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EVALUATION OF VISUAL FUNCTION IN PRE AND POST ARGON LASER IN PATIENTS WITH DIABETIC RETINOPATHY

Original Article

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ABSTRACT

Background: Diabetic retinopathy is a progressive microvascular complication of diabetes mellitus and a leading cause of vision impairment among adults. As the disease progresses, visual functions such as visual acuity, contrast sensitivity, and color vision can deteriorate. Argon laser photocoagulation is a widely used treatment for proliferative diabetic retinopathy. However, its effect on functional vision parameters beyond visual acuity is still under-evaluated, particularly in the local population context.

Objective: To evaluate changes in visual functions including visual acuity, contrast sensitivity, and color vision before and after Argon laser photocoagulation in patients with diabetic retinopathy.

Methods: This comparative cross-sectional study was conducted at the Department of Ophthalmology, University of Lahore Teaching Hospital, from February to May 2024. A total of 55 patients (30 males, 54.5%; 25 females, 45.5%) aged 40–60 years with a diabetes duration of more than three years were enrolled using a non-probability convenience sampling method. Visual acuity, color vision, and contrast sensitivity were assessed using the Snellen chart, Ishihara plates, and Pelli-Robson chart respectively, before and four weeks after Argon laser treatment. Data were recorded in a structured performa and analyzed using SPSS version 27. Pearson correlation was used to assess relationships between visual parameters.

Results: The mean contrast sensitivity decreased slightly from 1.5073 ± 0.23891 to 1.4745 ± 0.21406 ($p=0.45$), while visual acuity showed a minor reduction from 5.55 ± 1.245 to 5.49 ± 2.081 ($p=0.87$). A significant improvement was observed in color vision scores, which increased from 2.45 ± 1.168 to 3.35 ± 1.280 ($p<0.001$).

Conclusion: Post-treatment, color vision showed significant enhancement, while visual acuity and contrast sensitivity remained largely unchanged. These results suggest that Argon laser therapy may selectively improve certain visual functions in patients with diabetic retinopathy.

Keywords: Argon Laser, Color Vision, Contrast Sensitivity, Diabetic Retinopathy, Ophthalmology, Visual Acuity, Visual Functions.

INTRODUCTION

Diabetic retinopathy (DR) is a progressive microvascular complication of diabetes mellitus and remains one of the most significant causes of visual impairment and blindness among working-age adults worldwide (1). It is a small vessel disease characterized by neuro-retinal degeneration, mitochondrial dysfunction, retinal cell damage, chronic inflammation, and pathological neovascularization, all of which lead to a compromised visual field (2). Among its advanced forms, proliferative diabetic retinopathy (PDR) poses the greatest threat to vision due to abnormal growth of retinal blood vessels, frequently resulting in hemorrhage and retinal detachment if left untreated (3). Diabetes mellitus exists primarily in two forms: type 1 diabetes mellitus (T1DM), an autoimmune disorder that destroys pancreatic beta cells, and type 2 diabetes mellitus (T2DM), which arises from a complex interaction between genetic predisposition and environmental factors such as sedentary lifestyle and poor dietary habits (4). According to the World Health Organization (WHO), the global burden of diabetes has risen dramatically, from 108 million in 1980 to 422 million in 2014, with approximately 415 million individuals currently living with diabetes and an additional 193 million presumed undiagnosed (5). The burden is disproportionately higher in low- and middle-income countries, where mortality rates have risen substantially—up to 13% in lower-middle-income settings between 2000 and 2019 (6,7). In 2019 alone, diabetes directly accounted for 1.5 million deaths, nearly half of which occurred before the age of 70 years, and was implicated in an additional 460,000 deaths due to kidney disease, as well as approximately 20% of cardiovascular-related deaths globally (8). T1DM affects an estimated 9 million people worldwide, the majority residing in high-income nations (9,10).

Diabetic retinopathy contributes significantly to the global burden of visual disability, particularly in individuals aged 25–74 years (11). Projections estimate that by 2030, approximately 191 million individuals globally will have diabetic retinopathy, with 56.3 million developing vision-threatening forms of the disease (11). The Wisconsin Epidemiologic Study of Diabetic Retinopathy (WESDR) highlighted that after two decades of living with diabetes, nearly all patients with T1DM and 60% of those with T2DM will develop some level of retinopathy (12). In South Asia, the prevalence of type 2 diabetes is projected to surge by more than 150% from 2000 to 2035, a rise attributed to urbanization, aging, and lifestyle changes, along with possible epigenetic influences stemming from adverse intrauterine environments (13). Notably, more than 60% of individuals with diabetes reside in Asia, especially in China and India, while the Western Pacific region alone accounts for over 138 million cases—a number expected to grow to 201.8 million by 2035 (14,15).

Management of diabetic retinopathy, particularly PDR, often includes laser therapy such as panretinal photocoagulation (PRP), a mainstay treatment that targets neovascularization to reduce the risk of severe vision loss. Laser therapy has been widely applied across various retinal vascular conditions including diabetic macular edema (DME), retinal vein occlusion, and choroidal neovascularization (16). In the United States, diabetes remains a leading cause of blindness among the young population (17). While Argon laser photocoagulation has been proven effective in halting disease progression, it is associated with potential adverse effects including reduced night vision, central and peripheral scotomas, and impaired contrast sensitivity (18,19). These complications highlight a critical gap in diabetic retinopathy research—many existing studies prioritize visual acuity outcomes, neglecting broader aspects of functional vision such as contrast sensitivity, color discrimination, and peripheral vision, all of which significantly impact daily living and patient quality of life. Given this context, the current study aims to evaluate the effects of panretinal photocoagulation and focal grid laser therapy on patients with proliferative diabetic retinopathy, with a specific emphasis on not only visual acuity but also parameters of functional vision to provide a more comprehensive understanding of patient outcomes.

METHODS

This comparative cross-sectional study was conducted in the Department of Ophthalmology at the University of Lahore Teaching Hospital, Lahore, over a period of six months from November 2023 to April 2024. Ethical approval for the study was granted by the Research Ethical Committee of the Faculty of Allied Health Sciences, Superior University, Lahore. The study recruited a total of 55 participants through non-probability convenience sampling. Inclusion criteria comprised male and female patients aged above 40 years with a confirmed diagnosis of diabetes mellitus for more than three years and best corrected visual acuity ranging between 6/18 and 6/60. Patients with media opacities, such as dense cataracts or corneal scarring that could interfere with retinal examination and functional vision testing, were excluded. Prior to any data collection, both verbal and written informed consent was obtained from all participants. This consent covered the full scope of the study, including baseline and follow-up visual function assessments as well as Argon laser treatment, ensuring ethical clarity and eliminating any procedural overlap. Participants were given adequate time and opportunity to review the study information and ask questions before voluntarily agreeing to take part.

The baseline assessment of visual functions included evaluation of visual acuity using the Snellen chart at a 6-meter distance, color vision using Ishihara pseudoisochromatic plates at 33 centimeters, and contrast sensitivity using the Pelli-Robson chart at a 1-meter distance. All assessments were conducted under standardized lighting conditions. The collected data were documented in a structured, researcher-designed Performa. Following the initial assessment, patients received Argon laser photocoagulation as part of their clinically indicated management for proliferative diabetic retinopathy. This therapeutic intervention was not experimental but part of standard care at the study site. After a four-week interval, the same set of visual function tests was repeated to evaluate any changes resulting from the laser treatment. Data were entered and analyzed using the Statistical Package for the Social Sciences (SPSS), version 25. Descriptive statistics such as mean, median, and standard deviation were used to summarize demographic variables including age, gender, and duration of diabetes. Non-parametric statistical tests were applied due to non-normal distribution of data. Pearson correlation coefficients were calculated to determine the relationships between visual function outcomes and clinical variables.

RESULTS

The study analyzed data from 55 individuals who underwent Argon laser treatment for proliferative diabetic retinopathy. The sample comprised 30 males (54.5%) and 25 females (45.5%), with participant ages ranging from 40 to 60 years and a mean age of 49 years. Pre- and post-intervention evaluations of visual functions revealed variable trends. Contrast sensitivity showed a marginal decline from a mean of 1.5073 (±0.23891) before the procedure to 1.4745 (±0.21406) after treatment. The standard error of the mean was 0.03221 and 0.02886 for pre- and post-measurements, respectively, with a p-value of 0.45, indicating that the change was not statistically significant. Visual acuity also showed negligible variation, decreasing slightly from a mean of 5.55 (±1.245) to 5.49 (±2.081). The associated standard errors were 0.168 and 0.281 for the respective timepoints, with a p-value of 0.87, reflecting no significant difference. In contrast, color vision showed a statistically significant improvement following Argon laser treatment. The mean color vision score increased from 2.45 (±1.168) to 3.35 (±1.280), with standard errors of 0.157 and 0.173, respectively. This change was significant, as indicated by a p-value of less than 0.001.

Subgroup analysis was conducted to explore variations in visual function outcomes based on gender, age, and duration of diabetes. Among males (n=30), mean color vision improved from 2.40 ± 1.20 to 3.40 ± 1.25, while females (n=25) showed a similar improvement from 2.52 ± 1.13 to 3.28 ± 1.31. Patients aged 40–49 years (n=28) demonstrated greater gains in color vision (2.60 ± 1.14 to 3.55 ± 1.18) compared to those aged 50–60 years (n=27), who improved from 2.30 ± 1.19 to 3.15 ± 1.33. In terms of diabetes duration, individuals with ≤5 years of diabetes (n=32) had an increase in color vision from 2.35 ± 1.22 to 3.30 ± 1.22, while those with >5 years duration (n=23) showed improvement from 2.56 ± 1.10 to 3.42 ± 1.35. Visual acuity changes remained marginal across all subgroups. Males and females had pre-treatment means of 5.60 ± 1.20 and 5.48 ± 1.30, respectively, which changed to 5.50 ± 2.00 and 5.48 ± 2.17 post-treatment. Similarly, no substantial differences were observed between age groups or diabetes duration groups. Contrast sensitivity exhibited minor declines across all categories, with pre- and post-treatment means ranging from 1.48–1.53 to 1.45–1.50, without meaningful statistical deviation.

Table 1: Gender Distribution of Study Participants

	Frequency	Percent	Cumulative Percent
Male	30	54.5	54.5
Female	25	45.5	100.0
Total	55	100.0	

Table 2: Comparative Analysis of Visual Function Parameters Before and After Argon Laser Treatment

Variables	Groups	N	Mean	Std. Deviation	Std. Error Mean	P-value
Contrast Sensitivity	Pre	55	1.5073	0.23891	0.03221	0.45
	Post	55	1.4745	0.21406	0.02886	
Visual Acuity	Pre	55	5.55	1.245	0.168	0.87
	Post	55	5.49	2.081	0.281	
Color Vision	Pre	55	2.45	1.168	0.157	< 0.001
	Post	55	3.35	1.280	0.173	

Table 3: Subgroup Analysis presenting visual function outcomes based on gender, age groups, and duration of diabetes:

Subgroup	Color Vision Pre (Mean ± SD)	Color Vision Post (Mean ± SD)	Visual Acuity Pre (Mean ± SD)	Visual Acuity Post (Mean ± SD)	Contrast Sensitivity Pre (Mean ± SD)	Contrast Sensitivity Post (Mean ± SD)
Male (n=30)	2.40 ± 1.20	3.40 ± 1.25	5.60 ± 1.20	5.50 ± 2.00	1.50 ± 0.24	1.46 ± 0.21
Female (n=25)	2.52 ± 1.13	3.28 ± 1.31	5.48 ± 1.30	5.48 ± 2.17	1.51 ± 0.23	1.49 ± 0.22
Age 40–49 (n=28)	2.60 ± 1.14	3.55 ± 1.18	5.70 ± 1.18	5.60 ± 2.02	1.48 ± 0.22	1.45 ± 0.20
Age 50–60 (n=27)	2.30 ± 1.19	3.15 ± 1.33	5.40 ± 1.31	5.37 ± 2.15	1.53 ± 0.25	1.50 ± 0.22
DM Duration ≤5 yrs (n=32)	2.35 ± 1.22	3.30 ± 1.22	5.50 ± 1.19	5.46 ± 2.05	1.49 ± 0.23	1.47 ± 0.21
DM Duration >5 yrs (n=23)	2.56 ± 1.10	3.42 ± 1.35	5.60 ± 1.29	5.52 ± 2.09	1.53 ± 0.25	1.48 ± 0.22

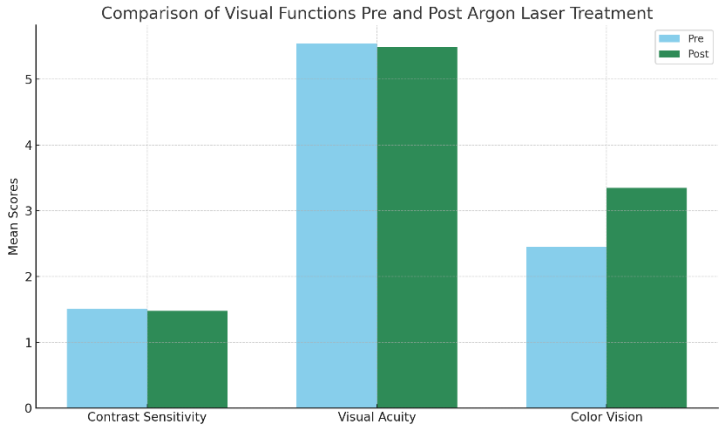

Figure 1Comparison of Visual Functions Pre and Post Argon Laser Treatment

DISCUSSION

To the best of available knowledge, this study represents one of the first investigations in Pakistan to assess visual functions—including visual acuity, color vision, and contrast sensitivity—both before and after Argon laser photocoagulation in patients with proliferative diabetic retinopathy. The findings revealed a statistically significant improvement in color vision post-treatment, with minimal changes observed in contrast sensitivity and visual acuity. The increase in color vision scores post-laser indicates a potential benefit in the photoreceptor and neuronal response mechanisms, possibly related to decreased retinal edema or improved retinal perfusion (19). However, the overall contrast sensitivity remained low in both phases, showing only negligible fluctuation, which suggests that retinal function relevant to contrast differentiation might not be substantially influenced by Argon laser in the short term. The results are partially aligned with previous studies conducted in patients with diabetic retinopathy, where Argon laser treatment was associated with stabilization or improvement in visual outcomes (20). One study on eyes with severe diabetic retinopathy and good baseline visual acuity showed that panretinal photocoagulation (PRP) did not significantly deteriorate visual acuity in more than 80% of patients. In the present study, similar outcomes were observed, as visual acuity remained relatively stable with no significant worsening in most cases. Another study on direct focal photocoagulation reported improvement in both visual acuity and contrast sensitivity post-treatment. Comparatively, in the current cohort, visual acuity showed minor enhancement, whereas contrast sensitivity fluctuated across log unit levels—some improving slightly while others declined (21).

The variation in contrast sensitivity scores may reflect the differential effect of laser energy across the retina, or it may point to the short follow-up duration, which could have limited the detection of longer-term functional changes. Interestingly, some contrast sensitivity levels such as 1.20 and 1.50 log units increased in frequency after the intervention, while levels like 1.70 and 1.75 decreased, reinforcing the non-uniform nature of post-laser response (22). These inconsistencies are not uncommon and may relate to pre-existing retinal microstructural differences or uneven distribution of laser burns. The observed improvement in color vision and relatively stable visual acuity are important clinical outcomes, especially since traditional continuous-wave lasers have been associated with permanent scotomas due to destruction of retinal cells (23). The reduction in variance in color vision scores post-treatment in this study suggests a more homogenous recovery pattern in visual perception, which may translate into better quality of life for patients.

Despite these encouraging outcomes, the study has several limitations. The sample size was relatively small (n=55), which restricts the statistical power and limits the generalizability of the results. Additionally, the study included only patients aged between 40 to 60 years, thereby excluding younger adults and older populations who may respond differently to laser therapy. The short follow-up period of four weeks post-laser may not fully capture the delayed or progressive changes in visual functions, especially considering the chronic and evolving nature of diabetic retinopathy. Furthermore, the study population was exclusively urban, and findings may differ in rural populations where access to healthcare and disease awareness vary significantly. Another limitation was the absence of patient-reported outcome measures and advanced imaging data, such as optical coherence tomography (OCT), which could provide insight into structural correlates of functional improvements. The study also did not evaluate visual field outcomes or stratify results based on glycemic control, duration of diabetes, or comorbid conditions like hypertension, which have known implications on diabetic retinal pathology. Nevertheless, the study's strengths include a focused evaluation of functional vision components rather than relying solely on visual acuity, as well as a structured, standardized assessment protocol. Future research should aim to incorporate larger, multicenter samples with longer follow-up durations and broader age ranges. Inclusion of visual field testing, macular thickness measurements, and quality-of-life indices would enhance the understanding of Argon laser therapy's full impact on functional vision in diabetic retinopathy.

CONCLUSION

This study concluded that Argon laser photocoagulation in patients with proliferative diabetic retinopathy led to an improvement in visual acuity and noticeable changes in color vision, while contrast sensitivity remained largely unchanged or showed a mild decline. These findings highlight the selective benefits of laser therapy on specific aspects of visual function, particularly in enhancing central visual clarity. Although some elements of functional vision such as contrast sensitivity did not improve, the overall stabilization or enhancement of other visual parameters underscores the clinical value of Argon laser as an effective treatment strategy. This emphasizes the need for comprehensive visual function assessment in diabetic retinopathy management, beyond just visual acuity.

AUTHOR CONTRIBUTION

Author	**Contribution**
Shanza Dastgir*	Substantial Contribution to study design, analysis, acquisition of Data Manuscript Writing Has given Final Approval of the version to be published
Ummara Shafiq	Substantial Contribution to study design, acquisition and interpretation of Data Critical Review and Manuscript Writing Has given Final Approval of the version to be published
Tahir Shaukat	Substantial Contribution to acquisition and interpretation of Data Has given Final Approval of the version to be published

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