

## ORIGINAL INVESTIGATION

## Preoperative fasting for the infusion of “yerba mate”: a randomized clinical trial with ultrasound evaluation of gastric contents



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### Abstract

**Background:** The traditional infusion of “yerba mate” is widely consumed in South America and exported to countries around the world. Although generally considered a “clear fluid”, there is no data to date on the gastric emptying time of yerba mate and safe preoperative fasting intervals. The objective of this study was to evaluate the gastric emptying time of a standardized infusion of yerba mate using bedside ultrasound and compare it with the time confirm of hot and cold tea.

**Methods:** This was a prospective, randomized crossover experimental study. Thirty healthy volunteers were evaluated after 8 hours of fasting for both fluids and solids. Gastric antral area and gastric volume were evaluated at baseline and every 20 minutes after drinking 300 mL of randomly assigned infusion of “yerba mate”, hot tea, or cold tea.

**Results:** The mean gastric emptying time was:  $69.7 \pm 22.1$  min,  $63.1 \pm 14.5$  min, and  $64.3 \pm 23.5$  min for the mate, hot tea, and cold tea respectively. No significant differences were found in emptying time among the infusion groups ( $p$ -value = 0.043). When same time measures were compared, the only significant difference detected was between hot teas and mate infusion at 20 minutes ( $p$ -value = 0.012)

**Conclusion:** Yerba mate infusion has a similar gastric emptying time to that of tea. All subject’s gastric volume returned to baseline values by 100 minutes. It is reasonable to recommend a similar fasting period of 2 hours for mate infusion prior to elective surgery.

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## Introduction

Broncho-pulmonary aspiration of gastric contents may occur during general anesthesia in an unprotected airway given the abolition of protective airway reflexes. This is a rare but serious complication.<sup>1</sup>

To reduce this risk and enhance patient safety in the perioperative period, fasting guidelines have been used for a long time. However, a traditional period of total fasting for 8 hours may lead to metabolic and hydro-electrolytic alterations, patient discomfort, hunger, thirst, and irritability.<sup>2</sup> In recent years, more flexible guidelines for fasting have been developed by different scientific societies. These include fasting recommendations from the American Society of Anesthesiologists published in 2011<sup>3</sup> and updated in 2017<sup>4</sup> and those by the European Society of Anesthesiology published in 2011.<sup>5</sup> They recommend the intake of clear liquids until 2-hours before an elective procedure. An exemption to these guidelines is patients with pre-existing comorbidities or physiologic conditions that may prolong gastric emptying time such as pregnancy, obesity, diabetes, hiatal hernia and gastroesophageal reflux disease.

These guidelines do not include the infusion of yerba mate (*Ilex Paraguariensis* -IP) as a clear fluid, as this is not a popular drink in North America or Europe. The guidelines refer to water, black coffee (without added milk), tea, juice without pulp, and isotonic clear fluids, as they leave no residue, and quickly leave the stomach. Iso-osmolar or hypo-osmolar drinks (compared to plasma) are considered clear fluids for the purpose of preoperative fasting.<sup>6</sup>

Yerba mate infusions are consumed daily by millions of people in Brazil, Uruguay, Argentina, Chile, and Paraguay where they represent a deeply rooted social tradition. For example, it is estimated that 85% of Uruguayans consume yerba mate infusions on a regular basis at least once a week.<sup>7</sup> The consumption of mate is not only limited to this region; according to official data of the producing countries, yerba mate is exported to more than 50 countries in the five continents.

Research shows that yerba mate infusions have positive effects on human health, such as antioxidant activity, radioprotective effect, antihypercholesterolemic activity, inhibition of auto oxidation of LDL. Based on its high content of polyphenols, vitamins and minerals, yerba mate can be considered a medicinal plant.<sup>8-14</sup>

Up until recently, there were no tools available to evaluate gastric content in the immediate preoperative period. Gastric ultrasonography has become a clinically useful, non-invasive tool to accurately determine the volume of gastric content and evaluate gastric emptying, with important implications for assessing the risk of perioperative aspiration.<sup>15</sup>

The main objective of this study was to evaluate the gastric emptying time of a yerba mate infusion using bedside ultrasound and compare it with that of tea. We hypothesized that the gastric emptying time of a yerba mate infusion

would be similar to that of tea. The secondary aim was to identify possible differences between the gastric evacuation of cold and hot drinks.

## Methods

### Study design

After approval by the Research Ethics Committee of the Hospital de Clínicas, Montevideo, Uruguay, and registration with the Ministry of Public Health (registry number 4477845), a prospective, randomized crossover experimental study was conducted. Written informed consent was obtained from all participants.

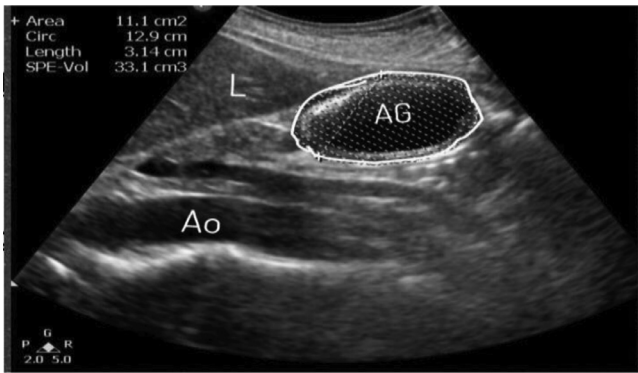
An exploratory study was carried out with a convenience sample size, where thirty healthy volunteers were evaluated on three different occasions, at least 24 hours apart, over a period of 2 months. The inclusion criteria were age over 18 years old, ASA (American Society of Anesthesiologists) physical status I or II. Exclusion criteria: co-morbidities or physiologic states that may alter gastric emptying (diabetes, obesity, gastroesophageal reflux disease and pregnancy).

For the evaluation of the gastric antral area and gastric volume, a previously described standardized scanning protocol and a validated volume model were used.<sup>16-17</sup> The gastric antrum was identified with the volunteer in the right lateral decubitus position, placing the curved low frequency transducer (2–4 MHz) in a sagittal plane over the epigastrium, identifying the antrum between the left lobe of the liver in the anterior part and the pancreas and aorta in the back. The area was measured from serosa to serosa and with the antrum at rest without peristaltic contractions. All examinations were performed with the same portable ultrasound equipment (General Electric Vivid II, GE Healthcare) and by the same imaging physician with 5 years of experience and blinded to the nature of the liquid ingested by each participant in turn, this was supervised directly by an imaging specialist with 20 years of experience in abdominal ultrasound.

The gastric antral area was measured using the free tracing technique as previously described.<sup>18</sup> Then the gastric content volume was determined by means of a mathematical model described and validated by Perlas et al.<sup>17</sup> (Fig. 1), using the following formula: Vol (mL) = 27.0+14.6 CSA (cm<sup>2</sup>) – 1.28 Age (years). Gastric emptying time was defined as the time in minutes elapsed from taking the infusion until the antral area (and gastric volume) returned to fasting baseline values.

Each participant was assigned the infusion to ingest on each day of the study (yerba mate, hot tea or cold tea) in an order determined by a random number generator, in a 1:1:1 ratio.

With fasting of at least 8 hours for liquids and solids, the participants were given an ultrasound examination to measure the baseline antral area, and then the measurement was repeated after they ingested the 300 mL of the infusion



**Figure 1** Abdominal ultrasound, longitudinal section in the epigastrum. Ao, Abdominal aorta; Dotted line, antral gastric area, presents anechoic (liquid) content.

assigned for that day, and every 20 minutes until the antral area was found to be equal to or smaller than the initial one. The sonographer did not know the nature of the swallowed fluid.

### Preparation of infusions

The Yerba Mate infusion was prepared using 30 g of *Ilex paraguariensis* (Yerba Mate, Canarias SA, Pando, Uruguay) infused for 15 minutes in 700 mL of non-carbonated mineral water (Salus SA, Minas, Uruguay) at 90°C. It was then filtered and served in thermal glasses (300 mL) at 50°C.<sup>19</sup>

The tea infusion was prepared using 2 g of *Camellia sinensis* (Té Negro, Canarias SA, Pando, Uruguay) infused in 300 mL of non-carbonated mineral water (Salus SA) at 90°C for 4 minutes, filtered and served in thermal cups (300 mL) at 50°C.

The cold tea infusion was prepared in the same manner and then allowed to cool down to room temperature. Osmolarity, pH, and Caffeine Concentration of the three infusions were analyzed with an OSMOMETRO-Advanced Instrument Model 3250 (Table 1).

### Statistical analysis

One way analysis of variance (ANOVA) for repeated measures was performed. To verify that the conditions for this test were met, the normality of the independent variable was investigated with the Shapiro-Wilk test and the sphericity of the variances with the Greenhouse-Geisser epsilon. The *t*-test for paired means was used for post hoc comparisons when differences were detected among the infusion groups.

**Table 1** Characteristics of infusion and water.

	pH	Kcal	Osmolarity mmoL.Kg <sup>-1</sup>
Yerba Mate infusion	4.5–5	45	128
Black Tea infusion	6.5–7	< 0.5	10
Water used for the infusion	7	0	4

A *p*-value < 0.05 was considered significant. The statistical analysis was performed with the software STATA, version 15.1. (2017).

### Results

A total of 30 volunteers were studied. Demographics are presented in Table 2. Each participant was evaluated once after drinking each infusion, except for two volunteers, who underwent two of the three measures. A total of 88 measurements were obtained, of which 29 corresponded to the mate group, 29 to hot tea and 30 to cold tea.

The gastric emptying time was similar in the three groups with mean and standard deviation of 69.7 ± 22.1 min, 63.1 ± 14.5 and 64.3 ± 23.5 for yerba mate, hot tea and cold tea respectively. No significant differences were detected (ANOVA for repeated measures, *p*-value = 0.41).

Figures 2 and 3 shows gastric volume as a function of time: at each time point the mean and its 95% Confidence Interval was represented for each infusion. Volumes were considered stable after returning to baseline.

Mean volumes at 0, 20, 40, 60, 80, and 100 minutes were compared using one way ANOVA for repeated measures. *P*-values are shown in Table 3. Differences were only significant at 20 minutes (*p*-value = 0.043), post hoc comparisons using *t*-test for paired observations showed that mean volume between hot tea and mate was significantly different (*p*-value = 0.012), while volume at 20 minutes had no significant differences between hot and cold tea (*p*-value = 0.325) nor between mate and cold tea (*p*-value = 0.158).

We found that gastric volume returned to baseline in 60% of cases by 40-minutes, 93% of cases by 60-minutes, and in 100% of cases by 100 minutes (Table 3).

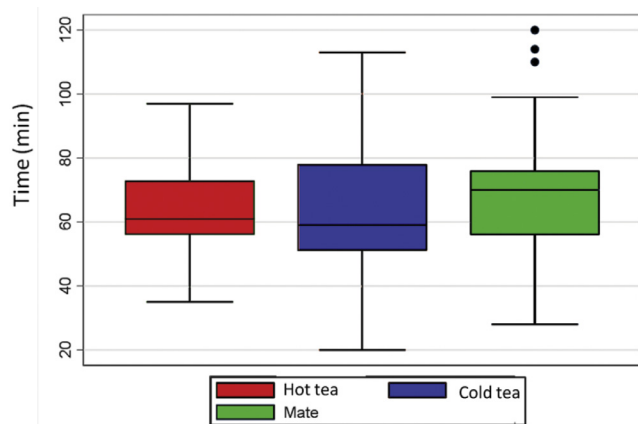
### Discussion

Our results suggest that the mean gastric emptying time for a yerba mate infusion is approximately 1 hour and is similar to that of hot or cold tea, and that all healthy subjects return to baseline gastric volume within 100 minutes of yerba mate ingestion. This suggests that a similar preoperative fasting time of 2 hours could be recommended for an infusion of yerba mate. The current flexible fasting guidelines of different societies recommend the intake of clear liquids up to 2 hours before an elective procedure.<sup>3-5</sup> The infusion of yerba mate is consumed in several countries of South America, and other countries of the world. Given the lack of data on the emptying time of yerba mate infusions to date, many anesthesiologists in South America request

**Table 2** Demographic characteristics of the 30 volunteers.

	n = 30
Age (mean ± SD)	26.9 ± 4.2
Weight (mean ± SD)	67.7 ± 13.2
Height (mean ± SD)	168.8 ± 8.3
Sex (M/F)	12/18
ASA (I/II)	20/10

SD, Standard Deviation.



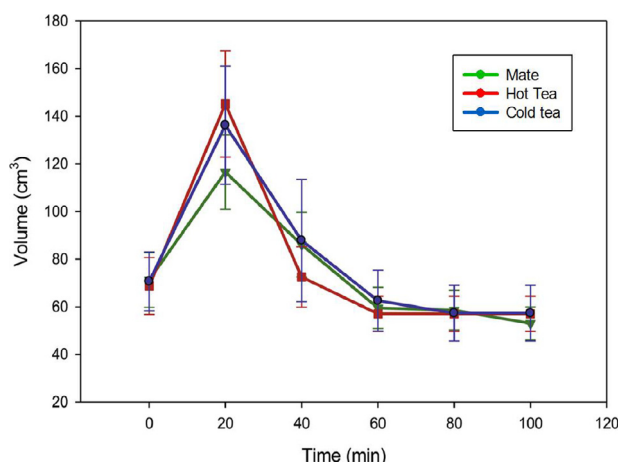
**Figure 2** Gastric emptying time after ingestion of 300 mL of infusion in 30 volunteers.

longer fasting time for yerba mate out of an abundance of caution. Our results suggest that this is overly conservative and that a fasting time of 2 hours is indeed safe for yerba mate infusions.

Vist and Maughan<sup>6</sup> demonstrated in 1995 that the two main determinants of gastric evacuation of liquids are osmolarity and carbohydrate content. More recently, Okabe et al.<sup>20</sup> studied the influence of fluid content for gastric emptying and concluded that the intake of a beverage whose content did not exceed 220 kcal and 500 mL (except beverages with high osmolarity, very high viscosity or both) was safe until 2 hours before an elective procedure. Our studied liquid was the infusion of yerba mate, a hypo-osmolar and hypocaloric drink, and would therefore be expected to behave like a clear liquid. This was confirmed by our results, thus suggesting that yerba mate infusion should be treated as other clear fluids in terms of pre-operative fasting.

Given that yerba mate infusions are usually ingested hot, we decided to compare the emptying time of hot and cold tea to establish if the temperature of the ingested fluid has any impact on gastric emptying rates. Our results showed that the temperature of the liquid ingested does not change the rate of gastric emptying, and it should not be considered a significant variable.

In 10% of all measurements obtained 20 minutes after ingestion, the gastric volume was lower than the ingested volume of 300 mL. Mendes et al.<sup>21</sup> similarly found that the gastric volume 10 minutes after ingesting 400 mL of coconut water was less than the volume ingested. These two observations suggest that gastric emptying of liquids starts very



**Figure 3** Gastric volume estimation as a function of time for 30 volunteers having 300 mL of mate, hot tea and cold tea. Measures obtained at time 0, 20, 40, 60, 80 and 100. Vertical lines show 95% Confidence Intervals for the means.

soon after, if not immediately after, ingestion. Unlike the study by Mendes, we made our measurements every 20 minutes after ingestion, rather than every 60 minutes, which allowed us to determine the emptying rate more accurately. We found that the gastric volume returned to baseline in 60% of cases by 40 minutes, 93% of cases by 60 minutes and in 100% of cases by 100 minutes.

Despite presenting with at least 8 hours of fasting, and not having co-morbidities that would alter gastric emptying, in 11 evaluations (12%), the baseline gastric content prior to intake of the infusion was greater than the one considered safe ( $> 1.5 \text{ mL}\cdot\text{kg}^{-1}$ ). These findings are consistent with other studies that have previously described that even in healthy individuals, standard fasting periods may not be sufficient to guarantee an empty stomach in all patients.<sup>22</sup>

The crossover design of our study, where the same 30 volunteers underwent the 3 measurements of liquids studied, reduced the possibility of interindividual variations, assuring the homogeneity of the sample and its comparison among the 3 infusions. In turn, the measurement bias was reduced when all the ultrasound examinations were done by the same expert.

One of the limitations of our study was that the mate infusion was ingested by sipping from a mug. We did that to standardize the conditions of ingestion in all 3 groups. It is

**Table 3** Estimated mean gastric volume 20, 40, 60, 80, and 100 minutes after drinking 300 mL of Mate, hot tea or cold tea in 30 volunteers.

Time (min)	Mean volume for MATE measures	Mean volume for HOT TEA measures	Mean volume for COLD TEA measures	ANOVA <i>p</i> -value
0	71.3	68.5	70.0	0.998
20	116.6	147.8	136.4	0.043 <sup>a</sup>
40	86.1	72.7	87.2	0.432
60	59.5	57.7	62.8	0.660
80	58.6	57.7	57.7	0.978
100	53.0	57.7	57.7	0.533

customary however, to drink mate infusions from a straw. It is unknown if drinking from a straw would result in greater air ingestion that could impact emptying time. Secondly, our study was performed in relatively healthy volunteers without comorbidities that could affect gastric emptying time and who were not in a preoperative period, where stress and anxiety could also potentially affect gastric emptying.

## Conclusion

We concluded that the infusion of yerba mate has a gastric emptying time that is similar to that of tea, thus it should be considered a clear liquid for the purpose of preoperative fasting. Its consumption within a period of up to 2-hours before an elective surgery, may be considered safe.

## Conflicts of interest

The authors declare no conflicts of interest.

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