Selective Visual Attention Assessment Using Landolt-C in MCI and Mild Dementia

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Introduction

Impairments of attention networks, working memory, information processing speed, and executive functions are recognizable features of Alzheimer's Disease (AD). These impairments increase with dementia's progression. Progressive attention impairment may be one of the markers of dementia but one that is often overlooked and less recognized or assessed. From our experience at least 25-30% patients with memory complaints also have attention problems (Unpublished Data).

There are many tasks to evaluate Selective Attention problems in Dementia/ Depression.
The classical Landolt-C task of selective attention was not utilized for many years until recently when it had been found to be sensitive to selective attention, higher cortical visual processing, functions of parietal lobe network (Saito et al., 2010; Bisley et al., 2009). This task is sensitive to ability to detect relevant visual signals and may be superior to other related tasks in different cognitive batteries as it minimizes linguistic and semantic processing.

Objective

The aim of our study was to investigate differences in selective visual attention of patients with mild cognitive impairment (MCI) and dementia (mild stage) using a classical Landolt-C task of selective attention.

Subject/Methods

Data were collected from the charts of 208 patients (females – 147, males - 61), mean age - 78.8±5.74, education - 16.4±2.74 yrs, with memory loss and depression. The patients were divided in 2 groups: group 1 (MCI) with MMSE ≥ 27 (147 patients) and group 2 with MMSE ≤ 24 (61 patients). Patients with MMSE 25 and 26 were excluded. All patients have multiple medical problems (hypertension, coronary artery disease, high cholesterol, diabetes, and others).

Cognitive Testing and Statistical Analysis:

Four tests were used from the patients' charts for data presentation.

1. The Folstein Mini Mental Status Exam (MMSE) with a maximum score of 30. For attention assessment serial 7s calculation task was used (Folstein, et al).
2. Clock Drawing Task (CDT).
3. Verbal Fluency Task (VFT) – semantic (animals) and phonemic (letters) fluency were both assessed.
4. Selective attention was evaluated by using Landolt-C, a computerized continuous performance test (LC-CPT), designed in our center. It involves a blue Landolt ring (Figure 1) with four gap orientation options, each presented on a computer screen for 800 ms with interstimulus interval approximately 800 ms and total target numbers of 80. Performance (accuracy), target and non-target errors and RT variables were used for statistical analysis.

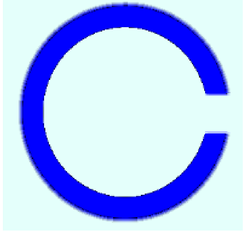

Figure 1. Colored landolt rings with four possible gap orientations.

Data analyses were carried out with SPSS for Windows, version 21.0 (SPSS Inc., Chicago, Ill.) Statistics included Wilcoxon signed-rank and Mann-Whitney U tests and Spearman's rho correlations.

Results

Table 1. Demographics and Clinical Characteristics

Demographics	Patients	Percentage
Men	61	29.3
Women	147	70.7
	Mean	**Standard Deviation**
Age	78.8	5.75
Education (years)	15.14	10.34
Diagnosis	**Patients**	**Percentage**
Hypertension	190	91.4
Dementia	188	90.4
Depression	188	90.4
Anxiety	186	89.4
High Cholesterol	176	84.6
Insomnia	155	74.5
Coronary Artery Disease	108	51.9
Diabetes	54	25.9
Thyroid Disorder	42	20.2
Head Trauma	41	19.7
Canser	31	14.4
Asthma	26	12.5
Stroke	18	8.7
Anemia	16	7.7
B-12 Deficiency	14	6.7
Duration of Illnesses (months)	**Mean**	**Standard Deviation**
Depression	46.3	39.33
Memory	33.4	28.25

The demographics and clinical profiles of the patients are presented in Table 1. All members of this cohort suffered from memory problems and depression. Most of the cohort had anxiety (89.4%) and insomnia (74.5%) The duration of memory loss was about 33.4 ± 28.25 months, and depression- 46.3 ± 39.33. Cardiovascular burden was high with more than 95% of patients having at least one cardiovascular disease. 25.9% of our group had diabetes mellitus, and 20.2% had thyroid problems

Table 2.Cognitive Profile in Dementia and Mild Cognitive Deficit

	MMSE ≥ 27			MMSE≤ 24			
	N	Mean	SD	N	Mean	SD	p value
MMSE	147	28.6	1.02	61	21.8	2.77	0.0001
CDT	145	3.3	0.98	59	2.5	1.21	0.0001
VFC	146	12.9	4.84	58	8.8	4.71	0.0001
VFL	146	10.1	4.63	58	7.5	3.81	0.0001
LCAE	147	76.3	4.66	61	73.3	6.25	0.0001
LCRT	147	594.5	66.66	61	605.9	105.68	0.152
LCOE	147	2.3	2.61	61	4.1	4.33	0.003
LCCE	147	0.7	2.01	61	1.4	1.79	0.002

Abbreviations
MMSE- Standard Mini Mental Status Exam
CDT- Clock Drawing Task
VFC- Verbal Fluency Category
VFL- Verbal Fluency Letter
LCAE- Landolt-C Accuracy Errors –performance
LCRT- Landolt-C Reaction time- brain speed
LCOE- Landolt-C Omission Errors
LCCE- Landolt- C Commission Errors

Cognitive Profile in Dementia and Mild Cognitive Deficit is presented in Table 2. The mean standard MMSE score was 28.6± 1.02 in group 1 and 21.8 ± 2.77 in group 2 (p< 0.0001). Clock Drawing Task and Verbal Fluency were decreased significantly in group 2. Performance on the LC-CPT in group 1 was higher than in group 2 (by 4%, 0.0001). Omission errors increased in group 2 (by 78%, 0.003). Commission Errors increased as well (by 246%, p < 0.002). No difference in RT was seen between groups.

In group 1 the total MMSE did not correlate with LC-CPT performance score (r + 0.685) while in group 2 there was positive correlation between them (r + 0.27, p < 0.036).

Discussion

To our knowledge, this is the first study analyzing attention in dementia using the aforementioned task, which minimizes linguistic and semantic processing. Although a Landolt C may appear as a simple stimulus and is known as a widely used test of visual acuity all over the world, it is a classical task sensitive to the ability to detect relevant visual signals. It probes selective attention and to some extent working memory network involvement. Recently, studies have shown relationships between Landolt C task performance and higher cortical visual processing, as well as the functions of the parietal lobe network (Saito et al., 2010; Bisley et al., 2009). The detection of a Landolt C orientation probes focal attention, with a search rate of about 100 ms/item in the visual search task (Gao, Shen, Gao, & Li, 2008; Shen et al., 2007; Woodman & Luck, 2003). Carlisle et al. (2011) used this task in a study of visual attention and visual working memory processes, in particular - mechanisms of transfer from working to long-term memory.

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Discussion (continued)

In our study, as we demonstrated previously, Group 1 patients performed much better on all "paper and pencil" tasks (MMSE, CDT, VFC, and VFL) than Group 2 (Bragin, et al., 2015). There were significant differences on performance and omission and commission errors between the two groups. However, there was no difference in the reaction time between the two groups. This may be explained by the visual registration of the Landolt C stimuli being similarly preserved in both groups.

It is important to note that the LC- CPT variables were significantly correlated with the total MMSE score only in Group 2, suggesting possible differential neurocognitive network recruitment for dementia as opposed to MCI.

In light of recent studies showing promising results of processing speed training in prevention of cognitive decline in mild cognitive impairment as well as dementia (Edwards et al., 2017), there appears a need for further studies investigating differential performance and usefulness of attention and processing speed protocols in different stages of neurodegenerative conditions, progressing from mild cognitive impairment to dementia

Conclusion

Landolt-C continuous performance test is a clinically useful and promising task that minimizes linguistic processing demands and that can also be used in cognitive interventions addressing processing speed and visual attention in MCI and dementia.

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Key words : Landolt C, visual attention, selective attention, reaction time, processing speed, dementia, mild cognitive impairment, attention in dementia, MMSE