Gastric fluid volume and pH in elective inpatients. Part I: coffee or orange juice versus overnight fast

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In order to assess the effect of preoperative oral fluids, with and without ranitidine, on gastric fluid volume and pH, 300 elective surgical inpatients, ASA physical status I or II, were randomly assigned to one of six groups. The three groups that received placebo are discussed in this paper, Part I, and the three that received ranitidine in Part II. Between two and three hours before the scheduled time of surgery patients received either 150 ml coffee (Group 1), or 150 ml orange juice (Group 2), while the control group continued their overnight fast (Group 3). No opiate or belladonna premedication was given. Immediately following induction of anaesthesia the residual gastric fluid was obtained by suction on a nasogastric tube and its volume and pH measured. Residual gastric fluid volumes showed no statistically significant differences among the groups (Group 1: 24.5 ± 21.6 ml; Group 2: 23.7 ± 18.4 ml; Group 3: 23.2 ± 17.3 ml; $p > 0.1$). Values for pH among the groups were also similar (Group 1: 2.18 ± 1.58; Group 2: 1.95 ± 1.24; Group 3: 1.95 ± 1.62; $p > 0.1$).

Key words
GASTROINTESTINAL TRACT: gastric emptying; ANAESTHESIA: inpatient, preoperative oral fluids.

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The stomach may secrete up to 50 ml·hr^{-1} of highly acidic fluid, even in fasting patients.[1] Healthy patients presenting for elective surgery commonly have gastric fluid volumes greater than 25 ml and pH less than 2.5, despite having endured a prolonged overnight fast.[2,3] At induction of anaesthesia, therefore, a completely empty stomach cannot be guaranteed by fasting. Over the years recommendations have increased the duration of fluid fast from three hours to five hours, or simply "NPO after midnight".[4–6] There is no clear justification for this change. These attempts to ensure an empty stomach mean that patients scheduled for afternoon surgery may be deprived of oral fluid for more than 12 hours. Also, patients who have been instructed to fast may forget and inadvertently take a drink, and few anaesthetists agree on how long anaesthesia should be delayed in such circumstances. Unnecessary cancellation is time consuming and stressful for the patient as well as for the surgeon and anaesthetist.

Previous studies from this centre indicated that, in outpatients, the mean residual gastric volume (RGV) and pH were not significantly different in patients who had ingested 150 ml water 2–3 hr before surgery from those who had fasted since midnight.[7,8] Other liquids may stimulate gastric secretion more than water. Coffee is a strong stimulant of gastric acid secretion, even when decaffeinated.[9]

Many elective patients are either hungry or thirsty after prolonged overnight fasting. The provision of a drink might alleviate these symptoms. The present study was undertaken to compare the effect of ingesting coffee or orange juice 2–3 hr preoperatively with a mean overnight fast of 12 hr on volume and pH of gastric fluid, and on the severity of hunger and thirst.

Methods

The study protocol was approved by the University of Calgary Conjoint Ethics Committee. Informed consent was obtained from 300 inpatients scheduled for elective surgical procedures. All patients were between the ages of 18 and 60 yr, ASA physical status I or II, and were

scheduled for elective surgery at 1000 h or later. Pregnant, emergency, and ambulatory patients were excluded, as were those taking medication known to affect gastric secretion or motility, and those for whom an opiate or belladonna alkaloid premedication was prescribed.

Three hundred consecutive patients were stratified by sex and randomised within strata to one of six groups using a table of random sampling numbers.[10] This paper, Part I, deals only with the three placebo groups (Table I). Groups 4, 5, 6 who received oral ranitidine are described in Part II.[11]

Between two and three hours before the scheduled time of surgery, immediately before randomisation, patients graded the severity of their hunger and thirst as nil, slight, moderate, or severe. Their age, sex, weight, fasting interval, smoking habit and history of heartburn or vomiting within the previous two weeks, were recorded. The patients were then observed as they ingested either coffee 150 ml (Group 1), orange juice 150 ml (Group 2), or 10 ml water (Control) with a placebo tablet.

Either no premedication was given, or oral diazepam 5–15 mg with 30 ml water 60–90 minutes preoperatively. Premedication was prescribed by the physican designated to anaesthetise the patient, and not by the investigators. Patients again graded their hunger and thirst on arrival in the operating room. Following induction of anaesthesia, a #18 FG Salem-sump tube was passed into the stomach and its position confirmed by auscultation of injected air. Gastric fluid was obtained with the patient in the supine position, and with the sampling tube in several locations within the stomach, by aspiration into a 60 ml syringe. The investigator taking the sample was unaware to which group the patient had been assigned. The volume of fluid was recorded, and its pH measured by a calibrated Corning 150 pH meter.

Results are given as means and standard deviations, ranges and correlation coefficients (r). Between groups tests of significance were performed using Student's unpaired t test, analysis of variance, and chi-square test. Within each group forward multilinear stepwise regression analysis was performed on the variables of residual gastric volume (RGV), pH, age, weight, sex, smoking habit, premedication, duration of fast, ingestion-induction interval, and osmolality and pH of the ingested fluid. Differences were considered statistically significant when $p < 0.05$.

TABLE I Randomised groups

	n	*Fluid*	*Tablet*
Group 1	50	Coffee 150 ml	Placebo
Group 2	50	Orange juice 150 ml	Placebo
Group 3	50	—	Placebo
Group 4*	50	Coffee 150 ml	Ranitidine 150 mg
Group 5*	50	Orange juice 150 ml	Ranitidine 150 mg
Group 6*	50	—	Ranitidine 150 mg

*Groups 4, 5, 6 are discussed in Part II.

TABLE II Patient characteristics (mean ± SD)

	Age (yr)	*Weight (kg)*	*Overnight fast (hr)*	*Ingestion interval (min)*
Group 1	40.3 ± 10.4	73.0 ± 14.5	12.0 ± 2.4	151 ± 41
Group 2	36.9 ± 12.5	74.2 ± 16.7	11.9 ± 1.9	163 ± 31
Group 3	38.4 ± 12.8	72.3 ± 13.8	12.1 ± 2.5	153 ± 32

TABLE III Gastric fluid volume and pH

	Volume (ml)		*pH*	
	Mean ± SD	*Range*	*Mean ± SD*	*Range*
Group 1 (coffee)	24.5 ± 21.6	0–96	2.18 ± 1.58	1.17–7.60
Group 2 (juice)	23.7 ± 18.4	0–76	1.95 ± 1.24	1.16–7.50
Group 3 (fast)	23.2 ± 17.3	0–75	1.95 ± 1.26	1.17–7.72

Results

There were no significant differences among the three groups with regard to age, weight, duration of overnight fast, and mean time from ingestion to sampling (Table II).

There were no statistically significant differences in volume ($p > 0.1$) or pH ($p > 0.1$) among the groups (Table III). The number of patients with a pH < 2.5 was significantly less in those who had orange juice compared with those who had coffee or continued fasting ($p < 0.05$). However, the number of patients in each group with the combination of RGV more than 25 ml and pH less than 2.5 was not significantly different ($p < 0.05$) (Table IV).

Within the fasting group multilinear stepwise regression analysis identified a positive correlation of RGV with duration of fast ($r = 0.38$, $p < 0.05$). In the coffee group RGV showed a negative correlation with oral diazepam

TABLE IV Incidence of patients with risk factors for acid-aspiration syndrome

	Volume > 25 ml	**pH < 2.5*	*Volume > 25 ml and pH < 2.5*
Group 1	19/50	42/49	19/50
Group 2	22/50	31/46	21/50
Group 3	25/50	44/49	24/50

*The difference between numbers in which pH was measured and numbers per group represents patients from whom no gastric fluid was recovered.

TABLE V Changes in hunger and thirst: effect of oral fluid

	Hunger			*Thirst*		
	Less	*More*	*No change*	*Less*	*More*	*No change*
Group 1	12	8	30	26	3	21
Group 2	21	7	22	27	1	22
Group 3	4*	9	37	3*	14*	33

Hunger and thirst on arrival in operating room compared with 2–3 hr preoperatively.
*$p < 0.05$ Groups 3 versus Groups 1 and 2.

premedication ($r = -0.28$, $p < 0.05$). No other within-group correlations were identified.

Changes in the severity of hunger and thirst are shown in Table V. More patients who had a drink (Groups 1 and 2) became less hungry ($p < 0.001$, $\chi^2 = 11.2$) and less thirsty ($p < 0.001$, $\chi^2 = 31.5$) compared with those who fasted (Group 3). More patients who continued fasting became more thirsty compared with those who had a drink ($p < 0.001$, $\chi^2 = 11.7$).

Discussion

Some guidelines for preoperative preparation of elective patients advocate nothing by mouth after midnight irrespective of the scheduled time of surgery, despite the lack of evidence that increasing the duration of fluid fast reduces the residual gastric volume. In this study we found no significant difference in either the mean volume or pH in patients who drank 150 ml oral fluid 2–3 hr before the scheduled start of surgery compared with those who had fasted since midnight.

The animal work of Roberts and Shirley[12] is often extrapolated to humans, with a gastric fluid volume of 25 ml or greater with a pH of 2.5 or less being considered potentially lethal if aspirated into the lungs. For obvious reasons this extrapolation can neither be verified nor refuted experimentally in humans. We have used these values not as "critical values" but merely as a means to compare results among the three groups, and our results with those of other investigators. In rats James *et al.* showed that pulmonary aspiration of small volumes of fluid with very low pH resulted in a high mortality.[13] Higher volumes with a higher pH carried a lower mortality. The aspiration syndrome may occur in humans even with alkaline gastric fluid.[14]

A high proportion of patients presenting for elective surgery have a volume and pH of gastric contents which puts them at risk of developing pulmonary acid aspiration syndrome, even after prolonged fasting.[2,3,6] Even so, the incidence of pulmonary aspiration appears to be low in elective surgical patients. In a retrospective study of 185,358 anaesthetics in Sweden only five cases of pulmonary aspiration, all non-fatal, occurred in elective patients in whom there were no factors indicating an increased risk of aspiration. However, pulmonary aspiration occurred in ten additional patients in whom there were difficulties with the airway or intubation, particularly children, and in 68 in whom there were factors such as emergency abdominal surgery, trauma, or coma to indicate that the stomach might not be "empty".[15]

The method we used to obtain the gastric fluid underestimates the total gastric contents. However, the degree of underestimation is often small.[16] In this study the investigator taking the sample was unaware to which group the patient had been assigned, and therefore the magnitude of this inaccuracy should be similar in all groups.

The incidence of patients with a residual gastric volume greater than 25 ml with a pH below 2.5 were similar in the three groups, ranging from 38 to 48 per cent. We found no evidence that a cup of coffee or a glass of orange juice taken 2–3 hr before the expected time of surgery had any effect on mean gastric volume or pH.

In approximately half the patients in all groups there was no change in severity of hunger or thirst in the 2–3 hr before surgery. However, in patients who were given oral fluid, the degree of hunger and thirst decreased in significantly more patients than in the fasting group.

Emergency and obstetric patients were excluded in this study. All our patients were healthy adults undergoing elective surgery who had not been given narcotic or belladona premedication. Our findings should not be extrapolated to patients who do not meet these criteria.

Acknowledgements

This study was supported by a grant-in-aid from Glaxo Canada Ltd. The authors wish to thank Mr. R.D. Kirk for laboratory analyses, and Dr. A.F. Rademaker and Dr M. Nosal for advice regarding statistical analyses.

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Résumé

Afin d'évaluer l'effet de l'ingestion de liquide par voie orale en période préopératoire avec ou sans ranitidine sur le volume liquidien gastrique ainsi que son pH, 300 patients chirurgicaux électifs, ASA classe I ou II ont été randomisés et divisés en six groupes. Les trois groupes avant reçu du placebo sont discutés dans cette étude (la première partie) et les trois ayant reçu la ranitidine dans la deuxième partie. Entre deux et trois heures avant le temps cédulé de la chirurgie les patients ont reçu soit 150 ml de café (groupe 1), ou 150 ml de jus d'orange (groupe 2), alors que le groupe contrôle a continué son jeûne (groupe 3). Aucune prémédication aux opiacés ou belladone n'a été administrée. Immédiatement aprés l'induction de l'anesthésie le liquide gastrique résiduel fut obtenu par succion sur le tube nasogastrique et son volume et pH ont été mesurés. Les volumes du liquide gastrique résiduel n'ont pas démontré de différence statistiquement significative entre les groupes (groupe 1: 24.5 ± 21.6 ml; groupe 2: 23.7 ± 18.4 ml, groupe 3: 23.2 ± 17.3 ml; $p > 0.1$). Les valeurs de pH entre les groupes étaient aussi similaires (groupe 1: 2.18 ± 1.58; groupe 2: 1.95 ± 1.24; groupe 3: 1.95 ± 1.62; $p > 0.1$).