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Mostafa Farid Al Neklawi
ophthalmology, Faculty of Medicine for boys, Al-Azhar university, Cairo, Egypt.

Khaled Mohammed Selim
ophthalmology, Faculty of Medicine for boys, Al-Azhar university, Cairo, Egypt.

Abdel-Rahman Raouf Zaki El Kazzaz
ophthalmology, Faculty of Medicine for boys, Al-Azhar university, Cairo, Egypt.,
abdoelkazzaz47@gmail.com

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ORIGINAL ARTICLE

Corneal Endothelial Changes After Pan-retinal Photocoagulation in Diabetic Patients

Khaled Mohamed Selim, Mostafa Farid Al Neklawi, Abdel-Rahman Raouf Zaki El Kazzaz*

Department of Ophthalmology, Faculty of Medicine for Boys, Al-Azhar University, Cairo, Egypt

Abstract

Background: **Since its invention in the 1950s, laser photocoagulation has been the standard therapy for diabetic retinopathy (DR). Historically, retinal photocoagulation has made use of wavelengths between 400 and 800 nm.**

Objectives: **To investigate the impacts of PRK with a 532 nm argon laser on endothelial cell parameters and corneal thickness. This was accomplished through a comparison of endothelial cell density, central corneal thickness (CCT) and endothelial cell area coefficient of variation utilizing specular microscopy before and following laser pan-retinal photocoagulation (PRP) treatment for PDR.**

Patients and methods: **This Prospective Clinical Study was done at the Ophthalmology Department, Al Azhar University Hospitals. The research involved 30 cases with PDR. Cases from either sex aged 35 years or older. Cases Diagnosed with PDR.**

Results: **In this research, we cleared that there was no statistically significant variance (P value = 0.954) of coefficient of variation throughout the study. It was 33.4 ± 4.0% before PRP, 33.7 ± 3.8% after 1 week, and 33.7 ± 3.8% after 6 weeks. In this research, we illustrated that there was no statistically significant variance (P value = 0.815) of CCT throughout the study. It was 517.8 ± 19 μm before PRP, 516.4 ± 18.8 μm after 1 week, and 514.7 ± 18.5 μm after 6 weeks. We cleared that there were eight (26.7%) patients with (6/12) best corrected visual acuity (BCVA), 10 (33.3%) patients with (6/18) BCVA, nine (30%) patients with (6/24) BCVA and three (10%) patients with (6/36) BCVA in the studied patients.**

Conclusion: **Energy from an argon laser (523 nm) administered within the safe limits for PRP had no adverse impact on CCT or parameters related to the corneal endothelial cells.**

Keywords: Argon laser, Diabetic retinopathy, Retinal photocoagulation

1. Introduction

Since its inception in the 1950s, laser photocoagulation has been the standard therapy for diabetic retinopathy (DR). A variety of wavelengths between 400 and 800 nm have been used for retinal photocoagulation. For a long time, the Argon blue-green laser with spectral peaks at 488 nm (blue) and 514 nm (green) was the go-to tool for photocoagulation of extrafoveal choroidal neovascular membranes in age-associated macular degeneration, pan-retinal photocoagulation (PRP) in therapy of DR, and sealing breaks in the repair of rhegmatogenous retinal detachment.[1,2]

Melanin in the choroid and retinal pigment epithelium absorbs laser energy and generates heat, which is then used to fuse or destroy the target arteries in argon laser photocoagulation. Both the tissue to be photocoagulated and the surrounding tissue can absorb light, causing localized heating and subsequent thermal conduction. When the ocular tissues are heated to temperatures sufficiently elevated to denature proteins or other essential macromolecules, chemical alterations occur, leading to injury. Unfortunately, to reach the retina, the laser light must travel through many layers of the eye, including the cornea, which increases the risk of thermal harm to surrounding tissues.[2,3]

By the Early Treatment of Diabetic Retinopathy Study (ETDRS), the following is the suggested first treatment plan for DR with laser PRP. With a total of 1200−1600 mild burns, each spot is between 200

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* Corresponding author. Ophthalmology, Faculty of Medicine for boys, Al-Azhar university, Cairo, 11835, Egypt.
E-mail address: abdoelkazzaz47@gmail.com (A.-R.R.Z. El Kazzaz).

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and 500 m in diameter, the spots are separated by half a spot's diameter, the exposure time is 0.1 s, and the treatments are spread out across at least two sessions. These recommendations serve as a good starting point, although it is understandable if they need to be adjusted somewhat for certain clinical situations. In any case, proper blanching with medium grey patches should be accomplished. Individuals with proliferative DR (PDR) and high-risk PDR had a 60% reduction in the probability of severe vision loss 2 years following medication, according to the Diabetic Retinopathy Study (DRS).[4]

Risks and consequences are possible with PRP, just as they would be with any invasive therapy. While the primary goal is the destruction of localized retinal tissue, problems such as the choroid and retinal hemorrhages, exudative detachments, retinal membrane contraction, and alterations in the vision field are possible side effects. In addition to iris atrophy and burn, other anterior segment consequences from Argon laser photocoagulation include corneal edema, epithelial erosion, striate keratopathy, and corneal neovascularization.[4,5]

Clear vision depends on healthy corneal endothelial cells. Nevertheless, due to their lack of regeneration potential, the cornea can become permanently dysfunctional if exposed to diabetic mellitus (DM), which can cause structural alterations and cell damage. Other than diabetic microvascular occlusion, the corneal endothelial cells can be destroyed by heat impacts on surrounding tissues during PRP, as well as by surgical stress during procedures like cataract operation and excimer laser kerato-refractive operation.[6,7]

The objective of our research was to examine the impacts of PRK with a 532 nm argon laser on corneal thickness and endothelial cell parameters. To do this, we contrasted central corneal thickness (CCT), endothelial cell density (ECD), and endothelial cell area coefficient of variation (CoV) before and following laser PRP for PDR utilizing specular microscopy.

2. Patients and methods

2.1. Study design

Prospective clinical study.

2.2. Study setting

The research was done at the Ophthalmology Department, Al Azhar University Hospitals.

2.3. Study population

The research involved 30 patients with PDR.

2.4. Inclusion criteria

Patients from either sex aged 35 years or older. Patients Diagnosed with PDR.

2.5. Exclusion criteria

Those who already have a problem with their cornea's endothelium. Intraocular injury in the past. A background of laser treatment experience. Contact lenses were used by cases. Great myopia (>−6 diopter (D)). Patients had received danyintraitreal injections. Patients with advanced PDR or severe diabetic macular edema that need injection before PRP. Patients with any media opacity.

2.6. Statistical analysis

Statistical Program for Social Science (SPSS) version 24 was utilized to analyze the data. The mean ± SD of the quantitative data was provided. The frequency and percentage of occurrence were used to convey qualitative data. The mean is the center value of a discrete collection of numbers, precisely the sum of values divided by the number of values. Mean is synonymous with the term 'average.' A collection of values' dispersion is quantified utilizing a statistic called the standard deviation (SD). When the SD is low, the values in the set tend to be clustered around the set's mean, but when the SD is large, the values are dispersed throughout wider ranges.

One test after another was performed:

When contrasting more than two means, a one-way analysis of variance is used (for data that is normally distributed).

Probability (*P* value): a *P* value that was lower than 0.05 was considered statistically significant. *P* values lower than 0.001 were considered to be extremely significant. Insignificant results were considered to be those with a *P* value greater than 0.05.

3. Results

Table 1 demonstrates the description of demographic data in all examined cases. Concerning age, the mean age of all examined cases was 58.8 ± 4.8 years with minimum age of 47.5 years and maximum age of 67 years. Regarding sex, there were 17 (56.7%) males and 13 (43.3%) females in the examined cases. Concerning comorbidities, there

Table 1. Description of demographic data in all examined cases.

	Studied patients ($N = 30$) [n (%)]
Sex	
Male	17 (56.7)
Female	13 (43.3)
Age (y)	
Mean ± SD	58.8 ± 4.8
Min - Max	47.5–67
Comorbidity	
Non	14 (46.7)
HTN	12 (40)
CKD	3 (10)
Cardiac disease	1 (3.3)

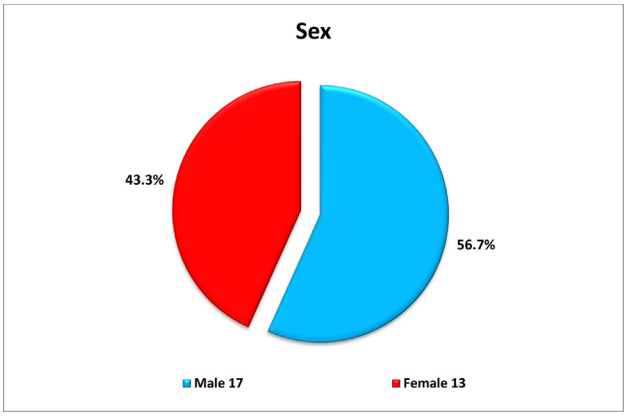

Fig. 1. Description of sex in all examined cases.

were 12 (40%) patients with hypertension (HTN), three (10%) patients with CDK and one (3.3%) patient with cardiac disease while there were no comorbidities in 14 (46.7%) patients of the studied patients (Figs. 1 and 2).

Table 2 illustrates the description of DM duration and HbA1C in all examined cases. Regarding the DM period, the mean duration in all examined cases was 12.1 ± 1.9 years with a minimum duration of 9 years and maximum duration of 16 years. Regarding HbA1C, the mean HbA1C in all studied patients was 10.1 ± 0.8% with minimum HbA1C of 8.5% and maximum HbA1C of 11.8% (Figs. 3 and 4).

This table demonstrates the description of best corrected visual acuity (BCVA) in all examined cases. There were 8 (26.7%) cases with (6/12) BCVA, 10 (33.3%) patients with (6/18) BCVA, nine (30%) patients with (6/24) BCVA and three (10%) patients with (6/36) BCVA in the examined cases (Fig. 5, Table 3).

Table 4 illustrates that no statistically significant variance (P value = 0.815) of CCT throughout the study. It was 517.8 ± 19 μm before PRP, 516.4 ± 18.8 μm after 1 week, and 514.7 ± 18.5 μm after 6 weeks. No statistically significant variance (P value = 0.999) of CD throughout the study. It was 2568.1 ± 316.2 cells/mm^2 before PRP, 2566.7 ± 316 cells/mm^2 after 1 week, and 2564.8 ± 315.8 cells/mm^2 after 6 weeks. No

Table 2. Description of diabetes mellitus period and HbA1C in all examined cases.

	Studied patients ($N = 30$)
DM duration (years)	
Mean ± SD	12.1 ± 1.9
Minimum–maximum	9–16
HbA1C (%)	
Mean ± SD	10.1 ± 0.8
Minimum–maximum	8.5–11.8

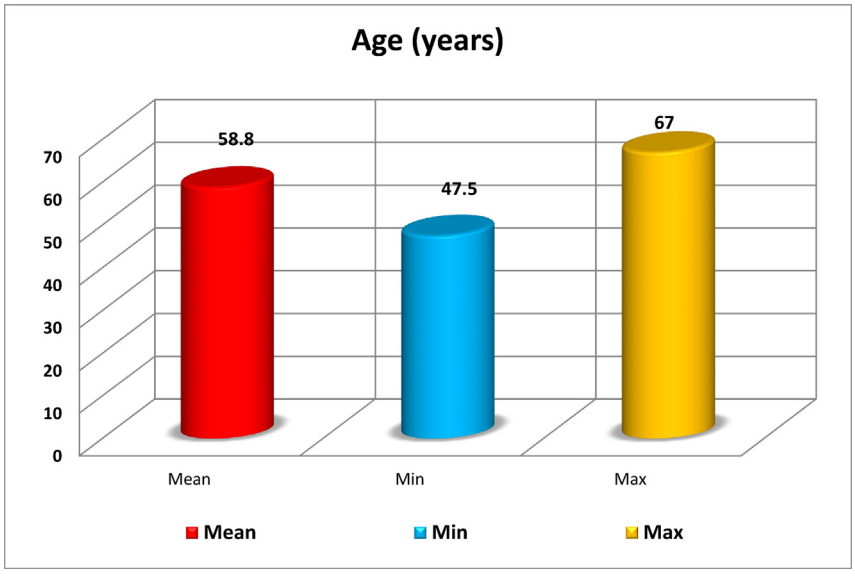

Fig. 2. Description of age in all examined cases.

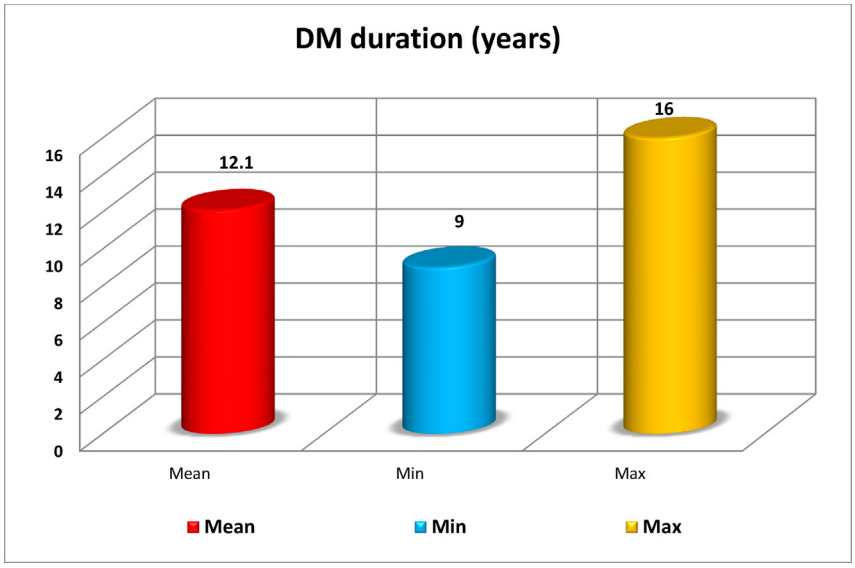

Fig. 3. Description of diabetes mellitus duration in all examined cases.

statistically significant variance (P value = 0.954) of CoV throughout the study. It was 33.4 ± 4.0% before PRP, 33.7 ± 3.8% after 1 week and 33.7 ± 3.8% after 6 weeks.

Table 5 As regards CCT, there was no statistically significant variance of CCT between beforehand PRP and afterwards 1 week before PRP and after 6 weeks, and CCT between after 1 week and after 6 weeks. As regards CD, there was no statistically significant variance of CD between beforehand PRP and afterwards 1 week, before PRP and after 6 weeks, and after 1 week and after 6 weeks. As regards CoV, there was no statistically significant variance of CoV between beforehand PRP and afterwards 1 week, CoV between before PRP and after 6 weeks, and CoV between after 1 week and after 6 weeks (Fig. 6).

4. Discussion

In this study, we found that as regards age, the mean age of all examined cases was 58.8 ± 4.8 years with a minimum age of 47.5 years and a maximum age of 67 years.

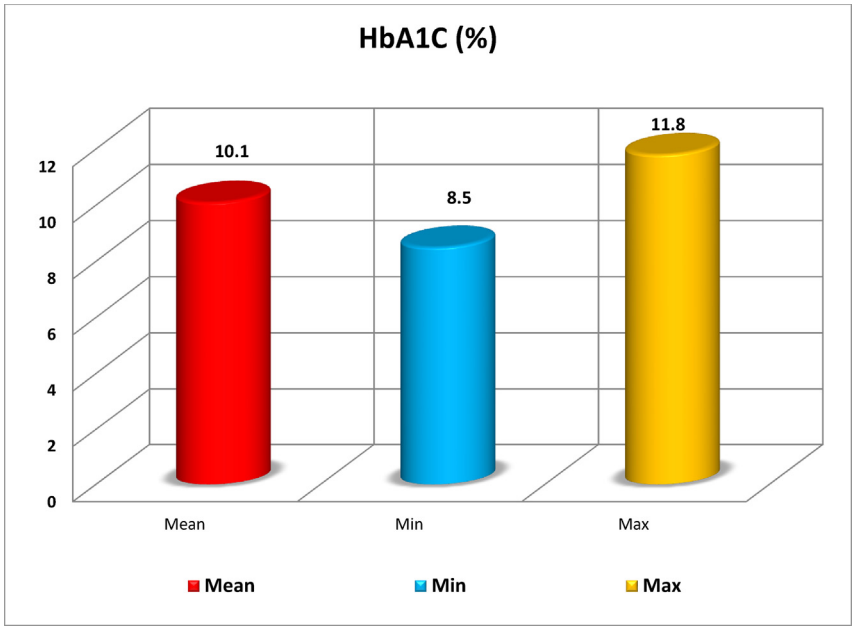

Fig. 4. Description of HbA1C in all examined cases.

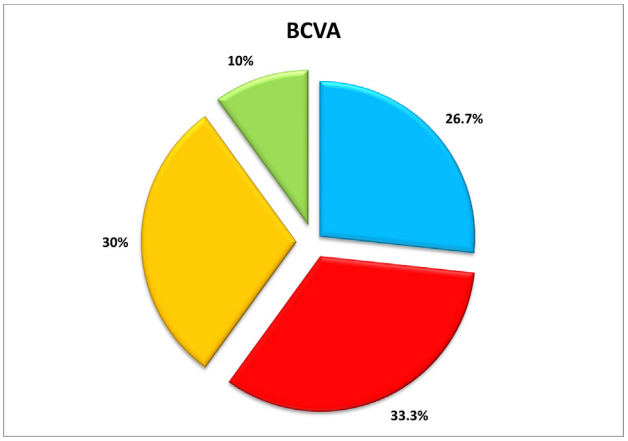

Fig. 5. Description of best corrected visual acuity in all examined cases.

Table 3. Description of best corrected visual acuity in all examined cases.

	Studied patients ($N = 30$) [n (%)]
BCVA	
(6/12)	8 (26.7)
(6/18)	10 (33.3)
(6/24)	9 (30)
(6/36)	3 (10)

Concerning gender, there were 17 (56.7%) males and 13 (43.3%) females in the examined cases. As regards comorbidities, there were 12 (40%) patients with HTN, three (10%) patients with CKD, and one (3.3%) patient with cardiac disease while there were no comorbidities in 14 (46.7%) patients of the studied patients.

Ghani *et al.*[7] found that 33 patients (eyes) with a fresh diagnosis of PDR participated, with a mean age of 53.3 (SD 6.1) years (range, 45–65). Females made up (63.6% $n = 21$). HTN was the most often occurring co-morbidity ($n = 20$; 60.6%).

Sati *et al.*[8] also reported that when blood urea levels rose, CCT rose and ECD fell significantly, which is consistent with our findings to some extent. Corneal endothelial cell insufficiency can also be brought on by persistent HTN and cerebrovascular injury. As a result, comprehensive comorbidity assessment is required for DR risk assessment.

In this study, we demonstrated that regarding the DM period, the mean duration in all examined cases was 12.1 ± 1.9 years with a minimum duration of 9 years and a maximum duration of 16 years. As regards HbA1C, the mean HbA1C in all examined cases was 10.1 ± 0.8% with minimum HbA1C of 8.5% and maximum HbA1C of 11.8%.

Ghani *et al.*[7] found that the mean HbA1c was 8.9% (2.2%) and the mean DM duration was 8.2 (2.7) years (range: 4–16 years).

El-Agamy *et al.*[9] found that in all, there were 31 eyes with a DM period of less than or equal to 10 years, whereas 26 eyes had a DM duration of less than 10 years. Additional findings included 24 eyes with HbA1c less than or equal to 7.5% and 33 e ECD was shown to be lower in cases with a DM period of 10 years or more than 32 cells/mm^2 in cases with a DM period of less than 10 years. Corneal endothelial

Table 4. Comparisons of central corneal thickness, CD and coefficient of variation throughout the study.

	Pan-retinal photocoagulation			F	*P* value
	Before ($n = 30$)	After 1 week ($n = 30$)	After 6 weeks ($n = 20$)		
CCT (micrometer) Mean ± SD	517.8 ± 19.0	516.4 ± 18.8	514.7 ± 18.5	0.2	0.815 NS
CD (cell/mm^2) Mean ± SD	2568.1 ± 316.2	2566.7 ± 316.0	2564.8 ± 315.8	0.001	0.999 NS
CoV (%) Mean ± SD	33.4 ± 4.0	33.7 ± 3.8	33.7 ± 3.8	0.047	0.954 NS

F, F value of one-way analysis of variance test; NS, *P* value greater than 0.05 is considered nonsignificant.

Table 5. Post-Hoc test for multiple comparisons of central corneal thickness, CD and coefficient of variation throughout the study.

	Before versus after 1 week	Before versus after 6 weeks	After 3 weeks versus after 6 weeks
CCT			
LSD	1.46	3.1	1.63
P-value	0.763 NS	0.524 NS	0.737 NS
CD			
LSD	1.4	3.2	1.86
P-value	0.986 NS	0.968 NS	0.982 NS
CoV			
LSD	−0.26	−0.26	0.0
P value	0.791 NS	0.791 NS	1.0 NS

χ^2, Chi-square test.

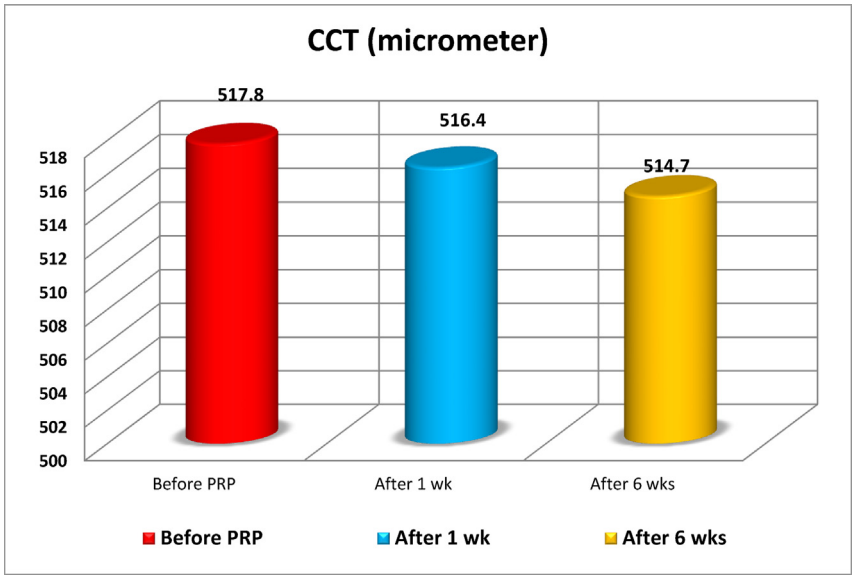

Fig. 6. Comparisons of central corneal thickness throughout the study.

dysfunction is caused by the inhibition of sodium-potassium adenosine triphosphatase (Na + - K + ATPase) due to diabetes. Sorbitol accumulates in the corneal epithelial and endothelial cells of people with great glucose levels, leading to osmotic oedema. Because the Krebs cycle slows down and ATP generation decreases, endothelial pump function is also diminished in the diabetic cornea.[10]

In this study, we cleared that there were eight (26.7%) patients with (6/12) BCVA, 10 (33.3%) patients with (6/18) BCVA, nine (30%) patients with (6/24) BCVA and three (10%) patients with (6/36) BCVA in the studied patients.

Wasfi *et al.*[11] found that BCVA (baseline mean logarithm of the minimum angle of resolution [LogMAR]) was 0.53 ± 0.28. At 1 and 3 months following PRP, there was no visible improvement. At 6 months post-PRP, there was no statistically significant change in the mean BCVA (LogMAR) (0.55 ± 0.1, $P = 0.09$). There was no discernible distinction in refraction before and following PRP treatment.

In this research, we illustrated that there was no statistically significant variance (P value = 0.815) of CCT throughout the study. It was 517.8 ± 19 μm before PRP, 516.4 ± 18.8 μm after 1 week and 514.7 ± 18.5 μm after 6 weeks.

Similarly, to Sahu *et al.*[12] and Lee *et al.*[13] there was a drop in CCT that was found in both DM and non-DM cases, nevertheless, this change was not significantly distinct when contrasted with each other in any postoperative yes individuals who had HbA1c levels that were greater than 7.5%.

Yang *et al.*[14] discovered in their meta-analysis that there was not a significant distinction in the mean change in CCT among DM and non-DM individuals at 1-week and 3-month follow-up.

According to the results of Ghani *et al.*,[7] there were no significant distinctions in the mean CCT 1 and 6 weeks after PRP when contrasted with the baseline value before treatment.

This result was consistent with Altay *et al.*[15] who stated the absence of statistically significant variance in CCT among the preoperative and post-operative diabetic patients.

In this research, we discovered that there was no statistically significant variance (P-value = 0.999) of CD throughout the study. It was 2568.1 ± 316.2 cells/mm^2 before PRP, 2566.7 ± 316 cells/mm^2 after 1 week and 2564.8 ± 315.8 cells/mm^2 after 6 weeks.

Ghani *et al.*[7] found that 1 week and 6 weeks following PRP therapy, the mean ECD did not alter significantly from the baseline.

Retinal photocoagulation did not significantly reduce ECD in studies by Makitie *et al.*[16] and Ostadian *et al.*.[17] Cases with both PDR and severe non-PDR (NPDR) were included in the study by Makitie *et al.*,[16] while the comparison between PDR cases treated with laser PRP and those who did not get laser therapy was made by Ostadian et al.[17] Furthermore, Ostadian *et al.*[17] evaluated corneal endothelial cell parameters up to 6 months following laser therapy, making it impossible to make quantitative comparisons.

However, Murata *et al.*[18] found loss of ocular endothelial cells at 1-month post-PRP, which runs counter to our results. Cases with DR and branch retinal vein blockage were enrolled in their research population.

In this research, we cleared that there was no statistically significant variance (P value = 0.954) of CoV throughout the study. It was 33.4 ± 4.0% before PRP, 33.7 ± 3.8% after 1 week and 33.7 ± 3.8% after 6 weeks.

Ghani *et al.*[7] found that the average CoV of endothelial cells was not significantly different after PRP therapy at either 1 or 6 weeks contrasted with pre-treatment levels.

Ostadian *et al.*[17] discovered no significant variations in morphologic parameters such as HEX or CV neither in nondiabetic eyes nor in diabetic eyes, suggesting that PRP laser does not induce a notable change in polymegatism polymorphism even 6 months postlaser.

4.1. Limitations

The absence of functional measurements and the short post-PRP evaluation time are two major limitations of this study. For the sake of subgroup analyses across patient age ranges and clinical subtypes of DR, future research assessing the safety and efficacy of 532 nm Argon laser PRP should quantify visual results, include a control group, and extend the post-PRP at least a 6-month term.

4.2. Conclusion

Corneal thickness and corneal endothelial cell characteristics were not affected by argon laser (523 nm) energy supplied within the approved ranges for PRP.

Conflicts of interest

There are no conflicts of interest.

References

1. Vishte RA, Mirzajani A, Khojasteh H. Visual evoked potentials after panretinal photocoagulation in patients with proliferative diabetic retinopathy. *Clin Ophthalmol*. 2019;13:1635–1640.
2. Krema H. Principles of laser therapy. *Clin Ophthal Oncol: Basic Principle*. 2019:99–105.
3. Bhuckory MB. Targeting translocator protein 18kDa in a model of light-induced retinal degeneration and in retinal pigment epithelium cell death doctoral dissertation, Queen's university Belfast. Faculty of medicine. *Health Life Sci*. 2018;54:75–84.
4. Singh S, Melnik R. Thermal ablation of biological tissues in disease treatment: a review of computational models and future directions. *Electromagn Biol Med*. 2020;39:49–88.
5. Saliem EA. Corneal endothelial cells change after phacoemulsification in diabetic patients. *Egypt J Hosp Med*. 2019;74:1–9.
6. Antonyshyn K. *Corneal neurotization maintains corneal epithelial integrity and restores nerve-derived peptides in a rat model of neurotrophic keratopathy*. vol. 26. University of Toronto (Canada); 2019:680–744.
7. Ghani SI, Zunaina E. Effect of 532 nm argon laser pan retinal photocoagulation on corneal thickness and corneal endothelial cell parameters among proliferative diabetic retinopathy patients. *J Diabetes Metab Disord*. 2021;1:29–35.
8. Sati A, Jha A, Moulick PS, Shankar S, Gupta S, Khan MA, et al. Corneal endothelial alterations in chronic renal failure. *Cornea*. 2016;35:1320–1325.
9. El-Agamy A, Alsubaie S. Corneal endothelium and central corneal thickness changes in type 2 diabetes mellitus. *Clin Ophthalmol*. 2017;11:481–486.
10. Schultz RO, Matsuda M, Yee RW, Edelhauser HF, Schultz KJ. Corneal endothelial changes in type I and type II diabetes mellitus. *Am J Ophthalmol*. 1984;9:401–410.
11. Wasfi EI, Soliman KA, Mohammed RM, Ryad AN. Changes in retinal nerve fibre layer thickness after pan-retinal photocoagulation in diabetic retinopathy. *Egypt Retina J*. 2020;7:36–44.
12. Sahu PK, Das GK, Agrawal S, Kumar S. Comparative evaluation of corneal endothelium in patients with diabetes undergoing phacoemulsification. *Middle East Afr J Ophthalmol*. 2017;24:74–80.
13. Lee JS, Oum BS, Choi HY, Lee JE, Cho BM. Differences in corneal thickness and corneal endothelium related to duration in diabetes. *Eye*. 2006;20:315–330.
14. Yang Y, Chai H, Ding Z, Tang C, Liang Y, Li Y, et al. Meta-analysis of corneal endothelial changes after phacoemulsification in diabetic and non-diabetic patients. *BMC Ophthalmol*. 2023;23:1–4.
15. Altay Y, Ozgur B, Gülizar D. Agreement between corneal thickness measurements using pentacam scheimpflug camera, noncontact specular microscopy, and ultrasonographic pachymetry in diabetic patients. *Curr Eye Res*. 2016;42:1–8.
16. Ostadian F, Farrahi F, Mehdinejad A. Comparison of corneal endothelial cell parameters detected by specular microscopy pre and post-panretinal photocoagulation laser in patients with diabetic retinopathy. *Paripex - Indian J Res*. 2015;4:246–277.
17. Mäkitie J, Koskenvuo M, Vannas A, Järvinen E, Ahonen R. Corneal endothelium after photocoagulation in a diabetic patient. *Acta Ophthalmol*. 1985;63:355–380.
18. Murata H, Kato H, Fukushima H, Tsutsumi A, Numaga J, Amano S. Corneal endothelial cell density reduction: a complication of retinal photocoagulation with an indirect ophthalmoscopy contact lens. *Acta Ophthalmol Scand*. 2007;85:407–420.