



Severity of reduced near point of convergence in patients with Parkinson's disease: a cross-sectional study

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ABSTRACT

Objective: To assess the severity of reduced near point of convergence (NPC), indicative of convergence insufficiency (CI), in patients with Parkinson's disease (PD).

Methods: This cross-sectional study was conducted on 80 patients with PD at Services Hospital, and Lahore General Hospital, Lahore, Pakistan from March to September 2024. Patients aged 40–70 years with a confirmed diagnosis based on the UK Parkinson's Disease Society Brain Bank criteria were included. Demographic and clinical data were collected using a structured investigator administered questionnaire. NPC was measured with a Royal Air Force ruler under standardized conditions. Patients with refractive errors of ≥ 5.00 DS and those with coexisting neurological or ocular disorders were excluded. Data were analyzed using SPSS version-25.0.

Results: The study included 42 males (52.5%) and 38 females (47.5%). Mean age was 55.90 ± 8.33 years in males and 51.39 ± 5.47 years in females. Mean disease duration was 2.33 ± 1.44 years, while the mean NPC value was 19.94 ± 3.97 cm. Based on NPC measurements, 35 patients (43.8%) had mild CI (10–18 cm), 35 (43.8%) had moderate CI (19–26 cm), and 10 (12.5%) had severe CI (27–34 cm). A statistically significant positive correlation was observed between disease duration and NPC values ($r=0.628$, $p<0.001$), indicating greater convergence impairment with longer disease duration.

Conclusion: Reduced NPC, consistent with convergence insufficiency, was universally present among patients with Parkinson's disease, with severity predominantly in the mild-to-moderate range. These findings highlight the importance of routine neuro-ophthalmic screening.

Keywords: Parkinsons Disease (MeSH); Insufficiency, Convergence (MeSH); Vision Disorders (MeSH); Ocular Motility Disorders (MeSH); Orthoptic Procedures (MeSH); Ophthalmodynamometry (MeSH); Vision, Binocular (MeSH); Neurologic Examination (MeSH); Neurodegenerative Diseases (MeSH); Disease Progression (MeSH); Visual Function Tests (MeSH)

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INTRODUCTION

Convergence insufficiency (CI) is a common binocular vision disorder characterized by impaired ocular convergence during near-vision tasks, resulting in a receded near point of convergence (NPC). The reported prevalence of CI in the general population ranges from 2% to 17%, depending on the diagnostic criteria, study population and assessment methods used.¹ Clinically, CI commonly presents with diplopia, eyestrain,

headaches, and reading difficulties, adversely affecting near vision and quality of life.²

Parkinson's disease (PD) is the second most common neurodegenerative disorder after Alzheimer's disease. It is characterized by progressive degeneration of dopaminergic neurons in the substantia nigra pars compacta, leading to dysfunction of the frontal-thalamo-striatal circuitry and a wide range of motor and non-motor manifestations.^{3,4} Although PD affects

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individuals across all ethnic and socioeconomic groups, its prevalence increases with advancing age and is higher in males.⁵ While the cardinal motor features-bradykinesia, rigidity, and resting tremor-are well recognized, non-motor manifestations, particularly visual and oculomotor dysfunction, are increasingly recognized as important contributors to functional impairment and reduced quality of life.^{6,7}

PD is associated with a variety of ocular abnormalities, including CI, reduced blink rate, impaired smooth pursuit, saccadic dysfunction, and diplopia.⁸ The prevalence of CI in patients with PD has been reported to range from 25% to 50%, substantially higher than that in the general population, and it is a major contributor to reading difficulties and impaired near vision.^{9,10} Borm CD, et al., reported that ophthalmological disorders, including CI, frequently go undetected in PD patients despite their clinical significance.¹¹ Similarly, Kwan SC, et al., found that among 43 PD patients evaluated at a neuro-optometry clinic, 30% demonstrated CI as the most common binocular vision dysfunction.¹² Management strategies, including orthoptic exercises, vergence training, and optical rehabilitation, have demonstrated benefits in improving convergence function in affected patients.¹³

Despite the recognized burden of CI in PD, data on its frequency and severity stratification from low- and middle-

income country settings remain sparse. Furthermore, the relationship between disease duration and severity of convergence impairment warrants further investigation. The present study was therefore conducted to determine the frequency and severity of reduced near point of convergence, as a measure of CI, in patients with PD presenting to a tertiary care institution. The Objective of the present study was to determine the frequency of reduced near point of convergence (indicative of convergence insufficiency) in patients with PD aged 40–70 years at a tertiary care center.

Despite the recognized burden of convergence insufficiency PD, data on its severity and relationship with disease duration remain limited, particularly in low- and middle-income countries. The present study was therefore undertaken to assess the severity of reduced near point of convergence (NPC), as an indicator of CI, and its association with disease duration in patients with PD attending a tertiary care hospital.

METHODS

The data for this cross-sectional study was collected from Services Hospital, Lahore and Lahore General Hospital, Lahore, Pakistan from March to September 2024, over a period of seven months. Non-probability consecutive sampling was employed. A total of 80 patients with a confirmed diagnosis of Parkinson's disease, based on the UK Parkinson's Disease Society Brain Bank (UKPDSBB) clinical diagnostic criteria, were enrolled. The sample size was calculated using the prevalence of CI in PD of 36% as reported in the literature,⁹ with a 95% confidence interval and a margin of error of 10%, yielding a minimum required sample of 78 patients; thus, 80 patients were enrolled to ensure adequate precision.

Patients aged 40–70 years with a confirmed diagnosis of PD who were able to stand unaided and walk with or without an assistive device were included. Patients with refractive errors ≥ 5.00 diopter sphere (DS), other concurrent neurological disorders (e.g., epilepsy, stroke, multiple sclerosis), ocular pathologies (e.g., glaucoma, cataract, strabismus, retinal disorders),

uncontrolled mood disorders, or any debilitating condition other than PD that would impede full participation were excluded.

Demographic and clinical data including age, gender, disease duration, and medication use were collected using a structured, investigator-administered questionnaire. The NPC was measured using a Royal Air Force (RAF) ruler under standardized conditions: uniform illumination, patient seated comfortably and corrective lenses worn where applicable. The RAF ruler target was advanced at a rate of approximately 1–2 cm per second toward the patient's nasal bridge, and the point at which the patient reported doubling of the target or the examiner observed divergence of one eye was recorded. Three measurements were taken per patient, and the mean value was used for analysis. All measurements were performed by a single trained examiner to ensure consistency and minimize interobserver variability. To facilitate the data analysis and comparison among participants, NPC values were categorized as low degree CI (10–18 cm), intermediate degree CI (19–26 cm), and high degree CI (27–34 cm). The categorization was used as descriptive categories for data stratification and were not intended to imply a validated clinical severity grading, this was to develop to facilitate statistical comparisons between group. For this study, an NPC > 10 cm was considered indicative of reduced convergence, consistent with CI. Ethical approval was obtained from the Institutional Review Ethics Committee of the University of Lahore, Lahore (Reference #: REC-UOL-286/08/24, dated: July 29, 2024) prior to commencement of data collection. Written informed consent was obtained from all participants.

Data were analyzed using SPSS version 25.0 (IBM Corp., Armonk, NY, USA). Descriptive statistics were reported as mean $\pm$ standard deviation (SD) for continuous variables and as frequencies and percentages for categorical variables. Pearson's correlation coefficient was used to assess the relationship between disease duration and RAF ruler values. A p-value of

< 0.05 was considered statistically significant.

RESULTS

Out of 80 patients with Parkinson's disease, enrolled in this study, 42 (52.5%) were male and 38 (47.5%) were female, yielding a male-to-female ratio of 1.1:1. The age range of all participants was 40–70 years. The mean age of male patients was 55.90 ± 8.33 years, and the mean age of female patients was 51.39 ± 5.47 years. The demographic characteristics of the study population are summarized in Table I.

The mean disease duration was 2.33 ± 1.44 years, with a minimum of 0.25 years and a maximum of 6 years. The mean RAF ruler value (NPC) was 19.94 ± 3.97 cm (range: 12–34 cm). A statistically significant positive correlation was found between disease duration and NPC values (Pearson's $r = 0.628$, $p < 0.001$), indicating that patients with longer disease duration tended to have a more receded near point of convergence. Descriptive statistics for disease duration and NPC are presented in Table II.

Based on NPC grading, 35 patients (43.8%) demonstrated mild CI (NPC: 10–18 cm), 35 patients (43.8%) demonstrated moderate CI (NPC: 19–26 cm). Thus, the overall frequency of reduced NPC consistent with CI was 100% of the enrolled PD cohort, with the majority presenting in the mild-to-moderate range. The frequency distribution of CI severity is presented in Table III.

DISCUSSION

The present study evaluated the frequency of reduced near point of convergence, as a measure of convergence insufficiency, in 80 patients with Parkinson's disease aged 40–70 years. A high frequency of CI was identified: 43.8% of patients had low degree CI, 43.8% had intermediate degree CI, and 12.5% had high degree CI based on RAF ruler measurements. A significant positive correlation was found between disease duration and NPC values ($r = 0.628$, $p < 0.001$), suggesting that convergence

Table I: Demographic characteristics of study participants by gender

Gender	Frequency (%)	Age Range (years)	Minimum Age (years)	Maximum Age (years)	Age (years) [Mean $\pm$ SD]
Male	42 (52.5%)	40-70	40	70	55.90 $\pm$ 8.33
Female	38 (47.5%)	42-65	42	65	51.39 $\pm$ 5.47
Total	80 (100%)	40-70	40	70	53.78 $\pm$ 7.47

Note:SD=Standard Deviation

Table II: Descriptive statistics for disease duration and near point of convergence (RAF ruler value)

Variable	Minimum	Maximum	Mean $\pm$ SD	Correlation (r / p-value)
Disease Duration (years)	0.25	6.00	2.33 $\pm$ 1.44	r=0.628; p,0.001
NPC-RAF Ruler Value (cm)	12	34	19.94 $\pm$ 3.97	

NPC=Near Point of Convergence; SD =Standard Deviation; r=Pearson's Correlation Coefficient

Table III: Frequency and severity grading of convergence insufficiency based on near point of convergence

Grade	NPC Range (cm)	No. of Patients	Percentage
Low degree CI	10-18	35	43.8
Intermediate degree CI	19-26	35	43.8
High degree CI	27-34	10	12.5
Total	—	80	100

Note:CI=Convergence Insufficiency; NPC =Near Point of Convergence

impairment worsens with disease progression. Male patients constituted a slightly greater proportion of the cohort (52.5%), consistent with the well-established male predominance in PD epidemiology.

These findings are consistent with the broader literature demonstrating a high burden of CI in PD. Irving EL, et al., reported a prevalence of CI of approximately 36% among PD patients using standardized diagnostic criteria, noting that CI was significantly more common in PD patients than in age-matched controls.¹⁴ O'Neal EC, et al., similarly documented convergence insufficiency in a substantial proportion of PD patients, emphasizing that it remains underdiagnosed in clinical practice.¹⁵ Kwan SC, et al., found that CI (30%) was the most common binocular vision dysfunction among PD patients evaluated at a neuro-optometry clinic, followed by oculomotor dysfunction (14%) and vertical gaze palsy (18%).¹² The high frequency observed in the current study (with all enrolled patients demonstrating some degree of reduced NPC) may in part reflect the use of a single NPC measurement tool (RAF ruler) rather than a multi-criteria

diagnostic approach, which is an acknowledged limitation.

Borm CD, et al., documented that ophthalmological disorders, including convergence dysfunction, frequently go undetected in PD patients despite their impact on functional ability.¹¹ Holden SK, et al., reported that cognitive impairment did not significantly differ between symptomatic and asymptomatic CI groups in PD, highlighting the complex interplay between visual and cognitive dysfunction in this population.¹⁶ The significant correlation between disease duration and NPC values observed in the present study aligns with evidence suggesting that vergence dysfunction worsens as PD progresses, likely due to progressive dopaminergic degeneration affecting oculomotor circuitry.^{3,8} Hamedani AG, et al., further demonstrated that diplopia in PD is associated with both motor and non-motor impairment, underscoring CI's contribution to the overall burden of disability.¹⁷

From a clinical standpoint, these findings carry important implications. CI in PD patients impairs reading, near-work tasks, and overall quality of life.

Management options including orthoptic vergence training, base-in prism lenses, and visual rehabilitation have demonstrated efficacy in this population.¹³ Routine neuro-ophthalmic assessment, including NPC measurement, should therefore be considered as part of the standard multidisciplinary evaluation of PD patients.

Several limitations of the present study must be acknowledged. First, CI was assessed using RAF ruler NPC measurement alone, without supplementary assessment of near exophoria, positive fusional vergence, or symptom questionnaires such as the Convergence Insufficiency Symptom Survey (CISS). This represents a deviation from the full COVA diagnostic criteria for CI and may have led to an overestimation of CI frequency; accordingly, results are more accurately described as reflecting reduced NPC rather than fully confirmed CI. Second, this was a single-center study, and the findings may not be generalizable to all PD populations. Third, the absence of a control group prevents a direct statistical comparison with healthy age-matched individuals, and comparative claims are therefore based on published literature. Fourth, disease severity (e.g., using the Hoehn and Yahr scale) and medication status were not systematically recorded, despite their potential influence on vergence function. Fifth, the possibility of selection bias inherent to a consecutive convenience sample cannot be excluded. Future studies should incorporate multi-criteria CI diagnostic standards, include a matched control group, stratify findings by disease severity and medication regimen and utilize larger, multi-center samples.

CONCLUSION

The present study identified a high frequency of reduced near point of convergence, consistent with convergence insufficiency, in patients with Parkinson's disease. Low and intermediate grades of CI were equally prevalent, each accounting for 43.8% of the cohort, while high degree CI was observed in 12.5% of patients. A significant positive correlation between

disease duration and NPC values suggests that convergence impairment progresses with disease advancement. Male patients were more frequently affected than female patients. These findings underscore the need for routine neuro-ophthalmic screening, specifically NPC assessment, in all patients with Parkinson's disease, and highlight the potential role of vision rehabilitation in improving functional outcomes in this population.

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AUTHORS' CONTRIBUTION

The following authors have made substantial contributions to the manuscript as under:

SS: Conception and study design, acquisition, analysis and interpretation of data, drafting the manuscript, critical review, approval of the final version to be published

HH, SH, RA & GS: Acquisition of data, drafting the manuscript, approval of the final version to be published

Authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

CONFLICT OF INTEREST

Authors declared no conflict of interest, whether financial or otherwise, that could influence the integrity, objectivity, or validity of their research work.

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DATA SHARING STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.



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