

A Model of the Oral Glucose Tolerance Test that Defines the Gastric Emptying Process

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4.1. Units.

The unit for glucose (**g**) concentration is the milligram/deciliter (mg/dl) and the mass unit is the milligram (mg). Insulin (**h**) is in micro-Units/ml ($\mu\text{U/ml}$). The unit of time is the minute (min).

4.2. Physiological Model.

The simple model that we propose consists of three compartments: the gastro-intestinal (GI), the blood and the tissue(s). We seek the dynamics of “emptying” from the GI to the blood compartment. From the analytical data of glucose and insulin obtained in the blood compartment we seek the following transfer rates: **a2**, the rate of transfer of glucose from the blood compartment to the tissues; **b1**, the rate of transfer of inactive insulin to active insulin with its release into the blood compartment and, **b2**, the rate of inactivation of insulin.

4.3. Mathematical Model

The model is represented equivalently by either a system of simultaneous differential equation or homogeneous second order differential equation. The simultaneous equations are:

$$[1] \quad \dot{g} = a_2 h + J(t)$$

$$[2] \quad \dot{h} = b_1 g + b_2 h$$

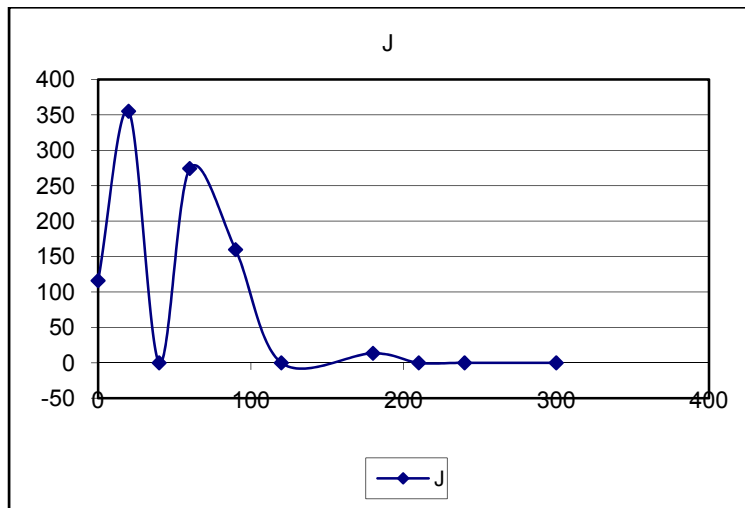
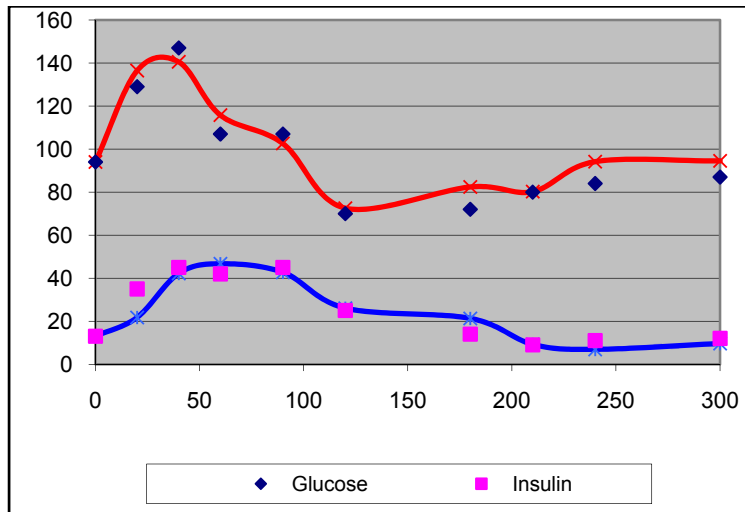
where $g(t) = G(t) - G(0)$ and $h(t) = H(t) - H(0)$, that is, g and h represent the differences of glucose and insulin from fasting values. This system can also be represented as a non-homogeneous second order differential equation:

$$\ddot{g} - b_2 g - a_2 b_1 g = \dot{J}(t) - b_2 J(t)$$

NORMAL

Patient:	FNOR4	
Time	Glucose	Insulin
0	94	13
20	129	35
40	147	45
60	107	42
90	107	45
120	70	25
180	72	14
210	80	9
240	84	11
300	87	12

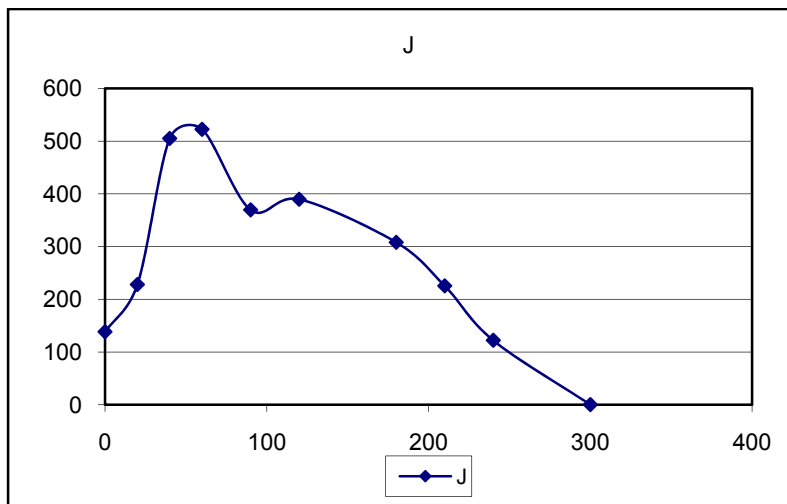
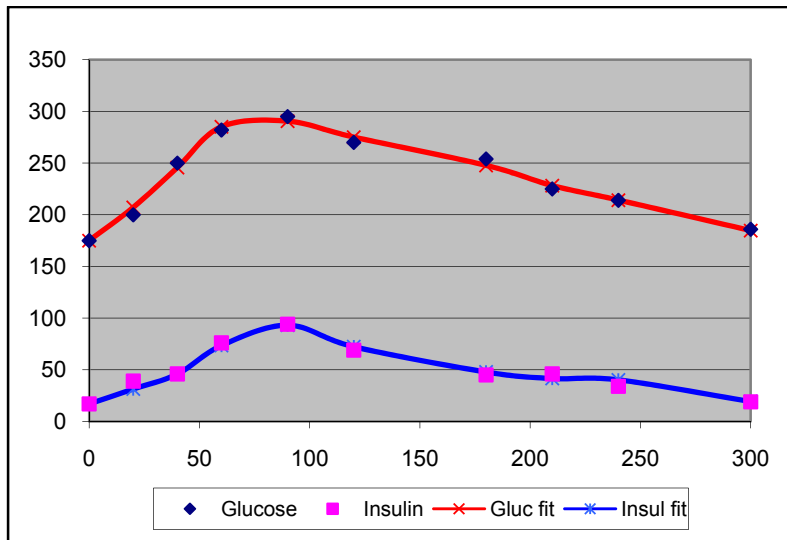
Parameters
a2 -8.0417
b1 2.6006
b2 -1.7482



NIDD (Non-Insulin Dependent Diabetes – Type II)

Patient:	FND2	
Time	Glucose	Insulin
0	175	17
20	200	39
40	250	46
60	282	76
90	295	94
120	270	69
180	254	45
210	225	46
240	214	34
300	186	19

Parameters	
a2	-7.7869
b1	8.5884
b2	-15.9568



FLAT

Patient: FFL14

Time	Glucose	Insulin
0	87	20
20	121	164
40	102	121
60	89	82
90	92	74
120	94	110
180	102	51
210	89	31
240	86	25
300	84	16

Parameters

a2	-2.8660
b1	31.4114
b2	-3.7852

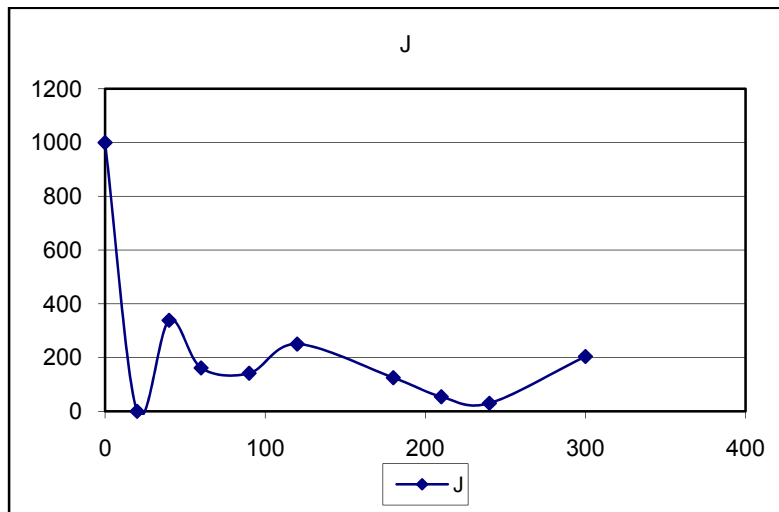
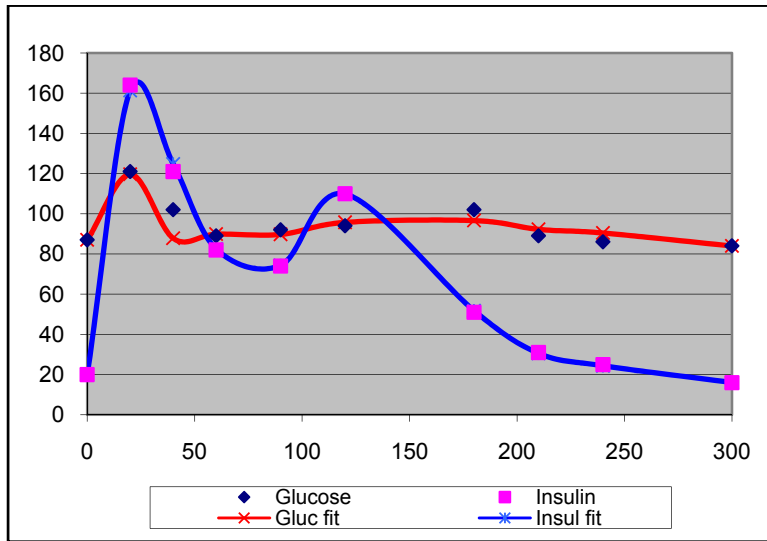


Fig. 5 - OGTT Female Patients

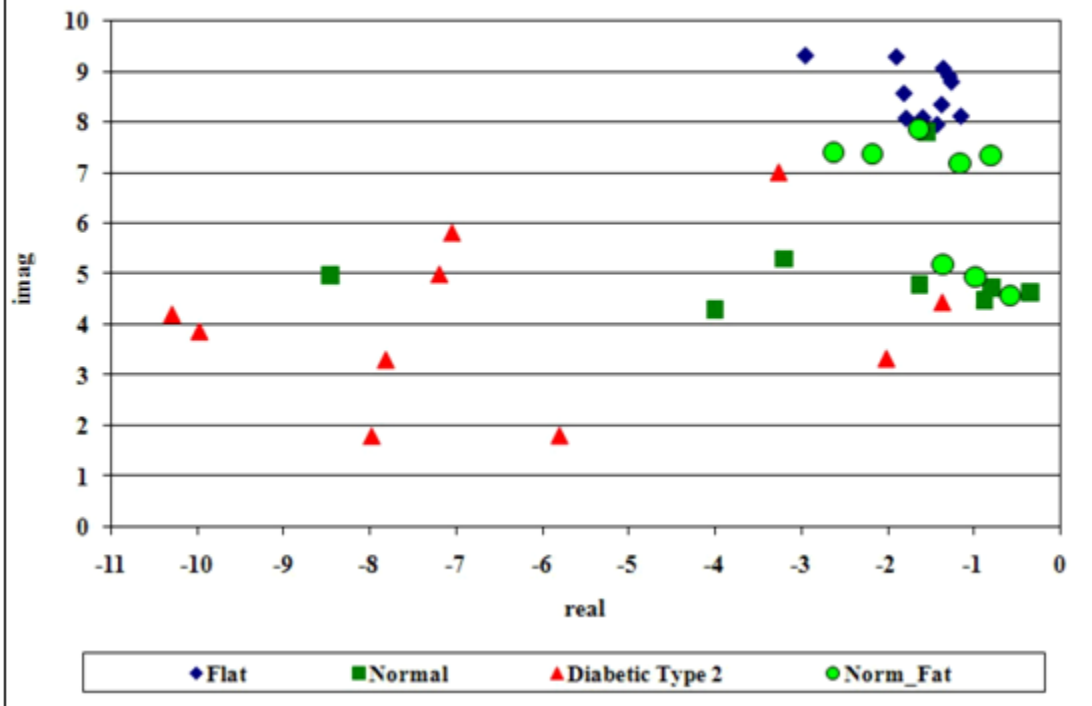


Table 1. The Population Characteristics

CLASS	CHARACTERISTICS	DEMOGRAPHICS				
		SEX NUM		AGE	HEIGHT	WEIGHT
				<i>Years</i>	<i>Inches</i>	<i>Pounds</i>
Normal	1. FBS 65-105 mgs/dl	M	25	32.5 ± 14	69.6 ± 2.6	188 ± 67
	2. Fasting Insulin < 25 µU.ml	F	16	40.7 ± 17	63.4 ± 3.8	179 ± 69
	3. Maxima of Glucose and Insulin in synchrony					
	4. Off all medications					
	5. Insulin @ 5 hrs. at or < fasting					
	6. Insulin is effective in lowering fasting FFA by 50%					
	7. Fasting HGH and Cortisol lowered during after glucose load					
	8. No glucosuria and no ketomuria					
	9. Control index of Swan ^[25] is 16.8 - 54.6					
"Flat"	1. Relative to fasting glucose blood levels (FBS), the rise is < 20 mgs/dl over the entire 5 hours.	M	16	38.0 ± 17	69.1 ± 4.0	169 ± 42
		F	41	36.6 ± 11	64.0 ± 2.2	158 ± 44
	2. Control Index of Swan is < 16.8					
Diabetes Type 2	1. Elevated FBS and failure to return to FBS levels after 5hrs.	M	9	58.4 ± 13	68.4 ± 3.5	190 ± 49
		F	16	56.0 ± 16	62.9 ± 2.6	179 ± 51
	2. Two consecutive levels >140 mgs/dl					
	3. asynchronous Glucose and Insulin maxima					
	4. Off all medications					
	5. Control Index of Swan is > 54.6					

Legend: FBS= Fasting Blood Sugar; HGH= Human Growth Hormone and FFA= Free Fatty Acids.