ORIGINAL ARTICLE

Effect of Panretinal Photocoagulation on Macular and Peripapillary Nerve Fiber Layer Thickness in Patients with Proliferative Diabetic Retinopathy and Correlation with Visual Acuity

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Abstract

Background: ***Diabetes mellitus is a metabolic disorder characterized by an inability to properly use glucose, leading to hyperglycemia and, eventually, serious eye pathology. Among people of working age around the world, diabetic retinopathy is the most common cause of blindness.***

Aim of the work: ***To evaluate the impact of panretinal photocoagulation on visual acuity, Thickness of the macula, and peripapillary nerve fiber layer in proliferative diabetic retinopathy patients.***

Patients and Methods: ***As part of this prospective interventional study, carried on 20 eyes of 20 PDR patients aiming to assess changes of macular Thickness, peripapillary NFLT using OCT and visual acuity changes following PRP. The study was conducted at the ophthalmology department, Al-Azhar university hospitals and the National eye centre, Egypt.***

Results: ***Nne men and eleven women made up the population of this study. Their average age was 52.65years, with a standard deviation of 7.02years. Their average diabetes duration was 16.3years with a standard deviation of 4.24 years. Their average HbA1c was 9.65 with a standard deviation of 1.44. The population of the study was subjected to three sessions of PRP, one week apart, with documentation of macular Thickness, peripapillary NFLT, and visual acuity pre- and post-PRP, 3 months apart. Uncorrected and best corrected visual acuity increases in all populations following PRP with a statistically highly significant value (p-value <0.001). Central macular Thickness of the entire population decreases, and "improved oedema" follows PRP with statistically moderate significance (p-value=0.004). Changes in peripapillary NFLT of the population varied between different quadrants; statistically insignificant in temporal (p-value=0.074) and superior (p-value=0.542) quadrants, but statistically significant in nasal (p-value=0.026) and inferior (p-value=0.008) quadrants.***

Conclusion: ***The results of this study show that panretinal photocoagulation (PRP) is a safe and effective way to treat and preserve vision in proliferative diabetic retinopathy (PDR). PRP works by improving the retina's ischemic status and by affecting macular Thickness, which could help with macular oedema. Optical coherence tomography (OCT) is a crucial tool for diagnosing and monitoring a wide range of eye diseases and evaluating the effectiveness of different treatment options.***

Keywords: PRP; PDR; OCT

1. Introduction

Significant pathological changes in the eye can occur as a result of diabetes mellitus, a metabolic abnormality characterized by a failure to utilize glucose and resulting in hyperglycemia. Among the working-age population around the world, diabetic retinopathy is the leading cause of visual impairment.[1]

The gold standard for treating PDR is Panretinal photocoagulation. Using a slit lamp, an indirect ophthalmoscope, or the Endo Probe, the laser burns the entire retina, avoiding the core macular area.[2]

One noninvasive diagnostic tool that can produce a cross-sectional image of the retina while the patient is still alive is optical coherence tomography. In 1991, optical coherence tomography (OCT) was initially utilized to examine specific types of non-transparent tissue.

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The Cornea's transparency makes optical coherence tomography (OCT) a prominent diagnostic tool in the field of ophthalmology. Images with a high resolution (5μ) and a faster scan rate are provided using Fourier domain optical coherence tomography (OCT).[3]

In this study, we look at PRP's effectiveness and safety as a treatment for PDR, as well as OCT's role in evaluating treatment-induced changes to retinal structures and treatment success.

2. Patients and methods

Prospective interventional research using patients with PDR was conducted for this study. From January2023 to June 2023, all investigations were conducted at clinics of the Al-Azhar University Hospitals and The National Eye Centre, Egypt. The study was carried on twenty eyes of twenty PDR patients aiming to evaluate changes of macular Thickness, peripapillary NFLT and visual acuity following sessions of PRP.

Inclusion criteria were type 1 and 2 diabetic patients with PDR.

Exclusion criteria: those who had NPDR, those who had other eye conditions (such as high myopia, optic nerve pathology, vitreous hemorrhage, dense cataract), those who were taking systemic medications known to cause retinopathy (such as chloroquine, tamoxifen, or canthaxanthin), and those who had undergone prior ocular surgery (such as retinal surgery or laser treatment).

All patients were subjected to full history taking, including age, gender, Onset, duration, type of diabetes, drugs used as treatment, Past history of medications, systemic diseases, previous operation, or laser therapy.

A TOPCON autorefractometer was used for automated refraction, and the Snellen chart and its algorithmic conversion were used to measure visual acuity and best corrected VA. Intraocular pressure measurement using Goldmann applanation tonometry, a thorough evaluation of the eye's anterior segment using slit lamp bio-microscopy, and examining the fundus under a slit lamp biomicroscope after dilating the eye with tropicamide 1% eyedrops.

OCT (NIDEK RS-3000) imaging scans were done with dilated pupils and measurement of Macular thickness and Peripapillary NFLT were collected pre and post PRP. The first capture was done pre PRP and the second capture after 3 months of the last PRP session.

A single ophthalmologist helped with the procedure of PRP laser treatment on dilated eyes with PDR utilizing the "Quantel Medical Corp.Vitra 2: 532nm flagship green photocoagulator" and an HR wide field lens from Volk. Optical, Inc. of Mentor, OH, USA. Featuring 150 μm spots and a range of 1500-1700 spots in total. To achieve the desired effect of grayish-white burns, the power was adjusted to 0.02-0.05 s/spot laser. The treatment was carried out over the course of three sessions, with one to two weeks between each session.

Ethical Considerations

Al-Azhar University's Medical Ethics Committee gave their approval to the study protocol. Every participant received information about the study and was asked to provide signed consent.

Analysis and data interpretation

The data was examined for normality using the Kolmogorov-Smirnov test. For parametric data, the results are shown as the mean plus or minus the standard deviation, while for non-parametric data, the median is used. Quantitative and qualitative data were characterized by percentages and counts. Patients with PDR who underwent PRP before and after the procedure were compared using a paired samples t-test and the Wilcoxon signed-rank non-parametric test. The results of all statistical tests were deemed not statistically significant if the P value was greater than 0.05. A P value less than 0.05 was deemed statistically significant, a P value less than 0.01 was deemed moderately significant, and a P value less than 0.001 was deemed extremely significant. The following software was used for data analysis: GraphPad Prism V.8.3, Microsoft Excel 365, and IBM SPSS Statistics for Windows, Version 27 (Microsoft Corporation, USA).

3. Results

Table 1. Demographic data of studied populatio

I.DEMOGRAPHIC DATA	
GENDER (%) (TOTAL N= 20)	
MALE	9 (45%)
FEMALE	11 (55%)
AGE	
MEAN ± SD	52.65 ± 7.02
MED. (MIN-MAX)	53 (41-68)
OD/OS	
OD	9 (45%)
OS	11 (55%)

This table demonstrates the demographic data of the study population, total of 20 patients, 9 males and 11 females. The mean age of patients was (52.65±7.02) range of years. Ratio between right to left of selected eyes was 9 to 11.

Table 2.: Clinical Data of studied population.

II. CLINICAL DATA DATA	
DURATION OF DM (YEARS)	
MEAN ± SD	16.3 ± 4.24
MED. (MIN-MAX)	15.5 (9 - 25)
HEMOGLOBINA1C (HBA1C)	
MEAN ± SD	9.65 ± 1.44
MED. (MIN-MAX)	9.65 (7 - 11.8)
OTHER PAST MEDICAL HISTORY (PMH)	
HTN	7 (35%)
HTN-CARDIAC	1 (5%)
NO	12 (60%)

PAST OCULAR HISTORY (POH)	
RT IVI *1	1 (5%)
RT IVI *3	1 (5%)
RT CAT EXT	1 (5%)
LT CAT EXT	1 (5%)
LASIK	1 (5%)
NO	15 (75%)
INTRAOCULAR PRESSURE (IOP)	
MEAN ± SD	15.8 ± 2.63
MED. (MIN-MAX)	16 (11-20)

this table demonstrates the clinical data of studied population, the mean dutation of D.M was (16.3±4.24) range of years. The mean HBA1C was (9.65±1.44). 12patients have no medical history other than diabetes . 7 patients have Hypertension. 1 patient has hypertension and cardiac condition. 15 patients have No past ocular history. 2 patients had cataract surgery in eye other than the selected for the study. 2 patients had intravitreal injection in eye other than the selected for the study. 1 patient had refractive surgery.

Table 3. Changes in (UCVA) pre and post PRP in patient with PDR

	PRE	POST	STATISTICAL TEST
UCVA			Wilcoxon Signed Ranks Test
MEAN ±	0.13 ± 0.1	0.3 ± 0.18	Z-Value= 3.93
MED. (MIN-MAX)	0.1 (0.01-0.3)	0.3 (0.03-0.6)	p-value < 0.001***

This table demonstrates mean pre PRP UCVA in population was (0.13±0.1). Post PRP mean UCVA in population is (0.3±0.18). These changes of UCVA are found to be statically highly significant.

Table 4. Changes in (BCVA) pre and post PRP in patient with PDR

	PRE	POST	STATISTICAL TEST
BCVA			Wilcoxon Signed Ranks Test
MEAN ± SD	0.23 ± 0.17	0.53 ± 0.24	Z-Value= 3.927
MED. (MIN-MAX)	0.15 (0.01-0.6)	0.55 (0.15-0.8)	p-value < 0.001***

This table demonstrates the mean Pre PRP BCVA was (0.23±0.17). While Post PRP mean BCVA is (0.53 ± 0.24). These changes in BCVA are found to be statically highly significant.

Table 5. Changes in central macular thickness (µm) pre and post PRP in patients with PDR

	PRE	POST	STATISTICAL TEST
CENTRAL MACULAR THICKNESS (MM)			Wilcoxon Signed Ranks Test
MEAN ± SD	308.85 ± 85.02	287.8 ± 66.27	Z-Value = 2.86
MED. (MIN-MAX)	279.5 (247-541)	267.5 (200-467)	p-value = 0.004**

This table demonstrates that the Pre PRP mean central macular thickness of population was (308.85±85.02) µm. While the Post PRP mean central macular thickness was (287.8±66.27) µm. These changes are found to be statically moderately significant.

Table 6. Changes in temporal quadrant peripapillary NFLT.

	PRE	POST	STATISTICAL TEST
TEMP			Paired Samples t-Test
MEAN ± SD	75.7 ±	74.65 ±	t-value = 1.89
MED. (MIN-MAX)	74.5 (56-	73.5 (57-99)	p-value = 0.074 n.s.

This table demonstrates that Pre PRP mean temporal quadrant NFLT was (75.7±11.51) µm. While Post PRP mean temporal quadrant NFLT was (74.65±10.41) µm. These changes are found to be statically insignificant.

Table 7. Changes in nasal quadrant peripapillary NFLT.

	PRE	POST	STATISTICAL TEST
NASAL			Wilcoxon Signed Ranks Test
MEAN ± SD	70.9 ± 13.75	70.2 ± 13.2	Z-Value = 2.23
MED. (MIN-MAX)	71.5 (47-90)	72.5 (54-89)	p-value = 0.026*

This table demonstrates that Pre PRP mean Nasal quadrant NFLT was (70.9±13.75) µm. While Post PRP mean Nasal quadrant NFLT was (70.2±13.2) µm. These changes are found to be statically significant.

Table 8. Changes in Inferior quadrant peripapillary NFLT.

	PRE	POST	STATISTICAL TEST
INFERIOR			Paired Samples t-Test
MEAN ± SD	130.05 ± 10.62	126.05 ± 12.8	t-value = 2.94
MED. (MIN-MAX)	129.5 (114-148)	129 (102-147)	p-value = 0.008**

This table demonstrates that Pre PRP mean inferior quadrant NFLT was (130.05±10.62) µm. While Post PRP mean inferior quadrant NFLT was (126.05±12.8) µm. These changes are found to be statically Moderately significant.

Table 9. Changes in Superior quadrant peripapillary NFLT.

	PRE	POST	STATISTICAL TEST
SUPERIOR			Paired Samples t-Test
MEAN ± SD	119.55 ± 11.83	118.9 ± 12.11	t-value = 0.621
MED. (MIN-MAX)	117 (106-145)	116 (105-145)	p-value = 0.542 n.s.

This table demonstrates that Pre PRP mean Superior quadrant NFLT was (119.55±11.83) µm. While Post PRP mean Superior quadrant NFLT was (118.9±12.11) µm. These changes are found to be statically insignificant.

4. Discussion

As a result of diabetic macular edema, vitreous hemorrhage, tractional retinal detachment, neovascular glaucoma, and capillary nonperfusion, diabetic retinopathy is a leading cause of blindness in people of working age.[4]

Patients with DR have a 50% lower chance of significant visual impairment after receiving PRP. After being proven to stabilize and manage the

proliferative disease in the Diabetic Retinopathy Study, PRP became the treatment of choice. Laser radiation is absorbed by melanosomes within the RPE, leading to thermal damage and coagulation of the neighboring photoreceptors and RPE cells in PRP. Photocoagulation decreases metabolic load, ischemia, and ischemia-driven angiogenic chemicals, which is beneficial because photoreceptors are the retina's metabolically most active cells and have a high oxygen consumption rate.[5]

To acquire high-resolution cross-sectional pictures of the retinal layers, one can employ optical coherence tomography (OCT), a contemporary noninvasive biomicroscopic imaging method. OCT's SD-system is an improvement over its earlier TD-system. Evidence suggests that SD-OCT improves scan quality, reduces perimetric RNFL flaws, and exhibits high reproducibility.[6]

In our study, according to the analysis of the results, we found a highly significant improvement in visual acuity post-PRP (UCVA/BCVA) compared with visual acuity (UCVA/BCVA) pre-PRP. In our study, the mean pre-PRP UCVA in the study population was (0.13±0.1). Post PRP mean UCVA in the study population is (0.3±0.18). At the same time, the mean Pre PRP BCVA was (0.23±0.17). While the post-PRP mean BCVA is (0.53±0.24). So, every patient in our study experienced improvement in visual acuity in some way. Although the exact mechanism by which PRP improves visual acuity is not fully comprehended, this improvement could be explained by the state of improved ischemia of the PRP-spared central retina.

These changes in visual acuity found in our study are in accordance with a study by Kim et al, in which the majority of the subjects (118 patients) have stable or improved visual acuity after 6 months of PRP7. A study by Shimura et al in which 90% of subjects maintained their pre-PRP visual acuity and only 10% of subjects had worsened visual acuity due to uncontrolled systemic disease or exacerbating macular edema8. A study by Mukhtar et al. was carried out on 67 eyes of 46 patients. There was an improvement of visual acuity combined with improvement of cystoid macular edema.[9]

In our study, according to the analysis of the results, we found a moderately significant change (reduction) in the central macular Thickness. The pre-PRP mean central macular thickness of the studied population was (308.85±85.02) µm. While the Post PRP mean central macular Thickness is (287.8±66.27) µm.

These changes in macular Thickness are found to be in accordance with a study by Mukhtar et al, in which 67 eyes of 46 patients showed an improvement of visual acuity, combined with improvement of cystoid macular edema.[10] Study by Gaucher et al The average thickness of the central macular region in 17 eyes was 468.23+/-113.63 µm. Following PRP, DME naturally returned to normal in both eyes after an average of 7.1 months (plus or minus 2.68 months) of follow-up. The average Thickness of the central macular region shrank to 268.12+/-54.67 µm. The statistical analysis revealed that these variations in macular Thickness were extremely noteworthy.[11]

Our study results of changes in macular Thickness were contradictory to the study by Soman et al, in which central macular Thickness increased following PRP. In this research, the average central foveal Thickness before surgery was (222.05±59.11) µm for 76 eyes out of 68 patients. After one week, it rose considerably to (266.84±84.67) µm (P = 0.001), stayed elevated at (264.05±102.56) µm (P = 0.01), and reached (256±101.38) µm (P = 0.04).[12] A study by Lee et al. showed that the central macular thickness also rose following PRP. Compared to the Thickness before PRP (199.0±20.9 µm; P 0.05 for each), the central macular Thickness increased at 1 month (223.3±40.6 µm), 3 months (216.8±23.5 µm), 6 months (219.4±33.1 µm), and 12 months (220.4±17.3 µm) after PRP.[13]

Our study's results showed a statistically significant decrease in peripapillary NFLT in the inferior and nasal quadrants, but no change in the temporal or superior quadrants. The average nasal quadrant NFLT before performing PRP was 70.9±13.75 µm. The mean nasal quadrant NFLT after PRP is 70.2±13.2 µm. The NFLT in the lower quadrant before PRP was (130.05±10.62) µm. A mean inferior quadrant NFLT of (126.05±12.8) µm was seen after PRP. The average length of the temporal quadrant before PRP was 75.7±11.51 µm. The NFLT after PRP is (74.65±10.41) µm. A possible explanation for this very slight reduction in the temporal quadrant after laser treatment is the sparing of the papillomacular bundle. The mean value of the superior quadrant NFLT before PRP was 119.55±11.83 µm. After PRP, the average NFLT in the superior quadrant is (118.9±12.11) Im.

These results of our study regarding peripapillary NFLT were found to be in accordance with the study by Kim et al At six months after PRP, a statistically significant decrease in average RNFL thickness was seen in all four quadrants in 118 eyes .[14] Study by Wadhwani et al At baseline, the average RNFL thickness was (89.88±14.26) µm; at 1-year follow-up, it was (85.75±11.36) µm; and at 3-year follow-up, it was (83.33±11.96) µm. The average RNFL thickness differed statistically between baseline, 1 year after PRP, and 3 years after the procedure. At 1-year follow-up, measurements of

superior, inferior, and nasal RNFL decreased significantly from baseline ($P < 0.01$).[15]

Our study results of changes in RNFL thickness were contradictory to: Study by Lee et al, 31 eyes. Wherein the Thickness of the superior, nasal, inferior, temporal, and mean peripapillary RNFLs rose until six months following PRP before declining .[16]

There were some limitations to our study: The 20 eyes included in this study is a relatively small in number. The results might be slightly off since we used an automated method to measure the NFL thickness, but it was the best clinical method we could find with the OCT equipment we had at the time. Study duration is relatively short comparing with other studies especially those regarding peripapillary NFL thickness changes.

4. Conclusion

Intramedullary fixation of mid-shaft clavicular fractures with TENS is most appropriate for young patients who are medically free and have acute simple two-part middle 3rd clavicle fractures. The primary benefit of this methodology is that it is minimally invasive and has excellent functional outcomes; this method facilitates an earlier resumption of daily activities and a more rapid shoulder range of motion with protection of the supraclavicular nerve.

Disclosure

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Authorship

All authors have a substantial contribution to the article

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