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RESEARCH ARTICLE

Estimating the Effects of Conventional Argon Panretinal Laser Photocoagulation on Retinal Nerve Fiber Layer and Driving Visual Fields in Diabetic Retinopathy

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ABSTRACT

Diabetic retinopathy (DR) is a leading cause of visual impairment and blindness among adults worldwide, often progressing to proliferative diabetic retinopathy (PDR). Argon panretinal laser photocoagulation (PRP) is a standard treatment for PDR, aimed at reducing the risk of severe vision loss. However, this treatment has potential side effects, including damage to the retinal nerve fiber layer (RNFL) and visual field loss, which may impact driving vision. This study aims to evaluate the effects of conventional argon PRP on the RNFL thickness and driving visual fields in patients with DR. A total of 60 patients with PDR were included in the study. Pre-treatment and post-treatment evaluations were performed using optical coherence tomography (OCT) to measure RNFL thickness and visual field testing using the Humphrey Field Analyzer (HFA). Results indicated a significant decrease in RNFL thickness and a decline in driving visual fields post-PRP, especially in the central and para-central regions. The findings suggest that while PRP effectively manages DR, it may lead to functional impairment in the RNFL and compromise driving vision, underscoring the need for regular monitoring of these parameters in treated individuals.

Keywords: Diabetic retinopathy, argon panretinal laser photocoagulation, retinal nerve fiber layer (RNFL), driving visual fields, visual function, laser treatment, diabetic complications.

INTRODUCTION:

Diabetic retinopathy (DR) is a major microvascular complication of diabetes and a leading cause of vision loss in adults, particularly in patients with prolonged or poorly controlled diabetes. The disease progresses through stages, from mild non-proliferative retinopathy to severe proliferative diabetic retinopathy (PDR). In PDR, abnormal growth of retinal blood vessels can lead to retinal hemorrhages, vitreous hemorrhage, and retinal detachment. Argon panretinal laser photocoagulation (PRP) has been the cornerstone of treatment for PDR for decades, aimed at preventing vision loss by reducing retinal oxygen demand and halting neovascularization (1).

While the efficacy of PRP in preventing blindness due to PDR is well-established, its potential side effects, particularly on the retinal nerve fiber layer (RNFL) and visual fields, have been a topic of concern. The laser burns used in PRP can cause scarring and may lead to thinning of the RNFL, which could result in visual field loss, especially in the central and para-central regions, critical for activities such as reading and driving (2). Additionally, the impact of PRP on driving visual fields, which is crucial for safe driving, remains insufficiently explored. Understanding these potential risks is essential for evaluating the overall benefit-risk balance of PRP in patients with PDR.

Several studies have suggested that PRP can lead to changes in the RNFL and visual field, yet the extent of these changes and their clinical significance remain unclear. This study aims to assess the effects of conventional argon PRP on the RNFL thickness and driving visual fields in patients with PDR, with the goal of improving patient management and guiding clinical decisions.

Aim and Objectives

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Aim:
To estimate the effects of conventional argon panretinal laser photocoagulation on the retinal nerve fiber layer (RNFL) thickness and driving visual fields in patients with diabetic retinopathy.

Objectives:

1. To evaluate changes in RNFL thickness following conventional argon panretinal laser photocoagulation in patients with PDR.
2. To assess the impact of PRP on the driving visual fields using visual field testing before and after treatment.

Materials and Methods

Study Design:

This prospective cohort study was conducted at a tertiary referral center for retinal diseases. A total of 60 patients with bilateral proliferative diabetic retinopathy (PDR) were included. The inclusion criteria were as follows: (1) diagnosis of PDR in both eyes, (2) age between 40-70 years, (3) stable blood glucose control, and (4) no previous ocular surgery or laser treatment. Patients with significant coexisting eye diseases (such as glaucoma or macular edema) were excluded.

Pre-Treatment Evaluation:

1. **Optical Coherence Tomography (OCT)**: Baseline RNFL thickness was measured using a spectral-domain OCT (Cirrus HD-OCT, Carl Zeiss Meditec). RNFL thickness was assessed in four quadrants (superior, inferior, nasal, and temporal) and averaged.
2. **Visual Field Testing**: The Humphrey Field Analyzer (HFA 24-2 test) was used to assess the visual field, particularly focusing on the central 10° and the regions important for driving vision (central 20°).
3. **Blood Pressure and HbA1c Levels**: As part of the baseline assessment, patients' blood pressure and HbA1c levels were recorded to ensure optimal diabetic management.

Intervention: All participants underwent conventional argon panretinal laser photocoagulation (PRP) using a standard 532-nm wavelength laser. The total number of laser spots varied based on the severity of PDR, with treatment targeting the peripheral retina. The treatment was administered over two sessions, spaced 4-6 weeks apart.

Post-Treatment Evaluation: Post-treatment OCT and visual field testing were performed 6 months after the completion of PRP. Changes in RNFL thickness and visual field scores were analyzed, with particular focus on the central and para-central visual fields, which are crucial for tasks like reading and driving.

Results

Table 1: **Changes in Retinal Nerve Fiber Layer (RNFL) Thickness before and after PRP**

RNFL Region	Pre-PRP (µm)	Post-PRP (µm)	p-value
Superior	102.5 ± 8.2	98.4 ± 7.1	0.032
Inferior	108.3 ± 9.5	104.1 ± 8.3	0.021
Nasal	95.2 ± 6.8	92.3 ± 7.0	0.045
Temporal	97.5 ± 7.4	94.6 ± 6.9	0.041
Average RNFL	**100.3 ± 7.7**	**97.3 ± 6.3**	**0.035**

Table 2: **Changes in Driving Visual Fields before and after PRP (Central 20°)**

Visual Field Parameter	Pre-PRP (%)	Post-PRP (%)	p-value
Central 10° (degree)	85.6 ± 5.4	80.2 ± 6.3	0.027
Central 20° (degree)	92.3 ± 4.8	86.5 ± 5.2	0.035
Total Visual Field (%)	91.4 ± 4.1	85.1 ± 5.3	0.040

Discussion

The results of this study indicate that conventional argon panretinal laser photocoagulation (PRP) for proliferative diabetic retinopathy (PDR) leads to a significant reduction in retinal nerve fiber layer (RNFL) thickness, particularly in the superior and inferior quadrants. This thinning of the RNFL is consistent with previous studies that have shown laser-induced damage to the retinal structures, even though

PRP is primarily intended to treat neovascularization (3, 4). The thinning of the RNFL observed in this study may be attributed to both direct thermal injury from the laser and subsequent scarring, which can result in a loss of retinal ganglion cells and axons (5).

Moreover, there was a significant decline in the driving visual fields, particularly in the central 10° and 20°, areas crucial for tasks like reading, driving, and other daily activities. These results corroborate findings from previous research showing that PRP can impair visual field sensitivity, especially in patients with advanced DR (6, 7). The central and para-central visual fields are particularly vulnerable to laser treatment due to their proximity to the macula, which plays a vital role in high-resolution vision.

While PRP remains an essential treatment for preventing severe vision loss in PDR, these findings highlight the potential for functional impairment in visual fields, which could affect patients' ability to drive safely. This emphasizes the importance of considering functional outcomes, such as driving vision, when managing patients with PDR and conducting follow-up assessments after PRP.

Conclusion

This study demonstrates that conventional argon panretinal laser photocoagulation for proliferative diabetic retinopathy results in a significant reduction in retinal nerve fiber layer (RNFL) thickness and a decline in driving visual fields. These findings underscore the need for careful consideration of both the structural and functional outcomes when treating diabetic retinopathy. While PRP remains an effective treatment for preventing vision loss, patients should be regularly monitored for changes in RNFL and visual fields, especially those involved in activities requiring high visual acuity, such as driving.

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