Effect of Alcohol on Blood Glucose Levels in Streptozotocin Induced Diabetic Rats

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Abstract: Diabetes mellitus is one of the most common chronic diseases in the United States, affecting 7.8% of adults 20 years of age or older. The aim of present study was to measurement of blood glucose levels in Streptozotocin induced diabetic rats. Forty healthy male Wistar rats (about 220±10 g body weight) were purchased from Animal House, Islamic Azad University. Diabetes was induced by intravenous injection of streptozotocin (Sigma, St. Louis, Mo, USA) into the tail vein at a dose of 65 mg/kg body weight. Blood glucose was measured and after that alcohol at the dose of 3 ml/kg was gavaged once a day for 8 weeks. After 8 weeks, blood glucose level of rats was measured. Results showed that mild consumption of alcohol yields to decrease the blood glucose level significantly.

Key words: Alcohol • Blood Glucose • STZ • Diabetes • Rats

INTRODUCTION

Diabetes mellitus is a common condition affecting an estimated 180 million people worldwide, a figure that is set to double by 2030 making diabetes a condition of epidemic proportions [1-3]. It occurs when the pancreas does not produce enough insulin or the body cannot use insulin effectively [3]. Insulin is the hormone released by the pancreas that enables the body to metabolise glucose from food to energy and to return the blood glucose levels to normal after food [4]. A normal blood glucose level (normoglycaemia) is between 3.5 and 6.0 mmol/L [1, 5], however when there are insufficient amounts of insulin released or the insulin released does not function correctly blood glucose levels can rise, causing health complications [4].

Diabetes mellitus can be classified into 5 sub-groups [3], as outlined below:

- Insulin-dependent diabetes mellitus (also known as type-1 diabetes)
- Non-insulin-dependent diabetes mellitus (also known as type-2 diabetes)
- Malnutrition-related diabetes mellitus
- Other specified diabetes mellitus (including Gestational diabetes)
- Unspecified diabetes mellitus

This review aims to discuss how alcohol affects people with diabetes mellitus, focusing particularly on studies using adolescent to adult participants. It will discuss the two principal forms of diabetes mellitus, type-1 diabetes mellitus (T1DM) and type-2 diabetes mellitus (T2DM).

Absorption of alcohol occurs in the stomach and small intestine, metabolism occurs in the liver [6]. It is associated with hypertension, stroke, coronary heart disease, liver disease, various cancers, mental health problems and impotence [7, 8]. In addition to these long-term health problems, excessive alcohol use can lead to poisoning and risks associated with being intoxicated. The Department of Health report that half of all violent...
crime is alcohol related and seventy per cent of Accident and Emergency admissions between midnight and 5am are alcohol related [8]. Alcohol-related problems cost the UK an estimated £20 billion a year, highlighting the need for publicised health promotion strategies. However, alcohol consumption is not wholly negative. A small amount of alcohol two to three times per week may reduce the risk of heart disease.

The aim of present study was to measurement of blood glucose levels in Streptozotocin induced diabetic rats.

**MATERIALS AND METHODS**

**Chemicals:** Streptozotocin was from Sigma-aldrich (St. Louis, MO, USA). All chemicals used in this study were of analytical grade and were obtained from Nanjing Jiancheng Bioengineering Institute, Nanjing, China.

**Induction of Diabetes Mellitus:** Diabetes was induced by intravenous injection of streptozotocin into the tail vein at a dose of 65 mg/kg body weight. STZ was extemporaneously dissolved in 0.1 M cold sodium citrate buffer, pH 4.5. After 18 h, animals with fasting blood glucose levels greater than 120 to 250 mg/dl were considered diabetic and then included in this study [9].

**Fasting blood glucose was estimated by using one touch glucometer (Accu-check sensor of Roche Diagnostics, Germany).**

**Subjects:** The selected subjects (diabetic Rats) were medically examined and given code numbers. Forty healthy male Wistar rats (about 220±10 g body weight) were purchased from Animal House, Islamic Azad University. All animals were conditioned at room temperature at a natural photoperiod for 1 week before experiment execution. A commercial balanced diet and tap water ad libitum were provided. The duration of experiment was 8 weeks. In first day, after 12 hour fasting, blood glucose of Rats was measured then after above mentioned stage, alcohol at the dose of 3 ml/kg was gavaged once a day for 8 weeks. After 8 weeks, blood glucose level of rats was measured.

**Blood Sample:** Blood samples (3-5 ml) were drawn from each patient and control subject by vein puncture through plastic disposable syringes. The blood samples were collected in clean oven dried glass bottles which were previously rinsed with 1% sodium fluoride, 3% potassium oxalate solution to prevent coagulation and glycolysis. The plasma was separated after centrifugation. Any sample showing haemolysis was discarded. After separation of plasma, it was transferred to clean, previously acid rinsed, washed and oven dried glass bottles with plastic caps. The plasma glucose estimation was done immediately on the same day by kit method [10].

**RESULTS**

The results are showed in the Table 1. Based on data showed in the Table 1 it has been revealed that mild consumption of alcohol yields to decrease the blood glucose level significantly.

<table>
<thead>
<tr>
<th>Rats</th>
<th>Mean value of blood glucose (mg/dl) before consumption of alcohol</th>
<th>Mean value of blood glucose (mg/dl) after consumption of alcohol</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>201.4±7.86</td>
<td>130.5±6.54</td>
</tr>
<tr>
<td>2</td>
<td>200.6±6.87</td>
<td>132.6±6.80</td>
</tr>
<tr>
<td>3</td>
<td>199.7±6.08</td>
<td>140.8±7.60</td>
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<tr>
<td>4</td>
<td>202.3±7.09</td>
<td>130.9±7.08</td>
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<tr>
<td>5</td>
<td>190.7±7.25</td>
<td>141.2±7.92</td>
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<td>6</td>
<td>201.2±6.98</td>
<td>140.6±6.09</td>
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<tr>
<td>7</td>
<td>198.6±6.80</td>
<td>139.9±6.10</td>
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<tr>
<td>8</td>
<td>199.4±7.34</td>
<td>143.6±7.65</td>
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<tr>
<td>9</td>
<td>201.8±7.40</td>
<td>140.2±7.34</td>
</tr>
<tr>
<td>10</td>
<td>204.3±7.61</td>
<td>138.8±7.23</td>
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<td>199.5±7.01</td>
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<td>13</td>
<td>203.5±8.03</td>
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<td>14</td>
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<td>151.3±6.87</td>
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<td>15</td>
<td>193.9±6.62</td>
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</tr>
<tr>
<td>20</td>
<td>202.6±8.06</td>
<td>150.2±7.63</td>
</tr>
</tbody>
</table>
DISCUSSION AND CONCLUSION

Alloxan acts as a cytotoxin for beta-cells of the islet of Langerhans, causes diabetes by inducing cell necrosis [11, 12]. The Reactive Oxygen Species mediates the cytotoxic action with the increase in cytosolic calcium concentration, leading to rapid beta-cells destruction [13]. Diabetes mellitus is a group of metabolic diseases characterized by hyperglycemia, altered metabolism of lipids, carbohydrates and protein and increased risk of complication from various diseases [14, 15].

The literatures have been suggested that alcohol affects glycaemia by: (i) inhibiting gluconeogenesis; (ii) altering carbohydrate absorption; and (iii) by suppressing GH.

Inhibition of Gluconeogenesis: Have found that both morning and post-meal blood glucose levels were lower following moderate alcohol consumption due to the inhibition of gluconeogenesis, as this is responsible for a significant proportion of glucose output in people with diabetes [22]. It was thought that alcohol causes hypoglycaemia by inhibiting gluconeogenesis as a result of its metabolism and is metabolised by alcohol dehydrogenase to acetaldehyde and then to acetate by aldehyde dehydrogenase, which depletes hepatic levels of nicotinamide adenine dinucleotide, a critical factor in the gluconeogenetic pathway [7, 16]. Hepatic gluconeogenesis is decreased by up to 45% following the consumption of alcohol [17, 18].

Altered Carbohydrate Absorption: Have discussed the possibility of altered carbohydrate absorption as a result of alcohol, stating that alcohol accelerates the rate of carbohydrate absorption in the human small intestine [17]. Conversely, other studies found that alcohol absorption was significantly slowed following a solid meal, particularly containing carbohydrate [19, 20]. Has advised carbohydrate containing meal or snack prior to alcohol consumption prevent hypoglycaemia [21], in spite of there being conflicting evidence surrounding this.

Suppression of Growth Hormone: In addition to the finding that alcohol consumption leads to lower blood glucose levels the following morning, have found that GH levels appeared to be lower during sleep after alcohol consumption [22]. Although this was not statistically significant (P=0.15), it may be clinically significant due to the role of GH in the hypoglycaemic pathway, particularly in light of the reduced rate of gluconeogenesis, which would lessen hypoglycaemia recovery following alcohol. Acute hypoglycaemia stimulates the secretion of GH as it acts to limit utilisation of glucose and results in raised blood glucose levels [16, 23]. GH and other counter regulatory hormones will be discussed further in the section on impaired hormonal response.

Have concluded that: “In type I diabetes moderate consumption of alcohol in the evening may predispose patients to hypoglycaemia after breakfast the next morning.” Following breakfast at 8am, five of the six participants had symptomatic hypoglycaemia requiring treatment between 10am and midday, with a range of 1.9–2.9mmol/L [22].

Have concluded that both alcohol and hypoglycaemia have a marked effect on cognitive ability individually, more so when experienced together [24]. The study tested reaction time, trail making, digit symbol substitution, visual change detection, hazard perception and hypoglycaemia symptom scores. Hypoglycaemia and alcohol combined significantly impeded the ability of participants to perform well in these tests. The final test, a driving-related hazard perception test, was unaffected by alcohol, hypoglycaemia or both combined.

Also they have assessed participants according to hypoglycaemic symptoms. Both autonomic symptoms (palpitations, sweating, shaking and hunger) and neuroglycopenic symptoms (confusion, drowsiness, odd behaviour, speech difficulty and incoordination) increased significantly when alcohol and hypoglycaemia were experienced together. Alcohol reduced the ability of the subjects to recognise hypoglycaemia when it occurred; two of the 17 participants reported hypoglycaemic symptoms when blood glucose was normal after having consumed alcohol.

Have concluded that: “A moderate amount of alcohol with an evening meal was associated with an increased risk of delayed hypoglycaemia” [25]. After an alcoholic drink participants were twice as likely to report hypoglycaemic symptoms. The mean number of participants reporting symptoms of hypoglycaemia with consumption of alcohol was 1.3, compared with 0.6 from the control group (P=0.02). Those who had consumed alcohol had an average interstitial blood glucose level 1.2mmol/L lower than that of the control group (P=0.02). While this varied in magnitude and time during the 24-hour study period, the prevailing blood glucose led to an increased risk of hypoglycaemia during the study period and through the next day.
REFERENCES


