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GLUCOSE METABOLISM AND MEMORY FUNCTIONS IN ADULTS WITH TYPE 2 DIABETES MELLITUS

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Abstract
Among studies which say patients with diabetes have lower performance on cognitive tests most of them found deficiencies especially in the memory level. This paper investigates the memory of patients with type 2 diabetes compared to healthy individuals. The study sample consists of 55 (N= 55) adult participants, from which 21 participants had type 2 diabetes and the control group consisting of 34 healthy adults. All participants were assessed with WMS-R psychometric memory test. The results show that the group of healthy adults has a significantly better level of performance in delayed memory and verbal memory than the group of adults with type 2 diabetes. The results also indicate that the group of diabetes with a balanced glycemic control has a significantly better level of performance in verbal memory, in general memory, in delayed memory and visual memory than the group with unbalanced diabetes. Our study concludes that we can notice interdependence between glucose metabolism and cognitive dysfunctions.

Keywords: type 2 diabetes, glycemic control, verbal memory, visual memory, general memory, attention, delayed memory, working memory

1. INTRODUCTION

The brain covers its energy needs using primarily glucose. As a consequence, blood glucose is essential to the survival of the organism. However, when blood sugar rises above the range considered normal, it can be dangerous and diabetes appears.

Patients with diabetes are a high risk group to cognitive disorder thanks to the imbalances occurred in glucose metabolism. The first research which tried to obtain an answer to the association between diabetes and cognitive dysfunction was published in 1922. Miles and Root (1922) found that the performance of people with diabetes is 15-20% lower on tests of memory and attention than those in the control group.

Several studies (Cukierman, Gerstein, Williamson, 2005; Greenwood, 2003; Messier, 2005; Warren, Zammitt, Deary, Frier, 2007) have linked diabetes mellitus with cognitive deficiencies. Among studies which say patients with diabetes have lower performance on cognitive tests most of them found deficiencies especially in the level of memory (Pasquier, 2010).

The study of Kodl and Seaquist (2008) summarizes the results of previous research on cognitive dysfunctions in people with diabetes, the article reviewing the specific literature about the nature of cognitive dysfunctions in diabetics. Type 2 diabetes is associated with the damaging of the following functions: verbal memory, working memory, delayed motor speed, verbal fluency and attention (Kodl and Seaquist, 2008).

The relation between diabetes and cognitive function, however, is not clearly documented. Regarding the issue of memory disorders in patients with diabetes study results are inconsistent, often with a high degree of ambiguity, because of discrepancies between methods of measurement and quantification of memory’s complicated and unknown nature as well as different approaches of studies (Desrocher, Rovet, 2004).

1.1. Objectives

This paper investigates the memory of people with type 2 diabetes compared to healthy people. The study seeks to answer the question whether global cognitive deficiency in diabetics can define some dysfunction of the memory components (verbal memory, visual memory, general memory, attention and concentration, delayed

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memory and working memory) which is characteristic of the group and if possible by analyzing existing disorders can identify differences between people with diabetes and the control group by the quality of glucose metabolism.

2. METHOD AND PROCEDURE

2.1. Participants

The study sample consists of 55 (N = 55) adult participants, homogeneous by age, sex and education. The inclusion criterion was that the participants to be aged between 40 and 55 years and an average education level (high school or college).

The diabetic group consists of 21 type 2 diabetic participants. Characteristics on the formation of type 2 diabetes sample are described in Table 1. Patients will be divided into two subgroups according to glycemic control. The selection criterion was the level of glycosylated hemoglobin (HbA1c), classified as: 10 adults with balanced diabetes mellitus (good glycemic control, HbA1c <7%) and 11 adults with unbalanced diabetes mellitus (inadequate glycemic control, HbA1c >7%).

Table 1. Sample with type 2 diabetes

<table>
<thead>
<tr>
<th>n</th>
<th>Age/ years</th>
<th>Sex %</th>
<th>Education/ years</th>
<th>Length of disease/ years</th>
<th>HbA1c</th>
<th>Related diseases %</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M</td>
<td>SD</td>
<td>Male</td>
<td>Female</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total sample DM type 2</td>
<td>21</td>
<td>47.66</td>
<td>5.76</td>
<td>47.6</td>
<td>52.4</td>
<td>10.95</td>
</tr>
<tr>
<td>DM type 2/ balanced glycemic control</td>
<td>10</td>
<td>49.2</td>
<td>5.94</td>
<td>70</td>
<td>30</td>
<td>11.60</td>
</tr>
<tr>
<td>DM type 2/ unbalanced glycemic control</td>
<td>11</td>
<td>46.27</td>
<td>5.49</td>
<td>27.3</td>
<td>72.7</td>
<td>10.36</td>
</tr>
</tbody>
</table>

The control group consists of 34 healthy adults. Features referring to the establishment of the control sample are described in Table 2.

Table 2. Control sample composition

<table>
<thead>
<tr>
<th>n</th>
<th>Age/years</th>
<th>Sex %</th>
<th>Education/years</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M</td>
<td>SD</td>
<td>Male</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total control sample</td>
<td>34</td>
<td>46.58</td>
<td>4.56</td>
</tr>
</tbody>
</table>

The selection criteria were the lack of chronic diseases and good health.

2.2. Instruments

From general practitioners’ offices, with the patient’s consent, data was collected from medical records of the patients with diabetes on the last value of glycosylated hemoglobin (HbA1c). All participants were assessed with a psychometric test memory WMS-R (Wechsler Memory Scale – Revised) (verbal memory, general memory, delayed memory, visual memory, working memory) (Wechsler, 1987).

2.3. Data processing

Data collection was followed by their introduction into the database. Statistical data processing was performed using SPSS (Statistical Package for the Social Sciences) version 20.0.
3. RESULTS

3.1. The combination of the memory performance of glycemic control, the length of the disease in type 2 diabetic group

The primary analysis of the sample of type 2 diabetes revealed several trends of association between memory components, glycemic control and disease duration.

For a more detailed analysis of the association of these two variables and to obtain more accurate data, linear regression was calculated for each variable memory where initial results have shown significant associations with glycemic control and disease duration.

We found that the diabetes duration was not predictive on the cognitive dysfunctions.

The regression analysis have shown that glycemic control was a significant negative predictor of verbal memory ($\beta = -.861$, $p = .00$) explaining 74% of its variance ($R^2 = .740$, $F(1,19) = 54.21$, $p = .00$), of general memory ($\beta = -.848$, $p = .00$, ) explaining 72% of its variance ($R^2 = .719$, $F(1,19) = 48.57$, $p = .00$), delayed memory ($\beta = -.739$, $p = .00$), explaining 55 % of its variance ($R^2 = .546$, $F(1,19) = 22.82$, $p = .00$) and significant negative predictor of visual memory ($\beta = -.730$, $p = .00$), explaining 53 % of its variance ($R^2 = .533$, $F(1,19) = 21.69$, $p = .00$).

3.2. Differences between the group of adults with type 2 diabetes and healthy adults group in the memory components

The results show that the group of healthy adults has a significantly better level of performance in delayed memory ($t (50.19) = -9.339$, $p = .00$) and verbal memory ($t (39.05) = - 3.156$, $p = .003$) than the group of adults with type 2 diabetes, meaning that type 2 diabetes affects this cognitive functions. Among other memory components measured in attention and concentration, visual memory and in general memory we did not find significant differences between the two groups, nor the working memory, the results suggest that damage to these cognitive functions type 2 diabetes do not play an important role.

3.3. Differences between patients with type 2 diabetes by glycemic control on the memory components

The results show that the group of diabetes with a balanced glycemic control has a significantly better level of performance in verbal memory ($t (15.98) = 8.715$, $p = .00$), in general memory ($t (18.89) = 7.220$, $p = .00$) in delayed memory ($t (16.61) = 4.760$, $p = .00$) and visual memory ($t (15.43) = 4.208$, $p = .00$) than the control group balance. Among measured memory components, in attention and concentration we did not find significant differences between the two groups, nor in the working memory.

4. DISCUSSIONS AND CONCLUSIONS OF THE STUDY

Diabetes has repeatedly been associated with a wide variety of cognitive deficits, compared to non-diabetic control subjects. However, the neuropsychological results of different studies are heterogeneous in terms of affected cognitive domains and the severity of damage. As a result, the exact pattern and the magnitude of cognitive dysfunction are still unclear.

In both types of diabetes we can notice an interdependence between glucose metabolism and cognitive dysfunctions, a direct link existing between the increased values of hemoglobin glycolysis (HbA1c) and low performance on cognitive tests (Kodl, Seaquist, 2008).

We found that the diabetes duration was not predictive on the cognitive dysfunctions.

Our study concludes that a good glycemic control in patients with diabetes has little impact on cognitive functions. Our analyses showed that in the group with type 2 diabetes the glycemic control was a significant negative predictor of delayed memory, verbal memory, general memory and visual memory.

Our results suggest that we can specify the interdependence between glucose metabolism and cognitive dysfunction. The type 2 diabetes group with a balanced glycemic control has significantly better performance levels in almost all components measured memory than the group with the unbalanced control. Therefore, recent researches distinguish among both types of diabetes mellitus, between an ordered and a disordered metabolism of glucose.
Most studies (Naguib, Kulinskaya, Lomax, Garralda, 2009; Christmana, Vannorsdallb, Pearlsonc, Hill-Briggse, Schretlenb, 2010) reported the negative impact of diabetes on cognitive abilities related to healthy individuals. Our results highlight the results of previous studies, according to which cognitive impairment is manifested in the constant verbal memory (van den Berg, Reijmer, de Bresser, Kessels, Kappelle, Biessels, 2010; Bruelh, Wolf, Sweat, Tirs, Richardson, Convit, 2009) and delayed memory (Sommerfield, Deary, McAulay, Frier, 2003; Kodl, Seaquist, 2008).

Our results also show that some cognitive functions are not affected by sugar imbalances such as visual memory, general memory, working memory and attention, being in agreement with some previous studies (Scott, Kritz-Silverstein, Barrett-Connor, Wiederholt, 1998; Gold, Dziobek, Sweat, Tirs, Rogers, Bruelh, Tsui, Richardson, Javier, Convit, 2007).

The results of the current study support the hypothesis that there is a relationship between cognitive dysfunction and diabetes, but the reason of this association is not absolutely clear, this assumption needs further research. The main open questions that remain are the role of the different disease variables, such as the development of micro vascular complications, and the possible influence of comorbid conditions.

5.REFERENCES


