Mini-environmental Control under the Drapes during Operations on the Eyes of Conscious Patients

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We have long been concerned about the environmental conditions that prevail under impermeable disposable drapes used for ophthalmic surgery. Weisman et al. reported that significant carbon dioxide build-up occurred below the drapes. Jaffe recommended insufflating 8 to 10 l oxygen/min in the vicinity of the patient’s nose to prevent hypoxia and flush out exhaled gas. In a pilot study of 30 patients, we found that this flow of oxygen was insufficient either to reduce carbon dioxide concentration to less than 1.5 per cent or to alleviate the hot, humid conditions surrounding the subject’s face. The addition of suction efficiently regulated the environment to within acceptable limits. We have, therefore, constructed a flexible hollow drape-supporting screen for use as both oxygen administer and simultaneous gas evacuator. The characteristics of the device and its ability to create a satisfactory miniclimatic environment are described.

METHODOLOGY

A flexible corrugated metal tube (90 cm long and 1.3 cm ID) was welded at each end to a metal plate 10 cm wide and 15 cm long (fig. 1). The lumen of the tube was sealed off at the center. A series of holes, 3 mm in diameter and 3 cm apart, were drilled on either side of the center of the tube between corrugations. The device was tested on seven consenting volunteers. A metal plate was placed under each shoulder with the corrugated tube forming a semicircular arch over the face. The center of the arch was brought to 15 cm above the bridge of the nose by judiciously flexing the device so that the central perforations faced downward. A humidity sensor attached to a Hy-

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considered the total water content of the selected area of the tissue.

A logarithmic graph of the radiance as a function of the
wavelength was constructed for each area of the tissue
studied.

Fig. 3. Scanning electron micrograph of a section of
the pericardium. (x5000.)


dynamics,† a thermistor probe connected to a telemeter, and the
sampling tube of a Godard capnograph were placed
on a wooden support 15 cm in front of the mouth of the
subject and 21 cm in front of and below the apex of the
corrugated arch. In addition, an Instrumentation
Laboratories** oxygen analyzer was inserted in the
sampling tube of the capnograph. A silica gel water
eliminator was also placed in that tube windward to the
oxygen analyzer.

Four sets of experiments were made in which the
following measurements were carried out before and
at stated intervals after draping the volunteers: 1) temperature;
2) relative humidity and absolute humidity calculated from relative humidity and temperature;
3) carbon dioxide and oxygen concentrations of
ambient gas. The experiments were conducted as
follows: 1) measurements under the drapes were made
15 minutes after draping without administering oxygen or applying suction; 2) measurements under
the drapes were made 15 minutes after the introduction of dry oxygen (10 l/min) through the left lower
end of the corrugated metal tube; 3) measurements under the drapes were made 15 minutes after the
introduction of dry oxygen (10 l/min) and after another 15 minutes while continuing to administer
oxygen but at the same time suctioning the right lower end of the corrugated metal tube at −50 torr; 4)
measurements under the drapes were made 15 minutes after both administering oxygen and applying
suction simultaneously from the onset.

Draping was performed by an ophthalmic surgeon
using Johnson and Johnson Surgikos Split Sheet
Disposable Drapes. The right eye was isolated as
during operation by a 3M†† small-central-aperture
draper.

†† Hygrodynamics Inc., Silver Spring, Md.
** Instrumentation Laboratories, Lexington, Mass.
†† 3M Company, St Paul, Minnesota.

Table 1. Temperature, Humidity, and Oxygen and Carbon Dioxide Concentrations in the Operating Room and Under the Drapes*

<table>
<thead>
<tr>
<th>Area Studied under the Drapes</th>
<th>Ambient (All Instances)</th>
<th>After 15 minutes without oxygen or suction Experiment 1</th>
<th>After 15 minutes of oxygen only Experiment 2</th>
<th>After 15 minutes of oxygen followed by 15 minutes of suction Experiment 3</th>
<th>After 15 minutes of oxygen plus suction Experiment 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature (C)</td>
<td>25.7 ± 2.4</td>
<td>32.6 ± 1.4</td>
<td>31.5 ± 1.3</td>
<td>30 ± 2.5</td>
<td>27 ± 1.5</td>
</tr>
<tr>
<td>Relative humidity (per cent)</td>
<td>47 ± 4</td>
<td>73 ± 7</td>
<td>62 ± 10</td>
<td>56 ± 7</td>
<td>45 ± 0</td>
</tr>
<tr>
<td>Absolute humidity (mg H₂O/l)</td>
<td>11.4 ± 1</td>
<td>25 ± 1.5</td>
<td>20.5 ± 2.3</td>
<td>18.4 ± 1.6</td>
<td>11.6 ± 1</td>
</tr>
<tr>
<td>CO₂ concentration (per cent)</td>
<td>0</td>
<td>3.5 ± 0.3</td>
<td>1.3 ± 0.3</td>
<td>0.5 ± 0.2</td>
<td>0.2 ± 0.1</td>
</tr>
<tr>
<td>O₂ concentration (per cent)</td>
<td>20.8</td>
<td>17.4 ± 1.5</td>
<td>54 ± 6</td>
<td>60 ± 7</td>
<td>59 ± 1</td>
</tr>
</tbody>
</table>

* 1, without oxygen or suction; 2, with oxygen only; 3, with oxygen first and then suction; 4, with oxygen and suction from the onset. Measurements were obtained from seven volunteers. Numbers indicate means ± 1 SD.
carbon dioxide concentration only 0.2 per cent and oxygen concentration 59 per cent). The most unfavorable conditions were found when neither oxygen nor suction was used (temperature and absolute humidity 6.9 C and 13.6 mg H₂O/l, respectively, above ambient, carbon dioxide concentration 3.5 per cent and oxygen concentration 17.4 per cent).

**DISCUSSION**

It is obvious from our findings that simultaneous administration of oxygen and suction immediately after draping effectively regulates the minienvironment around the face of the patient within satisfactory limits. When suction is applied too late it cannot sufficiently reduce temperature and humidity. This is partly due to condensation of exhaled moisture under the drapes. Increasing suction to more than -50 torr would probably be more effective, but at greater negative pressures a hissing noise disturbs the patient. When no measure is taken to increase atmospheric turnover under the drapes, the resulting hypoxia, hypercarbia, and high temperature-humidity index may cause restlessness, which interferes with the conduct of delicate operative procedures. Hypoxia is due partly to lack of efficient gas exchange and partly to increases in carbon dioxide and water vapor concentrations, which unfavorably offset the balance of partial gas pressures. An inhaled carbon dioxide build-up that exceeds 0.5 per cent may produce hypercarbia, which in turn can have adverse cardiovascular effects. Higher inhaled carbon dioxide concentrations may also increase retinal blood flow and intraocular tension and thus create unfavorable operative conditions. Since sedatives and/or narcotics are administered both pre- and intraoperatively in order to prevent restlessness, respiratory depression may occur. This is particularly the case for elderly arteriosclerotic patients, who often undergo operations on the eyes with local anesthesia. These drugs may interfere with the respiratory response to increases in inhaled carbon dioxide concentration, and severe hypercarbia may obtain.

The insufflation of oxygen at acceptable flow rates cannot in itself reduce the carbon dioxide and water vapor accumulation under the drapes. Moreover, the oxygen supply must be turned off when the electrocautery is used, to prevent flash fires. The addition of suction also increases the concentration of oxygen below the drapes, probably by improving cross ventilation.

The metal plates of our device were designed to prevent facial injuries to patients who raise their heads intraoperatively. Unlike fixtures attached to the operating table, the metal arch can freely rotate forward and thus move out of the patient's way.

**REFERENCES**


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**Chloroprocaine Analgesia in a Patient Receiving Echotothiate Iodide Eye Drops**

**JAY B. BRODSKY, M.D., MAJOR, MC,* AND FREDERICK A. CAMPOS, M.D., MAJOR, MC†**

The anesthetic chloroprocaine (Nesacaine) is hydrolyzed by plasma cholinesterase, an enzyme inhibited by

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