Assessment of Central Corneal Thickness in Adults With Indications For Kidney Transplantation and Commenting On Some Related Factors

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Abstract

Objectives

Central corneal thickness (CCT) is an important biological indicator of eyeball affecting intraocular pressure, which plays a vital role in glaucoma pathology. This study investigated the central corneal thickness in renal failure subjects with indications for kidney transplantation and commented on some related factors.

Methods

A cross-sectional descriptive study was conducted from January to June 2021 in Hanoi, Vietnam. Ninety-six adult patients with grade 3 and 4 renal failure indicated kidney transplantation had central corneal thickness measured. We investigated the mean value of central corneal thickness in patients with indications for kidney transplantation. The related factors were evaluated by multivariable linear regression.

Results

The mean thickness of the central cornea in the right eye was 529.3 ± 32 μm, and the left eye was 528.5 ± 32.1 μm, with no difference between the central corneal thickness in the two eyes. Corneal thickness has a positive correlation with IOP after dialysis and smoking habits, adjusted R^2 = 0.2405, has a negative correlation with age, adjusted R^2 = 0.2405, and with calcium concentration blood, adjusted R^2 = 0.032.

Conclusion

The thickness of the central cornea in patients with renal failure with indications for kidney transplantation in both eyes is similar. Factors related to corneal thickness are age, smoking habits, intraocular pressure after dialysis, and blood calcium levels.

Introduction

Central corneal thickness (CCT) is a parameter that may influence the results of intraocular pressure (IOP) measurement, an essential indicator in the diagnosis and monitoring of glaucoma[1–4]. When the cornea is thick, the elasticity of the cornea decreases, so the measured IOP will be higher than the actual pressure in the ocular. On the contrary, when the cornea is thin, the measured IOP will be lower than the accurate pressure of the ocular[1, 5]. Therefore, there will be errors in IOP measurement due to the omission of the relationship between these two factors, which may prompt the inability to assess the progression of long-term IOP variability, a significant cause of glaucoma. In patients on dialysis, the variability of IOP during dialysis is controversial[6]. However, some studies have shown that dialysis is related to changes in CCT and thereby affects IOP values[4, 7, 8]. Furthermore, these studies show that dialysis affects CCT, affecting the IOP value.

There are no reports in Vietnam on CCT assessment in renal failure patients with indications for kidney transplantation and its relationship with this sign. Therefore, we conducted a study with the objective:

"Assessment of central corneal thickness in adults with indications for kidney transplantation and commenting on some related factors."

Methods

We conducted a cross-sectional study at the 103 Military Hospital, Military Medical University (Hanoi, Vietnam). We calculated the sample size by the one-sample research formula, and the formula determined one means according to the World Health Organization)[9]. For the above procedure, the minimum study sample size was thirty-eight participants; the number of patients was ninety-six. Patients with indications for a kidney transplant were examined according to the criteria.

Inclusion criteria: Patients who were diagnosed with grade 3 to grade 4 renal failure were indicated for kidney transplantation with glomerular filtration rate < 60 ml/min/173m^2 according to the formula of KDIGO (Kidney Disease Improving Global Outcomes 2012)[10]. Chronic kidney disease is due to different causes, including chronic glomerulonephritis, hypertension, and other reasons: polycystic kidney, pyelonephritis, chronic lupus, gout, diabetes. In addition, studying both men and women, the age at the time of the study is over 18 years old, and the time of disease detection is different.

Exclusion criteria

acute systemic comorbidities such as sepsis, respiratory failure, pneumonia, stroke. In the eyes, there are inflammatory diseases of the ocular surface, acute and chronic glaucoma, chronic uveitis, degenerative eye disease, and the use of phosphate-containing drops.

All participants were dispensed with written informed consents, and the protocol was approved by the Ethical Review Committee of the Hanoi Medical University, Vietnam (Decision no. 467/GCN-HDDDNCSYHN-DHYHN dated 05/04/2021). All patients provided written informed consent, and that this study was conducted following the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Variables

The outcome variable was CCT (μm) of subjects with indications for kidney transplantation as measured by an OCT RTVUE 100 CAM (Optovue, Inc, Fremont, CA, USA) scanning speed of 26000 A-scan/sec, taking an average of 10 times.

Measurement of ocular factors includes axial length (mm), anterior chamber depth (mm), lens thickness (mm), which were measured by immersion ultrasound on an EZ-Scan AB 5500 ultrasound machine (SonoMed, USA). In addition, other variables such as best-corrected visual acuity (BCVA) measured by a projector at a distance of 5 meters (in logMar), Goldmann tonometry (normal mean value is 13.42 ± 2.33 mmHg) [11], in the group of patients on dialysis, it was measured twice at two-time points before and after dialysis for 30 minutes.

Systemic factors include age (years), sex (male or female), body nutritional status as calculated by BMI = weight /(height/100)^2 [12]. Diastolic and systolic blood pressure readings (calculated as hypertension when diastolic blood pressure ≥ 140 mmHg and/or systolic blood pressure ≥ 90 mmHg) [13]. The causes of renal failure included glomerulonephritis, hypertension, other reasons (polycystic kidney, pyelonephritis, chronic

lupus, gout, diabetes). Procedures of using dialysis (hemodialysis, peritoneal dialysis). Patient data on education, residence, history of smoking, and occupation as an estimate of socioeconomic status. The independent variables of the blood test index include glucose (mmol/l), urea (mmol/l), creatinine (mmol/l), calcium (mmol/l)[8]. Each participant underwent a physical examination that included a height/weight measurement for determining body mass index (BMI). The patient was measured systolic and diastolic blood pressure (BP) with an automatic sphygmomanometer (Omron, Japan). Blood samples were collected to determine blood glucose levels, serum calcium, serum urea, and serum creatinine as measured by the enzymatic method on an Olympus AU 680 (Tokyo, Japan).

Protocol

The visual acuity was measured with the best-corrected visual acuity (BCVA) using the Snellen visual acuity table at a distance of 5m. Apply one drop of Alkain 0.1% (Alcon) to each eye, Goldmann tonometer Fluorescein stain, model BQ-900 (Haag Streit; Haag Streit, Bern Switzerland) to obtain IOP readings from each eye. For the group of patients on dialysis, we measured intraocular pressure before and after dialysis. For the group of patients not on dialysis and peritoneal dialysis, the intraocular pressure was measured once. Evaluation of the ocular by CSO microscopy (Italy): cornea, anterior chamber, iris, pupil, and lens. Then, measure the thickness of the cornea in the center of the cornea by OCT and ultrasound to measure the axis of the eyeball, measure the depth of the anterior chamber, and measure the thickness of the vitreous by using ultrasound technique with the immersion probe. Mydrin-P pupil dilation evaluates the posterior part, including the vitreous, optic disc, and central retina.

Statistical analysis

Data entry was completed using EpiData software 3.1 (EpiData, Odense, Denmark). Statistical analysis and data cleaning with STATA 16.0 (Stata Corp, College Station, TX, USA). Quantitative data are presented as mean and standard deviation, while qualitative data were presented as absolute values and percentages. Test of normal distribution, comparing the mean of two groups by t-student test, of many groups by ANOVA test. For non-normal distributions, we test the mean of two independent groups using the Wilcoxon-Mann-Whitney test and test the mean of more than two separate groups using the Kruskal-Wallis test. Compare two proportions of one group by Chi-square test, two independent groups by Fisher test for qualitative variables. Use the adjusted linear regression equation R^2 to estimate.

Results

Ninety-six patients were selected for kidney transplants (seventy men, twenty-six women) with an average age of 38.1 ± 11.5, ranging from 18-70 years. (Table1)

When evaluating the condition of the eye, we found that in the right eye, there was one patient with band keratopathy, and one patient had cataract surgery, so we only measured the corneal thickness and depth, anterior chamber, vitreous thickness, and axial length over 95 right eyes. The intraocular pressure measured before hemodialysis in the right eye was 95 eyes (except for one eye with band keratopathy, so they measured no intraocular pressure); in the left eye, it was 96 eyes. IOP in the right eye measured after dialysis is 82 eyes, in the left eye is 83 eyes (there were eight patients without hemodialysis and five patients with peritoneal dialysis,

so the measurement IOP after dialysis was not performed). There was no difference between the mean values of CCT in both eyes (t-test, p>0.05). (FIGURE1)

Comparing the central corneal thickness distributed by age group in the right eye and left eye, respectively, there was no difference (p> 0.05, ANOVA). Therefore, we chose to evaluate the central corneal thickness and related factors in 96 left eyes. (TABLE2)

Table 2 examined the univariate correlation between the CCT and factors including living area, smoking habits, causes of renal failure, and postoperative intraocular pressure were -0.26, 0.25, -0.2, and 0.24, respectively (p < 0.05, Pearson). (TABLE3)

We found that the central corneal thickness was positively correlated with smoking status and IOP after hemodialysis, estimated at 24.05%. The central corneal thickness was negatively correlated with age and serum calcium concentration, estimated at 24.05% and 3.2%, respectively.

Discussion

This study was first conducted in Vietnam on renal failure patients with indications for kidney transplantation. We found that the mean values of CCT in the groups of causes of renal failure were similar. However, there was a difference in mean CCT between smokers and non-smokers. There is an inverse relationship between CCT with age and blood calcium concentration. There is a positive correlation between CCT and IOP after hemodialysis and smoking status. This study provides evidence on the level of CCT in patients with renal failure who are indicated for kidney transplantation and, at the same time, points out the existence of several related factors from which a guideline can be given. Prevent or minimize corneal thickness variation.

There were conflicting studies on the relationship between central corneal thickness and sex [2, 14, 15]. The results of our study showed that the central corneal thickness was not related to gender factors.

The relationship between corneal thickness and age has been concluded that the central corneal thickness decreases with age, confirmed in several studies [2, 15–17]. We also found an inverse linear relationship when analyzing the linear regression between the central corneal thickness and the age factor. Our study further confirms the conclusions of previous studies.

Habitual smokers have a thicker central corneal thickness, although the clinical impact of this finding is small [18, 19]. Our study is similar to the results of previous studies. This problem is a risk factor that it should warn in patients with a habit of smoking.

IOP has a positive relationship with central corneal thickness [1–4, 15, 17, 20]. We found this association with cyclic dialysis patients with IOP values after dialysis. It can be explained by changes in corneal endothelial physiology after filtration and increased colloidal osmotic pressure in the anterior chamber [20, 21]. After hemodialysis, changes in osmotic pressure lead to urea stagnation in the anterior chamber causing damage to corneal endothelial cells, leading to transient endothelial edema [4, 8, 21]

The relationship between central corneal thickness and axial length of the eyeball has not been studied. In Su's study, there was a relationship between central corneal thickness and axial length of the eyeball[2]. The results

of our study found that the relationship between these two factors was not statistically significant. This difference is due to research facilities; author Su uses the IOL Master optical axial measurement technique, while we use immersion ultrasound's ocular axial measurement technique. Our study is similar to Hwang [15].

Sati's study showed a positive linear relationship between serum urea concentration and central corneal thickness [8]. There was an inverse correlation between serum calcium concentration and central corneal thickness in our study, although this correlation was not close. This difference may be due to the ever-changing serum urea and calcium concentrations, especially in subjects undergoing hemodialysis.

The limitation of the study is the design of a cross-sectional study; when concluding that the central corneal thickness decreases with the degree of anemia and the age group, there should be a longitudinal study to monitor whether those changes occur in each subject. the statue or not. Another limitation in our study is the difference in means of research compared to other studies. Some studies used optical tomography of the axial axis while we used ultrasound to measure the axis of the eyeball. Or we measure the corneal thickness optically, and some other authors measure it with ultrasound. reason leads to differences in the comparison of study results.

Conclusion

The central corneal thickness in patients with indications for kidney transplantation was 528.5 ± 32.1 μm, with no difference between the no-dialysis group, the peritoneal dialysis group, and the hemodialysis group. Factors significantly related to central corneal thickness include age, smoking history, IOP after dialysis, and serum calcium concentration ($p < 0.05$).

Declarations

Acknowledgments

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Data Availability Statement

The data that support the findings of this study are available from the corresponding author, upon reasonable request. If you have concerns about sharing the data, please contact nguyenletrungb4@vmmu.edu.vn.

Ethical statements

All participants were dispensed with written informed consents, and the protocol was approved by the Ethical Review Committee of the Hanoi Medical University, Vietnam (Decision no. 467/GCN-HDDDNCSYHN-DHYHN dated 05/04/2021). All patients provided written informed consent, and that this study was conducted following the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Consent for Publication

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Tables

TABLE 1. Distribution of Central Corneal Thickness of the right eye and left eye, by Age and Gender among Participants

Age	All person		Men		Female	
	N	Mean(SD)	N	Mean(SD)	N	Mean(SD)
All ages						
OD	95	529.3 (32)	69	527.3 (32.9)	26	534.8 (30)
OS	96	528.4 (32.2)	70	526.7(33.5)	27	533.2 (28.4)
≤ 30 ys						
OD	21	541 (35.7)	15	545.6(31.3)	6	528.2 (45.7)
OS	22	543.6 (36)	16	547.7(32.8)	6	532.5 (44.1)
31-35 ys						
OD	28	529.7(35.2)	22	524.3 (36.2)	6	549.5 (24)
OS	28	530.1 (33.9)	22	524.9 (34.6)	6	549.1 (24.9)
36-39 ys						
OD	14	524.3 (24.3)	9	518 (29.6)	5	535.6 (11)
OS	14	521.9 (25.5)	9	516.9 (30)	5	530.8 (12.3)
40-49 ys						
OD	16	519.2 (24.3)	11	518.3 (26.1)	5	521.2(22.6)
OS	16	517.4(24.6)	11	516.3(28.6)	5	519.8(14.5)
≥ 50 ys						
OD	16	528.3(32)	12	524.8 (31.2)	4	538.7 (36.7)
OS	16	521.8(31.1)	12	518.7 (31)	4	530.7 (34.1)

OD: Right eye, OS: Left eye

TABLE 2. Relationship of selected Ocular,Systemic and Demograhic Factors with Central Corneal Thickness among Participants

Characteristic	*N*	*Mean CCT (SD), µm*	*P-value*
Area			<0.05***
Urban	47	537.1 (30)	
Rural	49	520.1 (32.2)	
Occupation			>0.05
Farmer	28	519.7 (32.9)	
Officer	27	534.4 (30.3)	
Other (Student,retire)	41	530.5 (32.3)	
Smoking			<0.05
Yes	31	516.9(28.4)	
No	65	533.9(32.6)	
Cause of renal failure			<0.05
Chronic glomerulonephritis	53	534.3 (29.9)	
Hypertension & Others[a]	43	521.3 (33.6)	
Pre-HD IOP[b]			>0.05
≤ 13 (mmHg)	31	521.5 (35.3)	
14-15 (mmHg)	30	528 (34.1)	
≥ 16 9 (mmHg)	36	535 (26.1)	
Post-HD IOP [c]			<0.05
≤ 13 (mmHg)	16	503.8 (27)	
14-15 (mmHg)	39	534.5 (33.2)	
≥ 16 (mmHg)	27	532.4 (30.1)	
AL [d]			> 0.05
≤ 23.5 (mm)	43	523.8 (31.3)	
23.51-24 (mm)	27	530 (29.5)	
≥ 24.01 (mm)	27	534.5 (35.4)	
ACD[e]			> 0.05
≤ 3.1 (mm)	31	523.9 (35.6)	
3.11- 3.5 (mm)	38	527.8 (23.6)	
≥ 3.51 (mm)	28	534.5 (37.5)	

LT [f]			> 0.05
≤ 4.0 (mm)	21	526.1 (36.7)	
4.01 – 4.5 (mm)	41	535.8 (28.7)	
≥ 4.51 (mm)	35	521.4 (31.7)	

a: others (polycystic kidney disease, chronic pyelonephritis, lupus, gout, diabetes); b:Pre- hemodialysis intraocular pressure; c: Post- hemodialysis intraocular pressure; d: axial length; e: anterior chamber depth; f: Lens thickness

TABLE 3. Multiple linear regression Models of CCT in the left eye of all participants

	Adjusted diffrence in CCT, model 1			Adjusted diffrence in CCT, model 2			Adjusted diffrence in CCT, model 3		
Variables	Beta	95% CI	P	Beta	95% CI	P	Beta	95% CI	P
Gender	0.02	[-14.4,17.7]	>0.05						
Age (Yrs)	-0.3	[-1.3, -0.2]	<0.05	-0.3	[-1.5,-0.2]	<0.05	-0.2	[-1.3,-0.05]	<0.05
Smoke (Y/N)	0.3	[4.0,34.0]	< 0.05	0.2	[1.9,30.3]	<0.05	0.2	[-0.2,30]	>0.05
Cause of kidney failure	-0.1	[-20.3,4.8]	>0.05						
BMI[a]	0.1	[-0.68,4.48]	>0.05						
Pre-HD IOP[b] **(mmHg)**				0.07	[-2.1,4.3]	>0.05			
Post-HD IOP[c] **(mmHg)**				0.3	[1.5,8.9]	< 0.05			
AL (mm)[d]				-0.07	[-10.9,5.5]	>0.05			
ACD (mm)[e]				0.2	[-4.2,32.4]	>0.05			
LT (mm)[f]				0.1	[-6.8,15.8]	>0.05			
Ca^{2+} (mmol/l)							-0.15	[-23.7,4.6]	<0.05
Crea (mmol/l)							-0.03	[-0.02,0.01]	>0.05
Glucose (mmol/l)							-0.04	[-3.6,2.6]	>0.05
Ure (mmol/l)							0.15	[-0.02,0.09]	>0.05
	Adj R^2 = 0.1276			Adj R^2 = 0.2405			Adj R^2 = 0.032		

a: Body mass index; b: Pre-hemodialysis intraocular pressure; c: Post- hemodialysis intraocular pressure; d: axial length; e: anterior chamber depth; f: Lens thickness; yrs: years.

Adjusted for gender, age, smoke, cause of renal failure, procedure of filtration, BMI (model 1); Age, smoke, pre-HD IOP, post-HD IOP, AL, ACD, Lens (model 2); canxi, creatinin, glucose, ure (model 3)

Figures

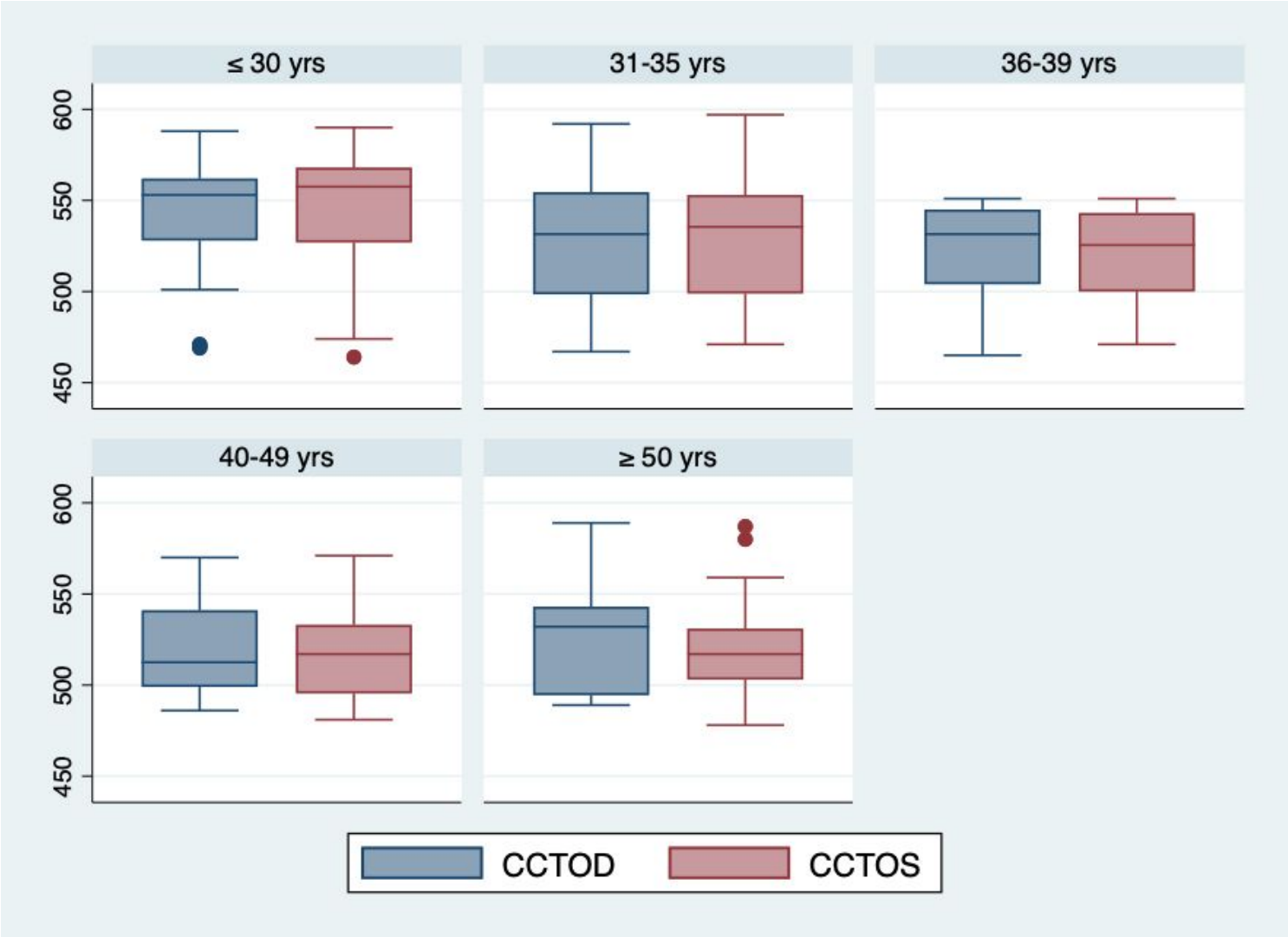

Figure 1

Distribution of CCT by Age group