EFFECT OF 0.5% GLUCOSE INTAKE ON THE TEAR PRODUCTION OF NORMOGLYCEMIC EMMETROPIC NIGERIANS

BY

TIMOTHY, C. O

DEPARTMENT OF OPTOMETRY, FACULTY OF HEALTH SCIENCES,
ABIA STATE UNIVERSITY, UTURU,
ABIA STATE NIGERIA.

ABSTRACT

Glucose, the primary source of energy for body's cell metabolism is used up by the body via the activities of insulin that breaks down the glucose into glycogens which is stored up in cells. 0.5% glucose was administered to 50 normoglycemic subjects without fundal or vascular pathology of both sexes with a mean age of 22.27±2.70 years, to determine its effect on tear production. The induced effects were checked at 30mins interval till the values approximated the normal. The result showed a slight decrease in tear production after 30mins (-1.74mm representing 6.5%). Further decrease was noticed at 60mins -5.32mm (19.78%) and peak decrease was observed at 90mins (-7.66mm representing 28.4 8%. It slowly increased towards baseline at 120mins (-5.82mm representing 21.64%), and 150mins (-3.92mm, representing14.57%). This effect was significant (p>0.05) using Z-test statistical analysis. The reduction was observed to be more significant in females than in males probably due to hormonal differences. Exhaustive case history is advocated on patients who report for eye care immediately after feeding on heavy carbohydrate diet at least for the first 90mins as this may reduce tear production leading to apparent dry eye in order to guard against misdiagnosis.

KEYWORDS: *Glucose, hyperglycemia, fasting blood sugar, tear production, dry eye syndrome.*

INTRODUCTION

Glucose is one of the most abundant organic compounds in nature. All major dietary carbohydrates contain glucose, either as their building blocks, as in starch and glycogen, or together with another monosaccharide, as in sucrose and lactose. It is also a major constituent of many oligosaccharides notably sucrose and of many glycosides[1].

Naturally, glucose can be found in ripe fruits, nectar of flowers, leaves, sap, blood, milk of mammals and as glycogen in the liver and muscles. It is found in its refined sources like baked food, beverages, sweeteners, juice (canned), oral drugs (glucose supplements) intravenous fluids and antibodies[2].

In the human body, glucose has three major fates; it may be stored (as a polysaccharide or as sucrose), oxidized to a three-carbon compound (pyruvate) via glycolysis or oxidized to pentoses via the pentose phosphate (phosphogluconate) pathway[3]. The principal role of glucose is as a fuel to yield energy carried by ATP. Some cells including red blood cells and cells in the brain, central nervous system (CNS) and muscles rely on glucose for energy. The blood glucose level in a typical person after an overnight fast is between 80-100mg/ml, after meals, a normal evaluation between 120-130mg/ml is expected. This is the so called fasting blood glucose level[4].

The tear film is composed of 3 layers, with the aqueous layer secreted by the lacrimal gland, forming the bulk of its volume. Both cholinergic and adrenergic fibers innervate the lacrimal gland; however, unstimulated tearing is controlled by the parasympathetic nervous system[5]. The lacrimal function is also influenced by other factors like age, menopause, certain drugs and pathologic conditions[6]. The rate of production should equal the rate of drainage; otherwise, the patient will have problems. The normal rate of tear production is taken to be 10mm and above in 5minutes. Five millimeters and below was considered deficiently abnormal and above 30mm wetting was considered excessive[7].

Since glucose enters the blood stream by absorption from the small intestine with the principal role of energy generation, the purpose of this study is therefore to find the effect of glucose intake on tear production.

MATERIALS AND METHOD

Potential participants for the study were recruited from young under graduates of Abia State

University, Uturu. The research subjects were of both sexes, with mean age of 22.27±2.70 years. Informed verbal consent were sought and obtained after detailed explanation of objectives and procedures of the research were given to them.

Subjects whose case history and examination were found to have the following conditions were excluded from the study. Those conditions included refractive errors of any kind, those with ocular disease(s) requiring treatment, subjects with high blood glucose levels (>140mg/dl) and low glucose levels (≤ 60mg/dl), also, those found to be diabetic or had nuclear family history of diabetes and currently on any systemic medication.

The One Tough Basic Blood Glucose Monitoring System certified and manufactured by LIFE SCAN (Johnson and Johnson Company) was used to determine their blood glucose levels. Only subjects that had blood glucose levels within 70-120mg/dl were used. These selection criteria were aimed at eliminating the factors that may invalidate the results. Fifty (50) healthy volunteers met the criteria for inclusion in the study.

The subjects served as their own control as their baseline values were obtained before administration of the glucose solution. Their weight were measured using the weighing scale and using the one touch Monitoring system, their fasting blood levels were obtained (following an overnight 8-10hrs fast).

The actual measurement of the tear production was done using the Schirmer tear strip test. The strips were folded 5mm from one end and inserted at the junction of the middle outer third of the lower lid. The subject was asked to keep the eyes open and to blink as necessary, after 5mins, the strip was removed and the amount of wetting measured. This was observed and recorded as the baseline measurement of the tear production of the respective subjects. After the intake of 0.5% glucose solution, the tear production levels were reassessed at 30mins, 60mins, 90mins, 120mins and 150mins. This time duration was used because previous studies have shown that between 20-30mins after intake, glucose will be completely absorbed and glucose level returns to normal within 120-180mins[4]. The data collected were analyzed statistically using Z-test at 0.05 level of significance.

RESULTS

There was a slight decrease in tear production between 30mins (6.47%) and 60mins (19.78%) post intake of 0.5% glucose solution with a peak decrease at 90mins (28.48%) and a gradual increase of tear production towards baseline between 120 and 150mins respectively (table 1).

It was observed that both males (table 2) and females (table 3) subjects showed a slight reduction in tear production after 30mins and 60mins of 0.5% glucose intake. The decrease however reached its peak at 90mins with a percentage decrease of 22.72% for the male subjects and 32.81% for the females and gradually returned to baseline at 150mins post intake.

DISCUSSION

The study showed that intake of 0.5% glucose solution caused decrease in tear production at 30mins interval, with peak decrease at 90mins and gradually increased approximating baseline value of 26.90mm at 150mins post intake (table 1). The peak decrease in tear production at 90mins post intake was statistically significant (P>0.05) at 0.05 level of significance using Z-test. According to Wolfe[4], induced hyperglycemic period in an individual goes back to its normal or baseline value of the individual between 1-2 hrs. This probably accounts for the decrease in tear production among the subjects used between 30 and 90mins post 0.5% glucose solution intake. At the cessation of the hyperglycemic condition, the tear production returned towards its baseline value which resulted in the increase in mean induced tear production between 120 and 150mins after intake. Within this time range insulin (a hormone regulating high plasma glucose level) is needed for the transport of glucose to the liver and adipose tissues with a subsequent breakdown of glucose which is carried into the blood stream and used as source of energy[8].

Kaiserman et al[9] reported that after ingestion of a heavy carbohydrate meal, within the first 90mins, there is an increase in renal threshold. The ingested glucose absorbs water for its metabolism from cells causing an increase in body fluid loss. This subsequently results in the decrease in tear production from the lacrimal and accessory glands. Pang et al[10] reported that in high blood glucose level, water is osmotically drawn out of cells into the blood resulting in concomitant loss of water through frequent urination and increase in blood osmolarity. Subsequently, this loss of water also affected the secretory fluid of the tear film, causing

a reduction in the water supplied to it through aquaporins and this accounted for the reduction in tear production of the subjects used in this research.

The reduction in the tear production of females than in males was found to be statistically significant (P>0.05) using Z-test and could be attributed to the action of sex steroid hormones. According to Sullivan et al[11], a link had been found between androgen and dry eye. The sex hormone (androgen) helps to regulate homeostasis of the tear secretion process. He also observed that women show an increase in incidence of dry eye due to suppression of endogenous androgen by increased estrogen levels. Therefore, this reduced tear secretion in females is attributed to the influence of more estrogen hormone and less androgen hormone.

Exhaustive case history is recommended for patients who report for eye care immediately after feeding on heavy carbohydrate diet at least for the first 90mins as this may reduce tear secretion leading to apparent dry eye to guard against misdiagnosis.

REFERENCES

1. McGraw Hill Encyclopedia of Science and Technology (2002): 9th Edn. pp162 - 617
2. Bird, D. (2000): Concise approach to nutrition. 2nd Edn. Ballack Company, pp11-12.
3. Davies, L. N. and Cox, M. M. (2000): Lehninger Principles of Biochemistry. 3rd Edn. Worth Publishing Co, New York, USA, vol. 9, pp293-592.
4. Wolfe, L. A. (2000): Carbohydrate metabolism and blood sugar monitoring. Handbook on Diabetes, vol. 11, pp7-10.
5. Jannus, S. D. and Bartlett, J.D. (2001): Adverse Ocular effects of systematic drug therapy. In: Bartlett J.D. and Jannus S.D. Clinical Ocular Pharmacology. 4th Edn. Butterworth Heineman, pp917 - 39.
6. Amaechi, O.U. and Savia, J. (2005): The effect of Caffeine on tear production. J. Nig. Optom. Assoc, 12:22-30.
7. Milder, B. (1987): Adler's Physiology of the eye: Clinical application-the lacrimal apparatus. 8thEdn. The C.V. Mosby Company, pp15-34.
8. Kaiserman, I., Kaiserman, N., Nakar S. F. and Vinker, S. (2005): Dry eye in diabetic patient. Am. J. Ophthalmol. 139 (3): 498-503.
10. Pang, G. X., Li, N.Y and XU, Z. Z. (2004): Tear Film Function of patients with type 2 diabetes. Zhongguo YI Xue Ke Xue Yua Xue Bao, 26 (6): 682 - 6.
11. Sullivan, D. A. and Schuamber, D. A. (2002): Topical Androgen Administration-an effective therapy for the treatment of Dry-Eye Syndrome. Rev. Ophthamol, 9(3):130-41.

TABLE 1: BASELINE AND INDUCED TEAR PRODUCTION AFTER INTAKE OF 0.5% GLUCOSE SOLUTION. (MEAN BASELINE = 26.90MM)

Post Intake Time (Min)	Mean Induced Tear Production(mm)	Induced change (mm)	Percentage change (%)
30	25.16±1.23	-1.74	6.47
60	21.58±3.76	-5.32	19.78
90	19.24±5.42	-7.66	28.48
120	21.08±4.12	-5.82	21.64
150	22.98±2.77	-3.92	14.57

TABLE 2: BASELINE AND INDUCED TEAR PRODUCTION OF MALE SUBJECTS AFTER INTAKE OF 0.5% GLUCOSE SOLUTION

Post Intake Time (Min)	Mean Induced Tear Production(mm)	Induced change (mm)	Percentage change (%)
30	24.35±0.52	-0.74	2.95
60	21.00±2.89	-4.09	16.30
90	19.39±1.20	-5.70	22.72
120	20.78±3.05	-4.31	17.18
150	21.78±2.34	-3.31	13.19

TABLE 3: BASELINE AND INDUCED TEAR PRODUCTION OF FEMALE SUBJECTS AFTER INTAKE OF 0.5% GLUCOSE SOLUTION. (MEAN BASELINE = 28.44MM)

Post Intake Time (Min)	Mean Induced Tear Production(mm)	Induced change (mm)	Percentage change (%)
30	25.85±1.76	-2.59	9.11
60	22.07±4.50	-6.37	22.40
90	19.11±6.60	-9.33	32.81
120	21.23±5.10	-7.11	25.00
150	24.00±3.14	-4.44	14.61