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Evaluation of the Foveal Avascular Zone Alterations through Optical Coherence Tomography Angiography in Eyes with Retinal Vein Occlusion

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ABSTRACT

Background: To detect the effectiveness of OCT-A in the evaluation of the foveal avascular zone (FAZ) alterations in eyes with retinal vein occlusion.

Objectives: To investigate the relationship between best-corrected visual acuity (BCVA) and the FAZ in patients with (RVO) evaluated with (OCT-A) in comparison to the unaffected fellow eyes.

Patient and Methods: The current study was performed between August 2018 and December 2019, on 15 patients attending to Al- Sayed Galal Hospital during the time of the study. We retrospectively reviewed the medical records of 15 patients with (RVO); BRVO in 8 patients, CRVO in 7 patients) and we considered the unaffected fellow eyes of these patients as a control group, who were evaluated by OCT-A by a 6 mm × 6-mm region scan centered on the fovea and parafoveal area. The (FAZ), and foveal and parafoveal vascular density in superficial and deep vascular plexuses were analyzed.

Result: The mean superficial FAZ area (SL FAZ area) measured 0.40mm in the study group and 0.30mm in the control group. The mean deep FAZ area(DL FAZ area) measured 0.46 mm in the study group and 0.35 mm in the control group. The SL FAZ and DL FAZ areas in eyes with RVO were larger than those in control eyes (P = 0.002, P = 0.033).We found a negative correlation between the BCVA and the superficial FAZ area in eyes with RVO (r = _0.42, P = 0.11).We found a negative correlation between the BCVA and the deep FAZ area in the control group(r=_0.30, P 0.26).

Conclusions: OCT-A allows for detecting FAZ enlargement.Also, we found a statistically significant negative correlation between FAZ enlargement and BCVA in patients with RVO.

Keywords: Optical Coherence Tomography angiography; Retinal vein occlusion; Foveal avascular zone; visual acuity.

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INTRODUCTION

Retinal vein occlusion is the second commonest retinal vascular disorder after diabetic retinopathy (DR) and is considered a significant cause of loss of vision.[1] Retinal vein occlusions result in loss of vision by macular edema (ME), macular ischemia, foveal hemorrhage, submacular scarring, macular holes and lamellar holes, vitreous hemorrhage, epiretinal membrane, as well as tractional retinal detachment.[2]The FAZ is the capillary free zone in the central macula, and it is comprised histologically as a region exclusively containing photoreceptors with elongated outer segments. A precise and reliable method of measuring FAZ area and microvascular structure might play an important role in retinal vascular diseases that influence FAZ such as DR and RVO.[3] OCT-A allows reconstruction of 3D chorioretinal vasculature with no dye injection.[4]The the procedure utilizes the movement of erythrocytes in retinal circulation for the creation of an image of blood flow within the retina.[5] This permits a segmented assessment of FAZ and para-foveal capillary networks.[6] OCT-A allows separating the superficial and deep vascular network.[7] OCT-A is a useful tool for assessing the foveal avascular zone (FAZ) area in healthy and diseased subjects.[8]

The current work aims to assess the association between BCVA and FAZ among cases with RVO examined by OCT-A in comparison to the unaffected fellow eye.

PATIENT AND METHODS

The current study was performed between August 2018 and December 2019, on 15 patients attending to Al- Sayed Galal Hospital during the time of the study. The study included cases with RVO (branch retinal vein occlusion in 8 cases, central retinal vein occlusion in 7 cases) and we considered the unaffected fellow eyes of these patients as a control group. We considered the diseased eyes as cases group (group A) and the normal fellow eyes as a control group (group B).The entire patients administered at least 3 intravitreal anti-VEGF injections before OCT-A assessment and had then no evidence of ME as revealed by SD-OCT. We obtained6×6-mm OCT angiograms centered on the macula with the patient's gaze on central fixation En face OCT angiograms were segmented into 4 layers, namely superficial vascular plexus, deep vascular plexus, outer retina, and choriocapillaris. Superficial layer was measured from the internal limiting membrane to 15 lm beneath the inner plexiform layer (IPL) and the deep layer from 15 lm below IPL to 70 lm beneath the IPL. Foveal avascular zone areas were examined by OCT-A in both superficial and deep capillary plexus layers through the usage of 6×6–mm images of macula and this was compared to the unaffected fellow eyes.

The work included 2 Groups: Group (A) (15 eyes with RVO), Group (B) (15 normal eyes of the same patients in group A).

Inclusion criteria:

A fundus without significant ME in eyes with CRVO and BRVO, age between 20 – 70 years old of either gender and the normal fundus of the unaffected fellow eyes.

Examination included:

BCVA.

Evaluation of anterior segment.

Measuring intraocular pressure using applanation tonometer.

Fundus examination with indirect ophthalmoscopy and slit-lamp biomicroscopy.

OCTA was performed using swept-source (Topcon OCT Triton).

Exclusion criteria:

Previous intraocular surgical intervention within the last 6 months.

Previous laser photocoagulation.

Presence of macular edema.

Dense cataract and other media opacities that are dense enough to preclude adequate image quality for appropriate interpretation.

Glaucoma.

Diabetic retinopathy.

Statistical analysis

The collected data were coded, processed, and analyzed using SPSS (Statistical Package for Social Sciences) version 22 for Windows® (IBM SPSS Inc, Chicago, IL, USA). Data were tested for normal distribution by the Shapiro Walk test. Qualitative data were expressed as frequencies and relative percentages. Chi-square test ($\chi 2$) and Fisher exact were utilized for calculation of the difference between qualitative variables. Quantitative data were represented as mean ± SD (Standard deviation). Independent samples t-test was utilized for comparison between two groups of normally distributed variables (parametric data) whereas the Mann Whitney U test was utilized for non-normally distributed Data (non-parametric data). Spearman's correlation was utilized to test the association between two variables with non-parametric quantitative data.P-value < 0.05 was considered significant.

RESULTS

Table 1 shows no statistically significant difference between groups according to demographic data. There was a statistically significant enlargement of DL FAZ area in group A than group B as shown in table 2 and also SL FAZ area was larger in group A than group B as shown in table3.BCVA was better in group B than group A as shown in table 4.There was a significant negative association between DL FAZ area BCVA in group A as shown in table 5, while table 6 showed a significant negative association between SL FAZ area BCVA in group A.

		Groups		P-value
		Group A	Group B	
Deep FAZ area	Mean ± SD	0.464 ±0.229	0.356± 0.205	0.033*
	Median (range)	0.337 (0.299- 0.920)	0.301 (0.138- 0.864)	

Table 1: Comparison between groups according to demographic data.

		Groups		P-value
		Group A	Group B	
Deep FAZ area	Mean ± SD	0.464 ±0.229	0.356± 0.205	0.033*
	Median (range)	0.337 (0.299- 0.920)	0.301 (0.138- 0.864)	

Table 2:comparison of DL FAZ area between group A and group B.

		Groups		**P-value**
		Group A	**Group B**	
Superficial FAZ area	Mean ± SD	0.409 ±0.173	0.308 ± 0.129	0.002*
	Median (range)	0.351 (0.222- 0.729)	0.312 (0.113- 0.619)	

Table 3: comparison of SL FAZ area in group A and group B.

		Groups		P-value
		Group A	Group B	
BCVA	Mean ± SD	0.425 ± 0.142	0.808± 0.091	<0.001*
	Median (range)	0.45 (0.10-0.60)	0.8 (0.7-1)	

Table 4: Comparison between groups according to mean a change of BCVA.

	DL FAZ area	
	r	p
BCVA	-0.305	0.269

Table 5: correlation between DL FAZ area and BCVA in group A.

	SL FAZ area	
	r	p
BCVA	-0.168	0.602

Table 6: correlation between SL FAZ area and BCVA in group A.

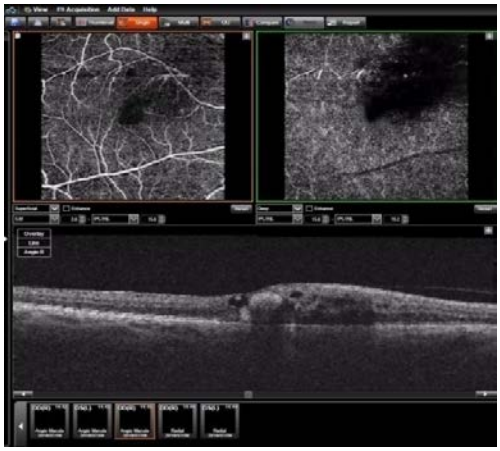

Fig. 1: case No 1
OCT-A report of BRVO of the right eye in a 58-year-old male patient showing markedly enlarged FAZ outside the 6×6–mm cube in both superficial and deep capillary plexuses making measurement impossible.

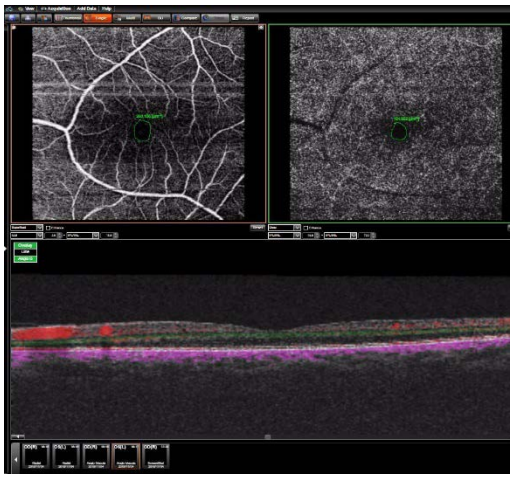

Fig. 3: case No 1.

OCT-A report of the normal left eye in the same patient in figure (1) showing both SL FAZ area and DL FAZ area measuring 0.26mm and 0.18 mm respectively.

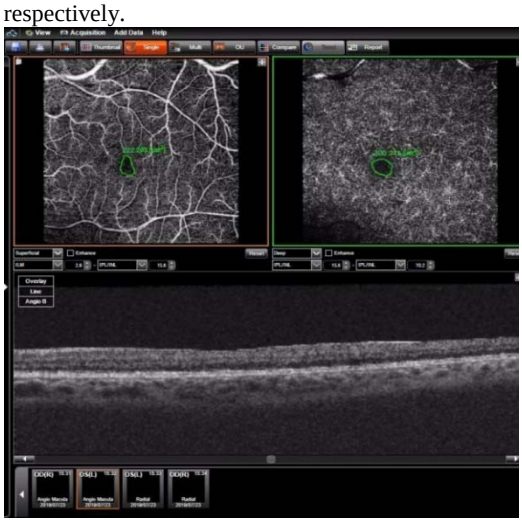

Fig. 5: case No 2.

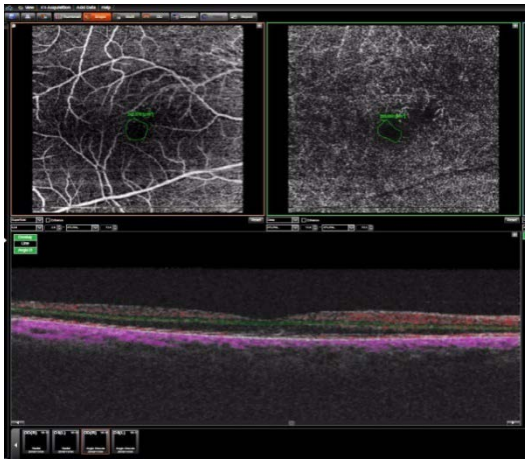

Fig. 2: case No 1.
OCT-A report of the same eye in Figure (1) after receiving three anti-VEGF showing both SL FAZ area and DL FAZ area measuring 0.34mm and 0.29 mm respectively.

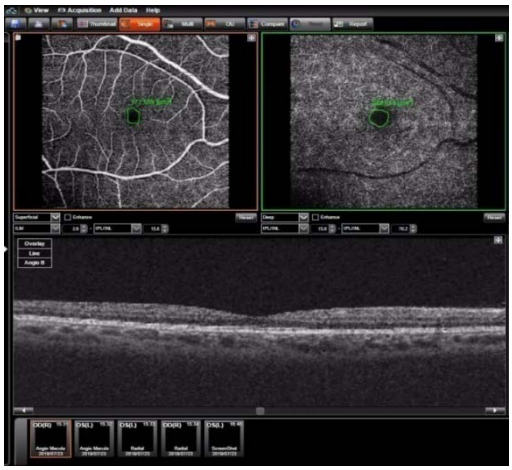

Fig. 4: case No 2

OCT-A report of the normal right eye in 29 years old female with SL FAZ area measuring 0.17mm and DL FAZ measuring 0.22mm.

OCT-A report of the left eye of the same patient in figure (4) showing CRVO with SL FAZ area measuring 0.22mm and DL FAZ area measuring 0.30mm.

DISCUSSION

This work to retrospectively assess FAZ area and its correlation with BCVA in CRVO and BRVO individuals with no ME underwent anti-VEGF therapy by OCT-A. OCT-A is a novel and non-invasive imaging device that permits visualization of retinal microcirculation through the detection of intravascular blood flow with no dye injection. It might be utilized in daily practice and might, in the future replace invasive procedures.[9]

OCT-A permits segmental examination of retinal capillary networks.[10]

Rispoli,et al.[11] showed capillary network anomalies such as FAZ enlargement, capillary non-perfusion, microvascular deformities, as well as vascular congestion signs in both superficial and deep capillary network in RVO. However, our study only focused on FAZ enlargement and capillary non-perfusion in RVO using OCT-A. In the current work, patients first administered at least three anti-VEGF injections till ME had been resolved to rue out the effect of ME on the visual outcome while in Casselholm de Salles M, et al .[12] patients administered at least 4 anti-VEGF injections.

The SL FAZ area in the study group ranged from 0.22 to 0.72mm.The SL FAZ area in the control group was ranging from 0.11mm to 0.61mm.The mean SL FAZ area was measured 0.40mm in the study group and 0.30mm in the control group respectively. The DL FAZ area in the study group was ranging from 0.29mm to 0.92mm.The DL FAZ area in the control group was ranging from 0.13mm and 0.86mm.The SL FAZ area was significantly enlarged in the study group than the control group and this is consistent with the study of Rispoli,et al.[11]. However, in the study of Joon-Won Kang,et al.[13], superficial FAZ area in an eye with RVO was marginally larger than that in fellow eyes. The DL FAZ area was significantly enlarged in the study group than the control group and this is consistent with the study of Joon-Won Kang,et al.[13] and also the study of Rispoli,et al.[11] FAZ enlargement indicates enlargement in the area of ischemia or non-perfusion. In the current work, we reported that deep capillary plexus was markedly influenced compared with superficial capillary plexus in RVO and such result is in agreement with the study of Coscas,et al.[14] Joon-Won Kang,et al.[13] showed that the DCP is more vulnerable to the ischemic change in RVO. This result suggests that ischemic damage by RVO in the DCP, resulting in decreased parafoveal VD, can cause visual acuity impairment. Many causes for the severity of deep capillary involvement have been proposed. This may be due to that SL has a more direct arterial supply from retinal arterioles resulting in greater perfusion pressure than that of deeper micro-circulation. outer retinal oedema could result in liquefactive necrosis of tissue causing damage of photoreceptors and reduction of foveal functions.[15] Also, superficial plexus drains through transverse venules into deep plexus.[16] In our study, we reported a significant negative association between SL FAZ area and BCVA and this result is consistent with the study of Casselholm de Salles M, et al.[12] We reported also a significant negative association between DL FAZ area and BCVA and this result is not consistent with the study of Casselholm de Salles M, et al.[12] in which the association between BCVA and DL FAZ area was not statistically significant. Coscas, et al.[14] did not report any association between disrupted perifoveal capillary network and BCVA. However, authors did not specifically measure FAZ area and their cases had different ME degrees likely influencing the vision. In our study, we considered the unaffected fellow eyes as a control group while in the study of Casselholm de Salles M, et al.[12], there was no control group. The study of Casselholm de Salles M, et al.[12] used 3 mm cube so six patients had DL FAZ area were reaching outside this consequently, we used a 6 mm cube in our study to avoid this. There are several limitations of the study: A segmentation error of the superficial/deep layers can be a retinal concern in case of disturbed morphologic features of the retina. However, by only including cases with no ME we can decrease such risk. Furthermore, projection artifacts are frequently observed within deep layers which represent vessels from superficial circulation. To reduce the artifact, the patients need to focus on the OCT angiography machine for a few seconds, and it is not always easy to acquire a clear macular image especially in patients with poor fixation.Another limitation of this study is its cross-sectional retrospective nature and the relatively few cases. Therefore, the eyes with RVO have different follow-up periods.

CONCLUSION

This work shows the potential clinical relevance of OCT-A as a new non-invasive imaging device, providing the vascular details including superficial and deep capillary plexuses. The OCT-A permits detecting FAZ enlargement increased parafoveal capillary non-perfusion in eyes with RVO. In this study, a statistically significant negative association between FAZ enlargement and BCVO was detected in patients with RVO using OCT-A. The latter can offer more information for the assessment of cases with RVO and can help the prediction of long-term visual outcomes. Now, OCT angiography can present the quantitative data of the SCP and DCP, and this

will provide more detailed information on the vascular network in retina vascular disease.

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