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ORIGINAL ARTICLE

Change in Central Macular Thickness on OCT after Pan Retinal Photocoagulation

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ABSTRACT

Background: Proliferative diabetic retinopathy is the proliferation of retinal neo vessels due to uncontrolled diabetes mellitus and long duration of this disease that leads to advance diabetic eye disease . proliferative diabetic retinopathy is treated by pan retinal photocoagulation which reduces retinal oxygen demand by retinal photocoagulation. Retinal photocoagulation leads to the laser tissue interaction called thermal damage leading to coagulative necrosis of the retinal pigment epithelial cells as these cells contain melanin a dark pigment that has the ability to absorb light energy in argon laser spectrum.

Objective: To determine the mean change in central macular thickness after pan retinal photocoagulation on optical coherence tomography of the macula in patients with proliferative diabetic retinopathy .

Material & Methods: Our study was a Quasi experimental study conducted at Department of Ophthalmology, Services Hospital Lahore for duration of six months from April 2021 to September 2021. In this study 40 eyes from 40 patients with proliferative diabetic retinopathy were selected who underwent pan retinal photocoagulation in one sessions with 1500 burn marks. Patients in the age group of 15 to 70 years, male and female, with proliferative diabetic retinopathy in at least one eye with no history of ocular surgery or ocular trauma in last one year were included in this study .

Optical coherence tomography of macula was performed before and four weeks after the session of pan retinal photocoagulation. CMT (central macular thickness) was measured for mean change in central macular thickness.

Results: In this study , the mean age of patients was 48.68±1.52 years, and gender ratio of female to male patients was 1:0.77,The mean CMT before start of treatment that was considered as baseline was 230.55±5.0 and the mean CMT value after four weeks of pan retinal photocoagulation was 238.50±6.43. (p-value=0.001)

Conclusion: No significant change in CMT was found from baseline CMT to four weeks after pan retinal photocoagulation.

Keywords: Optical coherence tomography, pan retinal photocoagulation, Central Macular Thickness, proliferative diabetic retinopathy

INTRODUCTION

Diabetes mellitus cause a range of pathological effects in the eye that start from mild or background diabetic retinopathy , early cataract , indexical myopia and extend up to proliferative diabetic retinopathy or advance diabetic eye disease either vitreous hemorrhage or tractional retinal detachment.[2] Development of proliferative diabetic retinopathy depends upon the duration of disease as well as long term glycemic control in patients with diabetes mellitis[2].

Proliferative diabetic retinopathy is caused by microangiopathic changes caused by persistent hyperglycemia that leads to endothelial damage and pericyte cell loss in capillaries which leads to formation of microanuresyms and capillary dropout .[4] This capillary drop out causes retinal ischemia and at least one quarter of the retina must be ischemic for the development of proliferative diabetic retinopathy which is caused by an imbalance between pro angiogenic and anti angiogenic vascular growth factors .[5] Apart from this imbalance between vascular growth factors there are many other contributing factor to the development of proliferative diabetic retinopathy which include endothelial cell damage via advance glycation end products, protein kinase c activation and basement membrane thickeinig.[6] Treatment for this proliferative stage of retinopathy is pan retinal photocoagulation in which light from a frequency doubled neodymium doped yattrium diode laser in the range of green light spectrum at around 532 nm is used to photocoagulate the retinal tissue that leads to regression of proliferative vessels that are formed in response to ischemia of the retina .The effectiveness of this pan retinal photocoagulation is indicated clinically by blunting and pruning of vessel tips, reduction in vascular density, absorption of vitreous and retinal hemorrhage ,improvement in retinal vascular tortuosity and reduction in retinal venous caliber.As pan retinal photocoagulation leads to the loss of photoreceptors , bipolar and ganglion cells which in turn reduce the thickness of retinal nerve fiber layer and is clinically seen as pale optic disc after weeks of this laser photocoagulation .Although regression of new vwssels is a sighn of effective panretinal photocoagulation but its most sensitive clinical sign on retinal examination is the reduction of venous caliber in the retinal vasculature that is observed in couple of weeks following pan retinal photocoagulation.pan retinal photocoagulation reverses the imbalance between the the pro angiogenic factors like VEGF and its isoforms and anti angiogenic factors like , pigment derived growth factor , edostatin and angiostatin. The reversal of this imbalance is caused by reduction of oxygen demand by retina and reduction in production of pro angiogenic factors which is the basis for effectiveness of pan retinal photocoagulation.

Optical coherence tomography (OCT) is equivalent to optical biopsy of the retina which can detect even a small amount of change in the central macular thickness (CMT).[7] OCT is a non-contact and non-invasive optical technique based on the principle of low coherence interferometery to capture super quality of image resolution with spatial resolution range of 7um to 10 µm . There are studies that show change in CMT after pan retinal photocoagulation [2],whereas some studies do not agree with this outcome and show no effect in CMT after panretinal photocoagulation.

Objective: This study was designed to detect any significant change in the CMT on OCT macula in patients with proliferative diabetic retinopathy after four weeks of single pan retinal photocoagulation session with at least 1500 burns of mild to moderate intensity .

MATERIALS AND METHODS

Study design: Quasi Experimental study.

Setting: Department of Ophthalmology, Services Hospital Lahore.

Duration of study: Six months i.e., from 1st April 2021 to 30 September 2021

Sample size: For this study a Sample size of 40 patients was calculated with 95% confidence interval.

Sample Technique: Non probability consecutive sampling
Inclusion Criteria: Patients in the age group of 15 to 70 years, male and female, with proliferative diabetic retinopathy in at least one eye with no history of ocular surgery or ocular trauma in last one year .
Exclusion Criteria: Patients with dense vitreous hemorrhage, dense cataract , corneal opacities , tractional retinal detachments, past history of retinal or any ocular surgery in last one year and history of ocular trauma.
Financial disclosure: There are no financial conflicts of interest to disclose.
Data Collection Procedure: In our study , patients who fulfilled our inclusion criteria were included in the study from our outpatient department after detailed clinical examination with slit lamp biomicroscopy and indirect fundoscopy using 90 D lens .All patients included in our study were explained in detail about the nature of this study and were also informed about no financial gains .Patients with proliferative diabetic retinopathy were included in this study after explaining and getting an informed consent both in English and in native language. Demographic parameters including , age and gender were recorded and analyzed for statistical output via SPSS. Visual acuity ,slit lamp fundus examination via 90 D lens and Intra ocular pressure by applanation tonometry was measured and were recorded for all the patients included in this study. OCT macula was performed before pan retinal photocoagulation and was repeated four weeks after the laser procedure . CMT was measured in units of micron meters(um).The change in CMT was calculated by subtracting macular thickness at four weeks after pan retinal photocoagulation with 1500 burns of mild to moderate intensity from the base line CMT .
Data Analysis: We used software SPSS version 21.0 for the statistical analysis of collected data . Quantitative variables like age and mean central macular thickness were represented as mean and standard deviation. Frequency and percentages were calculated for qualitative variables that include gender of the patients inducted in our study The change in mean central macular thickness was calculated by applying students paired t test with the P-value of ≤ 0.05 as a marker for consideration as statistically significant result.

RESULTS

The mean age of patients that were included in this study was 42.68±16.52 years. Out of total 40 patients 16(40%) male and 24(60%) were females .All patients had undergone a single session of pan retinal photocoagulation with 1500 burns of light to moderate intensity. Mean central macular thickness at baseline was 238.65±6.49 and after four weeks of pan retinal photocoagulation with 1500 burns of mild to moderate intensity, it was 239.90±6.43. The mean change calculated by paired student t test in our study was 1.25±0.59 which was below the cut off value to be statistically significant and so was regarded as insignificant change (p>0.05). Table 1

In the patients with age ≤50 years that underwent session of pan retinal photocoagulation , the mean central macular thickness at baseline of the was 239.00±6.58 and four weeks after the laser session was 240.28±6.52. Similarly in patients falling in the age group of >50 years the mean central macular thickness at baseline was found to be 238.07±6.52 after at four weeks of laser session was 239.27±6.44.Among all age groups there was no statistically significant change in mean central macular thickness between the pre laser and post pan retinal photocoagulation session after four weeks of the session. On analysis of our data we found that among the male patients the mean central macular thickness at baseline was 237.56±7.21 and four weeks post laser session was 239.00±7.16. Similarly in the female patients in our study the mean central macular thickness at baseline was found to be 239.38±6.001 and four weeks post laser session was 240.50±5.97. There was no statistically significant change in mean central macular thickness when the data was stratified by gender i.e., p-value=<0.05. Table 2

Table#1: Baseline characteristics

N		40
Age (years)		42.68±16.52
Gender	Male	16(40.00%)
	Female	24(60.00%)
Duration after surgery (months)		8.40±1.96
CMT at baseline		238.65±6.49
CMT at 1st week		239.90±6.43
Change in CMT		1.25±0.59*
p-value		0.001

Table 2: Comparison of change in CMT pre laser and post PRP

		At baseline	At 1st week	Change	p-value
Age(years)	≤50	239.00±6.58	240.28±6.52	1.28±0.61	0.001*
	>50	238.07±6.52	239.27±6.44	1.20±0.56	0.001*
Gender	Male	237.56±7.21	239.00±7.16	1.44±0.73	0.001*
	Female	239.38±6.001	240.50±5.97	1.13±0.45	0.001*

DISCUSSION

Proliferative diabetic retinopathy is one of the common forms in which diabetic retinopathy presents in the working age group and is also the leading cause of legal blindness in this age group across the world[2].

Diabetes mellitus is a metabolic disorder of impaired insulin action that presents as insulin resistance in type 2 diabetics or is caused by primary insulin production defect that causes insulin deficiency and is the cause of type 1 diabetes mellitus, whatever the reason this chronic hyperglycemia when remains uncontrolled for years leads to micro angiopathic changes in retinal vasculature that start with basement membrane thickening and pericyte loss around retinal capillaries this leads to the development of microaneurysms that lead to capillary out pouching and thrombosis due to disruption of blood flow and leads to the development of capillary dropout areas that correspond to hypofluorescent areas on fluorescin fundus angiography. .[9-11]This area of capillary drop out leads to the development of retinal ischemia which produces vascular endothelial growth factor or VEGF that causes vascular proliferation and development of proliferative diabetic retinopathy..[12]

According to diabetic retinopathy study or DRS , treatment of proliferative diabetic retinopathy consist of retinal photocoagulation in which light energy is focused and absorbed by retinal pigment epithelium and by the process of thermo coagulation , which means to increase tissue temperature and cause protein denaturation and cell necrosis , leads to cell death of corresponding photoreceptors and bipolar and ganglion cell which are connected to that retinal pigment epithelial cell being photocoagulated.[13] Cell death by this process causes a reduction in demand of oxygen and causes reduction in the production of VEGF that is being produced in response to retinal ischemia due to poor retinal circulation.

Optical coherence tomography corresponds to optical biopsy of the retina which is used as a tool to measure central retinal thickness which in normal population is in the range of 220um to 240um.The optical resolution of OCT depends upon the wavelength of light being used to perform this low coherence interferometry. As pan retinal photocoagulation produces sterile inflammation in the retinal layers it can cause fluid accumulation between retinal layers which can be measured as change in central macular thickness before and after the laser procedure. This measurement is divided into central field and sub fields according to the grid applied at the time of retinal image capture by OCT.

The use of energy in the form of laser in pan retinal photocoagulation generates heat at the level of retinal pigment epithelium which causes denaturation of this retinal layer and causes the outer blood retinal barrier to leak which can be the cause of increase in retinal thickness after pan retinal

photocoagulation as this leads to leakage and accumulation of exudative fluid in both subretinal and intraretinal space , and this inflammatory response depends upon the energy setting and duration of the laser shot being applied with inflammatory reaction directly proportional to the duration and spot size of laser being applied[11,12]. Laser energy in pan retinal photocoagulation is absorbed by melanin pigment in retinal pigment epithelial cells and is converted to thermal energy which raising the local tissue temperature approximately 20 or 30 degrees Celsius. Thermal burns as a result of this increase in temperature denature tissue protein which leads to local retinal cell death and causes coagulative necrosis . Later , these areas of thermally damaged tissue that have undergone necrosis eventually convert into a retinal scar due to glial cell proliferation and become more heavily pigmented by RPE stimulation , leaving visible laser scars at the level of the RPE.

CONCLUSION

Our research concluded that no statistically significant mean change in central macular thickness was observed from baseline to four weeks of the pan retinal photocoagulation laser treatment in proliferative diabetic retinopathy.

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