Comparison of 4% Lidocaine/0.5% Phenylephrine with 5% Cocaine: Which Dilates the Nasal Passage Better?

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Nasal administration of cocaine is used prior to nasotracheal intubation. Cocaine provides both local anesthesia and vasoconstriction, resulting in shrinkage of the nasal mucosa with enlargement of the nasal passage and reduced bleeding during nasal procedures.1,2 However, cocaine is a controlled substance with a high abuse potential. The handling and storage of controlled substances involves additional administrative costs and risks. For this reason, an alternative preparation might be preferable if proven to be equally effective.

Lidocaine is similar to cocaine in effectiveness as a local anesthetic,3 but it does not dilate the nasal passage. For this reason, phenylephrine is often combined with lidocaine to reduce nasal congestion. The combination of lidocaine and phenylephrine has been advocated as an alternative to cocaine as a premedication for nasotracheal intubation,4 but quantitative measurements of nasal patency have not been reported. Using a randomized, double-blind, crossover study design, we compared nasal patency after intranasal 4% lidocaine plus 0.5% phenylephrine, and after 5% cocaine by measuring nasal airway resistance and transnasal peak expiratory flow rate in normal volunteers.

METHODS AND MATERIALS

Twelve adult volunteers (age 32.1 ± 10.2, nine men and three women) were studied. The subjects had no gross nasal deformity or history of active nasal or paranasal sinus disease. No medications or over-the-counter preparations were permitted within 12 h of testing. In a randomized, double-blinded fashion, each subject received either the cocaine or the lidocaine/phenylephrine solution on the first study day, and received the alternate solution on the second study day, 48 h later.

Drug solutions of 5% cocaine and of 4% lidocaine/0.5% phenylephrine were prepared in our pharmacy and dispensed in paired vials marked day 1 and day 2. Using a manual atomizer, six sprays were administered into each nostril for a total volume of 0.6 ml. A total of 30 mg of cocaine or 24 mg of lidocaine plus 3 mg of phenylephrine was administered to each subject. On each day, baseline tests of nasal resistance and transnasal peak expiratory flow rate were performed prior to drug administration. The same tests were repeated beginning 5 min after drug administration. The testing procedures took 10–15 min.

Nasal resistance testing was performed by continuously recording nasal air flow and transnasal pressure through a modified “mask flowmeter” using a posterior rhinomanometric technique (fig. 1).5,6 A tightly fitting face mask (Respirronics®, Monroeville, Pennsylvania) was positioned to provide a seal without air leaks and without

![Pneumotach](image1.png)

![Transducer](image2.png)

**FIG. 1.** Schematic drawing of an apparatus to measure nasal resistance. Nasal airflow is measured by the pneumotach. Transnasal pressure is measured by the transducer.

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obstruction of nasal air flow. Nasal air flow was measured using a pneumotachograph (2107B, Hewlett Packard®, Waltham, Massachusetts) connected to the face mask. Transnasal pressure was measured using a differential pressure transducer (MP45-5, Validyne®, Northridge, California). One input of the transducer was attached to the small tube connected to the face mask; the other input was attached to a similar tube inserted into the oropharynx through an occluded mouthpiece. Thus, pressure difference across the nose and nasopharynx was measured.

All testing for nasal resistance was performed with the subject seated and breathing quietly. Initial measurements of airflow and pressure were obtained with both nares unoccluded for calculations of binasal resistance. Uninasal resistance testing then was performed for the left nasal chamber with the right nare occluded. A small cork was placed in the nostril so that the occlusion was complete, yet the nasal septum was not deviated. This process was repeated with the left nare occluded and the right nasal chamber open. Nasal airflow and transnasal pressure were displayed on a recorder (7758B, Hewlett Packard®, Waltham, Massachusetts). Nasal resistance (Rn) was calculated by dividing transnasal pressure (P), in cm H₂O, by nasal air flow (V), in 1·s⁻¹, and expressed as cm H₂O·l⁻¹·s. Each resistance value was calculated from six breaths for which the flow and pressure tracings were uniform in amplitude and contour. Nasal resistance values were calculated separately for inspiration and expiration. Data from both phases of respiration then were pooled and designated "total cycle" nasal resistance.

Transnasal peak expiratory flow rate (TPEFR) was measured using an automated water sealed spirometer (Eagle One®, Warren E Collins, Braintree, Massachusetts), with the subject performing a forced vital capacity (FVC) maneuver through a modified nasal mask pressed tightly against the face with the lips sealed. FVC maneuvers were repeated until no improvement in TPEFR was demonstrated, with a minimum of three trials. The largest TPEFR (l·s⁻¹) was analyzed. Arterial blood pressure was obtained using a sphygmomanometer, and heart rate was obtained by palpating the radial pulse for 60 s prior to and at 5, 10, and 15 min following drug application.

Statistical analysis was performed using t tests for all comparisons, except the comparison of uninasal resistance for the closed chamber. In this case, Wilcoxon's rank-sum test was used because the data were not normally distributed. Blood pressure and heart rate data were evaluated by analysis of variance. A P value of less than 0.05 was considered significant. Data are expressed as mean ± SD.

Approval of the protocol was obtained from the Virginia Commonwealth University Committee on the Conduct of Human Research, and each subject gave written, informed consent.

RESULTS

The results of nasal resistance and transnasal peak expiratory flow rate testing are summarized in Table 1. Predrug measurements of binasal Rn and TPEFR were similar for the two drugs. Binasal resistance decreased sig-

### Table 1. Nasal Resistance and Transnasal Peak Expiratory Flow Rate (TPEFR) before and after Lidocaine/Phenylephrine (L/P) and Cocaine

<table>
<thead>
<tr>
<th></th>
<th>Before Drug* (n = 18)</th>
<th>After Drug† (n = 18)</th>
<th>P‡</th>
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</thead>
<tbody>
<tr>
<td><strong>Binasal resistance</strong> (cm H₂O·l⁻¹·s)</td>
<td></td>
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</tr>
<tr>
<td>Inspiration L/P</td>
<td>3.3 ± 3.3</td>
<td>1.8 ± 1.4</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Cocaine</td>
<td>3.4 ± 3.3</td>
<td>1.7 ± 1.4</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Expiration L/P</td>
<td>3.0 ± 0.8</td>
<td>1.6 ± 0.9</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Cocaine</td>
<td>3.0 ± 1.5</td>
<td>1.7 ± 1.2</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Total cycle L/P</td>
<td>3.2 ± 2.1</td>
<td>1.7 ± 1.1</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Cocaine</td>
<td>3.3 ± 1.5</td>
<td>1.7 ± 1.2</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td><strong>Uninasal Resistance</strong> (cm H₂O·l⁻¹·s)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total cycle</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Closed L/P</td>
<td>26.2 ± 47.7</td>
<td>8.7 ± 10.2</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>Cocaine</td>
<td>14.7 ± 8.5</td>
<td>10.9 ± 19.6</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>Open L/P</td>
<td>6.0 ± 2.8</td>
<td>4.8 ± 3.8</td>
<td>NS</td>
</tr>
<tr>
<td>Cocaine</td>
<td>5.6 ± 3.4</td>
<td>4.9 ± 4.2</td>
<td>NS</td>
</tr>
<tr>
<td><strong>TPEFR (l·s⁻¹)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>L/P</td>
<td>6.4 ± 2.0</td>
<td>7.6 ± 1.7</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Cocaine</td>
<td>6.6 ± 2.0</td>
<td>7.4 ± 1.6</td>
<td>&lt;0.01</td>
</tr>
</tbody>
</table>

Mean ± SD.

* The differences between "Before L/P" and "Before Cocaine" values were not significant for any test (P = NS).

† The changes due to L/P and due to cocaine were not significantly different from each other for any test (P = NS).

‡ Significance is for "Before" drug versus "After" drug.
nificantly following administration of either lidocaine/phenylephrine or cocaine solutions. The change from baseline was of similar magnitude for the two groups. Inspiratory resistance was no different from expiratory resistance in each category. For uninasal resistance, only the "total cycle" data are displayed in table 1.

Baseline values of uninasal resistance varied somewhat among individuals. On day 1, baseline uninasal resistance was lower for the left nasal chamber in eight subjects and lower for the right chamber in four. Upon retesting 48 h later, the opposite nasal chamber had the lower resistance value in six of 12 subjects. For analysis, we designated the nasal chamber with lower resistance during baseline testing as the "open" chamber, and the chamber with the higher resistance as the "closed" chamber for each day. Closed chamber uninasal resistance decreased significantly following administration of both the lidocaine/phenylephrine and cocaine solutions. These changes were of similar magnitude for both groups. Following both lidocaine/phenylephrine and cocaine, open chamber uninasal resistance did not decrease significantly.

Transnasal peak expiratory flow rates increased significantly following both lidocaine/phenylephrine and cocaine (table 1). The drugs were equally efficacious. Arterial blood pressure and heart rate did not change from baseline at 5, 10, and 15 min after drug administration for either solution.

**DISCUSSION**

Nasotracheal intubation is preferred over the oral approach for situations in which direct laryngoscopy is difficult, for intraoral operations, and occasionally when long-term mechanical ventilation is anticipated. However, the nose is very sensitive to noxious stimuli. The nasal mucosa is highly vascular and, under the influence of the autonomic nervous system, the nasal mucosa is subject to mucosal congestion, which reduces the patency of the nasal airway. Intranasal administration of cocaine provides excellent topical anesthesia and mucosal vasoconstriction, resulting in reduced bleeding and decongestion with enlargement of the nasal chamber. The high abuse potential, however, complicates the handling of this drug. The combination of lidocaine and phenylephrine appears to offer the same anesthetic and vasoconstrictive properties as cocaine, while presenting no known abuse potential.

Comparison of these drugs has been the subject of several recent reports. Gross et al. measured heart rate, mean arterial pressure, and the incidence and severity of epistaxis following blind nasotracheal intubation in lightly anesthetized patients pretreated with intranasal 4% cocaine or 3% lidocaine/0.25% phenylephrine. They concluded that the lidocaine/phenylephrine combination was at least as effective as cocaine. Using similar parameters, Mitchell et al. found the combination of 4% lidocaine and 0.5% phenylephrine as effective as 5% cocaine, but no better than placebo for laryngoscopy and nasotracheal intubation. These studies address the effect of the drugs on the cardiovascular response to nasotracheal intubation and, indirectly, the vasoconstrictive effect (severity of epistaxis); but do not assess the effect of these drugs on nasal chamber size.

We measured nasal resistance and transnasal peak expiratory flow rate as indicators of the change in nasal chamber size. Measurement of nasal resistance using posterior rhinomanometry has been used to document efficacy of nasal septal surgery, to compare nasal mucosal swelling and skeletal stenosis in patients with impaired nasal air flow, and to investigate cyclic changes in nasal mucosal congestion. The anterior 2 to 3 cm of the nares offer the greatest resistance to nasal airflow; thus, a reduction in nasal resistance should reflect an increase in the diameter of the part of the nose through which the nasotracheal tube would be passed.

We demonstrated a significant reduction in binal nasal resistance and increase in transnasal peak flow rate following administration of 5% cocaine and 4% lidocaine/0.5% phenylephrine solutions. These changes were of similar magnitude for each solution. The use of other doses, however, may have yielded different data. Further study is needed to define the lowest effective doses for lidocaine and phenylephrine.

An intrinsic alternating congestion and decongestion of the nasal airways has been described as the "nasal cycle." As one nasal chamber becomes more open, the mucosa of the opposite chamber becomes engorged and the chamber narrows. Hasagawa and Kern demonstrated cyclic changes in uninasal resistance in 72% of 50 normal subjects. Our observation that baseline nasal chamber patency changed with time is consistent with nasal cycling. Some of our subjects probably exhibited nearly complete dilatation of the "open" nasal chamber as a result of "intrinsic" vasoconstriction; thus, the administration of vasoconstricting agents produced no additional decrease in uninasal resistance.

We conclude that nasal administration of either 4% lidocaine/0.5% phenylephrine solution or 5% cocaine causes nasal dilatation of similar magnitude. In view of the difficulty in storing and dispensing a controlled substance, we recommend the replacement of cocaine with 4% lidocaine/0.5% phenylephrine solution as an aid to nasotracheal intubation.

**REFERENCES**


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Lack of Correlation Between Transconjunctival O₂ and Cerebral Blood Flow during Carotid Artery Occlusion

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The primary goal of monitoring during carotid endarterectomy is the early and accurate recognition of impending cerebral ischemia, thereby allowing corrective measures to be taken to lessen the likelihood of postoperative neurologic deficits. A recent report by Shoemaker and Lawner has advocated the use of the transconjunctival oxygen (PCI₉₀) monitor for that purpose, and states that PCI₉₀ correlates well with cerebral ischemia during temporary occlusion of the carotid artery.¹ We compared the transconjunctival oxygen monitor (Orange Medical Instruments, Costa Mesa, California) to two standard methods of assessing intraoperative cerebral ischemia: intraarterial ¹³³Xe regional cerebral blood flow (rCBF) studies and continuous 16-channel electroencephalogram.²

METHODS

After obtaining institutional approval and informed consent, 18 patients scheduled for elective carotid endarterectomy were studied. Anesthesia was induced with thiopental, 3–5 mg/kg iv, and maintained with isoflurane (0.25–0.5% expired) and 50% N₂O in oxygen. Arterial blood pressure was maintained at the upper limits of each patient’s normal preoperative range by altering the anesthetic level. PICO₂ was maintained between 38–42 mmHg, as confirmed by periodic arterial blood gas sampling before and during carotid artery occlusion. Continuous values were available for arterial blood pressure, ECG, 16-channel electroencephalogram (EEG), bilateral PCICO₂, and end-tidal CO₂, O₂, and isoflurane by mass spectrometry. Measurements of ¹³³Xe rCBF were made prior to carotid occlusion, immediately after occlusion, and following restoration of flow.

For this study, the occlusion value for ¹³³Xe rCBF was compared to the maximal change in ipsilateral PCI₉₀ within 5 min of carotid occlusion, and EEG changes were noted.

To avoid making the assumption that our population followed a Gaussian distribution, a simple ranking system was used to describe the data and Kendall’s Rank Correlation Coefficients were calculated to measure the relationships.

RESULTS

Within 5 min of carotid occlusion, ipsilateral PCI₉₀ decreased in all patients, from –1 to –28 mmHg. Occlusion rCBF measurements ranged from 2 to 27 ml·100 g⁻¹·min⁻¹.

Fourteen of the 18 patients (77%) had occlusion rCBF of ≤18 ml·100 g⁻¹·min⁻¹. Five of the 18 patients (27%) had EEG changes of ischemia within 2 min of carotid artery occlusion (fig. 1). All five of these patients had oc-