How Quickly Does Diet Make For Change? A Study of Electrocardiographic (T Wave Height) Findings

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Abstract

This is the only reported study showing that, within a matter of three to four days in presumably healthy young men, one can significantly (and unfavourably) alter the height of the T-wave by glucose supplementation under reasonably controlled conditions.

Introduction

While the principal emphasis is presently being focused upon the relationship between fat consumption and cardiovascular disease, there is increasing attention to the possible correlation between carbohydrate consumption and cardiovascular pathosis. Employing the electrocardiogram as one estimate of cardiac status, many researchers have observed characteristic postprandial alterations. The most consistent change has been noted in the T wave in standard limb and chest electrocardiographic leads. Following a mixed meal or an oral glucose load, subjects with cardiovascular pathosis usually show a flattening or an inversion of the T wave. Reports confirming these observations are summarized in Table 1.

Investigations have also been extended to relatively healthy men and women in a variety of age groups. As observed and reported in cardiovascular subjects, alterations of the T wave have been shown to occur in the standard electrocardiography leads following a mixed meal or an oral glucose supplement. These observations have also been summarized in Table 2. A decrease in T wave height has been consistently reported for most of these normal subjects.

Actually, several authors have even suggested that postglucose electrocardiographic changes may indicate relatively silent heart disease[1 2].

This report is designed to contribute to the body of knowledge regarding the changes in the T wave observed in healthy young men (dental students) following glucose, sucrose, and placebo (nonglucose) supplements over a three-day experimental period.

Method of Investigation

Eighty-one presumably healthy dental students participated in this experiment (Table 3). Thirty-nine students were subdivided so that 23 were supplied with sucrose drinks (group 5a) and 16 served as controls (group 5b). Of the remaining 42 subjects, 21 were provided with glucose solutions (group 6a) and 21 received a low calorie drink (group 6b).

At the initial visit, on Monday of a week, each student reported (10:00 a. m.) following a 10-hour fast at which time a standard three limb lead electrocardiogram was taken. After this procedure, the groups were given instructions concerning the experimental period.

The sucrose group (23 students) was administered 50 grams of chemically pure sucrose in solution (7 ounces) at 7:45 a.m. and 1:15 p.m. (group 5a). The supplement was consumed under supervision beginning Monday at 1:15 p.m. and ending Friday at 7:45 a.m. The controls (16 students) were not given a carbohydrate supplement (group 5b). A 7-ounce carbonated glucose cola drink (Glucola, Ames Company, Inc.) supplying 75 grams of glucose was consumed (group 6a), under observation, daily at 7:45 a.m., 9:45 a.m. and 1:15 p.m. This procedure began at 9:45 a.m. on Monday and ended with the 7:45 a.m. supplement on Friday for 21 students. The remaining 21 (group 6b)' drank, with supervision, 7 ounces of a low-calorie carbonated cola drink (Tab, Coca

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Cola, Inc.) at the same time intervals.

Each subject reported for the final visit on Friday morning at 10:00 a.m. in a fasting state (10 hours). Those receiving the glucose and sucrose supplements at 7:45 a.m. had only this one interruption in the 10-hour fast. The second electrocardiogram was made. The initial and final recordings were taken by the same operator. Neither the student nor the examiner was aware of the nature of the supplements nor the original findings.

This report deals with the height of the T wave under these unusual experimental conditions.

Results

Table 4 summarizes the T wave height in lead I. Included are the initial and final mean scores along with standard deviations, the difference of the means, and the significance of the difference of the means[16] and the variances[17]. Of the four subsets studied, there is only a statistically significant reduction in the height of the T wave in the group supplied with glucose drinks thrice daily (group 6a). Similar findings are observed in lead II (Table 5). Interestingly and still to be explained, is the absence of these changes in lead III (Table 6).

Table 1
Summary of investigations concerning postprandial modification of the T wave in standard electrocardiographic leads in subjects with various disorders

text reference number	number of subjects and description	food intake	T wave change
1	124, coronary atherosclerosis (20-65 years, mean age 46.5), 88 men, 36 women	100 gm glucose	decreased height, flattening, inversion
2	99, coronary disease (40-60 years)	1200-calorie meal	decrease or increase in height, inversion
3	59, diabetes mellitus, 27 men, 32 women (16-66 years)	regular meal	decreased height, inversion
4	32, angina pectoris	mixed meal	decreased height
5	27, myocardial infarction, 16 men (37-71 years) 11 women (40-71 years)	standard hospital meal	inversion, increased + or - amplitude
6	20, cardiac	1000-calorie meal	inversion
7	7, coronary artery disease (24-61 years)	standard hospital meal or 100 gm glucose	flattening, inversion
7	7, rheumatic heart disease (mean 16 years)	standard hospital meal or 100 gm glucose	flattening, inversion
7	10, peptic ulcer	ulcer diet meal	flattening, inversion
8	23, coronary heart disease, men (39-86 years, mean age 61)	100 gm glucose	decreased height
9	47, hospital patients	100 gm glucose	decreased height
10	400, hospital patients	150 gm glucose	decreased height, modification
11	56, atherosclerosis (> 40 years)		

Table 2
Summary of investigations concerning postprandial modification of the T wave in standard electrocardiographic leads in presumably healthy subjects

text reference number	number of subjects and description	food intake	T wave change
3	111 subjects (20-37 years, mean age 27), 48 men and 63 women	100 gm glucose	decreased height
3	18 subjects	mixed meal	decreased height
4	14 subjects	mixed meal	decreased height
7	20 subjects (mean age 24)	standard hospital meal or 100 gm glucose	decreased height
8	30 men (22-66 years, mean age 46)	100 gm glucose	decreased height
9	85 young adults	100 gm glucose	decreased height
10	31 subjects	150 gm glucose	none
11	19 subjects	150 gm glucose	decreased height
12	9 young adults	mixed meal	decreased height
13	12 men (19-32 years)	mixed meal	decreased height
14	42 men (45-55 years)	1200-calorie meal	decreased height
14	12 women (39-59 years)	1200-calorie meal	decreased height
15	117 randomly selected women (18-75 years)	100 gm glucose	decreased height

Table 3

Experimental design

groups	sample size	treatment
5a	**23**	sucrose 50 grams twice daily
5b	**16**	no supplement
6a	**21**	glucose 75 grams three times per day
6b	**21**	artificially sweetened drink indistinguishable from glucose

Table 4

Summary of t wave height findings (Lead I)

groups	initial	final	difference	significance of the difference of the means t	significance of the difference of the variances F
5a	1.9 ±0.8	2.0 ±0.9	+0.11	0.69	1.17
5b	1.8 ±0.8	1.8 ±0.8	+0.00	0.03	0.97
6a	2.3 ±0.7	1.9 ±0.7	-0.36	2.54*	1.12
6b	2.0 ±0.9	1.9 ±0.8	-0.11	1.32	0.81

* statistically significant difference of the means

Table 5

Summary of t wave height findings (Lead II)

groups	initial	final	difference	significance of the difference of the means t	significance of the difference of the variances F
5a	2.7 ± 1.0	2.6 ±0.9	-0.18	1.2	0.9
5b	2.5 ± 1.2	2.5 ± 1.3	0	0	1.2
6a	2.9 ± 1.0	2.5 ± 1.1	-0.38	2.5*	1.1
6b	3.0 ±1.2	2.9 ±1.2	-0.14	1.2	1.0

* statistically significant difference of the means

Table 6
Summay oft wave height findings (Lead III)

groups	initial	final	difference	significance of the difference of the means t	significance of the difference of the variances F
5a	0.9+0.6	0.9 ± 0.6	-0.01	0.01	1.01
5b	1.1+0.6	1.1 +0.5	+0.03	0.35	0.65
6a	1.2 + 0.7	1.2 + 0.6	-0.07	1.71	0.73
6b	1.3+0.9	1.3+0.8	-0.03	0.26	0.64

Table 7

Mortality in healthy men with and without minor T wave changes

group	cases	mortality ratio	deaths from coronary occlusion	living with coronary occlusion
		%	%	%
normal control	1805	78	36	6
minor T wave	422	166	49	12

Discussion

The point should be emphasized that it is not uncommon to observe an electrocardiogram showing T wave changes (e.g. low, isoelectric, diphasic or inverted) in apparently healthy individuals. Surely, on the basis of these alterations alone, a definite diagnosis of cardiovascular pathosis is never justified. However, it is also true that some T wave changes are indeed evidence of either latent or unrecognized coronary artery disease. The question of how significant are minor T wave alterations is very difficult to resolve.

Simonson and McKinley[2] followed 16 patients (40 to 60 years old) in varying degrees of coronary disease for 1 to 3 years. All showed a decrease, increase, or inversion of the T wave in the standard limb leads following a 1200 calorie meal. Eight patients continued to suffer with angina pectoris and revealed electrocardiographic evidence of progressive myocardial involvement. Subsequently, two of these had a coronary thrombosis. Of four showing no postprandial change in the T wave, three had no further cardiac deterioration.

Kiessling and coworkers[18] published the only extensive experience of the significance of T wave changes in normal individuals. Four hundred and sixty-eight insured men who met the following criteria were followed for an average of eight years. Firstly, the electrocardiogram showed only T wave findings, being normal in all other respects. Secondly, each man was between 40 and 69 years of age. Thirdly, there was no other evidence of disease, cardiovascular or non-cardiovascular. Finally, there was no history of chest pain or cardiac origin origin.

A control group of 1805 men, clinically and electrocardiographically normal, was followed concomitantly. T wave deviations were specified as minor and major according to lead location, absolute amplitude and amplitude in relation to the QRS complex.

Major T wave changes were rare. Only 46 cases in subjects with no other disease evidence were found among approximately 11,000 files of the Prudential Insurance Company of America. The observed mortality experience of this group was 226 percent of the expected death rate.

Table 7 presents the significant differences in mortality risk between healthy insured men with and without minor T wave findings. According to Kiessling and his group, these figures would indicate that there is more coronary disease in the group with minor T wave changes than in the normal control group.

A smaller experience cited by Blackburn and Parlin[19] and based on Aetna Life Insurance Company statistics confirms these results. In the Aetna report low T waves in leads I and/or II were the only electrocardiographic findings which eventuated in mortality ratios from 148 to 194 percent.

Thus, minor T wave changes in presumably healthy middle-aged adults may indeed be evidence of latent coronary disease or a premonitory sign of a subsequent coronary occlusion. Hence, this might well be what actually occurred in this particular experiment.

One final note. The information presented in this report clearly deals with refined carbohydrate consumption and its effect upon ventricular repolorization as measured in the T wave. One may well get the impression that these are the only diet/electrocardiographic relationships studied.

The fact of the matter is that other measures of carbohydrate metabolism and other electrocardiographic parameters have been examined. As but one example, we have looked into the relationship of the height and duration of the P wave (lead I) versus carbohydrate metabolism as measured by nonfasting blood glucose[20 2I].

Thirty-eight presumably healthy junior dental students participated in an experiment in which the length of the P wave in lead I and blood glucose by the Somogyi-Nelson method were determined at 10:00 a.m. on Monday and Friday of the same week. The evidence suggests that the measurement of P, length is highly reproducible. Also, the data suggest that, for the group, P wave length is quite inconstant from Monday to Friday. It is noteworthy from the information available from that report[20] that those individuals with the most constant glucose also show the most constant electrocardiographic pattern.

Utilizing the same sample, the evidence further suggests that the measurement of P, wave height is highly reproducible. Also, the data suggest that, for the group, P wave height and blood glucose are quite variable

from Monday to Friday. Notwithstanding, one can conclude from the information in that report[21] that a significant negative relationship exists between P wave height in lead I and blood glucose.

Summary and Conclusions

Eighty-one presumably healthy dental students participated in a study to demonstrate the effect of carbohydrate supplements upon the height of the T wave in standard limb lead electrocardiography. A significant decrease in the height of the T wave was found in leads I and II only in the glucose supplemented group. No significant alterations were noted in the sucrose, control, or placebo groups.

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