Body weight and maximal acid output*

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Summary

Dose-response curves were obtained from forty male control subjects and forty male patients with duodenal ulcer from India on the subcutaneous histamine test.

The body weight and maximal acid output (MAO) showed a positive correlation just significant at the 5% level in control subjects ($P=0.05$) but not in patients with duodenal ulcer.

The values of MAO on dose-response curves are comparable in control subjects but are appreciably lower in patients with duodenal ulcer from India compared with those from Britain and North America. However, the values expressed as $\mu\text{Eq/kg}$ body weight are considerably higher in both groups of subjects from India compared with those from western populations.

DATA showing the relationship of 'maximal' acid output (MAO) to body weight are conflicting. Between these two parameters, no correlation was observed in the augmented histamine test (AHT) (Kay, 1953) in male or female patients with peptic ulcer from Britain and in male control subjects from Britain (Baron, 1964) and India (Vakil & Mulekar,

1965; Goyal, Gupta & Chuttani, 1966) but a significant positive correlation was observed in infants (Rodbro, Krasilnikoff & Christansen, 1967), children (Ghai *et al.*, 1965; Kopel & Barbero, 1967; Lari, Lister & Duthie, 1968) and adult female control subjects from Britain (Baron, 1964) and India (Vakil & Mulekar, 1965) (Table 1). A positive correlation was also observed in rats (Shay, Sun & Grunstein, 1954) and dogs (Baron, unpublished data).

The object of this study was to perform dose-response curves with subcutaneous histamine in male control subjects and patients with duodenal ulcer with a view to estimating MAO accurately in each individual included in the study and to observe its relationship to body weight.

Material and methods

Control subjects and patients

Forty adult male healthy subjects (average age 28.3 years) and forty male patients (average age 36.4 years) with duodenal ulcer (radiologically confirmed) were included in the study.

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TABLE 1. Relationship of body weight (BW) and lean body mass (LBM) to acid output

Author and date	Subjects	Weight (kg)	Method	Correlation	Conclusion
Cox (1952)	Peptic ulcer	—	Autopsy	BW and PCM	No
Baron (1964)	Control males	67.9	AHT	BW and PAO	No
	DU males	70.0	AHT	BW and PAO	No
Vakil & Mulekar (1965)	Control males	50.6	AHT	BW and MAO	No
Goyal <i>et al.</i> (1966)	Control males	62.9	AHT	BW and MAO	No
	DU males	57.9	AHT	BW and MAO	No
Lawrie & Forrest (1965)	Control males	—	IHT*	BW and PAO	No
Desai <i>et al.</i> (1969)	Control males	51.9	IHT†	BW and PAO	No
Baron (1964)	Control females	68.4	AHT	BW and PAO	Yes
Vakil & Mulekar (1965)	Control females	50.6	AHT	BW and MAO	Yes
Ghai <i>et al.</i> (1965)	Children	25.3	AHT	BW and MAO	Yes
Rodbro <i>et al.</i> (1967)	Infants	11.3	AHT	BW and MAO	Yes
Hume & Melrose (1967)	Control (M + F)	—	AHT	LBM and MAO	Yes
	DU (M + F)	—	AHT	LBM and MAO	Yes
Baron (1969)	Control males	67.9	AHT	LBM and MAO	Yes
	Control females	58.4	AHT	LBM and MAO	Yes

MAO, Maximal acid output; PAO, peak acid output.

* 0.04 mg/kg/hr.

† 2.00 mg/kg/hr.

Method

Subcutaneous histamine tests (SHT) were performed as described in a previous study (Desai, Zaveri & Antia, 1970). MAO (0–60 min) was calculated by method of Card & Marks (1960).

Thirty-nine control subjects and thirty-six patients with duodenal ulcer received doses of 1.6, 2.0, 2.4, 2.8, 3.2 mg histamine acid phosphate (HAP) subcutaneously on different days and one control subject and four patients with duodenal ulcer included from a previous study (Desai, Borkar & Jeejeebhoy, 1967) received 40, 50, 60 $\mu\text{g/kg}$ body weight doses of HAP. Six control subjects (with the minimal value of HAP of 1.6 mg for MAO) also received a 1.2-mg dose of HAP.

Results

Body weight and maximal acid output

Control subjects. The mean and standard deviation (SD) of body weight and MAO were 47.6 ± 9.17 kg and 20.7 ± 7.22 mEq/hr respectively. A positive correlation between these two parameters was just significant at 5% level (Fig. 1; $r = +0.31$, $P = 0.05$). The mean and SD of the value of acid output expressed as $\mu\text{Eq/kg}$ body weight/hr was 441.0 ± 148.9 .

Patients with duodenal ulcer. The mean and SD of body weight and MAO were 47.0 ± 8.79 kg and 30.06 ± 10.04 mEq/hr respectively. No correlation was observed between these parameters (Fig. 1;

$r = 0.05$, $P > 0.05$). The mean and SD of the value of acid output expressed as $\mu\text{Eq/kg}$ body weight/hr was 658.5 ± 235.8 .

The average values of MAO in control subjects (20.7 ± 7.22 mEq/hr) and patients with duodenal ulcer (30.06 ± 10.04 mEq/hr) showed significant differences ($P < 0.01$) and the values expressed as $\mu\text{Eq/kg}$ body weight/hr were also significantly different in these two groups ($P < 0.01$).

Body weight and minimal dose of histamine (independent of, or in relation to body weight) for MAO

Control subjects. A significant positive correlation was observed between body weight and the minimal dose of HAP, independent of body weight, for MAO (Fig. 2; $r = +0.43$, $P < 0.01$) and a significant negative correlation was observed between the body weight and the minimal dose of HAP, in relation to body weight, for MAO (Fig. 3, $r = -0.35$, $P < 0.05$) i.e. greater the weight of the subject, higher the 'absolute' dose and smaller the dose of HAP, in relation to body weight, for stimulating MAO.

Patients with duodenal ulcer. No correlation was observed between the body weight and the minimal dose of HAP, independent of body weight, for MAO (Fig. 2; $r = +0.08$, $P > 0.05$) but a highly significant negative correlation was observed between the body weight and the minimal dose of HAP, in relation to body weight, for MAO (Fig. 3; $r = -0.75$, $P < 0.001$).

FIG. 1. Correlation between the body weight and the maximal acid output in (a) control subjects and (b) patients with duodenal ulcer.

FIG. 2. Correlation between the body weight and the minimal dose of HAP, independent of body weight, for MAO in (a) control subjects and (b) patients with duodenal ulcer.

FIG. 3. Correlation between the body weight and the minimal dose of HAP, in relation to body weight, for MAO in (a) control subjects and (b) patients with duodenal ulcer.

Discussion

The relationship between body weight (or lean body mass, LBM) and MAO on SHT has been reported in several studies (Table 1). The difficulty of estimating MAO accurately in all individuals with

0.04 mg/kg body weight of HAP was recently emphasized (Desai, 1969; Stempien, 1970) as subjects weighing less than 60 kg receive a submaximal stimulus (Desai, Borkar & Jeejeebhoy, 1967a) while those weighing 80 kg or more may perhaps receive a

supramaximal stimulus causing a partial reduction of acid output (Desai *et al.*, 1969). In the present study, dose-response curves were hence performed to obtain MAO accurately in each individual. The body weight and the MAO showed a positive correlation in male control subjects which was just significant at 5% level ($r = +0.31$, $P = 0.05$) while no correlation was observed in patients with duodenal ulcer ($r = 0.05$, $P > 0.05$).

In the present study, the average value of MAO (20.7 mEq/hr) is appreciably higher than that reported (10.1, 12.0, 12.2, 16.9, 17.0) on AHT in studies from India (Raju *et al.*, 1963; Kedarnath & Garg, 1965; Vakil & Mulekar, 1965; Cowan, Joseph & Satija, 1966; Madangopalan, Subramaniam & Saroja, 1967). This value is comparable with that reported (22.4, 22.3, 17.1, 23.2 mEq/hr) on AHT for subjects from Britain and North America (Kay, 1953; Bruce *et al.*, 1959; Marks & Shay, 1959; Baron, 1963a). However, the average value of acid output expressed as $\mu\text{Eq/kg}$ body weight/hr (441) in our control subjects is higher than that reported (317) for subjects from Britain (Baron, 1969) due to the lower average body weight of Indian subjects. The average value of MAO (30.06 mEq/hr) in our male patients with duodenal ulcer from Bombay is considerably higher than that reported (17.9, 20.1, 25.0, 26.0) on AHT in studies from India (Raju *et al.*, 1963; Kedarnath & Garg 1965; Vakil & Mulekar, 1965; Cowan *et al.*, 1966; Madangopalan *et al.*, 1967). However, this value is still considerably lower than that reported (37.5, 37.0, 34.2, 39.6 mEq/hr) on AHT for subjects from Britain and America (Kay, 1953; Bruce *et al.*, 1959; Marks & Shay, 1959; Baron, 1963b). In contrast, the value of acid output expressed as $\mu\text{Eq/kg}$ body weight/hr (658.5) in our male patients with duodenal ulcer is considerably higher than that reported (608.2) for patients from Britain (Baron, 1969). The differences in values of $\mu\text{Eq/kg}$ body weight/hr in control subjects and patients with duodenal ulcer from India and Britain are in fact greater than indicated by these figures as the values of acid output were obtained from MAO (0–60 min) in the present study and from peak acid output (two highest consecutive 15-min values) in the study from Britain.

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