Original Article

The Effects of Macular Photocoagulation on Visual Field

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Abstract:

Background: This study aimed to assess the impact of macular photocoagulation on visual field and nerve fiber layer thickness in patients undergoing treatment for diabetic macular edema.
Material and Methods: A prospective interventional case series was conducted, involving 26 eyes of patients with a history of diabetes and clinically significant macular edema eligible for macular photocoagulation. All participants underwent 10-2 and 24-2 Humphrey Visual Field Test using the Swedish Interactive Thresholding Algorithm (SITA) standard strategy, as well as optic nerve and macular optical coherence tomography (OCT) before and six months after macular laser photocoagulation. Changes in visual field, peripapillary, and macular nerve fiber layer thickness were compared pre- and post-photocoagulation.
Results: The study included patients with a mean age of 57.60 ± 8.99 (range 33-73) years. No statistically significant changes were observed in mean deviation, pattern standard deviation, and foveal threshold during the 10-2 and 24-2 visual field tests after photocoagulation, except for the pattern standard deviation in the 10-2 test.
Conclusion: The findings of this study indicate that macular laser photocoagulation does not have a significant impact on the visual field.

Keywords: Visual Field; Macular Laser Photocoagulation; Diabetes.

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Introduction

Diabetic Macular Edema (DME) is a serious complication of diabetes mellitus that poses a threat to vision[1] . In the early stages of DME, the breakdown of the blood-retinal barrier can lead to the accumulation of extracellular fluid in the macula [2, 3]. Clinically significant macular edema (CSME) is characterized by certain criteria: a) thickening of the retina at the center (macula) or within 500 μm of it, b) presence of hard exudates at or within 500 mm of the center of the retina with associated retinal thickening, c) a zone of retinal thickening one disk area or larger, located within one disk diameter of the center of the retina [4]. Laser treatment is an effective approach to managing CSME, reducing the risk of visual loss by approximately 50 % [5].

Retinal damage resulting from DME can have implications for the visual field and subsequent assessments of glaucoma, including diagnosis and progression. Previous studies have demonstrated that conditions such as retinitis pigmentosa, retinal detachment, retinal artery occlusion, and non-perfusion areas in retinal vein occlusions can impact the outcomes of 24-2 or 10-2 perimetry tests [6]. To gain a deeper understanding of the effects of macular photocoagulation on the visual field and its potential interference with the diagnosis of other visual field-related diseases like glaucoma, we conducted an investigation to evaluate changes in the visual field following macular photocoagulation.

Material and Methods

This prospective study conducted at the retinal clinic included 26 eyes from 14 patients diagnosed with diabetic macular edema who met the eligibility criteria for macular photocoagulation between September and December 2018. The study protocol was approved by the Ethics Committee of Rassoul Akram Hospital, and all participants provided informed consent in accordance with the Declaration of Helsinki [7, 8]. The inclusion criteria required clinically significant macular edema confirmed by two medical retina specialists, who determined that the patients were suitable for macular laser photocoagulation using the SITA 10-2 and SITA 24-2 visual field tests, as well as a Humphrey Visual Field assessment prior to laser treatment. The selection of SITA 10-2 and SITA 24-2 was based on their common usage in clinical settings to evaluate the extent and severity of visual field loss in patients with various eye diseases [7, 8].

The SITA (Swedish Interactive Thresholding Algorithm) is a computerized algorithm that adjusts the brightness of visual stimuli until they are barely visible, allowing for the determination of a patient's visual threshold at different locations within the visual field. SITA 10-2 and SITA 24-2 differ in the number and size of test points used. SITA 10-2 has 68 test points, enabling more precise mapping of the central visual field, while SITA 24-2 covers a larger area [7, 8].

The Humphrey Visual Field Analyzer, which utilizes SITA algorithms, is a widely used device for conducting visual field tests. It consists of a computer-controlled projection system that presents visual stimuli and records patient responses. The software analyzes the results to generate a visual field map, aiding in the diagnosis and monitoring of various eye conditions.

Exclusion criteria encompassed recent intraocular surgery or laser photocoagulation, high refractive errors, glaucoma history, ischemic or inflammatory optic neuropathy, intraocular pressure above 22 mmHg, progressive central nervous system disorders, or the need for pan-retinal photocoagulation

or anti-VEGF therapy during follow-up. Both eyes of a participant were included if they fulfilled the inclusion criteria simultaneously. The study protocol received approval from the Rasoul Akram Hospital Eye Research Center Ethics Committee, and informed consent was obtained from all participants. Baseline demographic data, best-corrected visual acuity, intraocular pressure measurements, slit lamp biomicroscopy, and fundoscopic findings were recorded. Visual field tests (SITA 10-2 and SITA 24-2 algorithms, Humphrey Visual Field Analyzer) were performed before and six months after photocoagulation. Grid laser photocoagulation was conducted using an argon laser, targeting 2 to 3 rows of 50 µm spots located 500 µm to 3000 µm from the center of the macula. Focal leaks outside or within zones of diffuse leakage were treated with 50 µm spots, achieving mild whitening of the microaneurysms.

For visual field comparisons, each point on the 24-2 field was assigned a number from 1 to 52, excluding two points near the blind spot. Similarly, each point on the 10-2 field was assigned numbers from 1 to 68 (Figures 1 and 2). Numeric total and pattern deviation plots were used to compare each point in the visual field between the pre- and post-photocoagulation timepoints. Mean deviation, pattern standard deviation, and means of all points were also compared between the two groups. Statistical analysis was performed using SPSS software (version 22, SPSS Inc., Chicago, IL), and a paired t-test was used for analysis. $P < 0.05$ was considered significant.

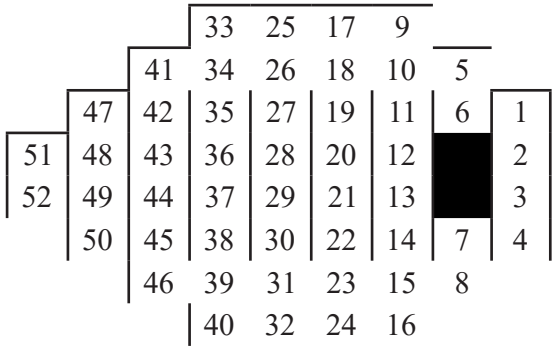

Figure 1: Assigned numbers for fifty-two points in the 24-2 visual field and six visual field sectors

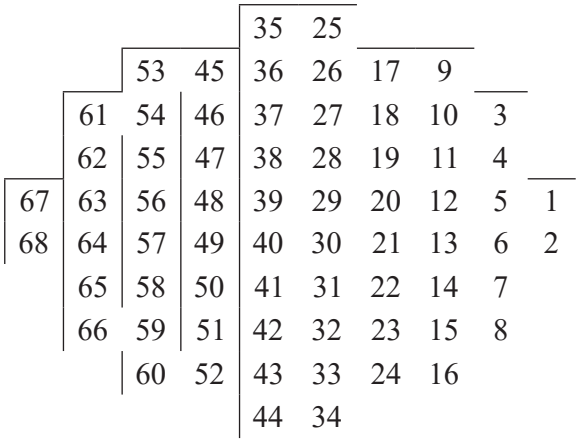

Figure 2: Assigned numbers for 68 points in the 10-2 visual field

Results

During the follow-up period, seven eyes were excluded since they required a procedure, so 19 eyes were analyzed. The mean age of patients was 57.60±8.99 (range 33-73) years. 64.3 % of patients were men. Table 1 shows the demographic characteristics of patients.

The average mean deviation, pattern standard, and foveal threshold in pre-operative and post-operative visual fields are shown in table 2. The 24-2 and 10-2 fields did not show clinically or statistically significant changes before and after macular photocoagulation.

Discussion

Twenty-six eyes from 14 patients were included in our prospective study, but seven eyes were excluded because they required pan-retinal photocoagulation or anti-VEGF

Table1: demographic characteristics of patients

Age (Mean±SD) (years)	57.60 ± 8.99	
Sex	Male	64.3 %
	Female	35.7 %
laterality	Right	50 %
	Left	50 %
Best corrected visual acuity (Mean ± SD) (LogMAR)	0.4 ± 0.32	
Intra-ocular pressure (Mean ± SD) (mmHg)	14.71 ± 3.20	

Table 2: Pre-operative and post-operative visual field indices of patients

Visual field	indices	Pre-operative	Post-operative	P Value
24-2	MD(Mean ± SD)	- 7.35 ± 4.22	- 8.15 ± 7.03	0.632
	PSD(Mean ± SD)	4.90 ± 2.67	5.45 ± 3.59	0.534
	FT(Mean ± SD)	28.50 ± 9.40	23.50 ± 10.00	0.128
10-2	MD(Mean ± SD)	- 4.18 ± 1.42	- 4.88 ± 4.50	0.481
	PSD(Mean ± SD)	1.92 ± 0.64	3.11 ± 1.41	0.007
	FT(Mean ± SD)	28.92 ± 6.94	23.92 ± 10.68	0.056

MD: Mean Deviation
PSD: Pattern Standard Deviation
FT: Foveal Threshold

therapy during follow-up, leaving 19 eyes for analysis. Macular laser photocoagulation was found to have no effect on the visual field. Previous studies have reported the occurrence of paracentral scotomata following grid laser photocoagulation for DME [9, 10].

Conversely, Striphet al.[11] documented a reduction in the mean sensitivity of the Humphrey Field Analyser (HFA) program 10-2 in 64 eyes of 36 patients with DME following grid laser photocoagulation. As Hodson et al. demonstrated in a prospective study involving 24 participants, laser photocoagulation for clinically significant DME invariably results in a localized loss of perimetric sensitivity within 10 degrees of the eccentricity of the fovea [12]. A prospective study by Sims et al. [13] performed automated perimeters of 8 participants before and six to eight weeks after macular laser photocoagulation. The results suggest that although focal treatment results in local absolute visual field defects, the effects are minimal with regard to global indexes. Our study found no statistically significant changes in either the area of the visual field or the mean deviation before and after macular photocoagulation. As a result, the procedure will not significantly impact other types of visual field defects. However, it is necessary to conduct more studies with larger samples to confirm this issue.

The present study aimed to evaluate the effect of macular photocoagulation on visual field indices in patients with macular edema due to branch retinal vein occlusion. The results showed that the 24-2 and 10-2 visual

fields did not exhibit any significant changes before and after the treatment. Although there was a slight decrease in the mean deviation and foveal threshold, the changes were not statistically significant. On the other hand, the pattern standard deviation of the 10-2 visual field showed a significant increase after the treatment.

Twenty-six eyes from 14 patients were included in our prospective study, but seven eyes were excluded because they required pan-retinal photocoagulation or anti-VEGF therapy during follow-up, leaving 19 eyes for analysis. Macular laser photocoagulation was found to have no effect on the visual field [7]. Previous studies have reported the occurrence of paracentral scotomata following grid laser photocoagulation for DME [8].

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The demographic characteristics of the patients revealed that most of the patients were male, and the mean age was 57.60 years. The best-corrected visual acuity was 0.4, which indicates moderate visual impairment, and the intraocular pressure was within the normal range. The study also excluded seven eyes that required a procedure during the follow-up period, which indicates that the results are more reliable as they only analyzed the eyes that completed the follow-up period without any complications.

The results of this study are consistent with previous studies that have shown that macular photocoagulation has a limited effect on visual field indices in patients with macular edema due to branch retinal vein occlusion. However, the present study has some limitations, such as the small sample size and the short follow-up period. Thus, larger studies with longer follow-up periods are required to confirm these findings [16].

Conclusion

Laser photocoagulation of the macular area does not appear to affect the visual field. The effect of the procedure on other types of visual field defects is, therefore, not of concern. However, the results should be interpreted with caution due to the small sample size and short follow-up period. Further studies are required to evaluate the long-term effects of macular photocoagulation on visual field indices in these patients.

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Footnotes and Financial Disclosures

Conflict of interest:

The authors have no conflict of interest with the subject matter of the present study.