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Optical coherence tomography angiography findings in malignant hypertensive retinopathy

Achados da angiografia por tomografia de coerência óptica na retinopatia hipertensiva maligna

Berna Dogan[1], Melih Akıdan[1], Muhammet Kazım Erol[1], Deniz Turgut Coban[1], Elcin Suren[1]

1. Department of Ophthalmology, Antalya Education and Research Hospital, Antalya, Turkey.

ABSTRACT | A 33-year-old male presented to our clinic with low vision in both eyes that started during the previous week. Visual acuity was 20/63 in the right eye and 20/50 in the left eye. Fundus examination revealed signs of hypertensive retinopathy; thus, a multidisciplinary approach was adopted for the diagnosis and treatment of this patient. We consulted the nephrology and cardiology departments on this case. Upon diagnosing malignant hypertension and renal failure, the patient was put on hemodialysis. His visual acuity was 20/20 at 6 months, whereas foveal assessment on optical coherence tomography angiography revealed neither marked superficial and deep capillary density loss and foveal avascular zone enlargement nor a decrease in disc flow and radial peripapillary capillary density. Early diagnosis and treatment of malignant hypertension are critical in preventing progression of end-organ damage including the eyes. Optical coherence tomography angiography may be useful in cases when fundus fluorescein angiography is relatively contraindicated (e.g., renal failure).

Keywords: Malignant hypertension; Tomography, optical coherence; Fluorescein angiography; Hypertensive retinopathy

RESUMO | Um homem de 33 anos apresentou-se à nossa clínica com baixa visão em ambos os olhos que começou uma semana antes. A acuidade visual foi de 20/63 no olho direito e 20/50 no olho esquerdo. O exame de fundo de olho revelou sinais de retinopatia hipertensiva; então, adotou-se uma abordagem multidisciplinar para o diagnóstico e tratamento desse paciente. Consultamos os departamentos de nefrologia e cardiologia neste caso. Ao diagnosticar hipertensão maligna e insuficiência renal, o paciente foi colocado em hemodiálise. Sua acuidade visual era 20/20 aos 6 meses, enquanto a avaliação foveal com angiotomografia de coerência óptica não revelou perda de densidade capilar superficial e profunda acentuada e aumento da zona avascular foveal nem uma diminuição no fluxo de disco e na densidade capilar peripapilar radial. O diagnóstico precoce e o tratamento da hipertensão maligna são fundamentais na preveção da progressão de danos nos órgãos-alvo, incluindo os olhos. A Angiografia por tomografia de coerência óptica pode ser útil nos casos em que a angiografia com fluoresceína do fundo de olho é relativamente contraindicada (por exemplo, insuficiência renal).

Descritores: Hipertensão maligna; Tomografia de coerência óptica; Angiofluoresceínografia; Retinopatia hipertensiva

INTRODUCTION

Malignant hypertension (MHT) is the most severe form of hypertensive retinopathy with regard to end-organ damage, whereas optical neuropathy is usually concomitant with choroidopathy and maculopathy[1]. Changes in retinal pigment epithelium (RPE), such as Elschnig spots and Siegrist streaks as well as pigment epithelial detachment and subretinal fluid (SRF), may develop because of choriocapillaris necrosis. In MHT, both the visual prognosis and end-organ damage in the brain, heart, and kidneys are closely related to blood pressure and elapsed time. Therefore, early diagnosis and a multidisciplinary approach are essential.

Optical coherence tomography angiography (OCTA, Optovue, Inc., Fremont, CA, USA) is an imaging method for the in-depth evaluation of retinal and choroidal vessels and may be useful in cases when fundus fluorescein angiography (FFA) is relatively contraindicated (e.g., renal failure).

We aimed to present the results of OCTA, FFA, spectral-domain optical coherence tomography (SD-OCT, Cirrus HD-OCT 5000, Carl Zeiss Meditec Inc., Dublin, CA, USA) in our patient diagnosed with MHT.

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Corresponding author: Melih Akıdan

Antalya Education and Research Hospital. Department of Ophthalmology - 07050 - Antalya - Turkey - E-mail: melcihhh@yahoo.com

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CASE REPORT

A 33-year-old male presented to our clinic with low vision in both eyes that had started during the previous week. Visual acuity was 20/63 in the right eye and 20/50 in the left eye. Intraocular pressure was 13 mmHg in both eyes, and examination of the anterior segment was normal. Fundus examination showed bilateral optic disc edema, star-like hard exudates around the optic disc and fovea, arteriovenous changes, and a few flame-shaped hemorrhages (Figure 1 A, D). In addition, RPE changes including Elschnig spots were visible outside the arcuate. FFA revealed bilateral optic disc hyperfluorescence increasing in the late phase and hypofluorescence in the zones we thought to be Elschnig spots (Figure 1B, E). Macular thickness measurements using SD-OCT revealed increased thickness. Increased reflectivity and SRF were seen on the nasal side of the macula because of the hard exudates (Figure 1 C, F). Measurements of subfoveal choroidal thickness measurements were performed using enhanced depth imaging optical coherence tomography (EDI-OCT). Retinal nerve fiber layer (RNFL) measurements revealed an increase in each quadrant in favor of optical disc edema (Table 1). OCTA macula was used to evaluate superficial, deep capillary density and en face images (Figure 1 G, H, I). OCTA disc was used to evaluate the nerve head, radial peripapillary capillary density, and en face images (Figure 1 J, K). Vascular flow was assessed in both the macular and disc regions (Tables 1 and 2).

Blood tests revealed a creatinine level of 6 mg/dL and blood urea nitrogen (BUN) level of 65 mg/dL. Serology results were negative. Cardiologic evaluation revealed that his systolic blood pressure was 260 mmHg, and diastolic blood pressure was 140 mmHg. Neurological evaluation was normal. Following the nephrology consultation, the patient was diagnosed with MHT and chronic renal failure and thus put on dialysis.

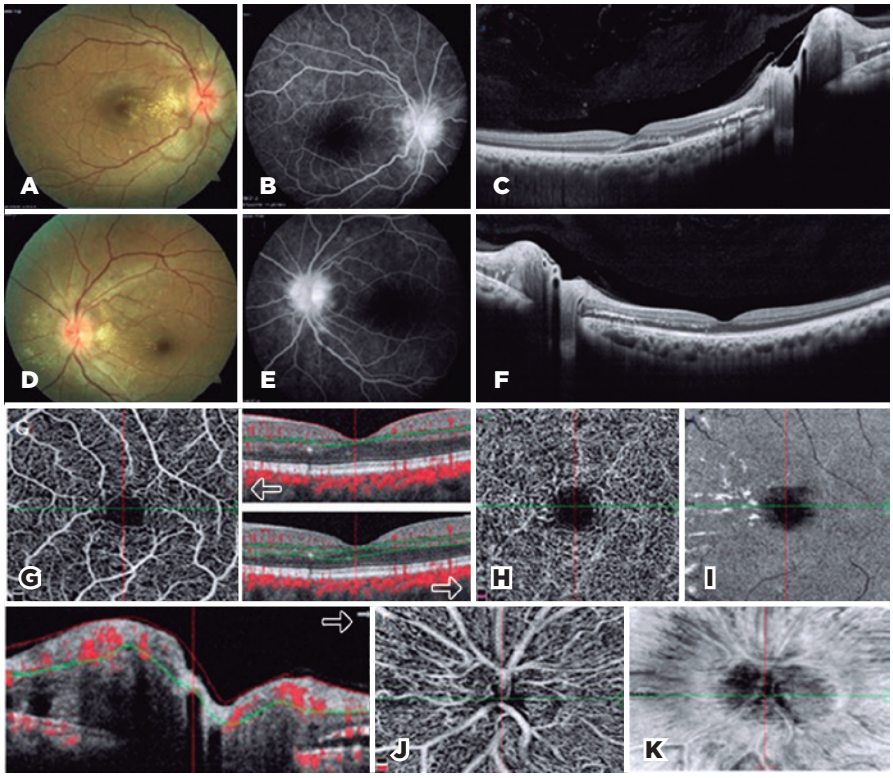

Figure 1. On the first day. A) Fundus image of the right eye; optic disc edema and star-like exudation. B) FFA image of the right eye; hyperfluorescence in the optic disc. C) EDI-OCT image of the right eye; SRF and hyper-reflectivity due to hard exudates in the nasal area. D) Fundus image of the left eye; optic disc edema and star-like exudation. E) FFA image of the left eye; hyperfluorescence in the optic disc. F) EDI-OCT image of the left eye; no marked SRF, hyper-reflectivity in the nasal area due to exudates. G) OCTA image of the superficial capillary plexus in the left eye (right arrow, B-scan image). H) OCTA image of the deep capillary plexus in the left eye (left arrow, B-scan image). I) En face OCTA image of the deep capillary plexus in the left eye. J) OCTA image of a radial peripapillary capillary cross-section in the left eye (left arrow, B-scan image). K) En face OCTA image of the radial peripapillary capillary in the left eye.

At 6-month follow-up, bilateral visual acuity was 20/20. Fundus autofluorescence imaging revealed regression in the signs of MHT (Figure 2 A, B, D, E), and FFA was not performed on the advice of the nephrology department. SD-OCT macular thickness measurements revealed thinning and total resolution of SRF (Figure 2 C, F). RNFL measurements showed regression of optical disc edema in all quadrants (Table 1). Subfoveal choroidal thickness in the right eye was 337 µm on the first day and 328 µm at 6 months and in the left eye was 402 µm on the first day and 343 µm at 6 months.

OCTA macula and disc were used to evaluate flow, foveal avascular zone (FAZ), density, and en face images at 6 months (Figure 2G, H, I). OCTA macula measurements did not show capillary density loss. OCTA foveal flow measurements were increased in all segments except the outer segment (Table 2). No enlargement was found either in the superficial or deep FAZ. OCTA disc measurements did not show a marked nerve head or loss of radial peripapillary capillary density (Figure 2 J, K). Flow measurements revealed increased choroidal flow and no perfusion loss in the other segments (Table 1).

At 6-month follow-up, a systemic assessment of the patient revealed that blood pressure was normal, creatinine was 3.2 mg/dL, and BUN was 38 mg/dL. Renal transplantation was performed at an external center.

DISCUSSION

In systemic hypertension, vascular endothelial structure, blood-retina barrier, and autoregulation mechanism are affected. Retinopathy evaluation assesses damage

Table 1. OCT and OCTA optic disc findings in malignant hypertensive retinopathy on the first day and the first 3 and 6 months

Capillary density	Day 1		Month 1		Month 3		Month 6	
Nerve head (%)								
Whole	62.240	61.720	61.900	63.230	63.660	62.610	63.690	62.940
Inside Disc	58.600	59.260	56.600	60.880	56.820	60.540	56.280	59.460
Peripapillary	62.470	62.400	64.270	66.610	65.020	66.100	66.830	65.640
Nasal	58.970	54.850	59.920	65.540	62.200	66.620	62.780	64.980
Inferior nasal	61.990	64.230	60.490	64.190	62.650	64.540	67.450	65.860
Inferior temporal	65.530	63.350	68.030	65.720	68.120	65.600	72.730	63.000
Superior temporal	66.740	71.580	64.540	64.670	62.940	61.730	65.430	66.020
Superior nasal	60.520	61.620	60.390	66.900	60.520	64.770	61.890	63.450
Temporal	65.810	66.870	65.540	70.070	68.810	68.880	70.370	70.130
Radial peripapillary (%)								
Whole	60.100	62.770	61.550	63.790	63.670	62.530	63.890	61.980
Inside Disc	64.890	62.120	60.110	60.800	60.800	60.890	58.270	58.470
Peripapillary	62.190	62.980	65.160	69.610	67.140	67.700	69.980	66.640
Nasal	60.810	56.390	64.220	67.190	64.090	66.430	63.330	62.790
Inferior nasal	62.030	62.640	68.810	68.730	67.210	67.390	70.670	67.060
Inferior temporal	67.420	66.850	71.100	69.420	70.760	69.210	72.610	67.930
Superior temporal	70.940	69.350	66.890	71.030	68.28	67.060	71.790	67.600
Superior nasal	64.730	64.290	60.220	71.470	62.390	67.600	63.230	67.230
Temporal	65.470	66.030	71.780	71.590	73.110	69.030	73.270	70.350
Disc flow								
Nerve Head	1.799	1.775	1.787	1.863	1.697	1.877	1.797	1.841
Radial Peripapillary	1.847	1.854	1.860	1.895	1.864	1.898	1.883	1.841
Retinal nerve fiber layer (µm)								
Total	252	200	131	116	104	98	101	98
Superior	300	282	168	144	135	119	128	123
Temporal	134	153	100	113	82	92	82	87
Inferior	304	203	153	133	126	120	123	117
Nasal	271	161	105	76	72	63	71	63

Cells are divided into two columns to show the results of the right and left eyes separately.

to other organs. In their study, Ahn et al., used fundoscopy and OCT in combination and reported that visual prognosis was correlated with SRF level rather than fundoscopic images in patients with severe hypertension, and blood pressure control also resulted in regression of retinal and choroidal thickness[2].

Manjunath et al. found that choroidal thickness in healthy individuals measured 272 ± 81 µm, and Osmanbasoglu et al. obtained measurements of 308.7 ± 64.5 µm[3,4]. In our case, subfoveal choroidal thickness in the right eye measured 337 µm on the first day and 328 µm at 6 months and in the left eye 402 µm on the first day and 343 µm at 6 months. Following the improvement in blood pressure and decrease in choroidal permeability, we observed a fast regression in SRF and reduced retinal and choroidal thickness.

OCTA is a new imaging system that allows in-depth evaluation of retinal and choroidal microvascular structures without the use of contrast agent. In more common ischemic cases such as diabetic retinopathy, arterial-venous occlusions, FAZ enlargement, and capillary density loss were detected quantitatively using OCTA. As in the study by Falavarjani et al., OCTA also can perform vascular calibration measurements, but no specific study has used it for measuring hypertension[5].

Table 2. OCT and OCTA-macular findings in malignant hypertensive retinopathy on the first day and the first 3 and 6 months

Capillary density	Day 1		Month 1		Month 3		Month 6	
Superficial (%)								
Whole	55.490	54.460	55.640	55.160	45.880	55.360	57.370	57.030
Fovea	39.130	33.810	35.430	36.270	30.400	34.060	37.030	35.360
Parafovea	56.880	53.620	57.170	56.410	46.790	52.810	59.160	58.410
Superior-Hemi	57.170	55.730	57.840	56.260	46.710	56.710	58.820	57.570
Inferior-Hemi	56.590	55.310	56.490	56.550	46.880	56.910	59.490	59.250
Superior	59.170	56.450	59.900	56.640	47.740	57.460	61.190	58.370
Temporal	55.690	54.830	55.210	56.440	46.530	56.870	57.500	57.320
Inferior	57.190	55.300	57.150	55.750	47.460	57.210	60.260	59.330
Nasal	55.420	55.480	56.180	56.820	45.390	55.730	57.480	58.550
Deep (%)								
Whole	60.820	61.000	58.730	59.020	61.030	59.590	62.540	60.710
Fovea	33.040	35.720	35.900	33.110	36.010	31.640	39.550	36.980
Parafovea	63.030	63.220	60.410	61.350	63.140	61.760	64.230	62.300
Superior-Hemi	63.920	62.480	60.900	61.270	63.490	61.480	63.790	61.490
Inferior-Hemi	62.130	63.970	59.920	61.430	62.800	62.040	64.680	63.110
Superior	66.000	62.060	61.670	60.890	64.650	62.620	64.280	62.190
Temporal	63.650	62.470	60.360	60.690	63.050	61.610	63.410	61.320
Inferior	63.260	66.360	62.160	62.000	64.020	59.540	66.180	63.460
Nasal	59.240	62.100	57.550	61.780	60.830	63.280	63.050	62.160
Foveal avascular zone (mm^2)								
Superficial	0.147	0.193	0.140	0.185	0.200	0.195	0.151	0.178
Deep	0.400	0.319	0.150	0.187	0.418	0.278	0.140	0.236
Foveal flow								
Superficial	1.534	1.467	1.533	1.534	1.161	1.509	1.560	1.539
Deep	1.547	1.587	1.578	1.559	1.334	1.583	1.689	1.639
Choroid	1.968	2.020	1.980	1.945	1.956	2.010	1.982	2.009
Macular thickness (µm)								
Fovea	326	289	268	274	272	273	270	264
Parafovea	347	346	333	338	327	333	335	334
Perifovea	296	301	291	290	285	282	287	284
Choroid thickness (µm)	337	402	382	349	317	327	328	343

Cells are divided into two columns to show the results of the right and left eyes separately.

Ghassemi et al. reported that superficial FAZ measured 0.22 ± 0.08 mm² and deep FAZ was 0.31 ± 0.11 mm² in normal eyes in their study[6]. In our case, superficial FAZ was 0.147 mm² on the first day and 0.151 mm² at 6 months in the right eye, and it was 0.193 mm² on the first day and 0.178 mm² at 6 months in the left eye. Deep FAZ measured 0.400 mm² on the first day and 0.140 mm² at 6 months in the right eye, and it was 0.319 mm² on the first day and 0.236 mm² at 6 months in the left eye. No significant superficial and deep phase enlargement was observed after 6 months of follow-up.

Coscas et al. evaluated macular density and flow in healthy subjects using 3 × 3 mm OCTA examinations. Their findings included superficial layer-whole 53.91 ± 2.09 and deep layer-whole 59.36 ± 1.74[7]. In our case, capillary density loss was not significant at the end of the sixth month, and there was no decrease in OCTA disc density and flow measurements at the end of the sixth month.

Rotsos et al. assessed choroidal blood flow at Elschnig points with OCTA and reported the results at 1 month[8]. Similarly, Saito et al. compared focal choroidal ischemic areas and reperfusion in hypertensive choroidopathy following treatment with en face OCTA images[9]. Both studies did not assess capillary density, FAZ, or flow. Grossi et al. compared OCTA results between the arterial hypertensive and normotensive group. Patients in the normotensive group had thicker choroids, whereas no vascular density differences were found[10]. They emphasized that OCTA was potentially useful for detecting early pathological damage and assessing progression.

We followed our patient regularly for 6 months. His ocular symptoms improved, and no loss of vascular density or flow reduction was observed. We believe that our

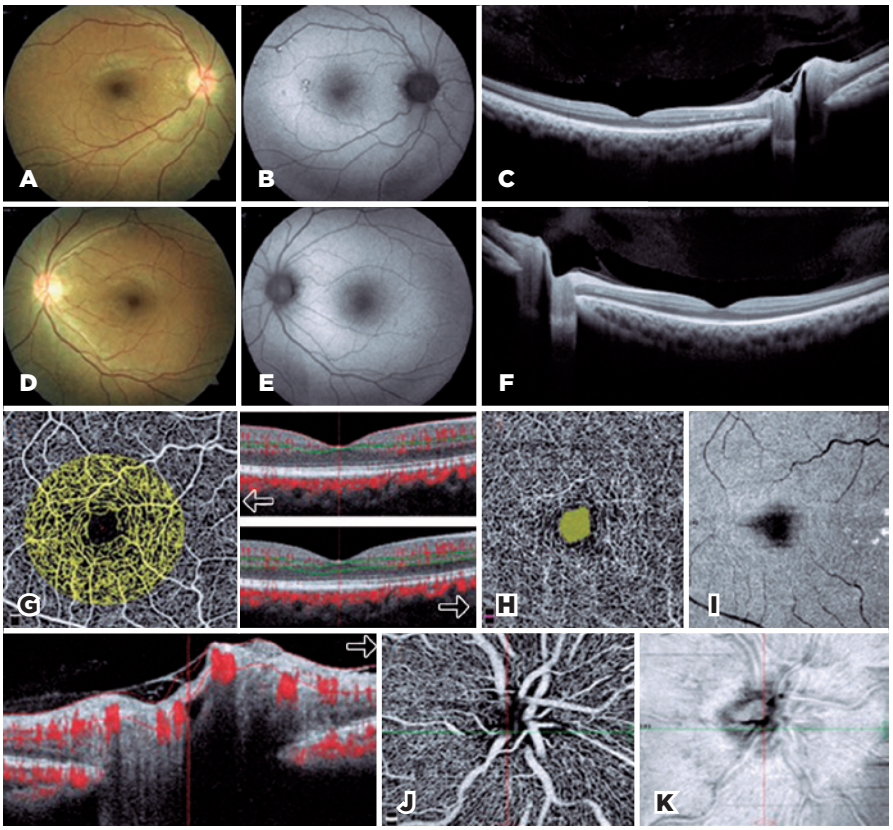

Figure 2. At 6 months. A) Fundus image of the right eye; total resolution of optic disc edema and minimal exudation. B) Autofluorescence of the right eye; defective hyperautofluorescence secondary to choroidopathy. C) EDI-OCT image of the right eye; hyper-reflectivity in the nasal area due to minimal hard exudation. D) Fundus image of the left eye; total resolution of optic disc edema and exudation. E) Autofluorescence in the left eye. F) EDI-OCT image of the left eye; total resolution of hyper-reflectivity. G) OCTA flow area image of the superficial capillary plexus in the right eye (right arrow, B-scan image). H) OCTA image of the foveal avascular zone of the deep plexus in the right eye (left arrow, B-scan image). I) En face OCTA image of the deep plexus. J) OCTA image of the optical nerve head in the right eye (left arrow, B-scan image). K) En face OCTA image of the optical nerve head.

study will contribute to our current knowledge regarding MHT with OCTA results such as angiodisc and capillary density. Further studies on using OCTA more effectively for the diagnosis, staging, treatment, and prognosis of hypertensive retinopathy are needed.

REFERENCES

1. Stryjewski TP, Papakostas TD, Eliott D. Multimodal imaging of elschnig spots: a case of simultaneous hypertensive retinopathy, choroidopathy, and neuropathy. Semin Ophthalmol. 2017;32(4):397-9.
2. Ahn SJ, Woo SJ, Park KH. Retinal and choroidal changes with severe hypertension and their association with visual outcome. Invest Ophthalmol Vis Sci. 2014;55(12):7775-85.
3. Manjunath V, Taha M, Fujimoto JG, Duker JS. Choroidal thickness in normal eyes measured using cirrus-hd optical coherence tomography. Am J Ophthalmol. 2010;150(3):325-9.
4. Osmanbasoglu OA, Alkın Z, Ozkaya A, Ozpınar Y, Yazıcı AT, Demirok A. Diurnal choroidal thickness changes in normal eyes of turkish people measured by spectral domain optical coherence tomography. J Ophthalmol. 2013;2013:687165.
5. Falavarjani KG, Al-Sheikh M, Darvizeh F, Sadun AA, Sadda SR. Retinal vessel calibre measurements by optical coherence tomography angiography. Br J Ophthalmol. 2017;101(7):989-92.
6. Ghassemi F, Mirshahi R, Bazvand F, Fadakar K, Faghihi H, Sabour S. The quantitative measurements of foveal avascular zone using optical coherence tomography angiography in normal volunteers. J Curr Ophthalmol. 2017;29(4):293-9.
7. Coscas F, Sellam A, Glacet-Bernard A, Jung C, Goudot M, Mierre A, et al. Normative data for vascular density in superficial and deep capillary plexus of healty adults assessed by optical coherence tomography angiography. Invest Ophthalmol Vis Sci. 2016;57(9):211-23. Comment in: Invest Ophthalmol Vis Sci. 2016;57(15):6713.
8. Rotsos T, Andreanos K, Blounas S, Brouzas D, Ladas DS, Ladas ID. Multimodal imaging of hypertensive chorioretinopathy by swept-source optical coherence tomography and optical coherence tomography angiography. Medicine. 2017;96(39):e8110.
9. Saito M, Ishibazawa A, Kinouchi R, Yoshida A. Reperfusion of the choriocapillaris observed using optical coherens tomography angiography in hypertensive choroidopathy. Int Ophthalmol. 2017 Sep 11, doi: 10.1007/s10792-017-0705-1.
10. Grossi A, Agostinis M, Moretti S, Tandurella N, Cavalaro G, Pierobon V, et al. Optical coherence tomography angiography and arterial hypertension: a role in identifying early vascular damage?. J Hypertension [Internet]. 2017;35. [cited 2018 may 24]. doi:10.1097/01.hjh.0000523746.72523.be.