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Binocular vision disorders and tear meniscus parameters using anterior segment-optical coherence tomography (AS-OCT) in Parkinson's disease: a case report

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ABSTRACT

BACKGROUND: Ocular abnormalities are potential consequences of early signs of Parkinson's disease (PD). The novelty of this case is that it provides additional binocular vision findings for better diagnosis and demonstrates the role of imaging techniques such as anterior segment-optical coherence tomography (AS-OCT) to quantitatively assess the ocular surface in PD.

CASE PRESENTATION: A 55-year-old male with early Parkinson's disease presented with a history of transient diplopia, irritation, and burning sensation one year after his PD diagnosis. On examination, his contrast sensitivity was reduced, and he had receded convergence amplitude, poor saccadic function, and reduced developmental eye movement (DEM) test. Additionally, his tear meniscus parameters were significantly reduced when measured quantitatively.

CONCLUSION: Convergence insufficiency and eye movement deficit may serve as early oculomotor signs of PD. Imaging techniques such as AS-OCT, which quantitatively assess the ocular surface, could also serve as diagnostic tools in the early detection of underlying symptoms associated with dry eyes.

KEY WORDS: Parkinson's disease; tear meniscus; developmental eye movement

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INTRODUCTION

Parkinson's disease (PD) is a common neurological condition that primarily affects middle-aged and older persons. It is a condition marked by a lack of dopamine in some parts of the midbrain, which results in a number of movement issues, such as akinesia, rigidity, and tremor [1]. Despite the focus on motor function in PD, non-motor symptoms may also significantly influence the patient's overall quality of life. As a result, PD symptoms may include depression, apathy, trouble sleeping, memory loss, dementia, and issues with the autonomic nervous system, the gastrointestinal tract, and the senses [1]. Early in the course of the disease, visual disturbances are frequently observed, and may be regarded as prodromal symptoms of PD [2]. This case report illustrates the ocular features in a patient with early-stage PD.

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CASE PRESENTATION

A 55-year-old male presented with a complaint of transient double vision for near, even after using near vision glass. He also complains of ocular irritation and a burning sensation. On further history-taking, it was noted that the onset of symptoms began after one year of his initial diagnosis of early PD two years back. He otherwise had a good general health status with no associated history of other systemic and ocular diseases. His current medication includes monoamine oxidase-B (MAO-B) inhibitors for PD. His best-corrected visual acuity (BCVA) was Plano (20/20) in each eye and N6 with +1.50 DS for near. The slit lamp examination was within normal limits. Colour vision in both eyes was intact. Contrast sensitivity with the Pelli-Robson chart was 1.65 units in each eye. His intraocular pressure was 18 mm Hg in both eyes. A dilated fundus examination showed a normal-appearing disc and fovea.

Binocular vision evaluation

The vergence and eye movement parameters were assessed to rule out any alternation in the oculomotor function. The near point of convergence was assessed using an accommodative target [3]. Fusional vergence amplitudes were carried out using a prism bar, and vergence flippers were used to assess the vergence ability of the patient [3]. Saccades and pursuits were examined using Northeastern State University College of Optometry (NSUCO) grading [4]. Developmental eye movement (DEM) test was also carried out to assess the reading performance of the patient [5]. On examination, it was found that the patient had a markedly reduced convergence amplitude and positive fusional vergence, which hampered his vergence facility ability with base out prism in vergence facility testing. He also had a moderate saccadic deficit and poor reading ability, as noticed in the DEM test (Tab. 1).

Table 1. Binocular vision parameters of the patient

Parameters	Baseline values	Morgan's expected value
Prism bar cover test (distance)	0	1 ± 2 exophoria
Prism bar cover test (near)	10 exophoria	3 ± 3 exophoria
NPC Accommodative target (cm)	Break: 25 cm Recovery: 30 cm	Break: 2.5 ± 2.5 cm Recovery: 4.5 ± 3 cm
NFV (Distance) [blur/break/recovery] in prism Diopters	X/12/8	–
NFV (Near) [blur/break/recovery] in prism Diopters	X/10/8	Break: 12 ± 5 Recovery: 16 ± 6
PFV (Distance) [blur/break/recovery] in prism Diopters	X/10/8	–
PFV (Near) [blur/break/recovery] in prism Diopters	X/8/6	Break: 23 ± 8 Recovery: 16 ± 6
Vergence facility (12BO/3BI) in cycles per minute	3 (difficulty fusing Base OUT)	15 ± 3 cpm
Saccades (NSUCO Score)	Ability = 2 Accuracy = 2 Head movement = 5 Body movement=5	
Pursuits (NSUCO Score)	Ability = 2 Accuracy = 2 Head movement = 5 Body movement=5	
Developmental eye movement-Horizontal time (percentile)	75 s	
Developmental eye movement-Vertical time (percentile)	70 s	
Developmental eye movement-ratio (percentile)	1.07	

NPC — near point of convergence; NRA/PRA — negative relative accommodation/positive relative accommodation; NFV — negative fusional vergence; PFV — positive fusional vergence, NSUCO — North Eastern State University College of Optometry

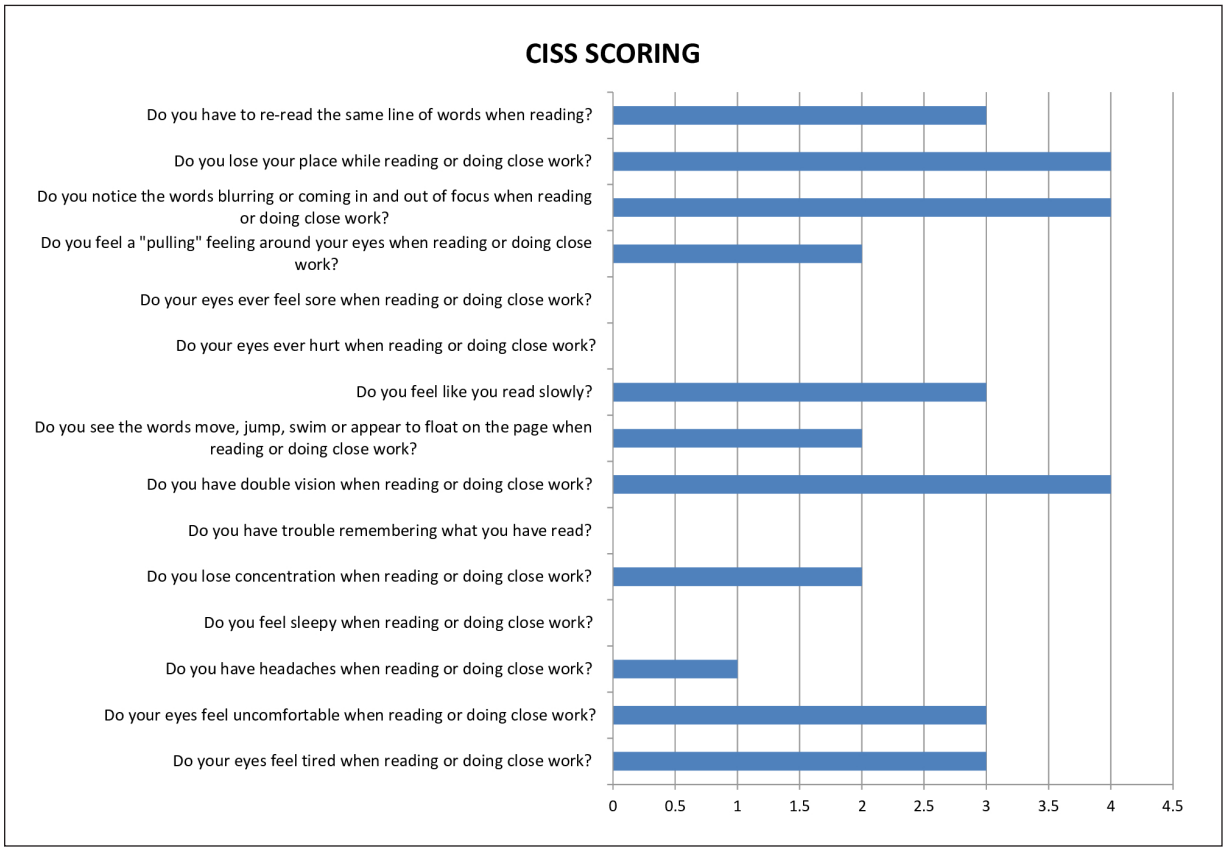

FIGURE 1. Convergence insufficiency symptom scale (CISS) scores of the patient

The results in convergence insufficiency symptom scale (CISS) suggested a diagnosis of CI (Fig. 1).

Dry eye evaluation

Ocular surface disease index (OSDI) questionnaires were used to assess the severity of dry eye symptoms and their effects on vision-related function [6]. The Schirmer 's-I test, tear break up time (TBUT), was assessed to examine the function of the ocular surface. The TMH and tear meniscus depth (TMD) were also further analyzed using an anterior segment-optical coherence tomography (AS-OCT) scan of spectral domain-OCT (SD-OCT). Using the full range anterior chamber radial scan technique with a scan size of 16 × 16 mm and a scan period of 3.37 seconds, the lower TM height (m) and lower TM depth (m) were assessed. The scan has an 8192 x 6/3 A x B scan and repeats. The tear meniscus height (TMH) and tear meniscus depth (TMD) were measured using the corneal caliper. On evaluation, it was found that his Schirmer's-I values were 5 mm in both eyes with a TBUT value of 0.3 seconds in both eyes. His TMH, TMD, and OSDI index were 97 μm, 53 μm, and 21, respectively (Fig. 2 and 3).

INTERPRETATION OF THE TEST AND DIAGNOSIS

A diagnosis of convergence insufficiency was made considering the receded NPC, PFV for near and distance, and difficulty in fusing base-out prism of vergence flippers. The patient also had type III oculomotor dysfunction as his NSUCO ability and accuracy scores were reduced, along with increased vertical and horizontal DEM test scores. Dry eye was another additional diagnosis for the patient as his Schirmer's-I values, TBUT, and TMH-TMD were reduced.

DISCUSSION

This paper illustrates the clinical ocular features in a patient with PD. 75% of PD patients have abnormal saccadic and smooth pursuit movements, which have a negative impact on fixation and read-

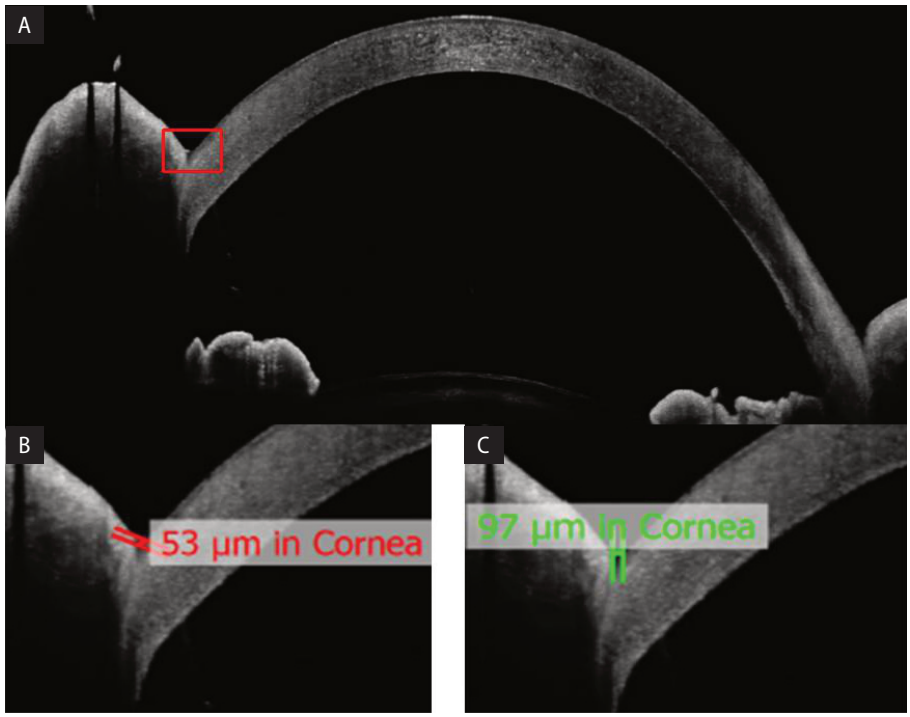

FIGURE 2. **A.** Tear meniscus of the patient using full range anterior chamber radial scan protocol; **B.** Tear meniscus depth (TMD) of the patient; **C.** Tear meniscus height (TMH) of the patient

FIGURE 3. Ocular surface disease index (OSDI) of the patient

ing.7Impaired accommodation, the eye's reaction to a near stimulus can result from convergence insufficiency (CI), resulting in headaches, diplopia, and eyestrain. In 20–30% of PD patients, abnormal convergence is a factor in diplopia.8 The finding of this case is also consistent with the previous literature data. Although CISS is not validated in PD, it was used to understand the difficulty in daily living. Alongside the reduction in positive fusional vergence, poor near point of convergence, and difficulty fusing base out prism in vergence facility, the CISS score was also increased, i.e. 31, which confirms the diagnosis of CI. Since the patient developed symptoms after one year of PD diagnosis, we hypothesize that to be as an early consequence of PD since previous studies indicate visual dysfunction as an early indicator of cognitive impairment in PD [9]. Additionally, patients with PD scan smaller regions than usual with fewer, hypometric saccades than is typical, which may result in a modest degree of visuospatial neglect [10]. This visual search pattern is thought to be caused by insufficient creation of voluntary saccades. Reading difficulties may be caused by the facilitation of tiny saccades. The ability to generate voluntary saccades can be impaired, which can potentially have an impact on balance and gait [10].

Reduced inhibitory direct pathway output and increased excitatory indirect pathway output onto the internal globus pallidus/substantia nigra pars reticulate (GPi/SNr) are the results of dopaminergic depletion in PD [11]. The increased SC inhibition brought on by the hyperactive SNr is thought to be the cause of the classic PD eye movement abnormalities. Although DEM has not been used extensively in PD research, little evidence supports the existence of oculomotor defects using DEM in PD [12]. Moreover, in this case, both the vertical and horizontal test scores are abnormal, with a nearly normal DEM ratio, suggesting difficulty in automaticity and number naming.

Moreover, the patient also had a reduced Schirmer's value and TBUT. All anomalies in tear film production resulted in more frequent ocular symptoms of dry eyes (higher OSDI index) in PD patients. These findings support earlier research and indicate that aqueous tear generation is the most impaired component of PD [13]. Previous studies hypothesized that the tear film deficit in PD might be due presence of Lewy bodies in sympathetic ganglia, substantia nigra and peripheral parasympathetic ganglia as a result of autonomic dysfunction [14]. There are limited studies that explain the use of AS-OCT scans of tear film in PD. However, there is evidence of using it in dye-based research [15, 16]. The TMH and TMD of the patient were reduced when compared with the normative data [17], suggesting a negative impact of PD on the ocular surface. Moreover, these findings could also serve as a potential biomarker in early diagnosis of PD. However, further research on a larger population is needed to reach a conclusion.

CONCLUSION

Convergence insufficiency, eye movement disorders, and dry eye are prevalent ocular complications associated with PD. Advanced imaging modalities such as AS-OCT offer precise quantification of ocular surface parameters, including tear film dynamics. These findings provide a valuable foundation for further investigation into the relationship between PD and ocular health, paving the way for future research endeavors to elucidate potential associations.

Author contributions

Study conception, data collection, analysis, and manuscript preparation were performed by PD.

Ethics approval and consent to participate

This study was carried out in accordance with the principle of the institutional guidelines and had been approved by the Medical Ethics Committee of Chandraprabha Eye Hospital, Jorhat. Informed consent was obtained from the participant.

Consent for publication

Written consent to publish was obtained from the patient using our institutional consent form.

Availability of data and materials

Data sharing is not applicable to this article as no datasets were generated or analyzed during the current study.

Conflict of interests

The authors declare that they have no competing interest

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