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Effect of nasal septum deviation on choroidal thickness

Nazal septum deviasyonunun koroid kalınlığı üzerine etkisi

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ABSTRACT

Objectives: This study aimed to investigate the choroidal thickness in patients with nasal septum deviation using enhanced depth imaging spectral-domain optical coherence tomography (EDI-OCT).

Patients and Methods: The prospective case-control study included 106 eyes of 53 patients (29 males, 24 females; mean age: 31.2±10.6 years; range, 18 to 50 years) who were detected to have nasal septum deviation by anterior rhinoscopy and nasal endoscopy between April 2020 and July 2020. Seventy-two eyes of 36 healthy participants (20 males, 16 females; mean age: 28.3±10.1 years; range, 18 to 50 years) were included in the control group. The degree of deviation of patients with septum deviation was graded with the nasal obstruction symptom evaluation (NOSE) scale. Choroidal thickness measurements were performed at subfoveal, temporal, and nasal regions using the EDI-OCT and compared in patients with and without deviation. In addition, the relationship between the severity of septal deviation and choroidal thickness measurements was examined.

Results: The mean subfoveal, nasal, and temporal choroidal thicknesses in the nasal septum deviation group were 361.0±99.4 µm, 334.5±101.1 µm, and 349.7±93.6 µm, respectively. The mean subfoveal, nasal, and temporal choroidal thicknesses in the control group were 381.2±75.5 µm, 345.5±72.8 µm, and 368.6±79.2 µm, respectively. There was no significant difference in choroidal thickness measurements between the groups ($p>0.05$). However, it was observed that choroidal thickness decreased as the NOSE scale grade increased ($p<0.05$).

Conclusion: This study shows that choroidal thickness measurements are similar between patients with nasal septal deviation and healthy participants and demonstrates a negative correlation between the severity of septum deviation and choroidal thickness.

Keywords: Choroidal thickness, enhanced depth imaging optical coherence tomography, nasal septum deviation, NOSE, rhinology.

ÖZ

Amaç: Bu çalışmada, nazal septum deviasyonu olan hastalarda optik koherens tomografi derin mod görüntüleme (EDI-OCT) ile koroid kalınlığı araştırıldı.

Hastalar ve Yöntemler: Prospektif olgu kontrol çalışmasına Nisan 2020 ve Temmuz 2020 tarihleri arasında anterior rinoskopi ve nazal endoskopi ile nazal septum deviasyonu saptanan 53 hastanın (29 erkek, 24 kadın; ort. yaş: 31.2±10.6 yıl; dağılım, 18-50 yıl) 106 gözü dahil edildi. Otuz altı sağlıklı gönüllünün (20 erkek, 16 kadın; ort. yaş: 28.3±10.1 yıl; dağılım, 18-50 yıl) 72 gözü kontrol grubuna dahil edildi. Septum deviasyonu olan hastaların deviasyon derecesi, nazal obstrüksiyon semptom değerlendirme (NOSE) skalası ile derecelendirildi. Optik koherens tomografi derin mod görüntüleme kullanılarak subfoveal, temporal ve nazal koroid kalınlıkları ölçüldü ve deviasyonu olan ve olmayan hastalarda koroid kalınlıkları kıyaslandı. Ayrıca septal deviasyonun şiddeti ile koroid kalınlıkları arasındaki ilişki değerlendirildi.

Bulgular: Nazal septum deviasyon grubunda ortalama subfoveal, nazal ve temporal koroid kalınlıkları sırasıyla 361.0±99.4 µm, 334.5±101.1 µm ve 349.7±93.6 µm idi. Kontrol grubunda ortalama subfoveal, nazal ve temporal koroid kalınlığı sırasıyla 381.2±75.5 µm, 345.5±72.8 µm ve 368.6±79.2 µm idi. Grupların koroid kalınlıkları arasında anlamlı farklılık izlenmedi ($p>0.05$). Ancak NOSE skalası derecesi arttıkça koroid kalınlığının anlamlı olarak azaldığı görüldü ($p<0.05$).

Sonuç: Bu çalışma, nazal septum deviasyonu olan hastalar ile sağlıklı gönüllülerin koroid kalınlığı ölçümlerinin benzer olduğunu ve septum deviasyonun şiddeti ile koroid kalınlığı arasında negatif ilişki olduğunu göstermektedir.

Anahtar sözcükler: Koroid kalınlığı, optik koherens tomografi derin mod görüntüleme, nazal septum deviasyonu, NOSE, rinoloji.

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Nasal septum deviation (NSD) is a common cause of upper airway obstructions. It could cause deterioration in the quality of life and sleep disorders and lead to chronic hypoxia, hypercarbia, and an increase in sympathetic activity as a result of the decrease in lung capacity caused by the deterioration in the nasopulmonary reflex.[1]

The choroid is a rather vascularized structure that provides more than 70% of the ocular blood flow. In thermoregulation, it has an important role in nurturing the retinal pigment epithelium and outer retinal segments and producing the visible pigmentation of the fundus.[2] An increase or decrease in the choroidal blood flow can affect choroidal thickness (CT).[3] Choroid vascularity and CT are reported to be affected in systemic diseases, such as diabetes, hypertension, chronic lung diseases, and obstructive sleep apnea (OSA).[4] The decrease in choroid vascularity is of importance as it might cause dysfunction in retina physiology.

Optic coherence tomography (OCT) is a quantitative measurement tool that detects even small changes in the retina by making a high-resolution, cross-sectional screening of the retina. Thanks to the technology called enhanced depth imaging (EDI)-OCT, the structure of choroidal tissue can be investigated in a more detailed way and the CT can be measured.[5]

In cases such as OSA and adenoid vegetation (tonsil hypertrophy causing upper respiratory tract obstructions), it is possible to observe microvascular damages that develop in a chronic hypoxia background and hence severe cardiovascular diseases, such as pulmonary hypertension.[6] Although some studies reported that with the same mechanism CT was negatively affected by nasal obstruction,[7,8] some other studies reported no significant differences.[9,10]

Nasal septal deviations may also negatively affect choroid vascularity by causing chronic hypoxia. A limited number of studies investigated the effects of this common pathology on the retina.[3,4,11] This study aimed to investigate the relationship between septal deviation and CT in patients with NSD.

PATIENTS AND METHODS

The prospective case-control study was conducted in the otolaryngology and ophthalmology units of the Hitit University Erol Olçok Training and Research Hospital between April 2020 and July 2020. The study included 106 eyes of 53 patients (29 males, 24 females; mean age: 31.2±10.6 years; range, 18 to 50 years) who had a nasal obstruction and who were detected to have NSD as a result of anterior rhinoscopy and nasal endoscopy. The control group included 72 eyes of 36 healthy participants (20 males, 16 females; mean age: 28.3±10.1 years; range, 18 to 50 years) who were matched with the NSD group in terms of age, sex, and body mass index.

Patients who had chronic upper respiratory obstruction, such as allergic rhinitis, concha hypertrophy, adenoid hypertrophy, nasal polyposis, and OSA, were excluded from the study. In addition, patients who had diseases with known effects on CT, such as hypertension, diabetes, autoimmune diseases, chronic lung diseases, and chronic heart diseases, were excluded from the study. Patients who had advanced myopia and hypermetropy (±3 diopter), history of ocular surgery, retinal diseases, history of intraocular surgery, who used systemic or topical medicine, and glaucoma patients were not included in the study. Those who had an axial length <22 mm and >25 mm were excluded from the study. Patients who smoked and used medicine for chronic diseases were also excluded.

All the patients who were involved in the study underwent a detailed otorhinolaryngological examination, including nasal endoscopy, and the level of nasal obstruction was assessed using the nasal obstruction symptom evaluation (NOSE) scale. Data obtained through the NOSE scale were multiplied by five and demonstrated as percentage values.

Ophthalmologic examinations

All the participants' full ophthalmological examination, including refraction defect measure (TOPCON KR-8900; Topcon Corporation, Tokyo, Japan.), best-corrected visual acuity measure (Snellen chart), intraocular pressure (IOP; Goldmann applanation tonometer), and anterior and posterior segment examination (split-lamp biomicroscopy) was performed in the ophthalmic unit of our hospital. Axial length measurement was done using Nidek AL-Scan device (Nidek Co, Aichi, Japan). The mean value of three measures done successively was accepted as the axial length. Spherical equivalent was defined as spherical + 1/2 cylindrical.

Enhanced depth imaging mode was used, a 6-mm horizontal single line scan, through the fovea between 10:00 and 12:00 in the morning (to avoid the diurnal variation of the CT) by a Heidelberg Spectralis® OCT (Heidelberg Engineering Inc., Heidelberg, Germany; excitation wavelength=840 nm, 40,000 A-scans/sec, and 5 Lm axial resolution). Choroidal thickness measurements were performed by manually measuring the distance between the sclera and retinal pigment epithelium using a caliper system in the

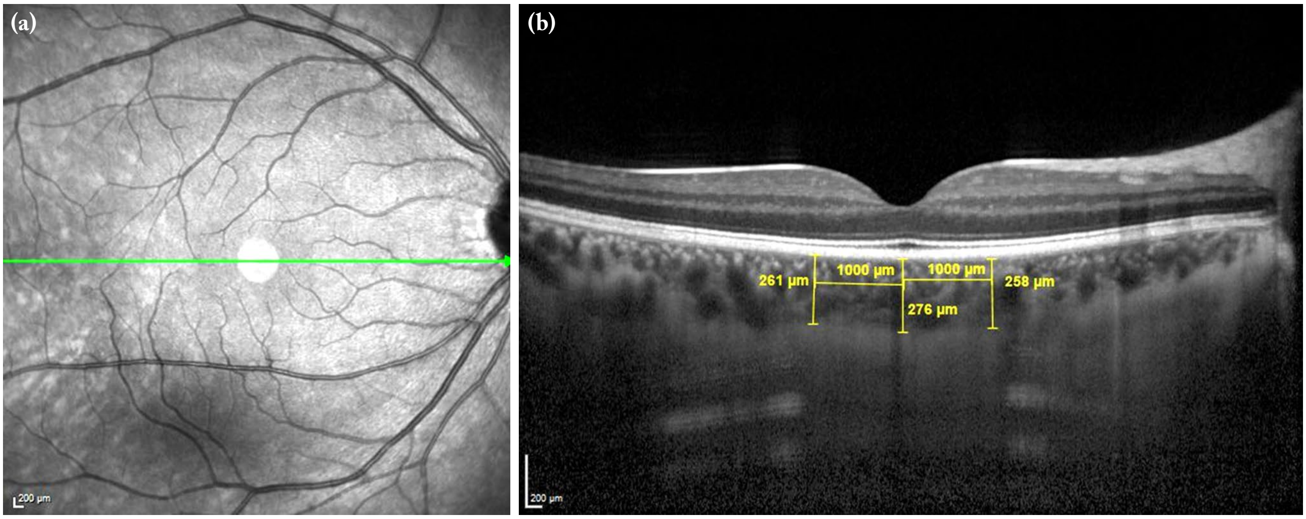

Figure 1. Enhanced depth imaging-OCT image of **(a)** the retina and **(b)** choroidal thicknesses.
OCT: Optic coherence tomography.

OCT device software. Measurements were taken at the subfoveal region 1000 µm nasal to the fovea and 1000 µm temporal to the fovea (Figure 1). If eye movements were detected during image acquisition, measurements were excluded and retaken. Central macular thickness (CMT) measurement was also performed. Choroidal thickness measurements were manually performed by an ophthalmologist.

Statistical analysis

Data were analyzed using IBM SPSS version 21.0 (IBM Corp., Armonk, NY, USA). Descriptive data were demonstrated as mean ± standard deviation. Data were normally distributed since the skewness and kurtosis values were between +3 and -3. A t-test was utilized to analyze the effect of septum deviation on CT. The relationship between categorical variables was analyzed using the chi-square test, and the effect between the variables was tested using regression analysis. The level of statistical significance was accepted as $p<0.05$.

RESULTS

No significant differences were found between the groups in terms of age, body mass index, axial length, spherical equivalent, and IOP values ($p>0.05$, Table 1). No significant

Table 1
Demographic and ophthalmological characteristics of the groups

	Category			
	Deviated	Control		
	Mean±SD	Mean±SD	t	*p*
Age (year)	31.2±10.6	28.3±10.1	1.292	0.200
Body mass index (kg/m²)	24.6±5.0	24.2±4.7	0.387	0.700
Right (Axl) (mm)	23.6±0.8	23.5±0.5	0.355	0.724
Right (SE) (D)	-0.4±1.2	-0.2±0.8	-1.290	0.200
Right (IOP) (mmHg)	15.0±2.1	15.6±2.3	-1.330	0.187
Left (Axl) (mm)	23.6±0.9	23.5±0.5	0.389	0.698
Left (SE) (D)	-0.4±1.3	-0.1±0.8	-0.904	0.368
Left (IOP) (mmHg)	15.1±2.0	15.4±2.8	-0.525	0.602

SD: Standard deviation; Axl: Axial length; SE: Spherical equivalent; IOP: Intraocular pressure; D: Diopter.

Table 2
Choroidal thickness at different positions and CMT measurements

	Category			
	Deviated	Control		
	Mean±SD	Mean±SD	t	*p*
CT, nasal (µm)	334.5±101.1	2±72.8	-0.846	0.399
CT, temporal (µm)	349.7±93.6	368.6±79.2	-1.402	0.163
CT, subfoveal (µm)	361.0±99.4	381.2±75.5	-1.537	0.126
CMT (µm)	262.6±20.5	265.1±20.9	-0.799	0.425

SD: Standard deviation; CT: Choroidal thickness; CMT: Central macular thickness.

Table 3
Choroidal thickness according to the NOSE scale

Dependent	Independent	Beta	t	*p*	r^2
CT, nasal	NOSE	-0.281	-2.059	0.042*	0.040
CT, temporal	NOSE	-0.375	-2.793	0.006*	0.073
CT, subfoveal	NOSE	-0.323	-2.385	0.019*	0.036
CMT	NOSE	-0.232	-1.710	0.090	0.052

NOSE: Nasal obstruction symptom evaluation; CT: Choroidal thickness; CMT: Central macular thickness; * p<0.05.

differences were found between the nasal (334.5±101.1 µm), temporal (349.7±93.6 µm), and subfoveal (361.0±99.4 µm) CT and CMT (262.6±20.5 µm) in the NSD group and nasal (345.5±72.8 µm), temporal (368.6±79.2 µm), and subfoveal (381.2±75.5 µm) CT and CMT (265.1±20.9 µm) in the control group (p>0.05, Table 2).

A significant relationship was found between the NOSE scale and CT in the nasal, temporal, and subfoveal regions in the NSD group (p<0.05). According to the NOSE scale, a decrease was found in the CT with the increase in deviation severity. No significant relationship was detected between CMT and the NOSE scale (p>0.05, Table 3). When the deviated side of the septum was compared with the other eye in patients with NSD, no significant effect of NSD on CT and CMT was found between the eyes (p>0.05).

DISCUSSION

Nasal septum deviation is one of the most important causes of upper airway obstructions, and as a result of chronic hypoxia and hypercarbia caused by obstruction, it is reported that the balance between the sympathetic and parasympathetic systems deteriorates. Furthermore, there may be circulatory issues, such as an increase in pulmonary artery pressure and deterioration in right ventricular functions.[1,12] The choroid layer is a tissue that shows very intensive vascularity and has an important role in nurturing the retinal outer layers.[2] As a result of hypoxia and hypercarbia, it is possible to observe endothelium destruction, an increase in the vascular endothelial growth factor release, permeability increase, and thinning in the choroid layer.[5] Therefore, the measurement of CT can give an idea about choroid vascularity.[3]

Since the decrease in choroid vascularity could cause a decrease in vision functions by affecting the normal physiology of the retina, this study investigated the effect of nasal obstruction caused by NSD on CT. The literature includes a limited number of studies on this issue.[3,4,11] Üstün Bezgin et al.[3] compared 26 patients who had marked NSD with healthy controls and found no significant differences between their CTs. Gurlevik and Kayabasi[4] classified the obstruction level of 50 patients using the NOSE scale as mild, moderate, and severe and reported that only patients who had severe septum deviation demonstrated a decrease in CT. Similar to the study conducted by Üstün Bezgin et al.,[3] our study reported no significant differences between the nasal, temporal, subfoveal CT and CMT in patients with septum deviation (p>0.05). However, when regression analysis of the NOSE scale was performed, it was found that nasal, temporal, and subfoveal CT was negatively affected by the increase in the nasal obstruction level ($p<0.05$). This finding is supported by the results reported in the study conducted by Gurlevik and Kayabasi[4] and made us conclude that the CT could be negatively affected in severe septum deviations. The present study investigated the relationship between CMT and the NOSE scale and found that CMT was preserved as the septum deviation severity increased ($p>0.05$). Since the mean age of the participants was low (31±10 years) and they had no other systemic diseases that could affect the retina or the choroid, this finding suggests that the central macula was more resistant to the negative effects caused by chronic hypoxia. Sahin et al.[11] compared the CT of 92 patients with NSD with healthy controls, and unlike in our study, they found that nasal, temporal, and subfoveal CT significantly decreased in patients with NSD. Although the study did not rank the NSD, the inclusion of patients who were operated indicated that the study group involved patients with relatively more severe deviation. The same study also reported that these patients who underwent septoplasty demonstrated a significant increase in their CT in the third postoperative month.

Epidemiological studies show that cardiovascular diseases, such as coronary heart disease, cardiac arrhythmias, hypertension, and stroke, were more common in patients who had OSA, which causes chronic hypoxia.[13] In a similar vein, moderate and severe OSA was reported to be associated with subclinical coronary artery diseases.[14] Although the cause of this condition has not been fully revealed, it is considered that the endothelium damage triggered by chronic hypoxia and oxidative stress caused by it intensifies atherosclerosis.[15,16] The choroid, which is a highly vascular layer, can be negatively affected by chronic hypoxia and the emerging systemic effects. Likewise, a thinned choroid layer could be an indicator of microvascular damage. Numerous studies have investigated the effect of upper airway obstruction emerging in OSA on CT. While some studies reported negative effects on CT,[5,17] some others reported no significant differences.[18,19] In their meta-analysis, He et al.[20] investigated seven case-control studies (558 eyes of OSA patients and 226 eyes of control group patients) and concluded that OSA had negative effects on CT. The same study reported that while choroid was significantly thinner in patients who had moderate and severe OSA, similar results were reported with the control group in patients who had mild OSA. It was concluded that the autoregulation mechanism in the choroid was preserved in mild OSA and no changes happened in the sympathetic and parasympathetic system balance. In a similar vein, Gurlevik and Kayabasi[4] also reported that CT was negatively affected in patients with severe septum deviation, which is supported by the finding that CT was preserved in mild and moderate deviations. The current study also found an inverse relationship between the increase in the NOSE scale and the CT and found that the CT decreased with the increase in the deviation severity. In this respect, our study is in line with the literature.

Although it is not fully known through which mechanisms NSD has effects on the choroid, like in OSA, possible mechanisms could be chronic hypoxia, hypercarbia, and deterioration of the sympathetic and parasympathetic system balance. No significant differences were found in this study when the CT on the deviated side was compared with the CT on the nondeviated side. This finding indicates that the effect of deviation on CT was systematic and that it had no relationship with the direction of deviation.

This study has some limitations. Patients' nasal obstruction was assessed through the NOSE scale, which was based on self-reported data, and therefore is subjective. In addition, since the Heidelberg Spectralis OCT equipment does not enable automatic segmentation, the measurements were performed manually.

In conclusion, the NSD detected in patients who presented to our clinic had no significant effects on CT, and the CT was preserved in these patients. However, the inverse relationship between the severity of deviation and CT is considered a sign that severe septal deviations could cause thinning in CT. When it is considered that septal deviation could continue until advanced age and that systemic and ocular pathologies affecting CT might emerge, we can conclude that the CT could be thinner in individuals with septal deviation, and the sight of this group of patients could be affected earlier and more than others.

Ethics Committee Approval: The study protocol was approved by the Hitit University Clinical Research Ethical Committee (date: 28.04.2021 no: 461). The study was conducted in accordance with the principles of the Declaration of Helsinki.

Patient Consent for Publication: A written informed consent was obtained from each patient.

Data Sharing Statement: The data that support the findings of this study are available from the corresponding author upon reasonable request.

Author Contributions: Article design, data collection, analysis, article writing: B.N.U.; Article design, data collection, article writing: S.C.

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