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Original Research Article

To Assess and Compare the Efficacy of Transnasal Humified Rapid Insufflation Ventilatory Exchange (Thrive) with Nasal Oxygen Supplementation for Apnoeic Oxygenation during Short Bronchoscopy Procedures

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Abstract:

Background: Transnasal humidified rapid insufflation ventilatory exchange (THRIVE) during apnoea has shown to delay desaturation. The primary aim of the study was to assess the effectiveness of THRIVE during apnoeic oxygenation for short bronchoscopy procedures and compare it with nasal oxygen supplementation method.

Method: A total 90 patients of either sex, between 12-45 years with ASA I, II undergoing short bronchoscopy procedures were enrolled in the study with two groups of 45 in each. Group N: patients received nasal cannula O2 supplementation @ 15 L/min and Group H: patients received O2 supplementation via THRIVE @ 70 L/min. Unpaired t-test was used to compare variables between two groups.

Results: There was no significant difference in the mean total apnoea time and apnoea cycles between two groups with cut off apnoea time of 6 minutes. The SPO2 drop in group H was more gradual as compared to group N and was statistically significant (P=0.028) Also, there was statistically significant difference noted with EtCO2 on intubation between both the groups (P<0.00001). After intubation at the end of procedure, PaO2 was higher in Group H, but not statistically significant (P=0.083). However, there was statistically significant difference in PaCO2 noted with higher values in group N (P<0.00001).

Conclusion: The oxygen supplementation for short bronchoscopy procedures during apnoeic oxygenation with THRIVE and nasal cannula were equally effective in maintaining oxygenation till six minutes of apnoea time, but PaCO2 values were seen higher in conventional nasal oxygen supplementation as compared to THRIVE at the end of procedure.

Keywords: THRIVE; Apnoea; Bronchoscopy; Oxygen supplementation; Nasal cannula.

Introduction

Laryngotracheal stenosis (LTS) implies partial or complete cicatricial narrowing of larynx and/or trachea. Benign strictures are the commonest form of obstructive type of tracheal lesions. They can be caused by prolonged intubation, inhalational injury, and trauma or may be idiopathic.

The evaluation bronchoscopy and short bronchoscopy procedures such as bougie or balloon dilatation for tracheal stenosis is used primarily as one of the treatment modalities in mild to moderate tracheal stenosis. [1,2]

Anesthesia for bronchoscopy procedures has always been challenging as anesthesia provider and surgeon share a common field. So, close and effective communication between the anesthesiologist and surgeon is essential. [3,4] There are various methods of giving anasethesia for bronchoscopy like using jet ventilation, ventilating bronchoscope, spontaneous ventilation and oxygen insufflation technique during apnoea. Anesthesiologists have to maintain oxygenation and ventilation in such a way so as to provide good visualization of the surgical field and sufficient

time to complete the procedure. These demands could only be met by providing an apneic anaesthetized patient who is not intubated. [5,6] Effective preoxygenation followed by oxygen supplementation during apneic period enables anesthesiologists to safely prolong the apnoea time. [7]

Apneic oxygenation using nasal cannula connected to an oxygen flow meter at 15 L/min [8-10] is routinely used in our institute for bronchoscopy procedures. The maximal oxygen flow rate delivered by nasal cannula is only 15 L/min, and it gets diluted by ambient air and finally the fraction of inspired oxygen (FiO2) is significantly reduced in the alveoli. Also, the use of conventional nasal cannula supplies cold, dry oxygen that will cause discomfort to a conscious patient, limiting the gas flow and a relatively low FiO2. Higher flow rates via conventional nasal cannula in sedated patients soon results in upper airway becoming inflamed due to the effects of cold, dry oxygen. [11,12]

Trans nasal humidified rapid insufflation ventilatory exchange (THRIVE) is a technique that uses rapidly insufflated, heated, humidified gases administered via High Flow Nasal Cannula to achieve apneic oxygenation and ventilation during general anesthesia (G.A.). High flow nasal oxygen is delivered at 50-70 L/min which enters the nose and loops around the soft palate and exits through the mouth, creating a highly turbulent supraglottic vortex which constantly replenishes the pharynx and prevents entrainment of room air. Commercial equipment which delivers THRIVE is an oxygen humidification unit which receives oxygen to a custom built Trans nasal oxygen cannula (optiflow) via a heated circuit.

This circuit is able to deliver air oxygen mixture and provides FiO2 between 0.21- 1.0. [2,13-17] Many studies have shown that patients maintained on THRIVE desaturate at a much slower rate under apneic oxygenation [13,15,18,19]. The present study was undertaken to assess the effectiveness of THRIVE during apneic oxygenation for short bronchoscopy procedures and compared it with nasal oxygen supplementation method.

Materials and Methods

After obtaining Institutional Ethical Committee approval and written informed consent from patients or relatives/ guardians, this prospective observational study was conducted in E.N.T. Operation Theatre during a period from October 2019 to September 2021. A total 90 patients of either sex, age between 12-45 years, ASA I and II and who underwent bronchoscopy procedures under general anesthesia with LTS grade I, II and III (no resp. distress) were included in the study. Patients with chronic respiratory diseases (COPD), children with congenital airway anomalies, nasal, bone, DNS, BMI more than 30 kg/m^2, patients with room air saturation less than 98%, pregnant and lactating mothers, patients not willing to consent were excluded from the study. The patients requiring tracheostomy were also withdrawn from this study. The pre-anaesthetic evaluation with a detailed airway examination was done regarding fitness for GA. Institutional fasting protocols were followed. IV line secured & and RL fluids started. Patient was nebulized with 3ml of 4% lignocaine. After taking the patient on OT table, standard monitors were attached and baseline parameters were noted: SpO2, EtCO2, ECG, HR, MAP. Baseline arterial blood gas (ABG) sample was sent.

The standard anaesthesia protocol for bronchoscopy followed in our institution as follows:

Premedication with inj. Glycopyrolate 0.004mg/kg and sedation with Inj. Fentanyl- 2ug/kg intravenously given. Inj. Dexmedetomidine continuous infusion at 0.5ug/kg/hr started. Patient preoxygenated with tidal volume breathing for 3 mins of 100% at 6 L/min using a tight-fitting face mask administered via semi closed circuit. The end tidal CO2 concentration was targeted to >0.90 as a marker of successful preoxygenation with gas monitor. Anesthesia was induced with intravenous Propofol 2-3mg/kg followed by inj. Atracurium 0.5mg/kg. Patient was ventilated with air oxygen mixture (1:1) for 3 & half minutes using breathing circuit with circle absorber system. The O2 supplementation was done as per the discretion of the attending anesthetist either with conventional nasal cannula or THRIVE OPTIflow nasal cannula. Surgeon was then allowed to proceed with the bronchoscopy procedure once muscle relaxation was achieved. The values of SpO2, ETCO2, heart rate, blood pressure was noted before the start of procedure. The apnoea period and duration of apnoea time with no. of apnoea cycles were noted. The patients were selected into 2 groups depending upon the method of oxygenation used during apnoeic period of bronchoscopy procedure. Group N: O2 supplementation via nasal cannula at 15 litre/min and Group H: O2 supplementation with THRIVE at 70 litre/min. The patient was monitored, and vital parameters were noted throughout the procedure.

'The apnoea time' - defined as the time to fall in O2 saturation to 90% from the commencement of the procedure. The permissible apnoea time allowed in our institute till the: - 1) Fall in O2 saturation less than or equal to 90%; 2) Six minutes of apnoea time has reached; 3) Hemodynamic parameters not maintaining within

20% of baseline values; 4) Occurrence of any arrhythmias.

In case of above-mentioned events whichever was earlier, the patient was mask ventilated with 100% O2 using close circuit breathing system till the oxygen saturation maintained at 99-100% & EtCO2 between 30-35mmhg. Subsequent to this, the procedure was resumed, if not completed already. The apnoea time for each cycle & number of such apnoea cycles were noted. Inj. Propofol 20-30mg bolus was given if HR or MAP increases to >20% of baseline. All patients received inj. Dexamethasone 0.1mg/kg & inj. Ondansetron 4mg. towards the end of procedure, infusion of Dexmedetomidine was stopped and an ABG sample collected and sent. Patient was intubated with appropriate small sized portex cuffed Endotracheal Tube and ventilated with O2, air mixture till the spontaneous respiratory attempts observed. The residual NM blockade was reversed with inj. Glycopyrolate 0.008mg/kg and inj. Neostigmine 0.06mg/kg slowly. Once the patient was awake with SpO2 99-100%, EtCO2 30-35 mmHg, and protective reflexes returned along with stable hemodynamic, patient was extubated and shifted to recovery room for monitoring of vital parameters.

The parameters noted were SpO2, EtCO2, HR, Mean Arterial Pressure (M.A.P. and ECG monitoring for arrythmias at baseline, after induction, (administration of muscle relaxant) mask ventilation, at the start of procedure and every 5 minutes till the end of procedure, before extubation and after extubation. Throughout the study, patients are observed for any adverse events like bradycardia, tachycardia, hypo and hypertension, desaturation, hypo or hypercarbia, arrhythmias and bronchospasm.

Statistical Analysis: Normally distributed numerical data were presented as mean+/- S.D. and categorical data as proportions (%) and data not normally distributed presented as median (interquartile range). Variables were compared between 2 groups using unpaired t-test or Mann Whitney U test whichever appropriate. Within group comparisons done by paired t test.

Observations and Results

A total of 90 patients of either sex, aged 12-45 years, ASA 1 or 2 undergoing short bronchoscopy procedures were enrolled in the study and divided into two groups of 45 in each group. Group H- THRIVE at 70 L/min and Group N- Nasal cannula at 15 L/min. Both the groups were comparable and found no significant difference (P>0.05) with respect to demographic data of patients.

Figure 1 shows the distribution of procedures done in each group and both groups were comparable. p value- 0.821 (not significant).

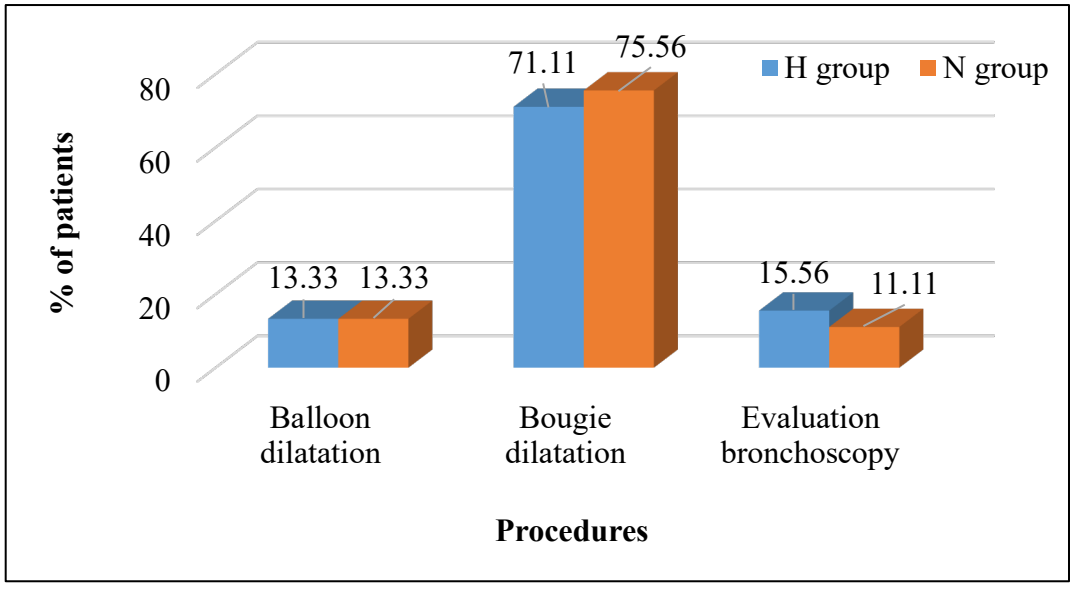

Figure 1: Procedures done

The grading of laryngotracheal stenosis of the participants in each group was not showing statistically significant difference between the two groups, (p>0.05).There was no statistically significant difference seen among the groups with respect to baseline parameters. The values of SpO2, EtCO2, haemodynamic parameters of the patients just after the induction of anaesthesia, after the mask ventilation and, after 5 minutes of procedure were statistically not significant, (p>0.05). While at 10mins after the start of procedure, mean SpO2 in Group H was 98.05 % and in group N was 97.22%, this difference was statistically significant (P <0.05) Also, statistically

significant difference was noted in MAP in both the groups. Whereas at 15mins after the start of procedure, the increase in MAP & HR; and the drop in oxygen saturation in group N was statistically significant (P <0.05). At 20mins after the start of procedure, the changes in heart rate and oxygen saturation in between the groups was statistically significant (P <0.05). At 25mins after the start of procedure, the drop in oxygen saturation between the groups was statistically significant (P <0.05), (Table 1).

Table 1: Post induction parameters

Parameters		H group	N group	P value
After induction (T1)	HR	80.53±10.66	80.24±7.74	0.46
	MAP	81.22±9.24	81±5.46	0.43
	SpO2	99.48±0.72	99.55±0.72	0.33
	EtCO2	38.71±3.03	38.73±2.26	0.48
After mask ventilation	HR	82.33±5.70	82.53±7.19	0.44
	MAP	82.42±5.87	81.62±7.10	0.28
	SpO2	100.0±0.00	100.0±0.00	0.5
	EtCO2	35.6±1.67	36.2±2.81	0.11
After 5 minutes (T3a)	HR	82.58±5.61	82.62±7.20	0.48
	MAP	82.53±4.65	83.97±5.91	0.1
	SpO2	99.8±0.69	99.84±0.42	0.35
After 10 mins (T3b)	HR	84.40±5.26	86.04±6.46	0.094
	MAP	84.53±4.00	86.67±4.80	0.012*
	SpO2	98.05±1.70	97.22±1.89	0.0032*
After 15 mins (T3c)	HR	87.67±4.15	89.96±8.22	0.049*
	MAP	88.49±3.19	89.98±3.41	0.017
	SpO2	97.49±2.56	95.78±2.97	0.002
After 20 mins (T3d)	HR	96.10±3.39	92.79±5.89	0.0015
	MAP	91.10±4.17	91.37±3.29	0.37
	SpO2	96.30±2.24	94.34±1.65	0.000019
After 25 mins (T3e)	HR	96.11±2.58	97.47±3.79	0.1
	MAP	91.26±4.16	91.32±4.67	0.48
	SpO2	97.11±2.56	94.95±2.32	0.0049

There was no significant difference in the mean total apnoea time and apnoea cycles between the 2 groups owing to the cut off criteria of 6minutes, this being the limitation of our study, (Table 2).

Table 2: Mean apnoea time and number of apnoea cycles

Parameters	H group	N group	P value
Apnoea time	7.33±2.78	6.87±2.88	0.770
Number of apnoea cycles	1.49±0.63	1.60±0.75	0.753

Table 3 shows various parameters between both the groups at the end of procedure.

The mean pH in group H was 7.33 and in group N was 7.32 (P= 0.02), mean PaCO2 in group H was 43 in group N (P <0.00001), etCO2 values in group H was 39 and 46.73 in group N (P <0.0001), The mean SpO2 in group H was 99 and in group N was 98.97 (P= 0.0285) before intubation between the groups. All the values were statistically significant (P <0.05).

Table 3: Parameters at the end of the procedure

Parameters		H group	N group	P value
Apnoea time		7.0±2.78	6.86±2.88	0.22
Number of apnoea cycles		1.0±0.63	1.60±0.75	0.2
Before intubation	pH	7.33±0.04	7.32±0.04	0.028
	PaCO2	43±3.44	47.06±2.19	<0.00001
	PaO2	258±45.06	245.41±40.60	0.083
	HR	90±4.63	94±6.24	0.0014
	MAP	88±3.97	91±3.93	0.0065
	SpO2	99±0.99	98.97±1.29	0.028
	EtCO2	39±1.86	46.73±2.35	<0.00001
Before extubation	HR	91±2.86	91.08±5.04	0.408
	MAP	89±3.36	90±3.11	0.015

	SpO2	100±0.00	100±0.00	0.5
	EtCO2	35.8±2.16	36.04±2.78	0.32

Discussion

This study compared the effectiveness of THRIVE (70 L/min) versus apneic oxygenation using nasal cannula at 15 L/min in short bronchoscopy procedures.

The primary aim was to assess the effectiveness of THRIVE during apneic oxygenation for short bronchoscopy procedures and compare it with conventional oxygen supplementation method. The secondary aim was to compare perioperative end tidal CO2 changes, hemodynamic changes and to note down complications, if any.

Conventional use of nasal cannula is associated with the use of dry or poorly humidified medical gas which may elicit patient complaints such as dry nose, dry throat, and nasal pain and also increase in airway resistance to protect the lungs from dry or cold inspired air by reducing the air flow in the upper airways and trachea. Also breathing dry air is known to reduce nasal mucociliary clearance. [20-22] in the present study we have used oxygen insufflation technique with intermittent mask ventilation as and when the patient demanded as per clinical condition. The oxygen supplementation within apnoea period was done by either conventional nasal cannula or THRIVE. With the use of THRIVE, conditioning of the gas minimizes airway constriction, reduces the work of breathing (WOB), improves mucociliary function and is associated with less atelectasis, resulting in a good ventilation/ perfusion ration and better oxygenation.

Many previous studies have shown prolonged apnoeic periods (>12 minutes) using THRIVE without much desaturation [3-7,16,23] but hypercarbia and its side effects mainly on the myocardium have always been a pressing concern during the apnoeic periods. [15,16] In the present study, the apnoea time period cut-off was kept at 6 minutes due to unavailability of transcutaneous CCO2 monitoring, remote location of ABG machine & cardiac catheterization lab in our hospital. This was as per our hospital protocol keeping in mind patient's safety as a priority. We conducted a prospective, observational clinical study in 90 patients who underwent bronchoscopy to assess the effectiveness of THRIVE during apneic oxygenation for short bronchoscopy procedures and compared it with nasal oxygen supplementation method. Demographic data were comparable in the two groups with respective to age, sex, ASA grade and procedure performed.

In our study, we found no significant difference in the apnoea time between the two groups, Group H vs. Group N (420.00 ± 166.00 vs. 408.00 ± 168.00 s, P = 0.22). In group H, at 5mins of apnoea, one patient had drop in oxygen saturation to 90%, while others continued to have SPO2 >95%. In group N, one patient had SPO2 <90% at 3 mins of apnoea and other at 5 mins of apnoea time. However, the drop in SPO2 in group H was more gradual as compared to group N.

At the end of procedure on intubation PaO2 was higher in Group H but not statistically significant (258.00±45.06 vs. 245.41±40.60, P=0.083), however PaCO2- Group H vs. Group N (43.00±3.44 vs. 47.06±2.19) was showing statistically significant difference (P<0.00001). So, there was statistically significant difference in PaCO2 between the groups.

Baseline haemodynamic variables were comparable in both groups. There was an increase in HR, MAP from baseline in both groups during apnoea which was not significant for most of periods of apnoea however statistically significant difference noted at the end of procedure between the groups with Group N showing mean HR (94 ± 6.24) and group H with mean HR was (90 ± 4.63) (P=0.0014) .Also MAP in Group H was (88 ± 3.97) and in group N was (91±3.93) which was statistically significant (P=0.0065). So, in current study THRIVE was found to be more efficacious than conventional oxygen supplementation in prolonging desaturation to <90% and reducing the incidence of hypercarbia. Similar results found by Rajan S et al [5] during apneic periods, where in time to desaturate to <90% was significantly prolonged with use of THRIVE. However, Rajan et al noted statistically significant difference in PaCO2 (69.46 ± 7.15 vs. 59.00 ± 4.64) and PaO2 ((295.20 ± 122.26 vs. 135.00 ± 116.78) in both groups at the end of procedure, this was in contrast to our study where PaCO2 was higher in conventional group than in THRIVE group (43.00±3.44 vs. 47.06±2.19). This may be because apnoea time duration was more in their study (12min vs 6 min) as compared to our study.

Doyle AJ et al [14] conducted a prospective, observational study where The THRIVE protocol was introduced to the CCU, OR and ED as part of routine care for patients at high risk of hypoxia during intubation. The THRIVE protocol consisted of pre-oxygenation for 3 minutes using a simplified Optiflow system. The study demonstrated that pre-oxygenation and apneic oxygenation using THRIVE was associated with a low incidence of desaturation during emergency intubation of patients at high risk of hypoxia emphasizing THRIVE has the potential to minimize the risk of hypoxia in these patient groups. Also, it was found

that THRIVE with flows of 70 L/min maintained better oxygen saturation than conventional nasal oxygenation with flows of 15 L/min in ASA grade I and II patients. Similar study was done by Patel et al [16] in which 25 adult patients undergoing laryngeal surgeries received HFNO with O2 flow 70lit/min during apnoea time. They found average apnoea time of 17 minutes (commencing from use of muscle relaxant till positive pressure ventilation started). No patient experienced arterial desaturation < 90%. Mean (SD [range]) post-apnoea end-tidal (and in four patients, arterial) carbon dioxide level was 7.8 (2.4 [4.9-15.3]) kPa. They concluded using THRIVE, the drop in oxygen saturation was delayed and occurrence of hypercarbia was prevented by the flushing off CO2 via the high flows in THRIVE. Similarly, in our study use of THRIVE was found to be more efficacious than conventional oxygen supplementation in prolonging desaturation to <90% and reducing the incidence of hypercarbia but apnoea time was limited to 6 minutes duration with repeat apnoea cycle. Our study has few limitations. Apnoea time was limited for 6 minutes duration due to unavailability of transcutaneous CO2 monitoring. The study outcome can be improved by further studies with large sample size and prolonged apnoea time beyond 6 minutes with continuous perioperative transcutaneous CO2 monitoring.

Conclusions

So, it can be concluded from present study that oxygen supplementation for short bronchoscopy procedures during apnoeic oxygenation with THRIVE and nasal cannula were equally effective in maintaining oxygenation till six minutes of apnoea time, but PaCO2 values were seen higher in conventional nasal oxygen supplementation as compared to THRIVE at the end of procedure and the difference was statistically significant.

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