Using A Comparison between Low-Carb and High-Carb Meals with A Detailed PPG Waveform Segmentation and Associated Energy Analysis to Investigate the Linkage between the Brain and Internal Organs (GH-Method: Math-Physical Medicine)

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Introduction

In this paper, the author analyzed his 1,707 meals that are segregated into low-carb and high-carb meals. The purpose is to attempt the validation of his hypothesis on the relationship from the directive of the brain to the gastrointestinal functions and liver’s glucose production capability by using PPG value changes over a smaller time segment (each segment with 15 minutes). The author uses the math-physical approach rather than a biochemical one.

Methods

The author used a continuous glucose monitoring device (Sensor) applied to his upper left arm. He has collected ~75 glucose data each day since 5/5/2018. In this particular analysis, he selected the entire Sensor period of 549 days (5/5/2018 - 11/4/2019) with 41,087 total glucose data, 1,706 PPG waveforms, and 20,484 PPG Sensor data (12 data per meal). He then subdivided the entire database into two major segments, low-carb meals (0-14.9 grams of carbs per meal) and high-carb meals (15-150 grams of carbs per meal).

From the collected Sensor PPG data of these two subgroups for each 15-minute time intervals during a three hour timespan, he compares glucose levels, speeds of rising and dropping, and data difference (i.e. separation gap) between low-carbs and high-carbs to discover the hidden signal transmission between the directive of the brain to other glucose related internal organs such as liver, pancreas, and gastrointestinal system. This research makes an effort to answer the following questions:

1. When does the brain direct the liver for glucose production after a meal?
2. When does the gastrointestinal system start its food digestion process and sends its signal back to the brain?
3. When does the "heavy" digestion of gastrointestinal system coordinate with the kickoff signal of the "high" glucose production by the liver?
4. When does glucose reduce to its natural "steady state" similar to the its "starting state" level?

5. How much excessive energy associated with high-carb meal is left behind at 180-minutes time point?

The main purposes of this study is to attempt to answer his existing questions and validate some of his instinctive belief regarding the brain neuroscience functions since the beginning of May of 2019, after one year of collecting his Sensor data.

Results

In this particular study, the low-carb meals have a total of 1,134 meals (66.4%) with an averaged 8.5 grams of carbs/sugar intake amount, and the high-carb meals have a total of 573 meals (33.6%) with an averaged 26.8 grams of carbs/sugar intake amount (this high-carbs is about three times higher than the low-carbs).

One important footnote is that his averaged post-meal walking steps are 4,232 for low-carb meals and 4,242 for high-carb meals. Due to his stringent discipline of maintaining ~4,000 steps of post-meal walking, we can ignore the important influence from exercise in this study.

Figure 1 lists a calculation table of prominent data related to this study. Explanations of this table will be provided in detail via Figures 2, 3, 4, and 5.

Figure 1: Table of prominent data calculation
Figures 2 and 3 show the comparison of low-carbs PPG (lower curve in each diagram box) wave versus high-carbs PPG wave (upper curve in each diagram box). Please pay attention to the separated gaps between these two curves.

Figure 2: Comparison of PPG waveforms between low-carb meals vs. high-carb meals

Figure 3: Comparison of PPG waveforms with data together

Figure 4: Comparison of PPG waveforms with incremental glucose data which are above 120 mg/dL

Graphic Data = (glucose value minus 120 mg/dL)

This reveals how much higher the PPG values above the commonly accepted “normal level” of 120 mg/dL.

Figure 5 illustrates a single curve with a data element’s format of:

Figure 5: Deviation gaps between high-carbs PPG curve and low-carbs PPG curve

Graphic Data = (high-carbs PPG minus low-carbs PPG)

The key observations from Figures 2 through 5 are summarized according to different time segment as follows:
1. The deviations (i.e. gaps) between two curves are relatively small (only 3-5 mg/dL) from 0-minute to 30-minutes. This could reflect that the brain has issued its initial glucose production order to the liver once it receives the “food entry” signal from the stomach. But the actual carbs/sugar digestion (particularly the carbohydrates, since sugar starts to be absorbed much quicker) has not been started yet. This is a “ready-to-act” but kind of delay mode.

2. The gaps between 30-minutes to 45-minutes are 8-13 mg/dL. This could mean that carbs are converted into glucose in a faster speed but still not reached its peak yet. This is a “gear-up” mode.

3. The gaps between 45-minutes to 60-minutes are 13-16 mg/dL. This could mean that the brain, liver, and gastrointestinal system are in a more synchronized mode; therefore, they work hard on producing gluoses. At the 60-minutes mark, both low-carbs and high-carbs have reached to their peak PPG positions (140 mg/dL for low-carbs and 156 mg/dL for high-carbs). This is a “full-production mode”.

4. After passing the peak position at 60-minutes, both waveforms start to decline; however, the gaps between 75-minutes and 105-minutes are still widening between a range of 18-21 mg/dL. This could mean that low-carbs glucose is dropping much faster than high-carbs glucose due to the excessive amount of carbs/sugar intake of high-carbs meals which cannot be digested fast enough by the gastrointestinal system. This is a “decline but with leftover” mode).

5. Finally, at 112-minutes, the low-carbs curve drops to the same level (128 mg/dL) as its starting state at 0-minute. This is a “cease operation” mode.

6. From 120-minutes to 180-minutes, the gap shrinks to a range of 20-14 mg/dL due to the different declining speeds between low-carbs and high-carbs (i.e. food digestion speed or energy consumption speed). The high-carbs wave is still dropping but with a slower slope and finally dragging itself to reach 141 mg/dL at 180-minutes which is still 10 mg/dL higher than 131 mg/dL at 0-minute (7% of 131 mg/dL). This could mean that these 7% left-over energy circulating within the blood flow inside the body will damage the internal organs by creating various diabetes complications. This is a “end-of-life” mode of one complete PPG waveform.

Here is a further simplified version of the above detailed summary:

A. The liver starts to produce a smaller amount of glucose from 0-minutes to 30-minutes (probably due to smaller intake amount of pure sugar) regardless of food type or carbs/sugar intake amount. However, glucose will then rise rapidly between 30-minutes to 60-minutes (probably due to larger intake amount of carbohydrates).

B. Glucose reaches to its peak at 60-minutes with 16 mg/dL deviation (~10%) between 140 mg/dL peak for low-carb meals and 156 mg/dL peak for high-carb meals.

C. After passing over the peak glucose level, high-carb meals decline in a slower speed (or on a smaller slope) than low-carb meals. The low-carbs meals will burn out their associated energy completely at 112-minutes. However, high-carb meals even still have a “leftover” energy of 9.6 mg/dL at 180-minutes (~7%).

D. Other patients who have different genetic conditions, carbs/sugar intakes, food varieties, and exercise amounts would definitely generate varying glucose data. However, their PPG wave patterns and behaviors would still be very similar to the author’s discovery in his research.

Conclusions

This article strived to interpret the complex PPG wave movements and patterns due to a variety of carbs/sugar intake amounts. From this detailed segmentation analyses, we can start to look into the vital communication channels and sophisticated inter-relationships among the brain, gastrointestinal system, liver, and pancreas.

References