Role of Saliva in the Aetiology of Peptic Ulcer

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Brit. med. J., 1965, 1, 1220-1222

Big differences in the incidence and severity of peptic ulcer in various parts of India have been reported by several workers (Somervell and Orr, 1936; Dogra, 1940; Hadley, 1959; Malhotra, 1964; Malhotra *et al.*, 1964).

Dogra found there were thirteen times as many cases among the population of Madras as compared with the Punjab. While the ulcer is rare in the arid plains of the Punjab, it is by no means uncommon in its humid hill districts (Wig, 1959). In an earlier communication these striking geographical variations were ascribed to the differences in the food habits producing different kinds of salivary secretions (Malhotra, 1964). In this study these variations in some of the properties of saliva have been examined by quantitative methods.

Materials and Methods

Thirty-one healthy South Indian adults (30 men and 1 woman) were included in the experiment. Each volunteer was given three different diets: South Indian ragi, South Indian boiled rice, buttermilk, and hot lentil soup; and the Punjabi diet. The diets were standardized as regards quantity, the method of cooking, and eating. The meals were taken in a room adjoining the work-bench in the laboratory to facilitate immediate examination of the saliva, as changes take place in some of its properties on keeping. The interval between different foods was not less than three hours.

Specimens of saliva were collected for a two-minute period before breakfast and after the different diets by spitting direct into a test-tube surrounded with ice. This step prevents polymerization of mucin (Dewar and Parfitt, 1954). An interval of two minutes was allowed after finishing the meal to avoid any gross particles being voided in the saliva. The samples of saliva were labelled by a blind technique, so that the type of diet eaten by the volunteers was not known while titration was being carried out.

Buffer capacity was determined by a modification of Hanke's (1937) method. In this, 0.5 ml. of saliva is mixed with 0.5 ml. of N/10 NaOH to dissolve the mucus. Titration is done against N/10 HCl, using 2 drops of 1% solution of methyl red as indicator. The titration was done immediately on collection (within one minute), as the buffer capacity has been observed to undergo slight changes if saliva is allowed to stand for too long.

Estimation of mucus content was done by the Congo red and alcohol (ACRA) method of Burnet (1948). The specific gravity was determined by the method of Willmore (1937). The remaining portion of the saliva was kept in a boiling-water bath for 10 minutes and utilized to determine the titre of the group-specific substances by inhibition technique (Boorman and Dodd, 1961).

When freshly voided saliva is kept in the water-bath it starts frothing owing to the escape of the dissolved gases. The time taken for the frothing to stop was recorded for each specimen,

as it was felt that this period could be used as a rough measure of the gaseous content of the saliva.

After the escape of gases it was easier to measure the volume, which was adjusted by adding 0.7 ml. removed earlier for the buffer capacity and ACRA estimations.

Results

Volume and Buffer Capacity.—The mean values for buffer capacity and the volume showed the highest readings after the Punjabi meals, less so after the South Indian food, and least with ragi, being 0.55, 0.54, 0.60, and 0.68 for buffer capacity, and 1.99 ml., 2.27 ml., 2.36 ml., and 3.38 ml. for volume, in respect of unstimulated saliva and after ingestion of ragi, the South Indian diet, and the Punjabi food respectively (Table I). The total volume of saliva swallowed per meal is much greater with the Punjabi food, as it requires longer mastication than the sloppy South Indian diets.

TABLE I.—Mean Values of Saliva

	Unstimulated		Ragi		South Indian Food		Punjabi Food	
	Mean	± S.E.	Mean	± S.E.	Mean	± S.E.	Mean	± S.E.
Volume (ml.)	1.99	0.1316	2.27	0.1886	2.36	0.1813	3.38	0.2488
Buffer capacity*	0.554	0.0016	0.546	0.0026	0.606	0.0061	0.682	0.0069
Frothing-time	131	9.88	170	13.06	173	11.27	220	13.82

* ml. N/10 HCl against 0.5 ml. saliva and 0.5 ml. NaOH.

Gaseous Content.—Frothing, due to the escape of dissolved gases such as nitrogen, oxygen, and carbon dioxide in solution, was generally more with the Punjabi food than with either ragi or the South Indian form of diet (Table I).

Group-specific Substances.—Seven subjects were non-secretors in all specimens, except one non-secretor of B group who secreted 1:64 after ragi but not with other foods. The titre variations in the 24 secretors ranged between 1:256 and 1:2,048. There were titre differences in 14 subjects of one dilution, in four subjects of two dilutions, in two subjects of three dilutions, and in two subjects of four dilutions; in the remaining two there were no differences with different foods.

ACRA Titre.—The mucin content as determined by ACRA titre showed individual differences not only from subject to subject but also with different diets. Specimens of secreted saliva which had a higher titre showed a greater concentration of the group-specific substances except in five subjects. Detailed results of group-specific substances and ACRA titre will be reported elsewhere.

Specific Gravity.—Contrary to the findings of Willmore (1937), and Dewar and Parfitt (1954), we have found no constancy in the specific gravity of saliva after various stimuli. In fact, saliva shows wide variations in specific gravity with different foods, ranging from 997 to 1010, presumably because of the variations in the mucin and electrolyte content (Table II).

Discussion

From the data in Tables I, II, and III it is seen that the effect of foods like the Punjabi diet, which requires much

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mastication, is the production of larger quantities of saliva of a higher buffer capacity than is the case with sloppy foods like ragi. Both these factors will help to reduce the acid level in the stomach to a greater extent than diets producing a saliva of a lower buffer capacity and in smaller total quantity. On the other hand, food such as the South Indian rice and curry or ragi produce a salivary secretion which lacks this capacity. In the case of ragi gruel, which requires no mastication, the buffer capacity is, in fact, lower than in the case of even unstimulated saliva. If mastication is the important thing, it is to be assumed that diets which do not require much mastication, be it the Western-style foods, or the simple maize gruel (staple diet of ulcer-prone Meenas and Dangas of Rajasthan), or sattoo (staple diet of the lower-income group, ulcer-prone Assamese and Bengalis), will have a similar lack of competence to meet the challenge of the stomach acidity.

TABLE II.—Analysis of Variance Tables

	Source	D.F.	M.S.S.	F	P
Volume	Due to diet	3	10.8119	10.3206	<0.001
	Residual error	111	1.0476		
Buffer capacity	Due to diet	3	0.1125	160.7	<0.001
	Residual error	111	0.0007		
Frothing-time	Due to diet	3	33965.87	9.54	<0.001
	Residual error	97	3560.70		

M.S.S. = Mean Sum of Squares
D.F. = Degrees of Freedom

TABLE III.—F Values for Different Comparisons

	I v. II	I v. III	I v. IV	II v. III	II v. IV	III v. IV
Volume F _{1, 111}	1.01876	27.6339†	1.9924	15.7905†	0.1055	14.6444†
Buffer capacity F _{1, 111}	1.3294	361.7143†	78.4286†	324.1428†	70.8571	123.2799†
Frothing-time F _{1, 97}	5.2207*	28.5315†	6.3291*	8.6719†	0.0402	7.6889†

* 5% level of significance. † 1% level of significance.

The above table gives the F values for different comparisons between I, II, III, and IV where I = unstimulated saliva, II = measurements based on saliva after ingestion of ragi, III = measurements based on saliva after ingestion of Punjabi type of food, and IV = measurements based on saliva after ingestion of South Indian type of food in volume, buffer capacity and frothing-time.

F values are based on error mean sum of squares of the analysis of variance.

The results of ACRA titre did not show any correlation with the buffer capacity, and it is therefore to be assumed that salivary mucin plays little part in the neutralization of the acid. The work of Sand (1951), Thaysen, Thorn, and Schwartz (1954), and Wechsler (1959) suggests that an appreciable proportion of the salivary bicarbonate in saliva and the dissolved CO₂, which contribute to its buffer capacity, are derived not only from the plasma but from the metabolism of the salivary glands, which shows an increase with mastication. This is supported by the correlation found between the buffer capacity and frothing-time (Tables I and II) in this study.

The significance of the variations in the titres of the group-specific substances, marked in some cases, and the ACRA titres with different foods in the same individuals is not clear. These differences had no uniform pattern in relation to particular diets, being higher with one type in some individuals and with another type in others, although these were correlated to each other: antigen titre being higher in specimens with a higher ACRA titre.

As mentioned earlier (Malhotra, 1964), saliva also has the capacity to reduce the clotting-time of blood, thus accelerating blood coagulation in a fresh mucosal trauma. Nour-Eldin and Wilkinson (1957) have shown saliva to possess activities resembling those of platelets, Christmas factor, and the anti-haemophilic factor. Saliva may thus also help to seal such a break in the duodenal mucosa and thus prevent ulceration in addition to its effect on the stomach HCl.

Conclusions

Diet has been found to influence certain properties of saliva, notably the quantity, buffer capacity, mucin content, and antigen titre. The total quantity and the buffer capacity are increased in the saliva produced with diets requiring proper mastication. Since peptic ulceration is the result of local breakdown of duodenal mucosal resistance in the face of what is usually an increased acid-pepsin aggression, a hypothesis is advanced that saliva of a higher buffer capacity and in larger total quantities swallowed with certain types of foods will check that cause. Saliva may also help to seal mucosal trauma in the stomach and duodenum owing to its property of reducing clotting-time and promoting healing.

While the role of variations in the mucin content and antigen titre with different foods is obscure, and is worthy of further investigation, the preparation of diets in a manner which requires thorough mastication and ingestion of large quantities of saliva of a slimy consistency and of a higher buffer value offers an explanation for the rarity of duodenal ulceration among the Punjabis as compared with the South Indians.

We are indebted to Miss P. A. Master, of Human Variation Group, Indian Cancer Research Centre, Bombay, for invaluable assistance in the statistical analysis. The group sera were obtained from the Red Cross Blood Bank, and the Director, Haffkine Institute, Bombay, to whom our thanks are due. We also wish to thank Dr. K. Janardanan for his help in collecting the samples.

Summary

Big differences in the prevalence of peptic ulcer in various parts of India were ascribed to the differences in salivary secretions produced by various food habits.

Effects of three different Indian diets on some properties of saliva have been studied by quantitative methods in 31 healthy adults.

Results showed that larger total quantities of saliva of a higher buffer capacity were secreted with Punjabi diet, which required thorough mastication, than was the case with sloppy South Indian foods. It is suggested that this will counteract the challenge of increased acid-pepsin aggression, the cause of local breakdown of mucosal resistance in duodenal ulcer, and thus also explain the rarity of ulcer in the Punjab as compared with South India. Variations were also observed in mucus and group-specific substances with different foods; but their significance is not clear, and requires further study. Saliva may also help in sealing fresh mucosal trauma by its property of reducing blood-clotting and promoting healing.

A Note on Diets

1. *Ragi (Eleusine coracana)*.—This is a common South Indian food eaten by low-income groups, among whom the incidence of peptic ulcer is the highest (Raghvachari, 1959). Its food value is: C. 76.3%, F. 1.3%, P. 13.1%. Its *in vitro* buffer capacity is nil, and it does not contain substances similar to blood group A or B antigens. The ragi powder is boiled in water, and is taken cold in the form of a thin gruel with salt or sugar, and, being "sloppy," it does not require any mastication.

2. *South Indian Rice and Curry*.—This is a bulky diet consisting of boiled rice, which is macerated with the fingers before eating, sambar (hot lentil soup), rasam or pepper-water, and buttermilk. None of the ingredients has substances similar to the blood-group antigens. Sambar, pepper-water, and buttermilk are slightly acidic: 0.5 ml. of each is capable of neutralizing 0.02 ml., 0.05 ml., and 0.08 ml. of N/10 NaOH respectively. It is interesting that in spite of the *in vitro* acidity, these foods produce an alkaline saliva. Being "sloppy," this type of diet has a tendency to be bolted down and is taken cold. Since the diet is bulky it is likely that it would produce a larger amount of HCl by the stimulus of distension.

3. *Punjabi Food*.—(a) Thick wheat chapatti with a lot of ghee (butter fat). (b) Dal urd (*Phaseolus mungo*) is made as a thick viscous curry with spices and chillies and a lot of ghee. (c) Rawan (*Vigna sinensis*) is made as thick curry after frying the beans; all the ingredients have a neutral reaction *in vitro* and no group-specific substances. Punjabi food is taken simmering hot and requires a good deal of mastication.

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Results of Behaviour Therapy in 77 Psychiatric Patients

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Brit. med. J., 1965, **1**, 1222–1225

Behaviour therapy has recently attracted interest and controversy, but results are still uncertain in view of conflicting reports. On the one hand, Wolpe (1958) has claimed that 90% of neurotic patients improved considerably with treatment, and similar enthusiastic reports have been made by Lazarus (1963). On the other hand, the only controlled follow-up study available (Cooper, 1963), although too small to allow definite conclusions to be reached, suggested that behaviour therapy had an advantage only in phobic patients. The frequent report of an improvement rate of about 70% in a mixed group of neurotic patients must be borne in mind when assessing these and other new therapeutic claims—for example, Giel *et al.* (1964).

The value of general statements about the effectiveness of therapy increases with the number of patients studied and with the degree of control available, and with this in mind the results of behaviour therapy in 77 psychiatric patients treated at the Bethlem Royal and Maudsley Hospitals and followed up for one year have been collected together in this paper. The patients suffered from a variety of neurotic disorders. Thirty of the 77 have already been reported by Cooper (1963), 31 who were treated for specific and generalized phobias are described in detail elsewhere (Marks and Gelder, 1965), and the remaining 16 (including 5 with obsessional neurosis and 8 with writers' cramp) are described here for the first time. The same method of retrospective comparison with control cases has been used for all the 77 patients, allowing them to be grouped together for the purpose of a general discussion of behaviour therapy (satisfactorily matched control cases were found for 55 out of the 77 patients).

Method

Assessment

This is described in detail elsewhere (Cooper, 1963; Marks and Gelder, 1965). Briefly, patients were included in the behaviour therapy groups only where they had five or more

treatment sessions. A similar criterion was used for inclusion of controls, except for three with "other phobias" and two with writer's cramp, where owing to scarcity of cases fewer treatment sessions were accepted. (Any bias present from this would have favoured behaviour therapy.) Control cases with the same diagnoses, but who had had treatment other than behaviour therapy, were matched with the behaviour-therapy cases, first for sex and type of symptom, and then as closely as possible for age and for duration and severity of symptoms. All available information about patients' symptoms and activities before and after treatment was then extracted from the case-notes of both the behaviour-therapy and control cases, and put through a process of blind assessment by two independent judges. Assessments were made of the patients' state before treatment, at the end of treatment, and one month and one year after the end of treatment on a specific five-point symptom improvement scale and also on a general improvement scale. Results on the general improvement scale are not reported here as information on this aspect was too scanty.

Enuresis, encopresis, and school phobias were not included in this study.

Clinical Features of the Various Groups

Sixty-one of the patients have already been reported elsewhere, so their clinical features are only briefly noted.

Agoraphobias (29 cases—23 female).—These included fears of being alone, in the street or travelling. All were in-patients, and were severely handicapped by long-standing symptoms starting in early adult life—mean duration 10 years, mean age at treatment 34. Many had previous psychiatric admissions and other psychiatric symptoms. They were much more disabled than the patients of Wolpe (1958) and Lazarus (1963). Controls were well matched.

"Other Phobias" (12 cases—10 female).—These had mainly fears of specific objects—for example, animals, insects, thunder—and as so few were available they were harder to match with controls. Only two were in-patients, and all had phobias of very long standing, largely starting in early childhood—mean duration 19 years, mean age at treatment 28. They were much

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