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Continuous Hypopharyngeal *p*H during Anesthesia *Via* Mask

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Silent regurgitation during general anesthesia with neuromuscular blockade and endotracheal intubation can occur in 5–20% of patients.[1-3] The techniques for detecting the presence of such regurgitation have included one-time measurement of hypopharyngeal *p*H at the end of surgery in patients whose tracheas are intubated,[1] or visual assessment for the presence of previously orally administered dye in the hypopharynx during[2] and at the conclusion[2,3] of a surgical procedure. Blitt *et al.*,[3] visually inspecting the hypopharynx at the end of surgery, determined an incidence of regurgitation with anesthesia *via* a mask of 4.4%. However, there have been no reports of the actual *p*H of hypopharyngeal secretions during anesthesia *via* a mask, and there have been no reports of devices which are simple to use which can provide continuous information regarding the *p*H of hypopharyngeal secretions. We report the use of a straightforward clinical *p*H probe to provide continuous intraoperative information regarding the *p*H of hypopharyngeal secretions. We used this probe to determine if there were differences in minimum hypopharyngeal *p*H between volatile anesthetics administered by mask.

METHODS AND MATERIALS

Following institutional approval and informed consent, patients (ASA class 1–2, 20–74 yr old) were premedicated with morphine 0.1 mg/kg im 30–60 min prior to arrival in the operating room. All patients were scheduled to have peripheral surgical procedures (urologic, gynecologic, plastic, orthopedic) conducive to inhalational anesthesia *via* a mask. No patient had had a nasogastric tube inserted or had received antacids, H2-histamine antagonist, or anticholinergic drugs. There were five to eight patients in each of three groups: halothane, enflurane, and isoflurane.

Anesthesia was induced with thiopental 3–4 mg/kg iv, and was subsequently maintained by administration of one of three volatile anesthetics *via* a mask, randomly selected, with 50–70% nitrous oxide and 30–50% oxygen. Ventilation was either spontaneous or assisted. Anesthetic concentration and airway management were left to the discretion of the individual anesthesiologist. When the patient was judged to be adequately anesthetized, an oropharyngeal airway with a distal *p*H probe was inserted into the patient's mouth (fig. 1). Hypopharyngeal *p*H was thus continuously monitored during surgery and recorded every 5 min for the duration of the surgical procedure.

The *p*H monitoring system consisted of a soft plastic *p*H probe, approximately 3 mm in diameter, containing a monocrystalline antimony electrode connected to a *p*H meter which converts electrical potential to a continuous liquid crystal display of *p*H (Biosearch Medical Products, Somerville, NJ).

The variation in minimum *p*H for each subject during the time course of measurement was evaluated for differences between anesthetic groups by analysis of variance.

RESULTS

The range of hypopharyngeal *p*H was between 5.0 and 7.7 (table 1). Hypopharyngeal *p*H averaged across subjects and time samples was 6.9 ± 0.5, 6.6 ± 0.4, and 6.8 ± 0.4 (±SD) in the halothane, enflurane, and isoflurane groups, respectively. No differences in average minimum *p*H were evident between the three anesthetic groups. In addition, in no patient did *p*H vary

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more than 1.0 from the initial value. At no time did the hypopharyngeal *p*H of any patient decrease below 5.0.

Discussion

Turndorf *et al.*[2] reported a 14.5% incidence of regurgitation in a series of patients undergoing general anesthesia with endotracheal intubation. Blitt *et al.*,[3] studying 900 patients, found a regurgitation rate of 7.8%, 8.6% of whom aspirated. They further found a regurgitation rate of 4.5% with anesthesia *via* a mask, 17% of whom aspirated. In both of these studies, dye was instilled into the stomach preoperatively with inspection of the larynx for dye at the end of surgery. Carlsson and Islander[1] reported an incidence of silent regurgitation of 20% in patients whose tracheas were intubated having laparoscopy in the head-down position, and none in patients having nonlaparoscopic surgery in the supine position. They assessed hypopharyngeal *p*H with *p*H test paper at the end of surgery, and found the average *p*H to be 5.6 ± 1.0. They considered a *p*H ≤ 3.0 indicative of regurgitation. These methods of assessing regurgitation are too unwieldy to use routinely clinically, and provide only one-time assessment for occurrence of regurgitation. In addition, dye assessment provides no indication of acidity of the potential aspiration.

The probe we describe cannot be used to assess the actual occurrence of silent regurgitation, but, rather, whether clinically significant regurgitation, as manifested by a low hypopharyngeal *p*H, is occurring. We do recognize, however, that our measurement techniques determined *p*H at only one point within the pharynx, the tip of the *p*H probe, and that probe placement might have influenced our results. Furthermore, with our small sample size, the true incidence of clinically significant acidic regurgitation cannot be determined with certainty. The 95% confidence interval for the incidence of clinically significant aspiration, given our findings of no incidence in 20 subjects, is 0–17%. A study with the express purpose of estimating the true incidence of aspiration (assuming it to be approximately 5%) would require 200 or more subjects. This was not the focus of this study. Rather, we have demonstrated the use of a hypopharyngeal *p*H probe and determined if there were any between-anesthetic differences.

We speculate that this device may provide valuable information in several clinical situations. Anesthesiologists commonly blunt protective airway reflexes in patients at increased risk of regurgitation under anesthesia (*e.g.*, full stomach, hiatal hernia). In such patients, the anesthesiologist occasionally must opt for a slower induction of anesthesia because of neurologic or cardiac considerations. Monitoring of hypopharyngeal *p*H might help guide the pace of induction of, or emergence from, anesthesia in such cases. Seegobin and Van Hasselt[4] recently reported a very high incidence of aspiration around large-volume cuffed endotracheal tubes. This disturbing information suggests that tracheal *p*H monitoring may have a role in tracheally intubated patients in the operating room and intensive care unit.

TABLE 1. Hypopharyngeal *p*H*

Time† (Min)	Halothane (n)	Enflurane (n)	Isoflurane (n)
0	7.0 ± .6 (7)	6.7 ± .6 (5)	6.9 ± .5 (6)
2	6.8 ± .8 (8)	6.6 ± .6 (5)	6.8 ± .4 (7)
5	6.9 ± .8 (8)	6.6 ± .7 (5)	6.7 ± .4 (7)
10	6.9 ± .6 (8)	6.7 ± .6 (5)	6.8 ± .4 (7)
15	6.8 ± .4 (8)	6.8 ± .5 (5)	6.7 ± .5 (7)
20	6.9 ± .3 (8)	6.7 ± .5 (5)	6.6 ± .4 (6)
25	6.7 ± .4 (7)	6.5 ± .4 (5)	6.5 ± .4 (5)
30	6.7 ± .5 (6)	6.5 ± .2 (5)	6.8 ± .2 (4)
35	6.9 ± .5 (3)	6.5 ± .1 (3)	6.4 ± .2 (2)
40	6.8 ± .2 (2)	6.6 ± .1 (2)	7.0 ± .4 (2)
45	6.8 ± .2 (2)	6.6 (1)	7.0 ± .6 (2)
50	6.9 ± .1 (2)	6.5 (1)	7.8 (1)
55		6.5 (1)	7.5 (1)
60	7.2 (1)	6.6 (1)	7.5 (1)
Mean	6.9 ± .5	6.6 ± .4	6.8 ± .4

n = number of patients studied at the indicated time of anesthesia.
* ± standard deviation.
† Time after induction of anesthesia.

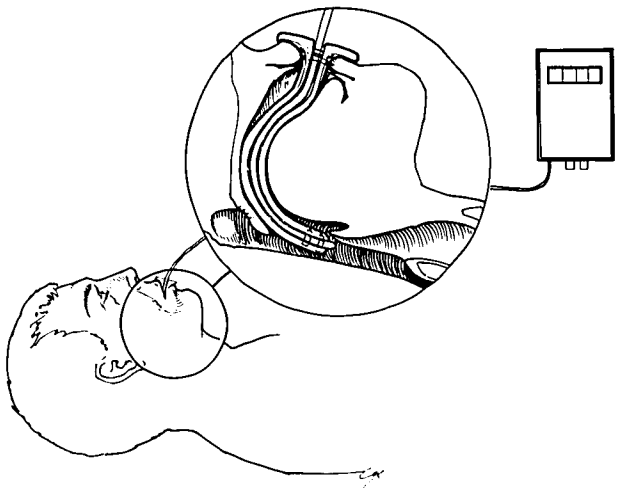

FIG. 1. Hypopharyngeal *p*H monitoring technique. An oropharyngeal airway with the *p*H probe placed into its side ribs and protruding from the end was inserted into the mouth. Silk stitches were placed where the probe entered and exited from the oropharyngeal airway to help maintain correct position of the probe in the oropharyngeal airway. Continuous hypopharyngeal *p*H was displayed and recorded from the digital display on the *p*H meter. See text for more details.

Finally, we suggest that a *p*H probe placed into the stomach could be a useful adjunct to prevent gastric ulceration in critically ill patients by facilitating prompt recognition and titrated treatment of gastric hyperacidity.

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Every Dose Given in Epidural Analgesia for Vaginal Delivery Can Be a Test Dose

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A test dose is recommended before performing an epidural blockade and before each subsequent dose, as a safeguard against accidental subarachnoid or intravenous (iv) injection. The test dose should contain 10–15 μg of epinephrine and sufficient local anesthetic to produce an identifiable tachycardia in case of an accidental iv administration, and a recognizable and safe level of spinal blockade in case of dural penetration.[1–4]

We have given epidural analgesia for vaginal delivery in over 13,000 cases, using bupivacaine 0.125% plus epinephrine 1:800,000, injected intermittently, with excellent results.[5–6] Our first and subsequent doses consist routinely of 10 ml of this solution, containing 12.5 mg of bupivacaine and 12.5 μg of epinephrine, injected over 30–60 s. These doses should also be adequate as a test dose (TD 12.5) in epidural analgesia.

We undertook this study to establish the efficacy and safety of our proposed test dose. We determined, firstly, whether the spinal blockade obtained with 10 ml solution containing 12.5 mg of bupivacaine plus 12.5 μg of epinephrine can be differentiated easily from an epidural blockade, without causing an excessively high level of anesthesia, and, secondly, whether an iv injection of the same solution produces enough signs and symptoms to detect an accidental iv administration, without causing untoward effects.

Materials and Methods

Forty-five unpremedicated patients scheduled for minor gynecological or surgical procedures and 34 pregnant women at term were investigated after informed consent was obtained (table 1).

Study 1. Twenty-five non-obstetric adult patients (ASA physical status 1) who received no medication or premedication were given the test dose, 10 ml of bupivacaine 0.125% plus epinephrine 1:800,000 (TD 12.5) iv, prior to their general anesthetic (table 1). The electrocardiogram and the heart rate were continuously recorded, and non-invasive arterial blood pressure was measured automatically at 1-min intervals. The test dose (TD 12.5) was prepared by diluting 2.5 ml of bupivacaine 0.5% with epinephrine 1:200,000, with 7.5 ml of sterile physiologic saline solution. After baseline values were obtained, TD 12.5 was injected iv over 30–60 s. The patient was asked to inform us about any symptoms that might be felt during or after the injection.

Study 2. Ten healthy non-obstetric adult patients (ASA physical status 1) who received no medication or premedication were given 12.5 mg of plain bupivacaine in 10 ml preservative free normal saline iv prior to their general anesthetic (table 1).

Study 3. Spinal anesthesia was administered to another ten non-obstetric patients (ASA physical status 1–3) requesting spinal anesthesia for minor urological

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