A relation between the energy of food and gastric emptying in men with duodenal ulcer

D. F. STUBBS AND J. N. HUNT

From the Department of Physiology, Guy's Hospital Medical School, London

SUMMARY Using information about the volume and energy density of meals, results from the literature on gastric emptying for healthy men can be marshalled into a consistent body. The same process applied to the published papers on men with duodenal ulcer shows that they have abnormally rapid gastric emptying, especially for meals of high-energy density. This provides confirmation of the view of Shay (1944) that the slowing of gastric emptying by duodenal receptors is less in men with duodenal ulcer than it is in healthy men.

It has been found that the greater the energy density of food (Kcal/ml) the slower is the rate at which the food leaves the stomach (Hunt and Stubbs, 1975).

The relationship (1) was based on 25 studies from seven different laboratories in over 250 healthy men. From the energy density of a meal and its volume, the time for the first half of a meal to pass from the stomach to the duodenum can be predicted. The link between the energy density of food and the rate of gastric emptying is believed to depend upon duodenal receptors responding to the products of hydrolysis of carbohydrates and of protein, and to the soaps formed during the digestion of fat.

In the present paper we list the half times of gastric emptying of a variety of meals given to men with duodenal ulcer and compare the rates with those predicted for healthy men, had they been given the same meals.

Methods

The energy density of the food or test solutions was based on 4 Kcal/g of carbohydrate and/or protein per ml of meal and 9 Kcal/g of fat per ml of meal. The values for energy density were substituted in the relation found by Hunt and Stubbs (1975):

$$t_{0.5} = V_0[0.1797 - 0.1670e^{-K}] \quad (1)$$

where $t_{0.5}$ = measured time to empty the first half of the meal [min]

K = Kcal/ml meal
 $[e^{-K}]$ was obtained from mathematical tables
 V_0 = volume of meal given [ml]

The value $t_{0.5}$ is literally the time to empty the first half of the meal and does not necessarily imply any particular pattern of emptying.

Results

The table shows the data taken from nine sources. It can be seen that the greater the energy density of the meal, progressing down the table, the shorter are the observed half times of the patients with duodenal ulcer relative to those computed for healthy persons. At zero calories the difference between the two groups is not significant.

Discussion

Relation (1) based on results for 250 healthy men, gives predictions about half times of gastric emptying from initial volumes of meals and their energy densities. Apart from meals of water, the values for men with duodenal ulcer show shorter times for emptying than those predicted for the healthy men. This confirms the view of the majority of the authors quoted. This conclusion is more apparent with meals of high-energy density (see table). Thus in men with duodenal ulcer gastric emptying is slowed less than

K [kcal/ml]	V ₀ [ml]	Measured t _{0.5} [min] (Patients)	Calculated t _{0.5} (Normals)	Differences D (min)	Source (and Number of Subjects)
0.00	750	14.8	13.0	- 1.8	Cobb <i>et al</i> (1971) (12)
0.36	400	21.2	25.3	+ 4.1	Donovan (1974) (12)
0.36	750	38.9	47.4	+ 8.5	Hunt (1957) (16)
1.00	300	22.7	35.5	+12.8	Humphrey <i>et al</i> (1972) (15)
1.00	550	55.2	65.0	+ 9.8	Griffith <i>et al</i> (1968) (27)
1.00	300	26.2	35.5	+ 9.3	Moberg <i>et al</i> (1972) (16)
1.16	300	22.4	38.2	+15.8	Moberg and Carlberger (1973) (6)
1.34	290	31.0	39.4	+ 8.4	Brömster (1969) (15)
2.30	350	30.4	57.0	+26.6	Harvey <i>et al</i> (1970) (5)

Table Gastric emptying in male patients¹ with duodenal ulcers

¹K = Calorie density of meal (kcal/ml); V₀ = initial volume of meal (ml); t_{0.5} = half-time of meal (min); (1 Kcal = 4.18 Kj). t_{0.5} (Patients) was abstracted or derived from papers cited; t_{0.5} (normals) was calculated from t_{0.5} = V₀ (0.1797 - 0.1670e^{-K}) (Hunt and Stubbs, 1975): D = t_{0.5} (normals) - t_{0.5} (patients). A regression analysis of D upon K gives: D = 0.2853 + 10.6727K (SE(Intercept) + 2.6222; SE (slope) + 1.7996)

it would be by an equivalent stimulus in healthy men.

Gastric emptying can be influenced by the interaction of nerves and hormones on smooth muscle. These nerves and hormones may also have effects on metabolism. Since patients with duodenal ulcer may be expected to have inflammatory damage of the duodenal mucosa, they may also have abnormal release by food of hormones controlling metabolism. The low fasting serum lipids (Zuber and Wozniak-Zuber, 1967) and the high serum insulin following oral glucose (Buchanan, McKiddie, Lindsay, and Manderson, 1967) in duodenal ulcer patients are interesting in this context.

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