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Effect of Pan retinal photocoagulation on macular vasculature using Optical Coherence Tomography Angiography

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Abstract

To evaluate the vascular response of the macular plexus after pan-retinal photocoagulation using OCT A to prove the hypothesis of its ability to improve macular perfusion in addition to clinically proven regression of neovascularization. A prospective interventional non-randomized study included 15 eyes of 12 patients with proliferative diabetic retinopathy (PDR) or severe non-proliferative (NPDR) with macular thickness < 350 who were candidates for PRP. best corrected visual acuity and expressed in (Log MAR) scoring, central macular thickness and superficial and deep vascular plexus density by OCT A were assessed before and six months following the completion of PRP treatment. The macular vascular density increased after PRP both in the superficial and deep plexus and the change in superficial vascular density only was statistically significant p=0.0034) and also there was a significant increase in central macular thickness (p=0.0023), but no significant change in best-corrected visual acuity (p=0.0961). Improved macular perfusion after PRP more in the superficial capillary plexus, the improvement in vision was not significant as the central macular thickness increased after PRP.

Keywords: Diabetic retinopathy, Pan retinal photocoagulation, central macular thickness, vascular density, optical coherence tomography angiography

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1. Introduction

The prevalence of diabetes increases worldwide so the number of people with diabetic retinopathy is increasing. Approximately 30% of diabetic patients will develop some degree of diabetic retinopathy. vision loss as a sequence of diabetic retinopathy becomes the main cause in working-age adults [1]. Vision loss in DR occurs because retinal ischemia can lead to retinal atrophy, diabetic macular oedema (DME), and neovascularization (NV) with subsequent vitreous haemorrhage and tractional retinal detachment [2]. Laser PRP aims to modify the natural progress of diabetic retinopathy by inducing regression of neovascularization [3]. The DRS established the benefit of pan-retinal photocoagulation (PRP) for proliferative

diabetic retinopathy and severe NPDR in type 2 diabetes particularly if close follow is unlikely [4]. The introduction of optical coherence tomography angiography is a non-invasive novel tool that gives three-dimensional vascular capillary details [5]. Previous studies demonstrated that OCTA is capable of detecting retinal capillary non-perfusion with better resolution than fluorescein angiography [6]. So, studying macular microvasculature changes by OCTA is important in monitoring the response to PRP and monitoring its effect on macular perfusion.

2. Patients and Methods

This prospective interventional non-comparative study included 12 diabetic patients (15 eyes) with PDR or severe NPDR with macular oedema < 350 μm who were candidates for PRP. All patients agreed with written informed consent to participate in the study and publish the results before enrollment. The study protocol was approved by the Local Ethics Committee of Al-Azhar University Hospital. The study was held at Al-Zahraa University Hospital. All patients were recruited in the Department of Ophthalmology, between September 2020 and September 2022. Inclusion criteria at baseline were severe NPDR or PDR with a macular thickness (MT) < 350 μm. All study participants gave written informed consent before enrolment.

2.1 Exclusion criteria

The presence of media opacity as corneal opacities, cataracts, and patients who had cataract surgery or previous laser treatment within the previous 3 months' aphakia, glaucoma, pre-retinal haemorrhage, vitreous haemorrhage and uveitis.

2.2 Preoperative Evaluation

All subjects were subjected to the following: History taking including Name, age, sex, medical history (underlying disease, duration and medications), and history of cataract or glaucoma. Complete ophthalmic examination including best corrected visual acuity (BCVA) in (Log MAR), IOP measurement (by Goldman applanation tonometer), anterior segment examination, Fundus examination (slit lamp biomicroscope with +90D volk lens and indirect ophthalmoscope).
Macular scanning (macular thickness and macular vascular density) using wide-field OCT (RTVue XR Avanti with AngioVue software (Optivue Inc, Fremont, USA)). Macular Thickness Measurement uses a Macular cube (6×6 scan) to measure the central macular thickness (CMT).

2.3 Swept-Source OCTA Imaging

Using wide-field OCTA system OCT-A, 6× 6mm raster imaging was performed Vascular density in the superficial capillary plexus (SCP) and deep capillary plexus (DCP) was calculated by the machine software. A minimum signal strength threshold of 6 out of 10 was required for inclusion. The OCT acquisition is done by the same examiner, Images were acquired at baseline and six months after completing PRP session treatment. The whole image density and superior and inferior hemispheres in the superficial and deep capillary plexus are measured.

2.4 Pan-Retinal Photocoagulation

Pan-retinal photocoagulation was performed using laser photocoagulation systems with a green laser (GYC-500 NIDEK Gamagori, Aichi443-0038, JAPAN). Photocoagulation was performed, by a retinal specialist, in four

sessions, with intervals of 1 -2 weeks between each session under topical anaesthesia, spot size is set at 350 microns using Mainster wide field lens and each eye was subjected to 1300–1500 burns, and duration and power were adjusted to 0.02 s and 300–500 mW, respectively, and PRP was applied in all 4 peripheral quadrants.

2.5 Statistical Methods

Analysis of data was performed using the software MedCalc v. 20.110. Comparison between quantitative variables was carried out by One-way analysis of variance (ANOVA) which was used to test the difference between the means of several subgroups of a variable. The P-value results are considered significant when the P-value ≤ 0.05 and non-significant when the P-value > 0.05.

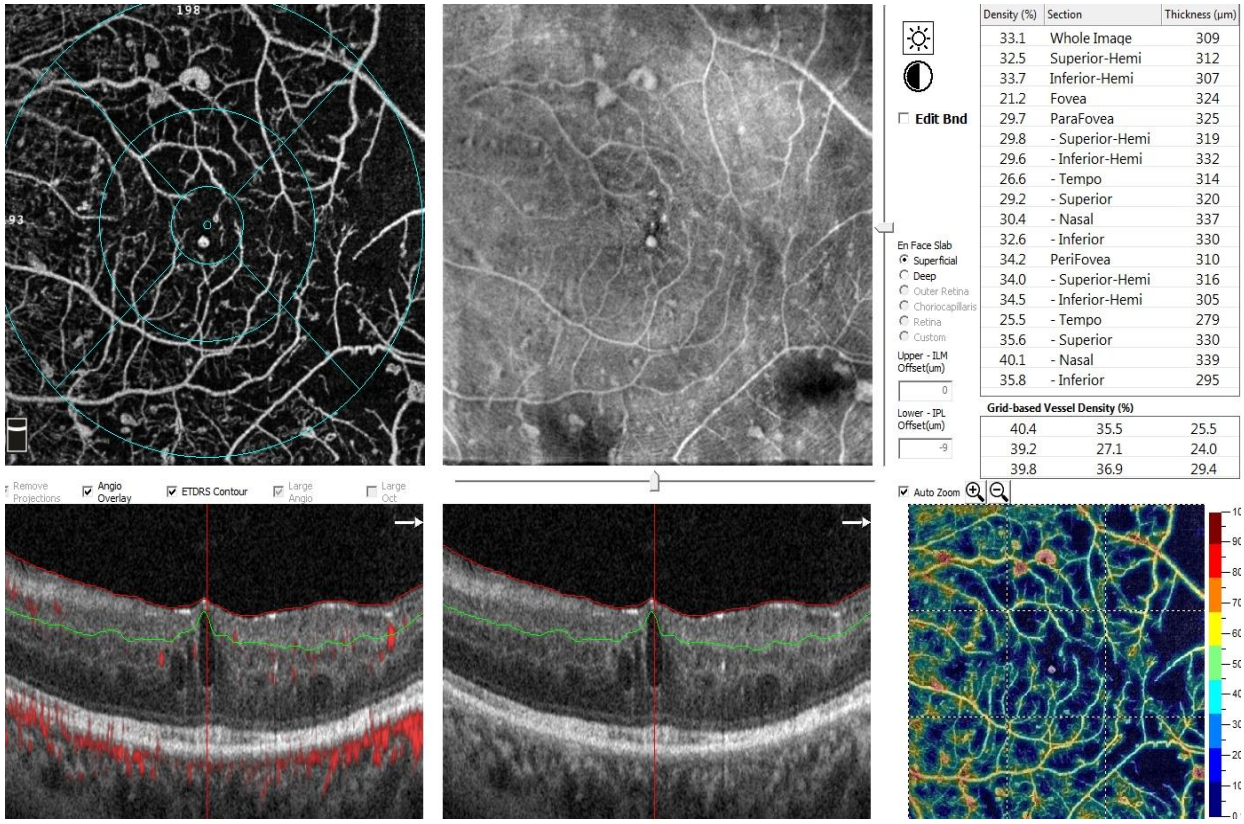
3. Results

This study included 12 diabetic patients (15 eyes); 9 eyes with severe NPDR (60%) and 6 eyes with PDR (40 %) who attend the outpatient clinic of the ophthalmology department at Alzahraa university hospital. The mean age was 58.2±9.01 years (44 – 71), duration of diabetes mean was 14.4±4.3 years (7 – 20) (Table 1). NPDR: Non-proliferative diabetic retinopathy, PDR: proliferative diabetic retinopathy. All patients need 3 PRP sessions except 2 patients who need additional sessions. As regard BCVA the improvement in BCVA was not statistically significant (P= 0. 0.0961) as it was 0.19± 0.08 (Log MAR), increased after treatment by PRP to be 0.17 ± 0.08 (Log MAR) and this can be explained due to increased macular thickness. The mean central macular thickness was 281.13± 32.88 µm, which increased after treatment to 313.13± 36.72 µm, this change was statistically significant (P= 0.0023). As regard macular vascular density, there was an increase in both SCP and DCP density, the increase in SCP density was statistically significant (P= 0.0034) as it was 39.16 ± 4.33, increased after treatment by PRP to 39.93± 3.96 but the increase in DCP density was not statistically significant (P= 0.1181) as it was 40.78± 4.94, increased after treatment by PRP to be 41.82 ± 3.4 (fig.1,2, table 2).

Table 1: Demographic data of the study group

Demographic data		**Study group (n= 15)**	
Age (years)		Mean ± SD	58.2±9.01
		Range	44-71
Duration of DM (years)		Mean ± SD	14.4±4.3
		Range	7-20
Diabetic Retinopathy	NPDR	N (%)	9(60%)
	PDR	N (%)	6 (40%)

A



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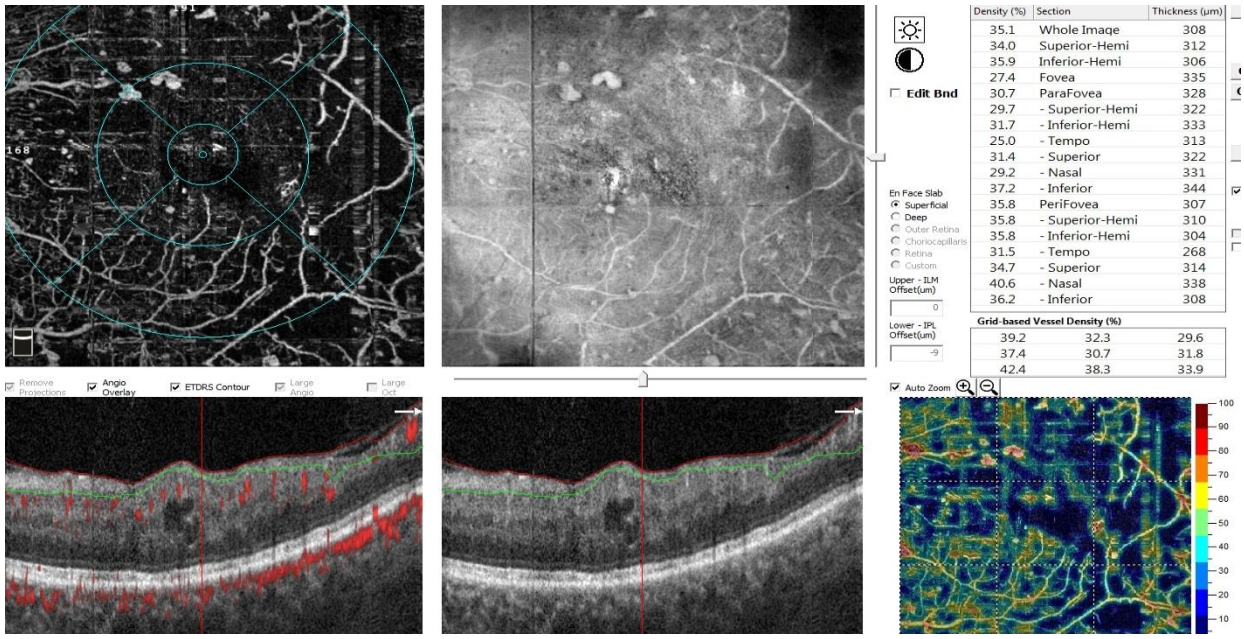

Figure (1): Optical coherence tomography angiography (OCTA) *en face* slab of the superficial capillary plexus (SCP) of case 5 before treatment showing superficial vascular density (A) and 6 months after treatment (B)

Table 2: Comparing superficial and deep vascular density between pre and post pan retinal photocoagulation study group.

Superficial vascular density	Study group (n=15)		
	Mean	SD	P.value
Pre photocoagulation	39.16	4.33	0.0034*
Post photocoagulation	39.93	3.96	
Deep vascular density	**Study group (n=15)**		
	Mean	**SD**	**P.value**
Pre photocoagulation	40.78	4.94	0.1181
Post photocoagulation	41.82	3.48	

*P ≤ 0.05 is considered significant

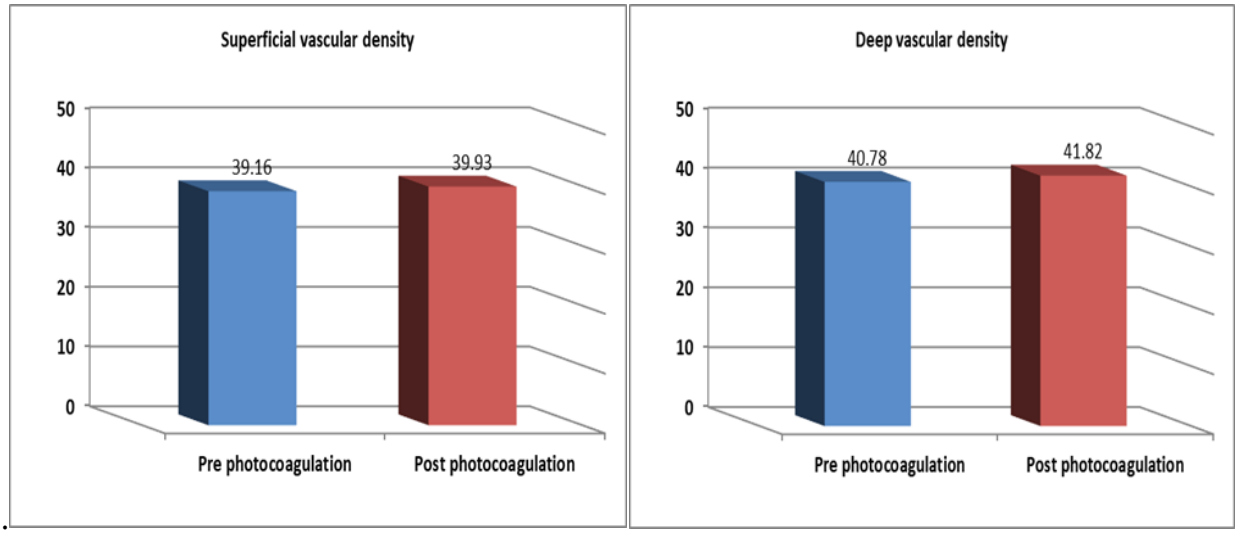

Figure (1): pre-and post-PRP macular vascular changes.

4. Discussion

In our study, we monitor macular vascular density changes following PRP therapy using OCTA, we found that in addition to the peripheral effect of PRP on regression of neovascularization, there is a significant improvement in the vascular density of the macula as a result of redistribution of blood flow from the periphery to the macular region, but this is not accompanied by improvement in visual acuity due to increase in macular thickness. SCP density was significantly increased after PRP, while the increase in DCP density was not statically significant. The effect of PRP on macular vasculature has been investigated by many researchers, and the result was contradictory. In agreement with our study, Lee *et al.* (7) showed that vessel constriction and increased flow velocity in the larger vessels around the optic nerve following treatment and the efficacy of PRP in PDR is thought to be related to improved inner retinal oxygen delivery with consequent decreased angiogenic drive and regression of neovascularization (7). And also, Fawzi *et al.* (8). reported an overall

increase in the vascular density of all capillary layers in the macula, 6 months after PRP. And also Mirshahi *et al* (9). reported that macular vascular density both superficial and deep increased significantly 3 months after PRP. On the other hand, in a similar study, Lorusso et al. (10) and Huang et al. (11) investigated the change in OCTA parameters following PRP. Contradictory to our results, they did not observe any vascular density changes or FAZ area changes. This difference can be explained due to the difference in scan size, the operating machine used, or different stages of retinopathy in the study populations. In conclusion, the current study found that PRP-treated eyes showed Improvement in macular perfusion after PRP, both in the SCP and the DCP and this improvement was statistically significant for the SCP only suggesting effective perfusion of the posterior pole after PRP. The improvement in vision was not significant as the central macular thickness increased after PRP, a longer follow-up period is mandatory to judge macular edema. The study's main limitation is the small study population and the short follow-up period a more patient number and longer duration are needed to monitor the effect of PRP on macular perfusion.

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Conflicts of interest There are no conflicts of interest.

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