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Assessment of Changes in Visual Field after Panretinal Photocoagulation Treatment in Proliferative Diabetic Retinopathy

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Abstract

Background: **After the Diabetic Retinopathy Treatment Study (DRS) and the Early Treatment Diabetic Retinopathy Study, laser photocoagulation has been the cornerstone of treatment for proliferative diabetic retinopathy for the past three decades (ETDRS).** ***Aim:*** **This study aimed to assess the effect of conventional PRP on fundus status visual acuity and BCVA in patients with PDR.** ***Patients and Methods*****: This quasi-experimental study was carried out in the Ophthalmology Department, Suez Canal University Hospitals. It included 23 eyes of randomly selected 18 diabetic patients with signs of proliferative diabetic retinopathy, with visual acuity not less than 2/60.** ***Results:*** **Ten patients (43.5%) were females and thirteen (56.5%) were males with a mean age of 52.65 ± 8.17 years (range, 29-63 years). 78.3% of patients had type II DM and 21.7% had type I with a mean duration of DM of 20.04 ± 7.53 years. 60.9% of patients were uncontrolled diabetics and 39.1% were controlled. there was a statistically significant difference before PRP, after one month, and after three months (p<0.001) in PSD. Patients had a significant increase in mean PSD before PRP (4.04 ± 3.57) to (5.62 ± 4.10) after one month. Also, mean PSD showed a significant increase from before PRP (4.04 ± 3.57) to (4.30 ± 2.03) after three months.** ***Conclusion:*** **PRP is safe and successful for treating PDR and maintaining eyesight, despite temporarily impairing vision and altering the macular shape and thickness. By three months, this visual loss can return to normal. The most frequent cause of this loss of vision is macular edema.**

Keywords: Panretinal Photocoagulation, Retinopathy, Diabetes Mellitus.

Introduction

About 93 million people worldwide are affected by diabetic retinopathy, which is a leading cause of vision loss and blindness. Of these, 21 million have macular edema and 17 million have proliferative diabetic retinopathy (PDR)[(1)]. In a hospital-based study in Egypt, diabetic patients over the age of 18 had a 20.5 percent prevalence of diabetic retinopathy. In this cross-sectional survey study, 82% of patients were not aware that diabetes can have negative effects on the eyes[(2)]. However, evidence from epidemiological research indicates that as a result of new medications and better Diabetes mellitus management, the incidence of vision-threatening phases of diabetic retinopathy is decreasing in high-income nations[(3)].

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There are many ways to treat diabetes, including strict glucose control, blood pressure control, HbA1c monitoring, routine follow-up, intravitreal steroids, and anti-VEGF agents. However, laser photocoagulation continues to be the preferred treatment for proliferative diabetic retinopathy and retinopathy that threatens vision[4]. As a result, the laser burns cause the retina to thin, which improves the retina's ability to receive oxygen from the choroid. Studies using vitreous and retinal microelectrodes have shown increased oxygenation of the retina as a result[5]. While panretinal photocoagulation may cause macular damage, damage to other ocular structures like the lens, bleeding from the choriocapillaris, or breaks in the Bruchs' membrane that may put the patient at risk for developing choroidal neovascularization in the future, the procedure may also have negative side effects like blurring of the central vision, constriction of the visual field, and problems in the dark[6]. The laser burns are concentrated in the outer retina to minimize visual field defect and RNFL loss[7]. The purpose of this research was to assess visual field changes after panretinal photocoagulation in patients with proliferative diabetic retinopathy.

Patients and Methods

This quasi-experimental study was carried out in Ophthalmology Department, at Suez Canal University Hospitals. It included 23 eyes of randomly selected 18 diabetic patients with signs of proliferative diabetic retinopathy, with best-corrected visual acuity not less than 2/60. All patients with (proliferative diabetic retinopathy) assessed by fluorescein angiography, are liable to Panretinal photocoagulation treatment. Patients with new vessels on or within one disc diameter of the optic disc (NVD) or new vessels elsewhere (NVE). And adults in the age group (18-65) years old were included in the study. Patients with best-corrected visual acuity less than 6/60. Corneal pathology; severe corneal edema, scarring, and corneal opacity. Glaucomatous patients. Those with macular edema. or uncontrolled systemic hypertension were excluded.

Methods

All patients in the study were evaluated for a) Personal history: age and sex. b) Ocular history: history of any previous ocular trauma, or previous ocular surgery. and c) Systemic history: history of any systemic disease other than diabetes to rule out the presence of systemic hypertension.

Examination

Detailed ophthalmic examination was performed to assess a) Visual acuity by Snellen's chart: unaided and best corrected. b) Fundus evaluation is done by indirect ophthalmoscopy and slit lamp, +90D examination. c) Intraocular pressure by Goldman applanation tonometer and, d) Crystalline Lens status and pupil size by slit lamp examination. Further assessment by investigations was done using a) blood sugar: fasting and postprandial. b) Fundus examination: fundus fluorescein angiography: to detect NVE &NVD and c) Visual field: assessment by Humphrey field analyzer II program 30-2 SITA standard before PRP and after one month &after 3 months.

Panretinal photocoagulation

The procedure and its risks are explained to the patients and appropriate consent was obtained. All the selected eyes underwent panretinal photocoagulation in 2 settings. Panretinal photocoagulation was done by slit lamp mounted double frequency Nd (532 nm) laser of carl zeiss. The

energy used was between 200 mW to 300 mW. Spot size being 300 µm for some time of 0.10 to 0.15 sec. Two spots were kept one spot size apart. An average of 700 to 1000 spots were done after dividing the eye into 4 quadrants: superior nasal, inferior nasal, and superior temporal and inferior temporal. Before each session of Panretinal photocoagulation, a complete fundus evaluation was done by indirect ophthalmoscopy to look for recent changes like retinal hemorrhage, vitreous hemorrhage, and retinal detachment.

Outcome measure
Changes in visual field after Panretinal photocoagulation.

Follow up visits
After completion of PRP patients were followed up at 1 month and 3 months. On each of the following patients were evaluated for visual acuity, fundus examination, and visual field assessment.

Statistical Analysis

Statistical analysis was performed using Statistical Package for the Social Sciences statistical program version 24. The Fisher exact test was used to identify the possible association between the categorical variables. Marginal Homogeneity Test. to analyze the significance between the different stages. Friedman test for abnormally distributed quantitative variables, to compare between more than two periods or stages, and Post Hoc Test (Dunn's) for pairwise comparisons. statistical significance was considered at a $P<0.05$.

Ethics consideration

The Research Ethics Committee of Suez Canal University approved the protocol of this thesis. The purpose of the study was explained to all participants. An informed oral and written consent was taken from every participant in the study. The name of the patient was omitted from the description of the results. All data obtained from every patient were strictly confidential. Individuals participating in the study were informed about the findings that pertain to their health. The procedure and possible complications were explained to the patient. All subjects were informed about the results of the study. Patients were assured they had the right to withdraw from the study without penalty. The researcher's phone number and all possible communication methods were identified to the participants to return at any time for any explanation.

Results

A total of 23 eyes fulfilling the inclusion criteria for this prospective clinical study were included. Ten patients (43.5%) were females and thirteen (56.5%) were males with a mean age of 52.65 ± 8.17 years (range, 29-63 years) as shown in Table 1. Diabetic eyes were 12 right eyes (52.2%) and 11 left eyes (47.8%). Fifteen patients (65.2%) had no surgery, 26.1% had Phacoemulsification+ IOL implantation, 4.3% had ECCE+ IOL implantation and 4.3% had ECCE as in Table 2. In Table 3, 78.3% of patients had type II DM and 21.7% had type I with a mean duration of DM of 20.04 ± 7.53 years. 60.9% of patients were uncontrolled diabetics and 39.1% were controlled. In Table 4, there was a statistically significant difference between before PRP and after three months in BCVA ($P=0.003$). Table 5 showed BCVA before PRP and after three months found that 7 patients had 6/6 to 6/12 BCVA which decreased to three patients after three months. 12 patients had 6/18 to 6/24 BCVA which decreased to 11 patients after three months.

Table 1: Distribution of the studied eyes according to demographic data (n=23)		
	No.	%
Sex		
Male	13	56.5
Female	10	43.5
Age (years)		
Min. – Max.	29.0 – 62.0	
Mean ± SD.	52.65 ± 8.17	
Median (IQR)	54.0 (49.0 – 58.0)	

Table 2: Distribution of the studied eyes according to eyes and ocular surgery (n=23)		
	No.	%
Eye		
OS	11	47.8
OD	12	52.2
Ocular surgery		
No	15	65.2
Phacoemulsification+ IOL implantation	6	26.1
ECCE+ IOL implantation	1	4.3
No	15	65.2
Phacoemulsification	6	75.0
IOL implantation	7	87.5
ECCE	2	25.0

Four patients had BCVA Less than 6/24 which increased to 9 patients after three months. In Table 6, 60.9% of patients had no loss of VA, 34.8% had one line loss and 4.3% had≥2-line loss of V.A. In Table 7, patients had a mean IOP of (13.87 ± 2.74) ranging from 10 to 18. In Table 8, there was a statistically significant difference before PRP, after one month, and after three months (p=0.001) in MD. Patients had a significant increase of mean MD before PRP (-5.49 ± 3.05) to (-7.64 ± 4.91) after one month. Also, the mean MD showed a significant increase from before PRP (-5.49 ± 3.05) to (-5.72 ± 2.78) after three months. In Table 9, there was a statistically significant difference before PRP, after one month, and after three months (p<0.001) in PSD. Patients had a significant increase in mean PSD before PRP (4.04 ± 3.57) to (5.62 ± 4.10) after one month. Also, mean PSD showed a significant increase from before PRP (4.04 ± 3.57) to (4.30 ± 2.03) after three months.

Discussion

This study was undertaken to improve the quality of life and reduce morbidities and mortalities arising due to proliferative diabetic retinopathy. In our study, we evaluated the effect of conventional PRP on fundus status visual field and BCVA in patients with PDR. In the present study, a total of 23 eyes fulfilling the inclusion criteria for this prospective clinical study were included. Ten patients (43.5%) were females and thirteen (56.5%) were males with a mean age of 52.65 ± 8.17 years (range, 29-63 years). 78.3% of patients had

type II DM and 21.7% had type I with a mean duration of DM of 20.04 ± 7.53 years. 60.9% of patients were uncontrolled diabetics and 39.1% were controlled. Similar to Saad et al.[8] study, in which 8 patients (53.3%) were older than 60th century and 7 were younger, the mean age was 59.009.93 years (range, 33-72 years) (46.7 percent). The Wisconsin Epidemiological Study of Diabetic Retinopathy also discovered that the length of diabetes rather than age influences how severe diabetic retinopathy and clinically significant macular edema are. The ultimate visual outcome was not significantly influenced by gender or the length of diabetes. These findings suggest that laser therapy and any changes in macular thickness control the final visual acuity. In our study, 60.9% of eyes had no loss of VA, 34.8% had one line loss and 4.3% had≥2-line loss of V.A. BCVA before PRP and after three months found that at 7 patients had 6/6 to 6/12 BCVA which decreased to three patients after three months. Twelve patients had 6/18 to 6/24 BCVA which decreased to 11 patients after three months. Four patients had BCVA Less than 6/24 which increased to 9 patients after three months.

Table 3: Distribution of the studied eyes according to diabetes (n=23)

Diabetes	No.	%
Type of diabetes		
Type 1	5	21.7
Type 2	18	78.3
Duration of diabetes (years)		
Min. – Max.	10.0 – 40.0	
Mean ± SD.	20.04 ± 7.53	
Median (IQR)	20.0 (15.0 – 20.50)	
Controlled or not		
Uncontrolled	14	60.9
Controlled	9	39.1

Table 4: Distribution of the studied eyes according to BCVA (n=23)

BCVA	Before PRP		After 3months	
	No.	%	No.	%
6/6 to 6/12	7	30.4	3	13.0
6/18 to 6/24	12	52.2	11	47.8
Less than 6/24	4	17.4	9	39.1
MH (p)	18.50* (0.003*)			
6/9	2	8.7	1	4.3
6/12	5	21.7	2	8.7
6/18	9	39.1	10	43.5
6/24	3	13.0	1	4.3
6/36	4	17.4	7	30.4
6/60	0	0.0	2	8.7

MH: Marginal Homogeneity Test,
p: p-value for comparing between before and after PRP
***: Statistically significant at p ≤ 0.05*

Table 5: Distribution of the studied eyes according to BCVA before PRP vs after 3 months (n=23)						
BCVA before PRP	BCVA After 3months					
	6/6 to 6/12		6/18 to 6/24		Less than 6/24	
	No.	%	No.	%	No.	%
6/6 to 6/12	3	100.0	4	36.4	0	0.0
6/18 to 6/24	0	0.0	7	63.6	5	55.6
Less than 6/24	0	0.0	0	0.0	4	44.4

Table 6: Distribution of the studied eyes according to lines of loss in VA after 3 months (n=23)		
No. of lines of loss in VA	No.	%
No loss of V. A	14	60.9
1 line loss of V. A	8	34.8
≥2 line loss of V. A	1	4.3

According to Mukhtar et al study[9], which comprised 67 eyes from 46 DR patients, the patients' BCVA ranged from 0.17 to 1.77 and their mean pre-treatment and post-treatment visual acuities were 0.670.43 and 0.570.3, respectively. Similar to the Saad et al.[8] trial, 3 months following PRP, 15 eyes (75%) of patients had stable or improved vision, while 25% had impaired vision. Additionally, the Diabetic Retinopathy Study found that 10% of eyes experienced vision loss following PRP. According to several research, 25 percent to 43 percent of eyes experienced visual alterations or loss after PRP[10]. In our study, there was a statistically significant difference before PRP, after one month, and after 3 months (p=0.001) in MD. Patients had a significant increase of mean MD before PRP (-5.49 ± 3.05) to (-7.64 ± 4.91) after one month. Also, the mean MD showed a significant increase from before PRP (-5.49 ± 3.05) to (-5.72 ± 2.78) after three months. While BCVA nearly reverted to baseline at the same follow-up visit, there was a statistically significant increase in central subfoveal thickness after 3 months of follow-up[8]. None of the eyes developed tractional retinal detachment or neovascular glaucoma, however, 6 eyes (30%) had cystoid macular edema and 4 eyes (20%) had diffuse edema. We excluded those who experienced vitreous hemorrhages before finishing PRP. There was a statistically significant difference in PSD before PRP, after one month, and after three months in the current study (p=0.001). Patients' mean PSD increased significantly from (4.04±3.57) before PRP to (5.62±4.10) after one month. Additionally, the mean PSD significantly increased throughout the three months from (4.04±3.57 before PRP) to (4.30±2.03). Previously, the mean pretreatment central subfoveal thickness was 253.05 µm, which increased during follow-up and remained higher at 281.45µm (89.9% increase) by 3 months of follow-up[8].

Table 7: IOP before the PRP procedure among the studied cases (n = 23)			
	Min. – Max.	Mean ± SD.	Median (IQR)
IOP (mm. hg)	10.0 – 18.0	13.87 ± 2.74	14.0 (12.0 – 16.0)

Table 8: Distribution of the studied eyes according to MD (n=23)					
MD (dB)	**Before PRP**	**After 1month**	**After 3months**	**Fr**	**p**
Min. – Max.	-11.02 – -1.39	-17.52 – -1.91	-14.62 – -2.97	14.000*	0.001*
Mean ± SD.	-5.49 ± 3.05	-7.64 ± 4.91	-5.72 ± 2.78		
Median (IQR)	-6.12(-6.35 – -2.97)	-7.30(-8.15 – -3.51)	-5.46 (-6.0 – -3.48)		
Sig. bet. periods	$p_1<0.001^*, p_2=0.302, p_3=0.010^*$				

Fr: Friedman test, Sig. bet. periods were done using the Post Hoc Test (Dunn's)
p: p value for comparing between different periods.
p_1: p-value for comparing between before and after 1 month.
p_2: p-value for comparing between before and after 3 months.
p_3: p-value for comparing between after 1 month and after 3 months.
***: Statistically significant at p ≤ 0.05*

Table 9: Distribution of the studied eyes according to PSD (n=23)					
PSD (dB)	**Before PRP**	**After 1month**	**After 3months**	**Fr**	**p**
Min. – Max.	1.58 – 12.44	1.95 – 15.45	1.92 – 9.90	19.565*	<0.001*
Mean ± SD.	4.04 ± 3.57	5.62 ± 4.10	4.30 ± 2.03		
Median (IQR)	2.44 (2.40 – 2.72)	4.20 (3.70 – 5.99)	3.16 (3.0 – 5.09)		
Sig. bet. periods	$p_1<0.001^*, p_2=0.027^*, p_3=0.027^*$				

Fr: Friedman test, Sig. bet. periods were done using Post Hoc Test (Dunn's)
p: p value for comparing between different periods.
p_1: p-value for comparing before and after 1 month.
p_2: p-value for comparing between before and after 3 months.
p_3: p-value for comparing between after 1 month and after 3 months.
***: Statistically significant at p ≤ 0.05*

The mean central foveal thickness at the final follow-up remained high, although the mean visual acuity had normalized by the end of 3 months of follow-up. The Manchester Pascal Study[11] conducted a randomized study comparing single spot, 100 ms, multisession PRP with a multi-spot, 20ms single session PRP. In their cohort, 19 eyes received multi-spot, 20ms, and single-session PRP. These patients developed a statistically insignificant 2 μm increase in central subfoveal thickness at 4 weeks post-treatment, with a statistically insignificant 2μm decrease at 12 weeks post-treatment. Retrospective research was conducted on 82 eyes with newly identified high-risk PDR who had received at least 6 months of follow-up by Chappelow et al[12]. In comparison to traditional PRP when applied as an equivalent number of laser spots, they found that eyes treated with multi-spot, 20 ms PRP had a greater treatment failure rate, which was characterized as either persistence or recurrence of neovascularization. They proposed a hypothesis to explain the difference in efficacy between these two laser parameters: the higher laser fluence of conventional, 100ms PRP caused a bigger area of heat diffusion and a larger area of coagulated retina following 100ms conventional PRP. Characteristics of macular diameter correlate better with visual outcome, as was seen in their study, where the presence of cystoid macular edema and epiretinal membrane resulted in poor visual outcomes in this group of patients[13].

Conclusion

Although it temporarily impairs vision and

alters the macular morphology/thickness, RP is a safe and effective treatment for PDR that preserves eyesight. By three months, this visual loss can return to normal. The most frequent cause of this loss of vision is macular edema. Macular edema-related vision loss in the eyes may require alternative treatment such as intravitreal medication or extra laser treatments. In our study, MD before PRP, after 1 month, and after 3 months showed a significant change. MD also showed a substantial increase from before PRP, after 1 month, and after 3 months. To support our findings, larger longitudinal investigations are required.

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