The effect of pre-operative oral fluid and ranitidine on gastric fluid volume and pH

A.D. Sutherland MB BS FFARACS,
J. Roger Maltby MB BCHIR FFARCS FRCPC,
J.P. Sale BSC MB FFARCS,
Crawford R.G. Reid MB CH B FFARCS

One hundred unpremedicated daycare patients were randomly assigned to one of four groups. Between two and three hours preoperatively all patients received either oral ranitidine 150 mg, or placebo, with bromosulphthalein (BSP) 50 mg in 10 ml water, immediately followed by either 150 ml water or no further fluid.

The residual gastric volume (RGV) in the two placebo groups was significantly lower in patients given 150 ml water (20.6 ± 14.1 ml) than in those who continued fasting (29.9 ± 18.2 ml) ($p < 0.05$). The RGV was further significantly decreased in the two ranitidine groups (10.0 ± 8.8, 9.7 ± 10.5 ml) compared with the two placebo groups (20.6 ± 14.1, 29.9 ± 18.9 ml) ($p < 0.01$).

Mean pH values were significantly higher in the two ranitidine groups (6.71 ± 0.99; 6.31 ± 1.81) than in the two placebo groups (2.05 ± 1.41; 1.72 ± 0.33) but were not significantly different in the fluid versus non-fluid groups. In patients who ingested 150 ml water there was no correlation between the premedication interval and either RGV or pH values. The extremely low percentage of the original BSP (<0.9 per cent) in the gastric fluid of these patients demonstrated that gastric emptying of the ingested water was virtually complete prior to surgery.

The combination of RGV of 25 ml or more with pH less than 2.5 was present in 56 per cent of patients who had only a sip of water with placebo, in 28 per cent of those who received 150 ml water with placebo, and in only two per cent of those patients who received ranitidine.

Key words

ANAESTHESIA: outpatient; HISTAMINE H_2 RECEPTOR BLOCKERS: ranitidine; GASTROINTESTINAL TRACT: stomach, gastric emptying.

From The Department of Anaesthesia, Foothills Hospital at the University of Calgary, Calgary, Alberta, Canada.

Address correspondence to: Dr. J. Roger Maltby, Department of Anaesthesia, Foothills Hospital at the University of Calgary, 1403 29th Street N.W., Calgary, Alberta, Canada T2N 2T9.

During the first 80 years of anaesthesia patients were encouraged to take oral fluids until three hours before elective surgery.[1–4] The fluid was specified as glucose-wafer, beef tea, or china tea. Solid food was withheld for a longer period. Such guidelines are consistent with our knowledge of gastric physiology. Water and isotonic fluids, which do not require digestion, pass through the stomach very rapidly with half of a 750 ml bolus being emptied in approximately 20 minutes.[7] On the other hand, the rate of gastric emptying for solid food varies considerably; the gastric emptying half-time ranges up to nearly five hours and the complete emptying time up to twelve hours.[5,6]

The current recommendations for preoperative fasting do not take this difference in emptying times into account. A four- or six-hour fast[8–10] for liquids as well as solids, or, simply, nothing by mouth after midnight[11] is now established practice. In elective patients, who do not receive narcotic premedication, there appears to be no scientific basis for this extended period of fluid deprivation. In countries with ambient temperature 30° C or greater, patients have been safely allowed to drink water freely until two hours before surgery.[12] Prolonged fasting does not ensure an empty stomach. One-third of patients who fast for seven to 22 hours may still have a residual gastric volume (RGV) of 25 ml or more with a pH 2.5 or less.[13] Conversely, a breakfast of tea and toast taken between two and four hours preoperatively does not increase the residual gastric volume.[14]

In this study we addressed three issues. First, is an overnight fluid fast, sometimes extending into the following afternoon, justified in elective surgical patients? Second, if a patient has disobeyed an "NPO after midnight" order, for how long should surgery be delayed? Third, is there a simple regimen which allows the comfort of drinking fluid on the day of surgery, and which also produces a lower RGV and higher pH?

Methods

The study protocol was approved by the University of Calgary Conjoint Ethics Committee and all patients gave informed consent. One hundred patients, ASA physical

TABLE I Randomized groups

All patients received bromosulphthalein (BSP) 50 mg plus:	
Group I	150 ml water + placebo tablet
Group II	150 ml water + ranitidine 150 mg
Group III	Placebo only
Group IV	Ranitidine 150 mg only

n = 25 in each group.

status I and II, between the ages of 18 and 60 years, presenting for elective surgery were studied. All patients stated that they had fasted since midnight. Those receiving any medication known to affect gastric secretion were excluded.

Patient characteristics of age, weight, smoking history, fasting interval, and history of recent vomiting or symptoms of reflux, were recorded. No sedation or narcotic premedication was given.

Patients were randomly assigned to one of four groups. Within 120 to 180 minutes preoperatively, every patient was given bromosulphthalein (BSP) 50 mg in 10 ml water with either a placebo tablet or oral ranitidine 150 mg. This was followed by either 150 ml water or no further fluid (Table I). There were 15 females and ten males in each group.

General anaesthesia was induced in all patients using intravenous thiopentone, followed by a neuromuscular blocking agent and tracheal intubation when this was indicated. Nitrous oxide and oxygen, supplemented with fentanyl and a volatile agent, were used for maintenance. Within ten minutes of induction an orogastric Salem-pump tube (FG 14 or 18) was passed and its position in the stomach confirmed by auscultation of injected air. The investigator taking the sample was unaware of the group to which the patient had been assigned. Gastric fluid was obtained with the patient in the supine and left lateral positions. The volume was recorded, pH was measured using a calibrated Radiometer PHM 82 pH meter, and BSP concentration using a Beckman spectrophotometer. The percentage of BSP which remained in the stomach was calculated by multiplying its measured concentration by the RGV and expressing this as a percentage of the original 50 mg. From this the degree of gastric emptying of the ingested fluid was obtained.

Results are given as means and standard deviations, with ranges where appropriate. Data were analysed using Student's unpaired t test, and Fisher's exact probability test where appropriate. Correlation of patient characteristics with RGV and pH was sought using linear regression analysis. Differences were considered statistically significant when p was <0.05.

Results

The four groups were comparable with respect to age, weight, fasting interval, and the ingestion-surgery interval (Table II). There was no difference in the incidence of smoking, heartburn, and dyspepsia among the groups.

The volume and pH of gastric fluid, and the percentage of BSP recovered, are shown in Table III. Patients who received 150 ml water with placebo (Group I) had a significantly lower RGV compared with those who received only BSP (Group III) although 28 per cent still had a residual volume of 25 ml or greater. There was no statistically significant difference in pH values between Groups I and III.

Patients who received ranitidine (Groups II and IV) had significantly lower RGV and higher pH compared with those who received placebo (Groups I and III). Patients given 150 ml water with ranitidine (Group II) had significantly lower RGV and significantly higher pH compared with the control, fasting group (Group III).

The calculated percentage of dye remaining was extremely low in all patients, the maximum value being 0.9 per cent (Table III). This suggests that virtually all the ingested fluid had passed beyond the stomach prior to surgery.

The RGV in patients given 150 ml water showed no correlation with the ingestion–surgery interval, nor with the duration of fast, patient's weight, history of smoking, heartburn or vomiting.

Discussion

During the past decade investigators have demonstrated that fasting for as long as 17 hours does not always guarantee an empty stomach.[13–18] This is not surprising because emotional stimuli may cause the stomach to produce up to 50 ml per hour of highly acid secretions, in a

TABLE II Patient characteristics (mean ± SD)

	Age (yrs)	*Weight (kg)*	*Fast (hrs)*	*Ingestion-surgery interval (minutes)*
Group I	34.0 ± 8.3	66.3 ± 13.6	11.2 ± 2.4	141 ± 22
Group II	32.4 ± 7.2	66.0 ± 11.8	11.2 ± 1.5	145 ± 22
Group III	34.6 ± 11.8	66.6 ± 16.7	11.2 ± 2.0	151 ± 22
Group IV	31.8 ± 9.5	68.3 ± 17.3	11.1 ± 1.8	138 ± 18

TABLE III Gastric fluid: volume, pH, and dye recovery

	Volume (ml)	*pH*	*% Dye recovered*
Group I	20.6 ± 14.1* (0–50)	2.05 ± 1.41 (0.76–5.84) n = 22	0.01 ± 0.04 (0–0.16)
Group II	10.0 ± 8.8† (0–42)	6.71 ± 0.99† (4.0–7.98) n = 21	0.05 ± 0.09 (0–0.28)
Group III	29.9 ± 18.2 (2–75)	1.72 ± 0.33 (0.95–2.33) n = 25	0.03 ± 0.00 (0–0.11)
Group IV	9.7 ± 10.5† (0–42)	6.31 ± 1.81† (1.5–7.95) n = 19	0.23 ± 0.05 (0–0.9)

Residual gastric fluid, pH and % dye recovery values: Mean ± SD (range). Number of patients (n) in pH column represents only those from whom gastric fluid was obtained.
*$p < 0.05$ Group I vs III.
†$p < 0.01$ Groups II and IV vs I and III.

manner similar to the cephalic phase of gastric secretion.[19] Prolonged fasting does not necessarily reduce either the volume or acidity of gastric fluid. Indeed, there is some evidence that this leads to an increase in the acidity of gastric fluid.[17]

The histamine H_2 receptor blockers cimetidine and ranitidine, administered preoperatively, have been shown to reduce both the volume and acidity of gastric contents at the time of surgery.[16,17,19] Oral ranitidine is superior to oral cimetidine in raising gastric pH and also has a longer duration of action.[16] The gastrokinetic drug, metoclopramide, reduces gastric volume but has much less effect on pH.[17,18] In all these studies, the patients had fasted overnight and the assumption that preoperative oral fluid increases RGV was not challenged. Evidence that oral fluids may not be dangerous comes from Prior who allowed water until two hours prior to surgery;[12] Miller *et al.* who allowed their patients tea and toast between two and four hours preoperatively;[15] and Hjortso and Mondorf who gave 50 ml water with oral diazepam premedication.[21] However, in these studies no marker dye was used to differentiate between the fluid ingested and continuing gastric secretions.

Bromosulphthalein (BSP) is one of several markers used to estimate volume changes in the gastrointestinal tract. In dogs prepared with watertight Heidenhain stomach pouches drained by a Gregory cannula,[22] Bloom *et al.* retrieved 83 per cent of instilled BSP, a value comparable with other non-radioactive markers.[23] By using BSP as a marker dye we have shown that, for practical purposes, all the oral fluid taken more than two hours preoperatively had passed through the stomach prior to induction of anaesthesia. The fluid obtained from the stomach therefore represents gastric secretion rather than the ingested fluid.

Other investigators have used a similar technique for sampling with comparable results.[16–18] However, the volume of gastric fluid obtained through a Salem sump tube may not represent the total volume.[14,24] Measurement using a dye dilution technique gives higher volumes, and is probably more accurate.[14] In this study the sampling was performed in a double-blind fashion. Any sampling error should therefore be consistent among the four groups, and valid comparisons may be made between group means. The proportion of patients in each group with high risk factors is likely to be underestimated rather than overestimated.

The mean RGV was greatest in those patients who fasted the longest and did not receive ranitidine. Even patients who ingested water without ranitidine had a lower mean RGV compared with those who continued fasting. Those who received oral ranitidine, with or without water, had the lowest mean RGV plus a highly significant rise in pH. This lower RGV with higher pH is clinically significant. The high risk combination of RGV 25 ml or more with pH 2.5 or less[25] was almost eliminated by ranitidine, even when patients had a drink of water up to two hours prior to surgery. The risk of gastric regurgitation and pulmonary aspiration is not necessarily dimin-

TABLE IV Incidence of patients with risk factors in each group

	RGV > 25 ml		*pH < 2.5*		*Volume > 25 ml and pH < 2.5*	
	No.	*%*	*No.*	*%*	*No.*	*%*
Group I	9/25	36	20/22	91	7/25	28
Group II	1/25	4	0/21	0	0/25	0
Group III	15/25	60	24/25	96	14/25	56
Group IV	2/25	8	1/19	5	1/25	4

Denominators in pH column represent patients in whom gastric aspirate was obtained.
$p < 0.05$ Group I vs III.
$p < 0.01$ Groups II and IV vs I and III.

ished, although, were this to occur, subsequent pulmonary damage would be minimised.

These results from males and nonpregnant females are very similar to those obtained from females in the first trimester of pregnancy.[22] It is often assumed that pregnant patients are at higher risk than others for gastric regurgitation and pulmonary aspiration[26] because, in the third trimester, gastrointestinal transit is slowed.[27] Also, lower oesophageal sphincter tone is decreased in the third trimester[28] whereas in the first trimester there is only subclinical reduction in sphincter responsiveness to gastrin and acetylcholine.[29] The gallbladder also shows progressive impairment of emptying during pregnancy,[30] especially after the first trimester. Comparison of mean RGV, and dye retrieval (as a measure of gastric emptying), in this and a previous study of ours[31] showed no statistically significant differences between pregnant and nonpregnant patients. This suggests that, if any delay in gastric emptying occurs in the first trimester, it is minimal and not of clinical importance.

Our findings show that, in elective surgical patients who do not receive narcotic premedication, prolonged fluid fasting is not justified. A drink of water with oral ranitidine between two and three hours preoperatively produces a lower RGV and higher pH in a greater percentage of patients than does a prolonged overnight fast. Further investigation is required to determine whether other liquids such as coffee or juice are as safe as water.

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Résumé

Cent patients externes ont été randomisés en quatre groupes. Entre la première et la troisième heure pré-op, tous les patients ont reçu avec de la bromosulphthalein (BSP) (50 mg dans 10 ml d'eau) soit de la ranitidine 150 mg soit du placebo. Ceci fut suivi immédiatement soit par l'ingestion de 150 ml d'eau soit par aucune ingestion de liquide.

Le volume gastrique résiduel (RGV) dans les deux groupes placebo étaient significativement plus bas chez les patients ayant reçu 150 ml d'eau (20.6 ± 14.1 ml) que ceux qui sont restés a jeun (29.9 ± 18.2 ml) ($p < 0.05$). Le RGV était encore plus significativement diminué dans les deux groupes ranitidine (10.0 ± 8.8, 9.7 ± 10.5 ml) comparativement aux deux groupes placebo (20.6 ± 14.1, 29.9 ± 18.9) ($p < 0.01$).

Les valeurs moyennes du pH étaient significativement plus élevées dans les groupes ranitidine (6.71 ± 0.99; 6.31 ± 1.81) que dans les deux groupes placebo mais n'étaient pas significativement différentes dans les deux groupes fluides versus groupe à jeun. Pour les patients ayant pris 150 ml d'eau il n'y avait aucune corrélation entre l'intervalle de la prémédication et soit la RGV ou les valeurs du pH. Le pourcentage extrêmement bas du BSP original (<0.9 pour cent) dans le liquide gastrique de ces patients a démontré que la vidange gastrique de l'eau ingérée était presque complète avant la chirurgie.

La combinaison de RGV de 25 ml ou plus avec un pH inférieur à 2.5 était présente dans 56 pour cent des patients qui ont pris une simple gorgée d'eau avec le placebo, 20 pour cent chez ceux qui ont reçu 150 ml d'eau avec le placebo, et seulement deux pour cent chez ceux qui ont reçu la ranitidine.