Immediate Intraocular Pressure and Ocular Pulse Amplitude Changes in Patients with Proliferative Diabetic Retinopathy After Panretinal Photocoagulation

Proliferatif Diyabetik Retinopatisi Olan Hastalarda Panretinal Fotokoagülasyon Sonrası Erken Göz İçi Basıncı ve Oküler Puls Amplitüd Değişiklikleri

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ABSTRACT Objective: To evaluate the immediate effects of panretinal photocoagulation (PRP) with argon laser on intraocular pressure and Ocular Pulse Amplitude (OPA). **Material and Methods:** Thirty-two eyes of 22 patients with type II diabetes mellitus and severe untreated proliferative diabetic retinopathy were involved in the study. We performed panretinal photocoagulation with 400 argon laser burns (200-500 mW, 0.2 seconds, spot size: 500 microns). Before and 15 minutes after the treatment the Intraocular Pressures (IOP) [by Goldmann Applanation Tonometry (GAT) and by Pascal Dynamic Contour Tonometry (PDCT)] and OPA were measured (by PDCT). The intraocular pressures and the OPA values measured before PRP were compared with those measurements after the procedure. **Results:** By GAT there was no difference between pre and post treatment IOP values (p= 0.67). PDCT yielded differences between pre treatment IOP (Mean ± SD: 19.30 ± 1.04 mmHg) and post treatment IOP (22.55 ± 1.08 mmHg) values (p= 0.002) and also in pretreatment OPA (2.73 ± 0.21 mmHg) and post treatment OPA (3.16 ± 0.24 mmHg) values (p= 0.039). **Conclusion:** The IOP and OPA levels measured by PDCT increased in the early period after panretinal photocoagulation. However the clinical significance of this increment and the OPA changes observed with PDCT should be evaluated in future studies by simultaneous recording of vital signs. PDCT may be valuable to study the ocular pulse amplitude changes in diabetic patients reflecting possible vascular changes in these patients.

Key Words: Tonometry, diabetic retinopathy, argon laser

ÖZET Amaç: Argon lazer ile Panretinal Fotokoagülasyon (PRP)'un Göz İçi Basınç (GİB) ve Oküler Puls Amplitüd (OPA) erken etkilerinin araştırılması. **Gereç ve Yöntemler:** Çalışmada, tedavi edilmemiş ciddi proliferatif diyabetik retinopatisi olan tip 2 diyabetli 22 hastanın 32 gözü incelenmiştir. Fotokoagülasyonda argon lazer ile 400 lazer atışı (200-500 mW, 0.2 saniye, spot büyüklüğü: 500 micron) uygulanmıştır. Tedavi öncesi ve tedaviden 15 dakika sonra GİB [Goldmann Aplanasyon Tonometresi (GAT) ve Pascal Dinamik Kontür Tonometre (PDKT) ile] ve OPA (PDKT ile) ölçüldü. Tedavi öncesi ve sonrası ölçülen GİB ve OPA değerleri istatistiksel olarak karşılaştırıldı. **Bulgular:** Tedavi öncesi ve sonrası GAT ile ölçülen GİB değerleri arasında anlamlı bir fark saptanmadı (p: 0.67). Tedavi öncesi GİB (Mean ± SEM: 19.30 ± 1.04 mmHg)ve tedavi sonrası GİB (22.55 ± 1.08 mmHg) arasında PDKT ile anlamlı bir fark (p: 0.002) saptanmış olup, yine PDKT ile tedavi öncesi OPA (2.73 ± 0.21 mmHg) ve tedavi sonrası OPA (3.16 ± 0.24 mmHg) arasında anlamlı bir fark bulunmuştur (p: 0.039). **Sonuç:** PRP sonrası erken dönemde PDKT ile GİB ve OPA değerlerinde artış izlenmektedir. Ancak bu artışın klinik önemi araştırılması ve PDKT ile ölçülen OPA değerlerinin vital bulgularla beraber değerlendirilmesi bundan sonraki çalışmalarda planlanmalıdır. Diyabetik hastalarda vasküler değişiklikleri yansıtabilen OPA değişikliklerini incelemede PDKT faydalı olabilir.

Anahtar Kelimeler: Tonometri, diyabetik retinopati, argon lazer

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Most studies of the effects of PRP are concerned with the retinal and the choroidal circulation, IOP and OPA in the long term.[1-3] It has been demonstrated that panretinal photocoagulation reduces pulsatility of the retinal vasculature and the retinal blood flow.[4-6] On the other hand the reports about the immediate changes in IOP are somewhat controversial.[7,8] The IOP and OPA changes in the early period after the photocoagulation procedure remain to be elucidated.

Although GAT has been considered the gold standard for measuring the IOP, there are numerous sources of error that significantly may influence the IOP readings including corneal thickness and corneal elasticity.[9,10] The central corneal thickness (CCT) is reported to be significantly greater in diabetic patients as compared to subjects without diabetes.[11]

The PDCT is a slit lamp mounted device for contact tonometry that is based upon corneal contact without corneal applanation. DCT claims independence of corneal properties by measuring IOP without causing considerable corneal deformation. A contour matched pressure sensing tip is applied to the corneal surface with a small constant force allowing direct transcorneal IOP measurement.[12]

By this study we aimed to evaluate the IOP and the ocular pulse amplitude changes immediately after argon laser panretinal photocoagulation by applanation tonometry and by dynamic contour tonometry.

MATERIAL AND METHODS

The study was approved by the appropriate institutional review board, and written consent was obtained from each patient after complete explanation of the procedure and possible side effects. Thirty two eyes of 22 patients with type II diabetes mellitus and severe untreated proliferative diabetic retinopathy characterized by either or both an area of epipapillary neovascularization larger than one-quarter disc diameter or areas of epiretinal neovascularization larger than one-half disc diameter but no other ocular illness were included in this study. Patients with corneal surface problems, glaucoma, pseudoexfoliation, neovascularization of iris or retinal vascular occlusion were excluded. None of the patients had received prior laser treatment of any kind or any other ocular intervention or therapy. The patients' characteristics are listed in Table 1.

Each patient received a complete eye examination including indirect ophthalmoscopy, stereo color fundus photography. The corneal pachymetry was measured by BVI Pocket Pachymeter (BV International, Clermont-Ferrand, France). The mean of five readings was considered for measurement. The IOP and OPA were measured by GAT and the dynamic contour tonometry (DCT, Pascal Tonometer, Swiss Microtechnology AG, Port, Switzerland).

All of the eyes received the first session of panretinal photocoagulation by argon laser (Coherent, Synergetics, Missouri, United States) with a total of 400 spots (size, 500 μm; treatment time: 0.2 second) in the inferior temporal and nasal quadrants. The energy necessary for the intended mild, white coloration of the coagulative spots ranged between 0.2 and 0.5 W in the eyes included in our study. The IOP and OPA were again measured by GAT and by DCT 15 minutes after the treatment. During measurements 10 minutes break was taken between GAT and DCT to minimize a tonographic effect. Applanation IOP was measured by Goldmann tonometry. Two measurements were consecutively

TABLE 1: Patient characteristics (data are expressed mean ± standard error of mean).

Age (yrs)	61.68 ± 1.70
Female (n)	18
Male (n)	4
Diabetes Mellitus Type II (n)	22
Duration of diabetes (yrs) (Mean ± SEM)	18.18 ± 0.93
Hypertension (n)	16
Duration of hypertension (yrs) (Mean ± SEM)	10.95 ± 1.46
HbA1 (%)	8.12 ± 1.32
Nephropathy (n)	1
Neuropathy (n)	3
Central corneal thickness (μ) (Mean ± SEM)	540.98 ± 5.34

taken for each eye; only the second one was used in the study (original Goldmann method). During measurements with DCT q values less than three were included.

Pretreatment and post treatment IOP and OPA values were compared by paired t test in the treated eyes and by Mann Whitney U test in the untreated eyes, p values less than 0.05 were considered significant.

RESULTS

The patients' characteristics are listed in Table 1. The anterior chamber angle was open in all of the patients before and after the treatment. With GAT the pretreatment and post treatment IOP values were not significantly different (p= 0.67). On the other hand with DCT both IOP and OPA differed significantly after photocoagulation treatment (p= 0.002 and 0.039 respectively). Table 2 shows the mean IOP and OPA values measured before and after treatment with each method.

The photocoagulation treatment was done unilaterally in 12 patients. The IOP values measured by each method and the OPA after the treatment were compared between untreated eye and the eye with the application of PRP. There was no statistically significant difference between treated and untreated eyes of these patients by nonparametric tests (The p values for IOP with GAT and DCT and OPA were 0.14, 0.43 and 0.93 respectively). The pretreatment and posttreatment IOP values of untreated 12 eyes measured by GAT (p= 0.50) and by DCT (p= 0.97) were not significantly different, but the OPA values were significantly higher after treatment (p= 0.02). Table 3 shows pretreatment and posttreatment IOP and OPA values of untreated eyes.

DISCUSSION

It has been demonstrated that PRP is effective in inducing regression of retinal neovascularization in patients with proliferative diabetic retinopathy.[13,14] However several problems may arise during photocoagulation.[7,15] Immediate complications were reported as choroidal detachment (81%), shallowing of the anterior chamber (38%), exudative retinal detachment (12%) and increased IOP (7%).[7] Also changes in retinal and choroidal hemodynamics in

TABLE 2: Pretreatment and posttreatment IOP of treated eyes measured by GAT and DCT and OPA values.

					95% Confidence interval of the difference	
	Mean±SEM	Minimum	Maximum	p value	Lower	Upper
Pretreatment IOP by GAT (mmHg)	14.00 ± 0.40	11	18	0.67	-1.26	-0.82
Posttreatment IOP by GAT (mmHg)	14.22 ± 0.59	11	25			
Pretreatment IOP by DCT (mmHg)	19.30 ± 1.04	8.30	35.20	0.002	-5.26	-1.26
Posttreatment IOP by DCT (mmHg)	22.55 ± 1.08	13.20	38.60			
Prettreatment OPA by DCT (mmHg)	2.73 ± 0.21	0.90	5.20	0.039	-0.84	-2.29E-0.2
Posttreatment OPA by DCT (mmHg)	3.16 ± 0.24	1.20	5.50			

TABLE 3: Pretreatment and posttreatment IOP of untreated fellow eyes measured by GAT and DCT and OPA values.

	Mean ± SEM	Minimum	Maximum	p
Pretreatment IOP by GAT (mmHg)	15.91 ± 0.62	11	20	0.50
Posttreatment IOP by GAT (mmHg)	15.41 ± 0.87	12	23	
Pretreatment IOP by DCT (mmHg)	19.39 ± 1.51	7.30	26.10	0.96
Posttreatment IOP by DCT (mmHg)	20.76 ± 1.30	12.40	26.60	
Prettreatment OPA by DCT (mmHg)	2.68 ± 0.33	1.40	4.40	0.02
Posttreatment OPA by DCT (mmHg)	3.15 ± 0.35	1.50	4.80	

the long term have been reported.[1-6] Although increased IOP has been reported as only a complication of low rate after PRP, in another study elevated IOP averaged about 10 mmHg has been reported in nearly all of the patients.[7,8]

The established tonometers for non invasive IOP measurement rely on indirect techniques by determining a force that is required to generate a defined amount of deformation of the cornea. In these applanation tonometers, the IOP is calculated based on a set of material constants supposed to be uniform in all eyes. Recent studies have clarified that individual corneal properties like CCT may influence these kinds of tonometers to a variable degree.[16,17] The IOP rhythmically alters over time due to the ocular hemodynamics. Therefore the IOP measured by static methods may be biased. A dynamic tonometer registers the pressure curve with both the recurrent diastolic and systolic pressures and its difference, the OPA.[12]

Due to the changes in CCT observed in diabetic patients we evaluated the changes in IOP by both GAT and DCT.[11] The IOP measured by GAT before photocoagulation treatment was not significantly different than the IOP measured after treatment. However both the IOP and the OPA values measured by DCT before the treatment were significantly less than the IOP values measured after the treatment.

In 12 patients the PRP was applied unilaterally. The post treatment IOP and OPA measurements were not different between the treated and untreated eye (Figure 1). There may be differences between both eyes of the same subjects in properties that may affect the IOP and OPA. Therefore the comparison of the same eye before and after treatment may be more valuable for evaluating the effect of photocoagulation in IOP.

The pre treatment and post treatment IOP values of untreated 12 eyes were not significantly different, but the OPA had increased significantly. The OPA is determined by intraocular volume changes predominantly dependent on the choroidal vasculature (80-90% ocular blood flow) and cardiac cycle.[18,19] Normally in eyes with photocoagulation the OPA decreases in the long term, thought to be due to the obliteration of choriocapillary vessels.[2,3] Also the IOP in the long term in argon photocoagulated eyes is reported to be unchanged or decreased relative to treated eyes.[3,20] The immediate increased OPA observed in both treated and untreated eyes maybe related to the cardiac cycle that may be increased by the sympathetic discharge due to the treatment and the immediate effects of photocoagulation on retinal and choroidal circulation which need to assessed independently. This maybe reflected to some degree to the IOP which was found to be increased by DCT in addition to some other factors related photocoagulation treatment. Local increases in preretinal and intraretinal oxygen tension and consequently the retinal vasoconstriction are observed in regions overlying the photocoagulated outer retina in weeks after the treatment.[1,4,21] This vasoconstriction however is not an immediate effect. This can be evaluated by future studies with simultaneous monitorization of the vital signs like blood pressure and heart rate starting before photocoagulation.

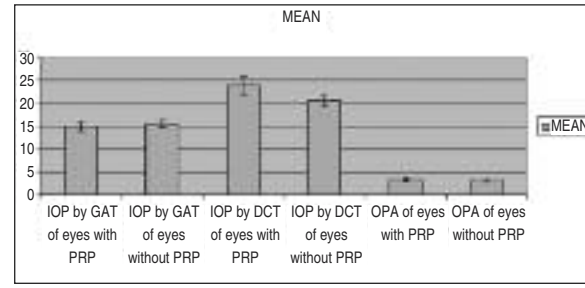

FIGURE 1: The IOP and OPA values (mmHg) of eyes with and without PRP after treatment in cases with unilateral application of treatment.

The high rate of increased IOP has been reported to be due to the choroidal detachment and the closure of angle in few cases with extensive retinal photocoagulation.[8,15] However in most of the cases in the same study, the angle was open as in our patients.[8] The reason for the increased IOP in cases with open angle is obscure. One factor may be the inflammatory reaction characterized by breakdown of the blood retinal barrier, protein leakage and increased PGE_2 levels after argon laser induced chorioretinal damage in addition to changes in

immediate ocular hemodynamic changes that should also be addressed in another study.[22-24]

IOP measurement by DCT is less influenced by corneal properties and is also correlated with measurements by GAT though higher values may be recorded by DCT.[25,26] Transient corneal edema that may sometimes follow argon retinal photocoagulation, although clinically may not be observable, may also influence the IOP readings with each method.[27] Clinical studies including manometric reference pressures and simultaneous monitorization of vital signs will be necessary to address these questions properly. The OPA value introduced to IOP readings should also be evaluated as well as the new cutoff values for DCT that may discriminate better normal and pathologic IOPs, because these will not be equivalent to the thresholds established for conventional tonometry.

Finally we think that DCT may be valuable to study the ocular pulse amplitude changes in diabetic patients reflecting possible vascular changes in these patients.

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