Topical Anesthesia for Bronchoscopy

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Whether topical anesthesia or one of a variety of general anesthetic techniques is preferable for bronchoscopic procedures has long remained unsettled.1,2 With the recent advent of fiberoptic technology, the use of topical anesthesia has begun to receive additional emphasis. In fact, the growing preeminence of fiberoptic instrumentation in bronchoscopic examinations may have relegated general anesthesia to a relatively minor, though still important, role despite the application of the Venturi injector principle to ventilation.

Despite this increased popularity, there has been little actual change in either the methodology or the local anesthetic agents used for topical anesthesia. Lidocaine, tetracaine, and cocaine either alone or in combination remain the principal agents used.1 They are applied by a variety of methods including soaked cotton pledges, aerosol spray, ultrasonic nebulization, translaryngeal injection, etc. In addition, lidocaine has been used for appropriate nerve blocks such as bilateral superior laryngeal and glossopharyngeal blocks.3 In clinical practice, there is probably little difference among these three drugs when properly and carefully used with due regard to their potential toxicity. Lidocaine, which is most widely used, is less toxic than either tetracaine or cocaine, but may be somewhat less effective topically. Cocaine has the special property of vasoconstriction due to its inhibition of the re-uptake of noradrenaline at sympathetic nerve endings.4 This makes it especially advantageous for transnasal intubation as it serves to shrink the nasal mucosa as well as numbing it. However, the vasoconstriction may interfere with the observation of color changes in the tracheobronchial mucosa. Whichever agent is used, it must be applied carefully, accurately and in divided doses over 10-15 minutes so as to avoid unduly high blood levels, as well as to achieve adequate topical anesthesia.

**Blood Levels**

It is well known that local anesthetics applied topically to the posterior pharynx, larynx, and tracheobronchial mucosa are rapidly absorbed. The amount and rate of absorption of any topical anesthetic varies according to the site of application, the dose and concentration of the drug, the amount coughed up or swallowed, and individual variation. Thus, the blood level achieved in a particular patient is often unpredictable even though safe dosage limits have been observed. In the vast majority of cases the blood level of anesthetic agent is within a safe, therapeutic range. An occasional patient, however, may develop an unexpectedly high level especially if maximum amounts of anesthetics have been used or exceeded. Campbell and Adriani6 showed that the endotracheal injection of topical anesthetics resulted in blood levels similar to intravenous injection with the peak level occurring at about five to six minutes. More recent work with lidocaine6,6 has shown the peak venous blood levels to occur at 10-15 minutes with a spread of 5-30 minutes. Again, these blood levels are usually well within the therapeutic range for lidocaine (1.2-5 µg/ml), but on occasion have been found to exceed 5-9 µg/ml, a level shown by Foldes and colleagues8 to be associated with the onset of toxic symptoms.

It is clear that the total dose of topical anesthetic administered must be limited so as to avoid the complications of overdosage. Table 1 lists the usual concentrations of lidocaine, tetracaine, and cocaine employed and shows the generally accepted maximal doses of these agents for an average adult. These amounts cannot be considered absolute maximum since it is impossible to judge the percentage of each dose that has been absorbed. However, over the years they have been shown to be generally safe, and should be exceeded only with due caution.

**Toxicity**

All patients undergoing bronchoscopic procedures, especially the elderly and those with cardiopulmonary problems, should have their vital signs

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<table>
<thead>
<tr>
<th>Drug</th>
<th>Concentration</th>
<th>Maximum dose, mg</th>
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</thead>
<tbody>
<tr>
<td>Cocaine</td>
<td>4-10</td>
<td>200</td>
</tr>
<tr>
<td>Tetracaine</td>
<td>1-2</td>
<td>80</td>
</tr>
<tr>
<td>Lidocaine</td>
<td>4</td>
<td>200</td>
</tr>
</tbody>
</table>
and sensorium monitored during the procedure. The patient’s ECG should be monitored when indicated, and some endoscopists may wish to have an intravenous infusion started. Such monitoring is the only way to detect early onset of local anesthetic toxicity or any adverse effects from the bronchoscopic examination.

The signs of toxicity from high blood levels of local anesthetic range from subtle to catastrophic. Early signs include tremulousness, shivering, talkativeness, dizziness, or sedation. This may be followed by unconsciousness, convulsions, respiratory arrest, and/or cardiovascular collapse. With cocaine, the effects of medullary depression may be preceded by signs of sympathetic stimulation such as tachycardia, tachypnea, hypertension, and fever. If improperly or inadequately treated, the end result may be some degree of cerebral anoxia with brain damage or death.

Since an occasional patient may have an adverse reaction during the procedure, the endoscopist must have available the drugs and equipment necessary for oxygenation, airway management, resuscitation, and life support. This may range from a few essential items to the full facility of an operating room complete with anesthesiologist. A source of oxygen and the means to administer it with assisted or controlled ventilation is mandatory. Oro- and nasopharyngeal airways plus at least a bag and mask for ventilation should be available. This should be supplemented by properly sized and cuffed endotracheal tubes, a functioning laryngoscope, and the ability to use it in an emergency. Drugs such as thiopental, diazepam and succinylcholine should be available for treatment of convulsions. Also needed are vasopressor drugs such as epinephrine and mephenetermine plus intravenous equipment and fluids. If cocaine is used, propranolol should be available in case of sympathetic overreaction. In short, the endoscopist should be well prepared to deal with occasional unexpected adverse reaction to bronchoscopy and topical anesthesia. To be unprepared is to invite disaster.

OXYGENATION

In addition to the possibility of a drug reaction, concern has recently been expressed about the adequacy of oxygenation during bronchoscopic examination under topical anesthesia. Albertini and co-authors found an average decrease in PaO2 of 20 mm Hg during fiberoptic bronchoscopic examination of patients in relatively good condition (resting PaO2 in 70-80 mm Hg range). Karitsky and associates showed that each of 14 patients demonstrated a decrease in PaO2 during fiberoptic bronchoscopy without consistent change in PaCO2. Almost all patients showed a recovery of arterial oxygenation following removal of the bronchoscope. However, Kwon et al found no change in PaO2 when the open rigid bronchoscope was used with topical anesthesia.

The decrease in oxygenation found with use of the fiberoptic bronchoscope in the awake patient may be due to a number of causes. These include a reflex from stimulation of carinal receptors, increased resistance to airflow due to the presence of the bronchoscope, especially when an endotracheal tube is used, and disturbance of ventilation-perfusion relationships. Whatever the cause, it seems wise to increase the FIO2 for all patients undergoing bronchoscopic procedures unless contraindicated. It would also help to keep periods of suctioning as brief as possible, and to remove the bronchoscope intermittently to allow the patient a period of improved gas exchange.

AIRWAY RESISTANCE

All instruments and equipment introduced into the tracheobronchial tree for bronchoscopic examination serve to increase airway resistance. It is apparent that this problem is greater with the fiberoptic bronchoscope passed through an endotracheal tube than it is with the open rigid bronchoscope. The increased airway resistance is influenced both by the size of the fiberoptic bronchoscope and by the internal diameter (ID) and design of the endotracheal tube. Figure 1 shows the effect on airway resistance of different sizes of fiberoptic bronchoscopes inserted through an 8.5 mm ID endotracheal tube. The small 4 mm instrument causes a relatively small increase in resistance, whereas the increase

![Air Flow Through 8.5 mm I.D. Endotracheal Tube with Fiberoptic Bronchoscope Inserted](image)

**Figure 1**
with the 6 mm bronchoscope is appreciable. Figure 2 demonstrates the effect of endotracheal tube size and design on airway resistance. The resistance is appreciably greater when the 6 mm bronchoscope is introduced through a straight 8.0 mm ID endotracheal tube than when an 8.5 mm ID tube is used. The increase in resistance through the Carden tube is shown to be minimal as compared to the other two. This is due to its design in which only that portion of the tube inserted through the larynx is narrowed, the proximal portion being large bore and offering almost no increased resistance to air flow. We\textsuperscript{15} and others\textsuperscript{16} have shown that the endotracheal tube should be at least 8.5 mm ID for gas exchange around the fiberoptic bronchoscope to be adequate. Even though the airway resistance with this system is still appreciably increased over normal (0.6-2.4 cm H\textsubscript{2}O/L/sec at 0.5 L/sec flow rate),\textsuperscript{17} most patients can readily increase their respiratory effort to compensate for this.

**Figure 2**

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(0.6,40)
(0.8,30)
(1.0,20)
};
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(0.4,40)
(0.6,30)
(0.8,20)
(1.0,10)
};
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(0.2,40)
(0.4,30)
(0.6,20)
(0.8,10)
(1.0,0)
};
\legend{8.0 mm I.D. tube, 8.5 mm I.D. tube, 8.0 mm I.D. Carden tube}
\end{axis}
\end{tikzpicture}
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**REFERENCES**