ORIGINAL ARTICLE

# Optical Coherence Tomography Angiography in Retinal Vein Occlusion: Correlation between Foveal Avascular Zone Area and Visual Acuity

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## ABSTRACT

**Purpose:** To find out correlation between visual acuity and deep capillary plexus (DCP) in foveal avascular zone (FAZ) area using OCTA in patients with retinal vein occlusion (RVO).

**Study Design:** Descriptive observational study.

**Place and Duration of Study:** Layton Rehmatullah Benevolent trust free Eye Hospital, from September 2018 to December 2019.

**Methods:** This observational study included 50 eyes of 50 patients, who were treated with intra-vitreal anti-VEGF for macular edema secondary to retinal vein occlusion. We excluded patients with macular edema due to other ocular diseases. OCTA was performed in every patient to measure the size of foveal avascular zone. FAZ area of 0.6mm$^2$ or less was taken as normal and any value above that was considered to be larger FAZ. IBM SPSS version 25 was used to analyze the data. Frequencies with percentages were used to present qualitative variables and mean ± SD were calculated for the quantitative variables. P-value ≤ 0.005 was taken as significant.

**Results:** Mean age was 58.38 ± 7.51 years. There were 28 males and 22 females. Mean best-corrected visual acuity was 0.62 ± 0.26 logMar. The patients with normal FAZ area in DCP showed a mean BCVA of 0.51 ± 0.265 logMAR in comparison to those who had larger FAZ in DCP, where the mean BCVA was 0.75 ± 0.204 logMAR. DCP was larger in patients with CRVO than BRVO.

**Conclusion:** OCTA is a good diagnostic tool for qualitative and quantitative evaluation of the deep capillary plexus. Improvement in visual acuity is related with the size of the DCP in FAZ.

**Key Words:** Retinal vein occlusion, Foveal avascular zone, Optical Coherence Tomograghy Angiography.

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## INTRODUCTION

After diabetic retinopathy, retinal vein occlusion is the second most common retinal vascular disorder. The leading cause of decrease vision in patients with retinal vein occlusion (RVO) is cystoid macular edema (CME).[1,2] There are many treatment options for macular edema which include intra-vitreal anti-VEGF, Laser and intra-vitreal steroids. They all have been reported to be effective in reducing macular edema and improving vision. However, intra-vitreal anti-VEGF is found to be superior in treating central macular edema.[3]It has been observed that in many patients there is a poor visual recovery despite complete resolution of macular edema. Thus, there is a need to improve our understanding of pathophysiologic mechanism and anatomically correlate the fovea with its physiological function.

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Fundus fluorescence angiography (FFA) has been the gold standard in RVO diagnosis for many decades. It cannot be denied that it has certain serious adverse reactions including anaphylactic reactions which may range from skin rash and itching to severe anaphylactic shock.[4] Moreover, FFA can evaluate only the superficial layer of the FAZ while studies support that deep capillary plexus (DCP) correlates more significantly with the visual status of the patient.[5] Therefore, there was a search for a non-invasive technique which at the same time achieves non-inferior diagnostic accuracy. Optical coherence tomography angiography (OCTA) is a non-invasive diagnostic technique for the evaluation of micro perfusion in both retina andchoroid.[6,7] The SPECTRALIS OCT-A provides three-dimensional visualization of perfused vasculature of the retina and choroid. It not only analyses the intensity of reflected light but also the temporal changes in the reflection caused by moving particles, such as erythrocytes moving through vessels. Such changes are detected by repeatedly capturing images at each point on the retina and allowing for the creation of image contrast between perfused vessels and static surrounding tissues. This technique enables a depth selective view of blood flow in different retinal layers.[8] The SPECTRALIS OCT-A divides the retinal image into different slabs on the basis of capillary plexus which are superficial capillary plexus, intermediate and deep capillary and avascular layer. Thus, OCTA can be utilized to assess the deeper layer capillaries around fovea instead of only superficial plexus as in FFA.[9,10] Most important vascular changes occur in the DCP, and decreased perfusion and DCP ischemia have significant role in poor visual status. Therefore, the aim of this study was to assess the correlation between visual acuity and deep capillary plexus in the FAZ using OCTA in RVO patients.

## METHODS

This observational study included 50 eyes of 50 patients, who were treated with intra-vitreal anti-VEGF for macular edema secondary to retinal vein occlusion. Patients with more than eighteen years of age were enrolled using non-probability consecutive sampling technique. Subject recruitment started from 1st September 2018 to 31st December 2019. The Hospital Ethics Committee approval was taken prior to the commencement of this study.

We excluded patients with macular edema due to other ocular diseases (such as diabetic retinopathy, and stage 4 hypertensive retinopathy, diagnosed with fundoscopic examination and SD-OCT); those with history of ocular surgery, laser treatment for macular edema, age-related macular degeneration, epiretinal membrane, vitreous hemorrhage, and uveitis; and those with complications of high myopia or with significant media opacities. We also excluded data from those with poor quality images (defined as scan quality < 6/10 or presence of significant artifacts). RVO diagnoses were based on medical and ophthalmic history and complete ophthalmic examination including best corrected visual acuity (BCVA)using a Snellen chart which was converted to logarithm of the minimal angle of resolution (logMAR) unit, slit-lamp biomicroscopic and fundus examinations.In our study, visual acuity equal to or better than 6\24was considered good. Spectral Domain Optical Coherence Tomography (Spectralis, Heidelberg Engineering) was used to confirm macular edema. OCTA was performed in every patient to measure the size of foveal avascular zone. Written informed consent was taken from the patients who fulfilled the criteria for the study. We evaluated 3×3mm OCT angiograms for the measurement of FAZ ($mm^2$) in the DCP (automated segmentation selecting area between inner plexiform layer and outer plexiform layer) by two trained independent graders. FAZ area of 0.6$mm^2$or less was taken as normal and any value above it was considered to be larger FAZ.[11] The scans with poor image quality were repeated and the ones with persistent low-quality images were excluded.

IBM SPSS version 25was used to analyze the data. Frequencies with percentages were used to present qualitative variables and mean ± SD were calculated for the quantitative variables. Visual status was stratified with respect to foveal avascular zone. Independent t-test was applied to determine the significance of difference in BCVA with respect to deep capillary plexus in FAZ. P-value $\leq$ 0.005 was taken as significant.

## RESULTS

There were 50 eyes of 50 patients with resolved macular edema. They underwent OCTA to measure deep capillary plexus in FAZ. Among 50 eyes there were 17 CRVO and 33 BRVO. The mean age was 58.38 ± 7.51 years. Out of them, 28 were males and 22 females. The patients presented with mean best-corrected visual acuity of 0.62 ± 0.26 LogMar. DCP was evaluated using OCT-A manually by two independent observers. It was observed that patients with good BCVA had normal FAZ area as compared to those who had poor BCVA (shown in table 1). It was also found that the patients with normal FAZ area in DCP showed a mean BCVA of 0.51±0.265 logMAR (equal to 6/19 Snellen notation) in comparison to those who had increase FAZ in DCP, where the mean BCVA was 0.75 ± 0.204 logMAR (equal to 6/30 Snellen notation). Independent T test was applied and the difference in BCVA was found to be statistically significant (p-value = 0.001), shown in table 2. It was also seen that DCP was larger in patients with CRVO than BRVO.

**Table 1:** *Correlation between FAZ and BCVA.*

| BCVA Correlated with FAZ AREA | | | | |
|---|---|---|---|---|
| | | FAZ Area | | Total |
| | | ≤ 0.60 | > 0.60 | |
| BCVA | 6\6p | 2 | 0 | 2 |
| | 6\9p | 2 | 0 | 2 |
| | 6\12 | 3 | 1 | 4 |
| | 6\12p | 7 | 0 | 7 |
| | 6\18 | 2 | 4 | 6 |
| | 6\24 | 3 | 3 | 6 |
| | 6\24p | 1 | 5 | 6 |
| | 6\36 | 2 | 1 | 3 |
| | 6\36p | 2 | 5 | 7 |
| | 6\60 | 2 | 5 | 7 |
| Total | | 26 | 24 | 50 |

**Table 2:** *Difference in BCVA.*

| Difference in BCVA with Respect to FAZ | | | | | |
|---|---|---|---|---|---|
| FAZ | | N | Mean | Std. Deviation | Std. Error Mean |
| BCVA | ≤ 0.60 | 26 | .508 | .2652 | .0520 |
| | > 0.60 | 24 | .746 | .2043 | .0417 |

## DISCUSSION

We investigated the patients of retinal vein occlusions with resolved macular edema and measured their deep capillary plexus in FAZ and correlated it with their best corrected visual acuity. We found that those patients who had poor visual acuity despite completely resolved macular edema, actually had larger FAZ in deep capillary plexus. The results of our study are supported by Manuel et al., and others who reported a reduction in vascular densities in both the Superficial capillary plexus (SCP) and DCP, correlating FAZ areas and visual acuities.[12,13,14] This is explained by the ischemia in the deep capillary plexus area which has resulted in increase in size of FAZ.[15] Thus, causing decline in the visual status of the patient.Moreover, it was also observed that the patients with CRVO had larger FAZ than in BRVO. It is because of the fact that ischemia is more pronounced in CRVO than BRVO.[16]

In this study, we found that OCT-A is a valuable tool in investigating the foveal avascular zone, where it is a quick and non-invasive technique. Moreover, it does not require any pre-requisite as in FFA and is capable of evaluating the deeper layer of capillaries in comparison to FFA.[17,18]

In another study it was seen that FAZ was irregular and larger in sizein eyes with BRVO after CME was resolved.[19]

Our study has several limitations. Firstly, it was an observational study and the patients were evaluated at different time after the diagnosis and treatment of RVO. Number of injections were not considered. Furthermore, projection artifacts were commonly encountered, although these were tackled by means of post processing system incorporated in SPECTRALIS OCTA.[20] Finally, the small scan window (3x3 mm) allows accurate evaluation of the central macula but visualization of more peripheral fundus changes is hampered. Nevertheless, our study has the major advantage of the quantitative analysis of angiographic data using OCTA, which has been shown to be reliable. In summary, we have shown that an enlarged FAZ area is correlated significantly with poorer visual outcomes. Optical coherence tomography–A can supply additional information in the evaluation of patients with RVO and can help us predict patient's long-term visual prognosis.

## CONCLUSION

OCTA is a good diagnostic tool which enables qualitative and quantitative evaluation of the deep capillary plexus during the follow-up of patients treated for RVO. Improvement in visual acuity is related with the size of the DCP in FAZ.

### Ethical Approval

The study was approved by the Institutional review board/Ethical review board.
**(LRBT/TTEH/ERC/2722/07)**

### Conflict of Interest

Authors declared no conflict of interest.

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## Authors' Designation and Contribution

Lubna Feroz; *Consultant Ophthalmologist: Concepts, Literature search, Manuscript preparation.*
Najia Uzair; *Consultant Ophthalmologist: Design, Data acquisition, review.*
*Mariam Shamim; Consultant Ophthalmologist: Data analysis, Manuscript review.*
*Shahab ul Hassan Siddiqui; Senior Consultant Ophthalmologist: Data analysis, Statistical analysis, Manuscript review.*
*Syed Asad Mehmood; Consultant Ophthalmologist: Manuscript editing, Manuscript review.*

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