

Effect of general anaesthesia on prolonged intraoesophageal pH monitoring

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Abstract

Investigation of gastro-oesophageal reflux often includes endoscopy, usually under general anaesthesia, and pH monitoring. In most cases, the pH probe is passed when the child is awake and is poorly tolerated. The effect of general anaesthesia on pH monitoring is unknown. The aim of the study was to determine if placing the probe in the anaesthetised child gives a representative pH study. Twenty children aged 4 months to 13 years underwent oesophago-gastroduodenoscopy under general anaesthesia. A pH electrode was placed under direct vision in the distal oesophagus. pH monitoring was begun after completion of anaesthesia and continued for 18-24 hours. The study was repeated within 14 days without anaesthetic. The reproducibility of values of percent pH <4, number of reflux episodes/hour, reflux episodes lasting >5 min, and longest reflux episode was 85%, 90%, 75%, and 75% respectively. These results are comparable with those in adults and children in whom pH studies were performed on consecutive days (without anaesthetic) keeping all variables constant. Therefore pH data collected in a child within 24 hours of endoscopy under general anaesthesia are representative.

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Keywords: intraoesophageal pH monitoring, general anaesthesia, reproducibility.

Intraoesophageal 24 hour pH monitoring is widely regarded as the gold standard for diagnosing gastro-oesophageal reflux. In most centres where pH monitoring is performed, the naso-oesophageal electrode is passed while the child is awake; this is obviously painful and is poorly tolerated, particularly in the toddler age group. Since there is a poor correlation between the severity of gastro-oesophageal reflux as judged by pH studies and the presence of histological or endoscopic oesophagitis,^{1,2} few paediatricians and paediatric surgeons would base the need for antireflux surgery on an abnormal pH study alone. Therefore the complete assessment of children with symptoms suggestive of pathological gastro-oesophageal reflux requires endoscopy and oesophageal biopsy, which is commonly performed under general anaesthesia. General anaesthetic agents may have an effect on oesophageal and gastric smooth muscle relaxation and thereby may alter lower oesophageal sphincter pressure and gastric emptying. The aim of this study was to

determine if general anaesthesia affects the reproducibility of pH studies.

Methods

PATIENTS

Twenty children aged 4 months to 13 years (mean 4.4 years) who presented with symptoms suggestive of pathological gastro-oesophageal reflux underwent oesophago-gastroduodenoscopy under general anaesthesia. Each anaesthetic was standardised. Anaesthesia was induced with sodium thiopentone (5 mg/kg), and suxamethonium (1 mg/kg) was used to facilitate endotracheal intubation. Anaesthesia was maintained with halothane 1-2% in 30% oxygen with nitrous oxide. Routine cardiovascular and respiratory monitoring were performed throughout. Endoscopy was performed using a flexible paediatric endoscope (Olympus GIF P20) which has an external diameter of 9 mm (equivalent to FG 28). In each case the lower oesophageal sphincter was intubated by the endoscope to enable visualisation of the gastro-oesophageal junction from within the stomach as well as of the gastric and duodenal mucosa. The duration of anaesthesia was 20 to 35 minutes (mean 25 minutes). A pH electrode was placed under direct vision in the distal oesophagus with its tip approximately 13% of the distance from the gingival margin to the gastro-oesophageal junction above the junction.³ Recording of pH data began six hours after completion of anaesthesia to allow sufficient recovery from the anaesthetic, and continued for 18 to 24 hours. The pH study was repeated within 14 days without the use of anaesthetic or sedative drugs; the probe was passed, under fluoroscopic control, to the same distance. A diary detailing activities and diet was kept during the first study and where possible was repeated during the second study. The reproducibility of four pH indices (percentage of time during which intraoesophageal pH was less than 4, number of reflux episodes per hour, number of reflux episodes lasting longer than 5 minutes, and duration of longest reflux episode) was determined and compared with two previous studies in which the reproducibility of these variables, measured on consecutive days without general anaesthesia, had been ascertained.^{4,5}

pH MEASUREMENTS

Synectics semidisposable monocrystant antimony pH electrodes with an external diameter of 2 mm and silver/silver chloride cutaneous

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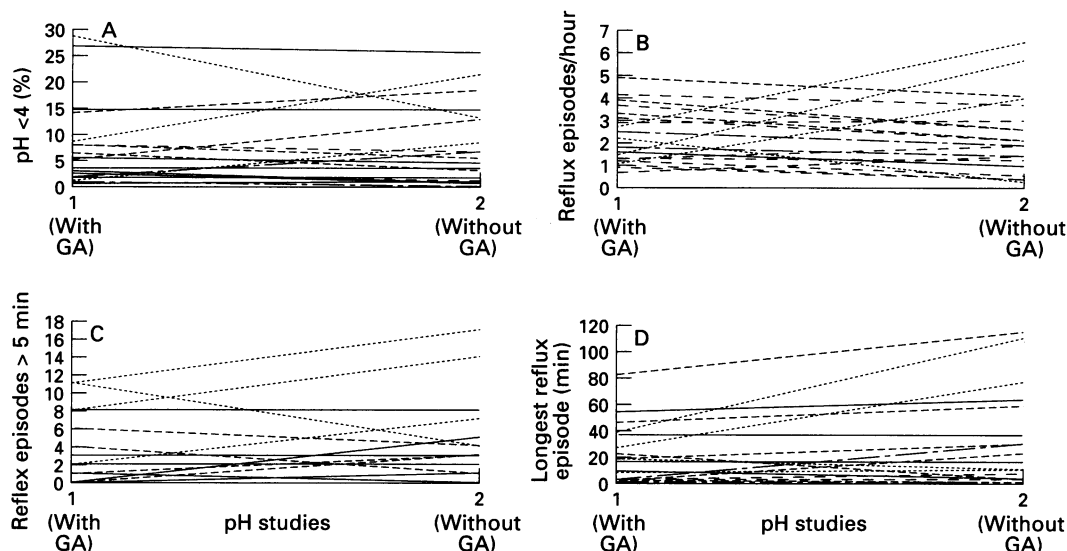


Figure 1 Variability in consecutive pH studies, the first study performed in association with general anaesthesia and endoscopy. (A) Percent of time that intraoesophageal pH was <4. (B) Number of acid reflux episodes per hour. (C) Number of acid reflux episodes greater than 5 min duration in 24 hours. (D) Longest acid reflux episode (minutes).

reference electrodes were used. The electrodes were tested before and after each recording in Synectics buffers of pH 7 and pH 1. No results were discarded because of excessive drift (exceeding 0.3 pH units). pH data were recorded on a Synectics Digitrapper Mark II Gold and analysed using 'EsopHogram' (Gastrosoft Inc). The four reflux indices (above) were analysed for the total study period. A diagnosis of abnormal gastro-oesophageal reflux was made if any of the variables exceeded published normal values.^{6,7} A pH index was defined as reproducible if the patient retained a normal or abnormal result during both pH studies.

STATISTICAL METHODS

Natural logarithmic transformation was performed on each reflux variable since any difference between the variables in the two studies is likely to be proportional to the mean. Logarithmic transformation of the data would

show more clearly any relationship between the differences in consecutive pH indices studied. One was added to each variable before taking the transformation to avoid using the logarithm of zero. The difference between the transformed variables in each pH study was determined and the standard deviation of the differences calculated. By taking the antilog of 1.96 times the standard deviation of the differences, 95% confidence limits were obtained. The latter represent the limits within which the differences between the two results for each reflux variable (one with general anaesthetic, one without) should lie.

The study was approved by the Research Ethics Committee of the Queen's University of Belfast.

Results

The variability of the four pH indices from the first study (performed immediately after general anaesthesia and endoscopy) to the second study (performed in the absence of anaesthetic or endoscopy) is shown in fig 1 A-D.

The reproducibility of the four pH indices, and hence the effect of general anaesthesia, is shown in fig 2 and is compared with two similar studies in which the reproducibility of pH monitoring was tested on two consecutive days in the absence of anaesthetic or sedative agents, one study involving adults (Wiener *et al*⁸) and the other study involving infants aged 7 days to 11 months (Hampton *et al*⁹). In the present study, the reproducibility of two measurements of percent pH <4, one taken in association with and the other remote from general anaesthesia, was 85%, identical to that found by Wiener in adults, compared with the value of 62% reported by Hampton in infants. The reproducibility of the number of reflux episodes per hour in this study (91%) was greater than that found by Wiener or Hampton (70% and 62% respectively). While the reproducibility of the two pH indices that assessed

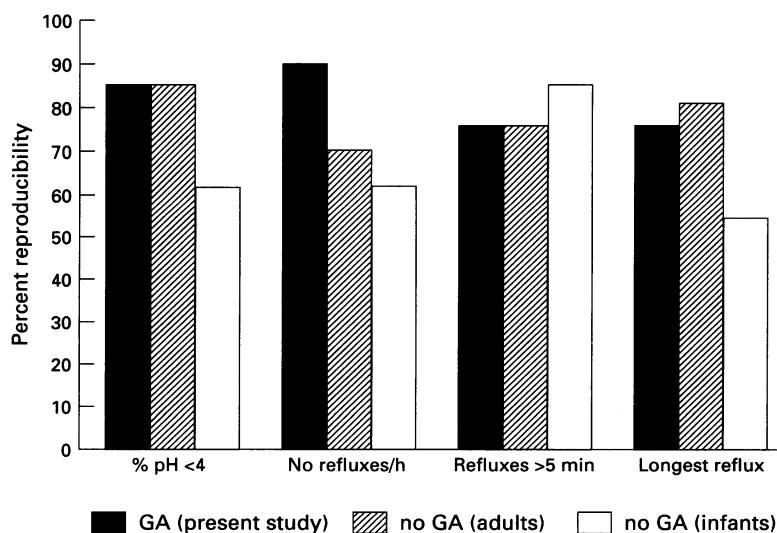


Figure 2 Reproducibility of two separate pH studies: the effect of general anaesthesia (GA).

Comparison of the upper confidence limits of four pH indices from three independent studies

Study	% pH <4	No of reflux episodes/h	Refluxes >5 min	Longest reflux (min)
Present study (GA v no GA)	3.3	2.5	4.7	4.4
Hamptom (infants, no GA)	3.7	3.8	2.4	11.9
Weiner (adults, no GA)	3.2	nc	nc	nc

GA=general anaesthetics; nc=not calculated.

prolonged acid reflux in the present study (each 75%) was similar to that found by in adults by Wiener, in infants the reproducibility of the longest reflux episode and the number of reflux episodes lasting more than 5 minutes and was 85% and 54% respectively.

The table shows the upper confidence limits for each of the four pH indices derived from the antilog of 1.96 multiplied by the standard deviation of the logged differences. It can be seen, for example, that the percentage of time intraoesophageal pH was less than 4 varied by up to 3.3-fold between two consecutive studies, one performed immediately after general anaesthesia and the other performed at a time remote from anaesthesia. However, this compared very favourably with the day to day variability noted in infants by Hampton (3.7-fold difference) and in adults by Wiener (3.2-fold difference).

Discussion

Performing pH monitoring requires accurate placement of the oesophageal electrode. This may be achieved using fluoroscopic guidance, or by the withdrawal method whereby the tip of the electrode is passed into the stomach until an acidic reading is obtained and then slowly withdrawn into the oesophagus, or by placing the electrode tip proximal to the manometrically determined proximal limit of the lower oesophageal sphincter. While these techniques are well tolerated in adults, placement of the intraoesophageal electrode in children is difficult and compliance is usually poor. To assess the severity of gastro-oesophageal reflux fully, endoscopy and oesophageal biopsy are essential in order to determine the presence and extent of oesophagitis. In paediatric practice endoscopy is usually performed under general anaesthesia. The aim of this study was to ascertain if pH studies performed in the 24 hours following general anaesthesia (having placed the intraoesophageal electrode under direct vision in the anaesthetised child) is representative of the child's reflux profile.

It is known that anaesthetic drugs can promote gastro-oesophageal reflux. Induction agents such as thiopentone and suxamethonium, as well as laryngoscopy and endotracheal intubation, have been shown to induce reflux.⁸ Inhalational agents such as halothane delay gastric emptying⁹ and may therefore predispose to gastro-oesophageal reflux in the postanaesthetic period. Furthermore drugs such as atropine and neostigmine used to terminate the anaesthetic reduce lower oesophageal sphincter pressure, although these effects appear to be transient.¹⁰ Thus theoretically general anaesthesia may predispose to

gastro-oesophageal reflux or exacerbate pre-existing reflux by several mechanisms.

The endoscopic assessment of children presenting with upper gastrointestinal symptoms includes gastroduodenoscopy as well as oesophagoscopy in order to inspect the gastro-oesophageal junction from below and to rule out concomitant pathology such as *Helicobacter pylori* gastritis.¹¹ This requires the passage of an endoscope (28 F) through the lower oesophageal sphincter which might render the sphincter (more) incompetent in the postendoscopic period. There are no published data on the manometric assessment of the lower oesophageal sphincter before and after endoscopy in children or adults. However, in one study the presence of a nasogastric tube did not affect the degree of gastro-oesophageal reflux as judged by pH studies performed before and during intubation of the lower oesophageal sphincter.¹² One could speculate, therefore, that following removal of the tube (or endoscope) gastro-oesophageal reflux would not be exacerbated.

In order to assess the effect that general anaesthesia and intubation of the gastro-oesophageal junction by the endoscope has on the competence of the lower oesophageal sphincter, the results of pH studies begun six hours after completion of endoscopy (to enable the child to 'recover' from the anaesthetic and resume normal activities) have been compared with those performed 2 weeks later (in the absence of general anaesthesia and endoscopy). This assumes that when all variables are constant, consecutive pH studies give reproducible results. The reproducibility of pH monitoring, that is, when an abnormal profile on one occasion is also abnormal in a subsequent study, has been established in adults^{5 13} and children.⁴ In these three studies the reproducibility of percent pH <4 (the most reliable pH index) on consecutive days, keeping all variables constant where possible, is reported to be 85%, 77%, and 62% respectively. In other words there is considerable day to day variability in acid reflux, and more so in infants than adults. In the present study, with the introduction of general anaesthesia as a variable and keeping all other variables constant where possible, the reproducibility of percent pH <4 was 85%, identical to that found by Wiener⁵ in adults and considerably better than that reported in infants by Hampton.⁴ Indeed the reproducibility of the remaining three pH indices in the present study compared favourably with Wiener's results (fig 2), suggesting that general anaesthesia and endoscopy do not significantly alter the reproducibility of pH monitoring.

The upper limits of the day to day variability in gastro-oesophageal reflux have also been documented. In adults, Wiener noted that percent pH <4 may vary by as much as 3.2-fold between consecutive pH studies, and in infants Hampton observed that the same index could vary by up to 3.7-fold from one pH study to the next. From the results shown in the table, with the introduction of general anaesthesia as a variable, percent pH <4 was seen to vary by

up to 3-3-fold from one study (with anaesthetic) to the next (without anaesthetic). This result compares very favourably with those of Wiener and Hampton in which no anaesthetics were used.

We conclude, therefore, that general anaesthetic drugs and the act of intubating the lower oesophageal sphincter with a paediatric endoscope do not adversely affect the results of pH monitoring in children. It is therefore justifiable to pass a pH electrode at the time of endoscopy under general anaesthesia, thereby obviating the need to pass a naso-oesophageal electrode while the child is awake and minimising the trauma to the child.

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