

# Calcium and Potassium Content of Secretions from Noncancerous and Cancerous Stomachs\*

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There is more or less general agreement that the calcium content of rapidly growing tumors is relatively low, whereas the potassium content is relatively high (11). Since changes in the secretions of a given parenchyma might reflect certain changes within its cells, a study of the calcium and potassium content of gastric juice from noncancerous and cancerous stomachs was undertaken, to observe whether or not characteristic "mineral patterns" might be detected.

Gamble and McIver (2) found the calcium content of gastric juice from stomach pouches in cats to be 10.6 mgm. per cent (similar to that of blood serum) 2 to 4 hours after eating, while 8 to 12 hours after food the content was 5.7 mgm. per cent (about half of the earlier value); the potassium content was 45 mgm. per cent and 53 mgm. per cent at corresponding intervals. Ingraham and Visscher (5) observed inverse concentration ratios between the sodium and potassium in the gastric juice and blood plasma of anesthetized dogs injected with histamine, the juice having been obtained from the cannulated pylorus. Rudd (8) obtained juice from man, both with and without histamine stimulation; calcium concentrations varied from 4.1 to 8.6 mgm. per cent, and potassium concentrations from 25 to 74 mgm. per cent. In a later paper (9) values of 4.06 to 8.64 mgm. per cent for calcium and 42.12 to 72.54 mgm. per cent for potassium were reported. Calcium appeared to increase in amount as the acidity fell. Klerks (1) found the average calcium in the fasting gastric juice of 31 Javanese patients and of 33 Chinese and 32 native students to be 4.4, 3.4, and 3.6 mgm. per cent respectively. Kirsner and Bryant (6) studied the calcium content of gastric juice in 65 patients after histamine injection; in spite of variation in individual cases there was a definite direct relationship between the calcium level and the hydrogen ion concentration. For example, juices with a pH range of 1.49 to 1.91 from 36 patients contained an average of 2.06 mgm. per cent of calcium, while those from 12 patients with a pH range of 3.05 to 8.38 contained an average of

4.54 mgm. per cent of calcium. Many of these patients had healing or healed duodenal ulcers. Gray and Bucher (4) obtained samples of gastric juice from the vagotomized pouches of dogs. In 9 pooled samples the calcium was 1.14 to 1.22 mgm. per cent and the potassium 27.3 to 28.9 mgm. per cent. Grant (3) concluded that mucus from the epithelial cells is an immediate source of calcium in gastric secretions. Val Dez and Sendroy (12) state that the hydrogen ion concentration as a factor governing the calcium content of gastric juice is a reflection of the extent to which parietal hydrochloric acid secretion is diluted with non-parietal cell secretion.

## MATERIALS AND METHODS

Gastric juice was obtained from patients according to the usual method after histamine stimulation. Aspirations were carried out at 10 minute intervals. The series includes 24 patients without gastric cancer and 14 with gastric neoplasms (10 carcinomas, 4 lymphoblastomas). In addition juices from 5 other patients without gastric cancer were studied; these patients had an achlorhydria induced by x-ray in the therapy of duodenal ulcer. The specimens were brought without delay to the laboratory, measured, and titrated for free acidity. When the secretion was ample, as was usually the case except where there was little or no free acid, the specimens withdrawn 30 to 40 minutes after histamine injection, presumably at the height of gastric secretion, were studied. They were mixed, filtered through gauze, and then filtered in the cold through Whatman #42 filter paper. When secretion of the juice was scanty it was occasionally necessary to pool all specimens before filtration. Four cubic centimeter samples of the clear, filtered gastric juice were taken in duplicate for determination of calcium, 1 cc. of 4 per cent ammonium oxalate being added. The pH was adjusted to 4.2 to 4.4 with bromcresol green as the indicator, and the mixture placed overnight in the icebox. The calcium oxalate precipitate was washed, redissolved in dilute sulfuric acid, and the resultant oxalic acid titrated according to the method of Kramer and Tisdall

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(7). Potassium determinations by the method of Shohl and Bennett (10), using 0.5 or 1.0 cc. samples in duplicate of gastric juice, were made in 9 of the gastric tumor patients, in 11 of the control patients, and in all 5 of the patients with x-ray achlorhydria.

## RESULTS

In summarizing the data the juices from gastric tumors (carcinomas and lymphoblastomas) are discussed together, as calcium and potassium contents were similar. In Table I it is seen that the calcium

TABLE I: CALCIUM AND POTASSIUM CONTENT OF GASTRIC JUICE FROM CANCEROUS AND NONCANCEROUS STOMACHS  
GASTRIC TUMORS: 14 CASES

Patient	Age	Diagnosis	Amt. juice, cc.	Aver. free acid, clin. units	Calcium, mgm. %	Potassium, mgm. %
1. Ni.	61	Carc. "in situ"	172	77	8.84	
2. Al.	57	Carcinoma	68	59	18.46	50.31
3. Mu.	74	"	121	20	7.32	78.78
4. Du.	55	"	310	0	0.72	2.34
5. Da.	52	"	102	0	4.52	95.94
6. Wo.	66	"	67	0	6.28	73.71
7. Or.	59	"	59	0	21.38	84.24
8. We.	70	"	167	0	3.86	
9. McC.	83	"	44	0	0.74	
10. Me.	52	"	60	0	6.15	65.47
11. Co.	59	Lymphoblastoma	260	24	6.06	
12. Ka.	57	"	83	6	4.14	52.65
13. Gl.	60	"	51	0	3.62	62.79
14. Bo.	28	"	15	0	5.26	
Average	59		113	13	6.95	62.91
<i>Control cases: 24</i>						
a. Ma.	66	Carc. of larynx	53	15	5.81	60.47
b. Fr.	83	Carc. of rectum	69	101	2.50	76.75
c. Fl.	60	"	92	57	1.56	53.59
d. Ma.	26	"	97	16	4.56	66.54
e. Le.	65	Carc. of colon	104	65	4.10	64.05
f. Do.	61	Normal stomach	55	45	7.76	73.32
g. Ho.	25	Stoma ulcer	270	28	2.61	78.85
h. Ec.	43	Gastric ulcer	114	90	2.60	99.57
i. Jo.	37	"	246	111	1.93	
j. Mo.	63	"	238	61	2.62	55.94
k. Da.	47	"	149	21	3.84	
l. Gr.	56	Duodenal ulcer	118	66	1.77	
m. Po.	48	"	184	50	4.92	55.38
n. Ne.	35	"	181	47	2.14	
o. Ba.	36	"	278	66	2.44	
p. Ha.	64	"	154	69	2.49	
q. Ch.	43	"	70	60	2.72	
r. McL.	62	Cholecystitis	155	89	2.13	
s. Ur.	39	"	300	90	2.65	
t. Sc.	35	"	227	62	3.17	
u. Gl.	34	Hernia	82	42	3.31	67.94
v. Sc.	46	Functional col.	108	63	2.03	
w. Wi.	39	"	123	39	2.92	
x. Tr.	32	"	147	72	3.55	
Average	48		151	59	3.17	68.40
<i>Patients with duodenal ulcer treated by x-ray: 5 cases:</i>						
I. Ra.	47	X-ray therapy	140	3	5.04	84.24
II. Ha.	36	"	59	0	5.61	117.27
III. Ro.	51	"	68	0	9.65	154.76
IV. Lu.	41	"	204	0	6.36	177.97
V. Bu.	44	"	146	0	4.19	115.53
Average	44		123	1	6.17	129.95

content in gastric juice varies in the neoplastic stomachs from 0.72 to 21.38 mgm. per cent, and in control stomachs from 1.56 to 7.76 mgm. per cent. In spite of the fact that there are two low calcium readings in the neoplastic series, the average of the group as a whole is 6.95 mgm. per cent, or more than twice that of the control group. The range of potassium determinations in the neoplastic group is 2.34 to 95.94, the one low reading being an exception, and of the control group 53.59 to 99.57 mgm. per cent. The average values are 62.91 and 68.40 mgm. per cent respectively. The juices from 5 stomachs with achlorhydria as a result of x-ray therapy are considered separately. It will be noted that calcium values are high, averaging 6.17 mgm. per cent, and thus similar to those of the gastric tumor cases, which, except in 5 cases, showed an achlorhydria. The concentration of potassium in the juices of these patients was uniformly high, averaging 129.95 mgm. per cent.

#### DISCUSSION

In accordance with the findings of Kirsner and Grant and others the higher calcium excretion in gastric cancer patients and in those with achlorhydria induced by x-ray appears to be a factor of the smaller amount of free acid excreted. There was no free acid in 13 of the 19 juices in these two groups, and the average free acid was 10 clinical units as contrasted to 59 clinical units in the control group, in which all 24 juices showed free acid. In addition the average age of the patients with gastric cancer, 59 years, is greater than that in the control group, 48 years. The incidence of achlorhydria and "hypochlorhydria" is known to increase with advancing age. The potassium excretion is not changed in stomachs with malignant neoplastic disease. The definite increase in the potassium content of juices from patients with x-ray-induced achlorhydria remains unexplained; possibly it is a reaction to injury by irradiation. It is also of interest that the calcium content of these juices was not depressed, as might be expected in view of the antagonism between potassium and calcium.

#### SUMMARY

Calcium determinations were carried out on juices from 14 patients with gastric tumors (10 carcinomas

and 4 lymphoblastomas) and 24 control patients. Differences in calcium could be explained on the basis of the higher acidity in the juices from control stomachs. Potassium determinations were carried out on the juices of 9 patients with gastric tumors (7 carcinomas, 2 lymphoblastomas) and 11 control patients; no significant differences in the amounts secreted were observed. The secretion of both calcium and potassium was increased, compared with controls, in the juices of 5 patients with achlorhydria induced by the x-ray treatment of duodenal ulcer.

The calcium and potassium concentration of gastric juice from cancerous stomachs is not characteristic. These negative findings are in contrast to significant differences observed in nonneoplastic and neoplastic gastric (and colon) mucosa, which will be described subsequently.

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