VAGAL AND ADRENAL INFLUENCES ON GASTRIC SECRETION IN SHAY RAT

J. VASANTHA KUMAR, A.K. GANGULY AND O.P. BHATNAGAR

Department of Physiology,
Jawaharlal Institute of Post-graduate Medical Education and Research, Pondicherry-605006

Summary: The present experiment was planned to assess the role of vagus and adrenals in gastric secretion in the pylorus ligated rats. Vagotomy significantly reduced the volume of gastric juice but the reduction following adrenalectomy was not significant. Both vagotomy and adrenalectomy significantly reduced the free acid, total acid and pepsin contents of the gastric secretion, the reduction being more pronounced following vagotomy.

Key words : vagotomy adrenalectomy free acidity total acidity pepsin

INTRODUCTION

The association of vagal and adrenal pathways with gastric secretion is well know The involvement of the above pathways in the production of stress-induced gastric ulcers h been reported (7, 8, 10). However, the quantitative role played by either pathways in influe ing gastric secretion is not clearly understood.

Vagal pathway has been shown to play a dominant role in stress-induced gastric ulce tion (5, 6, 1). On the other hand, adrenals have been implicated to have a greater influence gastric secretion in pylorus ligated rats (13.). Further, it has been observed in human su jects that non-vagal mechanisms are mainly responsible for stress-induced gastric secreti (15).

Regarding pepsin secretion, although there is general agreement that vagotomy redu it, conflicting reports exist so far as the influence of adrenals on it is concerened. Followi adrenalectomy, decrease in pepsin output has been observed (18, 2). On the other han administration of Metapirone which reduces the cortisone secretion in dogs, does not cause a significant decrease in pepsin output (14, 4, 16).

In the present experiment, an attempt has been made to investigate the influence of va and adrenal pathways on gastric secretion in pylorus ligated rats.

MATERIALS AND METHODS

60 healthy albino rats of either sex having body weight ranging between 80 and 130 g were housed in separate cages. They were maintained by providing food and water *ad libit*

Presented at post Congress Symposium of XXVI International Congress of Physiological Sciences on Clini Physiology at Madras in November, 1974.

and acclimatized to the laboratory environment for seven days before being divided into 3 groups. of 20 each. The weights were matched for the different groups. Only solid food was withdrawn on 8th day for a period of 24 hours from all the groups. On the 9th day, Group II rats were subjected to subdiaphragmatic vagotomy and Group III rats were subjected to bilateral adrenalectomy. Vagotomy was confirmed by electric stimulation test (9). Removal of adrenals in toto along with capsule was taken for the completeness of adrenalectomy. A combined operation of vagotomy and adrenalectomy in individual rats resulted in total failure of the rats to survive. Hence, group IV which was originally planned is not included. Rats belonging to Group II were allowed food and water *ad libitum* for a period of 7 days. However, Group III rats, i.e. bilaterally adrenalectomised ones, were maintained by allowing food and saline for the same period of 7 days. At the end of this period, solid food alone was withdrawn again for 24 hours in all rats, irrespective of any group following which pylorus ligation was performed in all of them. Out of 20 rats in each group 10 were sacrificed 6 hours after pylorus ligation and the rest 12 hours after pylorus ligation. The completeness of adrenalectomy was once again confirmed by inspecting the upper poles of kidneys for any remnants of adrenal tissue.

Before sacrificing each animal abdomen was opened and a ligature placed on the oesophagus at the cardiac end of the stomach. The stomach was then removed and nick was made on its wall towards the pyloric end and the gastirc contents collected in a measuring cylinder. The volume was measured accurately and the sample was analysed for its acidity and pepsin contents. Free acidity of the sample was estimated by titration against 0.01N NaOH utilizing Topfer's reagent as indicator. Titration was continued with alcoholic phenolphthalein as indicator for estimating total acidity. Peptic activity of the sample was determined by plasma protein digestion method (12).

RESULTS

The results of analysis of gastric contents collected 6 hours after pylorus ligation in Group I (Control), Group II (Vagotomy) and Group III (Bilateral adrenalectomy) rats have been presented in Table I, which shows that the volume of gastric secretion is reduced to a highly significant extent following vagotomy ($p < 0.001$), whereas the reduction of gastric secretion following bilateral adrenalectomy is not significant.

Both free and total acidity were reduced to a highly significant extent ($p < 0.001$) following vagotomy as well as bilateral adrenalectomy. But the reduction was more pronounced after vagotomy.

Peptic activity of the sample was also reduced to a highly significant extent ($p < 0.001$) following bilateral adrenalectomy. However, peptic activity of the sample collected from the vagotomised group could not be estimated due to insufficient volume.

Table I : Effect of vagotomy and bilateral adrenalectomy on volume, free and total acidity and pepsin content of gastric juice in six hour series of pylorus ligated rats.

Experimental condition and number of animals	*Mean volume of gastric juice in ml* ±*S.E.*	*Mean free acidity in mEq per litre* ±*S.E.*	*Mean total acidity in mEq per litre* ±*S.E.*	*Mean pepsin content in units per m* ±*S.E.*
Control (10) (Group I)	5.11±0.766	67.3±3.162	106.2±3.44	13.89±0.
Vagotomy (10) (Group II)	1.72±0.282	3.1±1.58	70.8±4.658	—
Bilateral adrenalectomy (10) (Group III)	3.63±0.69	28.7±1.9	71.3±2.61	9.23 ±0.

Statistical analysis 't' values

Experimental condition	*Volume of gastric juice*	*Free acidity*	*Total acidity*	*Pepsin cont*
Between control and vagotomy	*4.185	*15.75	*6.115	—
Between control with bilateral adrenalectomy	+1.432	*9.072	*8.108	*7.544

*p<0.001 +p = 0.2

The results of analysis of gastric content collected 12 hours after pylorus ligation in Gr I (Control) and Group II (Vagotomy) rats have been presented in Table II. The values for Gr III (bilateral adranalectomy) rats could not be presented because these rats did not survive for hours following pylorus ligation.

However, Table II shows that the volume, free and total acidity as well as pepsin con were reduced to highly significant extent ($p < 0.001$) following vagotomy.

DISCUSSION

From our results in both 6 and 12 hours series of experiments it can be concluded t vagotomy reduced the volume of gastric secretion to a great extent. The decrease in vol following vagotomy may be due to a loss of secretomotor cholinergic background (1 Bilateral adrenalectomy also reduced the volume of gastric secretion, However, the decrease volume following adrenalectomy is not significant, a finding which suggests its less signific role in stress induced secretion.

As suggested by Jones and Harkins (13), pylorus ligated rats exhibit increase in a concentration in the gastric juice. This might be the result of stimulation of pressure recept situated in the antral region of the stomach inducing secretion via a vago vagal reflex (3), besi releasing gastrin by the distension that accompanies the pylorus ligation. In view of the fact t

TABLE II : Effect of vagotomy on volume, free and total acidity and Pepsin content of gastric juice in 12 hour series of pylorus ligated rats.

Experimental condition and number of animals	*Mean volume of gastric juice in ml ±S.E.*	*Mean free acidity in m.Eq per litre ±S.E.*	*Mean total acidity in mEq per litre ±S.E.*	*Mean pepsin content in units per ml ±S.E.*
Control (10) (Group I)	7.38±0.333	70.8±3	109 ±3.378	14.65± 0.67
Vagotomy (10) (Group II)	3.34±0.297	6.3±2.695	83.4±4.94	2.93± 0.499
Bilateral adrenalectomy (10) (Group III)	Values for this group are non-existant because bilaterally adrenalectomised rats did not survive for 12 hours following pylorus ligation.			

Statistical analysis
't' values

Experimental condition	*Volume of gastric juice*	*Free acidity*	*Total acidity*	*Pepsin content*
Between control and vagotomy	*9.05	*16	*4.342	*14.24

*$p < 0.001$

vagotomy has markedly reduced free and total acidity in both 6 and 12 hours series of experiments, it is reasonable to assume that the secretion of HCl is highly dependent on the extrinsic vagal innervation rather than on a local reflex. In other, words, the reduction in gastric secretion is due to removal of steady cholinergic background for the secretion of HCl by the interruption of vagal pathway. The decreased acidity following vagotomy may also be accounted for by the decreased gastrin release. Our results also show that bilateral adrenalectomy reduced the free and total acidity to a significant extent, but the reduction was relatively less than that in the vagotomised group. These facts clearly demonstrate that adrenals play a definite though smaller role in controlling these parameters. Whether this is due to a direct withdrawal of the hormones or to secondary changes is a subject of controversy.

Our results also demonstrate a significant reduction in the peptic activity of the gastric content following vagotomy as well as bilateral adrenalectomy. The result of vagotomy in reducing peptic activity of gastric content is well known. Our observation on the effect of bilateral adrenalectomy in reducing peptic activity of gastric content in albino rats is also in agreement with that of Tuerkischer and Wertheimer (18) and Bralow (2), though this may not be true in other species (4, 14, 16).

REFERENCES

1. Baron, J.H. The relationship between basal and maximal output in normal subjects and patients with duodenal ulcer. *Clin. Sci.*, **24** : 357-370, 1963.
2. Bralow, S.P., S.A. Komarov *et al.* Effect of total adrenalectomy on gastric secretion in chronic gastric fistula rats. *Amer. J. Physiol.*, **206** : 1309-1320, Jan-June, 1964.
3. Brodie, D.A. The mechanism of gastric hyperacidity produced by pylorus ligation in the rat. *Amer. J. Dig. Dis.*, **11** : 231-241, March, 1966.
4. Cooke, A.R. and M.I. Grossmann. Effect of hydrocortisone on secretion of acid and pepsin by Heidenhain pouches. *Proc. Soc. Exp. Biol. & Med.*, **123** : 704-707, Oct. 1966.
5. Dragstedt, L.R., P.V. Harper Jr., E.G. Tovee and E.R.Woodward. Section of the vagus nerves to the stomach in the treatment of peptic ulcer. *Ann. Surg.*, **126** : 687-708, 1947.
6. Ferguson, D.J. The antral phase of gastric secretion before and after vagotomy—Experiments on gastric pouch dogs. *Surgery*, **33** : 352-360, 1953.
7. Ganguly, A.K. Role of vagus nerve in stress-induced gastric ulcers in the albino rat. *Ind. J. Physiol. Pharmac.*, **16** : 271-272, 1972.
8. Ganguly, A.K. and S.K. Lal. The role of blood sugar level in the production of experimental gastric ulcers in the albino rats by pylorus ligation. *Ind. J. Physiol. Pharmac.*, **14** : 121, 1970.
9. Ganguly, A.K. and S.K. Lal. Assessment for completeness of gastric vagotomy. *Ind. J. Physiol. Pharmac.*, **15** : 151-154, 1971.
10. Ganguly, A.K. and O.P. Bhatnagar. Effect of bilateral adrenalectomy on production of restraint ulcers in albino rats. *Can. J. Physiol. & Pharmacol.*, **51** : 748, 1973.
11. Heathcote, B.V., D.W. Daley *et al.* Secretary responses before and after vagal denervation of a gastric pouch. *Gastroeonterol.*, **48** : 463-471, 1965.
12. Hunt. A method for estimating peptic activity in gastric contents. *Biochemical Journal*, **42** : 104-109, 1948.
13. Jones, T.W. and H.N. Harkins. Evaluation of mechanisms involved in gastric acid secretion in pylorus ligated rats. *Gastroenterol.*, **35** : 309-311, 1958.
14. McIntosh, J.W., N. Anderson *et al.* The effect of an adrenergic inhibitor (SU 4885) on gastric secretion in dogs., *Gut., Vol. I* : 345-356, 1960.
15. Moore, G. High gastric acid secretion after vagotomy and pyloroplasty in man-evidence for non-vagal mediation. *Amer. J. Dig. Dis.*, **18** : 661-669, Aug. 1973.
16. Nicoloff, D.M. and Nostrand. Inhibition of Cortisol production—its effect on gastric secretion and ulcer provocation. *Jr. Surg. Res.*, **8** : 214-219, 1968.
17. Shay, H., S.A. Komarov *et al.* A simple method for the uniform production of gastric ulceration in the rat. *Gastroenterol.*, **5** : 43-61, 1945.
18. Tuerkischer, E. and E. Wertheimer. Adrenalectomy and gastric secretion, *J. Endocrinol.*, **4**: 143-151, 1945.