

ORIGINAL RESEARCH

Assessment of Cognitive Functions In Type-2 Diabetes Mellitus Patients of Western Maharashtra: A Cross Sectional Study

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INTRODUCTION

The disease Diabetes mellitus is a group of various symptoms in which there is increased blood glucose level due to Insulin resistance, lack of sufficient insulin secretion, or excessive secretion of glucagon hormone. Diabetes Mellitus Type II (DM2) is an exponentially growing international health hazard without foreseeable end. Complications of DM2 involve a myriad of comorbidities such as: poor wound healing, severe chronic ulceration, and resultant limb amputation¹ 415 million people throughout the world are diagnosed with diabetes mellitus and nearly 193 million people are estimated to have undiagnosed diabetes. The case load, for the same, is projected to reach over 640 million by 2040. TY2DM accounts for more than 90% of patients with diabetes leading to microvascular and macrovascular complications that cause profound psychological and physical distress²

However, a problem commonly not brought to the forefront by the healthcare providers is the link between diabetes and cognitive impairment. This is despite of the fact that the relationship being well established in medical literature. In recent years, studies proved strong evidence of presence of cognitive dysfunction in diabetic patients³ In a recent systematic review it was estimated that the occurrence of mild cognitive impairment in type 2 diabetes mellitus (TY2DM) patients was found out to be as high as upto 45%⁴ Diabetes, commonly in midlife is associated with 19 % greater decline in cognitive

function over 20 years compared to non-diabetic patients. The rising cases of diabetes mellitus throughout the world and in India, is a public health concern mostly due to end organ complications of this disease.

Research studies have shown deficits in various cognitive domains in patients suffering from Type-2 Diabetes mellitus⁵, while both TY1DM and TY2DM are congruent enough to imply the fact that there is impairment of cognitive functions, the current data suggests a stronger association with TY2DM. Patients with TY2DM displayed the greatest impairment in motor and executive function, processing speed, verbal and visual memory⁶

With this background, this research study was planned as there is a dearth of studies analysing the cognitive dysfunction associated with Type-2 Diabetes mellitus in Western Maharashtra region. The study will help the healthcare providers to provide quality treatment as well as avoid complications associated with this disease.

OBJECTIVES

1. To Assess cognitive functions in patients diagnosed with type 2 Diabetes mellitus.
2. To Correlate Blood glucose level (Fasting and post prandial) and duration of disease with MMSE score in type 2 diabetic patients.

METHODOLOGY

Study design: A Cross-Sectional study (with face-to-face interviews and conduction of Mini Mental State Examination - MMSE test⁷) Reference population: The study population was intended to represent diabetic patients from the western Maharashtra region and to address their cognition related aspects. The MMSE test shall provide a psychological edge in understanding the effects of diabetes mellitus.

Study Period: The data was collected between April 2023 to October 2023.

Inclusion criteria: The study included only adult patients diagnosed, by a treating physician with Type 2 Diabetes mellitus. The patients were diagnosed with the disease for more than 5 years and belonged to the age group 40-70 years. Patients on oral hypoglycemic medications were taken in the study.

Exclusion Criteria: Patients suffering from any mental illness, neurological disorders or visual impairment were excluded from the study. Patients suffering from depression, Post-traumatic stress disorder (PTSD), Alzheimer's disease, dementia, and insomnia were excluded from the study. Also, patients with a history of head injury and those who were on anti-depressants and anti-psychotic medication were excluded.

The study tools: • Blood sample by finger prick method was taken for assessing using Glucometer (ACCU CHECK) during the study.

• MMSE: The MMSE test was conducted to assess their orientation, language, recall and basic functions tests.

Sample Size

Based on studies, surveys and reported prevalence of diabetes mellitus in Western India the required sample size for this study was 32 subjects.

Pretest: The MMSE test was pre-tested on 7 individuals, who were not part of this study. The test has been proved to be effective in all situations. The patient was thoroughly explained the purpose of the study and was asked to sign the informed consent form. The patient was asked about his/her socio-economic status, and other details related to the study (as mentioned in the data collection form). English as well as translated Marathi versions were made available to the patients.

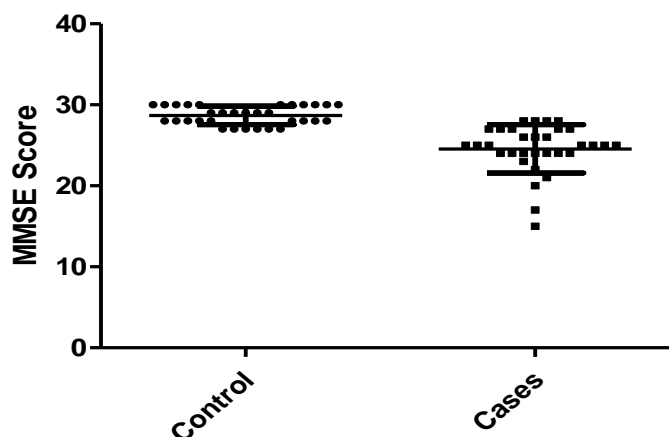
RESULTS

The data collected through MMSE and data collection proforma was analysed with the help of SciPy coding (scientific python) and Microsoft Excel software. Male patients were directly approached in Sassoon general hospital, Pune in Endocrinology OPD. **58.28 ±10.68** and **58.75 ±10.55** were the case and control age group, respectively {**p value= 0.86**}. Most subjects were local residents of Pune rural area. Average fasting blood sugar level and post prandial blood sugar level was **149.55 ± 50.12** and **204.03 ±60.33**, respectively. Mean MMSE score of the subject was **24.56 ±2.99** whereas MMSE score of the control group was **26.68 ± 1.14**. **The difference was statistically highly significant {p value = 7.1E-10}**.

Table I Comparison of MMSE score and age in Cases and Controls

Parameter	Control (N=32) Mean±S.D	Cases (N=32) Mean±S.D	P value
Age	58.28±10.68	58.75±10.55	0.86
MMSE Score	28.69±1.15	24.56±2.99	7.12E-10**

*P< 0.05- statistically significant, **p< 0.001- statistically highly significant



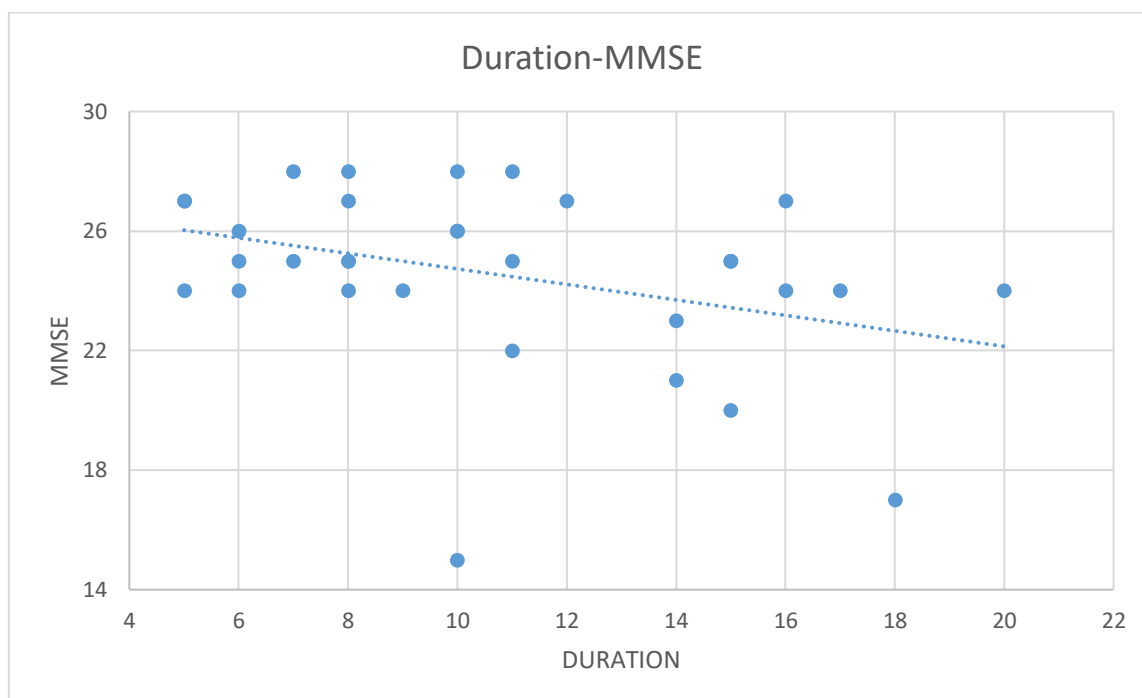
Graph I: Comparison of MMSE score in Cases and Controls

Duration and MMSE score were also compared using **Pearson coefficient test in type 2 diabetic patients.**

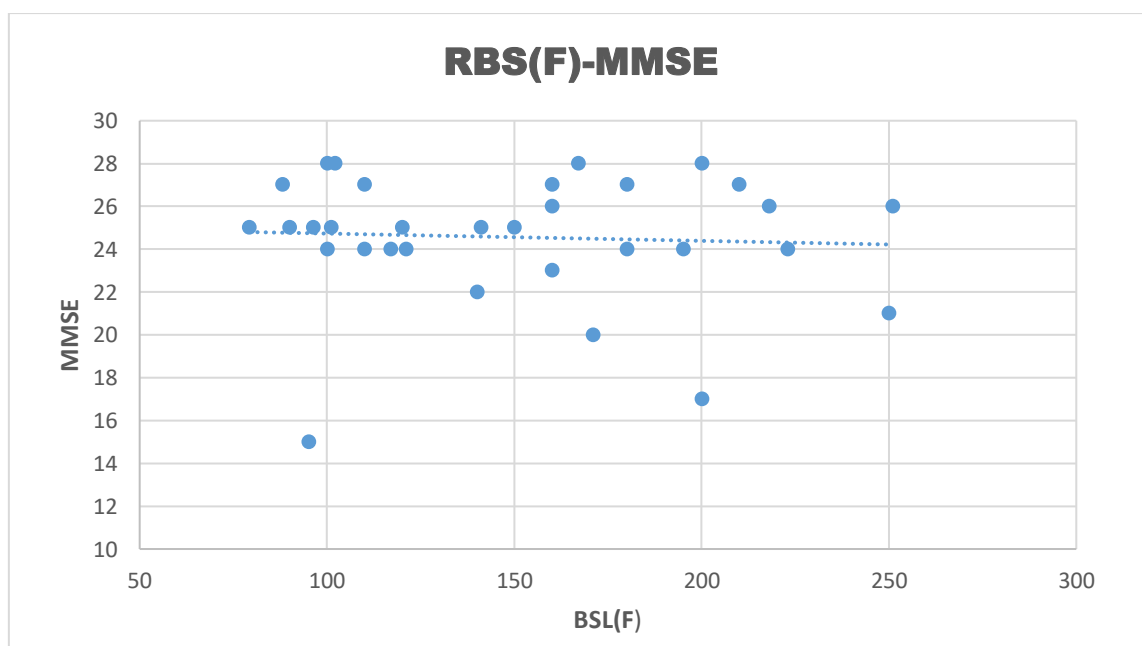
Table II: Correlation between various parameters with MMSE score in Diabetic patients

Variable	Pearson's Correlation Coefficient r	p value
Fasting BSL	Pearson: -0.0569 P-value: 0.7568	p>0.05
Postprandial BSL	Pearson: 0.0409 P-value: 0.8238	p> 0.05
Duration of the disease	Pearson: -0.36367 P-value: 0.0407	p<0.05*

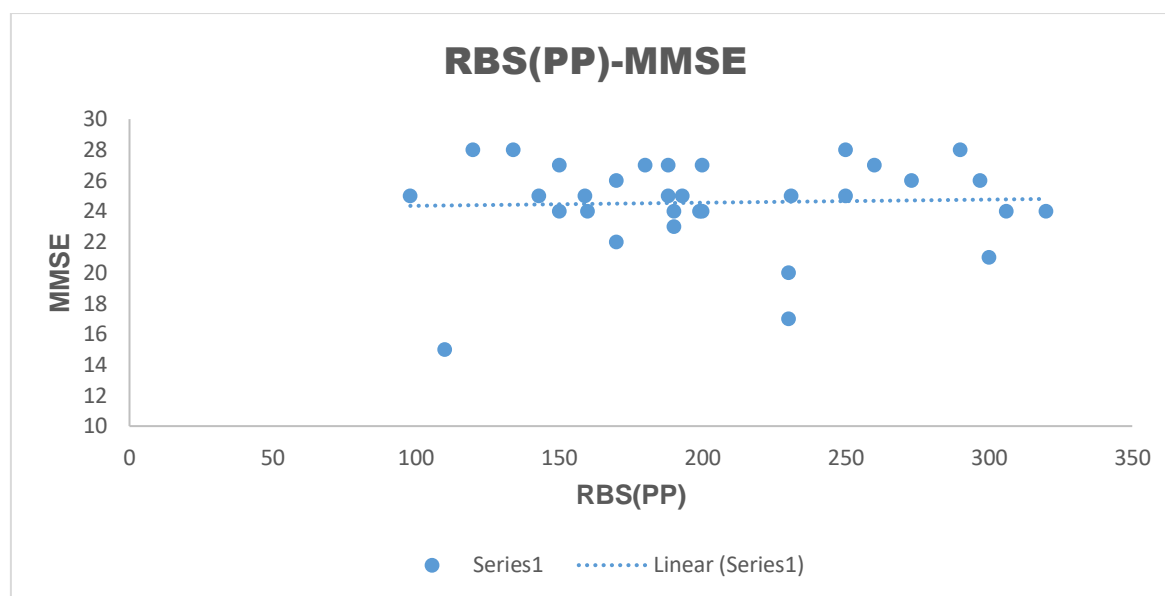
*P< 0.05- statistically significant, **p< 0.001- statistically highly significant



Graph II: MMSE Score correlation with duration of the disease in type 2 diabetic patients.



Graph III: MMSE Score correlation with Blood glucose level (Fasting) in type 2 diabetic patients.



Graph IV: MMSE Score correlation with Blood glucose level (Post Prandial) in type 2 diabetic patients.

DISCUSSION

The study showed that cognitive impairment is not uncommon in TY2DM. There was a high percentage of patients suffering with mild cognitive impairment (MCI) especially patients suffering from TY2DM since 10 years of duration. The same study was conducted with healthy non diabetic control subjects of similar age group, gender and same educational qualifications. In MMSE, 30 is a perfect score. It is recommended that a score of minimum 24 must be maintained. Score less than 23 indicates dementia. Variation in MMSE score due to age and education related aspect is found out to be 12 %⁹. Average MMSE score of case and control group shows a difference of 4.13. T test results of the MMSE score elucidates significant difference between the two groups.

Awareness about MCI associated with this disease will improve the quality of treatment provided to patients. Hence MCI must be factored in as a potential effect of TY2DM. Cognitive impairment might be result of multiple factors such as poor compliance of patients to lifestyle modification, age and education of the patient and pharmacotherapy used to treat the disease.

Co-variance of BSL (Fasting and Post prandial) with MMSE score was found to be not significant in this case. There was a negative correlation found between duration of diabetes and MMSE score, with $p < 0.05$. This means duration of disease is a stronger factor causing impairment of cognitive functions.

Our result might also have some potential limitations. Firstly, Sample size taken may be small and larger cohort could have better elucidated the investigation and relationship between the factors of study. Secondly, sensitivity of MMSE for more cognitive functions like memory, logical confronting and complex attentional deficits etc is poor. Lastly,

including levels of HbA1c as a factor might have elucidated potential relationship with MMSE score.

Pathophysiology

Few important factors found to affecting cognitive impairment are: chronic hyperglycemia induced osmotic insults, oxidative stress, formation of advanced glycation end products (AGEs) and activation of deleterious microglia. The pathophysiology of cognitive impairment in diabetes is yet not very clear. However, the most important mechanism is insulin signaling dysfunction that causes failure of glucose absorption in the neurons which in turn is needed for energy generation.

Insulin resistance refers to a condition where brain tissues do not respond sufficiently to physiological insulin concentration. It is a vital component in bringing forth association between TY2DM and cognitive decline. Long-term consequences of diabetic states include cellular energy failure, increased plasma lipids, and hypertension. One of the most important hypothesis affecting cognitive functions is peripheral insulin resistance.

Suggestion

A promising idea to avoid cognitive decline associated with TY2DM is use of intranasal insulin. It was found that use of intranasal insulin may modify functional connectivity among different regions of brain and complex cognitive behaviours.

Improved visuospatial memory and better perfusion in insular cortex was seen¹⁰ Improvement in cognitive function may be due to vasodilatation in anterior brain regions. Hyperglycemia leads to accumulating AGEs that leads to reactive oxygen species generation and free radical mediated injury. Formation of H₂O₂ and superoxide results in lipid peroxidation and free radical mediated injury to brain tissue¹¹

CONCLUSION

Cognitive impairment in male individuals suffering from TY2DM is common and is strongly associated with the duration of the disease confronted. Hence as the disease progresses, there is higher risk of cognitive impairment. However, no significant difference of cognitive impairment is found between blood glucose fasting and also post prandial blood glucose.

Apart from controlling the blood glucose levels the patients of diabetes should be counselled for keeping their cognition intact by solving puzzles and mathematical calculations. Use of intranasal insulin must be

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