

A study to observe the association of pupil-to-limbus diameter ratio with blood pressure and pulse rate in type 2 diabetic patients



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Submission: 06-08-2022

Revision: 02-11-2022

Publication: 01-12-2022

ABSTRACT

Background: Understanding the autonomic activity in the early hand helps to begin with effective treatment for the benefit of the individual with type 2 diabetes. **Aims and Objectives:** The present study was undertaken to observe the association of pupil-to-limbus diameter ratio with blood pressure and pulse rate in type 2 diabetic patients. **Materials and Methods:** A total of 100 participants with type 2 diabetes were part of the study after obtaining written, voluntary, and informed consent. Recording of the pupil-to-limbus diameter (PLD) ratio was performed using two box method which is a standard method mentioned in the literature. Blood pressure and pulse rate were used using a diamond digital sphygmomanometer (BPDG024). **Results:** There was a significant ($P < 0.00001$) positive correlation between the PLD ratio of the right eye and pulse rate. There was a significant ($P < 0.05$) negative correlation between the PLD ratio of the right eye and systolic blood pressure (SBP). There was a significant ($P < 0.05$) negative correlation between the PLD ratio of the right eye and diastolic blood pressure (DBP). There was a significant ($P < 0.00001$) positive correlation between the PLD ratio of the left eye and pulse rate. There was a significant ($P = 0.000076$) negative correlation between the PLD ratio of the left eye and SBP. There was a significant ($P = 0.000458$) negative correlation between the PLD ratio of the left eye and DBP. **Conclusion:** The study results revealed a significant positive correlation between the PLD ratio of the right and left eye with the pulse rate. There was a significant negative correlation between the PLD ratio of the right and left eye with both systolic and DBP.

Key words: Autonomic functions; Diabetes mellitus; Pupil-to-limbus diameter

INTRODUCTION

Diabetes is a global disease. India was labelled as the diabetic capital of the world. Dysregulation of metabolic activities plays a key role in diabetic patients. Altered lipid profile levels and autonomic activity is commonly seen in these patients. Assessment of autonomic activities helps in the early diagnosis of diabetes and if it is diagnosed early, the management can be offered effectively. Pupil-to-limbus diameter (PLD) ratio is one of the classical

autonomic function tests. Pupil can be constricted and dilated depending on the activity of the autonomic activity. The increased sympathetic activity causes pupil dilatation, whereas increased parasympathetic activity causes pupil constriction. However, the diameter of the limbus remains the same. Hence, the diameter ratio of pupil-to-limbus gives an idea about the autonomic activity. Understanding the autonomic activity in the early hand helps to begin with effective treatment for the benefit of the individual. However, related studies in this area are limited. Hence, the

Access this article online

Website:

<http://nepjol.info/index.php/AJMS>

DOI: 10.3126/ajms.v13i12.47278

E-ISSN: 2091-0576

P-ISSN: 2467-9100

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present study was undertaken to observe the association of PLD ratio with blood pressure and pulse rate in type 2 diabetic patients.

Aims and objectives

The present study was undertaken to observe the association of PLD ratio with blood pressure and pulse rate in type 2 diabetic patients.

MATERIALS AND METHODS

Study design

The present study was an observational study.

Study setting

The study was conducted at the Department of Physiology, R. D. Gardi Medical College in collaboration with the Department of Biochemistry, Government Vellore Medical College, Adukkamparai, Vellore-11 and Department of Physiology, the Oxford Medical College, Bangalore, Karnataka, India.

Study participants

A total of 100 participants with type 2 diabetes were part of the study after obtaining written, voluntary, and informed consent. Willing participants within the age group of 35–70 years were part of the study. Participants with severe complications were excluded from the study.

Recording PLD ratio

Recording of the PLD ratio was performed using two box method which is a standard method mentioned in the literature.¹ Picture of the eye was taken at constant luminance in the research laboratory of Physiology. Measurement of the luminance was performed using the lux meter (Model no MTQ 1010A). Images were captured using a realme ×7 5G, 64mp camera. All the participants were exposed to ambient light for 5 min before capturing the picture of an eye. Both right and left eye pictures were taken from all the participants. Pictures of eye were captured at 9 am from all the participants to avoid diurnal variations.

Recording blood pressure and pulse rate

Blood pressure and pulse rate were used using a diamond digital sphygmomanometer (BPDG024). All the recordings were done simultaneously with capturing the picture. Blood pressure and pulse rate were recorded from the right hand.

Ethical considerations

The present study protocol was approved by the Institutional Human Ethical Committee. Confidentiality of the data was maintained. Written and voluntary informed consent was obtained from all the participants.

Statistical analysis

Data were analyzed using SPSS 20.0. Pearson correlation coefficient was used to observe the association between the variables.

RESULTS

The results are presented in Tables 1-3. Table 1 presents the demographical and autonomic parameters and PLD ratio of the participants. Table 2 presents the correlation of autonomic parameters and PLD ratio right eye of the participants. There was a significant ($P < 0.00001$) positive correlation between the PLD ratio of the right eye and pulse rate. There was a significant ($P < 0.05$) negative correlation between the PLD ratio of the right eye and systolic blood pressure (SBP). There was a significant ($P < 0.05$) negative correlation between the PLD ratio of the right eye and diastolic blood pressure (DBP). Table 3 presents the correlation of autonomic parameters and PLD ratio left eye of the participants. There was a significant ($P < .00001$) positive correlation between the PLD ratio of the left

Table 1: Demographical and autonomic parameters and PLD ratio of the participants

Parameter	Mean and SD
Age (years)	47±12
Height (cm)	156±45
Weight (kg)	74±18
Pulse rate (per min)	84±22
Systolic blood pressure (mmHg)	148±36
Diastolic blood pressure (mmHg)	74±13
PLD ratio right eye	0.443±0.06
PLD ratio left eye	0.462±0.02

Data were presented as mean and SD. PLD: Pupil-to-limbus diameter

Table 2: Correlation of autonomic parameters and PLD ratio right eye of the participants

PLD ratio right eye	Pulse rate (per min)	Systolic blood pressure (mmHg)	Diastolic blood pressure (mmHg)
0.443±0.06	84±22	148±36	74±13
	R=0.9934	R=-0.2698	R=-0.2998
	R ² =0.9868	R ² =0.0728	R ² =0.0899
	P<0.00001	P=0.006805	P=0.002512

PLD: Pupil-to-limbus diameter

Table 3: Correlation of autonomic parameters and PLD ratio left eye of the participants

PLD ratio left eye	Pulse rate (per min)	Systolic blood pressure (mmHg)	Diastolic blood pressure (mmHg)
0.462±0.02	84±22	148±36	74±13
	R=0.5573	R=-0.3856	R=-0.3449
	R ² =0.3106	R ² =0.1487	R ² =0.119
	P<0.00001	P=0.000076	P=0.000458

eye and pulse rate. There was a significant ($P=0.000076$) negative correlation between the PLD ratio of the left eye and SBP. There was a significant ($P=0.000458$) negative correlation between the PLD ratio of the left eye and DBP.

DISCUSSION

Diabetes mellitus is a mixture of multiple diseases. This disorder not only affects the system but also affects multiple systems. The major systems that are affected are the heart, blood vessels, kidney, nervous system, and eyes. It was explained that diabetes mellitus is a disease that is equal to starvation even though there is enough food available. All the metabolisms get disturbed in diabetes mellitus which includes, carbohydrate, lipid, and protein metabolism. Gradually, diabetes leads to the functional impairment of multiple systems. Type 2 diabetes mellitus is said to be age-onset diabetes. In this type of diabetes, the secretion of insulin is normal, but the tissues which contain the receptors for insulin were nonfunctional. That means tissues are resistant to insulin action. As tissues become resistant, glucose cannot be utilized by them even though glucose is present in plenty. Along with the nervous system, the autonomic functions of diabetic individuals get affected.

The entrance of the light into the eye depends on the structure called the pupil. The pupil can be as small as 1.5 mm and can be as large as 8 mm.^{2,3} In the earlier days, a scientist named Hess reported the relationship between emotional status and pupil diameter.⁴ Later, it was reported that pupil diameter increases when the person is anxious or during the stimulation of the sympathetic nervous system.^{5,6} The diameter of the limbus is constant. Hence, the measurement of the pupil-to-limbus diameter ratio can give an idea about the activity of the autonomic nervous system. However, to confirm this, there is a need to establish normal values first. Further, there is a need for studies with larger and multiple localities of populations. The present study was undertaken to observe the association of PLD ratio with blood pressure and pulse rate in type 2 diabetic patients.

Earlier studies reported that considering the pupil-to-limbus diameter ratio is more advantageous than only pupil diameter.⁷ Earlier studies reported that in males, there is a positive correlation between the PLD ratio of the right and left eye with the pulse rate, and systolic and DBP. However, in females, this positive correlation was observed only with the right eye but not with the left eye. There is a negative correlation with the left eye.⁸ Another study reported that the PLD ratio was not significantly different between diabetic individuals and healthy controls.⁹ Another study

revealed that there exists a positive correlation between the PLD ratio and the autonomic functions in hypertensive females.¹⁰ The present study did not separate male and female assessments as that is not the aim of the study. The study results revealed a significant positive correlation between the PLD ratio of the right and left eye with the pulse rate. There was a significant negative correlation between the PLD ratio of the right and left eye with both systolic and DBP.

Limitations of the study

The study limitation was its smaller sample size.

CONCLUSION

The study results revealed a significant positive correlation between the PLD ratio of the right and left eye with the pulse rate. There was a significant negative correlation between the PLD ratio of the right and left eye with both systolic and DBP.

ACKNOWLEDGMENT

Authors herewith acknowledge with thanks to all the participants for active participation in the study.

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Work attributed to:

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Source of Support: Nil, **Conflict of Interest:** None declared.