

Epidemiological study of peptic ulcer in the south of India

Observations from Madras on the changing incidence of peptic ulcer, with special reference to causation

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EDITORIAL COMMENT The evidence from this study suggests that peptic ulcer in India is no different essentially from peptic ulcer seen in western countries. This is a valuable epidemiological study with interesting speculation on aetiology. The study of regional differences may contribute towards the final solution of the ulcer problem.

Big differences in the prevalence of peptic ulcer are known to exist in different parts of India (Somervell and Orr, 1936; Dogra, 1940; Hadley, 1959; and Malhotra, 1964). It is also believed that peptic ulcer is different from the disease in the west in being less acute and less likely to bleed or perforate (Somervell and Orr, 1936; Raghavachari, 1959; and Gregg, 1959). Although the geographical variations in ulcer frequency noted by previous workers are mirrored in more recent studies (Konstam, 1959; Hadley, 1959; Malhotra, 1964, 1965; Malhotra, Majumdar, and Bardoloi, 1964), it is less certain whether the disease is different from the disease in the west, and our previous study of peptic ulcer in Assam (north-east part of India) has formed the basis for the conclusion that peptic ulcer in India is no different from peptic ulcer seen in the west (Malhotra *et al.*, 1964). The study reported in this paper was undertaken to determine the incidence and behaviour of ulcer, as it now occurs in the south of India.

MATERIAL AND METHODS

The study is confined to 30,942 railway workers, all south Indians, between the ages of 18 and 55 years, and

their families who live and work in the city of Madras. This number is derived by totalling the number of railway employees on the pay-rolls for the period 1 January 1961 to 31 December 1964, and dividing this by 4. The hospital services for this population are provided almost exclusively by the Perambur Railway Hospital at Madras and its associated units. The services provided are comprehensive, free of charge, and include all the specialities.

ASCERTAINMENT OF CASES The following methods of case findings were used:

1 All case records of peptic ulcer patients admitted to the hospital during the period from 1 January 1961 to 31 December 1964 were collected by a systematic search of the case records, which were then individually studied, and the relevant clinical data were gathered for each case on a separate record card modified from I.C.M.R. (1959). Patients treated as out-patients have not been included because of the serious disadvantages of the out-patients' records occasionally being less precise and complete and of varying competence. Data on perforation were especially studied, as perforation of an ulcer is usually a particularly painful and serious disease and expedites hospital admission in all in whom it develops. The incidence of perforation, therefore, would give an indication of the incidence of ulcer.

TABLE I
NUMBER OF ADMISSIONS FOR PEPTIC ULCER IN MADRAS RAILWAY HOSPITAL FROM 1 JANUARY 1961 TO 31 DECEMBER 1964

<i>Employees Served</i>	<i>Total In-patient Admissions for All Diseases</i>	<i>No. of Peptic Ulcer Cases</i>	<i>Percentage of Total Admissions</i>	<i>Four-year Incidence Rates (% of population)</i>	<i>Annual Incidence Rates of Active Ulcer (% of population)</i>
30,942	29,694	469	1.6	1.5	0.4

2 Railway employees have to obtain a medical certificate in the case of absence due to illness. Those certificates bearing a diagnosis of ulcer provided an additional source of information to check the clinical data.

To get a more realistic picture of the incidence of ulcer, a survey of a random sample of the railway staff was undertaken at the head office of the railway and at the integral coach factory, in which 520 railway employees from the head office of the railway and 840 railway employees from the furnishing shops of the integral coach factory were interviewed directly, using a prepared proforma (I.C.M.R., 1959).

DIAGNOSTIC CRITERIA The diagnostic criteria are the same as used in previous reports (Malhotra, 1964; Malhotra *et al.*, 1964), and consist of clinical signs and symptoms corroborated by radiological findings; an ulcer crater or a persistent and characteristic deformity of the duodenal cap with localized tenderness; or surgical demonstration of ulcer, scar, or perforation; or the presence of acute complications such as haemorrhage or perforation. In the case of the survey, the criteria used for inclusion in the list were epigastric pain lasting for a quarter of an hour or more at a time, occurring in bouts of at least a week with periods of freedom of more than two weeks, related to meals and relieved by food, alkali, or vomiting; or if there was a history of ever having been found radiologically positive at hospital; or of confirmation of ulcer at operation; or haematemesis; or perforation; but the final diagnosis had to be a matter of clinical judgment.

RESULTS IN ACCEPTED CASES

HOSPITAL RECORDS Four hundred and sixty-nine cases were admitted to the list of cases conforming to the diagnostic criteria, of which 204 were treated surgically, and this also confirmed the diagnosis in the latter. The admissions for ulcer expressed as a percentage of all admissions were 1.6%, which is consistent with the experience of Hadley (1959) from Vellore, but is considerably less than our experience from Assam (Malhotra *et al.*, 1964). The number of admissions expressed as a percentage of population works out as 1.5 for the four-year

period. In other words 0.4% of the population per year suffer from sufficiently acute symptoms so as to compel them to seek hospital admission. This is an underestimate of ulcer frequency, as nearly one half of the patients with active disease do not seek admission to the hospital. If this contention is correct, our figures are consistent with the survey data of Gault (1959) who found that nearly 1% of the general population suffers from active ulcer.

In a study using the retrospective approach several criticisms about the validity of data arise.

1 These studies almost invariably result in underestimates because of the difficulty of retrieving case records as one searches further back in time. Even though in this study we are concerned with a short and recent period of four years, this possibility must be considered. As one means of testing the possibility of loss of case records, we have followed the method of Evans and Acheson (1965) and have analysed the secular trends of prevalence which showed that the incidence rates have been more or less identical over the period. In fact, in 1963 there were more cases than in 1964 which makes any failure to retrieve older records unlikely. As a second and perhaps more convincing test, we collected from an independent source, namely, the operation registers of the hospital, all cases of peptic ulcer treated surgically. This showed that only two names had been missed from our list, one in 1962 and the other in 1964. It will not be unreasonable to assume, therefore, that ascertainment was fairly accurate as otherwise it would have shown its effect on the surgically treated cases also.

2 A number of patients may not have sought admission if the symptoms were mild; or the patient may have been treated in the Out-patient Department and, therefore, not been included in our list. These limitations would almost always result in underestimates of frequency and in the present mode of inquiry such errors are inevitable and have, to some extent, been overcome by carrying out a survey of the railway population.

TABLE II

AGE AND SEX DISTRIBUTION OF 469 PEPTIC ULCER CASES ADMITTED TO THE MADRAS RAILWAY HOSPITAL FROM 1 JANUARY 1961 TO 31 DECEMBER 1964

Age (yr.)	Male			Female		
	Gastric	Duodenal	Total	Gastric	Duodenal	Total
Below 20	0 (0%) ¹	4 (0.9%)	4 (0.8%)	0 (0%)	3 (23.1%)	3 (0.6%)
21-30	1 (0.21%)	129 (28.3%)	130 (27.7%)	3 (23.1%)	5 (38.4%)	8 (1.7%)
31-40	12 (2.63%)	195 (42.8%)	207 (44.1%)	0 (0%)	0 (0%)	0 (0%)
41-50	2 (0.43%)	96 (21.0%)	98 (20.9%)	2 (15.4%)	0 (0%)	2 (0.4%)
above 51	2 (0.43%)	15 (3.3%)	17 (3.8%)	0 (0%)	0 (0%)	0 (0%)
Total	17 (3.7%)	439 (96.3%)	456 (97.3%)	5 (38.5%)	8 (61.5%)	13 (2.7%)

¹Figures in parenthesis indicate proportion of case expressed as a percentage of the total number of cases.

SEX AND AGE Of the 469 proved cases, 456 were men and 13 women, the male preponderance of 35 : 1 being even more marked than in other Indian series (Raghavachari, 1959; Somervell and Orr, 1936; Dogra, 1940; Raghavan, 1962; Malhotra *et al.*, 1964). The age incidence is displayed in Table II. The peak age for gastric ulcer in men was 31-40 years and for duodenal ulcer 21-50 years; in women the peak age was 21-30 years, for both gastric and duodenal ulcers, after which the incidence dropped to rise again between 41 and 50 years (Table II).

GASTRIC ULCER/DUODENAL ULCER RATIO The duodenal ulcer/gastric ulcer ratio was 13 : 1 (Table III). Fifteen patients (3%) had both gastric and duodenal ulcers. Three others were interesting in that they had duodenal ulcers with normal acidities and developed gastric ulcers following gastro-jejunostomy.

TABLE III

ANATOMICAL DISTRIBUTION OF THE LESIONS IN 469 CASES OF PEPTIC ULCER ADMITTED TO MADRAS RAILWAY HOSPITAL

Diagnosis	No. of Cases	Percentage of Total
Duodenal ulcer	301	64
Gastric ulcer	22	5
Duodenal and gastric ulcers	15	3
Perforation	32	6
Obstruction	92	20
Miscellaneous, including stomal ulcers, and inadequate information	7	2
Total	469	

DISTRIBUTION OF ABO GROUPS The ABO blood groups were originally available only in 204 surgically treated patients. An attempt was made to ascertain the blood groups in the remaining patients subsequently during this investigation in order to get the complete picture. Fifty-eight patients defaulted. The ABO distribution in 411 patients is given in Table IV. Forty-one percent belonged to group O, 35% to group B, 18% to group A, and the remaining 6% to group AB.

INCIDENCE OF COMPLICATIONS History of haemorrhage was present in 57 (12.1%) patients, of whom 33 had haematemesis and 24 melaena. There were 32 patients admitted for perforation of the ulcer, thus accounting for 6.8% of the ulcer admissions: none of these were women. Of these cases, one was of gastric ulcer, one of jejunal perforation 1½ feet away from the duodenum, and the remaining 30 of chronic duodenal ulcer. In this series there were 15 other patients who gave a previous history of perforation: one for gastric ulcer, 13 for duodenal ulcer, and in one who had a gastro-jejunostomy perforation had occurred after a jejunal ulcer. Thus there were a total of 47 patients with either acute or old perforation which means that 10% of the patients in this series either had a recent acute perforation or a history of past perforation.

Since the population drainage of the hospital is precisely known, the annual incidence of acute perforation works out at 26 per 100,000 adult employees, which is similar to our experience from Assam (Malhotra *et al.*, 1964), and of haemorrhage, 46 per 100,000 per year.

Obstruction to a marked degree, requiring surgery, was present in 92 patients (20.0%). Surgical exposure in these showed marked cicatrization, consistent with the experience of others (Somervell and Orr, 1936; Raghavachari, 1959; Menon, 1964). Gopala Rao (1959), however, found this complication to be present in 246 of his 743 patients, an incidence of 33%.

GASTRIC ANALYSIS Results of gastric analysis were available in 371 patients and are presented in Table V, which shows that hyperchlorhydria was present in 188 (51%); 160 (43%) showed either a normal or an hypochlorhydric curve. In 23 (6%) there was achlorhydria.

CLINICAL FEATURES An analysis of signs and symptoms is presented in Table VI. Pain was the

TABLE IV

DISTRIBUTION OF ABO BLOOD GROUPS IN 411 CASES OF PEPTIC ULCER OF 469 CASES ADMITTED TO THE RAILWAY HOSPITAL, MADRAS

Blood Group	No. of Patients			Percentage of Total	Frequency of Blood Groups in Local Population (%)		
	Duodenal	Gastric	Total		Railwaymen ¹	Hindu Blood Donors ²	Hindus ³
A	70	3	73	18	17.38	22.9	24.4
AB	22	3	25	6	5.01	4.1	4.8
B	137	8	145	35	31.75	31.2	30.2
O	154	14	168	41	45.73	41.8	39.2
Total	383	28	411				

¹Data based on an analysis of a survey of 1,957 persons for blood donors, from Railway Hospital, Madras.

²After Reddi (1943).

³After Seshadrinathan and Timothy (1942).

TABLE V

GASTRIC ANALYSIS RESULTS IN 371 CASES OF PEPTIC ULCER¹

Acidity (mEq./l.)	No. of Patients
Free Hcl above 60	188 (51%)
Free Hcl between 20 and 60	104 (28%)
Free Hcl below 20	56 (15%)
Never any free Hcl	23 (6%)

¹Test meal of 100 ml. of 7% absolute alcohol.

most frequent symptom being present in 353 (75%) of all the patients. Vomiting, either self-induced or spontaneous, was present in 305 (65%) and 184 (39%) showed loss of weight. Anaemia (Hb 70.0% and R.B.C.s 3.5 m./cmm.) was a particularly frequent symptom, being present in 345 (73%) patients.

TABLE VI

ANALYSIS OF SIGNS AND SYMPTOMS IN 469 CASES OF PEPTIC ULCER ADMITTED TO RAILWAY HOSPITAL, MADRAS

Symptom	No. of Patients	Percentage of Total No. of Patients
Pain	353	75
Vomiting	305	65
Loss of weight	184	39
Periodicity	374	80
Haematemesis	33	7
Melaena	24	5
Anaemia	345	73
Visible peristalsis	62	13
Perforation	32	6.8
Epigastric tenderness	192	41
Indigestion	162	35
Hookworm infestation	5	1

OCCUPATIONAL AND SOCIO-ECONOMIC DISTRIBUTION

This information is presented in Table VII and shows that the incidence of the disease is more or less identical in the lower as well as in the higher income groups.

EFFECT OF SURGERY Two hundred and four patients were treated surgically: 98 with a Polya partial gastrectomy with a Hofmeister-Finsterer valve; 48 with gastro-jejunostomy; 22 with gastro-jejunostomy with vagotomy and four with enterectomy and vagotomy; and 32 were of emergency closure of perforation. Of these, the 30 cases of gastrectomy done in 1961 were followed up in 1965. In the case of patients operated upon during 1962 to 1964, the period elapsing after the operation was considered insufficient for this type of re-appraisal. Of these 30, although 14 (44%) had lost weight ranging from 4 to 10 lb. at the time of discharge from the hospital, four years later 23 (76%) had gained weight and seven (24%) lost weight; 15 (50%) had improved in their haemoglobin status and nine (30%) had become slightly more anaemic and the remaining six (20%) showed no change.

TABLE VII

DISTRIBUTION OF 469 PATIENTS ANALYSED ACCORDING TO SOCIAL CLASS

Social Class	No. at Risk	No. of Peptic Ulcers	Four-year Incidence Rate (%)
I (Rs. 700 to Rs. 2,250)	56	1	1.8
II (Rs. 350 to Rs. 950)	56	1	1.8
III (Rs. 110 to Rs. 575)	14,429	184	1.27
IV (Rs. 70 to Rs. 110)	16,401	283	1.72
Total	30,942	469	1.51

The operative mortality was extremely low, there being only one death out of 204 operated cases and this was in a patient with delayed perforation, who died of post-operative pulmonary complications.

SURVEY DATA

The result of the survey is given in Tables VIII and IX which show the incidence of active as well as healed ulcers is 8.3% among workshop staff (manual workers) and 15% among the clerical staff (sedentary workers) between the ages of 18 and 55 years. These figures are comparable with the figures found by Doll, Jones, and Buckatzsch (1951) in their notable London survey. It will be seen that only 52.8% of ulcer patients sought admission to the hospital for treatment (Table VIII). If this is to be accepted as the usual trend for admissions, our hospital data would obviously give an underestimate of ulcer frequency. This is further borne out by the estimate of ulcer cases provided by the number of perforations in this series. Ordinarily, if 3.6% of all ulcers perforate (Haubrich, 1963), we should have had an estimated 861 ulcer cases against our figure of 469.

Since our data are not large enough, it is impossible to work out the limits within which the general incidence must lie. But clearly nearly half of the patients are not admitted to a hospital, and either take treatment as out-patients or resort to self-medication with alkalis. This inference is supported by the survey data of Gault (1959) from an independent survey of peptic ulcer in villages in south India. He found 1% of the general population as suffering from active ulcer, whereas our hospital data show the incidence of active ulcer in the general population to be 0.4%.

INDUSTRIAL MORBIDITY RECORDS The number of railway employees who reported sick and remained absent with a diagnosis of peptic ulcer was studied for 1964. There were 56 sick certificates issued for

TABLE VIII

RESULTS OF THE SURVEY OF GENERAL POPULATION AT THE FURNISHING SHOP OF INTEGRAL COACH FACTORY
(PHYSICALLY ACTIVE WORKERS)

Total Interviewed	Total with History of Ulcer Pain and Periodicity (active and healed ulcers)	Dyspepsia	History of Taking Alkali for Relief of Pain	History of Induced Vomiting for Relief of Pain	Haemorrhage	History of Taking Alkalis for Dyspepsia Regularly	History of Perforation	History of Proved Ulcer from Earlier Hospital Admission
840	70 (8.3% of total interviewed)	51 (6% of total interviewed)	66 (94.3% of cases)	18 (25.5% of cases)	3 (4.4% of ulcer cases)	40 (57.1% of cases) (4.7% of total interviewed)	1 (1.4% of ulcer cases)	37 (52.8% of ulcer cases and 4.4% of total interviewed)
	Total with pain and dyspepsia during preceding three months (active ulcers) 33 (3.9% of total interviewed and 47% of cases)							

TABLE IX

RESULTS OF THE SURVEY OF THE CLERICAL STAFF AT THE SOUTHERN RAILWAY HEAD OFFICE

Total Interviewed	Total with History of Ulcer Pain and Periodicity (active dyspepsia and healed ulcers)	Dyspepsia	History of Taking Alkalis for Relief of Pain	History of Induced Vomiting for Relief of Pain	History of Haemorrhage	History of Perforation	History of Proved Ulcer from Earlier Hospital Admission	History of Taking Alkalis, Antacids, or Anticholinergics for Dyspepsia or Pain
520	78 (15% of total interviewed)	32 (6.1% of total interviewed)	59 (75.6% of cases)	33 (42.2% of cases)	13 (16.6% of cases)	Nil	45 (8.8% of total interviewed)	59 (11.3% of total interviewed)

gastric ulcer and 83 for duodenal ulcer. The total number of railway employees who reported sick for all diseases during this period was 10,998 and these figures, therefore, indicate that 1.3% of all illnesses is due to peptic ulcer or the annual incidence rate of active peptic ulcer in the general population $\left(\frac{\text{No. of cases in the year}}{\text{the mean population}} \times 100 \right)$ is 0.4%, a result which is consistent with the figures derived from our data on hospital admissions.

DISCUSSION

Previous work on peptic ulcer in India has given rise to a belief that the disease was different from the disease in the west in being less likely to bleed or perforate. Somervell and Orr (1936) came across only four cases of perforation in a series of 2,500 cases of peptic ulcer, an incidence of 0.16% only. In contrast to this, the incidence of perforation encountered in this study is very high, 7% of ulcer admissions being for perforation. If 15 others in this series are also taken into account who had a previous history of perforation, the incidence of acute and old perforations would be 10%. These figures are comparable with Hadley's (1959) study

from Vellore and our study from Assam (Malhotra *et al.*, 1964).

The incidence of haemorrhage in our data is also not so low as reported by previous workers (notably Raghavachari, 1959; Somervell and Orr, 1936; and Gopala Rao, 1959) but is in keeping with the experience of Hadley (1959) who found this complication in 15.5% of his patients as against 12.1% in the present series. The incidence of haemorrhage reported by us from Assam was unusually high, being 30.5%. The reasons for these wide geographical differences are not clear, but may perhaps be due to the modes of enquiry, as in Assam we especially looked for this complication, whereas in this study it was recorded only if the patient volunteered the statement.

The tendency of the south Indian ulcer towards cicatrization noted by others (Gopala Rao, 1959) is mirrored in this study also, though it was present to a much lesser extent.

SEX DISTRIBUTION The reasons for the very high incidence of the disease in men as compared with women are difficult to explain. The male/female ratio was 18 : 1 in Dogra's (1940) series from Madras General Hospital, 15 : 1 in Hadley's (1959) series

from Vellore, 10 : 1 in Gopala Rao's (1959) series from Hyderabad, and 16 : 1 in Raghavachari's (1959) series from Trivandrum, whereas it is 35 : 1 in the present series from a railway population in Madras, mirroring the experience of Konstam (1959). The reasons for this very marked sex discrepancy in our data are not clear but may possibly be explained by the age structure of our population. The age of superannuation from service for railwaymen is 55 years, and, therefore, the wives of railwaymen will be generally below 45 years of age; and because ulcer is less common in women in the reproductive period of life, our population, therefore, has fewer women in the vulnerable age group at risk, as compared with the general population in the country. This may partly explain the sex discrepancy; but obviously there must be other factors not yet determined.

We carried out a survey to find out if there were any difference between men and women in the pattern of eating, and this showed that in nearly 95% of the families interviewed, women ate less and took longer over their meals than men, who were largely 'meal scampers'. This was further confirmed by timing the actual eating times of meals in the men's and the women's wards at the Railway Hospital at Madras and Bombay, in which 57 men and 57 women were included: women took one-and-a-half times to twice as long with their meals as compared with men, the mean chewing times per meal being 10 minutes for men and 16.5 minutes for women, even though their meals were much smaller than those of the men. The pattern of eating was also different in that men tended to bolt down large boluses of rice whereas women macerated this with their fingers and made much smaller morsels which they chewed well before swallowing. Jennings (1965) has made a similar observation, and of his 22 patients with duodenal ulcer, all 'meal scampers', only one was a woman. This is of relevance in view of the effect of chewing movements of the jaw on the buffer capacity and the mucin content of saliva reported by several workers (for references see Afonsky, 1961) and more recently by the author (Malhotra, 1965, 1966a; 1967. Malhotra, Saigal, and Mody, 1965); and may thus be responsible for a better protective action of saliva in the case of women as compared with men, as discussed fully elsewhere (Malhotra, 1966b).

BLOOD GROUPS Aird, Bentall, Mehigan, and Roberts (1954) found a positive association between peptic ulcer and blood group O. A number of subsequent studies have confirmed this relationship (Clarke, Cowan, Edwards, Howel-Evans, McConnell, Woodrow, and Sheppard, 1955) from other countries

although not from India. Ghosh, Biswas, and Chatterjee (1957) and Raghavan (1962) found no significant difference in the frequency of group O in duodenal ulcers as compared with gastric ulcers. The present data show a higher frequency of group O and group B in duodenal as well as gastric ulcers and a much lower frequency of groups A and AB (Table IV). Even though this controverts the observations of Ghosh and Raghavan, and is in agreement with the accepted preponderance of blood group O in peptic ulcers, any causal significance of blood groups in peptic ulcer is uncertain because of a similar ABO blood group frequency in the general population in Madras (Table IV).

ULCER FREQUENCY AND HOOK WORM INFESTATION

Gopalan (1959) and Konstam (1959) have suggested that hook worm infestation may have a possible role in causing peptic ulcer. This suggestion has been revived by the recent work of Raju and Narielvala (1965). In this series there were only five (1%) patients who showed evidence of hook worm infestation. Although helminth infestations are common in south India, they are less prevalent in railway colonies because of the higher standards imposed by measures for environmental hygiene. Moreover, in Gurdaspur district of the Punjab, although heavy hook worm infestation is present, ulcer is practically unknown, and conversely, while ulcer is frequent in railway populations in Assam (Malhotra *et al.*, 1964), hook worm infestation is practically non-existent. These results, therefore, do not support the hook worm thesis.

GASTRIC ACIDITY The incidence of hyperchlorhydria in the present study is comparable with our Assam study and is not dissimilar from the western experience, although it is different from the reports of Raghavan (1962), Raghavachari (1962), and Hussain (1959). The results of a fractional test meal, as it is usually performed, lack constancy and repeatability and, therefore, much reliance cannot be placed on this variance. Vakil and Mulekar (1965) have found that the results varied from 5 to 20% on the same individuals when repeated. This has also been our experience and there were at least 25 patients in this series on whom the fractional test meal had been done more than once with widely varying results.

VOMITING Vomiting was a very frequent feature, being present in 65% of the patients, and in more than half of them it was self-induced, mirroring the experience of Hadley (1959), whose series showed this complication in well over 70% of his 406 patients. Unfortunately other workers interested in

the peptic ulcer problem in the south of India have not collected this information. Since vomiting will reduce gastric acidity not only by mere emptying of the gastric contents but possibly also by a regurgitation of the alkaline intestinal chyme into the stomach, it is interesting to speculate if this accounts for the greater cicatrization noticed by several workers (Somervell and Orr, 1936; Gopala Rao, 1959), and may also account for a lower rate of haemorrhage compared with Assam (Malhotra *et al.*, 1964).

SOCIO-ECONOMIC FACTORS AND DUODENAL/GASTRIC ULCER RATIO Whereas the top people have a duodenal ulcer, gastric ulcer has been regarded in western Europe for the past half century as an affliction of the materially and mentally underprivileged (*Lancet*, 1959). Doll *et al.* (1951) found that the gastric to duodenal ulcer ratio rises progressively from 1 : 3 to about 1 : 1 as age increases and as the level of the social class decreases. Dogra (1940) found the gastric ulcer: duodenal ulcer ratio was 1 : 30 whereas in Hadley's (1959) series the ratio was 1 : 13 and in the present series this was 1 : 12. Taking into account only the surgically confirmed cases, the gastric ulcer/duodenal ulcer ratio in our series was 1 : 6.

The south Indian peptic ulcer is thought to be a disease of the poor (Gopala Rao, 1959; Dogra, 1940; Konstam, 1959). The present data do not show this to be the case, and it is to be noted from Table VI that the ulcer is equally distributed in the various social classes. One criticism of the data of others (Gopala Rao, 1959; Dogra, 1940) is that they have based their impression from the much larger numbers of poorer people in their series. In the present series too, the number of the poorer people is high (Table VI), but when the incidence rates are examined not as a percentage of total number of patients but in relation to the population at risk, social class has no relation to ulcer prevalence. The lack of social-class gradient in this series can be explained by the fact that the pattern of eating among the rich and the poor shows no great differences in the south of India: both eat sloppy foods which do not require much mastication (Malhotra, 1964).

SOUTH INDIAN ULCER CHANGE In view of the marked discrepancies between the present results and earlier studies, certain pertinent questions need to be discussed more fully: Does the present investigation show a change in the behaviour of ulcer as compared with previous studies? If so, how can the present findings be reconciled with previous studies? Are there any apparent reasons for this change?

The first question must be answered in the affirmative. Because our findings of higher frequencies for perforation, haemorrhage, vomiting, and a higher gastric ulcer/duodenal ulcer ratio are consistent with another independent study from south India (Hadley, 1959), these are unlikely to have resulted merely from sampling variations. Moreover, when data collected in several different ways give the same conclusion, it is not unreasonable to say that it is independent of bias due to sampling. There are reports of similar ulcer changes from other parts of the world (*Lancet*, 1965) and, therefore, it may be reasonably concluded that there has been an ulcer change in the south of India also.

It is more difficult to answer the second question as to how the present findings can be reconciled with previous studies. While improvements in radiographic facilities and diagnostic methods and an increased awareness of the problem could be claimed to account for the change in the gastric ulcer/duodenal ulcer ratio, or even a higher incidence of haemorrhage, because, when one looks for a thing one is more likely to find it. Our experience of haemorrhage in ulcer in Assam showed that this complication was present in 30.5% of the cases, but, when especially looked for, 51.1% of the patients gave a history of haemorrhage, at some time or another (Malhotra *et al.*, 1964), so it is less easy to obtain a precise appraisal of the importance of these factors because in the absence of a single uniform opinion in different studies, using different methods of collection of data, varying emphases and criteria are inevitable. Perforation, on the other hand, is so dramatic in onset and has such a high mortality if untreated, that its diagnosis may well be expected to have been reasonably accurate and uniform for many years past. It could, however, be argued that because of the lethal nature of this complication fewer such patients reached hospital in earlier days, especially as the report of Somervell and Orr (1936) concerns mostly village populations, where difficulties of transport were then not inconsiderable. In spite of these criticisms, the very marked changes in the behaviour of ulcer in the south of India over the past 30 years seem to be real, especially when there have been similar changes in other parts of the world (Alsted, 1939; Billington, 1965).

The answer to the third question is even more difficult and far less certain. The familial and genetic factors associated with ABO blood group which have been claimed to predispose to gastric ulcer cannot explain this ulcer change, as it is unlikely that any significant changes in the distribution of blood groups in the population have taken place. It is also unlikely that the temperaments of

people have changed over the years; nor is there any evidence that smoking may be responsible for the change, because if anything, the sale of cigarettes per 1,000 of population is five times more in the Punjab compared with Madras (data from trade sources), even though the Punjabis are immune and the South Indians prone to ulcer. Such variations in disease patterns occurring from place to place and from time to time point to changes in environmental factors, chiefly dietary.

As reported elsewhere (Malhotra, 1964), the diets in south India are sloppy and the pattern of eating is such that the boiled rice or Ragi gruel are bolted down without much chewing. Such a pattern of eating does not exploit the increase in the total quantities, the buffer capacity, and the mucin contents of saliva which result from diets requiring mastication and prolonged chewing movements of the jaw (Malhotra, 1966a; Malhotra *et al.*, 1965; for other references see review by Afonsky, 1961). The part played by variations in the patterns of diet and eating in the causation of ulcer has been discussed (Malhotra, 1965). While the pattern of diet and eating can explain the higher prevalence of peptic ulcer in south India as compared with the Punjab, north India, (Malhotra *et al.*, 1965), the changes in the pattern of diet and eating which have undoubtedly taken place in the south during the last three decades, especially with regard to the methods of cooking and eating, are also of significance. For example, rice has replaced tapioca in several parts of south India and this has meant a change in the pattern of eating.

Two other factors, which almost certainly are recent, may bear responsibility for the change in the ratio of gastric to duodenal ulcers: (1) the very highly prevalent practice of inducing vomiting and (2) the habit of taking 'soda' (sodium bicarbonate) to relieve pain and dyspepsia. In our survey data 57% of patients were habituated to taking alkalis and nearly 65% of our hospital patients have a history of vomiting, chiefly induced. Both these factors would reduce gastric acidity, one by duodenal reflux and the other by neutralizing the HCl. With a fall in acidity the mucus becomes fluid and its barrier action is weakened (Ball and James, 1961). The increased duodenal reflux can also produce gastritis predisposing to gastric ulcer (Lawson, 1964; du Plessis, 1965; Malhotra, 1966b). It may be worth mentioning here that in the present series, three patients with duodenal ulcer with low acidities developed gastric ulcers after previous gastro-jejunostomies, possibly due to the same mechanism; and it could perhaps be anticipated that if these trends towards the liberal consumption of alkali and antacids for dyspepsias continue, further changes

in the ratio of gastric ulcer to duodenal ulcer will take place, as has happened in the west.

SUMMARY

The epidemiological aspects of peptic ulcer have been studied in a population employed on the railways in south India to define the prevalence, the clinical features, the effect of treatment, and the incidence of complications of the disease.

The report concerns a total of 469 patients. The sex discrepancy was more marked than in other reported series, the male : female ratio being 35 : 1; the peak age was much lower than in the west and a greater degree of cicatrization was noticed in operated cases. The incidence of haemorrhage and perforation was much higher than reported by earlier observers and is not very different from that in the west. The reasons for this ulcer change are not certain but are possibly related to changes in the pattern of eating, and to a higher consumption of alkalis, and possibly to a more frequent habit of vomiting, than in previous decades. There was a preponderance of blood group O and B; very few patients belonged to groups A and AB in this series. Operative mortality was low, there being only one death out of a total of 204 operated patients. The effect of surgery (partial gastrectomy) as determined after a four-year follow-up of the cases treated in 1961, was complete relief of symptoms and a gain in weight as well as an increase in haemoglobin in the majority of the patients.

After gastro-jejunostomy on the other hand, three patients with duodenal ulcer developed gastric ulcer. The possible causal relationship of diet to the development of ulcer is briefly discussed.

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