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Normal Renal Parenchymal Thickness Values in Ethiopian Adults

Messay Gebrekidan[1,2*], Michael A. Negussie[3], Asmelash Teka Hadgu[4,5], Negasi Haile Abadi[5,6]

[1]Department of Radiology, College of Health Sciences, Mekelle University, Mekelle, Ethiopia. [2]Department of Radiology, Menelik II Comprehensive Specialized Hospital, Addis Ababa, Ethiopia. [3]School of Medicine, College of Health Sciences, Addis Ababa University, Addis Ababa, Ethiopia. [4]L3S Research Center, Leibniz Universität Hannover, Hannover, Germany. [5]Lesan AI and Afro Chest x-ray. [6]School of Computing, Mekelle University, Mekelle, Ethiopia.

**Corresponding author: Messay Gebrekidan.*

Abstract

Purpose: The purpose of our study was to establish renal parenchymal thickness (RPT) values in a normal Ethiopian population.

Methods: A prospective cross-sectional study was conducted at Ayder Specialized Referral Hospital in Mekelle, Tigray region, Ethiopia, from February to May 2018. A total of 375 adult patients with no history of renal disease were included. Data were analyzed using descriptive statistics, paired t-tests, Pearson correlation, ANOVA, and multiple linear regression to determine RPT values and their relationship with demographic variables.

Results: The mean RPT in males was 15.63 ± 2.63 mm for the right kidney and 16.36 ± 3.45 mm for the left kidney. In females, the mean RPT was 15.54 ± 2.8 mm for the right kidney and 16.6 ± 4.11 mm for the left kidney. The left kidney's mean RPT was significantly higher than the right kidneys. A negative correlation was observed between age and RPT, indicating a decrease in RPT with increasing age. No significant gender differences were found in mean RPT.

Conclusion: This study established baseline RPT values for normal adults in Tigray, Ethiopia, revealing lower RPT values compared to other populations. These findings underscore the importance of localized normative data for accurate renal disease diagnosis and management. Further research is needed to explore the causes and implications of these differences, including early diagnosis of chronic renal disease (CKD).

Keywords: renal parenchymal thickness; ultrasound; ethiopia; adults

Introduction

Renal parenchymal thickness (RPT) is defined as the distance between the renal capsule and the sinus-pyramidal apex interface of the kidney [1]. Establishing normal RPT values is essential since these values can be influenced by various renal conditions [2,3]. Renal disease can alter renal size and may be accompanied by changes in the normal organ structure. Ultrasound measurement of renal dimensions, including RPT, is essential for studying renal function and its disorders [4-6]. This non-invasive, safe, and cost-effective modality is free from geometric magnification errors of X-ray imaging and avoids the increase in kidney size caused by osmotic diuresis from iodinated contrast material [4,7,8]. Additionally, studies have shown that measurements of renal length and parenchymal thickness by sonography are reasonably reliable, with minimal inter-observer and intra-observer variation [4,9].

Understanding the variability in RPT among different populations is critical for developing accurate diagnostic criteria. Previous studies have shown the normal dimensions of the kidneys can vary among different races and genders and even between the kidneys of the same individual [4,7,8].

To the best of our knowledge, there has been no published study on the RPT of a normal Ethiopian population. This study aims to determine the RPT values in normal adults specifically in the Tigray region, which represents both the northern and central regions of the country. The goal is to establish normal RPT values in this population, aiding clinicians in improving the diagnosis and management of renal diseases.

Material and Methods

Study Design and Population

This prospective cross-sectional study was conducted at Ayder Specialized Referral Hospital in Mekelle, Tigray region, Ethiopia, from February 1 to May 2018. The study included a total of 375 patients referred for non-renal conditions.

Inclusion Criteria

Participants were included if they had normal ultrasound findings of both kidneys at the time of evaluation, including renal size, corticomedullary differentiation, absence of dilatation of the pelvicalyceal system, absence of renal stones or signs of infection, no renal duplication or ectopia, and normal renal echotexture. Additionally, participants had normal serum creatinine levels, no history of renal disease, no evidence of renal cysts, and complete measurements of the upper, lower, and mid-level poles of both kidneys.

Exclusion Criteria

Participants were excluded if they had any history of renal diseases, such as frequent urinary tract infections (UTIs) or lower urinary tract signs and symptoms. Other exclusion criteria included diabetes mellitus, hypertension, atherosclerosis, collagen-vascular diseases, abnormal urinary or biochemistry laboratory tests, pregnancy, congenital renal diseases (e.g., duplication, ectopic kidney), and being under the age of 18 years.

Data Analysis

Data were recorded in Microsoft Excel and exported to SPSS version 25 for analysis. The variables included demographic data (age and sex) and renal parenchymal thickness (RPT) measurements at the upper, middle, and lower poles of both kidneys, as well as the mean RPT for each kidney. Descriptive statistics were used to summarize the demographic data and RPT measurements. The Shapiro-Wilk test was conducted to confirm the normality of the data, which allowed for parametric tests to be employed. Paired t-tests were used to compare the mean RPT between the right and left kidneys, while Pearson correlation assessed the relationship between age and RPT. Analysis of Variance (ANOVA) and Tukey's Honest Significant Difference (HSD) tests examined differences in RPT across age categories. Independent t-tests compared RPT between genders, and multiple linear regression was used to identify predictors of RPT.

Results

A total of 375 patients were analyzed, comprising 167 males and 208 females. The participants' ages ranged from 18 to 70 years, with a mean age of 33.6 years and a standard deviation of 13.1 years. The age distribution included 126 patients aged 18-30 years, 151 patients aged 31-40 years, 68 patients aged 41-55 years, 18 patients aged 56-60 years, and 12 patients aged 61-70 years (Table 1).

Table 1: RPT by age category.

Age Category	Left mean RPT in mm	Right mean RPT in mm
18-25 (n=126)	16.56	15.28
26-40 (n=151)	16.49	15.73
41-55 (n=68)	15.07	15.28
56-60 (n=18)	14.44	15.5
61-70 (n=12)	13.44	12.66

n: number of patients in each age category.

The RPT values varied from 10.25 to 23.6 mm in the right kidney and from 10.5 to 23.75 mm in the left kidney. The gender analysis showed no significant difference in the mean RPT between males and females. Among male participants, the mean RPT measured 15.63 ± 2.63 mm for the right kidney and 16.36 ± 3.45 mm for the left kidney. In female participants, the mean RPT was 15.54 ± 2.8 mm for the right kidney and 16.6 ± 4.11 mm for the left kidney. Comparing the right and left kidneys, the mean RPT of the left kidney was significantly higher than that of the right kidney, with a mean difference of 0.083 mm (Table 2).

Table 2: Paired difference in MPT between the left and right kidneys.

	Paired difference					T	df	Sig (2 tailed)
	Mean	SD	SEM	95% CI of the Difference				
				Lower	Upper			
Left - Right MPT	.083	.11	.006	.071	.095	13.841	346	.000

MPT: Mean Parenchymal Thickness, SD: Standard Deviation, SEM: Standard Error of The Mean, CI: Confidence Interval, T: T-Value, df: Degrees of Freedom, Sig: Significance Level

Pearson's correlation coefficient revealed a negative correlation between age and RPT, with r = -0.407 for the right kidney and r = -0.302 for the left kidney, indicating that the mean RPT decreases as age increases. For the right kidney, analysis shows that those aged 18-30 years have no statistically significant difference compared to those aged 31-40 years (95% CI = -0.0018 to 0.1103). However, there is a statistically significant difference when compared to those aged 41-50 years (95% CI = 0.0084 to 0.1177), 51-60 years (95% CI = 0.0753 to 0.2022), and 61-70 years (95% CI = 0.1470 to 0.3064) (Tables 3 and 4). For the left kidney, those aged 18-30 years show no statistically significant difference compared to those aged 31-40 years (95% CI = -0.0364 to 0.0916) and 41-50 years (95% CI = -0.0205 to 0.1041). However, there is a statistically significant difference when compared to those aged 51-60 years (95% CI = 0.0570 to 0.2017) and 61-70 years (95% CI = 0.0427 to 0.2246). In conclusion, the right kidney exhibits a progressive decline in mean RPT starting above the age of 45 years, while the left kidney shows this decline starting above the age of 50 years (Table 3 and 4).

Table 3: Pairwise comparisons of the right kidney RPT by age category.

Age Category (I)	Age Category (J)	Mean Difference (I-J)	Standard Error	Significance Level	95% Confidence Interval	
					Lower Bound	Upper Bound
18-30	18-30	.05429	.02044	.063	-.0018	.1103
	31-40	.06306*	.01992	.014	.0084	.1177
	51-60	.13874*	.02313	.000	.0753	.2022
	61-70	.22668*	.02907	.000	.1470	.3064
31-40	18-30	-.05429	.02044	.063	-.1103	.0018
	31-40	.00877	.02096	.994	-.0487	.0662
	51-60	.08445*	.02403	.005	.0186	.1503
	61-70	.17239*	.02979	.000	.0907	.2541
41-50	18-30	-.06306*	.01992	.014	-.1177	-.0084
	31-40	-.00877	.02096	.994	-.0662	.0487
	51-60	-.07568*	.02359	.013	.0110	.1404
	61-70	.16362*	.02944	.000	.0829	.2443
51-60	18-30	-.13874*	.02313	.000	-.2022	-.0753
	31-40	-.08445*	.02403	.005	-.1503	-.0186
	51-60	-.07568*	.02359	.013	-.1404	-.0110
	61-70	.08794*	.03169	.046	.0010	.1749
61-70	18-30	-.22668	.02907	.000	-.3064	-.1470
	31-40	-.17239*	.02979	.000	-.2541	-.0907
	51-60	-.16362*	.02944	.000	-.2443	-.0829
	61-70	-.08794*	.03169	.046	-.1749	-.0010

Significant differences are marked with an asterisk (*)

Table 4: Pairwise comparisons of the left kidney RPT by age category.

Age Category (I)	Age Category (J)	Mean Difference (I-J)	Standard Error	Significance Level	95% Confidence Interval	
					Lower Bound	Upper Bound
18-30	18-30	.02760	.02332	.761	-.0364	.0916
	31-40	.04181	.02273	.353	-.0205	.1041
	51-60	.12935*	.02639	.000	.0570	.2017
	61-70	.13367*	.03317	.001	.0427	.2246
31-40	18-30	-.02760	.02332	.761	-.0916	.0364
	31-40	.01420	.02391	.976	-.0514	.0798
	51-60	.10175*	.02742	.002	.0266	.1769
	61-70	.10607*	.03399	.017	.0129	.1993
41-50	18-30	-.04181	.02273	.353	-.1041	.0205
	31-40	-.01420	.02391	.976	-.0798	.0514
	51-60	.08754*	.02691	.011	.0137	.1614

	61-70	.09187	.03359	.051	-.0002	.1840
51-60	18-30	-.12935*	.02639	.000	-.2017	-.0570
	31-40	-.10175*	.02742	.002	-.1769	-.0266
	51-60	-.08754*	.02691	.011	-.1614	-.0137
	61-70	.00433	.03616	1.000	-.0948	.1035
61-70	18-30	-.13367*	.03317	.001	-.2246	-.0427
	31-40	-.10607*	.03399	.017	-.1993	-.0129
	51-60	-.09187	.03359	.051	-.1840	.0002
	61-70	-.00433	.03616	1.000	-.1035	.0948

Significant differences are marked with an asterisk (*)

Discussion

Our study found the lower limit of RPT to be 10.25 mm in the right kidney and 10.5 mm in the left kidney. Any value below this is considered a reduced RPT. The mean RPT in males was 15.63 ± 2.63 mm for the right kidney and 16.36 ± 3.45 mm for the left kidney. For females, the mean RPT was 15.54 ± 2.8 mm for the right kidney and 16.6 ± 4.11 mm for the left kidney. These results are lower than those reported in other countries.

In England, a study considered an RPT range of 2.0 - 2.5 cm to be normal in adults, with values less than 1.5 cm considered reduced [10]. An Iranian study reported mean RPT of 16.9 ± 1.6 mm for the right kidney and 18.2 ± 1.7 mm for the left kidney, indicating thicker parenchymal measurements compared to our results [11]. A Nigerian study also found higher RPT values of 18.5 ± 2.0 mm for the right kidney and 19.5 ± 1.9 mm for the left kidney [1]. An Indian study reported an even higher value with a mean RPT of 2.05 ± 0.1 cm [12]. In contrast, a Sudanese study showed lower RPT values for the right kidney (14.71 ± 3.3 mm) but higher values for the left kidney (17.17 ± 3.6 mm) [13] which appears more similar to our local data analysis.

Our study highlighted a significant negative correlation between age and RPT, with Pearson's correlation coefficients of r = -0.407 for the right kidney and r = -0.302 for the left kidney, indicating that the mean RPT decreases as age increases. Specifically, for the right kidney, the significant decline in RPT begins above the age of 45, while for the left kidney, this decline starts above the age of 50. This pattern is consistent with international studies, including those from Sudan, Nigeria and India, which also report a decline in RPT with advancing age [1,12,13]. The effect of sex on RPT varies, with no significant differences observed in our study and similarly in a Nigerian population, while a Sudanese study found significant gender differences for the right kidney [1,13]. These findings emphasize the necessity of considering age and sex when evaluating renal health and establishing normative RPT values.

Establishing localized normative data is crucial for accurate diagnosis and management of renal conditions. A study published on American Journal of Roentgenology in 2010 showed that renal parenchymal or cortical thickness has a better and direct relation with renal function test including GFR as compared to renal longitudinal size, which was previously used to estimate structural renal function predicting chronic kidney disease (CKD) [14].

Conclusion

While our findings reinforce the global trend of decreasing RPT with age and the lack of significant gender differences, they also underscore the relatively lower RPT values observed in Tigray, Ethiopia, compared to other populations. This highlights the need for further research to understand the underlying causes and potential implications of these differences in RPT across diverse populations. Our research has successfully established a local reference for the lower limit of RPT to predict renal diseases such as CKD in Ethiopia. These findings contribute to the understanding of RPT variations and can serve as a baseline reference for future studies in our region.

Limitations

The sample size, while adequate, may not fully represent the broader Ethiopian population, particularly those outside the region served by Ayder Referral Specialized Hospital. Additionally, potential confounding factors such as nutritional status, socioeconomic background, and environmental influences were not controlled for, potentially affecting the generalizability of the results. Lastly, the interobserver and interobserver variations in the measurements of RPT were not evaluated in this study.

Declarations

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Competing Interests

The authors have no relevant financial or non-financial interests to disclose.

Author Contributions

All authors contributed to the study conception and design. The first draft of the manuscript was written by Dr. Messay Gebrekidan and Dr. Michael A. Negussie, and all authors commented on previous versions of the manuscript. Material preparation and data collection were performed by Dr. Messay Gebrekidan. Data analysis was done by Asmelash Teka Hadgu, PhD and Negasi Haile Abadi. All authors read and approved the final manuscript.

Ethics Approval

The study was approved by the Ethical Review Board of Mekelle University, College of Health Sciences.

Consent Approval

Informed consent was obtained from all individual participants included in the study.

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