Special Focus, Retina, Original Article

Vitrectomy with arteriotomy and neurotomy in retinal artery occlusion – A case series

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Purpose: This study aimed to investigate the visual outcomes and anatomical changes after vitrectomy for retinal artery occlusion. **Methods:** Twelve patients with retinal artery occlusion (11 central retinal artery occlusion and 1 branch retinal artery occlusion) were part of this study. Our patients were treated with vitrectomy with arteriotomy or with neurotomy and arteriotomy. Complete ophthalmic examination was performed preoperatively, at 2 weeks, and 1, 3, 6, 9, and 12 months after surgery. **Results**: The mean preoperative best-corrected visual acuity (BCVA) was 1.94 logMAR, and the final BCVA after 12-months follow-up was 2.04 logMAR. After vitrectomy with arteriotomy, the BCVA in patients treated with neurotomy and arteriotomy was 1.65 and 2.45, respectively ($P = 0.038$). **Conclusion**: No benefits have been achieved from using vitrectomy in retinal artery occlusion cases.

Key words: Radial optic neurotomy, retinal artery occlusion, surgical embolectomy, vitrectomy

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The group of retinal artery obstructive diseases includes central retinal artery occlusion (CRAO), the occlusion of its branches (BRAO), cilioretinal artery occlusion, and cotton-wool spots, which represent precapillary arteriolar flow occlusion in the superficial plexus.[1] CRAO and BRAO need prompt medical intervention. The time between the onset of retinal artery occlusion to retinal infarction is crucial and can help prevent permanent visual loss. Treatment options in these cases can either be conservative or surgical.[2] Conservative methods include sublingual isorbide nitrite, rebreathing of expired carbon dioxide, hyperbaric oxygen treatment, ocular massage, and topical antiglaucoma drops. Surgical treatment for RAO include anterior chamber paracentesis, vitrectomy with incision of the blocked arteriole, Nd:YAG laser therapy, and intravenous and intraarterial thrombolysis.[2-5]

However, there is currently no consensus on a single recommended therapy that demonstrates clear efficacy over the others. We need to search for effective treatment options to restore flow in the affected vessel, thus providing potential opportunities to improve visual acuity.

In this paper, we present 12 cases of RAO in which, after conservative treatment and paracentesis, a decision was made to perform vitrectomy with arteriotomy or radial neurotomy and arteriotomy.

Methods

This retrospective study included an analysis of 12 eyes in 12 patients (4 females and 8 males). All patients presented visual deterioration for 24 h or more upon their visit to our institution's ophthalmology emergency room. After a complete ophthalmic examination that included indirect ophthalmoscopy, RAO (11 CRAO and 1 BRAO) was diagnosed without ciliary artery sparing in 11 cases, and with ciliary artery sparing in one case. In all cases with identified embolic material, Hollenhorst plaques were noticed. Conservative treatment was first implemented. Intraocular pressure-lowering drugs (per os 2 tablets of acetazolamide and intraocular pressure-lowering drops: timolol and brimonidine) were administered, and ocular massage was performed for 10 min by using a Goldman-type gonioscope. Finally, paracentesis was performed. Laboratory tests excluded the coexistence of giant cell arteritis.

Imaging diagnostics included SS-OCT, angio-OCT (Swept-source OCT, DRI-OCT, Topcon, Japan), and fluorescein angiography (Topcon, TRC-50EX, Japan).

The detailed characteristics of our patients are presented in Table 1.

No reperfusion after conservative methods and paracentesis were obtained and confirmed in ophthalmic examination and fluorescein angiography. All patients were informed about the natural course of the disease and available treatment options. After prolonged discussions with patients and obtaining written informed consent, 3-port vitrectomy was performed under periocular anesthesia by using the 23-G system. The

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procedure was started with cortical vitrectomy. Membrane Blue Dual® (DORC, Rotterdam) was used for staining. The stain was rinsed out after 1 min, and this was followed by induction of the posterior vitreous detachment. The location of the embolus or emboli, their number, and the extent of ischemia determined the type of surgical intervention undertaken.

Arteriotomy

In patients with a single visible embolus in the arterial vessel, the arterial vessel was longitudinally incised above the blockage material by using vitrectomy vertical scissors [Fig. 1].

Arteriotomy with neurotomy

Radial neurotomy with arteriotomy was performed without sparing the ciliary artery in patients with CRAO, with unidentified embolic material, or with multiple emboli and low visual acuity (logMAR >2.0) [Fig. 2a–c].

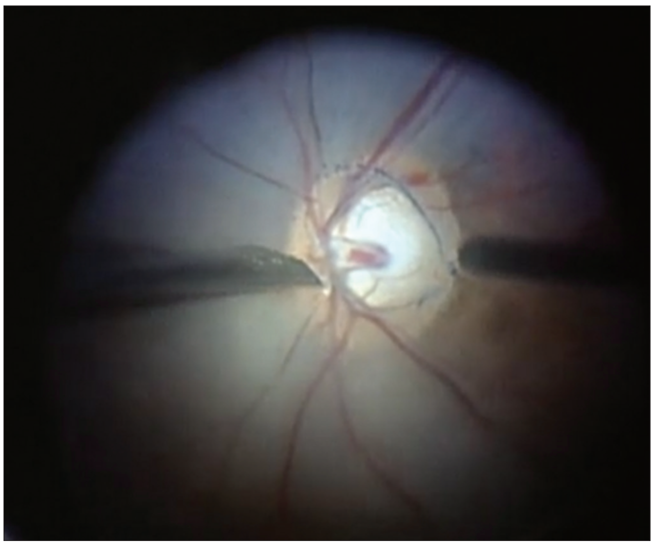

Figure 1: Intraoperative image. Central retinal artery occlusion with the embolic material on the optic disc

Two radial incisions of the optic nerve were made using a 20-G needle at a depth of approximately 1.5 –2.0 mm in its nasal part between vessels. Arteriotomy was then performed on several arterial vessels most affected by the pathology, which are those that are constricted and with multiple emboli. We did not observe any significant bleeding in any of the cases.

At the end of the procedure, fluid–air exchange was performed while maintaining the hypotonic state for 3–4 min. After that, we were able to observe the laminar reperfusion.

All patients underwent postoperative examinations 2 weeks, 1 month, 3 months, 6 months, 9 months, and at least 12 months after surgery. A complete ophthalmic examination with diagnostic imaging (SS-OCT and angio-OCT) was performed during follow-up.

The statistical analysis encompassed generalized linear models (GLM) with robust standard errors and the Kruskal–Wallis test. Two-sided tests were fitted. A level of $P < 0.05$ was deemed statistically significant. The statistical analyses were performed using Stata/Special Edition, release 14.2 (StataCorp LP, College Station, Texas, USA).

Results

The mean preoperative visual acuity was 1.94 logMAR (range: 0.49–2.8 logMAR). After a 12-month follow-up period, the value was 2.04 logMAR. A detailed analysis of the changes in visual acuity is shown in Fig. 3.

We then analyzed the preoperative visual acuity. The mean BCVA for patients with multiple emboli was 2.26 (SD = 0.29) and for those with single embolus was 1.52 (SD = 1.00) ($P = 0.180$). During the last visit after a 12-month follow-up period, the final visual acuity averaged 1.65 in patients after arteriotomy (SD = 0.67) and 2.45 after neurotomy with arteriotomy (SD = 0.44) ($P = 0.038$).

One patient developed neovascular glaucoma 2 weeks after hospitalization. The patient was treated with panretinal photocoagulation.

Table 1: Patient data

Patient No.	Age	Sex	Embolus	Procedure	BCVA before ppV	Final BCVA	Other
1	65	F	on the optic nerve disc in the arterial vessel	arteriotomy	1.8	1	VH
2	66	M	multiple	arteriotomy	2	1	-
3	78	M	on the optic nerve disc in the arterial vessel	arteriotomy	2.8	3	Rubeosis iridis
4	68	M	on the optic nerve disc in the arterial vessel	arteriotomy	1	1.5	-
5	78	F	multiple	neurotomy + arteriotomy	2.3	2.3	VH
6	62	M	multiple	neurotomy + arteriotomy	2.3	2.8	VH
7	62	M	multiple	neurotomy + arteriotomy	2.3	2.8	-
8	72	M	multiple	neurotomy + arteriotomy	2.3	1.7	-
9	74	M	multiple	neurotomy + arteriotomy	2.3	2.3	-
10	77	F	multiple	arteriotomy	1.8	1.8	cilioretinal artery sparing
11	68	M	on the optic nerve disc in the arterial vessel	arteriotomy	0.5	2.3	BRAO
12	80	F	multiple	neurotomy + arteriotomy	2.8	2.8	-

Patient data. F - Female, M - Male, BCVA - Best-corrected visual acuity, ppV - Pars plana vitrectomy, VH - Vitreous hemorrhage

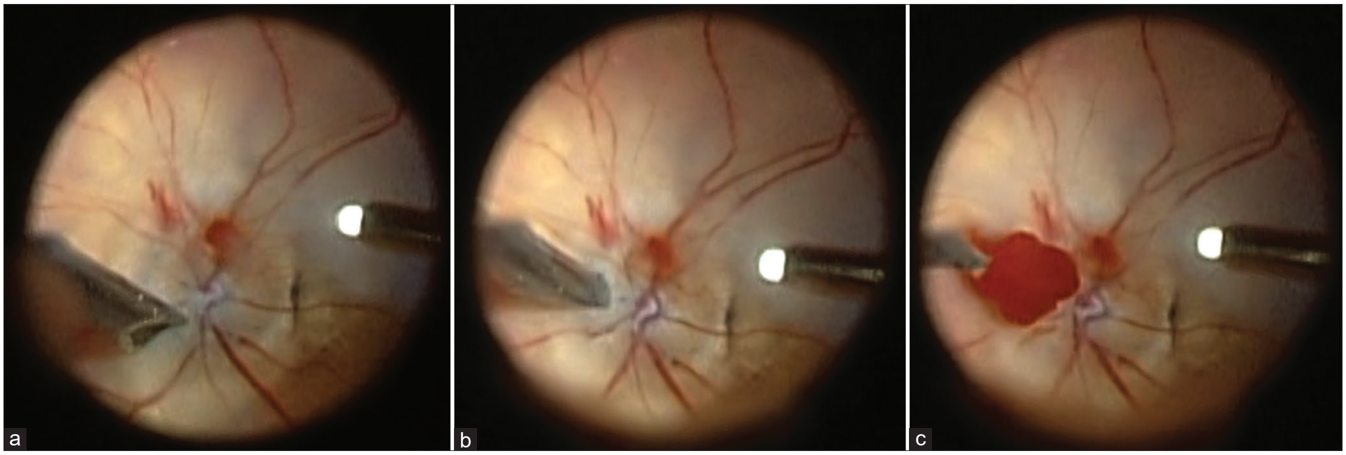

Figure 2: Intraoperative image. RON procedure: a) first incision with a needle; b) second incision with a needle; c) subsequent bleeding

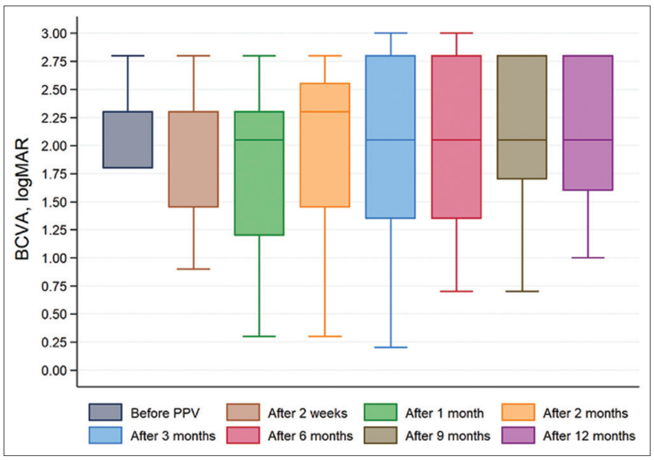

Figure 3: Analysis of changes in best-corrected visual acuity (BCVA), (logMAR) versus time change in BCVA (logMAR) versus time

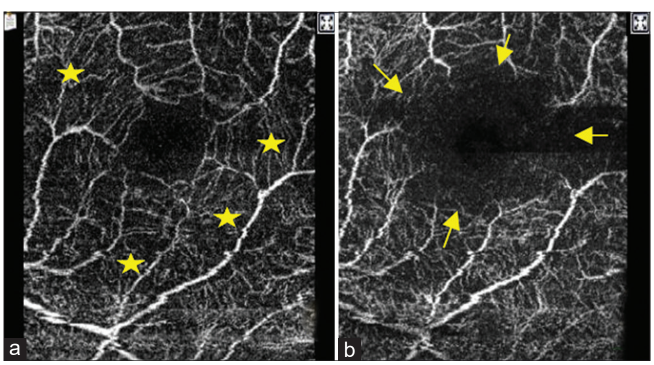

Figure 4: (a, b) Angio-SS-OCT of a patient with central retinal occlusion (CRAO) (patient 1 in Table 1). A- superficial capillary plexus (SCP). Reduced vessel density (asterisk). B- deep capillary plexus (DCP). Widening of the FAZ (arrow). The reduction in perfusion is greater in DCP

The imaging findings were then analyzed. For patients with a single embolus, there was a reduction in the density of the vascular network in the superficial capillary plexus (SCP) and a widening of the FAZ in the deep capillary plexus (DCP) [Figs. 4 and 5]. On the contrary, among patients with multiple emboli, there was significant loss of flow in both retinal capillary plexuses [Fig. 6].

The changes in angio-SS-OCT over time were then analyzed. In one patient with BRAO, an increase in capillary density was observed 6 months after surgery in the SPC and DPC [Fig. 7]. In all other cases, there were no improvements in vessel density.

Discussion

Surgical embolectomy for RAO remains controversial. Its variant is laser embolectomy, which aims at extrusion or fragmentation of the embolus.[6] The limitation of this method is the need to identify the embolic material, which occurs in 20%–40% of cases according to the literature.[7]

With the aim of returning perfusion to the affected vessel as quickly as possible, surgical embolectomy was the only potential option for successful treatment in the patients in our study. Conservative methods with paracentesis were not effective. In addition, a long period of more than 24 h between the onset of symptoms and presentation to the ophthalmologist is an unfavorable prognostic factor.[8] Surgical intervention seemed to be the only option to potentially improve vision.

Radial neurotomy with embolectomy was performed in six patients. Radial incision of the optic nerve disc (RON) was first described by Opremcak *et al*.[9] as a treatment for patients with central retinal vein occlusion. It is based on the treatment of a pathomechanism referred to as scleral outlet compartment syndrome. RON causes relaxation of the scleral ring and improves arteriovenous flow. We assume that in patients with profound ischemia who have multiple constrictions but without the presence of embolism under fluorescein angiography, the emboli must be located in vessels at the level of the scleral lamina or just behind it. Unfortunately, this cannot be visualized using available diagnostic tools. Performing an RON can potentially contribute to pushing embolic material to the periphery.

We analyzed the qualitative and quantitative microvascular changes in individual retinal layers by using angio-SS-OCT. Decreased density of capillary collaterals was observed in both retinal plexuses and was greater in DCP among patients with single embolisms. In patients with multiple emboli, ischemia affected all the layers.

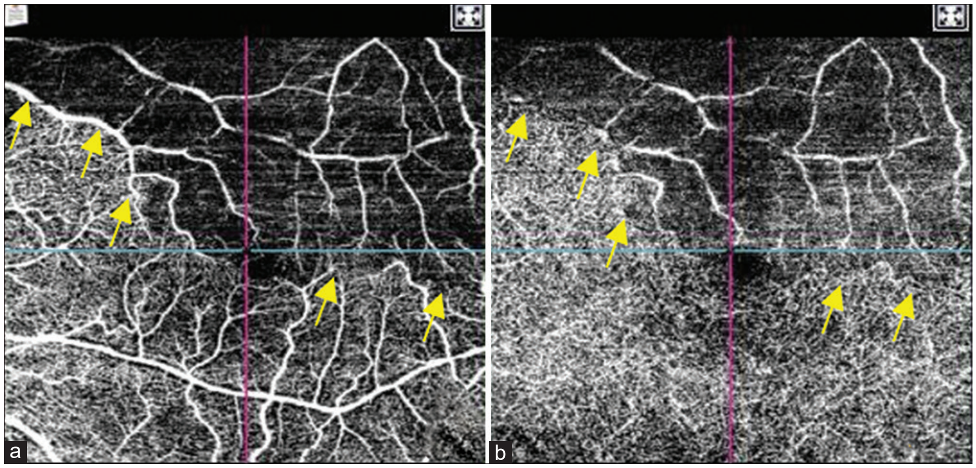

Figure 5: (a, b) Angio-SS-OCT of a patient with branch retinal artery occlusion (BRVO) (patient 11 in Table 1). A- superficial capillary plexus (SCP). Lateral branches loss after an embolic episode (arrow). B- deep capillary plexus (DCP). Visible loss of capillaries (arrow). Images A and B show a correlating area of ischemia.

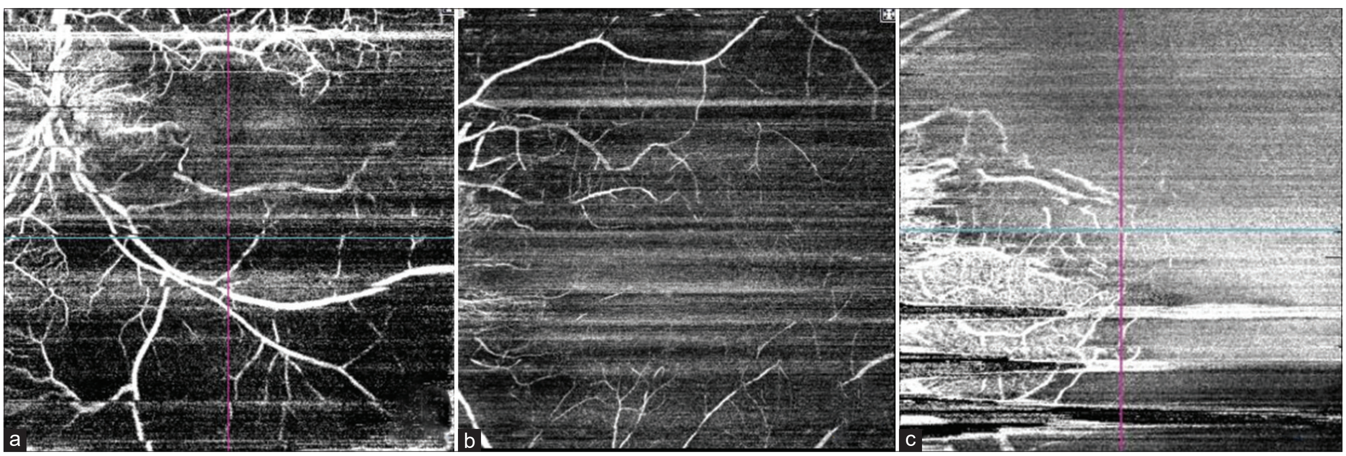

Figure 6: (a, b, c) Angio-SS-OCT of patients with central retinal occlusion (CRAO) and multiple emboli (patient 7 in Table 1). Noteworthy significant features of ischemia with capillary loss. Numerous motion artifacts

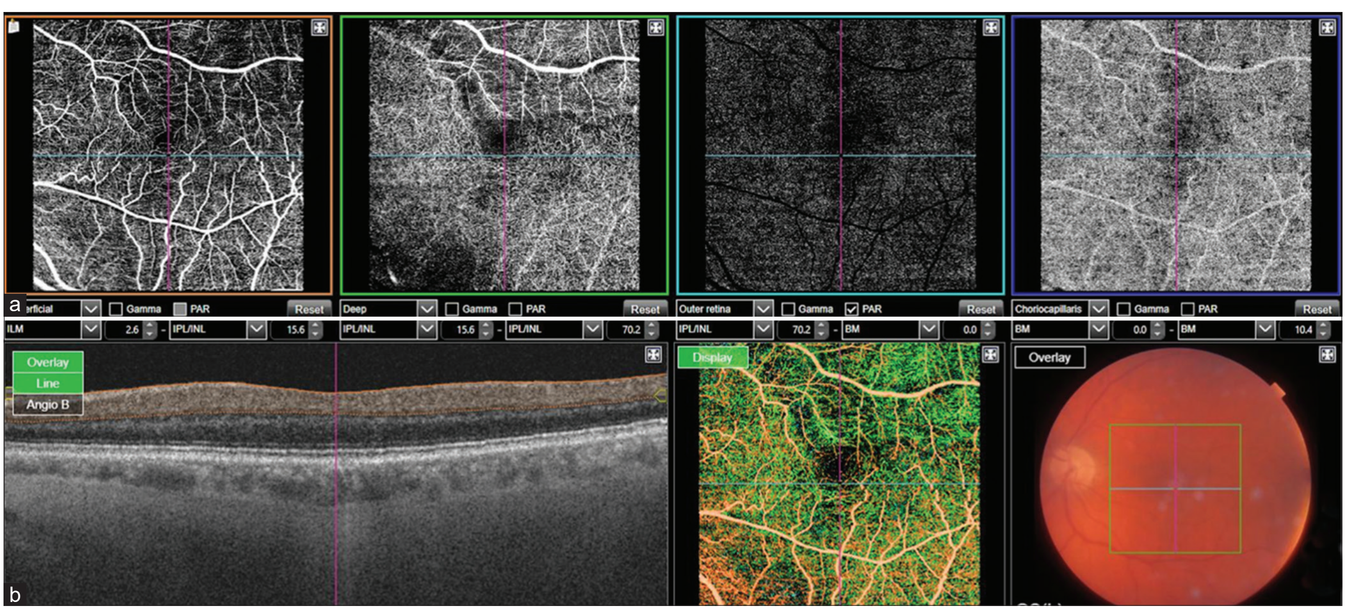

Figure 7: (a, b) Angio-SS-OCT of the patient with BRAO at baseline (a) and 6 months after surgery (b)

During the follow-up period, we observed an improved anatomical finding in one patient, in the form of capillary thickening in both vascular plexuses. The percentage of patients with improvements may have been greater if not for the difficulty in interpreting the angio-SS-OCT results. Massive swelling of the inner retinal layers masks the individual layers in the image.

Furthermore, the mean visual acuity improved compared with the preoperative visual acuity. It should be mentioned that according to data from previous literature, BCVA can also improve spontaneously without any intervention. Hayreh *et al*.[10] report that this occurs within 7 days in 67% of eyes with CRAO with ciliary-retinal artery sparing and in 22% of eyes with CRAO without ciliary-retinal artery sparing. In BRAO cases, there is far better visual prognosis both at presentation and during the final visit.[11] Ros *et al*.[12] reported that more than three-fourths of subjects with BRAO exhibit an initial acuity of 0.5 or better. However, the mean visual acuity decreased in patients with multiple emboli, probably resulting from the profound ischemia observed in angio-SS-OCT.

Conclusion

In this small case series, we did not observe any significant changes in postoperative OCT, OCT-A, and fluorescein angiography after arteriotomy or arteriotomy with neurotomy in CRAO or BRAO. Our study is not designed to determine factors affecting outcomes in RAO, and this needs further evaluation.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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