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Impact of catheter ablation procedure on optical coherence tomography angiography findings in patients with ventricular arrhythmia

Bengi Ece Kurtul[1*], Alparslan Kurtul[2], Onur Kaypakli[2]

SUMMARY

OBJECTIVE: Catheter ablation procedure may cause retinal complications associated with the risk of thromboembolism. We aimed to evaluate retina and optic disc microvascularity with optical coherence tomography angiography before and after the catheter ablation process in patients with ventricular arrhythmia.

METHODS: A total of 40 eyes of 21 ventricular arrhythmia patients were included in this cross-sectional study. Demographic characteristics and ophthalmic examination findings of patients were recorded. optical coherence tomography angiography measurements were evaluated before (group 1) and after (group 2) catheter ablation. Optical coherence tomography angiography was applied to all eyes with 6×6 mm sections for the macula and 4.5×4.5 mm sections for the optic nerve head. Foveal retinal thickness, peripapillary retinal nerve fiber layer thickness, vessel density in different parts of the retina, and optic disc were analyzed.

RESULTS: The mean age of ventricular arrhythmia patients was 53.48±13.02 years. In all, 13 (61.9%) of the patients were males and 8 (38.1%) were females. There was no significant difference between the groups in terms of average, inferior, superior, and temporal retinal nerve fiber layer thicknesses, foveal avascular area, flow areas, superficial and deep vessel densities, and optic disc capillary densities of the optic disc. However, when compared with group 1, significantly lower values in foveal retinal thickness and higher values in nasal retinal nerve fiber layer thickness were observed in group 2 (248.42±20.50 vs. 247.20±20.44, p<0.001 and 94.22±18.43 vs. 96.12±20.18, p=0.044, respectively).

CONCLUSION: Although foveal retinal thickness and nasal retinal nerve fiber layer thickness are affected in patients undergoing catheter ablation for ventricular arrhythmia, the stable retinal and optic disc vessel densities can be explained by the administration of effective anticoagulants during the procedure.

KEYWORDS: Arrhythmia. Catheter ablation. Angiography. Retina. Optic disc. Microvasculature.

INTRODUCTION

Catheter ablation (CA) by radiofrequency is the most effective treatment modality for ventricular arrhythmias (VAs) as premature ventricular contractions or ventricular tachycardia[1-4]. However, endocardial CA procedures may cause cardiac complications[5,6] as well as cerebral[7,8] and ocular[9] complications. Ablation in the left ventricle is associated with a risk of thromboembolism[10].

Optical coherence tomography angiography (OCTA) is an innovative, rapid, and high-resolution method that shows the retinal and choroidal perfusion in minimal acquisition time[11]. This noninvasive tool can be valuable to assess cardiovascular status having a promising biomarker as retinal vascular density[12].

There is a report about OCTA findings before and after CA in patients with atrial fibrillation[13]. However, to the best of our knowledge, there is no data regarding the effect of CA on optic nerve head and retinal microvasculature in patients with VA. Given the fact that OCTA is a noninvasive relatively simple and cost-effective examination, it may provide a useful tool for the evaluation of the risk of CA procedure. Therefore, in this study, we aimed to compare the OCTA parameters of VA patients before and after CA and to have an opinion about the safety of radiofrequency CA procedure for optic disc and retinal perfusion.

METHODS

This cross-sectional study was approved by the Ethics Committee of our institution (approval number: 2022/25) and conducted in accordance with all the relevant tenets of the Declaration of Helsinki. Patients with VA (including ventricular tachycardia or repetitive premature ventricular contractions), before and 24 h

[1]Hatay Mustafa Kemal University, Tayfur Ata Sökmen Faculty of Medicine, Department of Ophthalmology – Hatay, Turkey.
[2]Hatay Mustafa Kemal University, Tayfur Ata Sökmen Faculty of Medicine, Department of Cardiology – Hatay, Turkey.
*Corresponding author: becekurtul@yahoo.com

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after the CA procedure, referred to the ophthalmology outpatient clinic from the department of cardiology were included in the study. The mapping and CA strategy and periprocedural anticoagulation management were applied as described in the literature[7].

Eyes with a refractive error of ≥±2.00 diopters, amblyopia, previous ocular surgery, ocular trauma, and other ocular diseases such as uveitis, cataract, or glaucoma, any systemic disease such as diabetes except regulated hypertension and dyslipidemia, and history of anticoagulant drug use were excluded.

All subjects underwent full ophthalmologic examination including best-corrected visual acuity, biomicroscopic anterior segment, and fundus examination. Intraocular pressure (IOP) and central corneal thickness measurements were assessed by a noncontact tonometer.

The OCTA images were obtained by a single technician using a spectral-domain OCT system with the AngioVue OCTA software (Avanti RTVue-XR 100, OptovueInc, Fremont, CA). The OCTA image protocol involved two scans covering a 6×6 mm area centered on the macula and a 4.5×4.5 mm area centered on the optic nerve head. Foveal retinal thickness (FRT), vessel density in the fovea of superficial and deep capillary plexus, and 300 μm width around the foveal avascular zone (FAZ) were measured. Flow areas of the outer retina and choriocapillaris were noted, too. Radial peripapillary capillary (RPC) densities (including whole image, inside disc, and peripapillary capillary plexus densities) and retinal nerve fiber layer (RNFL) thickness were also obtained. The exclusion criteria were OCTA scans with a quality level of less than 8, artifacts, or decentered. Baseline and 24 h after the CA, OCTA measurements of all patients were taken.

Statistical analysis

All analyses were performed using SPSS 21.0 for the Windows software. Continuous variables were described using mean value±standard deviation. Categorical data were expressed as number and percentages. As for inferential statistics, in order to compare the OCTA measurements at baseline and 24 h after the CA procedure, paired-samples T test was used. A p-value<0.05 was considered significant.

RESULTS

A total of 40 eyes of 21 VA patients were enrolled. The mean age of VA patients was 53.48±13.02 years (range 27–75). In all, 13 (61.9%) of the patients were males and 8 (38.1%) were females. The baseline characteristics of VA subjects are shown in Table 1. There was no significant difference between the groups in terms of average, inferior, superior, and temporal RNFL thicknesses, foveal avascular area flow areas, superficial and deep vessel densities, and optic disc capillary densities of the optic disc. However, when compared with group 1, significantly lower values in FRT and higher values in nasal RNFL thickness were observed in group 2 (248.42±20.50 vs. 247.20±20.44, p<0.001 and 94.22±18.43 vs. 96.12±20.18, p=0.044, respectively). The outcomes of retina and optic disc parameters by OCTA are shown in Table 2 and Table 3, respectively.

DISCUSSION

This OCTA study demonstrated no significant difference between the groups in terms of retinal and optic disc vessel densities. However, when compared with group 1, significantly lower values in FRT and higher values in nasal RNFL thickness were observed in group 2.

OCTA has increasing use in clinical practice and also enables quantitative analysis of blood flow in the retina and optic nerve head. The different studies in the literature have evaluated changes in OCTA parameters in different cardiovascular problems[12,14] and cardiac interventions[11,13].

CA is an effective treatment option for VA. One of the most devastating complications of this procedure is cerebral thromboembolism[7]. Borišincová et al.[7] reported significant asymptomatic brain injury in one-fifth of subjects after ablation of ventricular tachycardia. Embolism can also occur in the retinal vasculature as in the cerebral vascular bed. In a study, the authors evaluated whether retinal microemboli were visible on OCTA following transcatheter aortic valve implantation[11]. They mentioned 28.6% of new capillary dropout lesions in OCTA scans after transcatheter aortic valve implantation. However, quantitative measurements of macular and peripapillary flow remained stable after transcatheter aortic valve

Table 1. Baseline characteristics of ventricular arrhythmia subjects.

	Mean±SD
Number of subjects, n	21
Number of eyes, n	40
Age, years (Mean±SD) Range	53.48±13.02 (27–75)
Female/male (n, %)	8/13 (38.1/61.9)
Intraocular pressure (mmHg) (Mean±SD)	18.78±4.8
Central corneal thickness (μm) (Mean±SD)	543.53±22.4
Body mass index (kg/m^2) (Mean±SD)	23.42±4.8
Hypertension, n	5
Smoking, n	7

VA: ventricular arrhythmia; SD: standard deviation.

Table 2. The outcomes of retina parameters by optical coherence tomography angiography.

	Before CA (Group 1)	After CA (Group 2)	p
FRT (µm) (Mean±SD)	248.42±20.50	247.20±20.44	**<0.001**
Superficial vessel density (%) (Mean±SD)			
Whole image	48.13±5.64	48.98±5.16	0.111
Fovea	20.77±6.44	20.04±6.85	0.068
Parafovea	50.65±6.17	50.79±7.95	0.904
Perifovea	48.61±5.72	49.35±5.43	0.177
Deep vessel density (%) (Mean±SD)			
Whole image	50.94±7.53	51.45±7.55	0.631
Fovea	37.67±7.44	36.96±8.49	0.191
Parafovea	55.19±4.78	55.84±5.06	0.424
Perifovea	52.13±8.34	52.77±8.33	0.598
FAZ area (mm^2) (Mean±SD)	0.26±0.08	0.28±0.16	0.344
Flow area for outer retina (mm^2) (Mean±SD)	0.70±0.43	0.72±0.51	0.789
Flow area for choriocapillaris (mm^2) (Mean±SD)	2.10±0.78	2.03±0.32	0.225

OCTA: optical coherence tomography angiography; CA: catheter ablation; FRT: foveal retinal thickness; FAZ: area of 300 µm width around the foveal avascular zone; SD: standard deviation. Bold indicates statistically significant p-values.

Table 3. The outcomes of optic disc parameters by optical coherence tomography angiography.

	Before CA (Group 1)	After CA (Group 2)	p
RNFL average thickness (µm) (Mean±SD)	106.51±17.60	109.12±21.48	0.134
Inferior quadrant (µm)	138.87±24.95	141.92±30.35	0.266
Superior quadrant (µm)	127.95±23.22	129.30±24.23	0.131
Temporal quadrant (µm)	68.05±11.97	69.22±14.67	0.438
Nasal quadrant (µm)	94.22±18.43	96.12±20.18	**0.044**
RPC density (%) (Mean ± SD)			
Whole image	47.80±4.56	48.15±5.22	0.515
Inside disc	48.45±6.43	48.78±5.89	0.730
Peripapillary	49.71±5.32	50.17±6.32	0.501

OCTA: optical coherence tomography angiography; CA: catheter ablation; RNFL: retinal nerve fiber layer; RPC: radial peripapillary capillary; SD: standard deviation. Bold indicates statistically significant p-values.

implantation, possibly indicating effective ocular blood flow regulation within the range of left ventricular ejection fraction. In concordance with this study, stable results of retinal and optic disc vessel densities were also obtained in our study. Moreover, we did not observe any capillary dropout lesions in OCTA scans. We thought that it can be explained by the administration of effective anticoagulants during the procedure. A loading dose of unfractionated heparin (10,000 IU) was given.

Then, heparin was administered by intermittent boluses to maintain the activated clotting time in the range of 300–350 s[7].

On the contrary, IOP alterations of patients during the CA process can be responsible for lower values in FRT. However, we did not have a chance to follow up IOP of patients during the procedure. Additionally, higher values in nasal RNFL thickness may be due to transient capillary rarefaction and limitation of blood flow through sparse capillary networks.

Our study has some limitations. First, the number of patients was relatively small. Second, it would be better if there was a control group. Third, the results can be affected by smoking status[14] and presence of hypertension[15] and dyslipidemia[16]. In this study, seven of the patients had a smoking history, and five had hypertension and dyslipidemia. As each compared measurement result is evaluated on the same patient basis and the hypertension and dyslipidemia were controlled, we thought that it would not affect the results. Finally, we do not have long-term results after the CA procedure. This can be the subject of another study.

CONCLUSIONS

Although the FRT and nasal RNFL thickness are affected in patients undergoing the CA for VA, the CA procedure appears to be safe due to the stable results of retinal and optic disc vessel densities. This stability can be explained by the administration of effective anticoagulants during the procedure. Larger prospective longitudinal OCTA studies are needed to determine the safety of radiofrequency CA procedure for optic disc and retinal perfusion.

AUTHORS' CONTRIBUTIONS

BEK: Conceptualization, Data curation, Formal Analysis, Investigation, Methodology, Project administration, Resources, Software, Validation, Visualization, Writing – original draft, Writing – review & editing. **AK:** Conceptualization, Data curation, Formal Analysis, Investigation, Methodology, Project administration, Resources, Supervision, Validation, Visualization, Writing – review & editing. **OK:** Data curation, Supervision, Validation, Visualization.

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