SUBMITTED 16 APR 23
REVISIONS REQ. 2 JUL & 13 SEP 23; REVISIONS RECD. 16 AUG & 28 SEP 23
ACCEPTED 19 OCT 23
ONLINE-FIRST: DECEMBER 2023
DOI: https://doi.org/10.18295/squmj.12.2023.086

Is High Flow Nasal Oxygenation a Game Changer in Endobronchial Ultrasound-Guided Transbronchial Needle Aspiration

A pilot study

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Abstract

Objectives: A pilot observational study was done to compare High Flow Nasal Oxygen (HFNO) and supraglottic airway device (SAD) technique in patients undergoing endobronchial ultrasound (EBUS) and transbronchial needle aspiration procedures (TBNA) with an objective to evaluate the efficacy of HFNO in oncological patients. ***Methods:*** The study was conducted in a tertiary cancer center in Muscat, Sultanate of Oman from May 2022 to March 2023. Consecutive patients undergoing EBUS TBNA under moderate sedation were quasi-randomized into HFNO and SAD groups. The episodes and duration of hypoxia and the lowest level of oxygen saturation were the primary outcome measured. ***Results:*** A total of twenty-four patients were taken into the study of which 10 were in the HFNO group and 14 were in the SAD group with an equal number of males and females. The duration of the procedure in both the groups was similar (45±20 mins in HFNO vs 44±17 in the SAD group). Mean lowest oxygen saturation in the HFNO group was (93.5%±4), which was statistically significant in comparison to the SAD group (90±6). In both groups, the maximum hypoxia occurred during the early phase of the procedure. However, both the groups

were similar for the cumulative duration of hypotension (140 secs in HFNO vs 55 secs in SAD) and bradycardia (25 secs in HFNO vs. 40 secs in SAD). ***Conclusion:*** HFNO can be a good alternative to the SAD and could be used safely and efficiently in the cohort of population in patients undergoing EBUS TBNA.

Keywords: High flow nasal oxygenation; Endobronchial Ultrasound-guided Transbronchial Needle Aspiration; Supraglottic airway devices.

Introduction

Endobronchial Ultrasound-guided Transbronchial Needle Aspiration (EBUS-TBNA) first popularized in 2002, is one of the common procedure used by interventional pulmonologists[1,2]. Providing anesthesia for such procedures has always been a challenge, due to sharing of the same airway space and in patients with poor physiological reserve, and comorbid like coronary artery disease, congestive heart failure, chronic pulmonary thrombo-embolism etc. Maintaining adequate depth of sedation, provision of stable hemodynamics, immobilizing the patient, and maintaining the oxygenation of the patient remain the main concerns in such patients[3,4]. Hypoxia and its consequences during the procedure are a real threat to the life of the patient. Traditionally across the globe, these procedures are done under general anesthesia (GA) or moderate sedation with a SAD. HFNO has been tried for EBUS TBNA procedures, however, currently, no study is available where it has been compared with the SAD with moderate sedation[5,6]. HFNO at high flow rates provides a continuous positive airway pressure (CPAP), washes out the CO2 from the respiratory dead space, and enhances the process of oxygen diffusion into the alveolar spaces. Apart from it, HFNO also reduces airway resistance and thus the work of breathing. The stress response to insertion of an airway device, dislodgement of the device during the procedure, and stimulation of a hyperactive airway can all be avoided while using HFNO. It also provides easy access to the pulmonologists for their intervention.

Methods

A quasi-randomized study was designed to compare the efficacy of HFNO and SAD patient undergoing EBUS TBNA with moderate sedation. The study was conducted in a tertiary cancer center in Muscat, Sultanate of Oman from May 2022 to March 2023 after approval from the Institutional Ethical Committee. We included all patients who were assessed to undergo the

procedure in ASA grade 1 to 4. Patients who had associated morbidities like coronary artery disease, diabetes mellitus, asthma, chronic kidney disease etc. were optimized with respect to their clinical conditions before being taken up for the procedure. The primary outcome was comparison of the duration and episodes of hypoxia during the procedure between the two groups. Hypoxia was defined as SpO_2 of less than 90 percent. The secondary outcomes included changes in cardiovascular parameters (Blood pressure and heart rate), changes if any in the blood gases, and discrepancies, if any in the diagnostic yield. Diagnostic yield was defined as the percentage of patients for whom EBUS- TBNA gave a specific diagnosis. Patients were explained both techniques of anesthesia in detail in the language they understood. Written consent was taken. Patients were divided into two groups: the HFNO Group and the SAD group.

Pre-procedurally 10% lidocaine spray was sprayed into the pharynx in both groups. ECG, SpO_2, HR, and NIBP were monitored continuously. In the HFNO group, patients received HFNO at a flowrate of 40 lit/min to 80 lit/min and the fraction of inspired oxygen was initially 0.3 and increased by an increment of 0.1 depending upon the oxygen demand to keep the oxygen saturation at 90%. HFNO delivers actively heated, humidified medical gas using an air/oxygen blender at flows up to 60 to 70 liters per minute with an FiO_2 varying between 0.21 to 1. To deliver high flow oxygen, we used nasal high flow Star adult system (Draeger company; Germany) as a patient interface connected to ventilator (EVE IN; Stephan Germany). In the SAD group, patients had a SAD with flow rates of 10 to 12 liters of oxygen and a fraction of the inspired oxygen at 0.5 to 0.6. Laryngeal Mask Airway (LMA Supreme: Teleflex Medical, Westmeath Ireland) or I-gel (Inter surgical LTD., Berkshire UK) were the supraglottic airway devices used in the study. These were placed at the level of the laryngopharynx, hence providing access to the bronchoscope to proceed below the level of cords. They all were ventilated in synchronized modes. The EBUS scope (Pentax medical; Japan) was introduced over a tight self-sealing diaphragm to prevent leaks.

All patients received premedication with Glycopyrrolate 0.2 mg intravenous (iv) (unless contraindicated) and dexamethasone 8 mg i.v. The sedation level was maintained in both groups with a Bispectral index (BIS) score around 50 during the procedure. Patients were given a loading dose of 1 microgram/Kg Dexmedetomidine and then were maintained on 0.1 to 0.3 microgram/kg/ hour of infusion. Injection propofol 1mg/kg was given slowly over 5 to 7 minutes. The patients

also received Remifentanil at an infusion rate of 0.2 to 0.5 microgram/kg/minute. The following parameters were recorded: NIBP every 3 minutes for the first 30 minutes and 5 minutes thereafter. Oxygen saturation (SpO2), Heart rate (HR), and electrocardiogram (ECG) were recorded continuously. Venous blood gases (VBG) were done at the start and end of the procedure and also whenever there was an episode of hypoxia. VBG was taken to assess the pO_2 levels. Although the correlation in assessing the hypoxia with VBG is not direct, it gives a good indirect evidence of hypoxia.

Each of the EBUS TBNA procedures was done as per the standardized institutional protocol i.e. each mediastinal/hilar lesion to be examined; minimum, of 3 passes with 15 wiggling's in each pass.

Statistical Analysis: Graph Pad Prism version 5 was used for statistical analysis. The procedure-related parameters including the episodes of hypoxia, cumulative duration of hypoxia, and the cardiovascular parameters (systolic and diastolic blood pressures, heart rate variations, venous blood gases) were described in means and standard deviations. Differences in the demographic characteristics and the procedure-related values were evaluated with Fisher's exact test or Mann-Whitney U test between the SAD and the HFNO group.

Results

Twenty four patients were taken into the study with 12 males and 12 females. The distribution of patients in HFNO group was 10 and in the SAD group was 14. The mean age in the HFNO group was 48 ±18 years, while in the SAD group was 54±12 years.

For the procedure-related parameters, the mean preoperative oxygen saturations were 86±4 for the HFNO group, while it was 88±4 for the SAD group. The HFNO group had 3 episodes of hypoxia with a cumulative duration of 120 seconds, while the SAD group had 5 episodes with a cumulative of 116 seconds. The longest duration of hypoxia in the HFNO group was 45 seconds while in the SAD group was 28 seconds, with no statistical significance between the groups. The maximum systolic blood pressure, diastolic blood pressure, episodes of hypotension, duration, and episodes

of bradycardia were comparable. The venous blood gases, average fluid input, and the total dose of propofol, remifentanil, and dexmedetomidine were all comparable in both.

The time courses of oxygen saturation and heart rate during the examination are shown in (Fig1, 2). There was no statistical difference between both groups. The oxygen saturation and heart rate fell in both groups in fourth, fifth and the sixth minute of the procedure after which it remained almost above 94 percent. (Table 1). The lowest SpO2 distribution in both groups has been presented in (Fig 3). The lowest saturation in the HFNO group (excluding preoperative levels) was 88 percent, while in the SAD group, it was 82 percent. The mean lowest oxygen saturation in the SAD group was 90±3 and in the HFNO group was 93.5± 4.5 ($p<0.005$), which was statistically significant. The pulmonologist was able to get adequate yield in 23 of the 24 patients.

Discussion

This prospective study compared the use of HFNO and SAD for moderate sedation for EBUS TBNA. We found HFNO with moderate sedation was as efficious as SAD in maintaining oxygen saturation.

Takakuwa et al. did a prospective study comparing HFNO with a nasal cannula during EBUS TBNA under midazolam sedation and found that the lowest level of mean oxygen saturation was higher in the HFNO group[6]. They found that the maximum FiO2 to maintain oxygen saturation in HFNO group was 0.45. This in our study was 0.6. Many studies have proven the utility of HFNO to maintain oxygen saturation while undergoing interventional bronchoscopic procedures[7,8,9,10]. There have been studies proving the efficacy of moderate sedation with a SAD providing equivalent or better maintenance of oxygenation than general anesthesia [11].

Miyagi et al, and Simon et al, have reported that bronchoscopy was tolerated well with HFNO for prevention of mild to moderate hypoxemia[12, 13]. In our study, we assessed the usefulness of HFNO to prevent hypoxemia during EBUS TBNA in subjects who had respiratory impairment preprocedural. The mean lowest oxygen saturation in the HFNO group was 93.5±4.5% and the minimum Spo2 was 88 %, which were significantly higher than the SAD group, which had a mean low oxygen saturation of 90±3% and the minimum SpO2 of 82 %. The total duration of hypoxia

was lesser in the SAD group. The lesser duration of hypoxia in the SAD group can be attributed to the fact that positive pressure ventilation quickly corrects the hypoxia while there is a time lag between increasing the FiO2/flow rate and the increase in saturation in the HFNO group.

In our study, the fall in oxygen saturation happened maximum at 4 to 6 minutes after the start of the procedure in both groups. Desaturation in the early phase of bronchoscopic procedures has been reported in multiple studies and this tendency was consistent with our results[6,12]. Similarly, the fall in heart rate was also noted in the first three to seven minutes of the procedure. This may be due to the concurrent development of hypoxia. There is always a real concern about raising end-tidal carbon dioxide (EtCO2) during the procedure. In our current study, we monitored $PaCO_2$ through venous blood gases, which was less in the HFNO group in comparison to the SAD group, however, it was statistically insignificant. This may be due to the fact that the ineffective ventilation in the SAD method due to leak of gases at the entry point of the EBUS scope on the catheter mount and also the EBUS scope being inside the SGA reduces the space available for ventilation. Hence there was ineffective maintenance of EtCO2. Some studies, have shown lesser retention of carbon dioxide in the HFNO group than in the nasal oxygen supply, but there is no study done to compare the SAD with HFNO[6,8,10]. However, there is always a possibility of a drop of CPAP when HFNO is applied with the mouth open. Hence further studies will be required with monitoring of EtCO2 and PaCO2. Roberto F Casal et al, had compared patients undergoing EBUS with SAD under general anesthesia and moderate sedation and found that the yield was similar[11]. In our study, we found that the diagnostic yield in both groups was comparable, which is an objective method of assessing the ease of operability. The limitations of the study were, a small sample size, which will definitely be unable to mask biases and for accuracy of hypoxia and hypotension during the procedure. Invasive blood pressure monitoring would have given better results for episodes of hypotension. However, the invasiveness of these procedures might be argued for risk-benefit for the study.

Conclusion

Based on our study, we concluded that HFNO could decrease the incidence and episodes of hypoxia considerably during EBUS-TBNA in comparison to the SAD under moderate sedation. Hence it could be safely used in our clinical practice with all the advantages. HFNO reduces airway

resistance. The stress response to insertion of an airway device, dislodgement of the device during the procedure and stimulation of a hyperactive airway can all be avoided while using HFNO. It also provides easy access to the pulmonologist for their intervention. However, study with a greater number of patients are needed to confirm all these findings.

Authors' Contribution

All authors contributed to the conceptualization and design the study. PRR, SSPM, AAM and SMB collected and assembled the data. PRR, SSPM, AAM, RK and SMB analysed and interpreted the data. PRR, SSPM, RK and SMB drafted the manuscript. All authors approved the final version of the manuscript.

Conflicts of Interest

The authors declare no conflicts of interests.

Funding

No funding was received for this research.

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Table 1: Patient Demography and procedural values.

PARAMETERS	VARIABLE	HFNO	SAD	P Value
Demo Graphy	Age (years)	48 ± 18	54 ± 12	
	Male (number)	6	6	0.370
	Female (number)	4	8	0.190
	Weight (Kilograms)	55 ± 16	61 ± 14	0.320
	BMI (kg/m^2)	24 ± 6	21 ± 3	0.270
	Duration of procedure (minutes)	45 ± 20	44 ± 17	0.170
	Mean preoperative SpO2 in %	86 ± 4	88 ± 4	0.280
Spo2	Maximum SpO2 (%)	99	100	
	Minimum spO2 (%)	88	82	
	Mean minimum spO2 (%)	**93.5 ± 4.5**	**90 ± 3**	**<0.001**
	Episodes of hypoxia (= 90%)	3	5	0.320
	Cumulative duration of hypoxia (seconds)	120	116	0.260
Bp	Mean Maximum SBP (mmHg)	110 ± 23	142 ± 46	0.320
	Mean Maximum DBP (mmHg)	82 ± 18	82 ± 18	0.260
	Episodes of hypotension (number)	2	1	0.450
	Cumulative duration of hypotension (seconds)	140	95	0.115
Heart Rate	Mean Maximum heart rate (beats/min)	106 ± 28	94 ± 18	0.230
	Mean Minimum heart rate (beats/min)	52 ± 11	58 ± 8	0.018
	Episodes of bradycardia (= 45beats/min)	1	2	
	Cumulative duration of bradycardia (seconds)	25	40	0.180
Venous Blood Gas	pH	7.34 ± 1.2	7.36 ± 1.8	0.360
	pCO2 (mmHG)	43.3 ± 7.2	44.4 ± 6.2	0.260
	pO2 (mmHG)	34.4 ± 4.2	33.8 ± 5.3	0.310
	H2CO3 (meq/ L)	23.2 ± 4.6	24.4 ± 5.2	0.270
	Lactate (mmol/L)	1.6 ± 1.8	1.9 ± 1.1	0.119
IV fluid	Average fluid input (milliliter)	425 ± 62	460 ± 32	0.670
Co Morbidities	Coronary artery disease	02	02	
	Hypertension	03	04	
	Diabetes	07	06	
	Congestive heart failure (number)	02	00	
	Cerebrovascular accidents (number)	04	01	
	MYSTHENIA GRAVIS (number)	00	01	
	SIGNIFICANT VALULAR DISEASE (number)	03	03	

	Respiratory Co morbidities (number)	05	04	
	Chronic pulmonary embolism (number)	02	01	
Diagnostic yield	No (number)	0	1	0.816
	Yes (number)	10	13	
Medication	Total propofol (mg) mean	180 ± 32	180 ± 18	0.460
	Total remifentanil (mcg) mean	350 ± 28	335 ± 18	0.350
	Total dexmedetomidine (mg) mean	7 ± 4.5	8 ± 3	0.180

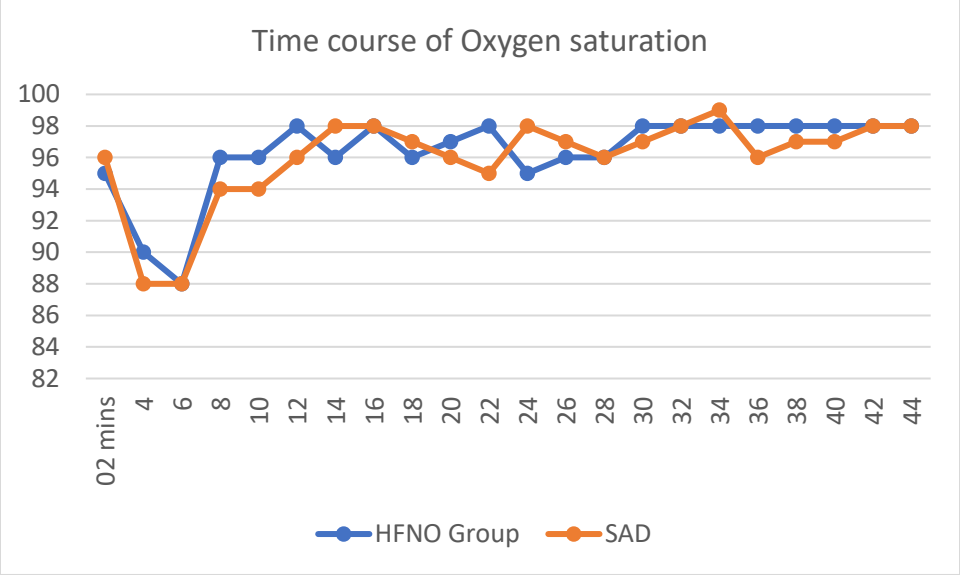

Figure 1: Time course of changes in oxygen saturation during EBUS TBNA in both groups. *HFNO = High frequency nasal oxygenation; SAD = supraglottic air way device.*

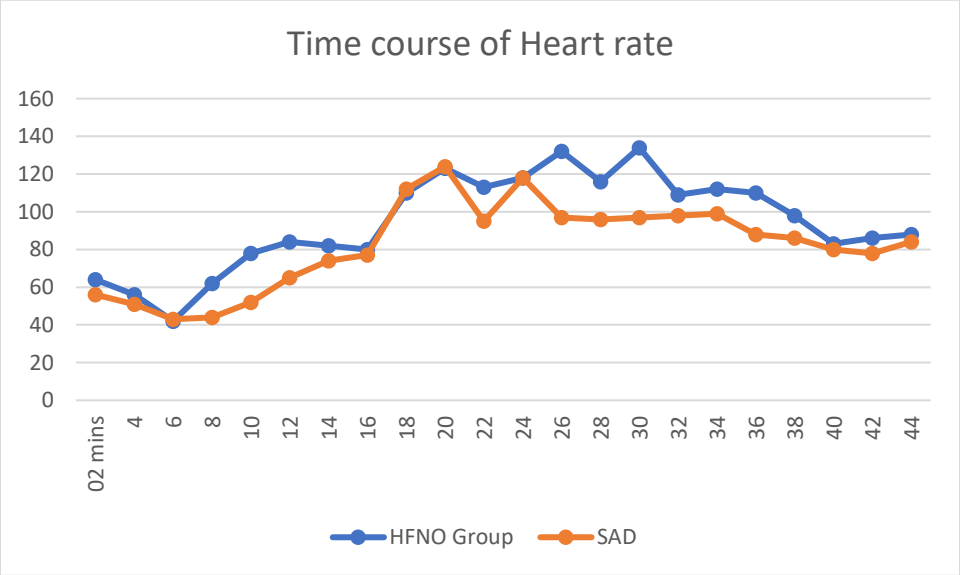

Figure 2: Time course of changes in heart rate during EBUS TBNA in both the groups.

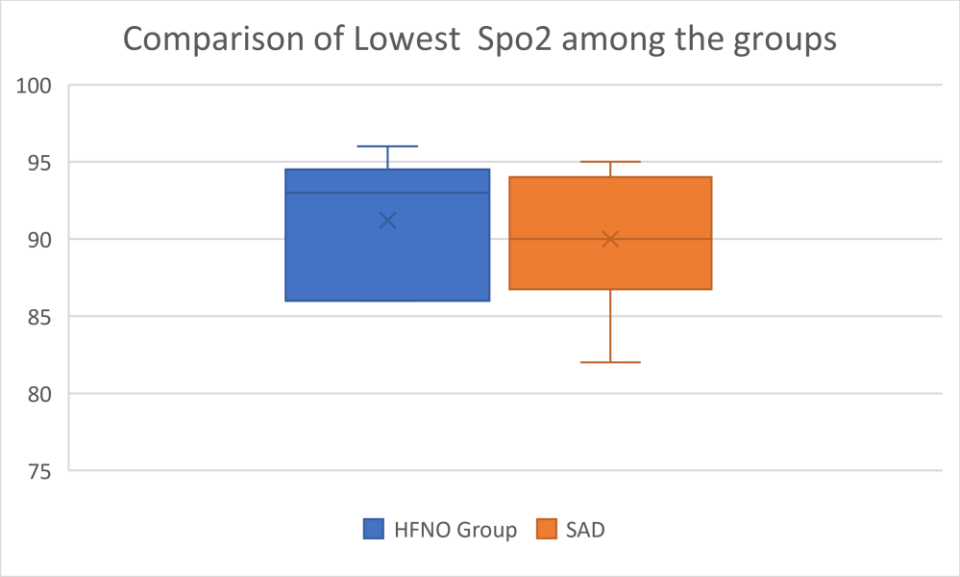

Figure 3: Comparison between the lowest oxygen saturations between the HFNO and the SAD group. The mean lowest oxygen saturation in the HFNO group was significantly higher than the SAD group.