Original Article

Safety and ease of awake fiberoptic intubation with use of oxygen insufflation versus suction to clear secretions during procedure

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Abstract

Background and Aims: During awake fiberoptic intubation (AFOI), clearing secretions is usually done by suctioning. The study objectives were to assess the safety of AFOI with the use of oxygen insufflation versus suction to clear secretions from the field of vision during the procedure as assessed by incidence of desaturation <95%, ease of intubation, and time taken to secure the airway.

Material and methods: This prospective randomized study was conducted in 40 adult patients with difficult airways requiring AFOI. All patients received dexmedetomidine 0.5mcg/kg intravenously, and the airway was topicalized. In Group-S suction and in Group-O oxygen was connected to the suction port of the bronchoscope to clear the secretions by activating the suction knob during bronchoscopy. Ease of intubation was scored as easy, moderate, and hard.

Results: Incidence of desaturation to <95% and the need for oxygen supplementation were significantly high in Group S compared to Group O (60% vs. 10%). Incidence of easy intubation (80% vs. 75%) and time taken to intubate (50.1 ± 16.6 vs. 53.8 ± 21.0 s) were comparable. The number of times (median) suctioning was done in Group S was significantly high compared to the number of oxygen insufflations required in Group O [3 (1–6) vs. 2 (0–5), *P* 0.033]. Desaturation to <95% was significantly low in Group O compared to Group S during bronchoscopy (10% vs. 60%, *P* 0.002).

Conclusion: The use of oxygen insufflation to clear secretions from the field of vision during AFOI is a safer alternative to suctioning as this technique reduces the chance of desaturation during the procedure without affecting ease of intubation, number of attempts, time taken for it, or patient comfort.

Keywords: Fiberoptic, insufflation, intubation, oxygen, suction

Introduction

Awake fiberoptic intubation (AFOI) is the gold standard for securing the airway whenever a difficult airway is anticipated.[1-4] Frequently, during the procedure, it becomes necessary to clear the secretions to have a clear view, which is usually done by suctioning through the inbuilt suction port of the fiberoptic bronchoscope (FOB). Alternatively, a jet of gas can be used to blow secretions away from the field of vision. We hypothesized that insufflation with a high flow of oxygen to clear secretions could offer an additional advantage of oxygen supplementation during the procedure warranting against the development of hypoxia, especially in patients who have received a sedative premedication during AFOI.

The primary objective of the present study was to assess the safety of AFOI with the use of suction versus oxygen

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insufflation to clear secretions from the field of vision during the procedure, as assessed by incidence of desaturation to <95%. The secondary objectives included assessment of ease of intubation, number of attempts at intubation, time taken to secure airway, need of suctioning while using the insufflation technique, hemodynamic changes, patient comfort, and level of sedation with both the techniques.

Material and Methods

The present study was a prospective randomized open-label study conducted after obtaining Institutional Ethical Committee Clearance and patients' consent before recruitment. The study was registered in the Clinical Trial Registry of India (CTRI/2019/07/020244).Patients aged 20–70 years, of the American Society of Anesthesiologists physical status (ASA PS) 1–3 with anticipated difficult airway requiring AFOI were included in the study. All procedures done in the study followed the ethical guidelines of the declaration of Helsinki.

The patients with restricted mouth opening due to malignancy of alveolus, anterior tongue, postradiation trismus, and temporomandibular joint ankylosis were included. Those with an allergy to local anesthetics, psychiatric illness, major cardiac or pulmonary disorders, bleeding disorders, and uncooperative patients were excluded. Patients requiring AFOI but having disease along the passage of FOB like those with nasal tumors or having lesions on the posterior tongue, pharyngeal or laryngeal areas were also excluded. The conditions were ruled out before the procedure by reviewing the video recordings of the indirect flexible laryngoscopy, performed by the head and neck surgical team, mandatorily done for such patients in our institute.

The patients were randomly allocated to either of the two groups, Group S or O, based on computer-generated random sequence of numbers, and allocation concealment was ensured using sequentially numbered opaque sealed envelopes. All patients received glycopyrrolate 0.2mg and dexmedetomidine 0.5mcg/kg body weight over 10 min intravenously, and the more patent nostril was selected and decongested with oxymetazoline drops3–5 min before topicalization. The upper airway of all patients was anaesthetized with lignocaine 10% spray (2 puffs) and 2% jelly (1 mL). The lower airway was anaesthetized with 4mL of 4% lignocaine through a transtracheal injection.

A 6.5 or 7mm internal diameter (ID) size endotracheal tube (ETT), as appropriate, was loaded to the FOB, (KARL STORZ 11301 BN1, Germany), with working length 54cm, distal tip diameter 5.2mm, and working channel ID 2.3mm. In Group O, oxygen at 6L/min was connected to the suction port located on the upper part of the body of FOB, whereas in Group S, suction tubing (suction force -50 kPa) was attached there [Figure 1].The lower channel inlet was kept closed. Before starting the procedure, the tip of FOB was dipped into normal saline, and the suction knob was activated. In Group S, saline was suctioned into the tubing connected to the suction port and in Group O, gas bubbles appeared on activation of the suction knob.

In Group O, during the passage of FOB, whenever the proceduralist came across secretions obscuring visibility, the suction knob was activated releasing oxygen which blew the secretions away from the field of vision. But in Group S, suction was used to clear the secretions. Under vision, FOB was advanced till the carina, and then ETT was railroaded into the trachea. Correct placement of the ETT was confirmed with the appearance of regular end-tidal carbon dioxide ($EtCO_2$) waveforms in the monitor and by auscultation. Then the patients were induced, paralyzed, and mechanically ventilated with isoflurane in oxygen and air mixture.

Time taken to intubate was calculated from the introduction of FOB to the nostril till the appearance of $EtCO_2$, which was recorded by an assistant not actively taking part in the anesthesia procedure. The number of times suctioning or oxygen insufflations were needed in respective groups and the need of suctioning in Group O, if required, were also noted. Saturation <95% was managed with oxygen supplementation at 10L/min via a clear disposable anesthetic facemask with a size sufficient enough to cover the mouth when placed across the mouth, and the patient was asked to breathe deeply through the mouth. Heart rate, mean arterial pressure (MAP), and oxygen saturation (SpO_2) were documented before and after sedation, just before the procedure, then at 1, 3, and 5 min

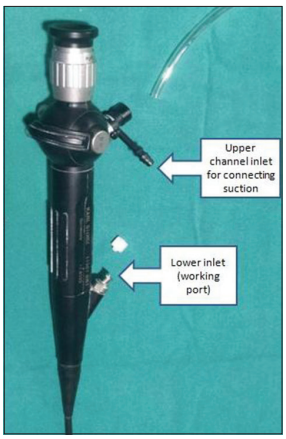

Figure 1: Body of FOB showing upper channel inlet and working port

after intubation. The lowest saturation recorded during bronchoscopy was also noted.

All intubations were performed by anesthetists with more than 5 years of experience in awake fiberoptic-assisted intubations. The level of sedation in both groups was assessed by Ramsay sedation score; cough, gag, and patient comfort were also scored.[5] Ease of intubation was scored as easy, moderate, and hard by the anesthetist who intubated, based on patient comfort, cough, and gag scores described by Malcharek *et al.*[5] and proceduralist's comfort.

As there is no similar study published, we initiated the present study as a pilot study in 20 patients with 10 in each group. All patients (100%) in the oxygen insufflation group retained saturation >95%, whereas only 60% in the suction group had a saturation of >95%. Based on this result with a 95% confidence interval and 80% power, the sample size to obtain statistically significant results was calculated to be 19 per group. We recruited 40 patients into the study with 20 patients in each group.

The normally distributed continuous variables are reported as mean and standard deviation. In a situation where the continuous variables were skewed, median with minimum and maximum was used. Categorical variables were presented as number and proportion. Chi-square test was used to compare the categorical variables. Independent sample *t*-test was used to compare the normally distributed continuous variables. Mann-Whitney U test was used to compare the sedation, patient comfort, cough, and gag scores. Paired *t*-test was used to compare the hemodynamic variables at different time points from the baseline within the group. Statistical analyses were conducted using SPSS Version 20.0 for Windows (IBM Corporation ARMONK, NY, USA).

Results

The data of 40 patients were analyzed [Figure 2]. The mean demographic variables and distribution of gender and ASA PS were comparable in both groups[Table 1]. The incidence of desaturation to <95% as well as the need for oxygen supplementation was significantly high in Group S compared to Group O (60% vs. 10%, *P* 0.002). Ease of intubation, time taken to intubate, and the number of attempts were comparable in both groups [Table 2]. The number of times suctioning was done in Group S to clear secretions was significantly high compared to oxygen insufflation in Group O for the same [median 2 (0–5) vs. 3 (1–6), *P* 0.033, Table 2]. The sedation score and patient comfort score did not show any significant difference between the groups. Incidence of coughing was minimal (<3, score 2) and was comparable in

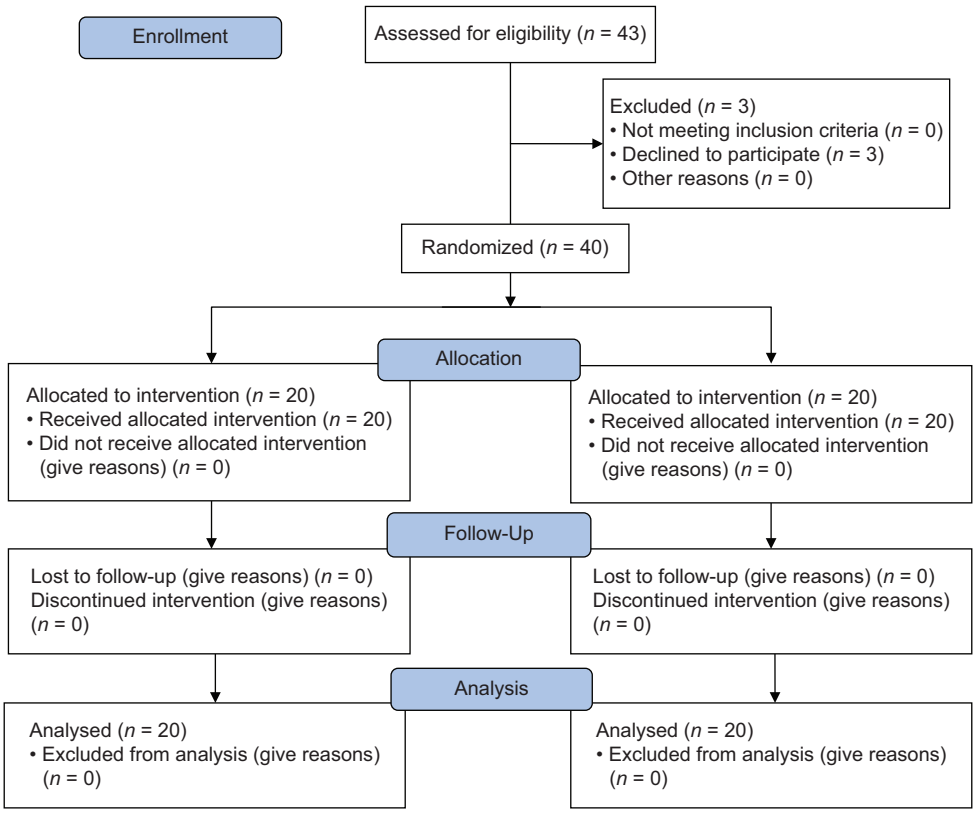

Figure 2: CONSORT Flow Diagram

both groups [Table 2]. Only one patient in Group O required suctioning to clear the secretions.

HR and MAP were significantly higher in group S during and 1 min after intubation. HR remained significantly higher at 3 min after intubation in group S. At other time points, hemodynamic parameters remained comparable in both groups. SpO_2 was significantly lower in group S during bronchoscopy (*P* 0.003). At other time points, there was no significant difference in SpO_2 in both groups [Figure 3].

Intragroup analysis showed that there was a significant fall in HR from the baseline in Group O after sedation at 3 and 5 min after intubation. In Group S, a significant fall in HR from baseline was observed after sedation, at 1 and 5 min after intubation. Significant fall in MAP from baseline occurred in Group O at 1,3, and 5 min after intubation. After sedation, at 3 and 5 min after intubation, Group S had a significant fall in MAP from the baseline values [Table 3].

Table 1: Comparison of age, weight, gender, and ASA PS

Variables	Group O		Group S		*P*
	Mean	SD	Mean	SD	
Age in years	47.2	11.2	52.9	9.6	0.095
Weight in kg	63.17	5.83	64.07	6.25	0.566
Gender	*n*	%	*n*	%	
Male	14	70.0	15	75.0	1.000
Female	6	30.0	5	25.0	
ASA PS 1	14	70.0	12	60.0	0.740
ASAPS 2	6	30.0	8	40.0	

Discussion

The present study had shown that incidence of desaturation to < 95% requiring oxygen supplementation was significantly low in group O during AFOI compared to group S. The need for suctioning to clear secretions during bronchoscopy compared to oxygen insufflation was significantly higher. The ease of intubation, time taken for intubation, sedation score, patient comfort, and hemodynamic changes during the procedure remained comparable in both groups.

Inappropriate sedation is considered a major reason for failure during AFOI based on the Fourth National Audit Project of the Royal College of Anaesthetists.[6]Commonly used sedatives to facilitate awake fiberoptic-assisted intubation are benzodiazepines, propofol, opioids, alpha-2-adrenoceptor agonists, and ketamine.[7] But, a meta-analysis of 37 randomized studies found no differences in intubation success rate with different sedatives. However, dexmedetomidine was found to offer a better safety profile compared to other sedatives. It was noted that the use of dexmedetomidine as premedicant was associated with fewer desaturation episodes compared to propofol and opioids with or without midazolam.[3]Mild conscious sedation with dexmedetomidine and maintaining spontaneous breathing, ensures patient comfort and co-operation during the procedure.[8,9]For these reasons, we chose dexmedetomidine as the sedative premedicant in our study. Agents such as propofol or opioids were not considered as respiratory depression could potentially be very dangerous in our study population of patients with difficult airways requiring AFOI.

Table 2: Comparison of time taken to intubate, attempts, the incidence of saturation <95%, need for oxygen supplementation, ease of intubation, number of times secretions cleared, sedation score, and patient comfort score

Variables	Group O		Group S		P
	Mean	SD	Mean	SD	
Time taken to intubate in seconds	50.1	16.6	53.8	21.0	0.540
	n	%	*n*	%	
Saturation <95% Yes	2	10.0	12	60.0	0.002
Saturation <95% No	18	90.0	8	40.0	
Easy intubation	16	80.0	15	75.0	1.000
Moderate & hard intubation	4	20.0	5	25.0	
Oxygen supplementation Yes	2	10.0	12	60.0	0.002
Oxygen supplementation No	18	90.0	8	40.0	
Number of attempts at intubation1	18	90.0	17	85.0	0.637
Number of attempts at intubation2-3	2	10.0	3	15.0	
	Median	(Min-Max)	Median	(Min-Max)	
Patient comfort score	2	(1-3)	2	(1-3)	0.915
Sedation score	2	(1--2)	2	(1-3)	0.187
Cough and gag score	2	(1-3)	2	(1-3)	0.915
Number of times secretions cleared	2	(0-5)	3	(1-6)	0.033

Table 3: Intragroup analysis of changes in heart rate and mean arterial pressures from baseline

Intragroup analysis of changes in heart rate from baseline (per min)						
Time points	**Group O**		***P***	**Group S**		***P***
	Mean	**SD**		**Mean**	**SD**	
Baseline	96.5	14.3		97.4	13.7	
After sedation	85.1	12.7	0.001	91.7	8.3	0.012
During intubation	91.0	10.7	0.082	103.4	20.8	0.067
1 min after intubation	89.0	14.2	0.087	110.8	21.3	0.001
3 min	81.2	12.9	0.003	95.0	10.9	0.475
5 min	82.5	14.7	0.012	90.1	9.1	0.005
Intragroup analysis of changes in MAP from baseline (mm Hg)						
Baseline	106.0	23.2		106.2	24.3	
After sedation	95.8	18.7	0.118	97.5	19.6	0.027
During intubation	98.8	10.3	0.140	110.7	18.2	0.496
1 min after intubation	85.8	19.7	0.013	101.7	14.5	0.567
3 min	77.1	18.3	0.001	81.5	12.0	<0.001
5 min	77.3	16.1	0.002	74.0	15.6	<0.001

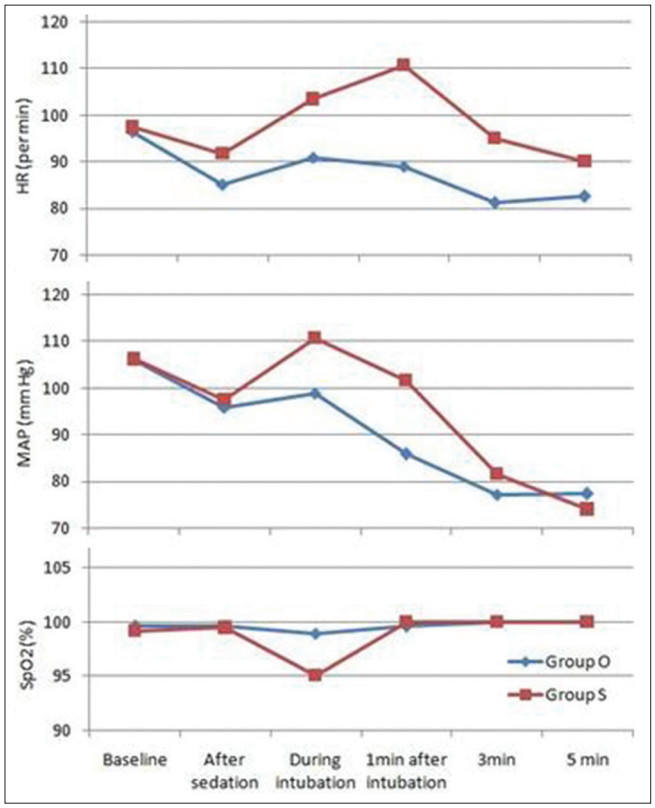

Figure 3: Changes in heart rate, mean arterial pressure, and oxygen saturation

Oxygen supplementation could be attempted through nasal prongs and with a face mask held near the mouth with high flow rates during the procedure. If a patient is well sedated with shallow respiration, adequate oxygen may not reach the alveoli with these techniques as oxygen delivery to the lungs in such situations solely depends on the respiratory efforts of the patients. Any associated airway obstruction adds to this problem. Though high-flow nasal oxygen-delivery system such as transnasal humidified rapid-insufflation ventilatory exchange (THRIVE) improves oxygenation and decreases the risk of desaturation during AFOI,[10-12] the equipment may not always be immediately available for use and nasal prongs may hinder the passage of FOB through the nostril. Moreover, during AFOI, the more patent nostril will be chosen for the introduction of scope; hence, supplementation using nasal prongs may no longer remain very effective.

Usually while performing fiberoptic bronchoscopy (FOB), to facilitate visualization by clearing the secretions, suctioning is usually done. Alternatively, secretions can be removed from the field of vision using a jet of high flow of oxygen, through the suction port of FOB, to blow the secretions away.[13]

FOB has two suction channel inlets, one at the upper part and the other at the lower part of the body of FOB [Figure 1]. Suction tubing is attached to the upper channel, and the channel inlet located on the lower part of the body of FOB is used for injection of local anesthetics and passage of forceps or brushes. When oxygen tubing is connected to the upper channel inlet, insufflation of gas occurs only on activation of the suction knob which is controllable, intermittent, and hence safe. Oxygen insufflation through the lower inlet (working port) will be continuous and is independent of the activation of the suction mechanism and hence carries risks of gastric distension.

The safety of the connection can be checked before starting the procedure by dipping the distal end of FOB in sterile water and by activating the suction knob. If gas bubbles appear only on activation of the suction knob, the connection is safe and correct. If oxygen is attached to the lower channel, gas bubbles continuously even without activation of the suction knob. Such a connection is unsafe and may even result in gastric rupture.[14]In our study, we connected oxygen tubing

to the upper channel, and the correctness of the connection was tested before the procedure in all cases.

Selection of patients could be important while using this technique. In those with airway malignancy with swallowing difficulty, you may come across a lot of thick tenacious secretions which might require suctioning out. Though we have included such patients also in our study, we were able to manage with oxygen insufflation only. But for those who are not well experienced with this technique may initially find it difficult to have a clear visual field in presence of excessive secretions. So we recommend this technique to be initially practiced in those with essentially normal airway, but with restricted mouth opening, then move on to patients with airway lesions. Anyway, suction should be kept ready and an assistant to disconnect oxygen and attach suction tubing to FOB should always be present. However, as patients are kept awake and spontaneously breathing, the delay while connecting suction which will take less than half a minute, will be well tolerated.

In critically ill patients with severe hypoxemia, noninvasive positive-pressure ventilation to assist spontaneous breathing was found superior to conventional oxygen supplementation in preventing worsening of gas exchange during awake bronchoscopy with better hemodynamic tolerance.[15,16] However, in a theatre setting, this practice cannot be adopted as the primary aim is to intubate.

No patient in our study had bradycardia, probably because of IV glycopyrrolate premedication, which was used mainly to make airway mucosa dry for better contact with local anesthetics thereby facilitating topicalization. As we had excluded patients with major cardiac illness, any rise in HR following glycopyrrolate did not affect the study population adversely. The significantly higher HR and MAP noted during intubation in our study in group S could be because more manipulation of the bronchoscope might have required for suctioning the secretions out.

The problems such as secretions being blown into distal alveoli could be of concern if a continuous high flow of gas is used. In the technique described in our study, a continuous flow was not delivered to the patient. A jet of oxygen was released only on activating the suction port of the FOB, which was of a short duration lasting for few seconds and done only when required. Moreover, as FOB was performed for intubation, oxygen insufflation was mostly done before entering the trachea; hence, the risk of blowing secretions into distal alveoli was minimal. This risk is possible if oxygen insufflation is used for bronchoscopy in already intubated patients. We did not observe any increased incidence of atelectasis, aspiration, or pneumothorax in the postoperative chest X-rays or had any added pulmonary complications in our patients.

Though there is a possibility that insufflation at oral/nasal passage could lead to swallowing reflex and gastric distension, the risk is more with continuous insufflation. With the use of intermittent insufflation of a very short duration, the chance of gastric distension is minimal. Ryle's tube was inserted in all of our patients after intubation for continuous intraoperative gastric drainage and postoperative feeding. At the time of Ryle's tube position confirmation by auscultation, we had not noticed any epigastric distension or escape of gas through the proximal end of Ryle's tube indicating the absence of insufflation of the stomach with this technique. No patient vomited or aspirated during AFOI.

We used 6.5 mm ID ETT for females and 7.0mm ID for males. Relatively smaller size was chosen to eliminate the inability to railroad the ETT after entering the trachea with FOB. Failure to railroad, a bigger tube and the subsequent tissue trauma along with associated patient discomfort would make a second attempt at AFOI more difficult.

Saturation <95% was managed with oxygen supplementation via an anesthetic facemask placed across the mouth, and an airtight seal was not possible to achieve. As the patient was breathing through the nose as well, it was anyway impossible to deliver 100% oxygen. However, in a spontaneously breathing awake patient, oxygen supplementation with this technique will usually be sufficient to correct desaturation, if the patient is also prompted to take deep breaths. Saturation <95% was chosen as a point of intervention for oxygen supplementation as the initiation of intervention at a lower saturation could result in overt desaturation adversely affecting patient safety. The reason for desaturation in our study despite a short duration of bronchoscopy could possibly be attributed to the administration of sedative premedication.

The major drawback of the study was that though the generation of random allocation sequence, enrolment of participants, and assignment of participants to interventions were performed by different persons, we were unable to blind the study as the proceduralist was aware of the technique used. The anesthetists who performed the intubations had more than 5 years of experience in AFOI. However, a certain degree of bias was still possible as the ease of intubation as assessed by proceduralists might have had some subjective variations.

Conclusion

Use of oxygen insufflation to clear secretions from the field of vision during the awake fiberoptic bronchoscope-assisted

intubation is a safer alternative to suctioning as this technique reduces the chance of desaturation during the procedure without affecting the ease of intubation, number of attempts, time taken for it, or patient comfort.

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Conflicts of interest
There are no conflicts of interest.

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