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Systemic Diseases in Non-inflammatory Branch and Central Retinal Artery Occlusion An Overview of 416 Patients

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Abstract

Background: To determine the frequency of essential cardiovascular risk factors in different vascular ocular diseases.

Methods: We compiled cardiovascular risk factor findings (RFs) from 416 patients with non-inflammatory ocular vascular occlusions in a retrospective study: 134 patients with BRAO, 253 patients with CRAO, and 29 patients with hemi-CRAO. 274 (65.9 %) male and 142 (34.1 %) female patients were examined. Mean age of all patients was 66 years (range: 18-90). The right eye was involved in 221 (53.1 %), left eye in 193 (46.4 %), and both eyes in 2 patients (0.5 %).

Results: Cardiovascular risk factors (RFs) were found in 243 patients. Three hundred and eight (308) out of 406 patients (75.9 %) presented with arterial hypertension. Hypertension was present in 96 patients with BRAO (73.8 %), in 197 patients with CRAO (79.8 %), and in 15 patients with hemi-CRAO (78.9 %).

RFs such as arterial hypertension, carotid artery diseases, diabetes mellitus, hyperlipidemia, hyperuricemia, and chronic smoking did not differ statistically between patients with BRAO, CRAO or hemi--CRAO. But visible emboli in retinal arteries were observed in patients with BRAO (47 %,), or hemi-CRAO (41.4 %), much more often than in patients with CRAO (11.1 %).

Conclusions: No statistical differences between the RFs of patients with BRAO, CRAO, or hemi-CRAO were noted. We maintain that every patient with retinal arterial obstruction should undergo extensive examination of essential RFs.

Key words: Central retinal artery occlusion, branch retinal artery occlusion, hemicentral retinal artery occlusions, cardiovascular risk factors

Introduction

Early recognition of cardiovascular risk factors (RFs) is necessary to prevent infarctions in the eye or other organs. Various non-inflammatory RFs cause acute ocular vascular obstructions, such as stenoses, occlusion, or dissecting aneurysm of the internal carotid artery (ICA), sclerosis or stenoses of the aorta, blood coagulation anomalies, and cardiac diseases such as chronic atrial fibrillation, valvular diseases, patent foramen ovale or intracardial thrombosis [1, 2, 9, 11, 12, 15 - 17, 20, 23, 25, 27 - 29].

Ros et al. [19] reported several associated systemic disorders among BRAO patients, observing hypertension in 59% of patients. Serious atherosclerotic cardiovascular disease in conjunction with angina pectoris and/or prior myocardial infarction was documented in 21% of BRAO patients. Chawluk et al. [7] reported a significant correlation between the degree of carotid stenosis and the number of vascular risk factors identified in individual patients. They also found that the risk factors were more common in CRAO and BRAO patients than in amaurosis fugax (AF) patients. Bull et al. [6] emphasized that patients with AF were more likely to have a significant carotid artery stenosis than those with asymptomatic Hollenhorst plaques or retinal artery occlusion. Douglas et al. [10] found a strong association between CRAO and ipsilateral carotid artery disease, with a significantly higher incidence of subsequent ipsilateral stroke in CRAO patients with carotid disease. Bruno et al. [5] observed that patients with retinal emboli showed a higher prevalence of hypertension and heterogenous or echolucent carotid plaques, and they smoked more.

Biousse et al. [3] found that 62% of 146 patients with extracranial carotid artery dissection presented ophthalmologic signs and symptoms (91/146). 28% of those patients had suffered transient monocular visual loss. Klein et al. [15] found that persons who were 65 years or older at baseline were 2.4 times as likely to develop a retinal embolus compared with persons 43 to 54 years of age at baseline. Savino et al. [21] showed that patients with retinal occlusions without visible emboli had a survival rate comparable to the matched control. But patients with visible emboli demonstrated a strikingly diminished survival rate. Cugati et al. [8] found that increasing age was significantly associated with incident emboli. In an older population, the 10-year cumulative incidence of retinal emboli was 2.9% among 2,361 persons at risk.

RFs cause different vascular obstructions in the eye. One-third to one-fourth of the patients with CRAO and BRAO revealed ≥ 50% stenoses or occlusions of the ICA, but, only one out of 51 patients with anterior ischemic optic neuropathy (AION) showed a high de-

gree ICA stenosis [22]. Wilson et al. [29] assumed that RFs in patients with CRAO differ from those in patients with BRAO. We therefore compared the risk factors in these ocular diseases.

Methods

RFs of 416 patients, 274 of whom were male (65.9 %) and 142 female (34.1 %), were examined in the University Eye Hospital Freiburg:

There were 134 patients with BRAO, 253 with CRAO, and 29 with hemi-CRAO from 1980 to 2004 (Table 1).

Table 1. 416 patients with retinal arterial occlusions.

patients	males	females
BRAO n: 134	91 (67.9 %)	43 (32.1 %)
CRAO n: 253	166 (65.6 %)	87 (34.4 %)
hemi-CRAO n: 29	17 (58.6 %)	12 (41.4 %)
total: 416	274 (65.9 %)	142 (34.1 %)

352 patients were examined in the Department of Internal Medicine, of whom there were 119 with BRAO, 208 with CRAO, and 25 with hemi-CRAO. 294 patients underwent echocardiography, of whom 91 had BRAO, 183 CRAO, and 20 hemi-CRAO. Blood pressure measurements were taken in 406 patients: 130 with BRAO, 247 with CRAO, and 29 with hemi-CRAO.

In the Department of Neurology examinations of the carotid arteries with Duplex/Doppler sonography were performed in 366 patients: 104 with BRAO, 238 with CRAO and 24 with hemi-CRAO.

Age: 416 consecutive patients (mean age: 66 years; range: 18-90); 134 patients (32.2 %) with BRAO 65.4 (range: 22-90) years, 253 patients (60.8%) for those with CRAO 66.8 (range: 18-90) years, and 29 patients (7%) with hemi-CRAO 61.7 (range: 22-77) years (Table 2).

We set up three groups according to patient´s age: the older patients > 65 years of age (Group 3), the middle-aged group at 45-64 years of age (Group 2), and the young group of patients < 45 years of age (Group 1).

Gender: All examinations revealed a distinct difference between male and female patients: male patients were observed to suffer more often from CRAO and BRAO than female patients.

We noted no statistical difference between the three diseases (contingency tables) with respect to gender.

Involved Eye

There was no significant difference in the number of

Table 2. Three age groups.

	BRAO: n = 134	CRAO: n = 253	hemi-CRAO: n = 29
Group 3	m: 51 (56 %) f: 23 (53.5 %)	m: 100 (60.2 %) f: 64 (73.6 %)	m: 8 (47.1 %) f: 7 (58.3 %)
Group 2	m: 34 (37.4 %) f: 17 (39.5 %)	m: 56 (33.7 %) f: 18 (20.7%)	m: 8 (47.1 %) f: 4 (33.3 %)
Group 1	m: 6 (6.6%) f: 3 (7%)	m: 10 (6.0 %) f: 5 (5.7 %)	m: 1 (5.9 %) f: 1 (8.3 %)
total:	m: 91 (67.9 %) f: 43 (32.1 %)	m: 166 (66 %) f: 87 (34.4 %)	m: 17 (58.6 %) f: 12 (41.4 %)

Table 3. Involved eye in 416 patients with retinal arterial occlusions.

patients	right eye	left eye	both eyes
BRAO n: 134	n: 64 (47.8 %)	n: 68 (50.7 %)	n: 2 (1.5 %)
CRAO n: 253	n: 144 (56.9 %)	n: 109 (43.1 %)	-
hemi-CRAO n: 29	n: 13 (44.8 %)	n: 16 (55.2 %)	-
total: 416	221 (53.1 %)	193 (46.4 %)	2 (0.5 %)

Table 4. Frequency of Cardiovascular Risk Factors in patients with retinal arterial occlusions.

Number of RF	BRAO total 134	CRAO total 253	hemi-CRAO total: 29	total of all groups together
1	8	10	4	22 (9.1 %)
2	12	40	4	56 (23 %)
3	18	39	4	61 (25.1 %)
4	24	36	3	63 (25.9 %)
5	5	28	1	34 (14 %)
6		5		5 (2.1 %)
7	1	1		2 (0.8 %)
total	68 (50.7 %)	159 (62.8%)	16 (55.2%)	243

Table 5. Blood pressure examinations in 406 patients with retinal arterial occlusions.

	BRAO (89 males)	BRAO (41 females)	CRAO (162 males)	CRAO (85 females)	hemi-CRAO (12 males)	hemi-CRAO (7 females)
Group 3	42 (47.2 %) RR>190/100: 15 (16.9 %); RR>160/95: 12 (13.5 %) RR>140/90: 3 (3.4 %); without detailed value: 12	19 (46.3 %) RR>190/100: 7 + very high values: 2 (4.9 %): 9 (17.1%); RR>160/95: 2 (4.9 %); RR>140/90: 1 (2.4 %); without detailed value: 7	86 (53.1 %) RR>190/100: 27 + 2 patients with very high values 29 (17.9 %); RR>160/95: 11 (6.8 %); RR>140/90: 5 (3.1 %); without detailed value: 41;	52 (61.2 %) RR>190/100: 19 + 3 with very high values 22 (25.9 %); RR>160/95: 9 (10.6 %); RR>140/90: 2 (2.4%); without detailed values: 19;	7 (58.3 %) RR>190/100: 4 (23.5 %); RR>160/95: 2 (11.8 %); without detailed values: 1	4 (57.1 %) RR>190/100: 2 (28.6 %); RR>160/95: 1 (14.3%); without exact values: 1
Group 2	22* (24.7 %) 2 patients with very high hypertension RR>190/100: 5 (5.6 %); RR>160/95: 7 (7.9 %); RR>140/90: 2 (2.2 %)	11 (26.8 %) RR>190/100: 4 (%); RR>160/95: 1 (%) + patient with very high values: 1); without detailed values: 5	37 (22.8 %) RR>190/100: 3 patients with very high values : 19 (11.7 %) RR>160/95: -- RR>140/90: 2 (1.2 %); without detailed values: 16	16 (18.8 %) RR>190/100: 2 + 2 with very high values 4 (4.7 %); RR>160/95: 2 (2.4 %); RR>140/90: 1 (1.2 %); without detailed values: 9 (10.5 %)	5 (41.7 %) RR>190/100: 2 (16.7 %) RR>160/95: 1 (8.3 %); without detailed values: 2	3 (42.9 %) including: RR>190/100: 2 (28.6 %) RR>140/90: 1 (14.3 %)
Group 1	1 RR>190/100: 1 (1.1 %)	1 RR>160/95: 1 (2.4 %)	5 RR>190/100: 3 (1.9 %)	1 RR>190/100: 1 (1.4 %)	----	----
total	65 (73.0 %)	31 (75.6 %)	128 (79.0 %)	69 (81.2 %)	9 (75 %)	6 (85.7 %)

* patients with very high hypertension: diastolic values≥ 130 mm Hg

right and left eyes affected by the three diseases (contingency tables) (Table 3).

In patients with hemi-CRAO, the superior arterial trunk was found to be occluded at a frequency similar to the finding of an inferior arterial trunk occlusion.

In 15 patients the superior retinal arteries were occluded and in 14 patients inferior retinal arteries.

Cardiovascular Risk Factors (RFs)

We identified a combination of RFs in most patients,

such as arterial hypertension and disease of the ICA or heart failure. For example, we detected seven cardiovascular risk factors in one 72-xear-old man with CRAO. He suffered from arterial hypertension, diabetes mellitus, hypercholesterolemia, hyperuricemia, a 50% stenosis of the ipsilateral internal carotid artery, global hypokinesia of the left ventricle, and mitral valve insufficiency.

Results

Cardiovascular Risk Factors

In a total of 243 patients, we identified only one RF in 9.1%, two RFs in 23%, three RFs in 25.1%, and four RFs in 25.9 % of the patients. Most patients had 4 RFs. Five RFs were diagnosed in 14 %, and six RFs in 2.1%. Two patients (0.8 %) showed even seven RFs (Table 4).

No statistical difference was found with respect to the number of risk factors between patients with BRAO, CRAO, and hemi-CRAO (Kruskal-Wallis-Test). No examinations were possible in the Department of Internal Medicine in six patents with CRAO, five patients with BRAO, and in three patents with hemi-CRAO. Missing sonographical and echocardiography examinations are listed in Table 6 and Table 7, respectively.

Arterial Hypertension as a Frequent Cardiovascular Risk Factor

The main RF was arterial hypertension, occurring in 308 (75.9 % out of 406 patients), in 96 patients (73.8 % out of 130 patients) with BRAO, in 197 patients (79.8 % out of 247 patients) with CRAO, and in 15 patients (78.9 % out of 19 patients) with hemi-CRAO (Table 5).

No significant difference between CRAO patients and BRAO patients was found with respect to hypertension when comparing these three ocular diseases (p = 0.2) (Cochran- Mantel-Haenszel-Test).

Extremely High Arterial Hypertension in Patients with CRAO

- a 51-year-old man with a blood pressure of 210/140 mm Hg (angiography revealing no changes in the ICA)
- a 58-year-old man with 230/130 mmHg (with Doppler sonography showing an ICA occlusion)
- a 69-year-old woman with 270/180 mm Hg (with an ICA elongation in Doppler sonography)

Extremely High Arterial Hypertensionin Patients with BRAO

- a 47-year-old man with 250/160 mmHg (Doppler sonography showing no ICA changes)
- a 60-year-old woman with 240/170 mm Hg (Doppler sonography showing no ICA changes)
- a 50-year-old man with 200/150 mm Hg (Doppler-sonography revealing plaques in the ICA)

Extremely High Arterial Hypertensionin in a

Table 6. Findings in Doppler Sonography in 366 examined patients with arterial retinal occlusions.

	total BRAO	**total CRAO**	**total hemi-CRAO**	**total**
	104	238	24	366
Occlusion of the internal carotid artery (ICA) or ≥ 70% stenosis	22	54	2	78
Medium-sized stenosis of ICA	17	29	1	47
Plaques or slight ICA Stenosis or elongations	30	79	7	116
Dissecting aneurysm		4		4
Relevant sonographical findings as possible causes for retinal arterial occlusions	69	166	10	pathological changes in 245 (66.9 % of 366 examined patients)
Without relevant pathological changes of ICA	35	72	14	121
Changes of the contralateral ICA	11	3	1	15
Missing sonographical examinations	30	15	5	50
total	path. changes: 69 normal: 35 no exam: 30	path. changes: 166 normal: 72 no exam: 15	path. changes: 10 normal: 14 no exam: 5	121 (33.1 %) = normal findings 245+121 = 366 366+50 = 416

Table 7. Echocardiographical findings in 294 patients with retinal arterial occlusions.

Diagnoses	**BRAO: 91 patients**	**CRAO: 183 patients**	**hemi-CRAO: 20 patients**	**total 294 patients**
A. Possible cardiac causes for ocular infarction				
1. Disorders of cardiac rhythm (for instance chronic atrial fibrillation)	7	34	6	47 out of 294 patients (16 %)
2. Disturbance of diastolic relaxation	9	7	2	18
3. Reduced function of left ventricle	7	15		22
4. Slight degree to medium-sized aortic stenosis	1	11		12
5. Medium-sized to high degree aortic stenosis	6	12	2	20 out of 294 patients (6.8 %)
6. Combined aortic vitium	3	2		5
7. Atrial thrombus		1		1
8. Combined vitium of aortic and mitral valves	3	8	1	12
9. Sclerosis of Aortic valve	12	19	2	33 out of 294 patients (11.2 %)
10. Aortic insufficiency (slight to medium)	4	3	2	9
11. Prior aortic valve replacement	2	2		4
12. Patent foramen ovale	8	10	1	19
13. Stenosis of mitral valve			1	1
14. Mitral valve insufficiency	9	17	6	32 out of 294 patients (11. 0)
15. Mitral valve prolaps	1	2		3
16. Prior mitral valve replacement	1			1
17. Calcareous mitral valve with myxomatous changes	2			2
18. Aneurysms of apex cordis or cardiac septum	1	3		4
Possible cardiac causes for infarction (1.-18.):	76	146	23	245
B. Unconditional or irrelevant cardiac causes for infarction				
19. Mitral ring sclerosis	5	15	2	22
20. Hypertrophic left ventricle	18	38	3	59
21. Coronary disease including prior myocardial infarction	16	49	5	70
22. Left atrium enlargement	4			4
23. Reanimation after cardiac arrest	1			1
24. Right ventricle enlargement		3		3
C. *Unconditional or irrelevant cardiac causes for infarction* (19.-24.)	44	105	10	159
All cardiac deficits	120	251	33	404
Normal echocardiographic findings	29 (31.9 %)	43 (23.5 %)	3 (15 %)	75 (25.5 %)
Missing echocardiographic examination	43 out of 134 patients (32.1%)	70 out of 253 patients (27.7 %)	9 out of 29 patients (31 %)	122 out of 416 patients (29.3 %)

PATIENT WITH HEMI-CRAO

– a 54-year-old woman with 220/140 mm Hg (Doppler sonography showing no ICA changes)

ULTRASOUND DIAGNOSIS OF CEREBRO-VASCULAR ARTERIES

366 patients with arterial retinal occlusions were subjected to color coded Duplex/Doppler sonography of the carotid arteries.

ICA disease was found in 245 (66.9 %) patients. To

Table 8. Cerebral vascular diseases and other vascular disorders in patients with retinal arterial occlusions.

Diagnoses	**BRAO total:**	**CRAO total:**	**hemi-CRAO total:**	**total**
	134	253	29	416
Prior Stroke	10	12	3	25
Prior TIA	6	8	1	15
PRIND or RIND		2	1	3
Simulataneous stroke or TIA with retinal arterial occlusion ("oculocerebral ischemia syndrome")	1	6		7
Clinical signs of cerebral ischemia cerebro-vascular insufficiency	3	6		9
Cerebral vascular diseases in patients with retinal arterial occlusions	20 (14.9 %)	34 (13.4 %)	5 (17.2 %)	59 (14.2 %)
Prior Bypass operation of subclavian artery in occlusions of brachiocephalic artery or arm arteries		4		4
Prior radiation and surgery of larynx carcinoma and retrolingual carcinoma with secondary occlusion of internal carotid artery		2		2
Abdominal aortic aneurysm	1	2		3
Peripheral arterial occlusion (with intermittent claudication)	11	20	1	32 (7.7 %)
High degree general vascular sclerosis in combination with renal insufficiency		2		2
Sleep apnoe syndrome		2		2
total numbers of patients with signs of general vascular diseases (without cerebral involvement)	12	34	1	45

be precise, in 104 patients (28.4 %) with BRAO, 238 patients (65.0 %) with CRAO, and 24 (6.6 %) patients with hemi-CRAO were examined (Table 6).

Statistical evaluation showed that ultrasound findings were significantly different in all three diseases ($p = 0.003$) regardless of the patient´s gender.

Comparison of ultrasound findings between CRAO patients and BRAO patients showed no significant difference ($p = 0.2$), nor were any differences identified in the age groups or regarding patient gender. No definitive difference between males and females was found ($p = 0.051$).

Four patients with CRAO presented a dissecting aneurysm of the ICA, detected by sonography. None of them had suffered a stroke, and they were treated with anticoagulants to prevent a potential cerebral embolism.

Cardiac Diseases

The most relevant RFs for arterial retinal infarction were cardiac rhythm disorders (mainly chronic atrial fibrillation) and valvular diseases. Cardiac rhythm disorders occurred in 47 out of 294 patients (16 %). Mitral valve insufficiency was found in 32 out of 294 patients (11 %), and a moderate to advanced aortic stenosis was detected in 20 out of 294 patients (6.8 %) (Table 7).

Vascular Brain Diseases in Patients with Arterial Retinal Obstruction

Cerebral deficits due to vascular diseases were present when documenting individual case histories (anamnesis) in 59 (14.2 %) patients (Table 8). Simultaneous stroke or TIA and retinal arterial occlusion ("oculocerebral ischemia syndrome") occurred in seven patients. 43 (10.3 %) additional patients had suffered stroke, TIA or PRIND weeks, months or years prior to retinal arterial occlusion. Peripheral arterial occlusion (with intermittent claudication) occurred in 32 out of 416 patients (7.7 %) with arterial retinal occlusion.

Additional Systemic Diseases as Cardiovascular Risk Factors

Additional RFs for retinal arterial infarctions are chronic smoking, diabetes mellitus, hyperlipidemia (particularly hypercholesterolemia), and hyperuricemia (Table 9). Comparison between BRAO, CRAO, and hemi-CRAO patients revealed no significant differences between these four diagnoses.

Ophthalmological Findings in Patients with Arterial Retinal Obstruction

Visual acuity in 126 patients with BRAO and in 29 patients with hemi-CRAO were evaluated. In 85 patients with BRAO (67.5 % out of 126 patients), visual acuity was better than > 0.5. In 19 patients with hemi-CRAO

Table 9. Additional cardiovascular Risk Factors for retinal arterial occlusions.

Diagnoses	**BRAO total:**	**CRAO total:**	**hemi-CRAO total:**	**total:**
	119	**208**	**25**	**352**
Chronic smoking	38 (31.9 % of 119 pat.)	70 (33.6 % of 208 patients)	7 (28 % out of 25 patients)	115 (32.7 % of 352 patients)
Diabetes mellitus	16 (13.4 % of 119 pat.	45 (21.6 % of 208 pat)	3 (12 %)	64 (18.2 % of 352 pat.)
Hyperlipidemia	35 (29.4 %)	79 (38 % of 208 pat.)	8 (32 %)	122 (34.7 %)
Hyperuricemia	9 (7.6 %)	38 (18.3 %)	6 (24 %)	53 (15.1 %)

Table 10. Visual acuity: BRAO and hemi-CRAO.

	BRAO	**hemi-CRAO**
no information	8	1
< 0.1 (20/200)	14	5
0.1-0.4 (20/200-20/50)	26	4
0.5-0.6 (20/40-20/32)	24	4
0.7-1.0 (20/30-20/20)	61 (48.4 % of 126 patients)	15 (51.7 % of 29 patients)
total:	> 0.5: 85 (67.5 % of 126 patients)	> 0.5: 19 (65.5 % of 29 patients)

Table 11. Frequency of emboli in 134 patients with BRAO.

Occlusion of macular artery	**Occlusion of inferior temporal artery**	**Occlusion of superior temporal artery**	**Occlusion of inferior nasal artery**	**Occlusion of superior nasal artery**
9 patients (6.7 % out of 134 patients)	53 patients (39.6 %)	47 patients (35.1 %)	1 patient	1 patient
visible Emboli: 3 out of 9 arteries (33.3 %)	visible Emboli: 27 out of 53 arteries (50.9 %)	visible Emboli: 20 out of 47 arteries (42.6 %)	1 Embolus (0.75%)	1 Embolus (0.75%)
Occlusion of cilioretinal artery	**Occlusions of two or more branch arteries (temporal and nasal arteries)**	**Occlusions of two or more branch arteries (temporal and inferior arteries)**		
4 (3. %)	5 patients	14 patients (10.4 %)		
Embolus: 1 (25 %)	**Emboli: 2 (40%)**	**Emboli: 8 out of 14 patients (57%)**		
total Emboli: 63 (47 % out of 134 patients)				

(65.5 % out of 29 patients) visual acuity was better than > 0.5 (Table 10).

Table 12. Amaurosis fugax (AF) in patients with retinal arterial occlusion.

	males	**females**	**total**
BRAO	13	5	18 (13.4 % out of 134 patients)
CRAO	24	7	31 (12.3 % out of 253 patients)
hemi-CRAO	4	1	5 (17.2 % out of 29 patients)
total:	41	13	54 (13 % out of 416 patients)

Embolic Occlusions of Retinal Arteries

CRAO or BRAO may occur due to an embolus originating from a stenotic internal carotid artery, from plaques within the aortic arch or from a diseased heart.

The severity of embolism in the retinal arteries depends on the type, quantity and size of the emboli.

Beyond embolism as a cause thereof, a CRAO may also occur in arterial hypertension, be due to an arterial spasm, particularly in migraine. 63 emboli (47 %) were found in 134 patients with BRAO (Table 11).

Emboli were found in 28 out of 253 patients with CRAO (11.1 %).

Fundus examination of visible emboli occurred significantly more often in patients with BRAO (63 patients, 47 % out of 134 patients) and in 12 (41.4 % of 29 patients) patients with hemi-CRAO compared to patients with CRAO (28 patients, 11.1 % out of 253 patients). Emboli were found in the superior retinal periphery in 5 patients and in the inferior periphery in 7 patients with hemi-CRAO. The difference in the prevalence of visible emboli between patients with CRAO and those with BRAO was highly significant ($p = 0.0001$), and between those with BRAO and hemi-CRAO ($p = 0.0001$).

Two or more very small glittering emboli were occasionally observed in the small retinal arterioles close to the macula in patients with CRAO. Single emboli in CRAO resembled small, glittering, yellowish crystals. Patients with BRAO usually presented one embolus, rarely revealing two or more emboli.

Amaurosis fugax (AF)

AF episodes in patients with BRAO, CRAO, or hemi-CRAO were reported in 13% of the patients. No statistical defference between the three different types of arterial ocular obstruction was found (Table 12).

Retinal Arterial Occlusion despite Phenprocoumon Therapy

Phenprocoumon did not prevent retinal arterial occlusion in 19 patients (4.6 %).

Retinal infarctions occurred despite treatment with phenprocoumon (MarcumarR) in 11 patients with CRAO, in 6 patients with BRAO, and in two patients with hemi-CRAO.

Discussion

Our examinations of patients with ocular arterial occlusive diseases showed that the main cardiovascular RF was arterial hypertension. However, no significant difference among BRAO, CRAO, and hemi-CRA patients was observed.

Other cardiovascular RFs, such as those revealing during Duplex/Doppler sonography (i.e. carotid artery diseases), diabetes mellitus, hyperlipidemia, hyperuricemia, and anomalies caused by chronic smoking revealed no statistical differences among patients with BRAO, CRAO or hemi-CRAO either. No significant difference was found among the patients of the three ocular diagnoses with respect to amaurosis fugax. A slight difference between the patients with CRAO and BRAO was found in cardiac arrhythmia, mainly in terms of chronic atrial fibrillation. However, the number of examined patients was too small to make a final judgement.

But a highly significant difference was found in the frequency of patients with retinal emboli. Those with BRAO had many more visible emboli in retinal arteries than patients with CRAO. In the BRAO group, emboli were found in 47 % of 134 patients, but in only 11.1 % of 253 patients in the CRAO group.

Emboli in patients with CRAO are not visible in most patients´ retinas because it is assumed that emboli obstruct the central retinal artery in the vicinity of the lamina cribrosa, as demonstrated histologically by Manz [18].

Visual acuity in most of our patients with BRAO and hemi-CRAO was normal or somewhat reduced, because the macula is not usually affected or is only partly involved. In contrast, patients with CRAO are by definition either totally blind or possess highly impaired visual acuity [4, 14, 24].

Comparing our data to those in the literature: Wilson et al. [29] showed that 68 patients with branch-artery occlusion (BRAO) had a higher prevalence of previous transient episodes and ischemic and valvular heart disease, and that they were more often embolic than 35 patients with central-artery occlusion (CRAO) who were more often hypertensive and showed a greater prevalence of complete carotid occlusion. Shah et al. [26] examined 14 patients with CRAO and 15 with BRAO. They found that the incidence of carotid atherosclerosis was similar among the central and branch retinal arterial groups. De Potter & Zografos [9] published a retrospective study including 151 patients with retinal artery occlusions. CRAO was diagnosed in 43% of the patients, BRAO in 53%, and cilioretinal artery occlusion in 4 %. They found a highly frequent arterial hypertension only, but no other RFs in patients with BRAO and CRAO. ICA stenosis was detected in 50% of 46 examined patients. Rüfer et al. [20] compared cardiovascular risk factor in patients with BRAO and CRAO. However, their CRAO pa-

tients also included patients with inflammatory diseases such as giant cell arteritis, making their data not comparable to our findings.

Regarding the comparison of RFs in patients with anterior ischemic optic neuropathy (AION): Hayreh et al. [13] reported prevalence rates of systemic diseases in patients with AION, noting a significantly higher prevalence of arterial hypertension and diabetes mellitis. Middle-aged and elderly patients showed a significantly higher prevalence of ischemic heart disease. However, they carried out no carotid artery examination. Our previous investigation [22] showed that patients with AION rarely present a high degree of stenosis or occlusion.

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