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OPTICAL COHERENCE TOMOGRAPHY ANGIOGRAPHY FOR DETECTING THE ALTERATIONS IN RETINAL MICROVASCULATURE IN SUBJECTS HAVING TYPE 1 DIABETES MELLITUS WITH NORMAL FUNDUS PHOTOGRAPHY

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ABSTRACT

Background: Diabetic retinopathy can be detected early to avoid progressive loss of eyesight. By measuring the movement of the erythrocytes in the retinal arteries, a three-dimensional picture of the capillary plexus may be created using optical coherence tomography angiography (OCTA).

Aim: The objective is to assess how well optical coherence tomography angiography can identify changes in the retinal microvasculature in individuals with Type 1 diabetes mellitus who have normal fundus photography. Techniques: Fundus photography, optical coherence tomography, and angiography were performed in the laser and diagnostic units on 96 eyes with 48 cases of Type 1 diabetes mellitus in order to evaluate alterations in the retinal vasculature.

Results: Deep plexus and superficial plexus parafoveal measures showed a significant difference ($p<0.001$) between participants with type 1 diabetes mellitus and controls. With a deep plexus of 56.2±4.5—a substantially lower value with $p<0.001$—than those with type 1 diabetes mellitus, the perifoveal parameters were significantly greater in the control group (60.2±2.4). With a p-value of 0.54, the FAZ perimeter was comparable in patients and controls. The foveal avascular zone (FAZ) area in participants with type 1 diabetes mellitus was 0.23±0.09 mm2 ($p=0.85$), whereas in controls it was non-significantly greater at 0.25±0.12 mm2

Conclusion: The current investigation shows that, prior to the disease's clinical manifestation on the fundus, there is a discernible difference between the microvasculature of healthy individuals and those with type 1 diabetes mellitus. A technology that shows promise for the early identification and treatment of eye problems in diabetics is optical coherence tomography angiography.

Keywords: OCT, OCTA, type 1 diabetes, diabetic retinopathy, and diabetes mellitus.

INTRODUCTION

Diabetes mellitus is a chronic, complicated metabolic disease that has to be closely monitored by a doctor in order to reduce the chance of acquiring a number of long-term consequences. One well-known consequence of diabetes mellitus that is observed in those who have had the disease for a longer period of time is diabetic retinopathy, which results in microvascular diabetic problems that can cause visual loss.1. Neovascularization, hyperpermeability, and capillary blockage in the retina are characteristics of diabetic retinopathy. The International Society for Paediatric and Adolescent Diabetes (ISPAD) consensus practice recommendations call for retinal screening and assessment either before age 11 or after the patient has had diabetes for two to five years.2.

After five years after receiving a diabetes diagnosis, individuals with type 1 diabetes mellitus should have a thorough and in-depth ocular evaluation, according to the ADA's 2021 criteria.3 After the initial annual examination, further screening should be carried out every year or two if there is no sign of retinopathy and the patient has satisfactory diabetes management. Fundus photography, optical coherence tomography (OCT), and optical coherence tomography angiography (OCTA) comprise the eye examination.4

The gold standard for diagnosing diabetic retinopathy is fluorescein angiography. Fluorescein angiography does have several drawbacks, though, such as the potential for adverse effects from the parenteral injection of the dye, the need for extra time, and the fact that it is an invasive procedure.5. A uncommon adverse effect of administering the fluorescein dye intravenously is anaphylaxis; pruritis and nausea are other possible consequences. Because optical coherence tomography (OCT) is a non-invasive method based on low coherence interferometry, it has become one of the most important ocular imaging modalities since its inception in the early 1990s. Due to its capacity to get high-resolution, cross-sectional pictures from backscattered light, OCT is useful in evaluating the structural changes observed in a variety of retinal disorders.Six

Optical Coherence Tomography Angiography (OCTA) evaluates the decorrelation signals of the erythrocyte movement in the retinal arteries to create a three-dimensional picture of the particular capillary plexus. As a result, it may separate the choroid's perfusion and the retina's deep and superficial layers of vasculature without the need for a dye injection.7. The goal of the current investigation was to identify clinical markers for the risk of retinopathy in individuals with type 1 diabetes mellitus who might benefit from optical coherence tomography angiography (OCTA) in an Indian context for participants with normal fundus photography.

MATERIAL AND METHODS

In this cross-sectional investigation, participants with Type 1 diabetes mellitus and normal fundus photography were used to assess the effectiveness of optical coherence tomography angiography in identifying changes in the retinal microvasculature. The individuals from the institute's Department of Ophthalmology made up the study population. All subjects gave their written and verbal informed permission after being fully told about the study's concept.

Out of the 96 participants in this study, 48 of both genders with a mean age of 15.2±1.8 years and an age range of 10–18 years had type 1 diabetes mellitus. The research also included 48 controls who were matched for gender and age. Each participant received a self-administered questionnaire designed to gather data on their current chronic medication, medical history, current therapy, length of diabetes, number of years they had smoked, gender, and age. To reduce measurement bias and potential autonomic effects, it was recommended to all research participants to abstain from coffee, alcohol, and smoking at least 6 hours before to the evaluation.

Pregnant women, subjects smoking more than five cigarettes per day, microvascular complications, nephropathy, hypertension, neuro-ophthalmic diseases, ocular hypertension, glaucoma history, high refractive error (spherical equivalent above +4.00 dioptres or below -6.50 dioptres), significant lens opacities, and any degree of diabetic retinopathy on fundus examination were the exclusion criteria for both the study and control groups. Following final inclusion, all individuals underwent a comprehensive ophthalmic evaluation, which included BCVA (best corrected visual acuity), optic biometry, colour fundus photography, intraocular pressure, auto-refractometer, and slit-lamp biomicroscopy of the posterior and anterior segments. Glycated haemoglobin (HbA1c) levels and the duration since diabetes diagnosis were also taken into account based on the medical history.

The evaluation of each patient using optical coherence tomography angiography (OCTA) was performed by a technician with specialised training after that. The technician used the macular procedure to conduct an examination. Using the OCTA device's software, the densities of perifoveal and parafoveal vessels in the deep and superficial plexus were assessed.

Areas of the foveal and peripheral avascular zones were also assessed. The research only considered high-quality photos with scores more than 8 out of 10. The study's apparatus featured the most recent projection artefact following algorithmic elimination.

Multivariate statistical methods and logistic regression were used to statistically evaluate the gathered data. Two forms were used to show the data: tabular and descriptive. IBM Corp., Armonk, NY, 2013) SPSS version 22.0, chisquare, and student t-test were used. With a significance threshold of 0.05%, the results were presented as percentages, numbers, mean, and standard deviations.

RESULTS

Out of the 96 participants in this study, 48 of both genders with a mean age of 15.2±1.8 years and an age range of 10–18 years had type 1 diabetes mellitus. The research also included 48 controls who were matched for gender and age. Table 1 lists the demographic details of the participants with type 1 diabetes mellitus and the controls. The control group's mean age was 15.2±2.2 years, whereas the type 1 diabetes mellitus group's mean age was 15.4±1.8 years. With p=0.15, the age was comparable.

Each control group and individual with type 1 diabetes mellitus included 20 males and 28 females. With a p-value of 0.14, the BMIs of the controls and Type I diabetes participants were also similar, at 22.4±3.2 kg/m2 and 24.2±3.2 kg/m2, respectively. With a non-significant p-value of 0.16, the intraocular pressure in participants with type 1 diabetes mellitus was 24.2±3.2 mmHg, whereas it was lower in controls at 13.1±2.3 mmHg. Table 1 illustrates that the axial length of participants with diabetes mellitus was 23.7±1.2 mm with p=0.08 and non-significantly longer in controls (24.3±0.7 mm).

After evaluating the parafoveal characteristics of the two research groups, it was observed that the control participants had a much greater deep plexus (60.2±2.4) than the subjects with type 1 diabetes mellitus (56.2±4.5), which was significantly lower (p<0.001). Additionally, the patients without type 1 diabetes mellitus had a considerably lower superficial plexus (55.6±3.4) than the subjects with the condition (51.6±4.7). As seen in Table 2, this difference was likewise statistically significant with p<0.001.

In this study, perifoveal characteristics were evaluated in both control and study individuals. The findings indicated that subjects without type 1 diabetes mellitus had a considerably lower deep plexus (60.6±3.2) than those with the condition (54.5±3.7, p=0.01). Additionally, in terms of perifoveal characteristics, the control group's superficial plexus measured 53.7±1.7, but that of the type 1 diabetes mellitus participants was 0.23±0.09. Table 3 indicates that this difference was similarly statistically significant at p=0.001.

Table 3 provides a summary of the findings on the evaluation of the foveal avascular zone (FAZ) parameters in the participants with type 1 diabetes mellitus and the controls. The FAZ perimeter was found to be similar in persons with type 1 diabetes mellitus and controls, with p-values of 0.54 and 1.85±0.42 mm and 1.83±0.29 mm, respectively. Table 3 shows that the foveal avascular zone (FAZ) area in participants with type 1 diabetes mellitus was 0.23±0.09 with p=0.85, while the FAZ size in controls was non-significantly greater at 0.25±0.12 mm2.

DISCUSSION

Out of the 96 participants in this study, 48 of both genders with a mean age of 15.2±1.8 years and an age range of 10–18 years had type 1 diabetes mellitus. The research also included 48 controls who were matched for gender and age. The control group's mean age was 15.2±2.2 years, whereas the type 1 diabetes mellitus group's mean age was 15.4±1.8 years. With p=0.15, the age was comparable. Each control group and individual with type 1 diabetes mellitus included 20 males and 28 females. With a p-value of 0.14, the BMIs of the controls and Type I diabetes participants were also similar, at 22.4±3.2 kg/m2 and 24.2±3.2 kg/m2, respectively.

With p=0.16, the intraocular pressure was non-significantly lower in participants with type 1 diabetes mellitus (24.2±3.2 mmHg) than in controls (13.1±2.3 mmHg). In participants with diabetes mellitus, the axial length was 23.7±1.2 mm with p=0.08, non-significantly longer than in controls (24.3±0.7 mm). The data underwent comparison with the investigations conducted by You WP et al8 in 2016 and Bianchi L et al9 in 2017, which evaluated participants with similar demographics to those of the current study.

The intraocular pressure in individuals with type 1 diabetes mellitus was non-significantly lower (24.2±3.2 mmHg) than in controls (13.1±2.3 mmHg), with a p-value of 0.16. The axial length of patients with diabetes mellitus was 23.7±1.2 mm (p=0.08), which was non-significantly longer than that of controls (24.3±0.7 mm). The information was compared with studies by You WP et al8 (2016) and Bianchi L et al9 (2017), which assessed people with comparable demographics to the ones in the present study.

The findings aligned with the research conducted by Mastropasqua R et al. (2017) and Scarinci F et al. (2016), which found that people with type 1 diabetes mellitus had lower values for deep plexus and superficial plexus when compared to control participants for parafoveal parameters.

In relation to the perifoveal characteristics in the study participants and control subjects, the findings also demonstrated that the deep plexus was considerably larger in the control individuals (60.6±3.2) than in the type 1 diabetes mellitus subjects (54.5±3.7, p=0.01). Additionally, in terms of perifoveal characteristics, the control group's superficial plexus measured 53.7±1.7, but that of the type 1 diabetes mellitus participants was 0.23±0.09. With p=0.001, this difference was likewise statistically significant.

These results were consistent with research by Freiberg Florentina J et al. (2015) and Hamid S et al. (2018), who proposed that controls had greater perifoveal parameter values than those with type 1 diabetes mellitus. The study's findings are summed up in Table 3 for the evaluation of the foveal avascular zone (FAZ) parameters in the participants with type 1 diabetes mellitus and the controls. The FAZ perimeter was found to be similar in persons with type 1 diabetes mellitus and controls, with p-values of 0.54 and 1.85±0.42 mm and 1.83±0.29 mm, respectively.

The foveal avascular zone (FAZ) area in participants with type 1 diabetes mellitus was 0.23±0.09 mm2 (p=0.85), whereas in controls it was non-significantly greater at 0.25±0.12 mm2. These findings were in line with those of Kim AY et al. (2016) and Xu H et al. (2016), who found that people with type 1 diabetes mellitus had significantly lower foveal avascular zone width and area than controls.

CONCLUSION

With all of its limitations taken into account, the current study finds that before the disease's clinical manifestation on the fundus, there is a discernible difference between the microvasculature of healthy participants and those with type 1 diabetes mellitus. For the early detection and management of ocular illness in diabetics, optical coherence tomography angiography has great promise. Smaller than expected population size, shirt monitoring, and regional bias were the study's weaknesses, which called for longer-term, longitudinal research plans.

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TABLES

Characteristics	Control group (n=48)	Type 1 diabetes group (n=48)	p-value
Axial length (mm)	24.3±0.7	23.7±1.2	0.08
Intraocular pressure (mmHg)	13.1±2.3	14.4±3.2	0.16
BMI (kg/m2)	22.4±3.2	24.2±3.2	0.14
Gender			
Males	20	20	
Females	28	28	
Age (years)	15.2±2.2	15.4±1.8	0.15

Table 1: Demographic and disease characteristics in controls and test study subjects

Parafoveal parameters	Control group (n=48)	Type 1 diabetes group (n=48)	p-value
Deep plexus	60.2±2.4	56.2±4.5	**<0.001**
Superficial plexus	55.6±3.4	51.6±4.7	**<0.001**

Table 2: Parafoveal parameters in the two groups of study subjects

Variables	Control group (n=48)	Type 1 diabetes group (n=48)	p-value
Perifoveal parameters			
Deep plexus	60.6±3.2	54.5±3.7	**0.01**
Superficial plexus	53.7±1.7	51.7±3.1	**0.001**
FAZ perimeter (mm)	1.85±0.42	1.83±0.29	0.54
FAZ area (mm2)	0.25±0.12	0.23±0.09	0.85

Table 3: Perifoveal parameters and FAZ parameters in the two groups of study subjects