ORIGINAL RESEARCH

Comparative study of pupil cycle time with different grades of primary open-angle glaucoma v/s normal study participants

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ABSTRACT

Aim and objective: To compare the pupil cycle time (PCT) measurements in study participants with different grades of primary open-angle glaucoma against normal study participants. **Materials & Methods**: 80 eyes of 80 study participants with primary open angle glaucoma group (Group I); 85 eyes of 85 healthy group study participants (Group II) were studied. All study participants underwent Ophthalmologic investigations and data were assessed by Chi-squared and Pearson correlation analysis. **Results:** In Group I study participants, the mean age was found to be 66.6 ± 8.4 and in Group II participants it was 63.1 ± 8.2 (p=0.400). In Group I study participants, 63.5% were female and in Group II study participants they were 56.2% (p=0.300). In Group I, the mean PCT was 956.5 ± 64.8 ms whereas in Group II it was 872 ± 35.6 ms(p=0.030). Statistical significant observation was seen for (PCT) and other variables like age (p=0.01), duration of glaucoma, BCVA, Ganglion Cell-Inner Plexiform Layer Thickness (GC-IPLT), and Retinal Nerve Fibre Layer Thickness (RNFLT). **Conclusion**: Pupil cycle time displayed a substantial association with optical coherence tomography (OCT) variables.

Keywords: primary open-angle glaucoma, PCT, RNFLT, BCVA

INTRODUCTION

A beam of light focused towards the margin of the pupil can determine oscillations of the pupil. The average period of these cycles called pupil cycle time (PCT) which is specific for all subjects can be measured and displays slight alteration among a pair of standard eyes [1-3]. PCT is often assessed as an independent predictor of Optic nerve function in several Ophthalmological disorders [3-5]. PCT prolongation is influenced by injuries of both afferent as well as efferent pathways of pupillary light reflex by certain disorders like optical neuritis (OT) [4, 5], compression of optic nerve [6], space-occupying lesions [7], multiple sclerosis (MS) [8-10], CNS medication [11], autonomous disorders [12], hereditary familial dysautonomia [13], autonomous diabetic neuropathy disorders [14-16].

Literature suggests that if the iris muscle is adequately innervated and responsive, pupil cycle time can be correlated with the promptness of conduction and Optic nerve impulse strength along with its numbers [1]. Glaucoma is an optic neuropathy; thereby apoptosis of ganglionic cells at the retina and loss of retinal nervous fibers and optical nervous axons results in functional discrepancies [17-22]. The current research was undertaken to evaluate the pupil cycle time measurements of study participants having glaucoma and to compare them with the normal study participants. In the current study, the relationship of pupil cycle time measurements with age, glaucoma duration, BCVA, VF, and OCT parameters of the study participants was also estimated.

MATERIAL AND METHODS

This prospective observational study was performed on patients attending our OPD at RIO, SCB Medical College and Hospital, Cuttack over 6 months from June 2022 -November 2022.80 eyes of 80 study participants with an established diagnosis of POAG primary open-angle glaucoma were taken in (Group

I); 85 eyes of 85 healthy group study participants in (Group II). The present research work was approved by the institutional ethics committee and informed consent was received from each study participant complete histories were also collected from all subjects and, subsequently, all study participants. POAG was defined as the raised intraocular pressure (IOP) consistently above 21 mm Hg in at least a single eye with a characteristic glaucomatous visual field and/or optic nerve head damage and an open, normal appearing anterior chamber angle with no other abnormality.

Inclusion criteria: All Group I study participants were above forty years of age with POAG, consistent visual fields done within ± 1 month of OCT imaging; refractive error within a ± 5 spherical diopter value, with < ± 3 cylinder diopters and BCVA above 6/12 (on the Snellen visual acuity scale). The inclusion criteria for Group II participants were the same as Group I except that there were no signs of POAG. One eye of each patient was selected for the study.

Exclusion criteria: Study participants with corneal opacity or dystrophy, surgical scar, any systemic disease that affects the autonomic system, neurological disorders, using drugs causing autonomic dysfunction, with diabetes mellitus, not compatible with our study methods have been omitted.

Visual Field: was established using the Humphrey Field Analyser.

Pupil cycle time: was performed in both groups by the technique described by Miller et al. [1].

OCT investigation: by Spectral Domain OCT. The mean RNFLT of specific quadrants and GC-IPL thickness was measured.

Data Analysis: through SPSS software and analyzed with Chi-square and Independent t-tests.

RESULTS

Table 1: Basic Characteristics of the study population

Variables (mean ± SD)	Group I	Group II	P-value
Age	66.6 ± 8.4	63.1 ± 8.2	0.453
Gender	15/25	16/19	0.323
BCVA	0.77±0.25	1.0±0.0	<0.001*
Cup / DiscRatio	0.54±0.18	0.29±0.08	<0.001*
PSD	3.9±2.7	1.6±0.2	<0.001*

Table 1 show that the mean age was found to be 66.6 ± 8.4 in Group I and 63.1 ± 8.2 in Group II. Female preponderance was 63.5% in Group I and 56.2 % in Group II. The mean glaucoma duration was 5.2±1.2

Table 2: Thickness RNFLT & GC-IPL among study participants

Variables	Group I	Group II	P-value
RNFLT(µm)			
Average	86.2±27.1	96.3±26.2	<0.001*
Superior	103±26.4	116.6±8.2	<0.001*
Nasal	68.4±12.2	74.6±7.6	0.001*
Inferior	108.6±28.4	118.6±16.4	0.001*
Temporal	64±14.6	69.3±3.16	0.001*
GC-IPL thickness (µm)			
Average	79.1±14.2	84.2±5.6	<0.001*
Superior	79.5±11.6	86±6.4	0.001*
Superiortemporal	77.46±12.6	80.8±5.4	0.001*
Superiornasal	78.6±13.4	86±6.6	0.001*
Inferior	74.2±12.5	82.8±4.5	<0.001*
Inferiortemporal	78.6±112.6	83.4±5.02	<0.001*
Inferiornasal	78.6±12.8	83.8±5.05	<0.001*

Table 2 shows that RNFLT as well as the GC-IPL thickness in Group I was found to be considerably lower than in Group II

Table 3: Correlation of PCT measurements

Dependent variables	R-value	P-value
Age	0.345	0.01*
Glaucoma Interval	0.478	<0.01*
BCVA	0.366	<0.01*
Cup-Discratio	0.026	0.785
VFvariables		
MD	0.108	0.20

PSD	0.455	<0.01*
RNFLT		
Superior	0.545	<0.01*
Nasal	0.568	<0.01*
Inferior	0.627	<0.01*
Temporal	0.467	<0.01*
GC-IPL thickness		
Superior	0.687	<0.01*
Superior-temporal	0.647	<0.01*
Superior-nasal	0.664	<0.01*
Inferior	0.727	<0.01*
Inferior-temporal	0.730	<0.01*
Inferior-nasal	0.656	<0.01*

Table 3 shows that the mean PCT measurements in 80 Group I cases were 956.5 ± 64.8 and the mean PCT in 85 Group II cases was 872 ± 35.6 ms ($p<0.001$). No association was observed between the cup-disc ratio and pupil cycle time of study participants with glaucoma.

Increasing age and duration of POAG in Group I were observed to be positively associated with PCT measurements. Increasing age was positively associated with PCT in Group II ($p=0.01$). A noticeable prolongation of PCT with decreasing RNFLT and GC-IPL was observed.

DISCUSSION

Pupil cycle time (PCT) offers us a noninvasive, reliable, and rapid clinical option that can be done by any Ophthalmologist for the detection of functions of optic nerves. This determination provides the peculiar benefit of being specific to the individual, being objective and quantitatively different for both eyes. The measurements of the Pupil cycle time are currently widely used in the healthcare system to evaluate the functions of optic nerves more specifically. A report on PCT measurements on diabetic study participants documented that it was prolonged with the increase in age as well as the duration of diabetes mellitus[15]. Similar results were obtained by Kaur and Kim [15, 16].

In our study, the mean PCT in Group I was found to be 956.5 ± 64.8 ms, and the mean PCT in Group II was 872 ± 35.6 ms showing prolongation of PCT in the POAG group as compared to the control group. This may be because of glaucomatous optic neuropathy affecting the afferent pathway at the pupillary reflex arc. Our study assessed the relationship of PCT with BCVA, VF, and OCT variables. Prolongation of PCT was seen with poor BCVA. Prolongation of PCT was seen with decreasing RNFL and GC-IPL thickness showing a negative correlation of PCT with RNFLT as well as GC-IPL thickness in Group I cases. A positive association of PCT with duration of glaucoma was observed.

In normal study participants, the mean pupil cycle time of 814 ms with an upper range of normal at 935 ms was documented by a recent study [3] and another study reported 980 ms as the average PCT value in abnormal study participants [9]. The average value of normal pupil size showed wide variation in Group II participants so it was unreliable as a universal technique [24]. Differences in age and pupil size of study participants led to confusing PCT values between study participants in the present report. Another documented study emphasized the positive correlation of PCT with age. Our study similarly documented the mean PCT in the age group between ten and forty-nine to be 739±74 ms and in the age group between fifty and seventy-nine with 872±83 ms. Merely two percent of eyes in age group ten and forty-nine showed pupil cycle time beyond 954 ms, whereas 23.9 percent showed pupil cycle time longer than 954 ms in the elder study participants [25]. A study with 50 normal study participants aged twelve to fifty years, reported with mean PCT of 822±69 ms in the group as a whole and pupil cycle time longer than 954 ms in merely five percent of the normal population [1]. Our study showed that normal study participants over fifty years displayed a clear tendency toward longer pupil cycle time. Age-matched study participants with high PCT measurements led to a wide range of PCT. Recent documentation on PCT studies reveals that pupil cycle time is related to pupil size non-linearly as size is enlarged. The waveform of pupil cycling is characteristic with contraction being considerably quicker than dilatation. [26].

LIMITATIONS

In the present work, POAG study participants showed a wide range and variation in PCT. The study participants had mild to severe glaucoma and this presented as a wide range of cup/disc ratio, MD, and PSD values. Further, limitations of PCT measurement in participants with POAG having severe afferent defects or on medications affecting pupil reactions, trauma, or surgery led to their exclusion from the study. Senile miosis causing fewer amplitude cycles posed difficulty in precise quantification. The small sample size led to limited statistical power to detect minor variances in pupil cycle time measurements. All the study participants included were eastern Indians, so ethnic variations of PCT could not be established.

CONCLUSION

Visual field testing and optical coherence tomography techniques were conventionally available to detect advanced glaucoma. However, the detection of glaucoma progression depends on the interplay of many ocular, systemic, and therapeutic factors. In this study, we conclude that despite promising observations concerning pupil cycle time, this seems too early to establish PCT as a supplementary diagnostic and prognostic technique for measuring glaucoma progression in clinical practice but it can pave the way for a larger prospective study correlating PCT in glaucoma.

REFERENCES

1. Miller SD, Hompson HS (1978) Edge-light pupil cycle time. Br J Ophthalmol 62: 495-500.
2. Lee H, Kim Y, Park J (2011) Pupil cycle time and contrast sensitivity in type II diabetes mellitus study participants: a pilot study. Indian J Ophthalmol 59: 201-205.
3. Hamilton W, Drewry RD Jr (1983) Edge-light pupil cycle time and optic nerve disease. Ann Ophthalmol 15: 714-721.
4. Ukai K, Higashi JT, Ishikawa S (1980) Edge-light pupil oscillation of optic neuritis. Neuroophthalmology 1: 33-43.
5. Miller SD, Hompson HS (1978) Pupil cycle time in optic neuritis. Am J Ophthalmol 85: 635-642.
6. Weinstein JM, Van Gilder JC, Hompson HS (1980) Pupil cycle time in optic nerve compression. Am J Ophthalmol 89: 263-267.
7. Manor RS, Yassur Y, Ben Sira I (1982) Pupil cycle time in space-occupying lesions of anterior optic pathways. Ann Ophthalmol 14: 1030-1031.
8. Manor RS, Yassur Y, Ben-Sira I (1982) Pupil cycle time in non-compressive optic neuropathy. Ann Ophthalmol 14: 546-550.
9. Wybar KC (1952) He ocular manifestations of disseminated sclerosis. Proc R Soc Med 45: 315-320.
10. Milton JG, Longtin A, Kirkham TH, Francis GS (1988) Irregular pupil cycling as a characteristic abnormality in study participants with demyelinating optic neuropathy. Am J Ophthalmol 105: 402-407.
11. Safran AB, Walser A, Roth A, Gauthier G (1981), influence of central depressant drugs on pupil function: an evaluation with the pupil cycle induction test. Ophthalmologica 183: 214-219.
12. Clark CV, Ewing DJ (1988) Ocular autonomic function in progressive autonomic failure. Doc Ophthalmol 70: 309-321.
13. Gadoth N, Schlaen N, Maschkowski D, Bechar M (1983) He pupil cycle time in familial dysautonomia, Further evidence for denervation hypersensitivity. MetabolPediatr Systemic Ophthalmol 7: 131-134.
14. Martyn CN, Ewing DJ (1986) Pupil cycle time: a simple way of measuring an autonomic reflex J NeurolNeurosurg Psychiatry 49: 771-774.
15. Kaur T, Devi AS, Devi MS (2014) A comparative study of Edge light pupil cycle time in type-II diabetes mellitus study participants and normal study participants. Journal of Dental and Medical Sciences 13: 19-23.
16. Kim GC, Ahn KW, Jun YM (1995) Pupil Cycle Time in diabetics. J Korean OphthalmolSoc 36: 691-696.
17. Tezel G, Wax MB (2007) Glaucoma. ChemImmunol Allergy 92: 221-227.
18. Song W, Huang P1, Zhang C1 (2015) Neuroprotective therapies for glaucoma. Drug Des DevelHer 9: 1469-1479.
19. L Shahsuvaryan M (2013) Glaucomatous optic neuropathy management: the role of neuroprotective agents. Med Hypothesis DiscovInnovOphthalmol 2: 41-46.
20. Kaushik S, Pandav SS, Ram J (2003) Neuroprotection in glaucoma. J Postgrad Med 49: 90-95.
21. Morrison JC (2006) Integrins in the optic nerve head: Potential roles in glaucomatous optic neuropathy (an American Ophthalmological Society thesis). Trans Am OphthalmolSoc 104: 453-477.
22. Marcic TS, Belyea DA, Katz B (2003) Neuroprotection in glaucoma: a model for neuroprotection in optic neuropathies. CurrOpinOphthalmol 14: 353-356.
23. Disorders of the autonomic nervous system. In: Bradley WG, 'aroؤ RB, Fenichel GM, Marsden CD. Neurology in clinical practice, 3rd ed. Boston: Butterworth-Heinemann, 2000: 2131–2165.
24. Abe RY, Gracitelli CP, Medeiros FA (2015) He Use of Spectral-Domain Optical Coherence Tomography to Detect Glaucoma Progression. Open Ophthalmol J 9: 78-88.
25. Manor RS, Yassur Y, Siegal R, Ben-Sira I (1981) The pupil cycle time test: age variations in normal study participants. Br J Ophthalmol 65: 750-753.
26. Howarth PA, Heron G, Whittaker L (2000)The measurement of pupil cycling time. Graefes Arch ClinExpOphthalmol 238: 826-832.