



Renal Sinus Fat Volume on Ct scan: Correlation with Essential Hypertension at Middle-Age Group

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Abstract

Background and objectives: High blood pressure is a major public health problem related to the risk of heart disease, stroke and early death. The aim of this study is to examine the correlation between renal sinus fat volume and hypertension for participation in the future management of hypertension. It could be used as screening parameter for hypertension or decreasing renal sinus fat volume as treatment of hypertension.

Methods: This study was an observational cross-sectional implemented in the Rizgary teaching hospital/radiology department- Erbil City-Kurdistan region/Iraq, in a period between February. 2023 till November.2023. The participants were 98 visitors (referred by physicians for diagnoses of other medical issues), divided into hypertensive and non-hypertensive patients. Native abdominal CT scans were captured and by ellipsoid equation the renal sinus volume of each kidney was measured. Renal sinus volumes in each group were evaluated and compared.

Result: The average size of renal sinus fat in left and right kidneys of hypertensive patients was $4.5814 \pm 1.088 \text{ cm}^3$ and $3.3802 \pm 1.02547 \text{ cm}^3$ respectively and in control group it was $3.8010 \pm 1.10739 \text{ cm}^3$ and $2.8004 \pm 1.14657 \text{ cm}^3$ respectively, it is significantly higher in patients with high blood pressure. There is a significant relationship between the presence of hypertension and renal sinus fat, more at the left kidney ($P < 0.001$). Also, there is a clear difference in size of the renal sinus according to sex.

Conclusion: Increased volume of renal sinus in middle-aged persons with essential hypertension, suggesting that there is a pathophysiological mechanism causing increasing volume of renal sinus fat in hypertensive people.

Keywords: Adipose tissue, Renal sinus, Essential hypertension, Ellipsoid equation

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Introduction

Hypertension is nowadays a major global risk factor for morbidity and mortality; this results in 182 million disabled people and 10.4 million mortality each year.¹ Hypertension is increased blood pressure in the form of elevated systolic, elevated diastolic blood pressure or both at same time. There is a varied criterion for diagnosis of hypertension in different hypertension guidelines; most commonly, systolic blood pressure ≥ 140 mmHg and diastolic blood pressure ≥ 90 mmHg are diagnoses of hypertension that need repetition of blood pressure measurement at different times.² If blood pressure is greater than 180/110 mmHg in a person with cardiovascular disease, diagnosis can be made by a one visit.³ Hypertension is either primary (essential) 90–95% or secondary 5–10%. Lifestyle and genetics play role in essential hypertension, while identified etiology are seen in secondary, such as, kidney disease, endocrine diseases, contraceptive pills use or etc.⁴ Among the risk factors of essential hypertension, the distribution and volume of adipose tissue, particularly around the heart and within the renal sinus, have garnered increasing attention due to their potential role in the pathogenesis of hypertension.⁵ Adipose tissue is a loose connective tissue consisting mainly of adipocytes. beside adipocytes other cells are seen such as preadipocytes, vascular endothelial cells, immune cells like macrophages and fibroblasts.⁶ According to the traditional view, adipose tissue acts as an energy reserve that covers the energy needs of various organs.⁷ Recently, besides its traditional function, adipose tissue has many other functions, such as immune, endocrine, mechanical functions with thermal regulation, and a crucial role in regenerative medicine.⁸ There is a different compartment of adipose tissue, each compartment has specific metabolic risk which is differ from other compartments. Subcutaneous and thigh

compartments less related to hypertension, while adipose tissue of thoracic and abdomen have a strong relationship.^{9,10} Fat in renal sinuses is an ectopic type of adipose tissue situated at the medial border of both kidneys; blood vessels, lymphatics, and ureters are passed through.¹¹ Different studies in Humans and animals detected that in many pathological state's fat accumulated in the renal sinuses.¹² In animal models, accumulation of renal sinus fat compresses low pressure renal veins and lymphatics. This compression elevates hydrostatic pressure of kidneys, then activation of the renin angiotensin aldosterone system results in hypertension.¹³ While previously considered a passive structural component, renal sinus fat has emerged as a metabolically active tissue capable of secreting various bioactive molecules, including adipokines and inflammatory cytokines, which can influence local renal function and systemic blood pressure regulation.¹⁴ The aim of this study is to investigate correlation between renal sinus fat volume, measured by CT imaging, and essential hypertension in a middle-aged human cohort, to explore the role of adipose tissue in hypertension pathogenesis. Understanding this relationship is of clinical significance, as it provides insights into novel therapeutic targets and strategies for hypertension management.

Patients and methods

This study was an observational cross-sectional implemented in the Rizgary teaching hospital- radiology department- Erbil -Kurdistan region/Iraq, in a period between February. 2023 till November.2023. Exclusion criteria are diagnosis of chronic kidney disease (nephrolithiasis, renal cyst, extra renal and renal lipomatosis), heart disease, thyroid disease, diabetes, body mass index (BMI) < 18 kg/m² and BMI > 30 kg/m² (to exclude underweight and over weights) and ages < 40 years and > 60 years (middle age according to encyclopedias





Britannica definition). Also, we excluded any case with incidental findings like adrenal lesions, angiomyolipoma, kidney scar and vascular atherosclerotic changes. A sample of ninety-eight (98) patients (44/54, F/M) were selected from visitors (referral cases for diagnostic imaging) after eligibility to inclusion and exclusion criteria. The participants were divided into two groups: group one, the “high blood pressure group,” which involves 49 patients with essential hypertension, and group two, the “control group,” composed of 49 persons with normal blood pressure. Demographic information such as age, sex, clinical data, and medical history (hypertension status, duration, and treatment) was collected directly from participant interviews and medical records review through a prepared questionnaire. Anthropometric measurements including weight and height were performed and body mass index calculated. Blood pressure was measured with the patient sitting for 10 minutes, Table (1).

Table (1): Participants demographic data

Variable	Frequency	Percent
Group		
Hypertension	49	50.0
Control	49	50.0
Total	98	100.0
Gender		
Male	54	55.1
Female	44	44.9
Total	98	100.0
Age group		
40 – 50	55	56.1
51 – 60	43	43.9
Total	98	100.0
Body mass index (BMI)		
Underweight (BMI <18.5)	3	3.1
Normal weight (BMI 18.5-24.9)	59	60.2
Overweight (BMI is 25 - 29.9)	36	36.7
Total	98	100.0

For purpose of this study a 64-slice multidetector CT (computed tomography) scanner machine was used. Computed tomography uses x-rays to make detailed pictures of structures inside of the body. The Scanner creates 64 high-resolution anatomical images per rotation which need 0.5 sec for full rotation and acquires great amount of diagnostic information in this short time. These multiple scans can be combined to create a 3-D image or volume. Patients put in supine position with elevated arms on a table that is attached to CT scanner, native abdominal CT scans (without contrast) were captured, the scan was craniocaudal from lung base till symphysis pubis. Slice thickness of 1.5 mm and 5mm in axial and coronal reformats were used and Fatty tissue of both renal sinuses was identified depending on pixel density, measured in Hounsfield units (HU). Window width for fatty tissue in between (-100 to -20) HU centered on -60. Renal sinus length was measured in a coronal section as the upper to lower sinus pole. A transverse plane was used for measuring renal sinus width, which is the distance between the renal hilum and the opposite cortex, and the depth is the anteroposterior distance. The equation for an ellipsoid is used for calculating renal sinus volume of each kidney in cubic centimeters.¹⁵

$$\text{volume} = \text{length} \times \text{width} \times \text{depth} \times \pi/6$$

The data that collected from our study were entered into, and then descriptive statistical tests, t-student and chi-square were used for analysis considering the significance level less than 0.05. The study ethics were implemented regarding the Helsinki Declaration of world medical association, by documented approval of the Kurdistan Higher Council of Medical Specialties, agreement of health authorities in Erbil, oral informed consent from participants, and management of any complications accordingly. The data that was collected from





our study was coded, then entered into IBM® SPSS® Statistics. Data were shown, and appropriate analysis was carried out based on the kind of data found for each parameter. The means of the two participant groups are compared using the Independent Samples t Test to see if there is statistical support for a significant difference in the corresponding population means.

Results

The average renal sinus volume of right and left kidneys in each group was compared to each other and found that left sinus volume greater than right. The average size of sinus fat in left and right kidneys of hypertensive patients was 4.5814 ± 1.088 and 3.3802 ± 1.02547 cm³ respectively while in control group it was 3.8010 ± 1.10739 cm³ and 2.8004 ± 1.14657 cm³ respectively. According to the mentioned data, volume of fatty tissue in renal sinus has a significant correlation with essential hypertension, the correlation being greater at the left kidney ($P < 0.001$). as shown in Table (2).

Table (2): comparison of renal sinus fat of both kidneys in hypertensive and control group

	Group	N	Mean \pm SD cm ³	p value
Left	Hypertension	49	4.5814 ± 1.08807	<0.001
	Control	49	3.8010 ± 1.10739	
Right	Hypertension	49	3.3802 ± 1.02547	0.010
	Control	49	2.8004 ± 1.14657	

Also, significant difference seen between male and female renal sinus fat volume in both right and left kidneys, as the mean volume at left kidney were 4.6630 ± 0.85204 cm³ in male and 3.6123 ± 1.23297 cm³ in female, also in right kidney were 3.5433 ± 0.84500 cm³ and 2.5343 ± 1.17421 cm³ in female as shown in table (3).

Table (3): gender effect on fat volume at sinuses of kidneys.

	Gender	N	Mean \pm SD cm ³	p value
Left	Male	54	4.6630 ± 0.85204	<0.001
	Female	44	3.6123 ± 1.23297	
Right	Male	54	3.5433 ± 0.84500	<0.001
	Female	44	2.5343 ± 1.17421	

Fatty tissue volume at left kidney sinus were 4.1207 ± 1.17360 cm³ in age group between 40-50 years and 4.2814 ± 1.15070 cm³ in age group between 51-60 years. The result in right kidney was 3.0320 ± 1.13604 cm³ in age group 40-50 years and 3.1649 ± 1.10945 in age group 51-60 years. There is no statistically significant increase in renal sinus fat volume detected according to age as we included only middle age groups. as shown in Table (4).

Table (4): Renal sinus fat volume and age variable relations

	Age group	N	Mean \pm SD cm ³	p value
Left	40 - 50	55	4.1207 ± 1.17360	0.499
	51 - 60	43	4.2814 ± 1.15070	
Right	40 - 50	55	3.0320 ± 1.13604	0.563
	51 - 60	43	3.1649 ± 1.10945	

Discussion

Investigating the correlation between renal sinus fat volume and essential hypertension in middle-aged individuals is clinically relevant as worldwide collected data among middle aged persons showed increase in hypertensive cases and its associated health risks, including cardiovascular disease and renal complications. Exploring this correlation can provide insights into the underlying pathophysiological mechanisms and potential targets for therapeutic interventions. Healthcare providers may consider incorporating renal sinus fat volume assessment into routine imaging studies for hypertensive patients to better assess their





cardiovascular risk profile and tailor treatment strategies accordingly. There are different imaging modalities including (ultrasonography, CT, MRI and angiography) for evaluation of fatty tissues at renal sinus, among them MRI or Multiplanar CT can allow exact evaluation of renal sinus diseases.¹⁶ We picked up computed tomography (CT) imaging for measuring the size of renal sinus fat for the purpose of our study. According to results of comparison between essential hypertensive patients and normotensive persons in our study, size of renal sinus in the middle age group was positively correlated with essential hypertension. This finding, highly consistent with results of previous research which suggests that increased renal sinus fat accumulation may contribute to renal dysfunction and hypertension through various mechanisms, including inflammation, oxidative stress, and alteration of renal hemodynamic.^{17,18} This article is unable to determine the mechanism of increasing renal sinus fat volume by essential hypertension because our study is a retrospective study which has an observational nature. However, it supports hypothesis that accumulation of fatty tissue in renal sinuses physically reduces renal external flow and increases interstitial hydrostatic pressure of kidneys which might cause activation of the renin-angiotensin system at local and systemic level.¹⁹ Another hypothesis for this correlation was an ectopic deposition of lipids into renal sinus fat which resulted in toxic metabolites accumulation, from fatty acids metabolism. These metabolites finally lead to renal injury.²⁰ There is no significant difference in renal sinus volume according to age in the middle age group (5th and 6th decades), this result is not opposed to the published study by Caglar et al.²¹ At base of BMI (18-30), we categorized reported cases in our study in to underweight, normal weight and overweight,

after evaluation we found that there is no significant difference in fat volume between normal and overweight but this difference seen between underweight and overweight which is consistent with previous article by Hadar Raphael et al. which concluded that there is difference in sinus fat between lean and obese.²² In female and male groups, the volume of renal sinus on the left side is greater than the right. Cohen et al in a previous article reached the same result.²³ We faced several limitations during study. The study was performed in a single center, which may lower the publicity of results to our community, cross-sectional nature of the study design, the complexity of hypertension etiology, and the influence of confounding variables.

Conclusion

The volume of renal sinus is greater in the left kidney than right in each person. This volume is also high in both kidneys of males in comparison to both kidneys of females. There is a significant relationship between the amount of fatty tissue accumulated in renal sinus and essential hypertension within the middle-aged population, as the volume is higher in hypertensive patients. For the future screening and management of essential hypertension renal sinus fat volume is an important target, and future research could explore causal relationships.

Acknowledgment

We have to thank all the participants who helped in this study, and also thank for their support.

Conflict of interest

The authors have no conflicts of interest to declare.

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