



Study of Cognitive Impairment in Type 2 Diabetes Mellitus

(Original Article)

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ABSTRACT

An observational and cross-sectional study was undertaken. 50 Diabetes Mellitus patients and 50 age and sex matched controls between 40 to 60 years of age in Bharati Hospital and Research Centre, Pune over a period of 2 years. The aim was to study the cognitive impairment in patients of Type 2 Diabetes Mellitus. The objective being to study and assess the association between the type 2 Diabetes Mellitus, the role of comorbidities associated with Type 2 Diabetes Mellitus and the duration of Type 2 Diabetes Mellitus and incidence of cognitive impairment and executive dysfunction.

The study has shown that people suffering from Diabetes Mellitus have statistically increased reaction time and also have decreased executive functions as compared to non Diabetic population. MMSE scores in Diabetics was not statistically significant, hence we can concluded that diabetics do not have moderate to severe cognitive impairment. The duration of Diabetes Mellitus, presence of other comorbidities did not affect cognition in Type 2 Diabetes Mellitus in our study.

Patients suffering from Type 2 Diabetes Mellitus should be regularly screened for cognitive impairment for early detection and prevention of progression of cognitive impairment.

Keywords: Diabetes Mellitus, Cognitive impairment, executive function, comorbidities.

INTRODUCTION

Diabetes Mellitus is a common metabolic disease and is characterised by high blood glucose levels resulting from deficits in insulin secretion (type 1 Diabetes), resistance to insulin accompanied by an inadequate compensation in the secretion of insulin, or both (type 2 Diabetes) ¹. The deleterious effects of Diabetes Mellitus on the

retinal, renal, cardiovascular, and peripheral nervous systems are widely acknowledged. The effect of Diabetes on cognitive function has been given less attention. Both type 1 and type 2 Diabetes Mellitus have been associated with reduced performance on numerous domains of cognitive function. The exact pathophysiology of

cognitive dysfunction in Diabetes is not completely understood.

The various neurocognitive tests used to assess cognitive dysfunction in our study were Folsteins Mini Mental Status Examination (MMSE), Stroop Colour Word test and Modified Stroop shape test.

Very few Indian studies have been done on this topic. L Kataria, et al.² investigated cognitive functioning in 104 type 2 diabetes patients with neurocognitive tests so did Tiwari, et al.³

Although much insightful research has examined cognitive dysfunction in patients with Diabetes, more needs to be understood about the mechanisms and natural history of this complication in order to develop strategies for prevention and treatment.

MATERIALS AND METHODS

An observational and cross-sectional study was undertaken. 50 Diabetes Mellitus patients and 50 age and sex matched controls between 40 to 60 years of age in Bharati Hospital and Research Centre, Pune over a period of 2 years and fulfilling the inclusion criteria were included in the study after taking an informed written consent. Institutional ethical committee's clearance for study was obtained.

Inclusion Criteria for Cases

All the participants either OPD or Indoor who are established Diabetes Mellitus. based on the ADA criteria above age 40yrs below the age of 60yrs and for more than 3 years.

Exclusion Criteria for Cases

Participants having history of stroke, Alzheimer's disease, Fronto Temporal Dementia, cranial tumours, Epilepsy, Traumatic Brain Injury. Patients with known diabetic complications such as Retinopathy, Nephropathy and Peripheral Neuropathy were also excluded.

Inclusion Criteria for Control

All Non-diabetics between 40 to 60 years of age were included in the study.

Exclusion Criteria for Control

Participant below 40 years and above 60 years of age with all the other exclusion criteria for case group study were excluded from the study.

OBSEVATIONS AND RESULTS

Distribution of study groups according to age

In the study, 50 diabetics (case) and 50 non-diabetic (control) subjects in the age bracket of 40 to 60 years were included. The mean age of the case group was 51.6 (+/-5.82) years, whereas the mean age of control group was 52 (+/- 5.96) years.

Distribution of study groups according to gender

In the study, 50 diabetics (case) and 50 non-diabetics (control) who met the inclusion and exclusion criteria were included. In both the study groups 26 males and 24 females were included.

Distribution of case group according to duration of Diabetes Mellitus (DM)

In the study we had included patients having Diabetes for at least 3 years or more. 16% of the diabetic subjects had Diabetes since ≤ 5 (3-5) years, 50% had Diabetes since 5- 10 years and 34% had Diabetes for more than 10 years.

Distribution of case group according to treatment of Diabetes Mellitus (DM)

62% cases were on treatment with oral hypoglycaemic agents, 22% were on treatment with insulin, 16% were on treatment with oral hypoglycaemic agents and insulin.

Distribution of Case Group with respect to Comorbidities.

In the case group 32 subjects had only Diabetes Mellitus, 12 subjects had Diabetes Mellitus(DM) + Hypertension (HTN), 6 subjects had DM + HTN + Atherosclerotic Cardiovascular Disease (ASCVD), no subjects had DM + ASCVD and DM + Chronic Kidney Disease (CKD).

Comparison between Case and Control Group with respect to Folsteins Mini Mental Status Examination (MMSE) Score

MMSE Score for Case Group was 29.22 (+/- 1.314) and Control Group was 29.34 (+/- 0.939).

This was statistically not significant ($p = 0.601$). Thus it could be concluded that MMSE scores are not affected by Diabetes Mellitus in our study. Independent sample T test was used.

Comparison between Case and Control Group with respect to Stroop Colour Word test mean time.

The mean Stroop Colour Word test mean time in seconds for Case Group was 29.22 (± 1.389) and Control Group was 26.98 (± 0.979). This was highly significant statistically ($p = < 0.001$). Thus it could be concluded that Stroop Colour Word test mean time in seconds was affected by Diabetes Mellitus in our study with a higher incidence of errors.

Comparison between Case and Control Group with respect to Modified Stroop Shape Test mean time.

The mean Modified Stroop Shape Test mean time in seconds for Case Group was 54.42 (± 0.810) and Control Group was 53.04 (± 0.755). This was highly significant statistically ($p = < 0.001$). Thus it could be concluded that Modified Stroop Shape Test mean time in seconds affected by Diabetes Mellitus in our study and more number of subjects having higher incidence of errors.

Comparison of Stroop Colour Word test mean time in Case Group with respect to Duration of Diabetes Mellitus.

Mean Stroop Colour Word test mean time in seconds for subjects with duration of Diabetes Mellitus ≤ 5 years was 27.63 (± 0.916), for subjects with duration of Diabetes Mellitus 6-10 years was 29.00 (± 1.225) for subjects with duration of Diabetes Mellitus > 10 years was 30.29 (± 0.849). This was highly significant statistically ($p = < 0.001$). Thus it could be concluded that Stroop Colour Word test mean time in seconds affected by duration of Diabetes Mellitus in our study.

The duration of Diabetes Mellitus increases the incidence of errors in Stroop Colour Word test also increase in case group

The Modified Stroop Shape Test mean time are not affected by presence or absence of Comorbidities .

Correlation between HbA1c, fasting blood and post prandial (2hrs) blood sugar levels and cognitive impairment.

In the present study, no significant correlation was observed between fasting blood sugar levels, post prandial 2 hours blood sugar level and HbA1c and the tests of Cognition carried out.

Table 1. Comparison between Case and Control Group with respect to Folsteins Mini Mental Status Examination(MMSE) Score

Group	MMSE Mean Score	SD	p-value
Case	29.22	1.314	0.601
Control	29.34	0.939	

Table 2. Comparison between Case and Control Group with respect to Stroop Colour Word test mean time.

Group	Stroop Colour Word test mean time in seconds	SD	p-value
Cases	29.22	1.389	< 0.001

Graph 3. Comparison between Case and Control Group with respect to Number of errors in Stroop Colour Word Test.

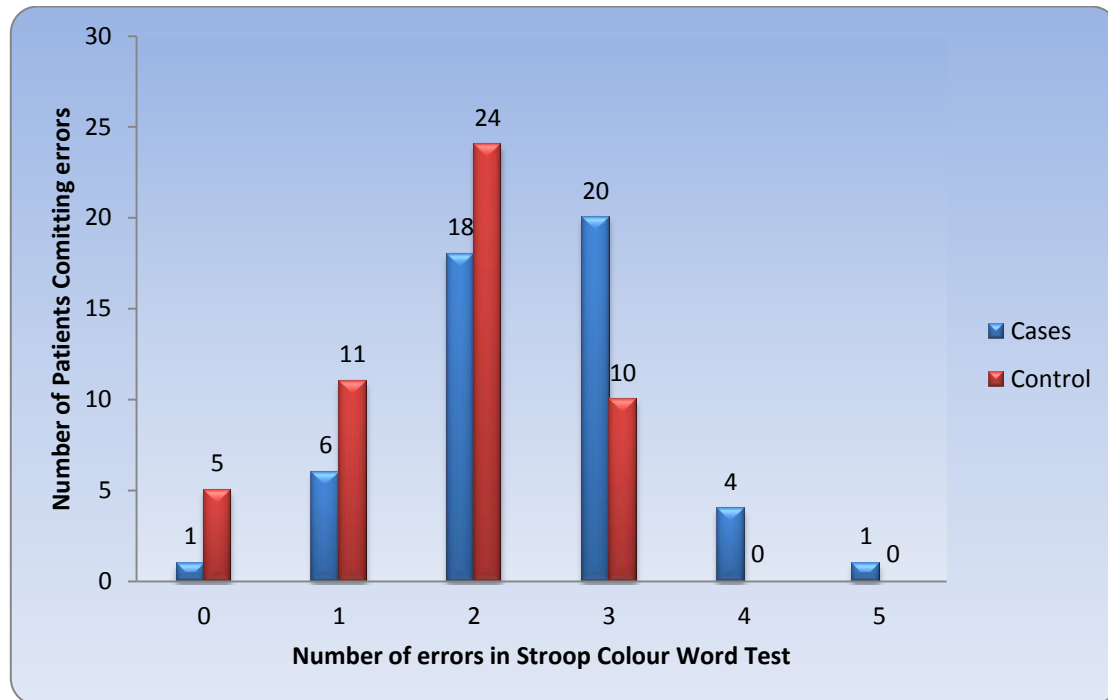
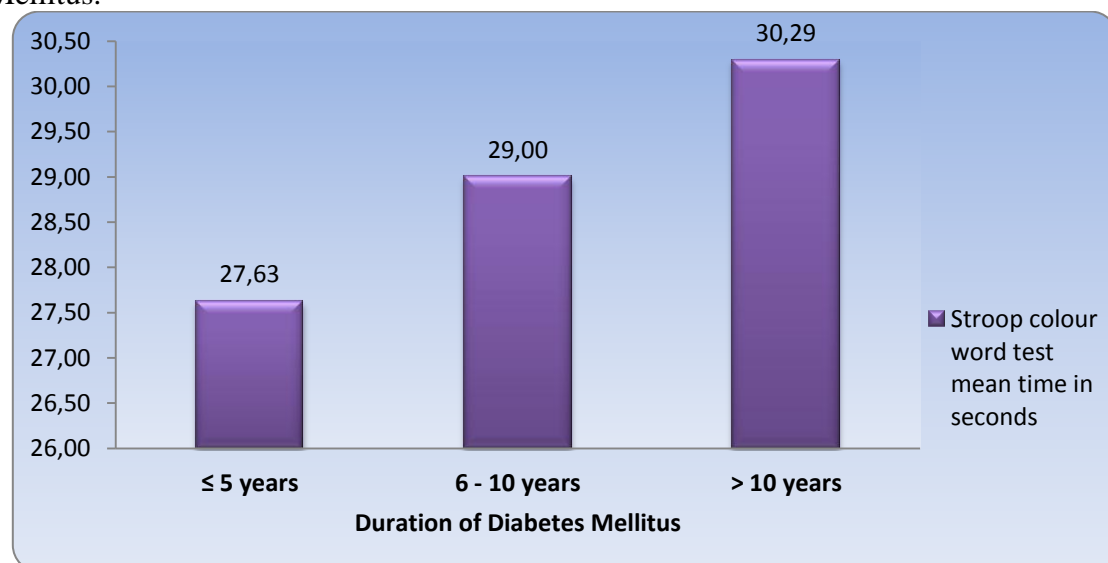


Table 4. Comparison between Case and Control Group with respect to Modified Stroop Shape Test mean time.

Group	Modified Stroop Shape Test mean time in seconds	SD	p-value
Case	54.42	0.810	< 0.001
Control	53.04	0.755	

Graph 5. Comparison of Stroop Colour Word test mean time in Case Group with respect to Duration of Diabetes Mellitus.



DISCUSSION

In the current study, a total of 50 subjects with Type 2 Diabetes Mellitus were studied for Cognitive Impairment and compared with 50 age and gender matched control subjects. 26 patients were male and 24 were female in each group. The mean age of the case group was 51.6 (+/-5.82) years and the mean age of control group was 52 (+/- 5.96) years.

Correlation between presence of diabetes Mellitus and neurocognitive tests

The Stroop Colour Word test time was significantly higher in diabetic cases as compared to the control group ($p < 0.001$). A more number of errors were committed by diabetic cases as compared to the control group. Similarly, the Modified Stroop Shape Test score time was also higher in diabetic cases as compared to controls ($p < 0.001$). As with Stroop Colour Word Test, a more number of errors were committed by diabetic cases as compared to the control group in Modified Stroop Shape Test.

However, there was non-significant correlation between diabetic cases and control for MMSE score time ($p = 0.60$).

Our findings are supported by the results of a study done by Garcia et al on 25 subjects aged 45-65 years⁴. A similar study was conducted by Van Elderen et al⁵ to investigate progression of MRI-assessed manifestations of cerebral degeneration related to cognitive changes. Patients with DM showed increased progression of brain atrophy ($p < 0.01$) after follow-up compared to control subjects. Patients with DM showed increased decline in cognitive performance on Stroop Test ($p = 0.04$) and other neurocognitive tests.

Croxson SC and Jagger C⁶ carried out a study concluded that the difference between known and newly found diabetic subjects might relate to duration of diabetes. In our study we did not find any significant difference in MMSE scores between Diabetics and Non Diabetics.

N S Karan⁷ assessed the cognitive status of diabetics and non diabetics and found a correlation of age, sex, the duration of diabetes

and HbA1C with the cognitive status among the diabetics.

Correlation between duration of DM and cognitive impairment

A significant correlation ($p=0.001$) was found between the Stroop Colour Word Test scores and the stratified duration of diabetes Mellitus (diabetes Mellitus ≤ 5 years, 6-10 years and > 10 years) in case group.

Also, the percentage of subjects committing 3 to 5 errors in the Stroop Colour Word and Stroop Shape Test was higher in subjects with long-standing diabetics (> 10 years) as compared to short duration diabetics (≤ 5 years).

Modified Stroop Shape Test scores also showed a significant positive correlation ($p < 0.001$) with the duration of diabetes Mellitus.

Similarly, the percentage of subjects committing 3 to 5 errors in the study was higher in subjects with long-standing diabetics (> 10 years) as compared to short duration diabetics (≤ 5 years).

However, in the present study a non-significant correlation was observed between the MMSE Test scores and the duration of diabetes Mellitus.

Alencar RC et al⁸ conducted a cross-sectional study on 346 diabetics in a group of type 2 diabetic outpatients. They concluded that patients with type 2 diabetes should be regularly evaluated for their cognitive function, because duration of disease could be associated with decline in cognition. Which were similar findings to our study.

Dey J et al⁹ performed a comprehensive neuropsychological evaluation of relatively young (age < 55 years) NIDDM patients and a group of control subjects. They found there was no significant difference in MMSE scores, compared with control subjects. The above study supports our findings that there is non-significant correlation between the MMSE scores and the duration of diabetes Mellitus.

Correlation between HbA1c, fasting blood and post prandial (2hrs) blood sugar levels and cognitive impairment.

In the present study, no significant correlation was observed between fasting blood sugar levels, post prandial 2 hours blood sugar level and HbA1c and the tests of Cognition carried out.

Our study is supported by a results of a study done by Rouch I et al¹⁰ on 165 subjects.

However, in several studies cited below there was found to be a significant correlation between hyperglycemia, HbA1c and the tests of executive function.

In a study conducted by Macander et al¹¹ Sanz CM et al¹² Solanki RK et al¹³ studied 50 diabetic and 30 control subjects concluded that poor cognitive performance is associated with adiposity and hyperglycemia in healthy middle-aged people. In a study conducted by Gluck ME et al¹⁴ it was observed that impairments in glucose regulation have been associated with poorer performance on tests of executive function and information processing speed. This study is not in accordance with our study findings.

Correlation between comorbidities and cognition tests

In the present study, no significant correlation was found between the presence or absence of comorbidities and the MMSE test score ($p=0.174$) and Modified Stroop Shape Test time. However higher incidence of errors in Modified Stroop Shape test was seen.

Tchistiakova E et al¹⁵ conducted a study to primarily identify brain regions where the combined effects of type 2 diabetes and hypertension on brain health exceed those of hypertension alone. They concluded that Individuals with T2DM and HTN showed decreased CVR and CThk compared to age-matched HTN controls.

Petrova M et al.¹⁶ assessed 113 cases with type 2 diabetes for cognitive impairment (CI) results showed that people with diabetes type 2 and hypertension demonstrate greater cognitive

changes as compared to normotensive diabetic patients.

SUMMARY AND CONCLUSION

This study included a total of 100 subjects between 40 to 60 years of age which included 50 diabetic, for 3 or more years and 50 non-diabetics. Each group had 26 males and 24 females.

MMSE Score for Diabetics was not significant statistically with respect to duration of Diabetes Mellitus, presence of comorbidities other than Diabetes Mellitus, HbA1c levels, Fasting and Post Prandial (2hrs) Blood Sugar levels.

Thus it could be concluded that Stroop Colour Word test mean time in seconds was affected by Diabetes Mellitus in our study with higher incidence of errors in Stroop Colour Word test as duration of diabetes Mellitus increased and also in patients having presence of comorbidities other than Diabetes Mellitus. Modified Stroop Shape Test was highly significant concluding that people suffering from Diabetes Mellitus have increased reaction time and also have decreased executive functions as compared to non Diabetic population. Patients suffering from Type 2 Diabetes Mellitus should be regularly screened for cognitive impairment for early detection and prevention of progression of cognitive impairment.

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