Ultrasonographic evaluation of gastric content during labour under epidural analgesia: a prospective cohort study

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Editor’s key points
- Pregnancy and labour are thought to impair gastric motility and emptying.
- Ultrasonographic measurement of antral cross-sectional area (CSA) provides an estimate of gastric volume.
- The authors measured antral CSA in parturients requesting epidural analgesia.
- Serial measurements indicated that gastric motility is maintained during labour under epidural analgesia.

Background. Women in labour are considered at risk of gastric content aspiration partly because the stomach remains full before delivery. Ultrasonographic measurement of antral cross-sectional area (CSA) is a validated method of gastric content assessment. Our aim was to determine gastric content volume and its changes in parturients during labour under epidural analgesia using bedside ultrasonography.

Methods. The cut-off value corresponding to an increased gastric content was determined by ultrasound measurement of antral CSA in six pregnant women in late pregnancy before and after ingestion of 250 ml of non-clear liquid. Antral CSA was then measured twice in 60 parturients who presented in spontaneous labour: when the anaesthesiologist was called for epidural analgesia catheter placement, and at full cervical dilatation. Patient-controlled epidural analgesia was performed with a solution of ropivacaine and sufentanil.

Results. After liquid ingestion, antral CSA (mm²) increased from 90 (range, 80–151) to 409 (range, 317–463). A CSA of 320 was taken as cut-off value. The feasibility rate of antral CSA determination was 96%. CSA decreased from 319 [Q1 158–Q3 469] to 203 [Q1 123–Q3 261] during labour (P=2×10^{-7}). CSA was >320 in 50% of parturients at the beginning of labour vs 13% at full cervical dilatation (P=0.006).

Conclusions. Bedside ultrasonographic antral CSA measurement is feasible in pregnant women during labour and easy to perform. The observed decrease in antral CSA during labour suggests that gastric motility is preserved under epidural anaesthesia. The procedure could be used to assess individual risk of gastric content aspiration during labour.

Keywords: anaesthesia, obstetric; gastrointestinal tract, volume; measurement techniques, ultrasound

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Since the first description by Mendelson in 1946,1 parturients receiving general anaesthesia during labour are considered at high risk of gastric content aspiration. According to the 2005 report on maternal morbidity and mortality in the UK, ‘the aspiration of gastric contents remains a clear risk during induction of general anaesthesia’.2 The hypothesis that pregnancy and labour impair gastric motility and stomach emptying has, however, been challenged recently, with guidelines even encouraging fluid intake during labour.3 In view of these uncertainties, bedside confirmation of an empty stomach during labour would be useful. Assessment of gastric contents could help select optimal airway management, if required.

The feasibility of ultrasonographic assessment of gastric contents and volume has been documented in healthy volunteers and surgical patients.4–7 Standard measurement of antral cross-sectional area (CSA) has been shown to correlate well with predicted gastric volume.4 In addition, aspirated fluid volume has been used to establish antral CSA cut-off values for increased gastric content.6 An antral CSA of 320 mm² has been proposed as the lowest validated value.6 However, ultrasound assessment of antral CSA in parturients has been performed in two studies only8,9 (n=10 for both). The purpose of these studies was to measure gastric emptying in women during the last term of pregnancy but not during labour. Ultrasound imaging to identify stomach contents has been performed in a single study10 in 39 labouring and 34 non-labouring volunteers. It reports the eventual presence of solid food in the stomach of parturients, but without any anatomic or reproducible measurement.

The aim of this prospective cohort study was to confirm the feasibility of ultrasonographic antral CSA measurement in
labouring pregnant women under epidural analgesia and to assess changes in gastric volume during labour.

**Methods**

**Study design**

This single-centre, prospective, cohort study was conducted over a 12 month time period, after obtaining Institutional Review Board approval on October 4, 2011 (Comité de Protection des Personnes Ile-de-France V, RCB 2011-A00919-32). Participants were included according to operator availability (A.B. and J.R.) after obtaining informed consent on arrival at the delivery room.

We used a portable ultrasound device (Venue 40™, GE Healthcare, Piscataway, NJ, USA) with a curvilinear abdominal probe (2.0–5.5 MHz) to measure antral CSA as previously described. Parturients were in the supine position with a head-of-bed elevation of 45°. As the volume occupied by the gravid uterus precluded routine use of the usual landmarks (superior mesenteric vein and inferior vena cava), antral CSA was systematically measured in a sagittal median plane (Fig. 1). Antral CSA was given by the formula \((D_1 \times D_2 \times \pi) / 4\), where \(D_1\) and \(D_2\) are the largest perpendicular diameters of the antrum, considered an ellipse. Each antral CSA determination was the average of three replicate measurements.

**Validation of antral CSA cut-off**

To validate application in pregnant women of the 320 mm² cut-off value for antral CSA established in surgical patients and healthy volunteers, we measured antral CSA (i) after overnight fasting and (ii) at rest after intake of 250 ml non-clear fluid (orange juice) in six non-labouring women in late pregnancy. The volume of 250 ml was chosen, knowing that it is the minimum volume to cause gastric regurgitation and pulmonary aspiration.

**Ultrasound assessment of gastric contents during labour**

Pregnant women at term, more than 18 years of age, in spontaneous labour, presenting no contraindication to epidural analgesia were included. The exclusion criteria were a previous history of upper abdominal surgery and twin pregnancy. Patient characteristic data (age, gravidity, parity, height, prepregnancy weight, and current weight), duration of liquid and solid fasting, and cervical dilatation stage were collected on arrival in the delivery room before the first assessment of gastric contents. Parturients were not allowed any oral intake during labour.

Ultrasound antral CSA measurements were performed (i) when the anaesthetist was called for epidural analgesia catheter placement, (ii) at full dilatation of the cervix uteri, before the second stage of labour. For a single patient, both measurements were done by the same operator. The first measurement performed was blind from either fluid or solid intake. Pain intensity was assessed using a Numeric Rating Scale at these times. Epidural analgesia was obtained with ropivacaine (1 mg ml⁻¹) and sufentanil (0.5 μg ml⁻¹). A 10 ml bolus was infused at catheter insertion and was followed by patient-controlled infusions of 5 ml boluses, with a locked-out interval of 30 min and a continuous epidural infusion of 5 ml h⁻¹.

**Statistical analysis**

According to the data from the cut-off validation study in fasting parturients (mean antral CSA = 100 mm², standard deviation = 29 mm²) and considering that a 15% increase or decrease in antral CSA would be significant, it was necessary to include at least 59 parturients (bilateral test, alpha risk = 0.05, power = 80%).

Data are given as frequencies and percentages for categoric variables and as medians (with 25th and 75th percentiles) for quantitative variables, unless otherwise stated. Reproducibility was given by the mean (with standard deviation) of the differences between the three replicate measurements. Comparisons were made by the Fisher or Wilcoxon test, as appropriate. A linear regression model and the Spearman rank rho coefficient were used to evaluate correlations between variables. All tests were two-sided at the 0.05 significance level. Analyses were performed using the R 2.14.1 statistical package [R Development Core Team (2011). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. http://www.R-project.org/].

**Results**

**Antral CSA cut-off validation**

The median antral CSA in the six non-labouring women of the cut-off validation study was 90 mm² (range 80–151) after an
overnight fast and 409 mm$^2$ (317–463) after ingestion of 250 ml of non-clear liquid (Fig. 2A), thus justifying use of 320 mm$^2$ as the cut-off value for a stomach at risk in pregnant women.

**Feasibility of antral CSA measurement and changes in CSA**

We included 60 labouring women (41 primiparous, 19 multiparous). The median age was 29 years (19–40) and the median body mass index was 27.7 kg m$^{-2}$ (25.8–30.7). Median dilatation stage at epidural catheter insertion was 4 cm (3–5). Median fasting duration before epidural insertion was 370 min (210–710) for liquids and 845 min (390–1072) for solids. Pain was properly controlled by epidural analgesia, with a median numerical rating scale of 1 (0–5) at epidural insertion and 0 (0–2) at full dilatation. The epidural sufentanil dose administration was between 2.5 and 7.5 μg h$^{-1}$. No women vomited between the two measurements during labour.

Among the 60 women, 51 (85%) underwent ultrasound antral CSA measurements at both epidural insertion and full cervical dilatation (Fig. 3). Antral CSA could be measured at epidural insertion in 58/60 women (97%): in two patients, antrum was not visible. Measurement at full cervical dilatation was 30% not possible in three women due to the presence of solid food residue. No women vomited between the two measurements during labour.

**Fig 2** Antral CSA assessed by ultrasonography (A) in six pregnant women after overnight fasting and after intake of 250 ml of non-clear liquid and (B) in 60 pregnant women during labour when calling the anaesthetist for epidural analgesia and on full cervical dilatation.

**Fig 3** Flow chart of the study with parturients included during labour.
precluded by three emergency Caesarean sections and two rapid expulsions, and three gastric antrum were not visible at this time. The overall feasibility rate of antral CSA measurement when imaging was performed was 96%. Reproducibility was 13 (12)%.

Median antral CSA was 319 mm$^2$ (158–469) at epidural insertion and 203 mm$^2$ (123–261) at full cervical dilatation ($P=2\times10^{-7}$) (Fig. 2a). The median change in antral CSA was 51 mm$^2$ (15–191). The median interval between the two measurements was 188 min (149–263).

Antral CSA was >320 mm$^2$ in 29/58 (50%) of women at epidural insertion vs 7/52 (13%) at full cervix dilatation ($P=0.006$). None of the 29 women with an antral CSA < 320 mm$^2$ at epidural insertion had a CSA >320 mm$^2$ at full cervical dilatation (Fig. 2a). Changes in antral CSA were correlated with values at epidural insertion ($\rho=-0.71; P=2\times10^{-8}$) and with the interval between measurements ($\rho=-0.46, P=0.001$) (Fig. 4).

Discussion

This prospective cohort study has confirmed the feasibility of ultrasound assessment of gastric contents during labour analgesia in more than 95% of women. Gastric contents decreased during labour, suggesting persistence of gastric motility under epidural analgesia, even in fasting women.

The study presents the limitation that correlation between ultrasonographic antral area measurement and gastric content volume has been previously determined in adult healthy volunteers or surgical patients but not in pregnant women. Designing the study, we considered gastric content collection through a Salem tube, but we thought that was not justified in the current trial, knowing that it could be uncomfortable for labouring women. Nonetheless, the gravid uterus and the free edge of the liver delimit a CSA for examination of the gastric antrum (Fig. 1) and we were able to obtain consistent and reproducible measurements of antral CSA by always placing the ultrasound probe in the mid-sagittal position. The significant and uniform increase we recorded in antral CSA with liquid intake also provided support for consistency. Before this study, antral CSA had been measured in only a limited number of pregnant non-labouring women at term, with a feasibility rate of more than 95%, as reported in the present study for labouring pregnant women. However, no cut-off CSA value for risk of gastric content aspiration had been determined. The published cut-off value of 320 mm$^2$ derives from a relationship between antral CSA and fluid intake or volume collected by gastric content aspiration in surgical patients or healthy volunteers. We chose instead a highly conservative approach by selecting as cut-off value the lowest extremity of the range recorded in the pregnant women of our validation study. This value proved similar to that reported for healthy volunteers and surgical patients, and should facilitate detection of any significant increase in gastric content that might cause harm to a parturient undergoing anaesthesia. It should nevertheless be viewed with caution.
According to this cut-off value for antral CSA, 50% of women initiating labour had a stomach likely to increase the risk of aspiration during anaesthesia, despite a median duration of fasting of 6 h for liquids and 14 h for solids before the first measurement. This finding supports the published observation that gastric motility might slow down in early labour in pregnant women at term. However, gastric motility persisted during labour as we recorded a decrease in antral CSA, with only 13% of parturients presenting significant gastric content at the end of the first stage of labour, before delivery. Thus, nearly 90% of parturients were at reduced risk of inhaling gastric content, had they required general anaesthesia. Moreover, if the antral CSA measurement at the beginning of labour in fasted women signalled an empty stomach, the stomach was likely to remain empty under epidural analgesia.

As bedside ultrasound assessment of gastric contents was easy and fast, it can be recommended as a simple safety procedure in parturients likely to undergo general anaesthesia before or immediately after delivery. If the first antral CSA measurement exceeds the cut-off value, a second measurement before delivery is warranted, even though the stomach will probably empty during labour. This procedure could also be used to assess the safety of fluid intake during labour in non-fasting parturients.

Further studies are required to investigate the factors that might influence gastric motility during labour. These may include pain and administration of opioids. In our study, administration of sufentanil might have impaired motility and epidural analgesia for pain relief might have promoted motility.

In conclusion, ultrasonographic measurement of antral CSA is feasible in most parturients and is easy to perform. By taking two measurements at an interval, we have shown that gastric motility is preserved and that the stomach empties during labour. The procedure could be used to assess individual risk of gastric content aspiration during labour.

**Authors’ contributions**

A.B.: patient recruitment, data collection, analysis and interpretation of data, and writing up of the first draft of the paper. J.R.: patient recruitment, data collection, revising the manuscript critically for important intellectual content, and final approval of the version to be published. E.M.: revising the manuscript critically for important intellectual content and final approval of the version to be published. F.B.: conception and design, interpretation of data, revising the manuscript critically for important intellectual content, and final approval of the version to be published.

**Declaration of interest**

None declared.

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