Original Article

# Sonographic Evaluation of Renal Cortical Thickness and Renal Parenchymal Changes as a Predictor of Renal Function Impairment in Hypertensive Patients

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**Abstract**

**Objective**: The aim was to evaluate the effect of hypertension on renal function by sonographic evaluation of renal cortical thickness and renal parenchymal changes.

**Study design:** It was an Analytical Cross Sectional study

**Place and duration of study:** The study was conducted at Rashad Hospital Shahkot from September to December 2024.

**Material and Methods:** The study was carried out on 100 patients above 30 years of age who had history of hypertension. Participants were selected by using purposive sampling technique (non-Random). Renal Ultrasound was performed by using Toshiba NEMIO 200 with convex probe 3-5 MHz and the collected data was analyzed by using SPSS. Renal cortical thickness and renal parenchymal changes were assessed to check their effect on renal function impairment.

**Results:** 100 patients total in which 59 females and 41 male patients with hypertension were added. The correlation coefficient (R) between the observed and predicted values of the dependent variable (CGeGFR) is 0.375, indicating a moderate positive correlation between the independent variable and the dependent variable. $R^2 = 0.140$, which means that approximately 14% of the variance is explained by the independent variable P-value, is 0.000, indicating that the model is statistically significant.

**Conclusion:** The assessment of Renal Cortical Thickness and changes in Renal Parenchyma through ultrasound may serve as indicators of renal function deterioration in individuals with hypertension. Research indicates that the predictor Mean Cortical Thickness exhibits a significant correlation with the dependent variable CGeGFR. Therefore, incorporating the evaluation of Renal Cortical Thickness and Renal Parenchymal Changes into routine examinations of hypertensive patients could provide important diagnostic and prognostic insights.

**Keywords:**.Hypertension, Ultrasound, Renal Cortical Thickness and Renal Parenchymal Changes

## 1. Introduction

The occurrence of hypertension and the related risks of renal and cardiovascular disease make it a significant global public health concern. It ranks third as a cause of impairment and has been found to be the primary risk factor for mortality. (1) Approximately 60 million Americans suffer from hypertension, which can cause serious morbidity and mortality, such as heart disease and kidney failure. While essential hypertension affects the majority of people, a significant portion (5% to 10%) has a secondary etiology. Renal parenchymal disease and renovascular disease are the most common of these secondary causes. (2) Renal sonographic data can be used to indirectly evaluate renal function or status because hypertension can indirectly affect the kidneys. In radiology departments, kidney ultrasonography has become the most common investigation. The most frequent causes of acute and chronic renal disorders are renal parenchymal diseases, which, if left untreated, can progress to end-stage renal diseases. If these cases arise, the cost of treating them is high, and ignoring them could be lethal. (3) Common techniques include computed tomography (CT), ultrasound (US), intravenous pyelography, and plain abdominal radiography. For renal imaging, US is a straightforward, affordable, non-invasive technique that is simple to

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use. [4] Creatinine is the endogenous marker most regularly used to estimate glomerular function. A suggestion of GFR is provided by the computed creatinine clearance. [5] The prediction of creatinine clearance (in ml/min) by the Cockcroft-Gault formula was calculated as (140 − age) × body weight/plasma creatinine × 72 (× 0.85 if female). [6] Cortical thickness is a commonly used metric that is measured longitudinally from the kidney's midpole boundary to the base of the medullary pyramids. Reduced cortical thickness could be a sign of declining GFR or increasing renal disease, as the normal cortical thickness is 7–10 mm. [7] A common biomarker for kidney health is renal echogenicity. Renal parenchyma's echogenicity is evaluated by contrasting it with a reference tissue, like the liver, which ought to be less echogenic. It is simple to compare the echogenicity of the medulla and cortex. The loss of CMD refers to the incapacity to differentiate between them. [8] Renal morphology can be evaluated using a range of metrics that include determining renal length, volume, and cortical thickness. Renal function can also be accessed through renal duration and cortical thickness, and important treatment choices can be made based on this information. [9] This study aims to predict renal function impairment in hypertension patients by measuring renal cortical thickness and renal parenchymal alterations. Cortical thickness, renal parenchymal alterations, and chronic kidney disease have all been clearly linked in previous studies. There is little research on how ultrasound can be used to measure renal cortical thickness in hypertension patients. By illustrating the sonographic results for cortical size and renal parenchymal changes and their impact on renal function impairment in hypertension patients, this study fills the knowledge gap.

## 2. Materials & Methods

A cross-sectional study was conducted at Rashid Hospital Shahkot from August to December 2024 involving 100 hypertensive patients selected via purposive sampling technique (non-Random) was done. One hundred hypertensive patients above age of 30 were enrolled in the study. Patient files were revised to collect data regarding age and hypertension. Weight was measured. Data was collected according to data collection sheet. Ethical approval was obtained, informed consent was secured and confidentiality was ensured through anonymized data storage. Ultrasound was performed by single clinical sonologist using Toshiba NEMIO 200, ultrasound machine. Low frequency (3.5MHZ) curvi-linear transducer was used. The patient was in comfortable supine posture with their arms either above their heads or in the right and left decubitus positions. (Fig.1) SPSS 25.0 was used to enter and analyze the data, and descriptive analyses was conducted to look into the distribution of the data. For quantitative variables, the mean and standard deviation was provided, and for categorical variables, frequency and percentages was computed. To analyze the relationship between mean cortical thickness and CGeGFR Linear Regression was used.


**Figure.1** Mild increased parenchymal exhogenicity bilaterally with right sided mild fullness of collecting system.

## 3. Results

Table 1 showed, 100 patients total were added in which 59 females and 41 males. In the current study, this table shows descriptive statistics

**Table 1: Frequency and percentage of Gender**

| Gender | Frequency | Percent |
|---|---|---|
| FEMALE | 59 | 59.0 |
| MALE | 41 | 41.0 |
| Total | 100 | 100.0 |

Table 2 showed the statics of age of 100 patients with minimum of 30 years and maximum of 85 years with mean 54.16 (SD=12.86).

**Table 2: Descriptive statistics of Age**

| | N | Minimum | Maximum | Mean | Std. Deviation |
|---|---|---|---|---|---|
| Age | 100 | 30 | 85 | 54.16 | 11.869 |

Table 3 showed relationships of Gender, and Parenchymal Echogenicity with renal function Impairment is shown. For Gender it was seen that in female patients there were 13 with borderline and 46 were with normal renal function but for male patients there were 12 with borderline and 29 were with normal renal function. For parenchymal echogenicity changes 16 patients with Grade I has borderline RFTs and 30 patients with Grade I has normal RFTs. 8 patients with Grade II has borderline RFTs and 2 patients with Grade II has normal RFTs. WITH Grade III only 1 patient has borderline RFTs. There was not a single patient with normal parenchymal echogenicity has borderline RFTs but there were 43 patients with normal parenchymal echogenicity has also normal values for RTFs.

Table 3: Relationship of Gender, CMD Ratio and Parenchymal Echogenicity with Renal Function Impairment.

| | | Renal Function Impairment | |
|---|---|---|---|
| | | Borderline | Normal |
| | | Count | Count |
| Gender | FEMALE | 13 | 46 |
| | MALE | 12 | 29 |
| Parenchymal echogenicity | Grade I | 16 | 30 |
| | Grade II | 8 | 2 |
| | Grade III | 1 | 0 |
| | Normal | 0 | 43 |

Table 4 showed the correlation coefficient (R) between the observed and predicted values of the dependent variable (CGeGFR) is 0.375, indicating a moderate positive correlation between the independent variable (Mean_Cortical_Thickness) and the dependent variable. R Square is the proportion of variance in the dependent variable (CGeGFR) that is explained by the independent variable (Mean_Cortical_Thickness). In this case, $R^2 = 0.140$, which means that approximately 14% of the variance is explained by the independent variable. Sig. F Change is the F-test's p-value, which is 0.000, indicating that the model is statistically significant. This suggests that the predictor (Mean_Cortical_Thickness) has a substantial relationship with the dependent variable (CGeGFR). Therefore, the model is statistically significant ($p < 0.001$).

**Table 4: Linear Regression between mean cortical thickness and CGeGFR**

| Model | R | R Square | Adjusted R Sq | Std. Error Estimate | Change Statistics | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | R Square Change | F Change | df1 | df2 | Sig. F Change |
| 1 | .375ᵃ | .140 | .132 | 18.84516 | .140 | 16.012 | 1 | 98 | .000 |

a. Predictors: (Constant), Mean_Cortical_Thickness

b. Dependent Variable: CGeGFR

## 4. Discussion

Hypertension is a serious universal public health issue because of the hazards it poses for renal disease. Because hypertension can have an indirect effect on the kidneys, renal USG data can be utilized to assess renal function or status. Renal parenchymal illnesses are the most common causes of both acute and chronic renal problems. If treatment is not received, these conditions can develop into end-stage renal diseases. The aim of the study was to determine how well ultrasound could diagnose hypertension by measuring changes in the renal parenchyma and cortical thickness. (10) According to a study by Musa MJ, hypertension patients had a smaller mean cortical thickness than normotensive patients. This could be because the left kidney's entire volume has risen.(11) There was a statistically significant difference among the hypertensive and control groups' results. As the renal cortical thickness decreases in hypertensive individuals, these results align with our findings. Cortical values in both groups did not differ based on gender variation, which is in line with earlier research. (12) Age and cortical size were significantly correlated negatively, with both sides experiencing a decline in cortical size as age grew. Reduced renal function, which may arise from long-term poorly managed high blood pressure, and decreasing perfusion to the kidneys as people age could be the cause of this. Additionally, the study discovered that cortical measures for obese patients rose as their BMI climbed and fell as their BMI declined. According to Adibi et al., a likely reason for this proportionate relationship is that larger bodies require more nephrons to meet metabolic demands. (13) In Pakistan, Buchholz et al. determined that the left renal cortical thickness was greater than the right. (14) Using a computed tomography (CT) scanner, Kojima et al. in Japan reported that patients with essential hypertension had less cortical tissue than those with normotension. (15) Because the patient in Beland et al.'s study complained of chronic kidney disease (CKD), their mean cortical thickness was lower than ours. (16) In individuals with hypertension, our series revealed a statistically significant correlation among renal function and cortical thickness as determined by USG. According to a more recent study, kidney length has a low specificity for predicting renal impairment, although kidney volume and length have a substantial correlation with the elderly's estimated glomerular filtration rate (eGFR). Alsafi Ahmed Abdella and colleagues, in their research, documented the relationship between ultrasound findings in renal failure patients and serum creatinine levels. The study indicated that as serum creatinine levels rise, kidney volume diminishes. Furthermore, the research found no correlation between cortical thickness and echogenicity in patients with chronic renal failure, as evidenced by a p-value of .131, which exceeds the significance threshold of .05, indicating a lack of significant association between the two variables. (17) In our research, we observed a moderate positive correlation between the independent variable (Mean_Cortical_Thickness) and the dependent variable, as indicated by a p-value of 0.000 from the test. This result demonstrates that the model is statistically significant. It implies that the predictor (Mean_Cortical_Thickness) has a meaningful association with the dependent variable

(CGeGFR). Consequently, the findings of the study are statistically significant ($p < 0.001$).

## Conclusion:

Hypertension, along with its link to renal disease, represents a major global health issue. The assessment of Renal Cortical Thickness and changes in Renal Parenchyma through ultrasound may serve as indicators of renal function deterioration in individuals with hypertension. Research indicates that the predictor Mean Cortical Thickness exhibits a significant correlation with the dependent variable CGeGFR. Therefore, incorporating the evaluation of Renal Cortical Thickness and Renal Parenchymal Changes into routine examinations of hypertensive patients could provide important diagnostic and prognostic insights.

## Future Recommendations:

Research indicates a notable relationship between Mean Cortical Thickness and estimated glomerular filtration rates. Therefore, it is advisable to routinely evaluate Renal Cortical thickness in patients with hypertension. This assessment can be performed through ultrasound during regular health examinations to detect early indicators of renal decline.

## Disclosure /Conflict of interest:

Authors declare no conflict of interest.

### References:


1. Kearney PM, Whelton M, Reynolds K, Muntner P, Whelton PK, He J. Global burden of hypertension: analysis of worldwide data. The lancet. 2005;365(9455):217-23.
2. Mills KT, Stefanescu A, He J. The global epidemiology of hypertension. Nature Reviews Nephrology. 2020;16(4):223-37.
3. Radermacher J. Ultrasonography of the kidney and the renal vessels: Part I: Normal findings, inherited and renoparenchymatous diseases. INTERNIST. 2003;44(10):1283-+.
4. El-Reshaid W, Abdul-Fattah H. Sonographic assessment of renal size in healthy adults. Medical principles and practice. 2014;23(5):432-6.
5. Stämmler F, Grassi M, Meeusen JW, Lieske JC, Dasari S, Dubourg L, et al. Estimating glomerular filtration rate from serum myo-inositol, valine, creatinine and cystatin C. Diagnostics. 2021;11(12):2291.
6. Rodrigues V, Rodrigues T, Martins A, Dias I, Coutinho A, Palma D. 4CPS-159 Estimating renal function for drug dosing: correlation between ckd-epi and cockcroft-gault in an elderly population. British Medical Journal Publishing Group; 2023.
7. Widjaja E, Oxtoby J, Hale T, Jones P, Harden P, McCall I. Ultrasound measured renal length versus low dose CT volume in predicting single kidney glomerular filtration rate. The British journal of radiology. 2004;77(921):759-64.
8. Zanoli L, Romano G, Romano M, Rastelli S, Rapisarda F, Granata A, et al. Renal function and ultrasound imaging in elderly subjects. The Scientific World Journal. 2014;2014(1):830649.
9. Reddy GM, Reddy SS. Correlation renal cortical echogenicity with serum creatinine in patients with chronic kidney disease. Int J Radiol Diagn Imaging. 2020;3(3):99-102.
10. Spit KA, Muskiet MH, Tonneijck L, Smits MM, Kramer MH, Joles JA, et al. Renal sinus fat and renal hemodynamics: a cross-sectional analysis. Magnetic Resonance Materials in Physics, Biology and Medicine. 2020;33:73-80.
11. Musa MJ, Abukonna A. Sonographic measurement of renal size in normal high altitude populations. Journal of radiation research and applied sciences. 2017;10(3):178-82.
12. Luyckx VA, Brenner BM. The clinical importance of nephron mass. Journal of the American Society of Nephrology. 2010;21(6):898-910.
13. Adibi A. Renal cortical thickness in adults with normal renal function measured by ultrasonography. Iranian Journal of Radiology. 2008;5(3).
14. Buchholz N-P, Abbas F, Biyabani SR, Javed Q, Talati JJ, Afzal M, et al. Ultrasonographic renal size in individuals without known renal disease. Journal of the Pakistan Medical Association. 2000;50(1):12.

15. Kojima S, Shida M, Tanaka K-e, Takano H, Yokoyama H, Kuramochi M. Renal macrostructure and cortical circulation in hypertension assessed by dynamic computed tomography. American journal of hypertension. 2001;14(6):516-23.

16. Korkmaz M, Aras B, Güneyli S, Yılmaz M. Clinical significance of renal cortical thickness in patients with chronic kidney disease. Ultrasonography, 37 (1), 50-54. 2018.

17. RS B. Chronic kidney disease in the developing world. New Engl J Med. 2006;354:997-9. World Health Organization. Facts about high blood pressure [Internet].