ORIGINAL ARTICLE

Mini-mental state exam versus Montreal Cognitive Assessment in patients with diabetic retinopathy

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Abstract

Background: Mini-mental state exam (MMSE) was used several times but no study has examined cognition on the Montreal Cognitive Assessment (MoCA) in diabetes and diabetic retinopathy (DR). In this study, we compared MMSE with MoCA in patients with DR and searched for an association between the severity of DR and cognitive impairment (CI).
Methods: This cross-sectional study comprised 120 consecutive patients with diabetes. Patients were divided into four groups as no DR, mild DR, severe nonproliferative DR (PDR) and PDR. Each group consisted 30 inviduals. CI was assessed using the MMSE and MoCA.
Results: The number of subjects with a score >21 were significantly lower on the MoCA than on the MMSE between groups (all $P < 0.05$). The mean MoCA score was significantly lower than the MMSE score ($P < 0.001$) There was a linear association between the grade of DR and a score <21 on both tests,
Conclusion: MoCA provides more insight into the cognitive function in DR.

Key words: Cognitive impairment, diabetic retinopathy, mini-mental state exam, Montreal Cognitive Assessment

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Introduction

Diabetes mellitus (DM) is a chronic disease characterized with hyperglycemia due to absence or insufficient action of insulin associated with various metabolic changes. The long-term persistence of metabolic changes can cause serious complications in various systems of the body. One of the most important of these complications is diabetic retinopathy (DR).

Diabetic retinopathy is one of the preventable causes of visual impairment in the world and it is an ocular manifestation of the disease. It is a microangiopathy including retinal capillary, venules and arterioles and initial findings are microaneurysms, intraretinal hemorrhages, exudates, intraretinal microvascular abnormalities and venous beading that occurs in nonproliferative DR (NPDR). The next stage of the progresion of the retinopathy is proliferative DR (PDR) including preretinal and vitreous hemorrhage due to growth of abnormal new blood vessels.

Microangiopathy occurs in the brain[1] as well as in other organs that leads to atherosclerotic cerebrovascular disease and/or neurodegeneration which may be related with cognitive decline in patients with DM.[2,3] The risk of cognitive impairment (CI), Alzheimer's disease and vascular dementia are increased in DM, especially in type 2 DM.[4,5] Both hyperglycemia and hypoglycemia have been implicated as the cause of cognitive dysfunction in patients with DM, and recurrent hypoglycemia could impair memory of patients with diabetes over time.[6,7]

In recent studies, the relationship between DR and CI were investigated by different cognitive tests such as mini-mental state examination (MMSE), Addenbrooke's Cognitive

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Examination-Revised and Digit Symbol Substitution Test which showed increased risk of CI in patients with DR.[8,9] However, to our knowledge, no study has examined cognition on the Montreal Cognitive Assessment (MoCA) in patients with DR. The aim of the present study was to compare the ability of the MMSE and MoCA to identify cognitive dysfunction in patients with DR.

Materials and Methods

This cross-sectional study was carried out between July 2014 and November 2014 and comprised 120 consecutive patients with diabetes. The research was confirmed by Institutional Review Board and was conducted in accordance with the Declaration of Helsinki. All patients gave written informed constent before their participation.

Exclusion criteria were past ocular trauma and previous ocular surgery within 6 months, best corrected visual acuity worse than 1/10, history of cerebrovascular events, the presence of life threatening illness and dementia.

Patients with diabetes were divided into four groups according to the criteria of the Early Treatment Diabetic Retinopathy Study.[10] Non-DR group consisted patients without retinopathy, mild DR group comprised patients with mild-moderate NPDR, patients with NPDR with common ischemia comprised the severe NPDR group, and patients in the PDR group had PDR. Each group consisted 30 inviduals. All the patients were studied and staged for DR according to the Early Treatment of Diabetic Retinopathy Study classification.[11]

Individuals were tested for CI using the MMSE and MoCA by the same specially trained research assistants in a quiet and well-lit room. There was a 10 min break between administration for two tests. The scores were recorded for all 120 participants. The cut off score <21 on the MoCA was used for CI.[12]

The statistical analysis was performed using the Statistical Package for Social Sciences (SPSS) program (SPSS Inc., Chicago, IL, USA). All variables were compared using ANOVA test for continuous data and Pearson's Chi-squared analyses for categorical data. $P < 0.05$ were considered as statistically significant.

Results

One hundred twenty participants (56 female, 64 male) were recruited into four study groups: No DR, mild NPDR, severe NPDR and PDR. Each group had 30 patients. The mean age of the patients in each subgroup was measured as 62.83 ± 7.81, 60.83 ± 5.83, 65.00 ± 8.00, 66.63 ± 7.65 years. The mean duration of diabetes and education level is shown in Table 1.

The score >21 on MMSE for each group was 22 (73.3%), 21 (70%), 17 (56.7%), 10 (33.3%) and on MoCA, it was 15 (50%), 10 (33.3%), 6 (20%), 4 (13.3%)

Table 1: Demographic data and social characteristics of the participants for each group

	DR			PDR
	No	Mild	Moderate	
Age (years)	62.83±7.81	60.83±5.23	65.00±8.00	66.63±7.65
Sex (%)				
Male	17 (56.7)	17 (56.7)	14 (46.7)	16 (53.3)
Female	13 (43.3)	13 (43.3)	16 (53.3)	14 (46.7)
Education level (%)				
Elementary school	20 (66.7)	24 (80)	27 (90)	28 (93.4)
High school	7 (23.3)	4 (13.3)	3 (10)	1 (3.3)
University	3 (10)	2 (6.7)	0	1 (3.3)
Diabetes duration (years)	12.07±5.24	15.07±5.42	15.27±5.42	20.77±8.11

Table 2: Number of participants with scores greater and lower than 21-point cut-off and mean scores on each test for each group

	DR			PDR
	No	Mild	Moderate	
MMSE ≥21 (%)	22 (73.3)	21 (70)	17 (56.7)	10 (33.3)
MMSE <21 (%)	8 (26.7)	9 (30)	13 (43.3)	20 (66.7)
MoCA ≥21 (%)	15 (50)	10 (33.3)	6 (20)	4 (13.3)
MoCA <21 (%)	15 (50)	20 (66.7)	24 (80)	26 (86.7)
mean MMSE score	23.63±4.10	22.13±3.71	21.10±2.33	20.17±2.16
Mean MoCA score	21.83±3.97	20.83±3.67	18.53±2.33	16.17±3.00

DR=Diabetic retinopathy; MMSE=Mini-mental state exam; MoCA=Montreal Cognitive Assessment; PDR=Proliferative diabetic retinopathy

Table 3: Comparison of the mean scores of MMSE and MoCA according to severity of DR

Groups	MMSE (P)	MoCA (P)
No DR-mild DR	0.287	0.647
No DR-severe NPDR	0.017	0.010
No DR-PDR	0.000	0.000
Mild DR-severe NPDR	0.619	0.040
Mild DR-PDR	0.027	0.000
Severe NPDR-PDR	0.372	0.033

DR=Diabetic retinopathy; PDR=Proliferative diabetic retinopathy; NPDR=Nonproliferative diabetic retinopathy; MMSE=Mini mental state exam; MoCA=Montreal Cognitive Assessment

respectively [Table 2]. The number of subjects with a score >21 was significantly lower on the MoCA than on the MMSE ($P < 0.001$) when compared between subgroups ($P = 0.002$, $P = 0.013$, $P = 0.024$, $P = 0.008$).

The mean MMSE score was 23.63 ± 4.10, 22.13 ± 3.71, 21.10 ± 2.33, 20.17 ± 2.16 and the mean MoCA score was 21.83 ± 3.97, 20.83 ± 3.67, 18.53 ± 2.33, 16.17 ± 3.00 consecutively [Table 2]. The mean MoCA score was significantly lower than the MMSE score for each subgroup ($P < 0.001$). With each scale, mean score significantly decreased with worsening stage of DR.

No subject with a score >21 on the MoCA scored <21 on the MMSE. On the MMSE test nine participants, on the MoCA test two participants had a score of 30.

There was a linear association between the grade of DR and a score <21 on each test when all subgroups were compared [Table 3].

Discussion

Diabetes mellitus is characterized by many clinical complications caused by small and large vessel pathology.[13] Peripheral microvascular complications such as DR and retinal microvascular abnormalities seem to be correlated with corresponding microvascular changes like small focal lesions and white matter hyperintensities as shown by brain MRI.[14,15] In recent years, studies have shown that diabetes declines cognitive functions most likely.[16,17] In addition, dementia patients with DM had more microvascular infarcts in the brain when compared with patients without diabetes.[18] Moreover, the risk of Alzheimer's disease and dementia were found to be increased in patients with diabetes.[19]

Ba-Tin *et al*.[20] reported that diabetes seems to cause cognitive dysfunction and cognitive dysfunction was not associated with peripheral microvascular disease. The Authors suggested that the cause of cognitive dysfunction in patients with diabetes may not be limited to vascular pathology In another study, Lesage *et al*.[8] reported that retinal vascular changes were associated with CI and emphasized adding evidence for the role of microvascular changes in cognitive decline.

Diabetic retinopathy is one of the microvascular complications of DM. Because of the similarities in barries of the blood–brain and blood–retina barrier, the microvascular damage may be particularly important.[15] There was evidence for association between microvascular changes of retina and brain. In the light of all this information some authors investigated association betwen DR and CI. Crosby-Nwaobi *et al*.[21] compared CI in patients with no/mild DR and PDR and found that there was an inverse relationship betwen severity of DR and CI. Patients with no/mild DR had lower CI scores than patients with PDR However Ding *et al*. showed that the level of CI had positive correlation with severity of DR and found that the CI scores was greater in advanced DR when compared with mild DR.[22]

The MMSE is commonly used to screen patients for CI and to evaluate the effects of drugs on cognitive function.[23] It is a short and simple test to administer. However, the MMSE gives 24/30 points for individual's orientation, mind and language and only 1/30 for visuoconstructive function and is insensitive to executive function and mild CI.[24] The MoCA was developed as a rapid screening tool for evaluating mild CI. It assesses memory, visuoconstructional skills, attention and concentration, language, executive functions and orientation.[25] Compared to MMSE, the MoCA has a sensitivity of 90% in detecting mild CI. Moreover, the MoCA includes more tasks to evaluate executive function, higher level language abilities, memory, and complex visuospatial processing.

As known, the most common screening tool for mild CI is the MMSE, which is often criticized for lower sensitivity. To eliminate this problem, MoCA was introduced, particularly for screening mild CI. Likewise MMSE, the MoCA has a maximum of 30 points but the number of its modules is higher than in MMSE. To our knowledge, this is the first study assessing the ability of MoCA to detect cognitive functions in patients with diabetes who had DR in comparison to MMSE.

In this study, we tested the MMSE and MoCA in a sample of patients with DR to show which cognitive screening tool should be used for cognitive decline. We demonstrated that the MoCA is superior than MMSE to evaluate CI when compared in patients with various stages of DR. Additionally, we found that the level of cognitive function declined as the stage of DR advanced.

Conclusion

In conclusion MoCA is an adequate screening instrument for brief assessment of CI and provides greatly more insight into the cognitive function in patients with DR when compared with MMSE.

References

1. Prins ND, van Dijk EJ, den Heijer T, Vermeer SE, Jolles J, Koudstaal PJ, *et al.* Cerebral small-vessel disease and decline in information processing speed, executive function and memory. Brain 2005;128:2034-41.
2. Biessels GJ, Deary IJ, Ryan CM. Cognition and diabetes: A lifespan perspective. Lancet Neurol 2008;7:184-90.
3. Bruehl H, Sweat V, Tirsi A, Shah B, Convit A. Obese adolescents with type 2 diabetes mellitus have hippocampal and frontal lobe volume reductions. Neurosci Med 2011;2:34-42.
4. Cheng G, Huang C, Deng H, Wang H. Diabetes as a risk factor for dementia and mild cognitive impairment: A meta-analysis of longitudinal studies. Intern Med J 2012;42:484-91.
5. McCrimmon RJ, Ryan CM, Frier BM. Diabetes and cognitive dysfunction. Lancet 2012;379:2291-9.
6. Widom B, Simonson DC. Glycemic control and neuropsychologic function during hypoglycemia in patients with insulin-dependent diabetes mellitus. Ann Intern Med 1990;112:904-12.
7. Duckrow RB, Beard DC, Brennan RW. Regional cerebral blood flow decreases during chronic and acute hyperglycemia. Stroke 1987;18:52-8.
8. Lesage SR, Mosley TH, Wong TY, Szklo M, Knopman D, Catellier DJ, *et al.* Retinal microvascular abnormalities and cognitive decline: The ARIC 14-year follow-up study. Neurology 2009;73:862-8.
9. Crosby-Nwaobi R, Sivaprasad S, Forbes A. A systematic review of the association of diabetic retinopathy and cognitive impairment in people with type 2 diabetes. Diabetes Res Clin Pract 2000;50:203-12.
10. Gardner TW, Sander B, Larsen ML, Kunselman A, Tenhave T, Lund-Andersen H, *et al.* An extension of the Early Treatment Diabetic Retinopathy Study (ETDRS) system for grading of diabetic macular edema in the Astemizole Retinopathy Trial. Curr Eye Res 2006;31:535-47.
11. Early Treatment Diabetic Retinopathy Study Research Group. Grading diabetic retinopathy from stereoscopic color fundus photographs: An extension of the modified Airlie House classification: ETDRS report number 10. Ophthalmology 1991;98:786-806.
12. Selekler K, Cangoz B, Uluc S. Power of discrimination of montreal cognitive assessment (MOCA) scale in turkish patients with mild cognitive impairement and Alzheimer's disease. Turk J Geriatr 2010;13:166-71.
13. Huber JD. Diabetes, cognitive function, and the blood brain barrier. Curr Pharm Des 2008;14:594-600.
14. Ferguson SC, Blane A, Perros P, McCrimmon RJ, Best JJ, Wardlaw J, *et al.* Cognitive ability and brain structure in type 1 diabetes: Relation to microangiopathy and preceding severe hypoglycemia. Diabetes 2003;52:149-56.
15. Patton N, Aslam T, Macgillivray T, Pattie A, Deary IJ, Dhillon B. Retinal vascular image analysis as a potential screening tool for cerebrovascular disease: A rationale based on homology between cerebral and retinal microvasculatures. J Anat 2005;206:319-48.
16. Luchsinger JA, Reitz C, Patel B, Tang MX, Manly JJ, Mayeux R. Relation of diabetes to mild cognitive impairment. Arch Neurol 2007;64:570-5.
17. Roberts RO, Geda YE, Knopman DS, Christianson TJ, Pankratz VS, Boeve BF, *et al.* Association of duration and severity of diabetes mellitus with mild cognitive impairment. Arch Neurol 2008;65:1066-73.
18. Sonnen JA, Larson EB, Brickell K, Crane PK, Woltjer R, Montine TJ, *et al.* Different patterns of cerebral injury in dementia with or without diabetes. Arch Neurol 2009;66:315-22.
19. Yoshitake T, Kiyohara Y, Kato I, Ohmura T, Iwamoto H, Nakayama K, *et al.* Incidence and risk factors of vascular dementia and Alzheimer's disease in a defined elderly Japanese population: The Hisayama Study. Neurology 1995;45:1161-8.
20. Ba-Tin L, Strike P, Tabet N. Diabetic peripheral microvascular complications: Relationship to cognitive function. Cardiovasc Psychiatry Neurol 2011;2011:723434.
21. Crosby-Nwaobi RR, Sivaprasad S, Amiel S, Forbes A. The relationship between diabetic retinopathy and cognitive impairment. Diabetes Care 2013;36:3177-86.
22. Ding J, Strachan MW, Reynolds RM, Frier BM, Deary IJ, Fowkes FG, *et al.* Diabetic retinopathy and cognitive decline in older people with type 2 diabetes: The Edinburgh Type 2 Diabetes Study. Diabetes 2010;59:2883-9.
23. Folstein MF, Folstein SE, McHugh PR. Mini-mental state. A practical method for grading the cognitive state of patients for the clinician. J Psychiatr Res 1975;12:189-98.
24. Lonie JA, Tierney KM, Ebmeier KP. Screening for mild cognitive impairment: A systematic review. Int J Geriatr Psychiatry 2009;24:902-15.
25. Nasreddine ZS, Phillips NA, Bédirian V, Charbonneau S, Whitehead V, Collin I, *et al.* The Montreal Cognitive Assessment, MoCA: A brief screening tool for mild cognitive impairment. J Am Geriatr Soc 2005;53:695-9.

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