



# Parkinson's disease and convergence insufficiency: A mini-review

Mashaeh Al-Namaeh <sup>1</sup>

<sup>1</sup> Oulu University of Applied Sciences, Oulu, Finland

## ABSTRACT

**Background:** A key manifestation of Parkinson's disease (PD) is visual impairment. Cognitive impairment has been found to overlap with convergence insufficiency (CI) in patients with PD and is associated with significantly greater near point convergence (NPC) distance. Difficulty in reading and diplopia were the most common symptoms of CI in PD. The prevalence of CI is greater among patients with PD. Therefore, this study aimed to assess the relationship between PD and CI.

**Methods:** Studies that had included data on CI, NPC, or both were selected by searching PubMed/MEDLINE and clinicaltrials.gov, without any timeline or language limitation. The following terms were used in PubMed/MEDLINE search: 'Clinical Trials', 'Parkinson's Disease', and 'Convergence Insufficiency'. For clinical trials.gov database, the terms 'Parkinson's Disease', 'Convergence Insufficiency', and 'Completed Studies' were used. Only those studies with control subjects were included. PubMed/MEDLINE search yielded 1,563 articles, but no article was found in the clinical trials.gov search.

**Results:** Overall, there were 1,563 articles; among them, 12 articles met the inclusion criteria. Nine articles were selected based on their data concerning CI or NPC distance (cm) and PD. Relative to the control group, the PD group had high CI. In addition, PD group showed increase in NPC distance than the control group.

**Conclusions:** These data suggest that the patients with PD had an increased likelihood of developing CI visual symptoms, and increased NPC distance than healthy controls. These findings indicate that regular eye examination is very important for patients with PD.

## KEY WORDS

Parkinson's disease, convergence insufficiency, near point convergence, cognitive impairment

## INTRODUCTION

Parkinson's disease (PD) is the second most common neurodegenerative disorder. Visual impairment is a primary manifestation of PD. The prevalence of convergence insufficiency (CI) is greater in patients with PD. Cognitive impairment (CIM) has been found to commonly overlap with CI in PD patients and is associated with a significantly greater distance of near point convergence (NPC). Eye clinicians should consider the possibility of a higher incidence of CIM in patients with PD and CI [1].

Since CI is common among PD cases and the most commonly cited symptoms associated with CI in PD were difficulty in reading and diplopia [2-4], this overview examined the relationship between PD and CI.

**Correspondence:** Al-Namaeh M, School of Health and Social Care, Oulu University of Applied Sciences, Kiviharjuntie 8, 90220 Oulu Teuvo Pakkalan katu 19, 90100, Oulu 90220, Finland. Email: [namaehm@aol.com](mailto:namaehm@aol.com) ORCID iD: <https://orcid.org/0000-0002-5253-1175>

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Table 1. Characteristics of the included studies in this report

First author	Study type	Diagnostic tool	Age (Years)	Subjects	Main findings
Visser et al. [3]	Observational cross-sectional	UK Parkinson's Disease Society Brain Bank criteria	Mean ± SD PD with diplopia, 72 ± 9 PD without diplopia, 73 ± 8 CS, 70 ± 8	41 PD (25 with diplopia, 16 without diplopia) 23 CS	NPC (cm): median (IQR) PD with diplopia, 13 (11); PD without diplopia, 7 (10); CS, 6 (11) CI, n: PD with diplopia, 15; PD without diplopia, 2; CS, 5. Note: Only 44% percent of patients with PD and diplopia had visual hallucinations. Median cognitive function using MoCA was 23 and 28 in PD and CS, respectively.
Biousse et al. [5]	Case-control	UPDRS motor score	Mean age, range: PD: 61 (34-79) CS: 58 (37-74)	30 PD 31 CS	CI: PD, n = 7; CS, n = 6 (P = 0.704). Decreased NPC: PD, n = 9; CS, n = 7 (P = 0.944). Decreased CAs: PD, n = 24; CS, n = 8 (P < 0.001). Note: Most cases with PD had normal NPC with decreased CAs. Patients with PD were in an early stage of disease, and details of CIM status in recruited cases was not mentioned in this paper. Twenty-five percent of patients had formed visual hallucinations, but no one developed dementia after two years of follow-up.
Borm et al. [6]	Observational multicenter cross-sectional	VIPD-Q	Median (IQR) [Range] PD: 70 (12.5) [33-93] CS: 70 (13.8) [31-94]	848 PD 250 CS	Oculomotor symptoms were significantly (P < 0.001) more common in patients with PD than in CS. Note: Visual hallucinations were found in 22% of patients with PD versus 2% of CS (P < 0.001). This paper does not give details of CIM status in recruited cases.
Law et al. [8]	Observational multicenter cross-sectional	CISS-15	Mean ± SD PD: 67.3 ± 8.9 CS: 67.2 ± 8.7	300 PD 300 CS	Significantly (P = 0.001) more patients with PD had a score of ≥21 on the CISS-15 compared with CS. Note: Cases with MMSE scores < 14 have been excluded.
Nowacka et al. [11]	Case-control	PD staging was assessed with the modified scale	Mean ± SD: PD: 68.5 ± 10.2 CS: 68.6 ± 9.8	100 PD 100 CS	CI: PD, 24.5%; CS, 9.7% (P < 0.001). Note: Four percent of patients with PD had visual hallucinations. This paper does not give details of CIM status in recruited cases, and stage of PD was quite low.
Irving et al. [12]	Case-control	CISS-15	Mean ± SD: PD: 67.4 ± 8.5 CS: 68.2 ± 8.1	80 PD 80 CS	Subjective NPC (cm): Mean ± SD PD, 11.2 ± 6.2; CS, 4.4 ± 3.7 (P ≤ 0.001). Objective NPC (cm): Mean ± SD PD, 14.5 ± 4.4; CS, 8.2 ± 1.0 (P ≤ 0.001). Significantly (P ≤ 0.001) more patients with PD (43.8%) had CI compared with CS (16.3%). Significantly (P ≤ 0.001) more patients with PD (53.8%) had scores on the CISS-15 of ≥21 compared with CS (18.8%). Note: Cases with MMSE scores < 24 have been excluded.
Repka et al. [14]	Case-control	PD staging was assessed with the modified Hoehn and Yahr (H-Y) scale	Mean (range, median): PD: 68 (45-80, 70) CS: 65 (47-77, 65)	39 PD 39 CS	NPC in cm, mean (range): PD, 15 (4-22); CS, 9 (4-33) (P = 0.002). CI was significantly (P < 0.001) more common in the patients with PD (n = 12) than in CS (n = 0). Note: Increasing severity of PD correlated with the presence of CI and deterioration of visual acuity. This paper does not give details of CIM status in recruited cases.
Kergoat et al. [15]	Case-control	CISS-15	Mean ± SD: PD: 1.2 ± 10.4 CS: 70.5 ± 9.2	82 PD 82 CS	Significantly (P ≤ 0.05) more patients with PD (45.1%) had scores on the CISS-15 of ≥ 21 against CS with co-existing oculovisual condition (17.1%). Note: This paper does not give details of CIM status in recruited cases.
Almer et al. [16]	Prospective comparative case series	PD staging was assessed with the Hoehn and Yahr (H-Y) scale and UPDRS motor score	Mean ± SD: PD: 58.8 ± 8.6 CS: 61.6 ± 13.9	27 PD 16 CS	NPC (cm): Mean ± SD PD "on" dopaminergic medication, 13.1 ± 9.1 (PD versus CS, P = 0.079) PD "off" dopaminergic medication, 18.1 ± 12.2 (PD versus CS, P = 0.002) CA (prism diopters): Mean ± SD PD "on" dopaminergic medication, 14.8 ± 10.3 (PD versus CS, P = 0.003) PD "off" dopaminergic medication, 10.7 ± 9.0 (PD versus CS, P = 0.0007) CS, 24.1 ± 8 Note: No correlation found between duration or severity of PD and the size of the exodeviation or CI. This paper does not give details of CIM status in recruited cases.

Abbreviations: CA, convergence amplitudes; CI, convergence insufficiency; CIM, Cognitive Impairment; CISS-15, Convergence Insufficiency Symptom Survey; cm, centimeter; CS, Control Subjects; IQR, the interquartile range; MMSE, mini mental state examination; MoCA, Montreal Cognitive Assessment; n, number; NPC, near point of convergence; PD, Parkinson's Disease; SD, standard deviation; UPDRS, the Unified Parkinson's Disease Rating Scale; VIPD-Q, The Visual Impairment in Parkinson's Disease Questionnaire.

## METHODS

Studies with data on CI, NPC, or both were selected from the PubMed/MEDLINE and clinicaltrials.gov databases. In the PubMed/MEDLINE search, the following terms were used: 'Clinical Trials', 'Parkinson's Disease', and 'Convergence Insufficiency'. For clinical trials.gov data base: 'Parkinson's Disease', 'Convergence Insufficiency', and 'Completed Studies' were used. The studies which included control subjects were recognized for further evaluation. There were no limitations with respect to the timeline or language.

## RESULTS

The PubMed/MEDLINE search yielded 1,563 articles, but no records were found in the clinicaltrials.gov search. Out of 1563 records found in PubMed/MEDLINE, the full texts of 12 articles were screened as per the defined eligibility criteria. Following the exclusion of case reports, letters to editorials, and studies without a control group, nine articles were selected for the current study [3, 5, 6, 8, 11, 12, 14-16].

We retrieved data from the CI screening survey and NPC. Altogether, these nine studies recruited 1547 patients with PD and 921 subjects as controls. Compared to the control group, a greater number of patients with PD had CI, decreased convergence amplitudes, or more common oculomotor symptoms [3, 5, 6, 11, 12, 14, 16]. In addition, the PD group showed increased NPC distances [3, 12, 14, 16]. Likewise, more patients with PD had scores on the Convergence Insufficiency Symptom Survey (CISS)-15 of  $\geq 21$  compared with controls [8, 12, 15, 16]. Table 1 summarizes the characteristics and the main findings from the nine primary included studies [3, 5, 6, 8, 11, 12, 14-16].

## DISCUSSION

Relative to the control group, the PD group had a higher number of CI. These data suggest that the patients with PD had an increased likelihood of developing CI visual symptoms, and increased NPC distance than healthy controls. The eye examination, especially the binocular vision test, for patients with PD cannot be overemphasized.

PD has been associated with diplopia, reduced visual acuity, pupil abnormalities, saccade abnormalities, smooth pursuit eye movement disorders, CI, vergence abnormalities, strabismus, slower reading time, and vertical gaze abnormalities [2, 17, 18]. Since diplopia has been reported in PD, and diplopia is one of the manifestations of CI, there is a clear correlation between diplopia and CI in PD [3, 14]. Therefore, we used CI as a keyword in our literature search. Other manifestations should be reviewed in future studies such as visual hallucinations and diplopia [3-5, 11].

Binocular vision tests such as positive fusional vergence (PFV) and NPC are required for the diagnosis of CI. It has been emphasized that simple reading tasks using 120 single-digit numbers can be used as a screening tool in clinical settings to assess functional ocular motor difficulties in PD, which can have a significant impact on the quality of life [19]. Other tests that may be used as screening tools are electrophysiological recordings, such as flash pattern electrooculography, multifocal electroretinography, and visual evoked potential [12, 20].

The data presented in this paper suggest that in patients with PD, the likelihood of CI visual symptoms and increased NPC distance is greater than that in the control group. Therefore, regular eye examinations are important for patients with PD. In addition, patients with objective findings of CI, irrespective of being symptomatic or not, might be at a higher risk of CIM. Although none of the included studies evaluated the association between CIM and CI (see Table 1), still eye clinicians should be highly aware of CIM in patients with CI [11, 21], while waiting for future studies to shed light on the subject.

Some limitations on the interpretation of our findings need to be noted. The selected studies for the CI in PD used various tools [3, 5, 6, 8, 11, 12, 14-16] to assess the subjects, and not all of the included studies had details of NPC (see Table 1). However, by summarizing these findings, we aimed to highlight the urgency of binocular vision examination in patients with PD. Also, the availability of only nine reports on the topic highlights the urgent need for more such clinical research on this subject. The strength of this report would be drawing attention to a novel association between CI and PD.

## CONCLUSIONS

The prevalence of CI-type visual symptoms is higher in individuals with PD. We emphasize the importance of regular eye examinations for individuals with PD, especially binocular vision tests. Our results highlight the need for more clinical trials to further evaluate CI in patients with PD.

## ETHICAL DECLARATIONS

**Ethical approval:** This study was a brief report, and no ethical approval was required.

**Conflict of interest:** None.

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