Using PPG Segmentation Analysis, Waveform Characteristics Analysis and Energy Theory to Investigate the Linkage among Brain, Liver, and Gastrointestinal System (GH-Method: Math-physical Medicine)

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Short Communication

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Introduction

In this paper, the author analyzed his 1,708 meals that are segregated into 26 different segments. 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.

Methods

The author used a continuous glucose monitoring device (Sensor) applied to his upper left arm. He has collected ~74 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 40,626 total glucose data, 1,706 PPG waveforms, and 20,472 PPG Sensor data (12 data per meal).

Each standard PPG waveform has an "open" glucose (0 minute, i.e. at first bite of meal), "peak" glucose (usually around 60-minutes), "120-minutes" glucose (close to Finger PPG measurement time), and "180-minutes" glucose. He also calculated the "averaged" Sensor PPG data over three hours and their associated energy which circulates within the blood flow in blood vessels reaching to every part of the internal organs, except hair. In addition, each meal's carbs/sugar intake amounts are also measured and recorded. The main purposes of this study is to attempt the validation of his existing and instinctive belief for six months, since the beginning of May of 2019, after collecting Sensor data for one year.

Results

Figure 1 lists glucose data in a calculation table of six low-carbs and high-protein meals and three standard meals, i.e. breakfast, lunch, and dinner.

(5/5/2018 - 11/4/2019)	Meals #	Meals %	Open PPG	Open%	Peak PPG	Peak%	120m PPG	120m%	180m PPG	180m%	Avg	Energy	Carbs (g)	Drop (P-120)	Fnger
Breakfast with egg only	39	2%	127	98%	153	105%	135	100%	131	100%	138	103%	7.4	18	114
Meal with Cheese only	33	2%	127	99%	142	98%	132	98%	127	97%	133	95%	7.0	10	111
Meal with Sashimi only	32	2%	131	101%	130	89%	110	82%	118	90%	119	77%	4.8	20	104
Breakfast in Mcdonald's	211	12%	122	95%	147	101%	135	100%	132	101%	135	99%	9.7	12	118
Meal with egg and others	348	20%	128	99%	145	100%	132	98%	130	99%	135	97%	8.7	13	112
Meal with 5 high-protein	663	39%	126	98%	145	100%	132	98%	130	99%	134	97%	8.7	13	114

(5/5/2018 - 11/4/2019)	Meals #	Meals %	Open PPG	Open%	Peak PPG	Peak%	120m PPG	120m%	180m PPG	180m%	Avg	Energy	Carbs (g)	Drop (P-120)	Fnger
Breakfast with All kinds	546	32%	123	95%	149	103%	137	102%	133	102%	138	102%	11.2	12	117
Lunch with All kinds	547	32%	135	104%	149	103%	139	104%	133	101%	140	106%	16.1	10	117
Dinner with All kinds	542	32%	130	101%	139	95%	127	94%	127	97%	131	92%	15.1	12	112
All Meals	1708	100%	129	100%	145	100%	134	100%	131	100%	136	100%	14.4	11	116

Figure 1: Six low-carb and high-protein meals with three standard meals

Figure 2 displays glucose data in a calculation table of five different eating places and six nations.

(5/5/2018 - 11/4/2019)	Meals #	Meals %	Open PPG	Open%	Peak PPG	Peak%	120m PPG	120m%	180m PPG	180m%	Avg	Energy	Carbs (g)	Drop (P-120)	Fnger
Home Cook	805	47%	132	102%	143	98%	127	94%	123	94%	132	94%	10.9	16	111
Chain Restaurant	274	16%	124	96%	149	102%	137	102%	135	103%	137	102%	11.8	12	118
Individual Restaurant	459	27%	129	100%	148	102%	143	106%	140	107%	141	107%	20.7	5	122
Airline	73	4%	132	103%	149	102%	145	108%	138	105%	143	109%	20.9	4	126
Supermarket	31	2%	136	105%	171	117%	163	121%	138	105%	155	129%	23.4	8	124
All Meals	1708	100%	129	100%	145	100%	135	100%	131	100%	136	100%	14.4	11	116
Taiwan	291	17%	128	99%	143	98%	127	95%	127	97%	132	93%	20.4	16	121
Japan	155	9%	129	100%	141	97%	136	101%	131	100%	136	99%	23.5	5	124
USA	904	53%	130	101%	146	100%	132	98%	131	100%	136	100%	12.2	14	114
Other Nations	222	13%	124	96%	147	101%	144	107%	136	104%	140	105%	18.6	3	120
Airlines	73	4%	132	103%	149	102%	145	108%	138	105%	143	109%	20.9	4	126
Canada	16	1%	132	102%	165	113%	157	117%	156	119%	154	127%	21.9	8	118
All Meals	1708	100%	129	100%	145	100%	135	100%	131	100%	136	100%	14.4	11	116

Figure 2: Five eating places and six nations

Figure 3 shows glucose data in a calculation table of two low-carbs meals and four high-carbs meals according to the difference range of carbs/sugar intake amount.

(5/5/2018 - 11/4/2019)	Meals #	Meals %	Open PPG	Open%	Peak PPG	Peak%	120m PPG	120m%	180m PPG	180m%	Avg	Energy	Carbs (g)	Drop (P-120)	Fnger
Low carbs (0-5 gram)	248	15%	127	99%	136	93%	125	93%	129	98%	129	90%	2.2	10	110
Low carbs (0-10 gram)	757	44%	128	99%	139	95%	125	93%	126	96%	130	91%	6.4	14	109
Low carbs (0-14.9 gram)	1134	66%	128	99%	140	97%	128	95%	127	97%	132	93%	8.5	12	111
High-carbs (15-20 gram)	297	17%	131	101%	151	103%	140	104%	132	101%	140	106%	17.7	11	118
High-carbs (15-30 gram)	449	26%	131	101%	153	105%	142	106%	136	103%	142	109%	20.4	11	121
High-carbs (15-50 gram)	541	32%	131	101%	154	106%	147	109%	139	106%	145	113%	23.6	8	124
High-carbs (15-100 gram)	570	33%	131	101%	156	107%	147	109%	140	106%	146	114%	26.2	9	125
High-carbs (15-150 gram)	573	34%	131	101%	156	107%	148	110%	140	107%	146	115%	26.8	8	126
All Meals (0-150 gram)	1708	100%	129	100%	145	100%	135	100%	131	100%	136	100%	14.4	11	116

Figure 3: Two low-carb meals and four high-carb meals

Figure 4 combines the above three separated tables together.

(5/5/2018 - 11/4/2019)	Meals #	Meals %	Open PPG	Open%	Peak PPG	Peak%	120m PPG	120m%	180m PPG	180m%	Avg	Energy	Carbs (g)	Drop (P-120)	Fnger
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Figure 4: Total of 26 glucose segmentation analysis results

(Combination of Figures 1, 2, 3)

The author will focus solely on the purpose of this paper and will omit many detailed information and some non-related items.

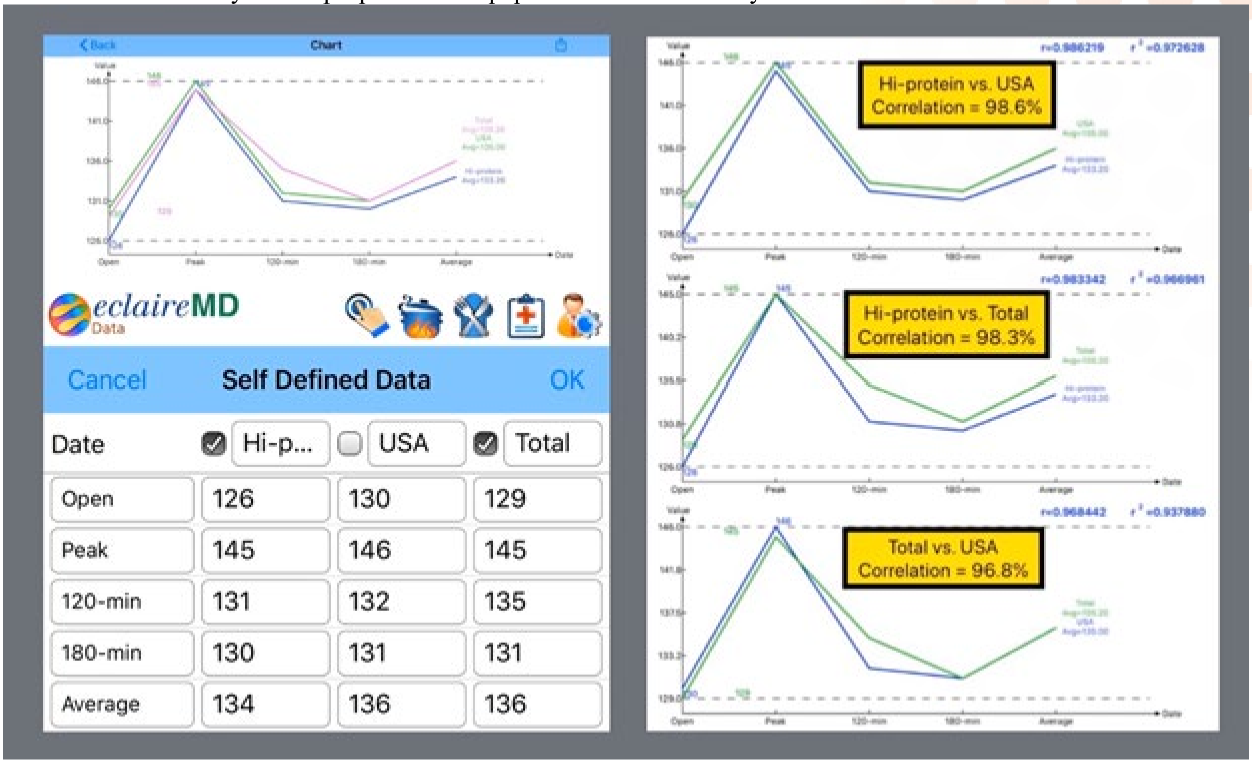

Figure 5: Quantitative and graphic interpretation of relationship between brain's order and liver's glucose production

The following paragraphs are based on Figures 4 and 5. Figure 5 is derived from Figure 4 and depicts those low-carbs meals, including both high-protein synthesized meal and U.S. meals (this is the most representative segment). It also compares with the total averaged glucose curve. The results show three very high correlation coefficients of 96.8%, 98.3%, and 98.6%.

At the peak glucose column, the overall peak glucose is 145 mg/dL with around 2% to 3% deviation. The low-carb meals tend to be at 141 mg/dL to 143 mg/dL and high-carb meals tend to be around 149 mg/dL to 152 mg/dL. This fact has proven his hypothesis that during the first hour after the first bite of food, the brain receives a "food-entry" signal from the gastrointestinal system and then almost immediately orders the liver to start glucose production. The small deviation of 4 mg/dL to 5 mg/dL (3% to 4%) may be due to carbs/sugar intake amount and exercise within the first hour.

However, the glucose at 120 minutes after the first bite of food (also close to conventionally recommended finger measurement time) is a different story. During the 60-minutes peak time to 120-minutes after eating a low-carb meal, the glucose reduces at an amount of 14 mg/dL (~10% drop in one hour). However, when eating other high-carb meals, PPG decreases only around 3 mg/dL to 8 mg/dL with an average of 5.5 mg/dL (~4% drop in one hour). This fact proves the high-carb food entry plays a vital role during the second hour. It cannot be "consumed" fast enough or completely; therefore, it creates an excessive left-over energy associated with these "unburned" glucoses circulating in the body within the blood flow.

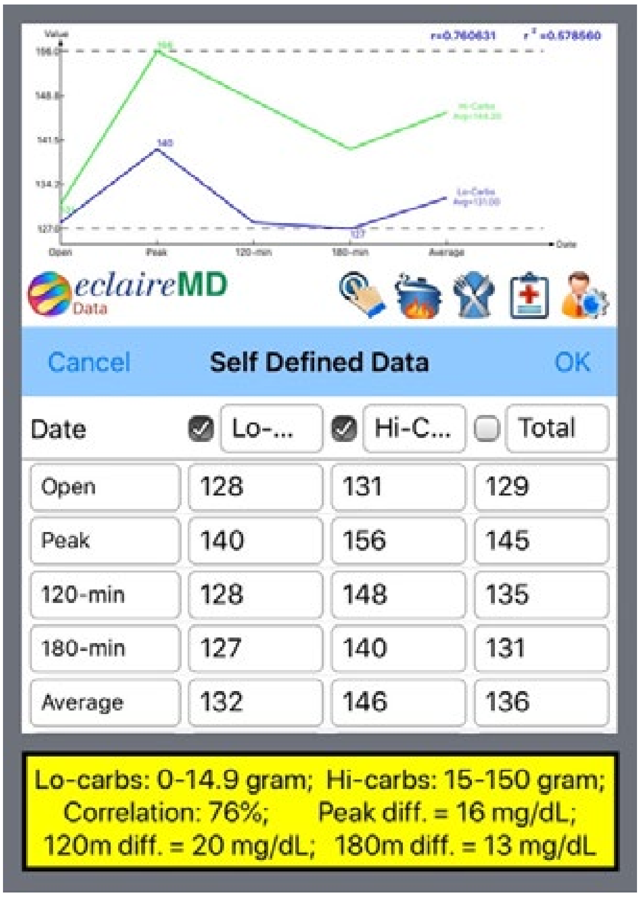

Figure 6: Comparison between low-carb meals vs. high-carb meals

The above two paragraphs and Figures 5 and 6 have actually described the author's simulation model of the cycle from the brain via stomach to liver. Food still serves as the initial stimulator from the directive of the brain to issue the start of glucose production, while carbs/sugar intake and post-meal exercise serve as two follow-on stimulators as well as two major components of the glucose simulation model.

Conclusion

This paper further enhanced the author's previous papers regarding the brain neuroscientific function on glucose production. However, it describes the glucose physical behaviors in detail and phenomena with quantitative proofs during two separated time spans of the first hour and second hour after eating [1-4].

References

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