

Gastric fluid volume and pH in elective patients following unrestricted oral fluid until three hours before surgery

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This clinical study was designed to assess the results of new preoperative fasting guidelines in which patients are instructed that they must not eat any solid food after midnight, but that they may drink unrestricted amounts of clear fluid until three hours before their scheduled time of surgery. We studied 199 healthy, elective surgical inpatients aged 18–70 yr to determine whether there was any correlation between the ingestion interval or the volume of fluid ingested, with the volume and pH of residual gastric fluid at induction of anaesthesia. Pregnant patients, and those with gastric disorders or who were taking medications that affect gastric motility or secretion, were excluded. Either no premedication was given, or oral diazepam 5–15 mg was given 90 min preoperatively. Of the 199 patients, 105 ingested 50–1200 ml on the morning of surgery. The ingestion-induction interval was less than three hours in 12 patients whose actual surgery time was ahead of schedule. The remaining 94 patients did not drink because they were scheduled for surgery before 11:00 (n = 51), they did not want to drink (n = 24), or they were advised not to drink by their nurse or surgeon (n = 16). Following induction of anaesthesia, gastric fluid was aspirated through a #18 Salem sump orogastric tube, the volume was recorded and pH was measured with a calibrated pH meter. Patients were divided retrospectively into four groups (in three of which patients ingested fluid) according to the ingestion-induction interval (1.3–3.0 hr, 3.1–5.0 hr, 5.1–8.0 hr, and

nothing by mouth after midnight). Values (mean ± SD) for residual gastric fluid volume (22 ± 19, 32 ± 26, 28 ± 19, 25 ± 19 ml) and pH (1.5 ± 0.3, 1.7 ± 1.3, 1.6 ± 1.1, 1.6 ± 0.9) showed no statistically significant differences among the four groups. Within each of the three fluid groups there was no correlation between volume of fluid ingested and residual gastric fluid volume. We conclude that healthy inpatients should be allowed to ingest unrestricted clear fluid until three hours before the scheduled time of surgery.

Cette étude clinique fut conçue afin d'évaluer les résultats des nouvelles directives de jeûne préopératoire par lequel les patients sont informés de ne pas ingérer de nourriture solide après minuit mais qu'ils peuvent boire une quantité limitée de liquide clair jusqu'à trois heures avant le temps cédulé de la chirurgie. On a étudié 199 patients en bonne santé devant subir une chirurgie élective âgés de 18 à 70 ans afin de déterminer s'il y avait une corrélation entre l'intervalle de l'ingestion ou le volume de liquide ingéré avec le volume et le pH du liquide gastrique résiduel à l'induction de l'anesthésie. Les patientes enceintes et ceux ayant des problèmes gastriques ou ceux qui prenaient des médicaments pouvant affecter la motilité ou la sécrétion gastrique furent exclus. En période préopératoire, aucune prémédication ne fut donnée ou du diazépam par voie orale 5–15 mg fut administré 90 minutes avant l'opération. Des 199 patients, 105 ont ingéré 50–1200 ml le matin de la chirurgie. L'intervalle entre l'ingestion et l'induction fut moins que trois heures chez douze patients chez qui le temps réel de la chirurgie était en avance de la cédule. Les 94 autres patients n'avaient pas bu car la cédule de leur chirurgie était avant 11 heures (n = 51), ou qu'ils n'avaient pas envie de boire (n = 24), ou ils furent avisés de s'abstenir de boire par l'infirmière ou les chirurgiens (n = 16). Après l'induction de l'anesthésie, le liquide gastrique fut aspiré à travers un tube oro-gastrique #18 Salem, le volume fut enregistré et le pH fut mesuré. Les patients furent divisés d'une façon rétrospective en quatre groupes (trois de ce groupe de patients ont ingéré du liquide) selon l'intervalle

Key words

ANAESTHESIA: adult;
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d'ingestion-induction (1,3-3,0 heure, 3,1-5,2 heure, 5,1-8,0 heure, et aucune ingestion orale après minuit). Les valeurs (moyenne \pm SD) pour le volume du liquide gastrique résiduel (22 ± 19 , 32 ± 26 , 28 ± 19 , 25 ± 19 ml) et le pH ($1,5 \pm 0,3$, $1,7 \pm 1,3$, $1,6 \pm 1,1$, $1,6 \pm 0,9$) n'a pas démontré de différence statistiquement significative entre les quatre groupes. Entre les groupes de patients ayant ingéré des liquides, il n'y avait aucune corrélation entre le volume des liquides ingérés et le volume du liquide gastrique résiduel. On conclut que les patients hospitalisés en bonne santé doivent être autorisés à absorber sans restriction du liquide clair jusqu'à trois heures avant le temps cédulé de la chirurgie.

The influence of preoperative oral fluid intake on gastric fluid volume in elective surgical patients has been the subject of recent studies in adults¹⁻³ and in children.⁴⁻⁶ Ingestion of oral fluid until 2-3 hr before the expected time of surgery, compared with an overnight fast of 14 hr or more, has no effect on residual gastric fluid volume or pH at the time of surgery and the necessity for an overnight fast has therefore been questioned.^{7,8} On the basis of these findings, our hospital's fasting guidelines were modified. Routine orders for elective inpatients are now written so that patients may eat their normal diet until midnight and, on the morning of surgery, they may drink an unrestricted volume of clear oral fluids until three hours before their scheduled time of surgery. The three hour recommendation allows patients to have surgery ahead of schedule because preoperative gastric emptying of clear fluids occurs within two hours in most patients.^{1,4,9,10} We now report the results of a follow-up study to determine whether the new guidelines are being followed by nurses, surgeons and patients, and whether residual gastric fluid volume and pH at induction of anaesthesia bears any relationship to time and volume of fluid ingestion.

Methods

The study protocol was approved by the University of Calgary Conjoint Ethics Committee. Written informed consent was obtained from 206 inpatients, ASA physical status I or II, who were scheduled for elective surgery. Pregnant patients, patients receiving drugs known to affect gastric secretion or emptying, including opiate premedication, and those with gastric pathology, were excluded. Age, sex, weight, smoking habit, history of heartburn within the previous two weeks, and times and volumes of fluid ingested were recorded.

Following induction of general anaesthesia, a #18 orogastric Salem sump tube was passed into the patient's stomach by an investigator who was unaware of the duration of fluid fast. Its position was confirmed either by the aspiration of obvious gastric contents or, if none was

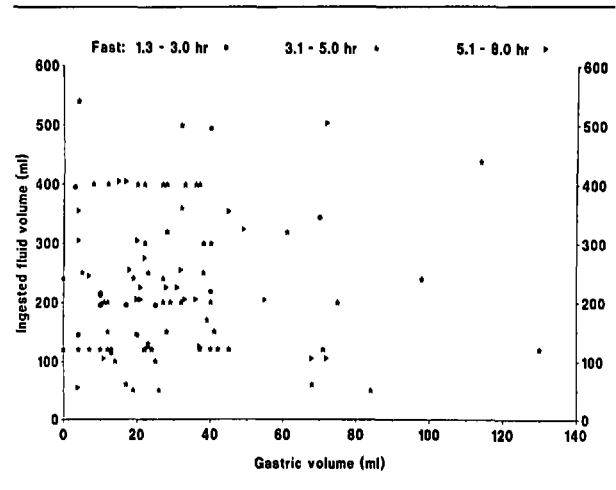


FIGURE 1 Scattergram of ingested fluid volume plotted against residual gastric fluid volume for the three non-fasting groups. One patient who ingested 1200 ml (not shown) had RGV 33 ml.

obtained, by auscultation of insufflated air. Seven patients in whom correct positioning of the tube was uncertain were excluded, to give a final study population of 199 patients. With the patient in the supine position, gastric fluid was aspirated into a 60 ml syringe, while the tube was manipulated into several positions within the stomach and an assistant massaged the patient's upper abdomen. The volume of fluid was recorded, and its pH was measured using a Corning 150 pH meter calibrated at pH 4.0 and 7.0. Patients were divided into one of four groups according to the duration of fluid fast: 1.3-3.0 hr, 3.1-5.0 hr, 5.1-8.0 hr, and nothing by mouth (NPO) since midnight.

Demographic data are given as mean \pm standard deviation (SD). Values for residual gastric fluid volume (RGV) and pH are given as mean \pm SD (range). Data were analyzed using SPSS¹¹ with analysis of variance (ANOVA) for continuous variables (age, weight, height, RGV, and gastric fluid pH), and chi-square analysis for sex and smoking habit. Differences were considered statistically significant if the *P* value was < 0.05 . A correlation coefficient was calculated for RGV with ingested fluid volume.

TABLE I Demographic data

Fast (hr)	n	Male:female	Age (yr)	Weight (kg)	Height (cm)
1.3-3.0	12	8 :4	37 \pm 11	80 \pm 15	171 \pm 8
3.1-5.0	62	25 :37	41 \pm 14	76 \pm 14	170 \pm 9
5.1-8.0	31	13 :18	43 \pm 12	73 \pm 17	168 \pm 10
NPO	94	40 :54	42 \pm 11	76 \pm 15	170 \pm 9

Values are mean \pm SD.

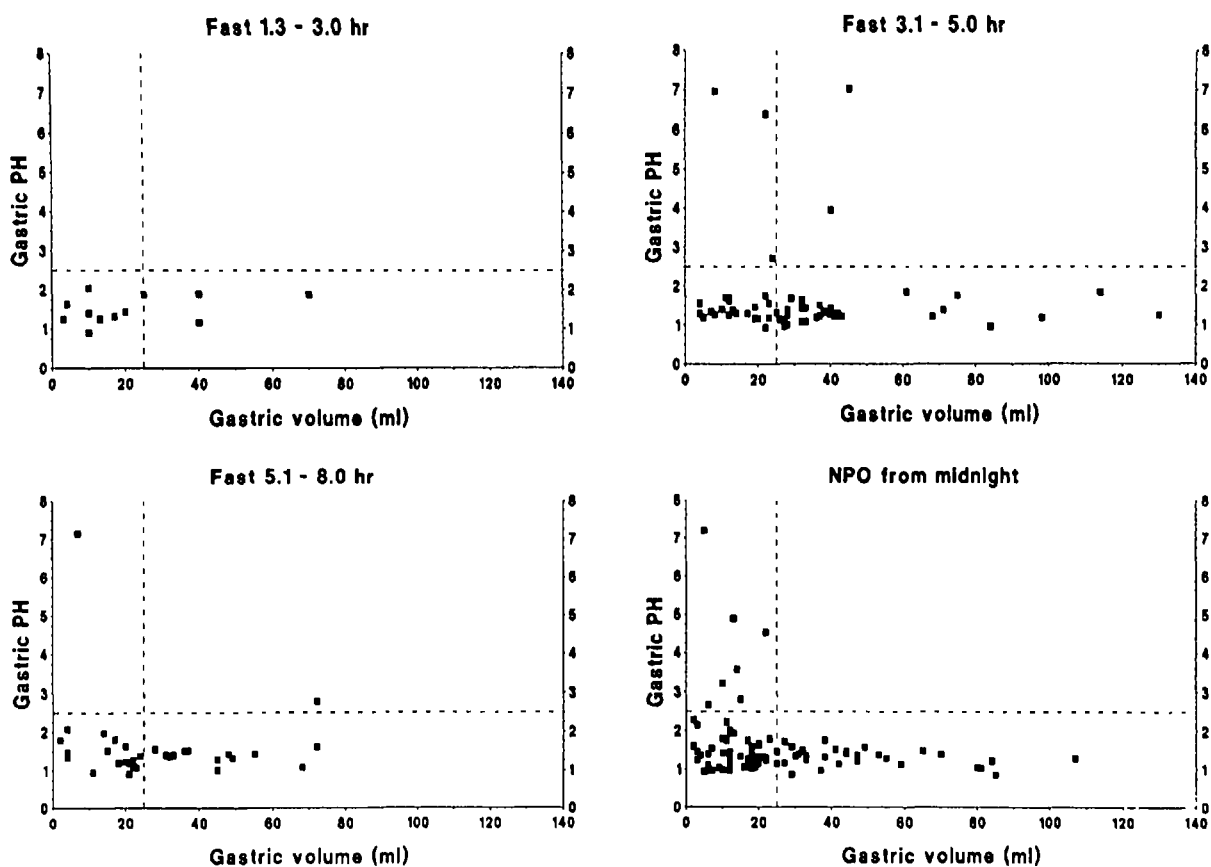


FIGURE 2 Scattergrams of gastric pH plotted against residual gastric fluid volume following fasts of 1.3–3.0 hr, 3.1–5.0 hr, 5.1–8.0 hr, and 10.5–24.7 hr (NPO from midnight).

Results

Demographic data are shown in Table I. There were no statistically significant differences with respect to sex distribution, age, weight, height, or smoking habit. Volumes and ranges of ingested fluid were similar in the three oral fluid groups; RGV and pH values showed no statistically significant differences among these groups (Figure 1), nor from those in patients who fasted from midnight (Table II). In the oral fluid groups there was a wide range of both ingested fluid volume and RGV, but there was no correlation ($r = 0.02$) between the two

(Figure 2). Within groups there was no correlation of RGV or pH with age, weight, height, or smoking status. The numbers of patients who received premedication (17%) and who gave a history of heartburn (17%) were so small in each group that correlation with these variables was not sought. Absolute RGV, but not $RGV \cdot kg^{-1}$, was greater in men than in women ($P < 0.05$). No patient regurgitated or aspirated gastric contents. Of the 199 patients who completed the study, 105 ingested 50–1200 ml clear fluid on the morning of surgery. The remaining 94 patients did not drink because their surgery

TABLE II Ingested fluid volume, residual gastric fluid volume (RGV) and pH

Fast (hr)	n	Ingested fluid (ml)	RGV (ml)	pH
1.3–3.0	12	244 ± 109 (120–500)	22 ± 19 (3–70)	1.5 ± 0.3
3.1–5.0	62	241 ± 177 (50–1200)	32 ± 26 (0–130)	1.7 ± 1.3
5.1–8.0	31	230 ± 111 (50–500)	28 ± 19 (2–72)	1.6 ± 1.1
NPO	94	—	25 ± 19 (0–107)	1.6 ± 0.9

Values are mean ± SD (range).

was scheduled before 11 :00 ($n = 51$), they were not thirsty or thought it would contribute to postoperative nausea ($n = 24$), or they were told not to drink by their nurse ($n = 12$) or surgeon ($n = 4$).

Discussion

Solid food is stored in the stomach until it has been converted to semi-liquid chyme with particles <2 nm in diameter.¹² Only then can it be emptied through the pylorus. The time required for this process of digestion depends on the type and volume of food ingested and the size of the food particles. Carbohydrates and protein are broken down and emptied more rapidly than are fats and cellulose. Complete digestion and emptying of solids usually takes from 3–6 hr, but may be prolonged by anxiety¹³ or opioid medication.¹⁴ Because of this variable time, and the changes which often occur in surgical schedules, we recommend that no solid food should be eaten on the day of surgery.

Clear liquids bypass the stages of storage and digestion, and they are emptied soon after they are ingested. This has been demonstrated by the dual isotope technique in which solids and liquids are labelled with different isotopes.¹² Approximately 95% of liquid was emptied within two hours, whereas nearly 50% of solid food remained in the stomach. It therefore appears that earlier generations of anaesthetists^{15–18} followed physiological principles when they recommended that clear liquids should be ingested two or three hours before surgery.

The routine preoperative order "NPO after midnight," which became ingrained in North American anaesthetic practice, made no allowance for the difference in emptying times between solids and liquids. Patients whose surgery is scheduled in the afternoon commonly fast for 14 hr or more.^{1–6} Nevertheless, many anaesthetists believe they have good reasons for adhering to this traditional order. Shortening the preoperative fast is at variance with the recommendations in authoritative textbooks,^{19,20} and thus with the generally accepted standard of practice. There is concern that preoperative patients may have delayed gastric emptying because of anxiety, or because of the administration of drugs which delay gastric emptying. However, use of a non-absorbable marker dye to assess gastric emptying in elective surgical patients has shown that 150 ml empties from the stomach within two hours in almost all patients,^{1,4,9} including those who received opioid premedication more than one hour after the ingested fluid.¹⁰ The earlier studies demonstrated that ingestion of small volumes of clear fluid, 150 ml for adults and 5 ml·kg⁻¹ for children, did not affect the volume or pH of gastric contents at induction of anaesthesia; recent studies in children^{5,6} have given similar results with unrestricted clear fluid. Concern that patients

who are allowed to drink liquids may also eat anything they wish has not been confirmed in our hospital with adult ambulatory patients.²¹ Approximately 20% of those patients volunteered that they drank more than the recommended 150 ml volume, but all denied that they had eaten solid food. Patients who eat solids on the day of surgery usually claim that they received no instructions on preoperative fasting. This problem has not increased since our guidelines were changed, and delays or cancellations because of patients' drinking or chewing gum has been almost eliminated.

During this study no changes were made in the surgical schedule to accommodate study patients. The results therefore represent everyday clinical practice. Surgical schedules are commonly altered at short notice, and we have no reason to believe that our hospital is better or worse than others. A patient's scheduled time of surgery may be advanced or delayed for a variety of reasons. To allow flexibility of the surgical schedule we recommend that fluids only be allowed until three hours before the *scheduled* time of surgery so that a one hour advance in the *actual* time still allows two hours for gastric emptying.

The technique of blind aspiration of gastric contents may be criticized because it underestimates the true volume. However, if a multiorifice sampling tube is used, the underestimate is small and the dye dilution technique is no more accurate.²² Whichever method is used, the study population must be large because of the wide range of RGV values among patients.

Comparison of the results in this study of inpatients with those of a similar study in ambulatory patients²¹ does not show any significant differences between the two types of patient. We conclude that healthy elective patients should not eat solid food on the day of surgery, but that they should be allowed to drink clear fluids until three hours before their scheduled time of surgery. The risk of unexpected regurgitation or vomiting is not altered, and the anaesthetist must always be prepared to deal with these complications. These guidelines should not be applied to obstetric cases or to patients who are to undergo emergency surgery.

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