CHANGES IN OXYGEN SATURATION DURING BRONCHOSCOPIES

THOMAS J. DEKORNFIELD, M.D., AND KARL L. SIEBECKER, M.D.

It is apparently a clinical observation that certain patients, suffering from pulmonary disease, show evidence of hypoxia during bronchoscopy. It was our purpose to try to substantiate this clinical impression through quantitative oxygen saturation studies.

In a series of 50 patients, we were unable to demonstrate any decrease in arterial oxygen saturation. Indeed, all patients showed a definite rise in oxygen saturation during the procedure.

METHODS

The patients in this series were all adult males ranging in age from twenty-two years to sixty-six years. All but one had some pulmonary pathologic condition (table 1), and 8 patients had previous intra-

<table>
<thead>
<tr>
<th>Disease of Patients Studied</th>
<th>Number of Patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tuberculosis:</td>
<td></td>
</tr>
<tr>
<td>Minimal-unilateral</td>
<td>7</td>
</tr>
<tr>
<td>Minimal-bilateral</td>
<td>2</td>
</tr>
<tr>
<td>Moderately advanced-unilateral</td>
<td>8</td>
</tr>
<tr>
<td>Moderately advanced-bilateral</td>
<td>10</td>
</tr>
<tr>
<td>Far advanced-unilateral</td>
<td>1</td>
</tr>
<tr>
<td>Far advanced-bilateral</td>
<td>16</td>
</tr>
<tr>
<td>Bronchogenic carcinoma</td>
<td>1</td>
</tr>
<tr>
<td>“Farmers Lung”</td>
<td>1</td>
</tr>
<tr>
<td>Histoplasmosis</td>
<td>1</td>
</tr>
<tr>
<td>Bronchiectasis</td>
<td>1</td>
</tr>
<tr>
<td>Chronic bronchitis</td>
<td>1</td>
</tr>
<tr>
<td>No disease</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>50</td>
</tr>
</tbody>
</table>

thoracic surgical procedures and previous bronchoscopy (table 2). Thirty-eight patients had pulmonary function studies performed prior to bronchoscopy with determination of their vital capacity and timed vital capacity (table 3) (1). All patients were given pentobarbital sodium, 100 mg., orally, two hours prior to the bronchoscopy, and morphine sulfate, 10 to 15 mg., and atropine hydrochloride, 0.43 mg., subcutaneously, one hour prior to bronchoscopy.

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TABLE 2

PREVIOUS SURGICAL PROCEDURES

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Number of Patients</th>
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<tr>
<td>None</td>
<td>42</td>
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<tr>
<td>Pneumonectomy</td>
<td>1</td>
</tr>
<tr>
<td>Lobectomy</td>
<td>2</td>
</tr>
<tr>
<td>Segmental Resections</td>
<td>2</td>
</tr>
<tr>
<td>Thoracoplasty</td>
<td>2</td>
</tr>
<tr>
<td>Decortication</td>
<td>1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>50</strong></td>
</tr>
</tbody>
</table>

The bronchoscopies were performed following topical anesthesia, using tetracaine, 1 per cent, as the anesthetic agent, and in strict observance of the U. S. Veterans Administration regulations concerning topical anesthesia for endoscopy (2). The buccal and pharyngeal mucosa were anesthetized with cotton pledgets held in a curved pharyngeal applicator and moistened with no more than 10 cc. of the anesthetic solution. Not more than 2 cc. of the anesthetic solution were instilled into the trachea, through the glottis, using a curved laryngeal delivery tube attached to a hypodermic syringe.

An anesthetic machine, mask, bag, pharyngeal airway, endotracheal catheter, laryngoscope, and a hypodermic syringe containing thiopental sodium in a 2.5 per cent solution were immediately available to treat any toxic manifestations of tetracaine. With this technique no toxic manifestations were observed in this series.

A no. 38 Chevalier Jackson bronchoscope was used for the procedure, and the entire procedure lasted from ten to fifteen minutes. Anesthesia was performed in the sitting position and bronchoscopy, in the semirecumbent position (3).

Oxygen saturation was determined with the Waters-Conley "Ear Oximeter" (4, 5) throughout the procedure.

RESULTS

The results are listed in table 4. This table shows the average of 50 observations taken before, during, and immediately following the procedure. The average time lapse between observations is about two minutes. Observations were taken continuously throughout the procedure, but for the sake of simplicity and clarity, the table includes only three recordings during the period of anesthesia; one recording when the patient’s position was changed, one at the time the broncho-

TABLE 3

PULMONARY FUNCTION—38 PATIENTS

Vital capacity—average: 102% (51%–135%)
Fifteen patients had vital capacity below 100%

Timed vital capacity (second sec.)—average: 84.6% (62%–100%)
Twenty-five patients had timed vital capacity below 90%
scope was introduced into the trachea, two observations each at the
time of examination of the right and left main stem bronchus, one
observation at the time the instrument was withdrawn from the trachea,
and, finally, one observation two minutes after the end of the procedure.

Table 5 shows the results of three individual cases, taken to illustrate
the similarity of the oxygen saturation pattern in spite of the
differences in the patients’ pathology and pulmonary function.

The results of this study indicate clearly that during bronchoscopy
the arterial oxygen saturation did not fall. On the contrary, there is
a rise in the oxygen saturation without the addition of oxygen to the
inspired atmosphere.

This rise begins to take place during the period of topical anesthesia
and continues until the withdrawal of the bronchoscope, except for the
period when the patient’s position is changed from the sitting to the
semirecumbent. Even at this time, however, the oxygen saturation
does not fall below the pre-bronchoscopy level.

The similarity of the results shown in table 5 illustrates the observation
that the pattern of oxygen saturation during this procedure is
not directly dependent upon the severity of pulmonary pathology.
Of the three patients, one had no pulmonary disease, one had unilateral
moderately advanced tuberculosis with normal pulmonary function,
and one had bilateral far advanced tuberculosis with significant
decrease in pulmonary function.

The rise in arterial oxygen saturation is due, in our opinion, to

### TABLE 4

**STUDY OF OXYGEN SATURATION IN 50 CASES**

<table>
<thead>
<tr>
<th></th>
<th>Preoperative</th>
<th>Anesthesia</th>
<th>Supine Position</th>
<th>Bronchoscope in</th>
<th>Right Main Stem Bronchus</th>
<th>Left Main Stem Bronchus</th>
<th>Bronchoscope-out</th>
<th>Postoperative</th>
</tr>
</thead>
<tbody>
<tr>
<td>Limits</td>
<td>85-99</td>
<td>87-100</td>
<td>88-101</td>
<td>89-100</td>
<td>86-100</td>
<td>87-100</td>
<td>86-102</td>
<td>89-102</td>
</tr>
<tr>
<td>Average</td>
<td>93.1</td>
<td>95.1</td>
<td>96.1</td>
<td>96.9</td>
<td>95.1</td>
<td>97.1</td>
<td>98.3</td>
<td>98.4</td>
</tr>
</tbody>
</table>

### TABLE 5

**COMPARISON OF OXYGEN SATURATION IN 3 PATIENTS AND DESCRIPTION OF THESE PATIENTS INDICATING THEIR DISEASE, VITAL CAPACITY AND TIMED VITAL CAPACITY**

<table>
<thead>
<tr>
<th>Patient No.</th>
<th>Preoperative</th>
<th>Anesthesia</th>
<th>Supine Position</th>
<th>Bronchoscope in</th>
<th>Right Main Stem Bronchus</th>
<th>Left Main Stem Bronchus</th>
<th>Bronchoscope-out</th>
<th>Postoperative</th>
</tr>
</thead>
<tbody>
<tr>
<td>1*</td>
<td>96</td>
<td>99</td>
<td>100</td>
<td>100</td>
<td>99</td>
<td>100</td>
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<td>100</td>
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<tr>
<td>2†</td>
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<td>98</td>
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<td>97</td>
<td>99</td>
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<tr>
<td>3‡</td>
<td>95</td>
<td>97</td>
<td>97</td>
<td>97</td>
<td>96</td>
<td>98</td>
<td>99</td>
<td>98</td>
</tr>
</tbody>
</table>

* 31-year-old male. No pulmonary disease. No pulmonary function studies.
increased ventilation. All the patients in this group had been hospitalized for at least several weeks prior to this study. They have remained at bed rest and they were all given a combination of a barbiturate and an opiate. Thus, their respiratory center was depressed and their tidal exchange was below the normal level. The procedure stimulated the cough reflex and this in most instances in combination with the emotionally induced hyperventilation was apparently sufficient to raise the patient’s minute volume significantly above the prebronchoscopy level.

No attempt is made to draw any conclusions from this study to the patterns of oxygen saturation encountered in patients during bronchoscopy following general anesthesia. The study indicates that in the majority of patients following careful topical anesthesia and from the point of view of arterial oxygen saturation, bronchoscopy is a relatively safe procedure. The addition of oxygen to the inspired air is unnecessary in most cases, as it has been in all cases of our series. In spite of the above observations we wish to point out, however, that bronchoscopy is not free of hazards. It is a potentially traumatic procedure and, in some patients, hypoxia may develop, particularly at the time the bronchoscope is withdrawn from the trachea. We wish to emphasize, therefore, that although the addition of oxygen to the inspired air during bronchoscopy following topical anesthesia is not necessary in the majority of patients, an oxygen supply has to be available and has to be used in every case in which hypoxia develops.

SUMMARY

A study was undertaken to determine the changes in oxygen saturation occurring during routine bronchoscopy.

Fifty adult patients suffering from pulmonary disease were studied. The oxygen saturation of these patients was determined with the aid of the ear oximeter before, during, and after bronchoscopy performed following topical anesthesia and without the administration of oxygen. It was found that during the procedure, the oxygen saturation rose in all of these patients.

ACKNOWLEDGMENTS

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REFERENCES