University of Medical Sciences.

Informed Consent: Written informed consent was obtained from all participants.

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