

Original Research Article

Association of duration of type 2 diabetes with short term and working memory

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ABSTRACT

Background: Type 2 diabetes mellitus has deleterious effects on brain resulting in loss of short term memory and working memory in elderly and poorly controlled diabetic patients. Less attention has been given to the effect of diabetes on cognitive functions. Hence, the study was undertaken to study the status of short term and working memory in type 2 diabetes mellitus and to correlate it with the duration of diabetes.

Methods: Study was conducted in Punjab Institute of Medical Sciences, Jalandhar, India, on 100 diabetic patients in the age group of 40-60 years. Short term memory and working memory was assessed using 4 memory tests. AVLT and VFT for short term memory and WDST and VST for working memory. The results expressed in average of total scores. One-way ANOVA followed by post hoc (t) test were used for statistical analysis.

Results: Short term memory and working memory status was negatively correlated with duration of diabetes. Diabetics more than 55 years showed greater cognitive decline compared to younger age group.

Conclusions: The short term and the working memory status decreased significantly in diabetic patients, which may be due to age of onset, duration, vascular dementia, hyperglycemia or hypoglycemia. These effects observed that duration, sex, age and blood glucose levels are of clinical importance as short term and working memory loss could have important practical implications for daily activities.

Keywords: Diabetes, Duration, Hyperglycemia, Hypoglycemia, Short term memory

INTRODUCTION

Diabetes mellitus is a complex metabolic disease that can have devastating effects on multiple organs in the body.¹ The global population of diabetes is expected to rise from 171 million people in 2006 to 366 million in 2030.² Although peripheral and autonomic neuropathy is a common complication of diabetes, one of the debilitating effects of diabetes can be memory loss. Studies have reported a 1.5-2-fold increased risk of dementia in individuals with diabetes compared to those without.³ Type 2 diabetes may result in cognitive impairment mainly in memory, executive function and attention. Esp. in elderly with type 2 diabetes. Memory is most

important cognitive domain and is defined as the recording, retention and retrieval of knowledge.^{4,5} Short term memory temporarily retains stimuli that have just been perceived, lasts for about 20sec. Working memory is a short-term memory system that allows concurrent retention and manipulation of information.⁶

Diabetes induced cognitive impairment may be an adverse outcome of vascular defects, impaired insulin metabolism or defect in glucose transport mechanism in the brain.⁷ Considering that large population of elderly is affected with diabetes mellitus, it can be well expected that there will be significant cognitive impairment in that group both as a result of aging and deleterious effect

diabetes on cognitive functions.⁸ So, this study was being done to study the impairment of short term and working memory with duration of diabetes.

METHODS

One Hundred patients suffering from type 2 diabetes Mellitus between age gap 40-60 years, both from urban and rural population and attending medicine OPD regularly, were volunteers for the study. Patients were divided into three groups according to duration of diabetes- Group A <5 years duration; Group B 5-10 years duration; Group C >10 years duration.

Inclusion criteria

All known patients of Type 2 Diabetes Mellitus attending medicine OPD of Punjab Institute of Medical Sciences, Jalandhar city, Punjab, India.

Exclusion criteria

H/o known psychiatric disorders, other endocrinal disorders, any sedative/narcotic abuse, medical disorders causing dementia or intake of any drugs known to cause dementia, Alzheimer’s and other medical disorder and education level less than 6th standard. Physiological parameters like age, sex, education level, duration of diabetes, pulse, BP, were assessed Biochemical investigation fasting blood sugar, post prandial blood sugar, Glycosylated Hb (HbA1C) were carried out. Four types of short term and working memory test were performed.

Auditory verbal learning test (AVLT)⁹

Assessed short term verbal learning and memory function. 5 trials were given. List of 15 words were read to the subject at the rate of 1 word/sec. Subject was asked to recall word immediately in any order. Total number of words remembered was taken as immediate score.

Verbal fluency test (VFT)¹⁰

Assessed executive frontal lobe function. 5 trials were given, told to enumerate all the animals or fruits subject can remember in 60 secs, less than 17 was abnormal.

Validation span test (VST)¹¹

Subjects were presented with 9 simple arithmetic problems of 2-3 digit, 3 trials of each set size, for 5 secs was given, subject calculated if the sum was correct or not. e.g. 9 (2x2) +3=7 On left side adjacent to problem an isolated word was placed, which the subject remembered. Total score was based on how many of isolated words were remembered correctly.

Working digit span test (WDST)¹²

Subjects were presented with series of 6 lists of digits of a set. Subjects were asked to recall the digits in the same sequence. Failure on two lists of a set, test was stopped. Digit span was maximum length of the lists of which the subject remembered.

RESULTS

AVLT

Refer to Table 1, The mean memory scores of group A diabetic patients was 7.84. Group B patients scored 7.7. The mean memory score of group C memory patients was 6.52.

WDST

Refer to Table 1. The mean memory scores of group A diabetic patients were 4.08 Grp B patients scored 4.00. The mean memory score of group C memory patients was 2.74

VFT

Refer to Table 1. The mean memory scores of group A diabetic patients were 20.57. Group B patients scored 17.18. The mean memory score of group C memory patients was 17.00.

VST

Refer to Table 1. The mean memory scores of group A diabetic patients were 5.35 Group B patients scored 5.2. The mean memory score of group C memory patients was 2.74.

Table 1: Mean, SD and SEM of memory scores of diabetic patients.

Tests	Group 1			Group 2			Group 3		
	M	SD	SE	M	SD	SE	M	SD	SE
AVLT	7.84	1.848	0.259	7.7	0.922	0.197	6.52	1.673	0.322
WDST	4.08	1.129	0.158	4.00	1.192	0.254	2.74	1.023	0.197
VFT	20.57	4.871	0.682	17.18	2.557	0.545	17.18	2.557	0.545
VST	5.35	2.741	0.384	5.59	2.404	0.512	2.74	1.534	0.295

In all the four tests mean memory score decreased with increase in the duration of diabetes.

When the duration of the diabetes was correlated with the scores of the memory tests the following results were found. Refer to the Table 2. A statistically significant correlation was found between the duration of the diabetes and AVLT ($r=-.285$ and $p<0.01$) indicating that as duration of diabetes increased the scores of AVLT were found to be decreased.

TABLE 2: r, t and P values of correlation test for memory tests.

Test	Duration of diabetes	
	r	p-value
AVLT	-.285	<0.01(S)
WDST	-.421	<0.01(S)
VFT	-.542	<0.01(S)
VST	-.383	<0.01(S)

WDST scores were found to decrease with the increase in the duration of diabetes which was statistically significant ($r=0.421$; $p<0.01$) which has negative correlation.

Scores of VFT were found to be negatively correlated with duration of diabetes ($r=0.542$; $p<0.01$).

VST scores were decreased with the increase in the duration of diabetes which was found to be statistically significant ($r=0.383$; $p<0.01$). It was observed that increase in the duration of the diabetes worsened the memory status and it was also observed that all the test showed that status of memory and duration of the diabetes were negatively correlated.

DISCUSSION

Present study showed memory worsened with increase in the duration of diabetes.

Diabetes mellitus duration and severity may be important in the pathogenesis of memory impairment in contrast to late onset diabetes mellitus, short duration diabetes mellitus or well controlled diabetes mellitus may have lesser effect.¹³ This is consistent with findings in which long duration of diabetes mellitus may be associated with greater cerebral microvascular disease, clinical and subclinical infarctions that impair memory.¹⁴

There was negative correlation between duration of diabetes and the memory status, which is similar to the studies by Luchsinger and Strachman.^{15,16} The decrease in memory may be due to microvascular complication, insulin resistance, increased levels of inflammatory cytokines.¹⁷ And also because of poorly controlled diabetes, increased duration of diabetes and early onset of disease.^{16,17} Severe diabetes mellitus is more likely to be associated with chronic hyperglycemia which in turn

increases the likelihood of cerebral microvascular disease and may contribute to neuronal damage, brain atrophy and memory impairment.^{18,19}

Alternate mechanism besides vascular disease may be involved in the pathogenesis of cognitive impairment and that is amyloid beta aggregation.²⁰⁻²²

CONCLUSION

There is a strong evidence that diabetes increases the risk of cognitive impairment, therefore good control of diabetes by lifestyle intervention, anti-diabetic medication, incorporation of regular mental exercise along with physical exercise and monitoring blood sugar level regularly may open a new horizon.

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REFERENCES

1. Kodi CT, Seaquist ER. Cognitive dysfunction and Diabetes Mellitus. *Endocr Rev.* 2008;29(4):494-511.
2. Wild S, Roglic G, Green A, Sicree R, King H. Global prevalence of diabetes: estimates for the year 2000 and projections for 2030. *Diabetes Care.* 2004;27(5):1047-53.
3. Biessels GJ, Staekenborg S, Brunner E, Brayne C, Scheltens P. Risk of dementia in diabetes mellitus: a systemic review. *Lancet Neurology.* 2006;5(1):64-74.
4. Cukierman-Yaffe T, Gerstein HC, Williamson JD, Lazar RM, Lovato L, Miller ME, et al. Relationship between baseline glycemic control and cognitive function in individuals with type 2 diabetes and other cardiovascular risk factors; the action to control cardiovascular risk in diabetes-memory in diabetes (ACCORD-MIND) trial. *Diabetes Care.* 2009;32(2):221-6.
5. Ryan CM, Geckle M. Why is learning and memory dysfunction in Type 2 diabetes limited to older adults? *Diabetes Metab Res Rev.* 2000;16(5):308-15.
6. Bhagoji SB, Patil M, Mirje M, Shivaprasad. Effect of duration of type 2 diabetes on short term and working memory. *Int J Med Pharm Sci.* 2014;4(6):26-30.
7. Naderali EK, Ratcliffe SH, Dale MC. Obesity and Alzheimer's disease: a link between body weight and cognitive function in old age. *Am J Alzheimers Dis Other Dement.* 2009;24(6):445-9.
8. Trushna T, Mohan DS, Nair S, Manjunatha S. A simple screening test with a potential to detect

- diabetic cognitive impairment in the geriatric population: a preliminary study. *Student Medical J.* 2011;3(1):17-21.
9. Rey A. *Clinical examination in psychology.* Paris: Press Universities de France. 2nd ed, Paris;1964.
 10. Borkowski JG, Benton AL, Spreen O. Word fluency and brain damage. *Neuropsychologia.* 1967;5(2):135-40.
 11. Kyllonen PC. Aptitude testing based on information processing: a test of the four sources model. *J General Psychology.* 1993;120:375-405.
 12. Muangpaisan W, Intalaporn S, Assantachai P. Digit span and Verbal fluency in patients with mild cognitive impairment and normal subjects in Thai community. *J Med Assoc Thai.* 2010;93(2):224-30.
 13. 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(8):1066-73.
 14. Longstreth WT, Bernick C, Monalio TA, Bryan N, Jungreis CA, Price TR. Lacunar infarcts defined by magnetic resonance imaging of 3660 elderly people: the cardiovascular Health Study. *Arch Neurol.* 1998;55(9):1217-25.
 15. Luchsinger JA, Reitz C, Patel B, Tang MX, Manly JJ, Mayeux R. Relation of diabetes to mild cognitive impairment. *Arch Neurol.* 2007;64(4):570-5.
 16. Strachan MW, Frier BM, Deary IJ. Type 2 diabetes and cognitive impairment. *Diabet Med.* 2003;20(1):1-2.
 17. Pelia R, Rodriguez BL, Launer LJ. Type 2 diabetes, APOE gene, and the risk for dementia and related pathologies: the Honolulu-Asia Aging Study. *Diabetes.* 2002;51(4):1256-62.
 18. Alencar RC, Cobas RA, Gomes MB. Assessment of cognitive status in patient with type 2 diabetes through a mini mental state examination: a cross sectional study. *Diabetology and Metabolic Syndrome.* 2010;2:10.
 19. Xu W, Qiu C, Gatz M, Pedersen NL, Johansson B, Fratiglioni L. Mid-and late-life diabetes in relation to the risk of dementia. *Diabetes.* 2009;58(1):71-7.
 20. Van Harten B, Oosterman JM, Potter van Loon BJ, Scheltens P, Weinstein HC. Brain lesions on MRI in elderly patients with type 2 diabetes mellitus. *Eur Neurol.* 2007;57(2):70-4.
 21. Den Heijer T, Vermeer SE, Van Dijk EJ, Prins ND, koudstaal PJ, Hofman A, et al. Type 2 diabetes and atrophy of medial temporal lobe structures on brain MRI. *Diabetologia.* 2003;46(12):1604-10.
 22. Qiu WQ, Walsh DM, Ye Z, Vekrellis K, Zhang J, Podlisny MB. Insulin degrading enzyme regulates extracellular levels of amyloid beta protein by degradation. *J Biol Chem.* 1998;273(49):32730-8.

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