Influence of patient posture on oxygen saturation during fibre-optic bronchoscopy

S. P. L. Meghjee*, M. Marshall†, E. J. Redfern‡ and D. V. McGivern†

*Department of Thoracic Medicine, York District Hospital, York, †Castle Hill Hospital, Cottingham, Hull and ‡University of Leeds, Leeds, U.K.

This study was designed to investigate the effect of posture on oxygen saturation during fibre-optic bronchoscopy (FOB). Thirty-eight consecutive patients requiring diagnostic FOB were randomized into two groups according to the initial posture in which the FOB was performed. In group 1 (20 patients), FOB was commenced supine, and in group 2 (18 patients) in a semi-recumbent position (45° from horizontal). Sedation with midazolam was titrated according to clinical response. All patients received atropine 0.6 mg intravenously and topical lignocaine. Observations of peak, trough and plateau oxygen saturation and pulse rate were recorded during six study periods, each lasting 3 min. Periods 1 and 2 were pre- and post-sedation without supplemental oxygen, respectively. The bronchoscope was then inserted into the distal end of the trachea and observations taken during periods 3 and 4 (no supplemental oxygen) and periods 5 and 6 (2 l oxygen by nasal cannulae).

In group 1, posture was changed from supine to semi-recumbent from periods 3–4 and reversed in periods 5 and 6. In group 2, posture changes were in reverse sequence. Patients with initial oxygen saturation of less than 90% or showing a fall below 85% during FOB were excluded. Five patients from each group were withdrawn because of hypoxia. In both groups, oxygen saturation fell significantly (P < 0.001) following sedation. There was no significant change in saturation (peak, trough or plateau) with change in posture from supine to semi-recumbency (group 1) or the reverse (group 2). These correspond to periods 3–4 and 5–6 in both groups. Supplemental oxygen was associated with a significant rise in oxygen saturation in both postures, attaining levels close to presedation levels.

Key words: fibre-optic bronchoscopy; oxygen saturations; supine position; semi-recumbent position.

Introduction

Since fibre-optic bronchoscopy (FOB) was first introduced by Ikeda (1) in 1968, it has been increasingly used as a diagnostic and therapeutic technique in thoracic medicine. Although considered a relatively safe procedure, retrospective surveys (2,3) have identified several complications in a small proportion of patients.

Arterial hypoxaemia is the commonest complication (2), since respiratory depressant drugs are used for premedication, and the airway is then partially occluded by the bronchoscope. Patients with chronic obstructive pulmonary disease have an even higher risk of hypoxaemia, and of associated major arrhythmias (4). A prospective study by Afsar et al. (5), of 50 patients undergoing FOB in the supine position, showed significantly less oxygen desaturation in the group receiving supplemental oxygen. Guidelines for care during FOB (6) do recommend that patients should be given supplemental oxygen to counter this potential hazard.

FOB is performed with the patient either supine or in the semi-recumbent position. It might be anticipated that the supine position would exacerbate hypoxaemia, due to diaphragmatic splinting and reduced functional residual capacity (FRC) (7). However, no previous studies have investigated this possibility. We, therefore, investigated the effect of posture on hypoxaemia during FOB and the influence of supplemental oxygen during this procedure.

Patients and methods

The study was approved by the local ethics committee. Informed consent was obtained in all patients. Bronchodilators were not administered as a routine, but patients with chronic obstructive pulmonary disease who were on bronchodilators received their usual medications 1 h prior to FOB. Pulmonary function tests (see Table 1) were performed in the ward or clinic at least 1 day prior to the test.

Thirty-eight consecutive patients requiring diagnostic FOB were randomized into two groups according to the initial posture in which the FOB was performed. In group 1...
(20 patients), FOB was commenced supine, and in group 2 (18 patients) in a semi-recumbent position. All patients were fasted overnight and received intravenous atropine 0.6 mg and midazolam titrated according to clinical response. Topical lignocaine was applied to the upper and lower respiratory tract. Patients with clinical conditions that could effect the accuracy of oximetry readings, (e.g. anaemia, jaundice and haemoglobinopathy) were excluded.

Observations of peak, trough and plateau oxygen saturation and pulse rate were recorded during six study periods, each lasting 3 min. Periods 1 and 2 were pre- and post-sedation without supplemental oxygen. The bronchoscope was then inserted into the distal end of the trachea and saturation readings recorded during periods 3 and 4 (no supplemental oxygen) and periods 5 and 6 (2 l oxygen by nasal cannulae). In group 1 (Fig. 1) posture was changed from supine (period 3) to semi-recumbent (period 4) and then reversed in periods 5 and 6. In group 2 (Fig. 2), posture changes were in reverse sequence. Patients with an initial oxygen saturation of less than 90% were excluded. Patients in whom the saturation fell below 85% during FOB, or remained in the range of 85–90% for more than 5 min were withdrawn and given supplemental oxygen.

**Equipment**

Oxygen saturation and pulse rate was measured continuously using Ohmeda 3740 finger probe pulse oximetry. FOB was performed with the Olympus IT20D fibre-optic bronchoscope using the transnasal route. Baseline pulmonary function tests were measured using the Vitalograph spirometry equipment. Oxygen was administered using a twin-nasal oxygen cannulae with a prong in each nostril (UnoPlast A/S, DK-3390 Hundested, Denmark).

**Statistical Analysis**

Differences in oxygen saturation and pulse rates between study periods were assessed by a repeated measures analysis of variance. Based on a sample size of 15 (group 1), to detect a drop of 3% in the mean levels over the study periods the power was 90%, while based on 13 observations

### Table 1. Clinical data. Pulmonary function tests and midazolam dose used for optimum clinical sedation. Means and standard deviations (in brackets) of clinical data for the two groups.

<table>
<thead>
<tr>
<th></th>
<th>Sex</th>
<th>Number</th>
<th>Age (years)</th>
<th>FEV₁ (l sec⁻¹)</th>
<th>FEV₁% Predicted</th>
<th>FVC (l)</th>
<th>FVC% Predicted</th>
<th>Midazolam (mg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group 1</td>
<td>Female</td>
<td>5</td>
<td>67.8 (9.1)</td>
<td>1.37 (0.51)</td>
<td>60 (0.61)</td>
<td>83 (2.6)</td>
<td>6.00 (2.8)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Male</td>
<td>10</td>
<td>59.6 (12.63)</td>
<td>2.24 (0.85)</td>
<td>66 (1.01)</td>
<td>88 (2.8)</td>
<td>6.85 (2.8)</td>
<td></td>
</tr>
<tr>
<td>Group 2</td>
<td>Female</td>
<td>6</td>
<td>74.83 (4.62)</td>
<td>1.17 (0.42)</td>
<td>59 (0.385)</td>
<td>83 (2.14)</td>
<td>4.8</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Male</td>
<td>7</td>
<td>68.86 (8.53)</td>
<td>2.00 (0.61)</td>
<td>69 (0.95)</td>
<td>89 (1.83)</td>
<td>5.00</td>
<td></td>
</tr>
</tbody>
</table>

FEV₁: forced expiratory volume (litres) in 1 sec; FVC: forced expiratory volume (litres).

**Fig. 1.** Trends in oxygen saturation during the study periods in Group 1 (starting position supine). [�; SD]; [�; SEM]

**Fig. 2.** Trends in oxygen saturation during the study periods in Group 2 (starting position semi-recumbent). [�; SD]; [�; SEM]
Values are observed only when hypoxia. This is because studies using pulse oximetry have shown a strong correlation between saturation and arterial oxygen tension ($PaO_2$) in the range of 75–99.9%, ($r = +0.88$, $P < 0.001$) with response times of less than 1 min (9,10).

The relationship between $PaO_2$ and $SaO_2$ is expressed in the oxyhaemoglobin dissociation curve. A moderate decline in $PaO_2$ from the normal range has only a slight influence on $SaO_2$. A normal $PaO_2$ of 13–3 kPa corresponds to a $SaO_2$ of approximately 97%, while a $PaO_2$ of 8.0 kPa corresponds to a $SaO_2$ of 90%. Significant changes in $SaO_2$ values are observed only when $PaO_2$ falls below 8.0 kPa (11).

Oxygen saturation can significantly fall with FOB and is corrected by oxygen supplementation (12,13). A recent survey by Honeybourne et al. (14) showed that pulse oximetry was used in 84% of units in the U.K. However, supplemental oxygen—which is a recommendation (5)—was only practised by 48% of units. In this survey, some respondents did comment that they would use supplemental oxygen for patients at 'high risk' or when the oxygen saturation fell below 91%. A previous postal survey by Simpson et al. in 1986 (15) showed that only 18% used routine supplemental oxygen.

The cause of hypoxaemia during FOB is multi-factorial. Sedation with opiates, benzodiazepine and hypnotics may reduce central respiratory drive (16,17). Insertion of the fibre-optic bronchoscope into the trachea results in a loss of 10–15% of the cross-sectional area of the trachea, increasing airflow obstruction. Secondly, the sub-epithelial receptors in the trachea may be affected by mechanical stimulation of the instrument resulting in bronchoconstric-

**Results**

The clinical data of the patients in both groups are shown in Table 1. Five patients from each group were withdrawn due to hypoxia. Trough oxygen saturation fell significantly following sedation ($P < 0.001$). As shown in previous studies (6,8), oxygen saturation fell significantly following sedation ($P < 0.001$) in both groups. During FOB, oxygen saturation levels were slightly lower in the supine position in both groups, but this was not statistically significant compared to corresponding saturation levels in semi-recumbent positions. Supplemental oxygen was associated with a significant rise in oxygen saturation in both postures ($P < 0.001$), attaining levels close to pre-sedation saturation. Similar statistically results were obtained with analysis of plateau and peak oxygen saturation (data not shown).

**Discussion**

The pulse oximeter has made it possible to perform continuous, non-invasive measurements of oxygen saturation ($SaO_2$). This is because studies using pulse oximetry have shown a strong correlation between saturation and arterial oxygen tension ($PaO_2$) in the range of 75–99.9%, ($r = +0.88$, $P < 0.001$) with response times of less than 1 min (9,10).

The relationship between $PaO_2$ and $SaO_2$ is expressed in the oxyhaemoglobin dissociation curve. A moderate decline in $PaO_2$ from the normal range has only a slight influence on $SaO_2$. A normal $PaO_2$ of 13–3 kPa corresponds to a $SaO_2$ of approximately 97%, while a $PaO_2$ of 8.0 kPa corresponds to a $SaO_2$ of 90%. Significant changes in $SaO_2$ values are observed only when $PaO_2$ falls below 8.0 kPa (11).

Oxygen saturation can significantly fall with FOB and is corrected by oxygen supplementation (12,13). A recent survey by Honeybourne et al. (14) showed that pulse oximetry was used in 84% of units in the U.K. However, supplemental oxygen—which is a recommendation (5)—was only practised by 48% of units. In this survey, some respondents did comment that they would use supplemental oxygen for patients at 'high risk' or when the oxygen saturation fell below 91%. A previous postal survey by Simpson et al. in 1986 (15) showed that only 18% used routine supplemental oxygen.

The cause of hypoxaemia during FOB is multi-factorial. Sedation with opiates, benzodiazepine and hypnotics may reduce central respiratory drive (16,17). Insertion of the fibre-optic bronchoscope into the trachea results in a loss of 10–15% of the cross-sectional area of the trachea, increasing airflow obstruction. Secondly, the sub-epithelial receptors in the trachea may be affected by mechanical stimulation of the instrument resulting in bronchoconstric-

**References**

12. Milman N, Faurishou P, Grode G, Jørgensen A. Pulse oximetry during fibreoptic bronchoscopy in...


