Prospective Randomized Trial Comparing Oxygen Administration During Nasal Flexible Bronchoscopy*

Oral vs Nasal Delivery

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Study objectives: To determine the optimal method of delivering supplemental oxygen during flexible bronchoscopy (FB).

Design: Prospective study.

Setting: University medical center.

Patients: Ninety-seven consecutive patients undergoing outpatient nasal FB during a 7-month period.

Intervention: During FB, delivery of oxygen was alternated weekly and administered by nasal cannula either nasally (52 patients) or orally (45 patients). Prior to the procedure, patients completed a questionnaire regarding oral or nasal breathing preferences, history of sinus disease, allergy history, and perceived degree of nasal congestion.

Results: Comparison of oxygen delivery groups demonstrated no significant difference in oxygen requirements (4.1 L/min nasal vs 3.8 L/min oral, p = 0.63), overall saturation nadir (90.9% nasal vs 91.4% oral, p = 0.85), or average saturation (95.8% nasal vs 95.7% oral, p = 0.57). No correlation between subjective symptoms or sinus or allergy history was found for oxygen requirements, average saturation, or saturation nadir.

Conclusions: These data suggest that during nasal FB, no discernible difference exists between administration of oxygen using cannulas placed either nasally or orally.

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Key words: anoxemia; bronchoscopy; oximetry; oxygen; oxygen inhalation therapy

Abbreviation: FB = flexible bronchoscopy

Arterial oxygen desaturation has been demonstrated to commonly accompany flexible bronchoscopy (FB). In some patients, hypoxemia can be severe and persist for several hours after completion of the procedure. Hypoxemia during FB may be aggravated as a result of certain interventions such as BAL. The addition of supplemental oxygen during FB and the recovery period can prevent bronchoscopy-induced hypoxemia.

Supplemental oxygen is routinely administered during FB to prevent desaturation and various methods of oxygen delivery have been used. Initially, oxygen was administered through an endotracheal adaptor. As transnasal FB became popular, supplemental oxygen was delivered by Venturi mask and, later, mouth-held nasal cannula (“prongs”). In one study, the delivery of oxygen via a pharyngeal catheter produced fewer episodes of hypoxemia compared to nasal cannula or no oxygen supplementation.

At our institution, patients undergoing FB usually receive supplemental oxygen by nasal cannula, which is placed either in the nares or in the mouth, depending on operator preference and training. We decided to compare methods of oxygen supplementation during transnasal FB using cannula placed orally or nasally. The principal outcome variables were oximetric saturation and intraprocedure oxygen flow. We also evalu-
ated whether patient factors such as a history of allergic rhinitis or sinus disease and subjective nasal congestion would predict the optimal route of oxygen delivery.

**Materials and Methods**

All patients undergoing outpatient FB completed a symptom questionnaire prior to the procedure. Questions were asked regarding nasal or mouth breathing preference, history of sinus disease or surgery, obstructive sleep apnea, hay fever or allergic rhinitis, and nasal congestion. Patients were also asked to quantify subjectively their perceived degree of nasal obstruction on the day of FB as rated on a scale from 0 (no congestion) to 5 (complete nasal obstruction).

Patients received narcotic premedication with either meperidine (range, 25 to 75 mg) or fentanyl (range, 25 to 100 µg) and IV sedation with midazolam (range, 0.5 to 5 mg) during the procedure. FB was performed via the transnasal route, and all patients were placed in the semirecumbent position during the procedure. Oxygen supplementation was provided via cannula placed orally (even weeks) or nasally (odd weeks), and patients were instructed to breathe via the mouth or nares depending on the placement of the cannula. Oxygen flow was begun at 2 L/min and increased by increments of 2 L/min to achieve an oxygen saturation of ≥ 94% prior to beginning the procedure.

If oxygen saturation decreased to < 90% during FB, oxygen flow was increased by 2 L/min every minute until the oxygen saturation was > 90% or 8 L/min was obtained. If oxygen saturation persisted at < 90% at 8 L/min, the patient was withdrawn from the study protocol, although the data were still included in the final analysis. Pulse oximetry was recorded throughout the FB using pulse oximetry (Nellcor NB-290 or Nellcor N-200, Mallinckrodt, St. Louis, MO). Data were analyzed using the Mallinckrodt Score program (Version 1.1a, Mallinckrodt) to determine average oxygen saturation as well as lowest oxygen saturation during the procedure.

**Statistical Analysis**

Average oxygen saturation, lowest oxygen saturation, and maximum oxygen flow rate during FB were analyzed using a t test for nasal vs oral route of oxygen delivery. All results were also analyzed relative to history of nasal or sinus disease, subjective nasal congestion, breathing preference, amount of sedation required, and procedure length. A p value < 0.05 was considered statistically significant.

**Results**

Ninety-seven patients were included in the data analysis. Four patients were withdrawn from the protocol due to desaturations requiring > 8 L/min oxygen by nasal cannula during FB, and one patient was withdrawn who required 40% oxygen by face shield to keep oxygen saturation of 90% prior to the procedure. Of the four patients withdrawn from the protocol during FB, two patients had bleeding after biopsy and required 10 L/min of oxygen by cannula, one patient had bleeding from the left lower lobe after brushings and washings and required 15 L/min of oxygen by nasal cannula, and one patient required 80% oxygen by face shield after bronchial washing. These data were included in the analysis. One additional patient specifically requested the cannula to be placed orally, and this patient’s data were included in the oral group.

Fifty-two patients received oxygen nasally, and 45 patients received oxygen orally. Allergy or sinus symptoms were present in 25 patients in the nasal group and 27 patients in the oral group. Nasal congestion (score ≥ 3) was present in six patients in both groups. There was no difference in the amount of sedation given to either the nasal or oral group (meperidine, 51.8 ± 9.4 mg vs 50 ± 14.2 mg; or fentanyl, 50 ± 19.4 µg vs 62.5 ± 21.2 µg; midazolam, 2 ± 1.3 mg vs 2.4 ± 1.3 mg). One patient received flumazenil for oversedation. The procedure duration was similar between the nasal and oral groups (21.6 ± 13.9 min vs 20.8 ± 10.1 min).

Both the average oxygen saturation and the lowest oxygen saturation during bronchoscopy were similar.
between the two groups (Fig 1), as was the maximum oxygen flow rate during bronchoscopy (Fig 2). No statistically significant difference was detected between delivering supplemental oxygen nasally vs orally relative to a history of allergy or sinus symptoms or nasal congestion on the day of the procedure. Subjects complaining of nasal obstruction who were administered oxygen nasally had higher flow requirements than those with the same complaint but with oxygen administered orally (5.2 ± 2.7 L/min vs 3.5 ± 1.8 L/min, p = 0.17) or those without this complaint who were administered oxygen nasally (3.8 ± 2.6 L/min, p = 0.22; Fig 3). When groups were compared by breathing preference (mouth or nose), no discernible difference in oxygen saturation levels and oxygen flow rate requirements were detected.

**Discussion**

Hypoxemia during bronchoscopy is common and can, occasionally, be pronounced.¹⁻⁶ The mechanisms for hypoxemia include oversedation, suctioning during the procedure, which can remove oxygen or decrease lung volumes below functional residual capacity,¹⁴ and increased ventilation-perfusion mismatching from bronchospasm, bleeding, and instillation of fluids.⁸,¹⁵ FB-associated hypoxemia may persist for several hours after the procedure¹,⁵ and necessitates monitoring patients closely during the recovery period. Significant hypoxemia can usually be prevented by the administration of supplemental oxygen during the procedure⁷⁻⁹ and recovery.
Methods of supplemental oxygen delivery during FB include nasal cannula, Venturi mask, continuous positive airway pressure mask, and pharyngeal catheter. Harless et al\textsuperscript{13} reported the efficacy of nasal prongs placed in the mouth of 16 patients undergoing transnasal FB. All of these patients received oxygen at a rate of 7 L/min, since this study was conducted in Salt Lake City at an altitude of 1,520 m and no patients had the prongs placed in the nares.\textsuperscript{13} In a study that included 160 patients, Milman et al\textsuperscript{9} clearly demonstrated that supplemental oxygen, provided either by a nasal catheter or a pharyngeal catheter, significantly reduced hypoxemia during FB compared to patients who did not receive supplemental oxygen. Although patients receiving 2 L/min of supplemental oxygen by pharyngeal catheter had fewer episodes of hypoxemia than those who used a nasal catheter, no patients in the pharyngeal catheter group had a BAL performed during their FB compared to 38% of the patients in the nasal catheter group.\textsuperscript{9}

Nasal cannula offers the simplest means of administering oxygen during transnasal FB. Nasal cannula can be placed in the nares or in the mouth, and theoretical advantages exist for both routes. When placed nasally, the insertion of the bronchoscope may potentially occlude the nasal passage on that side so that only one nare is available for flow. In patients with significant nasal congestion from various causes, the oral route may offer less impedance to oxygen delivery. However, if the patient preparation for bronchoscopy includes topical decongestants, vasoconstriction of the nasal passages may decrease nasal resistance by increasing the area available for flow. Conversely, patients may preferentially breathe through their mouth or their nose and placing the cannula in the preferred orifice might optimize oxygen delivery.

In this study, we were unable to detect a difference in average oxygen saturation, oxygen saturation nadir, or oxygen requirements regardless of location of cannula placement. Even when comparing oxygen delivery routes according to history of allergic rhinitis or sinus disease, subjective nasal congestion, or preferred route of breathing (mouth vs nose), no statistically significant difference was determined. The trend to higher supplemental oxygen requirements in the group with subjective nasal congestion who had the nasal cannula placed nasally could be explained by these patients’ compensating for their nasal obstruction by breathing primarily through the mouth.

Because oversedation can depress respiration and lead to hypoxemia, we reviewed bronchoscopy reports to document the sedative doses required for each procedure. Both groups received similar amounts of sedation, and there was only one case of oversedation requiring once dose of flumazenil for reversal. Therefore, differing levels of sedation do not appear to be a confounding variable.

During nasal FB, we were unable to discern a difference between oxygen delivery by nasal cannula using either a nasal or oral route. However, this study did not evaluate—individually or in comparison with nasal cannula—the effectiveness of oxygenation using other methods such as Venturi mask, continuous positive airway pressure mask, or pharyngeal catheter. If a cannula is the preferred method of supplemental oxygen delivery by the bronchoscopist, the choice of cannula placement during FB should be determined by subjective factors such as patient preference and bronchoscopist’s comfort and training.

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REFERENCES