

# Meat Extract-Stimulated Gastric Acid Secretion Before and After Parietal Cell Vagotomy without Antrum Drainage and Selective Gastric Vagotomy with Drainage in Patients with Duodenal Ulcer

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**A**FTER PARIETAL CELL VAGOTOMY (PCV) the parietal cell mass of the stomach is denervated, while the antrum is left innervated and without drainage. While the insulin stimulated acid secretion often disappears and the stomach emptying is normal after PCV in dogs,<sup>1</sup> this operation results in an enhanced acid response to feeding and in an approximately 50% increase of the 24-hour Heidenheim Pouch (HP) acid secretion.<sup>1,3</sup> In the normal dog the HP acid response to feeding can be substantially decreased, but not eliminated by denervating the antrum.<sup>6</sup> A similar decrease can be observed when a PCV in the dog is supplemented with a suprapyloric antrectomy or a suprapyloric mucosal antrectomy.<sup>2</sup> These experiments suggest that vagal innervation increases the antral response to food, and that in the absence of acid inhibition, antral secretion of gastrin is not only present, but may be increased. The clinical significance of a possible enhanced acid response to feeding in duodenal ulcer patients treated by a PCV<sup>5,10</sup> is not known.

This study was therefore performed to evaluate acid response to meat extract in duodenal ulcer patients before and after PCV or selective gastric vagotomy with antral drainage (SV + P), after which operation the whole of the stomach is denervated and the antrum drained by a pyloroplasty or a gastroduodenostomy.<sup>4</sup> Furthermore, the study determines the covariation of meat extract

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stimulated acid secretion with fasting, basal, insulin and pentapeptide stimulated acid secretion in the same patients.

## Material and Method

Twenty-five patients (4 females and 21 males, mean age 56 years (range 27-76)) underwent surgery for duodenal ulcer complaints. At operation a duodenal or pyloric niche was found in 17 patients, duodenal or pyloric ulcer scarring in 7 patients and no ulcer in one patient. In 19 patients with no pyloric stenosis PCV, and in 6 patients with pyloric stenosis of varying degree SV + P were performed.

Gastric secretion studies were carried out preoperatively and between two and three month postoperatively. The *pentapeptide test* was performed by stimulation with 6 microgram Peptavlon (ICI)/kg s.c. before the operation (25 patients) and with 10 microgram Peptavlon/kg s.c. after the operation (19 patients).

The doses of 6 and 10 microgram Peptavlon have previously been shown to elicit maximal acid output both before and after PCV.<sup>11</sup> The *insulin test* was performed by stimulation with 0.2 I.U./kg i.v. in 12 patients before and in 22 patients after operation. The *meat extract test* was done in 25 patients before and in 21 patients after operation, only slightly modified after Giles and Clark.<sup>8</sup> Three oxo cubes\* were dissolved in 200 ml warm water

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\* Containing protein:1.62 g, fat:0.58 g, carbohydrate:204 g.

and pH adjusted to 7.0 by adding 15–20 ml of 8% sodium bicarbonate. This solution was introduced into the stomach via the tube and left in the stomach 15 minutes with the patient in a sitting position. The stomach was then emptied by 5 minutes aspiration with the patient supine. The stomach was then rinsed by 200 ml of water and emptied by a further 5 minutes aspiration, the entire procedure of meat extract stimulation lasting about 30 minutes.

All tests were done after an overnight fast. Gastric tubes were placed under fluoroscopic control with the patients supine. Aspiration was performed by intermittent pump suction, which was constantly supervised; aspirates were collected every 15 minutes. The first 15-minute aspirate obtained before meat extract stimulation is designated "fasting secretion" and the total of the next 4 15-minute aspirates (which were analyzed separately) is designated "basal secretion."

After pentapeptide and meat extract stimulation, 6 15-minute aspirates were collected and after insulin there were 9 15-minute aspirate collections. For each aspirate over the 15-minute periods volume, pH (Radiometer) and acidity (by titration to pH 3.5) were measured. Maximal acid production is expressed as "peak acid output" (PAO), the highest acid production in two consecutive 15-minute periods multiplied by two (meq/hr.) and as acid production during the first hour after stimulation (meq/hr.). There was undoubtedly some loss of acid secretion, especially after SV + P, but no attempt was made to correct for this.

#### Statistical Calculations

The covariations were evaluated by Spearman's coefficient of correlation ( $r_{sp}$ ). The p-values were obtained from Documenta Geigy.

#### Results

Before operation all patients responded to meat extract with a significantly ( $p < 0.001$ ) increased acid secretion. PAO-meat extract averaged 60% of PAO-pentapeptide (Table 1, Fig. 1). There was a statistically significant positive correlation between PAO-meat extract and fasting acid secretion ( $p < 0.01$ ), basal acid output ( $p < 0.01$ ), and especially fasting volume ( $p < 0.001$ ) and PAO-pentapeptide ( $p < 0.001$ ) (Table 1). There was no correlation to PAO-insulin in 12 patients.

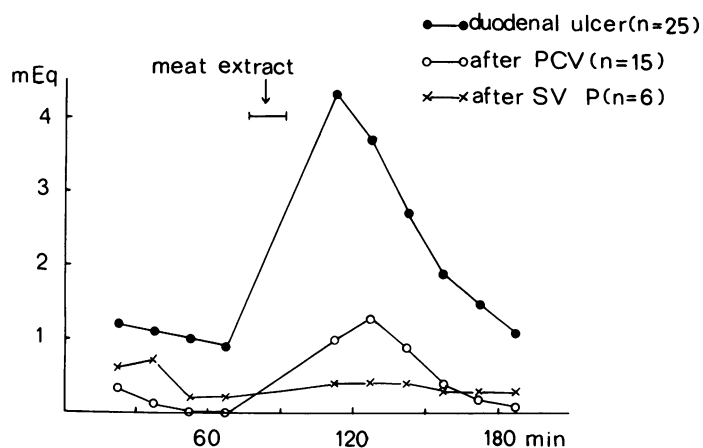


FIG. 1. Meat extract activated acid secretion during basal hour and the first hour after stimulation before and after PCV and SV + P in patients with duodenal ulcer.

After operation there was still a highly significant ( $p < 0.001$ ), but less pronounced ( $r_{sp} = 0.58$ ) positive correlation between the fasting volume and PAO-meat extract (Table 2).

No free acid in fasting and/or basal secretion was found in 15 patients and no correlation with PAO-meat extract was present (Table 2).

While the entire instilled amount of meat extract usually could be recovered preoperatively, this was after operation only the case in 7 patients, all of whom had a PCV. In the remaining 14 patients only about half of the instilled amount could be obtained by aspiration.

After operation PAO-meat extract was significantly ( $p < 0.02$ ) but less pronounced ( $r_{sp} = 0.58$ ) correlated positive with PAO-pentapeptide. The acid response to meat extract was significantly decreased, and PAO-meat extract averaged only 37% of simultaneous PAO-pentapeptide (Table 2, Fig. 1), because the mean postoperative reduction was respectively 71% (PAO-meat extract) and 52% (PAO-pentapeptide) (Table 3). A significant covariation ( $r_{sp} = 0.62$ ,  $p_{sp} < 0.02$ ) of reduction of PAO-meat extract with PAO-pentapeptide could be demonstrated only in insulin-negative patients ( $n = 12$ ),<sup>9</sup> while reductions of PAO-meat extract was much more pronounced than reductions of PAO-pentapeptide in insulin-positive patients ( $n = 7$ ) (Table 3).

If more acid secretion during the first hour after stimulation than during the basal hour is taken as evidence

TABLE 1. Preoperative Acid Tests (mean  $\pm$  sd) in 25 Patients with Duodenal Ulcer

	Fasting Volume ml	Fasting Acid Secretion mEq/15 min.	Basal Acid Secretion mEq/hr.	PAO-pentapeptide mEq/hr.	PAO-insulin mEq/hr.	PAO-meat extract mEq/hr.
	96 $\pm$ 41	1.8 $\pm$ 1.7	4.5 $\pm$ 4.4	28.1 $\pm$ 10.7	27.3 $\pm$ 10.3	16.9 $\pm$ 8.8
Correlation ( $r_{sp}$ ) to PAO-meat Extract	0.67 ( $P_{sp} < 0.001$ )	0.59 ( $P_{sp} < 0.01$ )	0.58 ( $P_{sp} < 0.01$ )	0.88 ( $P_{sp} < 0.001$ )	No correlation	

TABLE 2. Postoperative Acid Tests (mean  $\pm$  sd) in Patients with Duodenal Ulcer

	Fasting Volume ml	Fasting Acid Secretion mEq/15 min.	Basal Acid Secretion mEq/hr.	PAO-pentapeptide mEq/hr.	PAO-insulin mEq/hr.	PAO-meat extract mEq/hr.
	72 $\pm$ 43	0.7 (range: 0-6.4) (n = 21)	0.7 (range: 0-7.5) (n = 21)	12.1 $\pm$ 8.2 (n = 19)	1.5 (range: 0-5.6) (n = 22)	4.4 $\pm$ 4.7 (n = 21)
Correlation ( $r_{sp}$ ) to PAO-meat Extract	0.58 ( $P_{sp} < 0.001$ )	No correlation	No correlation	0.58 ( $P_{sp} < 0.02$ )	0.45 ( $P_{sp} < 0.05$ )	

of meat extract stimulation, this was found in 11 of 15 patients after PCV and in none of the 6 patients after SV + P (Table 3, Fig. 1). This difference is statistically significant ( $p < 0.05$ ).

### Discussion

Meat extract is a potent activator of acid secretion in patients with duodenal ulcer, confirming previous data.<sup>8,10,15</sup>

Before operation, the amount of fasting gastric juice is positively and significantly correlated to meat extract stimulated acid secretion, which is, furthermore, positively correlated to the fasting, basal and, especially, the pentapeptide activated gastric acid secretion.

Significant changes of acid secretion takes place after

PCV and SV + P; fasting, basal, insulin and pentapeptide stimulated acid secretion is reduced in same extent as previously reported in larger series.<sup>12,13</sup> The average reduction of PAO-meat extract is 71% and still positively correlated with the amount of fasting gastric juice. The fact that patients with the smallest amount of fasting juice have the lowest PAO-meat extract is well in accordance with the observation, that meat extract-stimulated serum gastrin response is twice as great after PCV (with more normal gastric emptying) than after PCV + pyloroplasty (with a significant more rapid gastric emptying).<sup>7</sup> Both observations indicate that a fast gastric emptying reduces both the amount of fasting gastric juice and the meat extract stimulated secretion of gastrin and acid.

TABLE 3. Gastric Acid Secretion 2-3 Months after Parietal Cell Vagotomy and Selective Vagotomy with Pyloroplasty

Patient No.	Basal Acid Secretion mEq/hr.	Acid Secretion One Hour after Meat Extract mEq/hr.	Postoperative Reduction of PAO-pentapeptide Per Cent	PAO-meat extract Per Cent
After PVC Insulin - ve				
7.615	0	0	—	—
24.809	0	3.7	69	71
25.326	0	8.1	60	63
25.728	0	3.2	-63	-25
25.746	0	4.8	38	24
25.868	0	9.8	67	41
25.947	0	0.1	88	97
26.076	0	0	61	100
26.422	0.4	6.1	39	58
26.498	0	0	78	100
20.860 (No Insulin test)				
After PCV Insulin + ve				
25.730 (late+ve)	0.2	1.5	29	89
26.158 (late+ve)	0.1	1.1	20	88
26.160 (early+ve)	0	1.9	43	65
26.402 (early+ve)	4.5	9.8	43	57
After SV + P Insulin - ve				
24.776	0	0	84	100
25.646	0.7	0	86	98
26.012	0.2	0	55	100
After SV + P Insulin + ve				
25.643 (late+ve)	0	0	63	100
25.682 (late+ve)	2.0	0.4	64	73
26.543 (late+ve)	7.5	7.7	69	54

After PCV, 11 of 15 patients demonstrated a low, but significant meat extract-stimulated acid secretion. During the first hour after stimulation an average of 3.6 meq of acid is produced ( $n = 15$ ). The average reduction of PAO-meat extract is 64% ( $n = 13$ ). This reduction is greater than the simultaneous reduction of PAO-pentapeptide, which in the same patients was 44%. In patients after PCV, gastric emptying is normal, the antrum is innervated and reduction of PAO-meat extract is positively correlated with reduction of PAO-pentapeptide in patients with complete vagotomy. This shows that meat extract stimulates the innervated and motorically normal functioning antrum, but to a much lesser degree than before operation. This in turn indicates that in man, complete denervation of the parietal cell mass, not denervation of the antrum, is the chief cause of the reduced acid response to meat extract.

In contrast to the secretory pattern after PCV, no meat extract-stimulated acid secretion was found after SV + P. This complete elimination of acid secretion can be caused either by different pattern of gastric emptying after the two operations or by antral denervation, which is included in SV:

Gastric emptying is normal or slightly increased after PCV. In contrast significantly increased gastric emptying is often seen after SV + P under which circumstances food remains in the antrum for too brief a time for it to be activated. An exact evaluation of the influence of gastric emptying on meat extract stimulation can, anyway, only be done by assessing recovery after marking the instilled meat extract. It is noteworthy that in this series recovery of the entire amount of instilled meat extract was only found after PCV.

The role of antral denervation on reduction of meat extract-stimulated acid secretion, is difficult to evaluate. Meat extract acid secretion is nil or sparse in patients with antral denervation after complete (insulin-negative) truncal vagotomy and pyloroplasty<sup>8,10,15</sup> and after SV + P, as shown in this study. The significant meat extract stimulation in patients with intact antral innervation after PCV and in patients with incomplete (insulin-positive) truncal vagotomy and pyloroplasty<sup>15</sup> seems to indicate that innervation of the antrum is necessary for the acid response to feeding with meat extract.

### Conclusion

After PCV a significant meat extract-stimulated acid secretion is to be expected. It is generated either by normal gastric emptying or the presence of an innervated antrum. In comparison with the preoperative acid pattern the postoperative meat extract activated acid secretion is greatly reduced, and is correlated with a positive pentapeptide response. No response is seen in patients

following selective vagotomy and antral drainage. It is too early to state whether persistence of stimulated acid secretion following parietal cell vagotomy will result in a higher recurrence rate in operations for duodenal ulcer.

### Summary

Meat extract is a potent activator of gastric acid secretion in 25 patients with duodenal ulcer. Maximal acid secretion after meat extract stimulation is positively correlated to the amount of fasting gastric juice, fasting and basal acid output, and especially pentapeptide activated acid secretion.

Meat extract is a poor activator of gastric acid secretion after parietal cell vagotomy and after selective vagotomy and pyloroplasty. Maximal acid secretion after meat extract stimulation retains only a positive correlation with the amount of fasting gastric juice and with pentapeptide activated acid secretion.

Significant, but greatly reduced, meat extract-stimulated acid secretion is found in 11 of 15 patients after parietal cell vagotomy. The postoperative reduction of maximal acid output after meat extract is positively correlated to the reduction of pentapeptide stimulated acid secretion in patients with complete (insulin-negative) parietal cell vagotomy.

Meat extract-stimulated acid secretion is eliminated in 6 patients after selective gastric vagotomy and pyloroplasty.

The difference of secretory pattern after the two operations is significant and the possible influence of antral denervation and gastric emptying on these results is discussed.

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