TABLE 1. Alarm Times (Mean Seconds ± SD, n = 5) at Different Fresh Gas Flows, Tidal Volumes, and Disconnection Conditions

| Tidal Volume | 10 Breaths per Min | | | |
|---|---|---|---|---|
| | I | I* | III | III* |
| 500 ml | | | | |
| A | 17.8 ± 0.4 | 17.1 ± 1.2 | 29.6 ± 0.9 | 42.2 ± 4.3 |
| B | 22.1 ± 1.4 | 22.8 ± 1.3 | 33.2 ± 0.2 | 58.9 ± 5.2 |
| 1000 ml | | | | |
| A | 11.6 ± 1.3 | 13.3 ± 0.6 | 18.7 ± 1.4 | 24.6 ± 5.7 |
| B | 13.2 ± 1.3 | 14.3 ± 0.7 | 27.0 ± 1.8 | 33.3 ± 4.2 |

I) Nitrous oxide:Oxygen = 2:1, 3 l/min fresh gas flow.
Oxygen concentration: 33%.
Alarm limit: 30%.
III) Nitrous oxide:Oxygen = 2:2, 4 l/min fresh gas flow.
Oxygen concentration: 50%.
Alarm limit: 30%.
A) Measurements with monitor A: Anemone, Draeger.
B) Measurements with monitor B: Mono 2, Kontron, Zurich, Switzerland.
* Disconnection under drapes (see text).

ceived. Of course, we do monitor the pressure within the circuit and use this device as a sensitive disconnection alarm. Using the measurement of expiratory oxygen we have another reliable backup system to detect a disconnection.

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# Macroglossia Causing Airway Obstruction following Cleft Palate Repair

*To the Editor:*—Cleft palate repair is a common procedure in the pediatric population and complications are unusual.[1] There have been three cases of severe macroglossia following cleft palate repair previously reported.[2,3] We recently encountered two cases of life-threatening airway obstruction due to macroglossia following this repair.

*Case 1.* A healthy 10 kg, 20-month-old girl was scheduled for cleft palate repair. Following iv methohexital, atropine, and succinylcholine, the trachea was easily intubated with a 4.0 ETT. Anesthesia was maintained with oxygen, nitrous oxide, and enflurane. No additional neuromuscular blocking agents were administered. She received penicillin 600,000 U intravenously and her palate was infiltrated with 6 ml of 0.5% lidocaine with 1:200,000 epinephrine. A Dingman retractor was in place during the entire 3 h 45 min procedure. The estimated blood loss was 110 ml and she received 800 ml of D51/2NS. At the conclusion of the procedure the child was awakened and the trachea was extubated. She was unable to breathe immediately after extubation and the lungs were difficult to ventilate by mask due to severe lingual edema. Reintubation was extremely difficult and required five attempts. She was taken to the intensive care unit while sedated and with her trachea intubated. Extubation was not tolerated on the first and fourth postoperative day. Endoscopy revealed a swollen tongue and supraglottic region. Ultrasonography of the tongue showed homogeneous tissue without evidence of abscess or other cystic abnormality. Persistent edema precluded tracheal extubation until the eleventh day postoperatively.

*Case 2.* A healthy 9.5 kg, 13-month-old boy was scheduled for bilateral cleft palate repair. Following an inhalation induction with oxygen, nitrous oxide, and halothane an iv infusion was started and the child received atracurium, 5 mg. His trachea was easily intubated with a 4.0 ETT and anesthesia was maintained with oxygen, nitrous oxide, and isoflurane. Shortly after induction, 25 $\mu$g of fentanyl and 0.35 mg of droperidol were also given. Other medications administered were cefazolin 125 mg iv and 3 ml of 0.5% lidocaine with 1:200,000 epinephrine infiltrated into the palate. A Dingman retractor was in place during the entire 3 h 40 min procedure. The patient lost 30 cc of blood and received 340 cc of RL. At the conclusion of surgery he received neostigmine 0.8 mg and glycopyrolate 0.1 mg iv. His last atracurium dose had been 2 h earlier. Upon extubation he immediately showed signs of upper airway obstruction. The lungs could not be ventilated despite jaw thrust and traction on the tongue suture but the trachea was easily reintubated. The tongue and floor of mouth were edematous. Dexamethasone 2 mg was given iv and he was taken to the ICU while sedated and with the lungs mechanically ventilated. Nine hours postoperatively the child removed the endotracheal tube. The edema had worsened and the tongue had become hard and immobile, filling the mouth. Again the lungs could not be ventilated despite jaw thrust, traction on a tongue suture, and oral airway insertion. Reintubation was extremely difficult. Multiple attempts at intubation were unsuccessful and he sustained a cardiac arrest. Cricothyroid puncture was also unsuccessful but an endotracheal tube was eventually inserted. While the child survived, and although eventually the trachea was extubated, he never regained consciousness.

The average time for cleft palate repair in our institution is 2½ h. The operative times of our two patients and the others that developed macroglossia were greater than 3½ h.[2,3] A longer procedure implies longer retractor times, a more difficult repair and perhaps other coexisting pathology. A longer procedure may also increase the effects of fluid administration, blood loss, and position.

While it is difficult to make quantitative comparisons among cases from different institutions, it is our opinion, after reviewing the five cases, that the development of macroglossia is related to the length of surgery. We strongly agree with the recommendations of Bell, Oh, and Loeffler that following cleft palate repair the mouth and tongue should be examined prior to extubation.[2] In lingual or sublingual edema is present then the trachea should remain intubated and the patient should be placed in an intensive care unit until the swelling has resolved and the trachea can be extubated safely. The development of the edema is insidious. It has occurred as late as 2½ h after surgery and has worsened over the subsequent 9–36 h. Even if no edema is seen at extubation, patients should be observed carefully, particularly after procedures lasting 3 h or more. Conventional management may fail to re-establish the airway should it be lost and emergency tracheotomy, cricothyrotomy or transtracheal jet ventilation may be required.

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# Proper Lateralization of Left-Sided Double-Lumen Tubes

*To the Editor:*—The placement of a left-sided Robertshaw design, double-lumen endobronchial tube is usually accomplished as follows. After the tip of the bronchial catheter is below the glottis, the stylet is removed, the tube is rotated counterclockwise through 90 degrees, and then advanced until resistance is met.[1] The bronchial lumen should now lie in the left mainstem bronchus. It is important to not advance the tube at all until it has been rotated, otherwise it may enter the right mainstem bronchus which arises from the carina at a less acute angle.

Despite following the above protocol, a left-sided tube may still become located in the right mainstem bronchus and repeated attempts at correct placement may be unsuccessful. When this was our experience on several recent occasions, we found that rotating the patient's head and neck to the right, prior to rotating and advancing the tube, resulted in proper lateralization of the left-sided Bronchocath (Mallinckrodt Inc., Argyle, NY) double-lumen endobronchial tube.

Bronchoscopists have long recognized the increased difficulty of inserting a rigid bronchoscope into the left mainstem bronchus because of the angle it makes with the trachea and because its orifice is partly covered with the tracheal carina in 74% of patients.[2] The technique recommended for passage of a rigid bronchoscope into the left mainstem bronchus is that, "after the carina is identified, the patient's head and neck are raised and abducted to the right, the patient's face being simultaneously turned to the right. In most cases the bronchoscope will now readily slip into the main bronchus, although sometimes it is necessary to displace the carina to the right."[2]

Kubota *et al.*[3] have reported their experience of selective blind left endobronchial intubations using a single-lumen endotracheal tube in 300 adults. The highest success rate (275/300, or 92%) was achieved when the tube was rotated 180 degrees (so that the bevel faced toward the right) and the patient's head was turned to the right. When the head was not rotated to the right the success rate was only 61% (182/300). The difference in success rates was statistically significant ($P < 0.01$). These authors[3] offered no explanation for why their success rate was improved when the head was turned to the right.

We have now incorporated this step, of rotating the head and neck to the right, as part of our routine technique during placement of left-sided double-lumen endobronchial tubes. In our recent experience, the method has so far been uniformly successful with the tube being correctly localized on the first attempt at placement.

We are presently studying the mechanism whereby turning the head and neck improves the success of tube placement. The most likely explanation is that turning the head shifts the larynx to the right in relation to the carina. This would tend to bring the axis of the left mainstem bronchus more into line with that of the trachea, *i.e.*, the bronchus would arise at a smaller angle, and the endobronchial tube would have a "straighter shot" at the left mainstem bronchus. It is also possible that head turning stretches the trachea and left main bronchus, thereby altering the anatomy of the origin of the left mainstem bronchus to make it wider or less slit-like, either way rendering it more receptive to the passage of the bronchial catheter of a left-sided double-lumen endobronchial tube.

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