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Original Article

Comparison of Choroidal Thickness in Controlled and Hypertensive Patients By Using OCT

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Abstract *- The objective of the study was to assess the choroidal thickness in control and hypertensive patients. To check the effects of hypertension on the thickness of the choroid by using the instrument, Optical Coherence Tomography(OCT).Methodology: The study design was a Prospective comparative cross-sectional study. 70 eyes of 35 subjects in the hypertensive group (A) and 70 eyes of 35 subjects in the control group (B) in the age group of 35–60 years were subjected. The thickness of the choroid was measured at the sub-fovea region, nasal and temporal to the fovea, with enhanced depth imaging mode of OCT. Systolic and Diastolic blood pressure were measured. Results: The choroidal thickness at subfoveal, temporal and nasal to fovea was significantly(p value 0.001) decreased in the hypertensive group. Choroidal thickness at subfoveal, nasal and temporal to fovea (252.34 ± 53.94 µm, 248.25±65.47,249.21±64.27 respectively) as compared to the control group choroidal thickness at subfoveal, nasal and temporal to fovea (305.35±54.78, 289.87±56.07, 298.50±54.06 respectively). Conclusion: The study showed that choroidal thickness was decreased in hypertensive subjects as compared to control subjects. We should check the choroidal thickness in hypertensive patients to reduce the chances of disease progression in the choroid.*

Keywords *- Choroid, Subfoveal, Choroidal Thickness, OCT, Hypertensive.*

1. Introduction

The main functions of the choroid include the delivery of blood to the outermost layers of the retina, the provision of vital nutrients and oxygen, the elimination of metabolic waste, and the maintenance of the temperature of the outer layers of the eyeball. It has an auto-regulatory mechanism of blood flow maintenance, which guarantees constant and stable perfusion. (Kaufman,2011) The course of the choroidal arteries is short and has few branches, and directs into the choriocapillaris at perpendicular positions. Due to such a unique structure, the choroidal circulation is especially susceptible to systemic hypertension. Its blood supply may be negatively impacted, and this may severely affect vital structures, which include the photoreceptor, optic nerve, and the retinal nerve fiber layer. As the choroid supplies one of the retina's blood supplies, there is a possibility that earlier cases of systemic hypertension can affect the choroid. Thus, the determination of choroidal blood flow and thickness may be a useful method of determining the presence of early ocular alterations in relation to high blood pressure. Hypertension may have an impact on different structures of the eye, and this causes hypertensive retinopathy, choroidopathy, optic neuropathy, retinal vascular blockages, age-related macular degeneration, and glaucoma, among others. (Wong,2004) Despite years of research on hypertensive retinopathy, it is still unclear how systemic hypertension affects the choroid. A variety of imaging techniques, such as Fundus Fluorescein Angiography (FFA), Indocyanine Green Angiography (ICGA), Optical Coherence Tomography (OCT), ultrasonography, and Magnetic Resonance Imaging (MRI), can be used to examine the choroid in living patients. (Singh R 2015, Margolis 2009) OCT has gained popularity recently, despite the fact that each of these methods has its own pros and cons. It allows for precise quantitative measurements and is quick, non-invasive, easy to repeat, and widely accessible. (Spaide RF,2008) It is now feasible to measure choroidal thickness precisely and see the sclero-choroidal interface more clearly, thanks to newer OCT technologies with deeper penetration, such as Enhanced Depth Imaging (EDI), Spectral Domain OCT (SD-OCT) or Swept-Source OCT (SS-OCT). The relationship between choroidal thickness and

variables such as age, gender, refractive error, axial length, and racial differences has been investigated by a number of researchers. (Sanchez-Cano A 2014, Tuncer 2015) The involvement of the eye as a target organ is frequently more complicated than is commonly understood, affecting the optic nerve, choroid, and retinal vessels. While optic neuropathy and retinal vascular changes are well known, hypertensive choroidopathy is often overlooked. It typically follows retinal vascular alterations, such as arteriovenous crossing changes and arteriolar narrowing.

Pathophysiology of hypertension effects on the eye

Marked elevation in systemic blood pressure	Autonomic regulatory capacity exceeded ↓ Fibrin-platelet obstruction ↓ Obstruction of choroid arteries and choriocapillaries ↓ Necrosis of the overlying retinal pigment epithelium ↓ Fibrinous exudation

A few studies have reported conflicting results regarding the relationship between choroidal thickness and systemic hypertension. The lack of an age-matched comparative group limits some of these studies. The relationship between choroidal thickness and blood pressure in people with hypertension has only been the subject of a few isolated studies. In light of these gaps in the literature, we therefore set out to use EDI-enabled SD-OCT to compare the choroidal thickness of hypertensive subjects with that of age-matched healthy individuals and to look into any potential relationships between choroidal thickness and blood pressure parameters in the hypertensive group. (Akay F 2016, Whelton PK 2018) There should be a proper check-up of every patient, and the duration of hypertension is also important for changes in the choroid. In the next study researcher should mention the duration of hypertension.

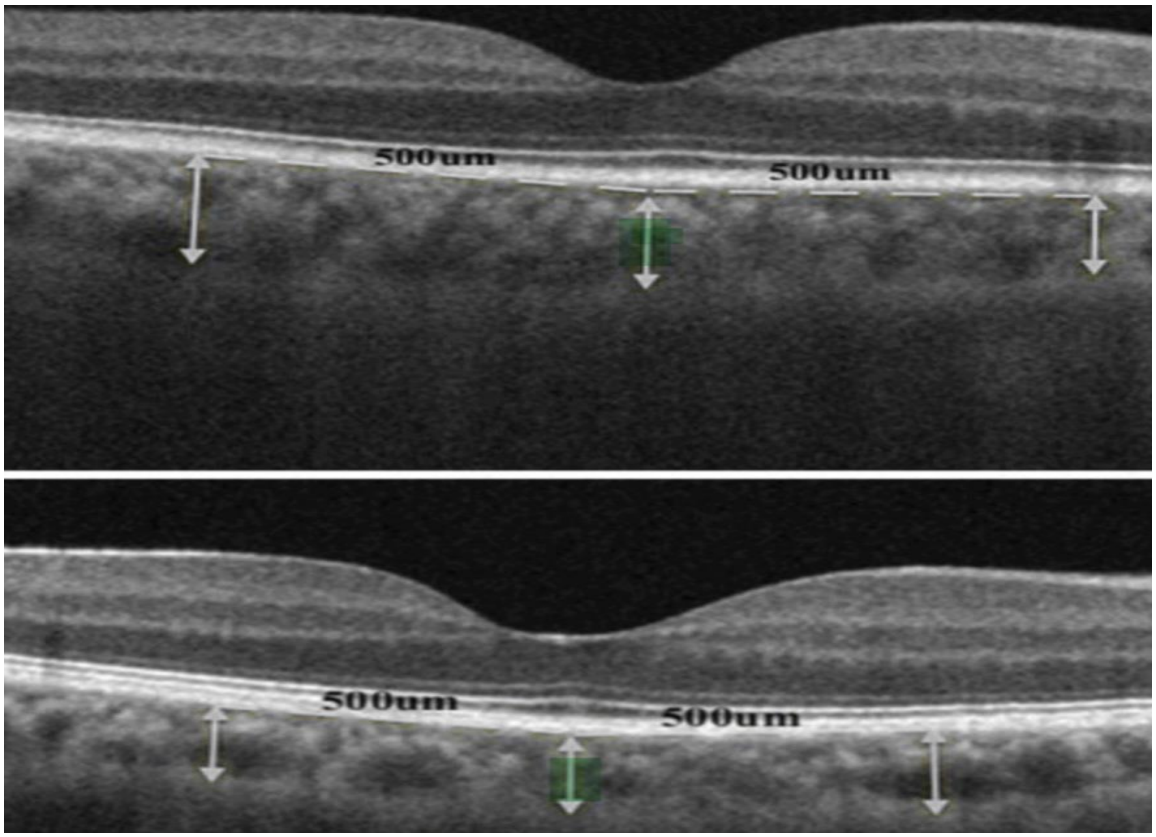
2. Methodology

A prospective comparative study was conducted at Sheikh Mohammed Bin Zayad Al Nahyan institute of cardiology in balochistan(pakistan) for a period of one year from december 2024 to November 2025. This study was conducted by Dr kanza, Dr Zunaira and was approved by the Ethical Committee of the hospital. The control group consist of 70 eyes of normal individuals, selected from healthy visiting individuals in hospital. The hypertensive group consisted of 70 eyes of individuals. The hypertensive group was diagnosed with systemic hypertension by the medicine department of our institute. The standard value for hypertension was decided in this study as systolic blood pressure ≥140 mmHg and diastolic blood pressure ≥90 mmHg. Any Patients with Systolic blood pressure exceeding 180 mmHg or Diasystolic blood pressure more than 110 mmHg were excluded. The hypertensive subjects were considered group A, and the control subjects were considered group B. Demographics data of all the subjects, including gender, age and systemic hypertension disease, were included. An age range of 35–60 years was applied for both the control and hypertensive groups. Subjects with clear optical media and good fixation were inclusion variables of the study. The exclusion variables of this study were subjects with any ocular posterior segment abnormalities, any past history of ocular trauma, any history of surgery, any refractive error greater than +3.50 to –3.50D, any history of glaucoma, any past experiences of ocular hypertension, posterior uveitis and neurodegenerative pathologies. Best-corrected visual acuity were assessed for each subject by using the log MAR chart. slit-lamp biomicroscopic also used to check the posterior segment abnormalities of both groups with a 90D lens.

The blood pressure measurements, systolic and Diastolic was checked by a mercury sphygmomanometer. Hypertensive Subjects were seated for 20 minutes Before to Blood pressure measurement. To reduce any diurnal variation, choroidal thickness was measured between 1 pm and 3 pm in all subjects of both groups. An average of two blood pressure measurements was mentioned, and after then mean arterial pressure was calculated by the formula.

$$MAP = (SBP + 2DBP)/3$$

In this study, both the control and hypertensive subjects were subjected to Optical Coherence Tomography Oct(SD-OCT, Carl Zeiss Meditec) after proper dilation of the pupil of eyes. Enhanced depth imaging with macular Line Raster scan mode was used to check the choroidal thickness at 3 locations in each eye of subjects: 1. subfoveal, 2. 500µm nasal and 3. 500µm temporal to fovea. Each eye of each subject was scanned separately. Data entry was entered in SPPS version 23. After analysis, the Values of data were expressed as mean ± standard deviation. A p-value <0.05 was considered statistically significant. Chi-square test was used to check the percentage of demographic data, and the non-parametric test Mann–Whitney U test, was applied to compare the group A and Group B after analysing whether the data were normally distributed or not distributed.



3. Results

In this study, no statistically significant difference was present between the mean gender and age distribution between the control and hypertensive groups. The blood pressure Systolic and diastolic were significantly increased in group A(hypertensive)as compared to group B(control) with P < 0.01. 35(50%) of 70 eyes were hypertensive group, and 35 (50%) of 70 eyes were in the control groups The demographic data of both hypertensive and control groups are mentioned in Table 1. The mean value of choroidal thickness at subfoveal, nasal and temporal to fovea in the control group(B) was 298.90±54.50 µm, which was higher than the mean choroidal thickness in the hypertensive group(A), which was 249.98±62.88 with a P value of 0.001. The independent subfoveal, nasal and temporal choroidal thickness was also found to be statistically decreased in the hypertensive group as compared to the control group, with P 0.001 for all locations of choroid. The choroidal thickness at subfoveal, nasal and temporal to fovea was significantly(p value 0.001) decreased in the hypertensive group choroidal thickness at subfoveal, nasal and temporal to fovea (252.34 ± 53.94 µm, 248.25±65.47,249.21±64.27 respectively) was significantly decreased in the hypertensive group, as compared to the control group choroidal thickness at subfoveal, nasal and temporal to fovea (305.35±54.78, 289.87±56.07, 298.50±54.06 respectively). Comparison of both groups was mentioned in Table.2.

Table 1. Demographic data of both individuals Control and hypertensive

Parameters	Control(n=70 eyes (B)	Hypertensive(n=70 eyes)(A)	P value
Number of individuals	35(50%)	35(50%)	1.000[2]
Gender			
Females	17(49%)	17(49%)	1.000[2]
Males	18 (51%)	18 (51%)	
Age			
35-45	18(51.4%)	16(45.7%)	1.000[2]
50-60	17(48.6%)	19(54.3%)	
BP(mmHg)			
Systolic BP	115.52±7.70	148.55±9.45	<0.001[1]
Diasystolic BP	70.75±5.07	95.53±4.98	<0.001[1]

1. Wilcoxon-Mann-Whitney U test 2. chi-squared test

Table 2. Comparison of choroidal thickness in the control and hypertensive groups

Parameters	Control n=70 eyes	Hypertensive n=70 eyes	P value
Foveal CT	305.35±54.78	252.34±53.95	0.001
Nasal CT	289.87±56.07	248.25±65.47	0.001
Temporal CT	298.50±54.06	249.21±64.27	0.001
Mean CT	297.90±54.50	249.93±62.88	0.001

The Wilcoxon-Mann-Whitney U test was applied to compare choroidal thickness in the control and hypertensive group, with a significant difference seen with a P value of 0.001.

4. Discussion

In previous researches many authors mentioned the change in choroidal thickness due to posterior segment of eye abnormalities. Choroid is a vascular layer of the eye, and any change in blood vessels, such as vasculopathy(polypoidal choroidal) of the choroid, can change the thickness. This disease increases the choroidal thickness, and also other disease vogt koyanagi harada syndrome and central serous retinopathy, increase the choroidal thickness.While other studies showed that high myopia, macular hole, choroid and retinal atrophy decrease the choroidal thickness.(Fujiwara T,2009) Excluding the above posterior segment eye pathologies, a conflicting relation of systemic hypertension with choroidal thickness has been mentioned in a few previous studies.(Niknam RM 2004, Akay F, 2016).The objective of the study was to assess the choroidal thickness in control and hypertensive patients and exclude the posterior segment eye pathologies. To check the effect of hypertension on the thickness of the choroid by using the instrument, Optical Coherence Tomography(OCT). In this study, both groups were comparable according to age and blood pressure, thus reducing the effects of these parameters on the measurement of thickness. To reduce any diurnal variation, choroidal thickness was measured between 1 pm and 3 pm in all subjects of both groups. The choroidal thickness in control or healthy subjects was also discussed in a previous literature review. (Margolis et al,2009)Used the fifty-four healthy eyes with a mean age of 50.4 years in his pilot study to assess the thickness of the choroid by using the tool of enhanced depth of OCT. The study showed that the high metabolic demand of sub foveal (mean 287 ± 76 μm) region of the choroid is thicker than the nasal and temporal areas of the choroid.Chhabalani et al (2014 conducted a study on the thickness of the choroid in which 211 eyes of control Indian individuals also concluded that thickness change according to the regions of choroid. They also concluded that the choroid is thicker in the foveal area than in the nasal region.Measurement values of our study showed that sub-foveal thickness and its topography variations temporally and nasally, and in both hypertensive and control groups, were consistent with the previous mentioned studies. Sansom et al. (2016in their study concluded that a modest negative correlation was present between choroidal thickness in healthy individuals. So, in this study, hypertensive subjects were not included.However, in our study, we concluded that significantly chages of choroidal thickness were present in the hypertensive group as compared to the normal group.On the other side of the previous literature and hypothesis, some authors did not find changes in the thickness in hypertensive individuals.Gok et al (2015 in their prospective cross-sectional study consist of one hundred and sixteen hypertensive patients and one hundred sixteen control individuals, did not show any significant changes in subfoveal thickness in the two groups. In this study, the author concluded that the choroidal vessels remains remains relatively relatively safe even in chronic hypertension because of their intrinsic nature, as the choroidal network has an important role in nourishment of retina and has the ability to maintain a perfusion pressure. This nature of the choroid might be the cause of unaltered thickness in the hypertensive group.(Balmforth et al,2016)In his study of three-arm comparative patients with chronic kidney disease, the normotensive and hypertensive groups showed decrease thickness in chronic kidney disease as compared to the normotensive and hypertensive group. However, the other two groups, hypertensive and normal, did not show any difference in choroidal thickness.(Whelton,2017) Niknam et al In their study, used LDF(Laser Doppler Flowmetry) to find the choroidal blood vessels properties in hypertensive individuals and results showed that systemic hypertension does not have any effect on the choroidal blood vessels dynamics in hypertensives.[19] In hypertensive choroidopathy, choroidal thickness in the region of the subfoveal increases due to the accumulation of interstitial fluid in acute hypertensive individuals.(Velazquez-Villoria D, 2019)The regulatory mechanism of blood is disturbed due to acute cases, which may increase blood pressure, because of increased blood pressure, vascular leaks leading to ischemia of choroid, breaking of choriocapillaris and cell death of retinal pigmented epithelium. After that accumulation of interstitial fluid occurs.(Tso MO,1982) So, due to acute blood pressure, pathophysiologic phenomena of vessels occur as compared to chronic systemic hypertension. Both acute and chronic hypertensive patients showed differences in choroidal thickness in these two conditions. Our study has some limitations too. The sample size was smaller than in the previous studies. For detailed measurements, some extra image analysis software should be used to avoid the biasness of measurements.This study was a Prospective cross-sectional study and did not have a longitudinal study design. The study should be a follow-up of the control and hypertensive groups to check the choroidal morphology. Optical coherence tomography gives the quantitative value of

the thickness of the choroid, not for the pathophysiology of blood vessels.Recent advancement in oct is Swept-source OCT and OCT-angiography, which gives us details examination of the posterior segment of the eye. So researchers should assess the details examination of choroid thickness to reduce the pathologies of the posterior segment of the eye.We can reduce the chance of disease progression of the choroid because the choroid is a highly vascular structure of the eye, which is responsible for the nourishment of the retina.

5. Conclusion

The study showed that choroidal thickness was decreased in hypertensive subjects as compared to control subjects. We should check the choroidal thickness in hypertensive patients to reduce the chances of disease progression in the choroid. In this study limitations was patients' cooperation. In the next study, authors should check the duration of drugs using and the duration of hypertension.

Ethical Declarations

Ethical approval: The study protocol was approved by the Institutional Review Board of Sheikh Mohammed Bin Zayad Al Nahyan institute of cardiology and written informed consent was obtained from all participants.

Conflict of Interests

None.

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