Premedication Drugs and Gastric Juice pH and Volume in Pediatric Patients

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The effects of premedication on gastric juice volume and pH were evaluated in five groups of 206 pediatric patients undergoing elective surgical procedures: Group 1 (Control) received no premedication; Group 2 was given morphine sulfate and pentobarbital as premedications. The other groups received, in addition to morphine and pentobarbital, atropine (Group 3), scopolamine (Group 4), or glycopyrrolate (Group 5). After endotracheal intubation, gastric aspirates were examined for volume, pH and color. Neither premedication with morphine and pentobarbital nor addition of atropine or scopolamine to the premedication significantly altered volume. In patients treated with glycopyrrolate, volume was reduced to less than a third of that of patients in Group 1 (P < 0.001), and the percentage of pH's higher than 2.5 was significantly greater in other groups. The incidences of unobtainable samples and samples with pH's higher than 2.5 were greatest with atropine (32.0 per cent, P < 0.05) and glycopyrrolate (58.1 per cent, P < 0.01). In 60 per cent of the bile-stained specimens, pH's were below 2.5. It is concluded that because of its selective inhibitory effect on gastric acid secretions, glycopyrrolate appears superior to other anticholinergic drugs. The reduction of gastric juice volume and acidity produced by glycopyrrolate would have important clinical implications in ease of accidental aspiration. It is also concluded that bile staining of gastric contents is not a reliable indicator of gastric juice pH. (Key words: Premedication, gastric juice pH and volume; gastrointestinal tract, stomach.)

ASPIRATION of gastric contents produces severe effects that have characteristic clinical, radiologic and pathologic features.1 A critical pH below 2.5 appears necessary for pulmonary damage to occur.1–4 Various preventive measures have been advocated.5–9 One of these is based on prior neutralization of acidic gastric contents to maintain a pH above 2.5,9 thus minimizing the effects of accidental aspiration. This has been accomplished by oral administration of antacids before induction of anesthesia for emergency and elective surgical procedures.9,10

Anticholinergic drugs inhibit basal gastric secretions.11 In spite of their common use as premedicants, the effects of anticholinergic drugs on gastric juice volume and pH at the time of induction of anesthesia have not been adequately studied. One of the newer anticholinergic quaternary ammonium compounds, glycopyrrolate, has been shown to have pronounced effects on gastric secretions.12 The present investigation was designed to ascertain the effects of these premedicant drugs on gastric juice volume and pH in anesthetized pediatric patients undergoing elective surgical procedures.

Methods

The investigation was reviewed and approved by the Hospital's Human Experimentation Committee. Two hundred and six patients between the ages of 1 and 12 years were chosen for the study. None had known gastrointestinal
TABLE 1. Mean Volumes of Gastric Aspirates

<table>
<thead>
<tr>
<th></th>
<th>Gastric Juice Volume (ml/kg)</th>
<th>Dry Cases</th>
<th></th>
<th>Cases with pH above 2.5</th>
<th></th>
<th>“Safe Cases”</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(Mean ± SEM)</td>
<td>Number</td>
<td>Per Cent</td>
<td>Number</td>
<td>Per Cent</td>
<td>Number</td>
</tr>
<tr>
<td>Group 1, control (no premedication) (n = 28)</td>
<td>0.60 ± 0.09</td>
<td>1</td>
<td>3.5</td>
<td>2</td>
<td>7.4</td>
<td>3</td>
</tr>
<tr>
<td>Group 2, pentobarbital and morphine (n = 28)</td>
<td>0.51 ± 0.05</td>
<td>1</td>
<td>3.5</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Group 3, pentobarbital, morphine, and atropine (n = 50)</td>
<td>0.42 ± 0.05</td>
<td>3</td>
<td>6.0</td>
<td>13†</td>
<td>27.6</td>
<td>161</td>
</tr>
<tr>
<td>Group 4, pentobarbital, morphine, and scopolamine (n = 45)</td>
<td>0.45 ± 0.05</td>
<td>4</td>
<td>8.8</td>
<td>6</td>
<td>14.6</td>
<td>10</td>
</tr>
<tr>
<td>Group 5, pentobarbital, morphine and glycopyrrolate (n = 55)</td>
<td>0.18 ± 0.05*</td>
<td>141</td>
<td>25.4</td>
<td>181</td>
<td>43.6</td>
<td>321</td>
</tr>
</tbody>
</table>

* P < 0.001.
† P < 0.01.
‡ P < 0.05.

disease. All had fasted for a minimum of 5 hours prior to induction of anesthesia. They were divided into five groups with equal age distribution. Group 1, 28 patients, received no premedication; Group 2, 28 patients, was given morphine sulfate, 0.18 mg/kg, and pentobarbital, 2.2 mg/kg. In addition to morphine and pentobarbital, the other groups received one of the following anticholinergic drugs: atropine (Group 3; 50 patients), scopolamine (Group 4; 45 patients) or glycopyrrolate (Group 5; 55 patients). Atropine and scopolamine were given in equal doses which varied between 15 and 20 μg/kg, depending on the patient's age. The dose of glycopyrrolate was half that of atropine. Drugs were given intramuscularly one hour prior to the anticipated time of operation. All patients were seen the day before operation. They were all properly prepared and reassured about their forthcoming anesthetic and surgical experience.

Anesthesia was induced with halothane or thiopental and endotracheal intubation was facilitated with intravenous administration of succinylcholine. A plastic catheter was then introduced into the stomach and the contents aspirated. Manual pressure was used to assure gastric emptying. The position of the catheter was verified by auscultation during the inflation of a few milliliters of air. Aspirates were examined for volume, pH and color. The pH determinations were made with a Radiometer electrode. Volumes of gastric contents per kilogram body weight were calculated. The incidence of pH's higher than 2.5 was determined. Patients from whom samples were unobtainable and those whose samples had pH's higher than 2.5 were designated "safe cases" and their occurrences in the various groups were compared with that in the control group utilizing the t test.

Results

The mean volumes of gastric aspirates are shown in table 1. In the control group, the mean volume was 0.60 ml/kg. Premedication with morphine and pentobarbital did not significantly alter volume. Addition of an anticholinergic agent resulted in a decrease in volume, but while the change was not statistically significant following atropine or scopolamine, it was highly significant after glycopyrrolate (P < 0.001). In the glycopyrrolate-treated group, the mean volume of gastric juice per kilogram was less than a third of that in the control group (table 1).

Gastric juice could not be obtained from 23 patients. The incidence of these "dry cases" was higher following glycopyrrolate (25.4 per cent) than in the other groups.

The numbers and percentages of samples with pH's above 2.5, after excluding "dry" cases, are shown in table 1. In the control
TABLE 2. Incidence of Bile-stained Specimens

<table>
<thead>
<tr>
<th>Group</th>
<th>Number of Patients</th>
<th>Number of Bile-stained Specimens</th>
<th>Number of Specimens with pH below 2.5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group 1</td>
<td>28</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Group 2</td>
<td>28</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Group 3</td>
<td>50</td>
<td>8</td>
<td>5</td>
</tr>
<tr>
<td>Group 4</td>
<td>45</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Group 5</td>
<td>35</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>TOTAL</td>
<td>20</td>
<td>12 (60 per cent)</td>
<td></td>
</tr>
</tbody>
</table>

Discussion

Aspiration of gastric contents continues to be a major hazard of anesthesia. In one report on pediatric anesthetic mortality, 26 per cent of anesthetic deaths were found to be due to aspiration of vomitus or blood. In a recent report, the occurrence of cardiac arrest in several instances has been attributed to aspiration of gastric contents. Various factors combine to make infants and children more susceptible than adults to regurgitation and aspiration. Various preanesthetic and anesthetic preventive measures, applicable to pediatric patients, have been previously outlined, including neutralization of acidic gastric contents by antacids. Preanaesthetic oral administration of antacids, which has been utilized in obstetrical patients, has not gained wide acceptance in other clinical situations. Furthermore, antacid therapy may not be effective in preventing the hazardous effects of low pH and/or solid material if aspirated.

The present investigation indicates that the addition of an anticholinergic drug to the premedication inhibits gastric juice production and acidity at the time of induction of anesthesia. The extents of inhibition produced by the drugs investigated were not, however, the same with all drugs. In the dosages tested, glycopyrrolate had greater effects than atro-ine or scopolamine. This agrees with the observation of Buatright et al. that glycopyrrolate is superior to atropine in suppressing gastric acid secretions at the time of induction of anesthesia. Although alteration of pH to a safe level did not occur in all patients receiving glycopyrrolate, the amount of gastric secretions was significantly reduced. This has important clinical implications in case of accidental aspiration.

Anticholinergic drugs have complex gastric effects. With large doses, they tend to prolong the emptying time. On the other hand, anticholinergic drugs have other beneficial effects, including suppression of acidic gastric secretions and increasing the resistance of the gastroesophageal angle to reflux. Glycopyrrolate does not affect gastric emptying or intestinal transit time. Its inability to cross the blood-brain barrier, and therefore, the absence of concurrent central nervous system effects compared with other anticholinergic agents, is an added attractive feature.

Other pharmacologic actions of glycopyrrolate relative to anesthetic practice have been recently studied and compared with those of other anticholinergic drugs. As an anticholinergic, it is twice as potent as atropine, while its duration of action is three times greater. Although glycopyrrolate causes less tachycardia, it affords protection equal to that of atropine against the bradycardiac effects of neostigmine or pyridostigmine. Therefore, it has been used in combination with neostigmine or pyridostigmine for re-
versal of curarization. The recommended dose is half the dose of atropine. Glyco-
pyrrolate also provides a longer duration of anticholinergic activity than atropine. This
may be advantageous in minimizing any delayed muscarinic effects of anticholinesterases
used for reversal of curarization.

That more than half the bile-stained specimens had pH values below 2.5 indicates that
bile staining of gastric secretions does not guarantee safe alteration of pH. This may
appear to be in contradiction to the findings of a previous study. Using material obtained
from spontaneous emesis, Kallos found that all nine bile-tinted specimens had pH values
of 5.0 or more. The discrepancy might be related to the presence of an adequate amount
of bile, which gave a distinct golden brown color, in Kallos' cases. Although the presence
of bile in the stomach does have a neutralizing effect by virtue of its high pH, our data do not
support the concept that bile coloration of gastric contents is a reliable sign that the pH of
the gastric contents is above 2.5.

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