

# Investigation of gastroesophageal reflux in various positions with a two-lumen *pH* electrode

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**SUMMARY** Normal people without symptoms of reflux do in fact reflux small quantities of acid into the oesophagus when either standing or sitting, but do not reflux acid when they are sleeping lying flat. This 'physiological' incompetence in the upright position is not of great importance in that the oesophagus is able to, and consistently does, deal with small concentrations of refluxed acid material. The oesophageal measurements of *pH* have a limited use as a diagnostic measure and may indicate acid reflux in the relaxed person not demonstrated by radiology.

A number of patients have typical symptoms of oesophageal irritation but reflux is not demonstrated at fluoroscopy. Some of these patients show evidence of oesophagitis at oesophagoscopy; a few may have reflux demonstrated by radiology at a later date, but many clinicians feel that they should discard oesophageal irritation as a cause of symptoms if reflux is not demonstrated radiologically, even though the history suggesting reflux is classical. It seemed possible that the discrepancy might arise because the circumstances of the radiological examination did not mimic those in which sufferers experienced these symptoms, and so evidence of the presence of acid in the oesophagus was sought by an indwelling *pH* glass electrode. The *pH* of the oesophageal contents was estimated continuously throughout a 12- to 24-hour period, through a standard sequence of events and positions of the patient's body. Initial interest was in those who suffered from symptoms of reflux but it was desirable that evidence be sought in a similar way in those without symptoms or radiological evidence of reflux. The results obtained in those without symptoms or radiological evidence of reflux are particularly interesting and have an important bearing on the mechanism of symptom production in reflux.

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## Method

The Cambridge Instrument Company two-lumen stomach electrode was used (Fig. 1). This consists of a small glass bulb electrode with a fine coaxial wire in one lumen, the other containing saturated potassium chloride solution which is retained by a sintered plug and ends 1.5 cm proximal to the glass electrode. This proximity of the reference KCl electrode to the glass electrode eliminates the errors which occur if a finger is placed in the potassium chloride solution as the reference electrode. The whole electrode system can be passed easily through the nose (Fig. 2), giving the patient great freedom of movement and comparative comfort at night. The electrode was connected to a Cambridge Instrument *pH* meter, recording on a Record pen-writer with a paper speed of 6 in. per hour. The *pH* scale 0-10 occupied the full width of the paper and a continuous record for 24 hours was possible.

The electrode is passed in the ward about two hours after a light breakfast. With the patient erect, the radiologist positions the electrode in the stomach by reference to his estimate of the position of the hiatus and the dome of the diaphragm made during screening and with the films obtained at a previous barium meal. A

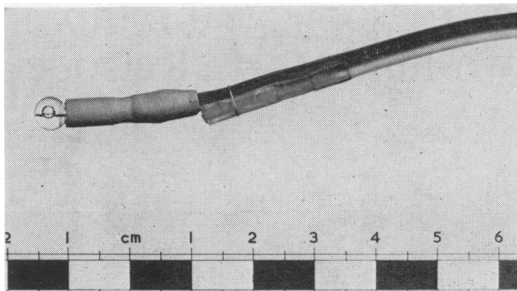


Fig. 1 *Detail of the electrode.*



Fig. 2 *Electrode in place showing oesophageal and gastric markers.*

small Sellotape band is wrapped round the tube, just below the nostril as the stomach marker. The electrode is then withdrawn so that it is about 5 cm above the estimated level of the hiatus and a second marker placed on the tube. An error in placing would be systematic, and the margin of error was such that the tip would always be above the cardiac sphincter unless a very large hernia was present. The tube is secured firmly to the cheek.

Early in the investigation, acid was found in the oesophagus when its presence there seemed unlikely, so oblique films were taken to see if there was any alteration in the position of the electrode between the standing and sitting positions (Figs. 3 and 4). Films of 10 patients in both

the standing and sitting positions showed no appreciable alteration in position.

The patient returns to the ward, the electrode is connected to the recording apparatus, and the patient remains seated until lunch. This consists of meat and vegetables or a salad, followed by a sweet, and is eaten standing up. The patient remains virtually upright for the next two hours if possible, getting some rest by propping himself on the edge of the bed. Some of the older patients have found it hard to remain upright for two hours and if they have complained, they have been allowed to sit on the edge of the bed.

Tea is taken sitting down at a table and the patient remains seated until supper, which is eaten in bed. At 21.30 hours the patient is given 400 mg of sodium amytal and, if desired, a warm milk drink, and at 22.00 hours he is settled down for the night on the right side and supported in this position by bolsters. At 01.30 hours the electrode is freed from the side of the face, pushed on to the stomach marker and secured in this position. After 30 minutes the patient sits upright, the electrode is withdrawn to the oesophageal marker, and he is given a drink of water to wash the electrode clean. He is then settled again for the remainder of the night on the left side. Sometimes the patient started the night on the left side and was later moved onto the right. The heavy sedation with sodium amytal has reduced the movement of patients on either the right or left side. At 06.30 hours the electrode is pushed into the stomach and withdrawn completely at 07.00 hours.

## Patients

The patients were divided into four groups: Group I consisted of 21 patients with symptoms and radiological evidence of reflux, either with or without hiatus hernia. In group II there were four patients with symptoms of reflux which was not seen at radiological examination. The control group, group III, contained 22 patients without symptoms and without radiological evidence of reflux. Nineteen had duodenal ulceration and so were likely to secrete amounts of acid greater than normal, so that it could be assumed there was acid content in the stomach available for reflux if such reflux did occur. The control group was subdivided. Group IIIa (12 patients) had the electrode in the oesophagus for a day and night with the same procedure as that carried out in groups I and II. The second half, group IIIb, consisted of 10 who were examined standing and sitting and sitting in bed during the day and the electrode was then moved into the stomach, where it remained all night. The record obtained during the night is not recorded here. In group IV there were two patients with radiological evidence of hiatus hernia with reflux with severe

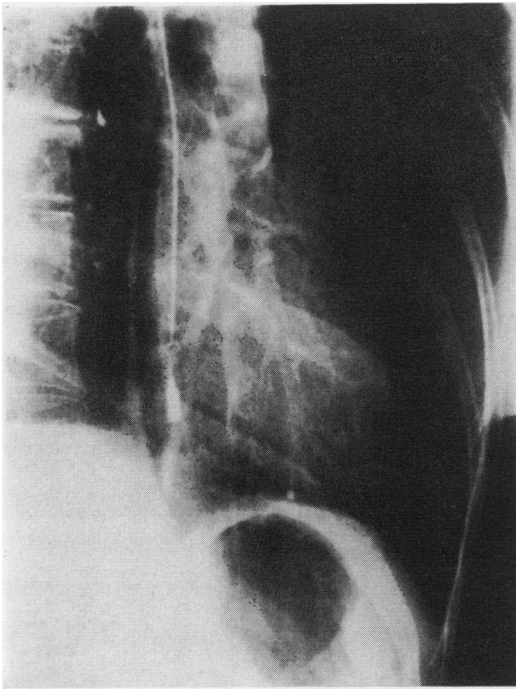


Fig. 3 Oblique radiograph in the standing position. Alteration in the position of the electrode is seen here as in Figure 4.

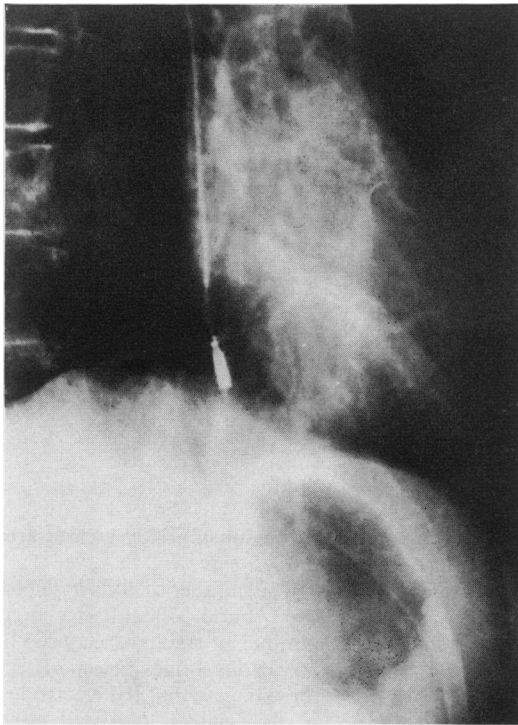


Fig. 4 Oblique radiograph in the sitting position. No alteration in the position of the electrode is seen compared with Figure 3.

symptoms, who were examined both before and after repair of the herniae, which was followed by marked clinical improvement.

## Results

The electrode is sensitive and reacts promptly. If the electrode is dipped in the acid gastric juice on the bench there is a sharp deflexion to the pH of the fluid; as the electrode is then withdrawn to air, there is a gradual return towards pH 4, which is the open circuit potential of the recording system. Kinking of the tube, sufficient to interrupt the electrical continuity of the KCl solution, will cause a sharp deflexion towards pH 4. A similar sharp deflexion can be obtained if the electrode is momentarily immersed in acid and then immediately cleaned by a neutral or alkaline solution, such as saliva. In practice it was usually possible to differentiate between a spurious deflexion and one due to a change in pH. When saliva is repeatedly swallowed as rapidly as possible after swallowing a small amount of HCl, there is some lag before neutralization is recorded, and it is likely that this lag would also occur after acid is refluxed into the oesophagus.

It is not possible to measure the amount of acid reaching the oesophagus by the present method but the frequency and duration of the fall in pH can be used to quantitate the reflux. The extent of the fall in pH will reflect to some extent the quantity of acid refluxed, and the duration of the fall will reflect the duration of exposure of the mucosa to the refluxed material. The tracings have been analysed, first, by measuring with a planimeter the area in  $\text{cm}^2$  between the trace and a baseline of pH 5 and, secondly, by counting the number of falls of pH to various values in four steps (ie, pH 1-2, 2-3, 3-4, and 4-5). A baseline of pH 5 gives a more accurate picture of the degree of reflux than would be obtained by using a baseline of pH 7, at which level the minor changes due to instability of the electrode and recording apparatus could give a misleading impression. A number of illustrative tracings are shown in Figs. 5, 6, 7, and 8, and the values obtained for the three groups of patients and the two subgroups of controls in Tables I, II, III, IV, and V. If the trace has been steady at a pH above 5 a zero is entered for the area measurement; if the trace has recorded a steady pH above 5, except for an occasional sharp deflexion with rapid return, a figure of 0.5 or less is entered for the area.

A fall in oesophageal pH indicates that acid has refluxed from the stomach, and it is clear from the records obtained in the asymptomatic patients with quiescent duodenal ulcers and no radiological evidence of reflux that short bursts of gastroesophageal reflux occurred at frequent

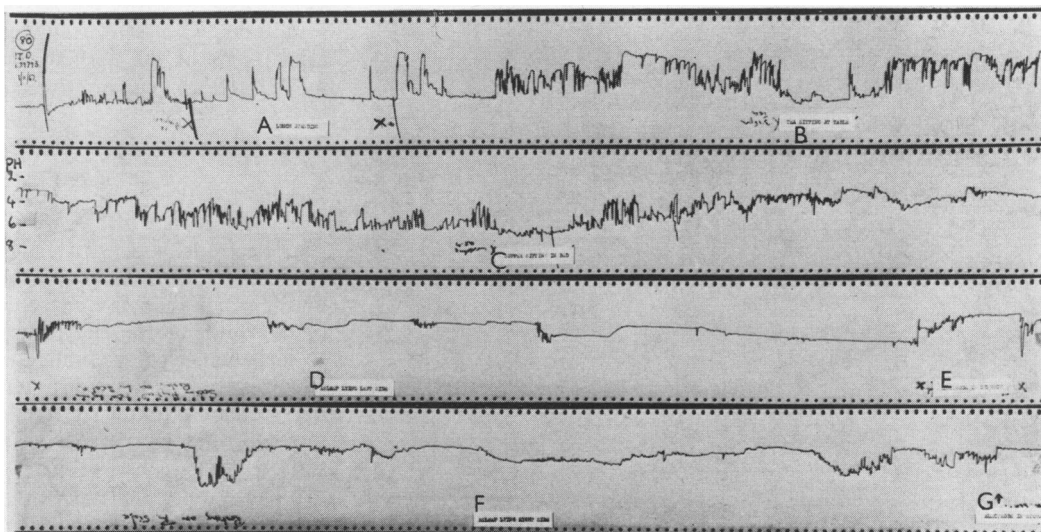


Fig. 5 A complete tracing from a patient with reflux, showing in particular the sustained level of acid in the oesophagus at night.

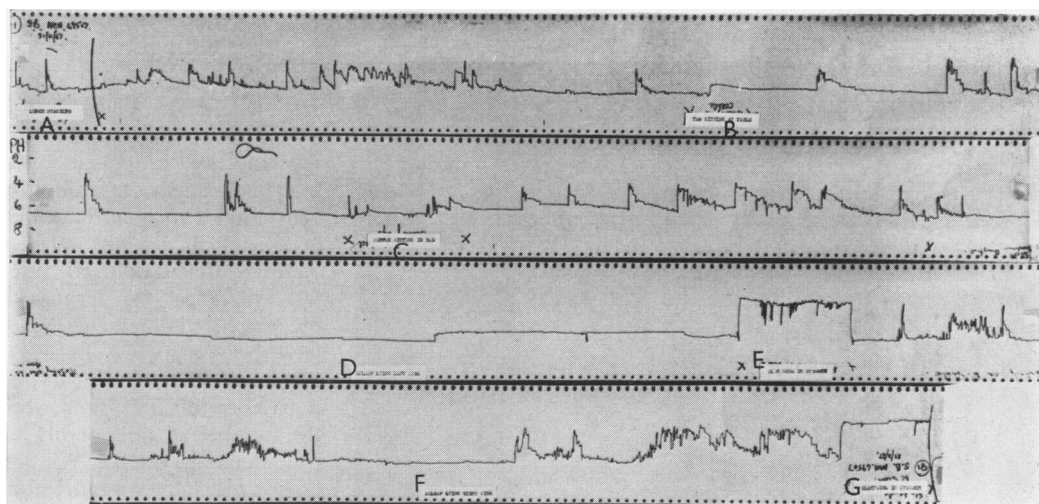


Fig. 6 A complete tracing from a patient with reflux, showing in particular the falls in pH when asleep on the right side.

Key to Figs. 5 and 6: A, lunch standing; B, tea sitting at table; C, supper sitting in bed; D, asleep lying on left side; E, electrode in stomach; F, asleep lying on right side; G, electrode in stomach.

intervals after meals in both the standing and sitting positions, but that when these patients were asleep, on either side, reflux was negligible.

By contrast, in those patients with symptoms and radiological evidence of reflux about the same area was recorded under the tracing as in those without symptoms when standing or sitting. For three-quarters of those with symptoms a substantially greater area was recorded under the curve when sleeping on the right side than for those without symptoms, and one patient

had a substantially greater area when sleeping on the left side.

The number of falls in pH to the various values was found difficult to quantitate because a number of tracings recorded a steady level of pH at various values below pH 5. These steady tracings suggest that the electrode was lying in a pool of fluid which persisted either because of sustained incompetence of the oesophagogastric closing mechanism, or because of failure of a peristaltic wave to wipe the oesophagus clean.

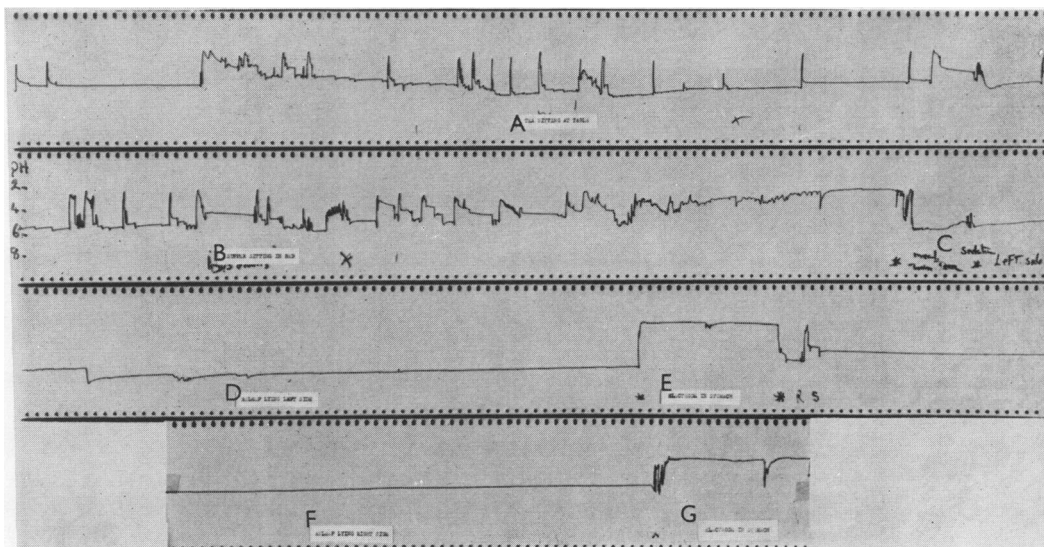


Fig. 7 A complete tracing from a control patient with a duodenal ulcer (key as for Figures 5 and 6).

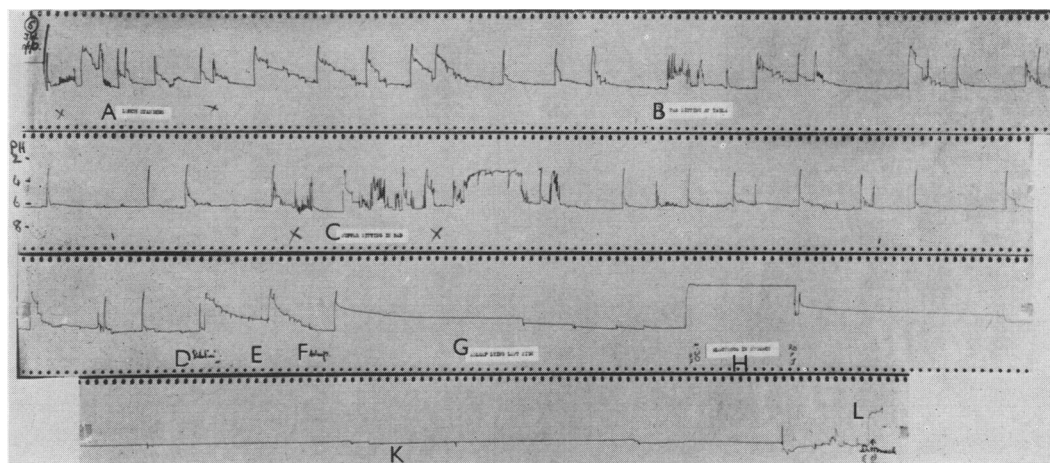


Fig. 8 A complete tracing from a control patient suffering from an anxiety state. It will be seen that the pattern of the tracing in the standing, sitting, and sitting in bed positions in Figs. 7 and 8 is not greatly different from that in Figure 6. However, there is no suggestion of acid in the oesophagus at night when asleep on either the right or the left side.

A, lunch standing; B, tea sitting at table; C, supper sitting in bed. D, Sedation. E, Patient restless. F, patient becoming drowsy; G, asleep lying left side; H, electrode in stomach; K, asleep lying right side; L, electrode in stomach.

The mean number of peaks recorded at each pH range in the controls was similar to the mean number recorded in those with symptoms of reflux, except during the night, when more peaks were recorded in those with symptoms of reflux.

## Discussion

The results indicate that reflux into the oeso-

phagus of gastric contents of low pH occurs almost as commonly in people without symptoms as in those with symptoms during the day when the patient is standing or sitting. Nor is the difference particularly prominent when the patient lies on the left side in bed. But those who suffer symptoms of reflux appear to reflux much more frequently when lying on the right side than do those who do not suffer symptoms. The similarity of the tracings obtained in both groups during the day might suggest that technical factors were

Tracing No.	Sex and Age (yr)	Clinical Condition	Stomach pH	Standing (2 hr)					Sitting (2 hr)				
				Area (cm <sup>2</sup> )	Peaks of pH				Area (cm <sup>2</sup> )	Peaks of pH			
					1 to 2	2 to 3	3 to 4	4 to 5		1 to 2	2 to 3	3 to 4	4 to 5
51	M 49	Reflux only	1.4	1.16	—	13	3	1	1.05	—	9	—	—
80	M 61	Hiatus hernia with reflux	2.0	25.6	—	Sustained trace			46.3	—	Sustained trace		
53	F 61	Slight reflux	2.0	—	—	Not recorded			—	—	Not recorded		
61	F 44	Hiatus hernia with reflux	1.6	—	—	Not recorded			—	—	Not recorded		
56	F 56	Hiatus hernia with oesophageal ulcer	1.8	—	—	Not recorded			—	—	Not recorded		
47	M 66	Reflux only	1.6	—	—	Not recorded			—	—	Not recorded		
3	F 66	Hiatus hernia with reflux	2.0	51.0	—	Sustained trace			49.0	—	Sustained trace		
48	M 48	Hiatus hernia with reflux	2.0	3.9	—	5	1	—	10.0	—	Sustained trace		
27	F 64	Hiatus hernia with reflux	1.9	—	—	Not recorded			1.6	1	8	—	—
23	F 49	Hiatus hernia with gastric ulcer	1.3	0.81	2	5	2	—	1.2	—	8	3	—
28	F 33	Hiatus hernia with reflux	1.2	18.0	6	8	3	2	11.6	6	4	3	—
8	M 74	Reflux only	1.4	25.5	1	8	1	—	8.1	2	4	3	—
9	M 74	Hiatus hernia with reflux	1.5	18.1	1	2	4	—	11.4	—	2	—	—
77	F 60	Hiatus hernia with reflux	1.4	4.67	—	2	4	4	5.2	2	3	2	—
65	F 73	Hiatus hernia with reflux	1.8	5.63	—	4	4	1	10.8	1	5	3	1
45	F 69	Hiatus hernia with reflux	1.7	—	—	Not recorded			—	—	Not recorded		
54	M 62	Hiatus hernia with reflux	1.6	—	—	Not recorded			—	—	Not recorded		
55	F 69	Reflux only	1.7	—	—	Not recorded			—	—	Not recorded		
50	F 75	Reflux only	2.0	—	—	Not recorded			—	—	Not recorded		
67	M 50	Hiatus hernia with reflux	2.2	33.9	—	Sustained trace			10.9	—	Sustained trace		
81	M 70	Reflux only	2.0	<0.5	—	—	5	11	2.2	—	2	1	2

Table I Values obtained from the tracings for patients in group I

Tracing No.	Sex and Age (yr)	Clinical Condition	Stomach pH	Standing (2 hr)					Sitting (2 hr)				
				Area (cm <sup>2</sup> )	Peaks of pH				Area (cm <sup>2</sup> )	Peaks of pH			
					1 to 2	2 to 3	3 to 4	4 to 5		1 to 2	2 to 3	3 to 4	4 to 5
16	M 62	Symptoms of reflux	2.2	—	—	Not recorded			—	—	Not recorded		
33	F 57	Symptoms of reflux	2.0	—	—	Not recorded			—	—	Not recorded		
42	M 42	Oesophagitis with bleeding	2.0	—	—	Not recorded			—	—	Not recorded		
12	F 65	Symptoms of reflux and oesophageal spasm	1.2	11.3	1	2	5	—	<0.5	—	2	2	—

Table II Values obtained from the tracing for patients in group II

Tracing No.	Sex and Age (yr)	Clinical Condition	Stomach pH	Standing (2 hr)					Sitting (2 hr)				
				Area (cm <sup>2</sup> )	Peaks of pH				Area (cm <sup>2</sup> )	Peaks of pH			
					1 to 2	2 to 3	3 to 4	4 to 5		1 to 2	2 to 3	3 to 4	4 to 5
26	M 62	Duodenal ulcer	2.2	1.45	—	1	1	1	0.5	—	1	—	—
22	M 40	Duodenal ulcer	1.4	0.96	2	2	2	—	4.74	3	6	1	—
30	M 38	Duodenal ulcer	1.2	14.2	12	2	—	—	9.67	13	—	3	6
31	M 52	Zollinger-Ellison syndrome	1.5	4.51	—	5	2	—	6.77	—	11	2	—
66	F 62	Duodenal ulcer	2.0	3.86	—	5	4	—	4.04	—	8	1	—
64	M 60	Duodenal ulcer	1.9	3.22	1	10	—	—	1.29	1	6	—	—
74	M 53	Duodenal ulcer	1.8	4.20	—	7	3	1	2.25	—	5	1	1
75	M 30	Duodenal ulcer	2.0	—	—	Not recorded			3.23	—	8	4	1
1	M 44	Duodenal ulcer	1.4	10.2	5	5	1	2	2.26	7	1	—	1
11	M 60	Duodenal ulcer	1.2	48.6	—	Sustained trace			42.5	—	Sustained trace		
5	M 36	Anxiety state	1.8	6.20	3	5	—	—	2.43	2	5	2	—
63	F 51	Anxiety state	1.8	—	—	Not recorded			—	—	Not recorded		

Table III Values obtained from the tracings for patients in group IIIa

Sitting in Bed (2 hr)					Asleep on Right Side (4 hr)					Asleep on Left Side (4 hr)				
Area (cm <sup>2</sup> )	Peaks of pH				Area (cm <sup>2</sup> )	Peaks of pH				Area (cm <sup>2</sup> )	Peaks of pH			
	1 to 2	2 to 3	3 to 4	4 to 5		1 to 2	2 to 3	3 to 4	4 to 5		1 to 2	2 to 3	3 to 4	4 to 5
1-2	—	7	2	4	0.7	—	1	—	—	0.0	Sustained trace			
53.0	Sustained trace				189.0	Sustained trace				166.0	Sustained trace			
5.05	Sustained trace				11.0	Sustained trace				0.0	Sustained trace 2			
8.25	Sustained trace				35.3	Sustained trace				0.0	—	1	—	—
6.0	Sustained trace				13.2	Sustained trace				6.1	Sustained trace			
7.3	Sustained trace				16.5	Sustained trace				19.2	Sustained trace			
49.3	Sustained trace				96.1	Sustained trace				93.5	Sustained trace			
10.0	Sustained trace				42.0	Sustained trace				6.2	—	3	—	—
8.1	—	7	4	—	20.1	Sustained trace				0.0	Sustained trace			
0.9	—	4	3	—	0.0	Sustained trace				0.0	Sustained trace			
21.2	3	8	8	2	0.0	Sustained trace				0.0	Sustained trace			
15.4	5	5	3	2	47.0	Sustained trace				100.0	1	3	5	—
20.9	2	1	2	—	33.8	Sustained trace				0.0	Sustained trace			
8.1	—	3	—	—	0.0	Sustained trace				0.0	Sustained trace			
26.4	2	4	—	—	0.0	Sustained trace				0.0	Sustained trace			
3.22	—	4	4	11	5.63	1	8	1	—	0.0	—	2	1	—
14.1	Sustained trace				108.0	Sustained trace				19.3	Sustained trace			
3.4	—	6	2	3	13.0	Sustained trace				1.69	—	—	5	—
0.64	—	1	4	—	8.25	—	5	2	—	0.0	Sustained trace			
13.2	Sustained trace				0.0	Sustained trace				0.0	Sustained trace			
4.6	—	—	8	—	11.2	—	4	4	5	0.0	Sustained trace			

Table I Values obtained from the tracings for patients in group I—continued

Sitting in Bed (2 hr)					Asleep on Right Side (4 hr)					Asleep on Left Side (4 hr)				
Area (cm <sup>2</sup> )	Peaks of pH				Area (cm <sup>2</sup> )	Peaks of pH				Area (cm <sup>2</sup> )	Peaks of pH			
	1 to 2	2 to 3	3 to 4	4 to 5		1 to 2	2 to 3	3 to 4	4 to 5		1 to 2	2 to 3	3 to 4	4 to 5
30.4	Sustained trace				<0.5	—	2	—	—	<0.5	—	2	1	—
4.35	—	4	3	4	79.0	Sustained trace				<0.5	—	—	1	
22.7	Sustained trace				63.5	Sustained trace				21.3	—	2	3	4
6.3	—	6	2	—	9.65	—	2	—	—	0.0	Sustained trace			

Table II Values obtained from the tracing for patients in group II—continued

Sitting in Bed (2 hr)					Asleep on Right Side (4 hr)					Asleep on Left Side (4 hr)				
Area (cm <sup>2</sup> )	Peaks of pH				Area (cm <sup>2</sup> )	Peaks of pH				Area (cm <sup>2</sup> )	Peaks of pH			
	1 to 2	2 to 3	3 to 4	4 to 5		1 to 2	2 to 3	3 to 4	4 to 5		1 to 2	2 to 3	3 to 4	4 to 5
0.5	—	4	2	1	0.0	Sustained trace				0.0	Sustained trace			
8.89	2	8	1	—	16.9	3	4	—	1	3.85	3	—	—	
6.29	9	1	3	1	0.0	Sustained trace				0.0	Sustained trace			
2.1	—	2	3	1	0.0	Sustained trace				0.0	Sustained trace			
16.8	—	5	3	1	0.0	Sustained trace				0.0	Sustained trace			
6.46	1	11	1	—	0.0	Not recorded				0.0	Sustained trace			
2.90	—	4	3	—	0.0	Sustained trace				0.0	Sustained trace			
3.70	—	7	7	1	0.0	Sustained trace				0.0	Sustained trace			
10.19	9	3	1	—	0.0	Sustained trace				0.0	Sustained trace			
44.5	Sustained trace				0.0	Sustained trace				0.0	Sustained trace			
5.81	—	7	2	1	1.99	—	3	—	—	0.0	Sustained trace			
0.96	—	2	3	—	0.0	Sustained trace				0.0	Sustained trace			

Table III Values obtained from the tracings for patients in group IIIa—continued

Tracing No.	Sex and Age (yr)	Clinical Condition	Stomach pH	Standing (2 hr)					Sitting (2 hr)					Sitting in Bed (2 hr)							
				Area (cm <sup>2</sup> )		Peaks of pH			Area (cm <sup>2</sup> )		Peaks of pH			Area (cm <sup>2</sup> )		Peaks of pH					
				1 to 2	2 to 3	3 to 4	4 to 5	1 to 2	2 to 3	3 to 4	4 to 5	1 to 2	2 to 3	3 to 4	4 to 5	1 to 2	2 to 3	3 to 4	4 to 5		
72	M 60	Duodenal ulcer	2.0	16.1	Sustained trace					28.2	Sustained trace					8.6	Sustained trace				
69	M 36	Duodenal ulcer	2.2	7.9	—	9	2	3	5.8	—	8	2	2	2.4	—	6	3	2			
19	M 58	Duodenal ulcer	2.0	8.6	—	8	1	—	18.5	—	3	1	1	4.84	—	3	2	—			
71	M 33	Duodenal ulcer	2.4	Not recorded					2.57	4	15	11	1.28	4	12	3					
44	M 50	Duodenal ulcer	1.8	3.7	—	4	—	7.69	—	4	1	1.29	—	4	2						
13	M 65	Duodenal ulcer	1.6	19.9	Sustained trace					1.77	3	2	—	3.22	—	8	—				
60	M 52	Duodenal ulcer	2.0	2.41	—	3	4	—	3.06	—	1	6	1	2.7	—	1	5	3			
15	M 55	Anxiety state	1.8	37.1	Sustained trace					53.9	Sustained trace					10.4	Sustained trace				
29	M 46	Duodenal ulcer	1.5	25.1	Sustained trace					42.5	Sustained trace					25.0	Sustained trace				
57	F 72	Duodenal ulcer	2.0	34.0	Sustained trace					49.0	Sustained trace					39.7	Sustained trace				

Table IV Values obtained from tracings for patients in group IIIb

Tracing No.	Sex and Age (yr)	Clinical Condition	Stomach pH	Standing (2 hr)					Sitting (2 hr)						
				Area (cm <sup>2</sup> )		Peaks of pH			Area (cm <sup>2</sup> )		Peaks of pH				
				1 to 2	2 to 3	3 to 4	4 to 5	1 to 2	2 to 3	3 to 4	4 to 5	1 to 2	2 to 3	3 to 4	4 to 5
3	F 66	Hiatus hernia with reflux	2.0	51.0	Sustained trace					49.0	Sustained trace				
6	F 67	Same patient 5 months later	1.8	66.3	Sustained trace					102.0	Sustained trace				
2	F 67	Same patient 5 months after repair	2.0	69.2	Sustained trace					20.5	Sustained trace				
48	M 48	Hiatus hernia with reflux	2.0	3.87	—	5	1	—	13.04	Sustained trace					
49	M 49	Same patient 7 months after repair	1.2	<0.5	1	—	1	5	<0.5	2	—	2	3		

Table V Values obtained from tracings for patients in group IV



blurring the result or that artefacts were entirely responsible for the tracings, but the dissimilarity of the night tracings and the experiments *in vitro* suggest that the method and the results obtained are valid.

Whether or not a person complains of reflux seems therefore to depend not so much on the occurrence of reflux as on the sensitivity of the oesophagus when reflux occurs. What determines the sensitivity of the oesophagus may be the amount of reflux which occurs during the night

and especially that which occurs when the subject is sleeping on the right side.

I wish to thank Dr D. A. W. Edwards of the MRC Department of Clinical Research, University College Hospital, London, for his continued encouragement and advice throughout this work, and the East Anglian Regional Hospital Board for a grant from its clinical research fund.

<i>Sitting in Bed (2 hr)</i>					<i>Asleep on Right Side (2 hr)</i>					<i>Asleep on Left Side (2 hr)</i>				
<i>Area (cm<sup>2</sup>)</i>	<i>Peaks of pH</i>				<i>Area (cm<sup>2</sup>)</i>	<i>Peaks of pH</i>				<i>Area (cm<sup>2</sup>)</i>	<i>Peaks of pH</i>			
	<i>1 to 2</i>	<i>2 to 3</i>	<i>3 to 4</i>	<i>4 to 5</i>		<i>1 to 2</i>	<i>2 to 3</i>	<i>3 to 4</i>	<i>4 to 5</i>		<i>1 to 2</i>	<i>2 to 3</i>	<i>3 to 4</i>	<i>4 to 5</i>
49.3	Sustained trace				96.1	Sustained trace				93.5	Sustained trace			
124.5	Sustained trace				142.0	Sustained trace				88.1	Sustained trace			
86.0	Sustained trace				0.0	Sustained trace				74.0	Sustained trace			
10.0	Sustained trace				42.0	Sustained trace				6.22	—	3	—	—
3.69	2	3	5	7	4.61	—	9	—	—	0.0	—	3	—	—

Table V Values obtained from tracings for patients in group IV—continued