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Original Research Article

A Prospective Observational Study of Use of High Flow Nasal Cannula for Airway Assessment Cases

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Conflict of interest: Nil

Abstract

Aims: To study the number of cases maintaining saturation (SpO_2) more than 90% during airway assessment. The median duration of saturation maintained > 90% during each case. Number of episodes of desaturation < 90% in each cases and any adverse events noted.

Methods: This study was Prospective observational study conducted in the ENT operation theatre in a tertiary care hospital over a period of one year. All the patients had received 30 Litres/minutes of oxygen with Airvo2 as high flow nasal oxygenanation method (Fisher and Paykel Company). After attaching monitors and premedication fraction of inspired oxygen (Fio2) was gradually increased to 100%. Anesthesia was maintained with propofol (2.0 – 4 mg /kg /min) and ketamine (0.1 – 0.5 mg/min) IV continues infusion. In our study single dose of Inj. Succunylcholine was given in all the patients. Parameters like pulse, NIBP, ECG and SpO_2 were monitored throughout the procedure. The total duration of SPO2 maintained above 90% was noted in all the patients.Number of times SpO_2 going below 90% was noted in each patient.

Results: The 45 Patients were included in this study with fulfilling the criteria. In our study total duration of surgery was between 10-15 minutes in 25(55.56%) patient followed by 16-20 minutes in 20 (44.44%) patients. The mean duration of surgery was 15.31±1.20 minutes. In our study, duration of anesthesia was between 16-20 minutes in 25(55.56%) patients followed by 21 to 26 minutes in 20 (44.44%) patients. The mean duration of anesthesia was 22+-2.5 minutes. In our study the Majority 35(77.78%) had apnea time between 10-15 minutes followed by 10(22.22%) cases with apnea time between16-20 minutes. Mean apnea time was 14.64±1.51 minutes. The confidence interval of apnea time in study subjects ranged between 14.199 – 15.081 minutes. Inter Quartile range (IQR) of apnea time IQR = (15 -14 minutes).The confidence interval of the total duration of Sp02 >90% in study subjects ranged between 14.199 – 15.081 minutes. Our results are consistent with studies showing the benefits of HFNC in maintaining saturation above 90% in various other clinical scenarios.

Conclusion: So we conclude that HFNC provides optimal working space to the surgeons and avoids desaturation and interferences with bag and mask ventilation without any adverse event up to apnea time of 14.64±1.51minutes and short-duration laryngeal and tracheal surgeries are possible without the need of endotracheal tube for oxygenation with use of HFNC.

Keywords: HFNC, Apnea time, Desaturation, Laryngeal tacheak surgery.

Introduction

Airway assessment surgery is performed in ENT Operation Theater for visual assessment of airway by an endoscope (bronchoscope) for diagnostic and therapeutic management of pathological conditions in the airway and for future course of management. Surgery of the upper airway requires diagnostic or therapeutic manipulation of the respiratory tree despite ongoing ventilation [1,2]. The rigid bronchoscope is used for diagnosis of lesions in the respiratory tract down to the main bronchus and therapeutic interventions such as dilation of tracheal stenosis, airway tumor resection and foreign body removal [2,3].

Surgical cases where the anesthesiologist has to maintain a patient's airway and ventilation in the same anatomical space in which the surgeon operates are referred to as shared airway anesthesia. Teamwork is an essential element of peri operative care. These cases require open communication and careful planning between anesthesiologist and surgeon to prevent catastrophic complications [3]. The first step in minimizing complications in shared airway anesthesia is a preoperative assessment with particular emphasis on airway examination. Different techniques of anesthesia are used like (1) monitored anesthesia care (2) mask ventilation (3) insufflations with a catheter with spontaneous respiration (4) jet ventilation and (5) laryngeal mask airway4. Complications that can lead to a respiratory compromise in the perioperative period include failed intubation, loss of airway due to laryngospasm or foreign body aspiration, surgical fire and cardiac arrest [4,5].

Several ventilation strategies are commonly used during airway assessment cases to provide adequate oxygenation and ventilation while maintaining appropriate sedation to minimize cough and movement and ensure patient and surgeons comfort. So any of the above mentioned strategies can be utilized as per availability of equipments, familiarity of each equipment and need for early recovery from anesthesia [6]. Alternative techniques to provide an unimpeded surgical field include jet ventilation (with attendant risks that include barotraumas) apneic ventilation and repeated intubations (with the potential for hypoxia from intermittent apnea and airway injury) and spontaneous respiration without tracheal intubation [7,8].

High- flow nasal oxygen cannula (HFNC) facilitates oxygenation and ventilation of both the spontaneously breathing and apneic patient. High- flow nasal oxygen came to prominence in anesthesia when it was shown to prolong the time to oxygen desaturation in patients with a difficult airway. A recent trial demonstrated equivalent blood gas profiles at the time of tracheal intubation for rapid sequence induction techniques using HFNC and facemask pre-oxygenation. We regard high-flow apneic oxygenation as a flow rate above 15 l/min. The use of High Flow Nasal Oxygen Cannula under total intravenous anesthesia (TIVA) for airway assessment surgeries has been proven beneficial to maintain oxygenation [9]. Use of HFNC maintains oxygenation and causes minimal interference during rigid bronchoscopy [10]. So we planned this study to know whether HFNC will be useful during rigid bronchoscopy for airway assessment cases for maintenance of oxygenation and to know the maximum apnea time achieved with it.

Materials & Method

Study design: Prospective observational study

Methodology

This study was conducted in the ENT operation theatre in a tertiary care hospital over a period of one year. After clearence from ethics commite assessment and enrollment of study subjects was done. Written informed consent was taken from all the patients. Patients fulfilling the

inclusion criteria were included in the study. Preoperative, Intraoperative and Postoperative records of all patients undergoing the airway assessment cases were collected and analyzed. The data collected was kept confidential.

Inclusion Criteria

1. Age group 18 – 65 year old.
2. Up to ASA-II status of patients
3. Patients posted for airway assessment
4. Pre-operative saturation above 98% on room air.

Exclusion Criteria

1. Patient refusal to participate in the study
2. Patients with ASA – iii status and above
3. Preexisting SpO_2 below 98% due to respiratory illness
4. Pts with BMI> 30%
5. Pts with sleep apnea

Adverse Event

Arrhythmias, ECG changes like myocardial ischemia and any other adverse events were noted

After written informed consent patients were taken inside the operation theatre. All patient's airway were topicalized with 4% lignocaine (40 mg) nebulization before the procedure.Inside the operation theatre standard monitors like ECG, NIBP, SpO_2 were attached. Baseline parameters were noted.

All the patients had received 30 Litres/minute of oxygen with Airvo2 as high flow nasal oxygenanation method (Fisher and Paykel Company). After attaching monitors and premedication fraction of inspired oxygen (Fio2) was gradually increased to 100%. Inj fentanyl 2mcg/kg was given as premedication in all the patients. Patients were induced with Inj propofol 2mg/kg, Inj ketamine 2mg/kg IV in titrated doses. HFNC rate was increased to 60 Litres/minutes and Fio2 was maintained at 100%. Anesthesia was maintained with propofol (2.0 – 4 mg /kg /min) and ketamine (0.1 – 0.5 mg/min) IV continues infusion. Surgeons were allowed to do airway assessment once the depth of anesthesia was achieved. Succinylcholine 2 mg/kg was given to patients if surgeon requested for same. In our study single dose of Inj. Succunylcholine was given in all the patients. Once patients were out of muscle relaxation spontaneous mode of respiration was maintained throughout the procedure.

Parameters like pulse, NIBP, ECG and SpO_2 were monitored throughout the procedure. The total duration of SpO_2 maintained above 90% was noted in all the patients. Number of times SpO_2 going below 90% was noted in each patient. If Saturation was going below 90% was treated as taking over for mask ventilation and the surgeon was requested to take out endoscope and assisted ventilation was started with a closed-circuit. Time taken to increase saturation to 98% was noted and then the surgeon was allowed to proceed for airway assessment. Events like hypoventilation need for endotracheal intubation were noted. Adverse events like arrhythmias, myocardial ischemia were noted.

1. The time duration of saturation maintained above 90% was noted for each case.
2. The number of times the fall of SpO_2 in each case was noted.
3. The number of Time mask Ventilation needed per case was noted
4. Total duration of airway assessment procedure was noted in minutes.
5. Total Duration of Anesthesia was noted in minutes.

Data Collection Procedure

Patients admitted as an inpatient for airway assessment in ENT department of tertiary care hospital.

Study duration: Study period was for 12 months after Ethics committee approval.

Sample size calculation

The primary objective of the study is to assess the proportion of patients maintaining SpO_2 more than 90% during bronchoscopy.

In a study by Booth *et al* desaturation below SpO_2 90% was noted in 4 out of 30 patients in patients with high flow nasal oxygen group during bronchoscopy, thus 26 out of 30 (86.7%) maintained SpO_2 above 90%. Using the formula for sample size calculation for prevalence studies,

Sample size = z2 p (1-p) /d2

Where, z = 1.96 for 95% Confidence interval p= prevalence = 0.867 1-p = 1-0.867 = 0.133 d= precision error 10% = 0.1

Thus, Sample size = (1.96 x 1.96) x 0.867 x 0.133 / 0.1 x 0.1

Sample size = 44.3 = 45 (rounded off) Thus, for the study, we need to enroll at least 45 cases

Statistical Analysis

- Data from the case record forms were entered in a Microsoft excel sheet and analyzed using SPSS version 21 software.
- Descriptive statistics were described as Mean+SD, frequencies or percentages.
- Quantitative data were compared using the unpaired t-test for normally distributed data.
- Proportions were compared using the Chi-square test

The level of significance in the study will be considered at a value of < 0.05.

Odds ratio with 95% confidence interval and p-value were computed to determine the strength of the association. A p-value.

Observation and Results

Table 1: Distribution of study subjects according to age

Age group(in years)	Number	Percentage
18-20	17	37.77
21-30	16	35.55
31-40	09	20.00
41-50	02	4.44
51-60	00	00
>60	01	2.22
Total	45	100
Mean± SD	26.24±9.33	
Range(in years)	18-62	

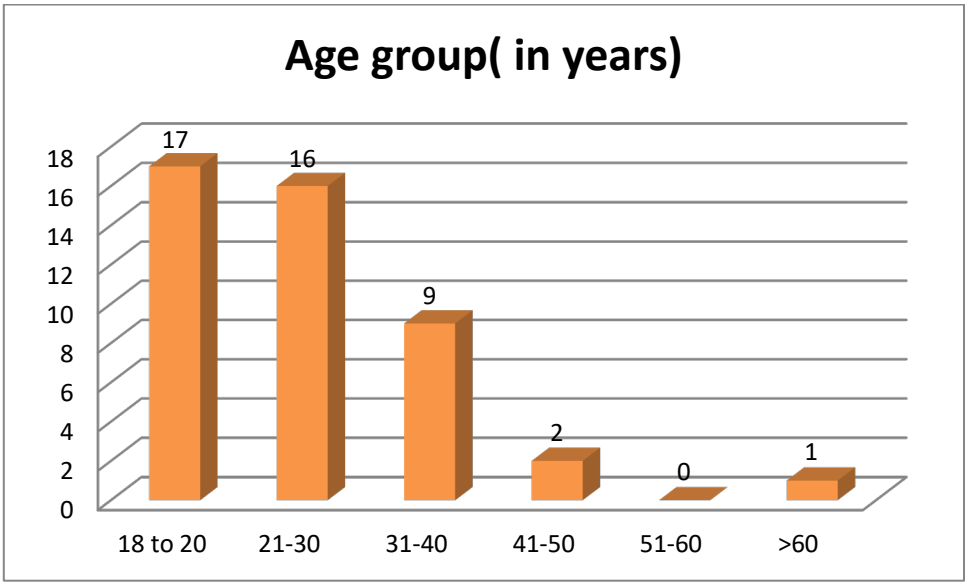

Figure 1: Distribution of study subjects according to age

Table no-1 shows distribution of study subjects according to age. Majority 17 (37.77%) of study subjects were in age group of 18-20 years followed by 16 (35.55%) subjects in age group of 21-30 years and 09 (20%) were in age group of 31-40 years. Mean age was 26.24±9.33years ranging between 18-62 years.

Table 2: Distribution of study subjects according to gender

Gender	Number	Percentage
Male	30	66.67
Female	15	33.33
Total	45	100

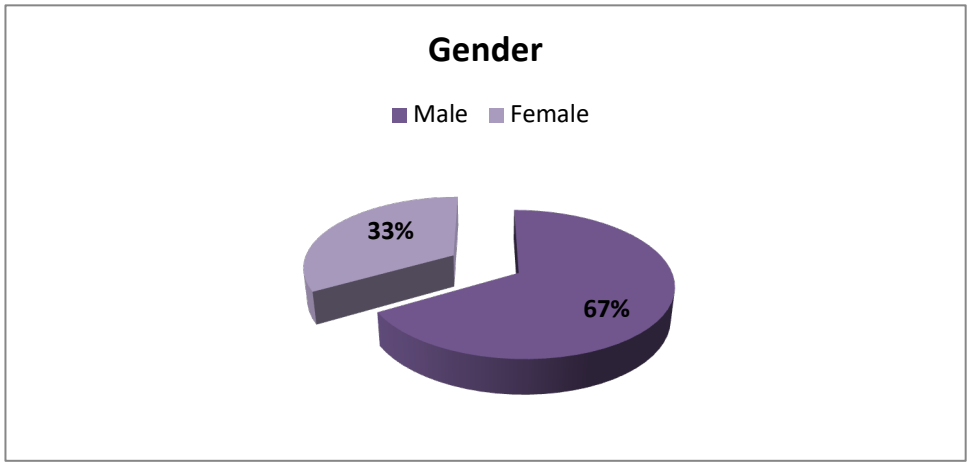

Figure 2: Distribution of study subjects according to gender

Table no. 2 shows distribution of study subjects according to gender. Majority 30 (66.67%) of study subjects were males and rest 15 (33.33%) were females.

Table 3: Distribution of study subjects according to ASA status

ASA status	Number	Percentage
One	40	88.89
Two	05	11.11
Total	45	100

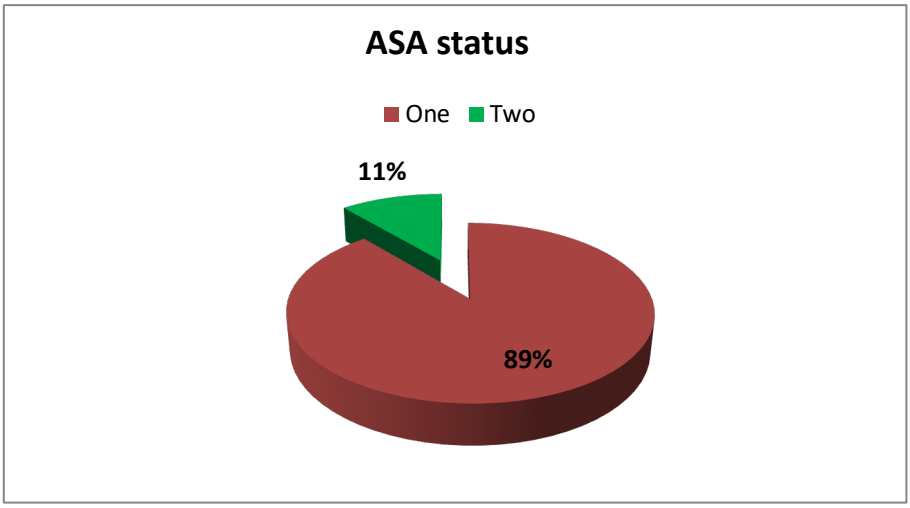

Figure 3: Distribution of study subjects according to ASA status

Table no. 3 shows distribution of study subjects according to ASA status. Maximum 40 (88.89%) cases had ASA status as one followed by 05 (11.11%) cases with ASA status of two.

Table 4: Distribution of study subjects according to total apnea time in minutes

Apnea time	Number	Percentage
10-15 minutes	35	77.78
16-20 minutes	10	22.22
Total	45	100
Mean apneatime(in minutes)	14.64±1.51	

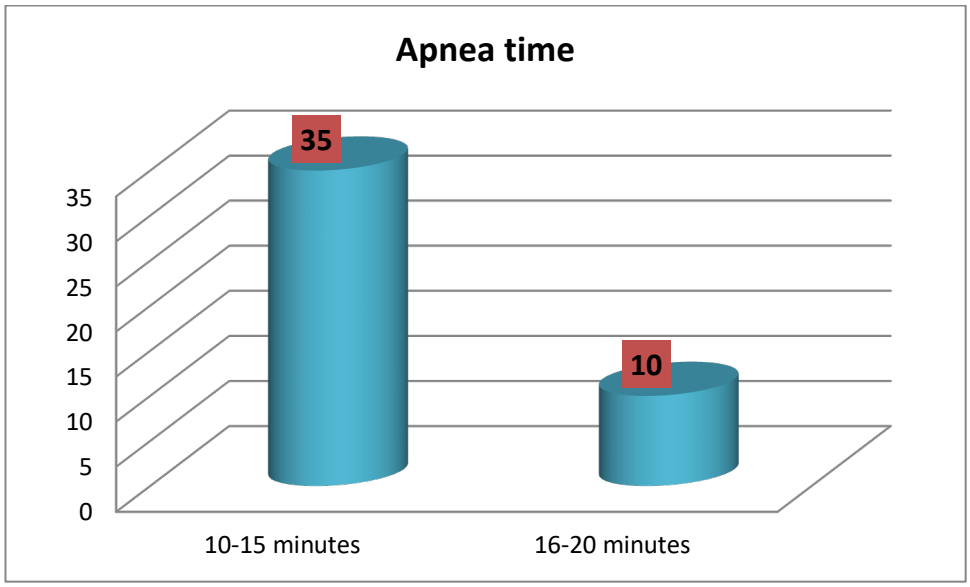

Figure 4: Distribution of study subjects according to total apnea time in minutes

Table no. 4 shows distribution of study subjects according to total apnea time in minutes. Majority 35 (77.78%) had apnea time between 10-15 minutes followed by 10 (22.22%) cases with apnea time between 16-20 minutes. Mean apnea time was 14.64±1.51 minutes.

Inter Quartile ranage (IQR) of apnea time

First Quartile Q1- 14 minutes

Second Quartile – 15 minutes

Third Quartile – 15 minutes

Median - 15 min

Inter Quartile ranage IQR = Q3 –Q1=15 -14= 1 min

Numbers	Min	Q1	Median	Q3	Max	Mean	SD	Group
45	0	14	15	15	16	14.32	2.44	Group1

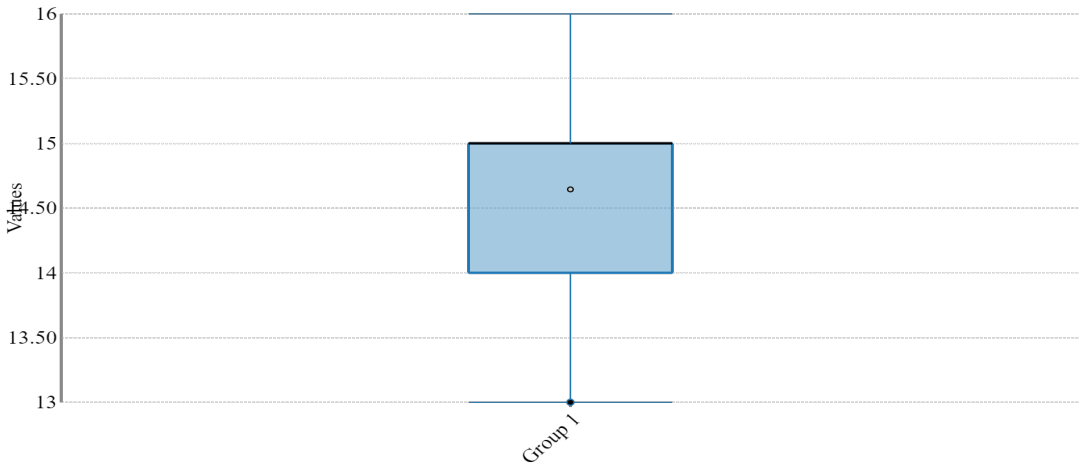

Figure 5

Table 5: Confidence interval of apnea time in study subjects

Apnea time	Confidence interval(in minutes)
	14.199 – 15.081 minutes

Table no. 5 shows confidence interval of apnea time in study subjects. It ranged between 14.199 – 15.081 minutes

Table 6: Confidence interval of total duration of Sp02 >90% in study subjects

Total duration of Sp02 >90%	Confidence interval(in minutes)
	14.199 – 15.081

Table no. 6 shows confidence interval of total duration of SpO_2 >90% in study subjects .It ranged between 14.199 – 15.081 minutes

Table 7: Distribution of study subjects according to total duration of SpO_2 >90% and apnea time

Apnea time	Total duration of SpO_2>90% (in minutes)				P value
	13 minutes N (%)	14 minutes N (%)	15 minutes N (%)	16 minutes N (%)	
10-15 minutes	02(100)	12(100)	16(100)	05(33.33)	0.02*
16-20 minutes	00(00)	00(00)	00(00)	10(66.67)	
Total	02(100)	12(100)	16(100)	15(100)	

*statistically significant

Table no.7 shows distribution of study subjects according to total duration of SpO_2>90% and apnea time. When chi square was used to see the association between apnea time and total duration of SpO_2 >90%, it was found to be statistically significant (p value=0.02).

Table 8: Distribution of study subjects requiring bag and mask ventilation

Bag and mask ventilation	Number	Percentage
Yes	01	2.22
No	44	97.78
Total	45	100

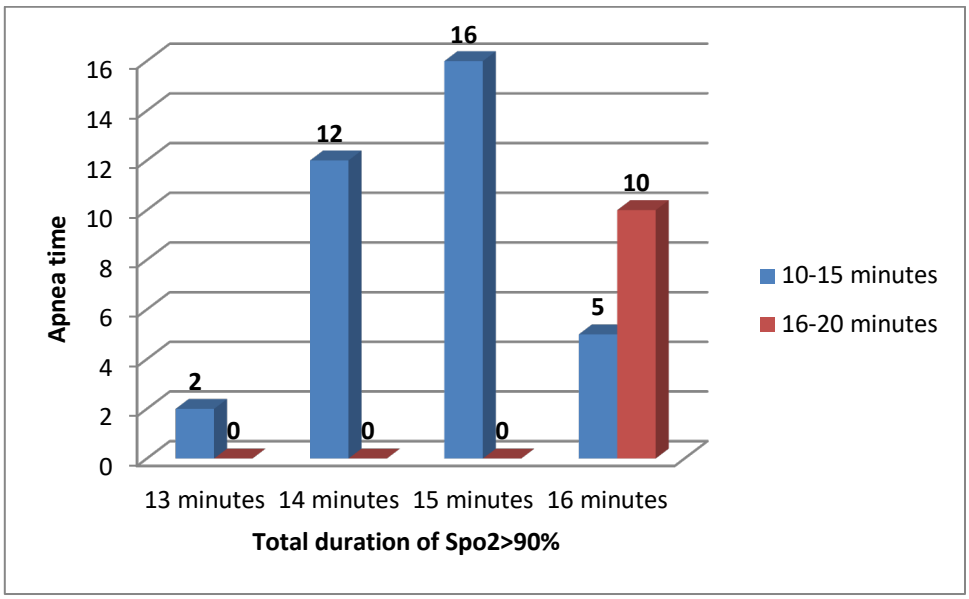

Figure 6: Distribution of study subjects according to total duration of SpO_2 >90% and apnea time

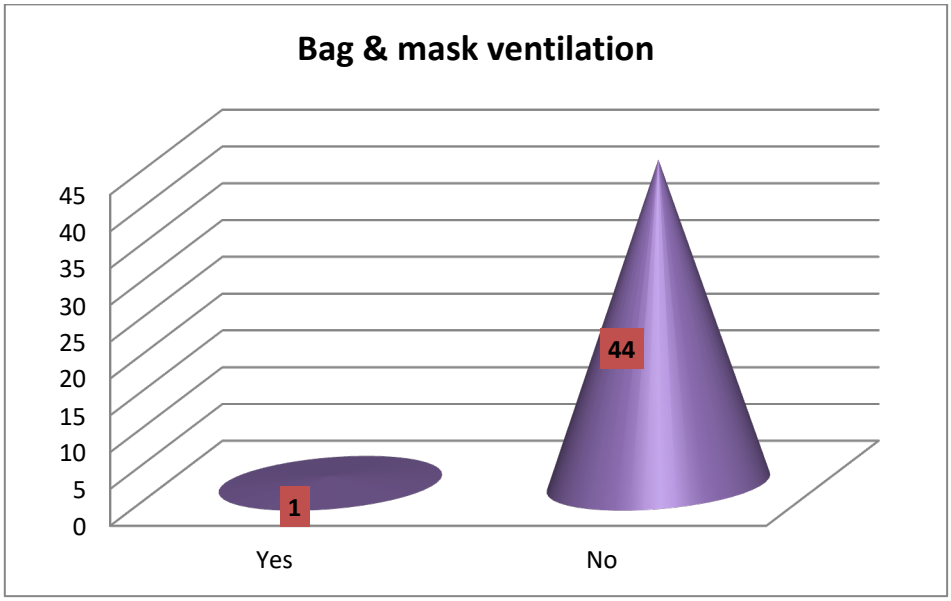

Figure 7: Distribution of study subjects requiring bag+mask ventilation

Table no. 8 shows distribution of study subjects requiring bag+mask ventilation. Out of 45 cases, only one patient (2.22%) required bag+mask ventilation.

Table 9: Distribution of study subjects according to duration of bag+mask ventilation used

Duration of Bag +mask ventilation	Number	Percentage
≤ 2 minutes	01	2.22
>2 minutes	44	97.78
Total	45	100

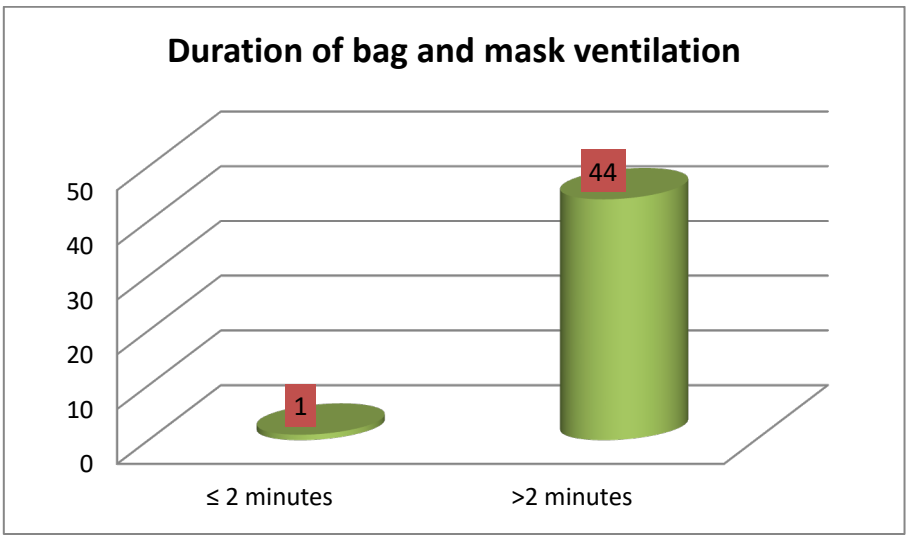

Figure 8: Distribution of study subjects according to duration of bag+mask ventilation used

Table no. 9 shows distribution of study subjects according to duration of bag+mask ventilation used. Maximum 44 (88.89%) did not required bag+mask ventilation >2 minutes.

Table 10: Distribution of study subjects according to total duration of airway assessment in minutes

Duration of airway assessment (in minutes)	Number	Percentage
10-15 minutes	25	55.56
16-20 minutes	20	44.44
Total	45	100

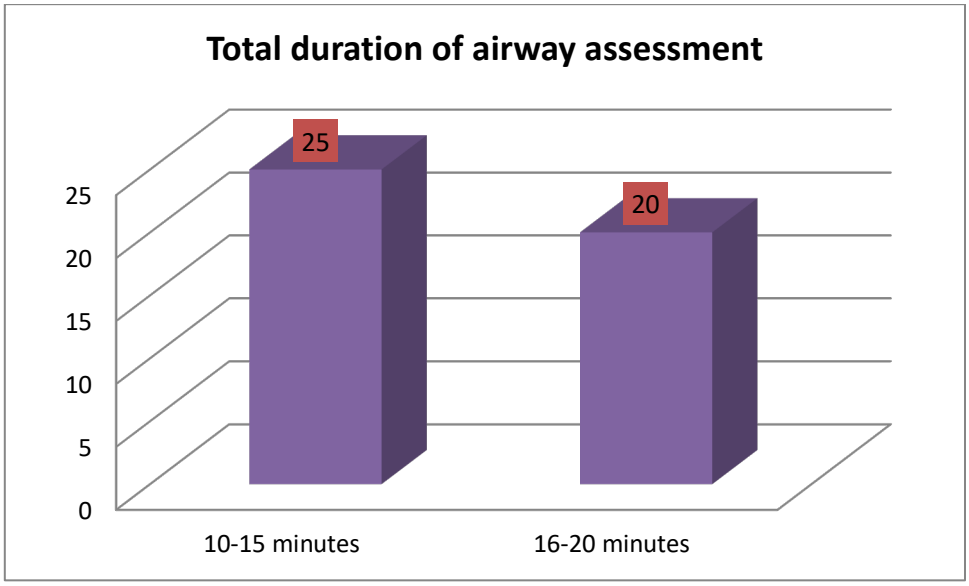

Figure 9: Distribution of study subjects according to total duration of airway assessment in minutes

Table no. 10 shows distribution of study subjects according to total duration of airway assessment in minutes. Majority 25 (55.56%) had total duration of airway assessment between 10-15 minutes followed by 20 (44.44%) cases with total duration of airway assessment between 16-20 minutes.

Table 11: Distribution of study subjects according to duration of surgery

Duration of surgery (in minutes)	Number	Percentage
10-15	25	55.56
16-20	20	44.44
Total	45	100
Mean duration of surgery (in minutes)	15.31±1.20	

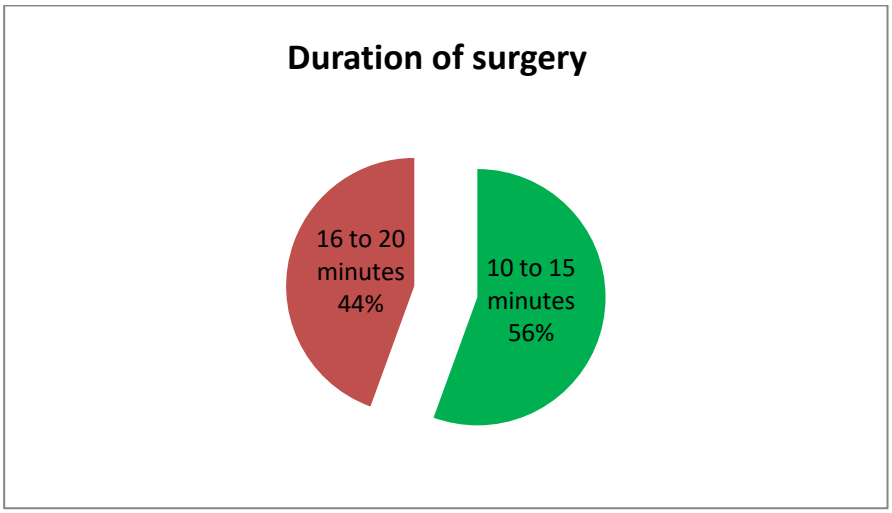

Figure 10: Distribution of study subjects according to duration of surgery

Table no. 11 shows distribution of study subjects according to duration of surgery. Majority 25 (55.56%) were operated between 10-15 minutes followed by 20 (44.44%) cases which were operated between 16-20 minutes. Mean duration of surgery was 15.31±1.20 minutes.

Table 12: Distribution of study subjects according to duration of surgery and apnea time

Duration of surgery	Apnea time		P value
	10-15 Minutes n(%)	16-20 Minutes n(%)	
10-15 minutes	20(57.14)	05(50.00)	0.96
16-20 minutes	15(42.86)	05(50.00)	
Total	35(100)	10(100)	

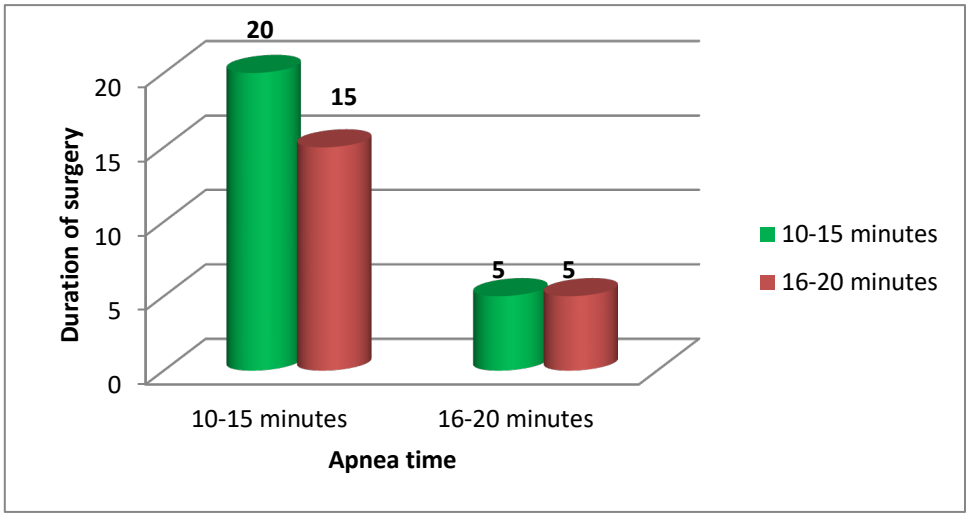

Figure 11

Table no. 12 shows distribution of study subjects according to duration of surgery and apnea time. When chi square was used to see the association between apnea time and duration of surgery, it was found not to be statistically significant.(p value=0.96).

Table 13: Distribution of study subjects according to total duration of anesthesia in minutes

Duration of anesthesia (in minutes)	Number	Percentage
16-20 minutes	25	55.56
21-26 minutes	20	44.44
Total	45	100

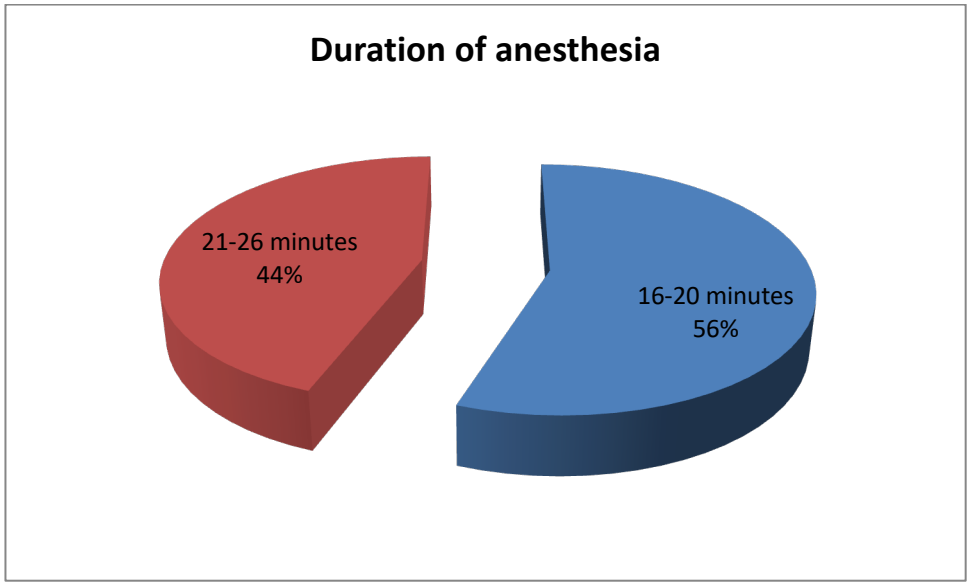

Figure 12: Distribution of study subjects according to total duration of anesthesia in minutes

Table 13 shows distribution of study subjects according to total duration of anesthesia in minutes. Majority 25 (55.56%) had duration of anesthesia between 16-20 minutes followed by 20 (44.44%) cases with duration of anesthesia between 21-26 minutes.

Discussion

All airway assessments i.e. tubeless airway surgery (rigid bronchoscopies) is difficult airway due to shared airway and its concern. Management of airway during airway assessment cases (rigid bronchoscopy) is often considered challenging which requires a constant effort to avoid desaturation and subsequent interruption during the procedure [11,12-28]. We had included adult patient undergoing airway assessment surgery in the ENT operation theatre and were posted for visual assessment of airway by rigid bronchoscope for pathological conditions in the airway and for future course of management. All patients had received 30 Liters/minute of oxygen with Airvo2 (Fisher and paykel company) as preoxygenation and a fraction of inspired oxygen (Fio2) 100% was given for 5 minutes. After induction HFNC rate was increased to 60Litres /minute. Surgeons were allowed to do airway assessment and any adverse events were noted.

In our study the total number of patients were 45 adults and the majority 17(37.77%) of study subjects were in the age group of 18-20 years followed by 16(35.55%) subjects in the age group of 21-30 years and 09 (20%) were in the age group of 31-40 years. Mean age was 26.24±9.33years ranging between 18-62 year. In our study, the Majority

30(66.67%) of the study subjects were males and rest 15(33.33%) were females. In our study most 40(88.89%) patients belonged to ASA status one followed by 05(11.11%) patients with ASA status two.

In our study total duration of surgery was between 10-15 minutes in 25(55.56%) patient followed by 16-20 minutes in 20 (44.44%) patients. The mean duration of surgery was 15.31±1.20 minutes. In our study, duration of anesthesia was between 16-20 minutes in 25(55.56%) patients followed by 21 to 26 minutes in 20 (44.44%) patients. The mean duration of anesthesia was 22+-2.5 minutes. In our study the Majority 35(77.78%) had apnea time between 10-15 minutes followed by 10(22.22%) cases with apnea time between16-20 minutes. Mean apnea time was 14.64±1.51 minutes. The confidence interval of apnea time in study subjects ranged between 14.199 – 15.081 minutes. Inter Quartile range (IQR) of apnea time IQR = (15 -14 minutes).

The confidence interval of the total duration of Sp02 >90% in study subjects ranged between 14.199 – 15.081 minutes. Our results are consistent with studies showing the benefits of HFNC in maintaining saturation above 90% in various other clinical scenarios.

We found the use of HFNC beneficial in extending apnoea time in our patients with difficult airways undergoing airway assessments with rigid bronchoscopy. There was only one patient who had desaturation below 90% for two minutes and picked up after 2 minutes with bag mask ventilation. Mean apnoea time of 14.64±1.51 minutes was found and no patients developed any major cardiac event or other adverse events suggestive of carbon dioxide toxicity.

When chi-square test was used to see the association between apnea time and the total duration of SpO_2 >90%, it was found to be statistically significant (p value=0.02).

When chi-square test was used to see the association between apnea time and duration of surgery, it was found not to be statistically significant (p value=0.96).

Patel and Nouraei *et al* (2015) [11] did a case series with 25 adult patients, who were posted for laryngotracheal stenosis, vocal fold pathology and obstructive sleep apnea, and benign and malignant hypopharyngeal obstruction. The Mean age group included 49±15 years. The ASA status was between I to IV, and the mean BMI was 30 (23 - 36) which was comparable to our study population. THRIVE (transnasal humidified rapid-insufflation ventilatory exchange) was used for Preoxygenation: HFNO(high flow nasal oxygen cannula) at 50 L/min with FiO2 of 1.0 was started for 10 min then, was increased to 70 L/min with FiO2 of 1.0. Neuromuscular relaxation with inj Rocuronium 0.5 mg/ kg was utilized. The apnea time was IQR range - 14 (9–19) [5–65] minute was acheived. There was no desaturation below 90%, despite an average apnoea time of 17 min and none of the patients developed cardiac arrhythmias or cardiac arrest and carbon dioxide toxicity.

In our study total number of patients was 45. The mean age was 26.24±9.33years ranging between 18-62 years. Majority 30 of the patients were males, and the rest 15 were female out of 45 and were ASA I and II status. we had used Airvo2 as method of HNFC technique for preoxygenation with flow rate at 30litre/min for 5 minutes at Fio2 1.0. After induction flow rate was increased to 60 litr/min at fio2 1. Single dose of muscle relaxant Inj succinylcholine was given in all the patients. Mean apnea time was 14.64±1.51 minutes. The confidence interval of apnea time in our study subjects ranged between 14.199 – 15.081 minutes. Inter Quartile range IQR of apnea time IQR = (15 -14 = 1 minutes). There was only one patient who had desaturation below 90% for two minutes and picked up after 2 minutes with bag and mask ventilation. An average

apnoea time of 15 min and no patients developed any major cardiac event or other adverse events suggestive of carbon dioxide toxicity. When chi-square was used to see the association between apnea time and the total duration of SpO_2 >90%, it was found to be statistically significant. (p value=0.02).The mean duration of surgery was 15.31±1.20 minutes. The mean duration of anesthesia was 22+-2.5 minutes. The apena time was comparable in both the studies.

A retrospective observational study was conducted by Booth *et al*. (2017) [12], using Spontaneous respiration using Intravenous anesthesia and High-flow nasal oxygen (STRIVE Hi) technique to manage 30 adult patients undergoing elective laryngotrachealsurgery. Airway was topicalised with lignocaine 25 mg. Preoxygenation with 100% oxygen was done using the Optiflow nasal cannula at a rate of 30 liters/min for one min followed by 50 liters/min for two min in a 10–20 degrees reverse Trendelenburg position. Induction of anesthesia commenced using the propofol TCI. The Optiflow rate increased to 70 l min/1 when the loss of consciousness occurred during the induction of anesthesia and was maintained until the period of surgery and spontaneous ventilation was maintained. No neuromuscular relaxation was given. Twenty-six patients (87%) presented with significant airway and/or respiratory compromise (16 were stridor, 10 were dyspnoeic). No episodes of apnoea or complete airway obstruction occurred during theprocedure using STRIVE Hi. The median [IQR (range)] lowest oxygen saturation during the induction period was 100 [99–100 (97–100)] %. The median [IQR (range)] overall duration of spontaneous ventilation was 44 [40–49.5 (18–100)] min. The median [IQR (range)] end-tidal carbon dioxide (ETCO2) level at the end of the spontaneous ventilation period was 6.8 [6.4–7.1 (4.8–8.9)] kPa. The mean rate of increase in ETCO2 was 0.03 kPa min.

In our study we had used Airvo 2 technique for preoxygenation flow rate at 30litre/min for 5 minutes at fio2 1 then induction with Inj propofol fentanyl ketamine. Then flow rate increased to 60litr/min at fio2 1.Single dose of short acting muscle relaxant Inj succinylcholine was given and letter patients maintained on spontaneous ventilation. Mean apnea time was 14.64±1.51 minutes. The confidence interval of apnea time in study subjects ranged between 14.199 – 15.081 minutes. Inter Quartile range IQR of apnea time IQR = (15 -14 = 1minutes). There was only one patient who had desaturation below 90% for two minutes and picked up after 2 minutes with bag and mask ventilation. An average apnoea time of 15 min and none of the patients developed any major cardiac event. In our study chi-square test was used to see the association between apnea time and the total duration of Sp02 >90% and it was found to be statistically significant p value< 0.02 which is statistically significant in our study. The mean duration of surgery was 15.31±1.20 minutes. The mean duration of anesthesia was 22 ±3.5 minutes.

Lyons C, Callaghan *et al* 2017 [28] did a case series which included 28 adult patients, who were posted for surgeries like microlaryngoscopy with the intervention (excision of granuloma/polyp/retention cyst, papilloma, tumor debulking, cordotomy, biopsy, injection thyroplasty, rigid bronchoscopy, subglottic stenosis dilatation). The Mean age group included 49±15 years. The ASA status was between I to III, and the mean BMI was 24.8±4.5. THRIVE (transnasal humidified rapid-insufflation ventilatory exchange) was used for Preoxygenation: HFNO (high flow nasal oxygen cannula) at 80 L/min with FiO2 of 1.0 was started for 3 min then, the flow rate remains the same to 80 L/min with FiO2 of 1.0 Induction was done with Propofol, remifentanil and Rocuronium 1mg/ kg. The apnea time was median (IQR [range]) apnoea time was 19 (15–24 [9–37]) min. Four patients experienced an episode of oxygen

desaturation to a value between 85% and 90%, lasting less than 2 min in each case. Median (IQR [range]) end-tidal carbon dioxide (ETCO2) level following apnoea was 8.2 (7.2–9.4 [5.8–11.8]) kPa. The mean (SD) rate of ETCO2 increase was 0.17 (0.07) kPa.min−1 from an approximated baseline value of 5.00 kPa. Venous blood saturation) of 6.29 (0.71) kPa at baseline and 9.44 (1.12) kPa . After 15 min of apnoea complications like desaturation and intubation was needed . Another patient required increase flow rate from 80 to 120 L min−1 and one patient needed supraglottic airway insertion for maintainence of oxygenation. The median apnoea time was 19 min in this case series with a range of 9–37 min. In our study the apnea time was 15 minutes and only one patient needed mask ventilation for saturation below 90% which was picked up within 2 minutes and no patient had any other adverse events. Duration of surgery was 22 – 25 minutes and anesthesia time was 20 – 30 minutes saturation and apnea time total duration of SpO_2 >90%, it was found to be statistically significant.(p value=0.02).

Gustafsson *et al* (2017)) [13] did a case series with 30 adult patients, who were posted , 4 for microlaryngoscopy, 26 for microlaryngoscopy with biopsy. The Mean age group included 51±12.7 years. The ASA status was between I to II, and the mean BMI was BMI 25.1±3.5. THRIVE (transnasal humidified rapid-insufflation ventilatory exchange) was used for Preoxygenation: HFNO (high flow nasal oxygen cannula) at 40 L/min with FiO2 of 1.0 was started for 3 min then it was increased to 70 L/min with FiO2 of 1.0. Induction with propofol and remifenyl and neuromuscular relaxation with Inj Rocuronium 0.5 mg/ kg was used.The apnea time was (IQR) [range]: 22.5±4.5 minute, Procedure duration>40 min, $PaCO_2$>82.5 mmHg, lowest SpO_2 was 91%. In this study one patient had desaturation below 90% supraglottic jet ventilation was utilized for oxygenation.

In our study we had used Airvo 2 technique for preoxygenation with flow rate at 30 litre/min for 5 minutes at Fio2 1.0 for preoxygenation was used. Induction was done with Inj propofol and ketamine and then flow rate increase to 60 litr/min at Fio2 of 1 was continued .single dose of short acting muscle relaxant inj succinylcholine was used. Mean apnea time was 14.64±1.51 minutes. The confidence interval of apnea time in study subjects ranged between 14.199 – 15.081 minutes. Inter Quartile range IQR of apnea time IQR = (15 -14 minutes). There was only one patient who had desaturation below 90% for two minutes and picked up after 2 minutes with bag and mask ventilation. An average apnoea time of 15 min and none of the patients developed any major cardiac. When chi-square was used to see the association between apnea time and the total duration of SpO_2 >90%, it was found to be statistically significant.(p value=0.02).

To K, Harding *et al.* 2017 [19] did a case series of 17 adult patients, who were posted for subglottic stenosis dilatations. The Mean age group included was Mean 52 (range 20–74) years. The ASA status was between II to III, and the mean BMI was BMI 27 (range 20–36). THRIVE (transnasal humidified rapid-insufflation ventilatory exchange) was used for Preoxygenation: HFNO (high flow nasal oxygen cannula) at 50 L/min with FiO2 of 1.0 was started for 10 min then, was increased to 70 L/min with FiO2 of 1.0.Induction with propofol and remifentanil and no neuromuscular agent was used. The apnea time was (IQR) [range]: Median 18 (range 10–27) minute .ne patient required bag-mask ventilation then supraglottic airway was used in view of desaturation below 80 %.

In our study we had used Airvo2 and the mean apnea time was 15 minutes.For preoxygenation flow rate at 30litre/min for 5 minutes at fio2 1 then post induction flow rate increased to 60litr/min at fio2 1 . Mean apnea time was 14.64±1.51 minutes.

The confidence interval of apnea time in study subjects ranged between 14.199 – 15.081 minutes. Inter Quartile range IQR of apnea time IQR = (15 -14 minutes). There was only one patient who had desaturation below 90% for two minutes and picked up after 2 minutes with bag and mask ventilation. An average apnoea time of 15 min and none of the patients developed any major cardiac event or other adverse events suggestive of carbon dioxide toxicity.

Maupeu *et al.* 2018 [23] conducted a case series with 22 adult patients, who were posted for subglottic stenosis, glottic closure insufficiency papillomatoses, and mucosal lesions of the vocal fold. The Mean age was 49 (range 26–76) years. The ASA status was between I to III, and the mean BMI was 25 (range 18–35). THRIVE (transnasal humidified rapid-insufflation ventilatory exchange) was used for Preoxygenation: HFNO(high flow nasal oxygen cannula) at 30 L/min with FiO2 of 1.0 was started for 7 min then, was increased to 70 L/min with FiO2 of 1.0.induction with propofol and remifentanil and neuromuscular relaxation not used. The apnea time was (IQR) [range]: 27±11 minute. One patient had one episode of laryngospasm and desaturation below 90%.

In our study total number of patients was 45 adults. The mean age was 26.24±9.33years ranging between 18-62 years. Majority 30 of the 45 patients were males.40 patients belonged to ASA status I and 5 patients were with ASA status II. we had used Airvo 2 technique for preoxygenation flow rate at 30litre/min for 5 minutes at Fio 2 of 1.0. Induction was done with Inj propofol, ketamine and single dose of short acting muscle relaxant Inj succinylcholine was used. Flow rate increased to 60litre/min at Fio2 of 1.0. Mean apnea time was 14.64±1.51 minutes. The confidence interval of apnea time in study subjects ranged between 14.199 – 15.081 minutes. Inter Quartile range IQR of apnea time IQR = (15 -14 minutes). There was only one patient who had desaturation below 90% for two minutes and picked up saturation after 2 minutes with bag and mask ventilation.

Yang *et al*. (2018), [21] did a case series with 23 adult patients, who were posted for micro laryngoscopy with polyp/cyst excision micro laryngoscopy with biopsy. The Mean age was 52 (39.25–67) years. The ASA status was between II to III and the mean BMI was 25.8 (22.5–27.3). THRIVE (transnasal humidified rapid-insufflation ventilatory exchange) was used for Preoxygenation: HFNO(high flow nasal oxygen cannula) at 20 L/min with FiO2 of 1.0 was started for 5 min then was increased to 50 L/min with FiO2 of 1.0.induction with inj propofol, Midazolam, alfentanil and neuromuscular relaxation with Inj Cistracurium and succinylcholine for apnea was utilized. The apnea time was (IQR) [range]: 24.1±6.4 minute. The lowest SpO_2 was 72%. There were complication in 5 patients who required intubation in view of desaturation below 82%.and short-term mechanical ventilation was needed to regain SpO_2 to 100%. No significant complication was noted in all patients.

In our study total number of patients was 45 adults. The mean age were 26.24±9.33 years ranging between 18-62 years. Majority 30 of the 45 patients were males and the rest 15 were female. ASA status was I and II. We had used Airvo2 as method of HNFC technique for preoxygenation with flow rate at 30litre/min for 5 minutes at Fio2 1.0. After induction flow rate was increased to 60 litre/min at Fio2 1. Single dose of muscle relaxant Inj succinylcholine was given in all the patients. Mean apnea time was 14.64±1.51 minutes. The confidence interval of apnea time in our study subjects ranged between 14.199 – 15.081 minutes. Inter Quartile range IQR of apnea time IQR = (15 -14 = 1 minutes).There was only one patient who had desaturation below 90% for two minutes and picked up after 2 minutes with bag and mask

ventilation. An average apnoea time of 15 min and no patients developed any major cardiac event or other adverse events suggestive of carbon dioxide toxicity. When chi-square was used to see the association between apnea time and the total duration of SpO_2 >90%, it was found to be statistically significant. (p value=0.02). The mean duration of surgery was 15.31±1.20 minutes. The mean duration of anesthesia was 22±2.5 minutes. The apena time was comparable in both the studies.

Rakesh shrivastav, Ashishagarwal *et al*.2019 [26] did a case series study with 16 adult patients, who were posted for airway surgeries (Carbon dioxide laser) for various pathologies The Mean age group included 40±15 years. The ASA status was between I to II, and the mean BMI was 30 (23 – 36) conditions. AIRVO 2 was used for Preoxygenation: HFNO (high flow nasal oxygen cannula) at 30 L/min with FiO2 of 1.0 was started for 10 min then, was increased to 60 L/min with FiO2 of 1.0. Anesthesia was commenced with intravenous induction boluses of 2–3 mg/kg Propofol, 1–2 μg/kg Fentanyl, and Dexmedetomidine 1 μg/kg over a 10-min period. Then maintained with Dexmedetomidine 0.5–1 μg/kg/h infusion along with 6–10 mg/kg/h infusion of Propofol. HFNC use was 6 min and 135 min respectively with an average of 34 min. The apnea time was (IQR) [range]: 22 (12–24) minutes. Oxygen saturation was maintained above 90% throughout the procedure with FiO2 of one. Intubation was required in two cases intraoperatively due to the trickling of blood into the trachea.

In our study we had used Airvo 2 technique for preoxygenation flow rate at 30litre/min for 5 minutes at fio2 1.0. Induction was done with Inj fentanyl, propofol, ketamine. Then flow rate increase to 60litr/min at fio2 1.0. Single dose of short acting muscle relaxant Inj succinylcholine was given and letter patients maintained on spontaneous ventilation. Mean apnea time was 14.64±1.51 minutes. The confidence interval of apnea time in study subjects ranged between 14.199 – 15.081 minutes. Inter Quartile range IQR of apnea time IQR = (15 -14 = 1minutes). There was only one patient who had desaturation below 90% for two minutes and picked up after 2 minutes with bag and mask ventilation. An average apnoea time of 15 min and none of the patients developed any major cardiac event. In our study chi-square test was used to see the association between apnea time and the total duration of SpO_2 >90% and it was found to be statistically significant p value< 0.02 which is statistically significant in our study. The mean duration of surgery was 15.31±1.20 minutes. The mean duration of anesthesia was 22 ±3.5 minutes.

Sayandeep Mandal, Barman *et al* 2019 [25] conducted a retrospective study in a tertiary level regional cancer center include 10 adult patients, who were posted for tracheal stenting. The Mean age included was 59±5.45 years. One patient was of ASA I, two were of II and seven patients were of ASA III with common comorbidities like hypertension, diabetes mellitus, and hypothyroidism. The mean BMI was 30 (23 - 36). AIRVO 2 was used for Preoxygenation: HFNO (high flow nasal oxygen cannula) at 30 L/min with FiO2 of 1.0 was started for 10 min then, was increased to 50 L/min with FiO2 of 1.0. Sedative agents, such as midazolam, fentanyl, and propofol were given and neuromuscular relaxation was not used. The spontaneous respiration was ensured by continuous clinical monitoring of chest excursion and respiratory waveform from the ECG leads. AIRVO 2 was maintained at 30-70 L min-1 during the procedure. Preoperatively mean room air SpO_2 was 96.7% with an SD of 1.25%, which improved following preoxygenation. Mean post-pre-oxygenation SpO_2 99.6% with an SD of 0.699%. The mean minimum SpO_2 during the procedure was 92.7% with an SD of 4.667. The median minimum SpO_2 during the procedure was

94.5%. Only three out of ten patients had a single hypoxic episode of SpO_2 below 90%. The mean duration of hypoxia was 11.67 seconds with an SD of 2.89 seconds. The mean duration of the procedure was 54.5 min with an SD of 7.62 min. No complications occurred during the procedure.

In our study total number of patients was 45 adults. The mean age was 26.24±9.33 years ranging between 18-62 years. Majority 30 of the patients were males, and the rest 15 were female out of 45 and were ASA I and II status. We had used Airvo2 as method of HNFC technique for preoxygenation with flow rate at 30litre/min for 5 minutes at Fio2 1.0. After induction flow rate was increased to 60 litre /min at Fio2 1. Single dose of muscle relaxant inj succinylcholine was given in all the patients. Mean apnea time was 14.64±1.51 minutes. The confidence interval of apnea time in our study subjects ranged between 14.199 – 15.081 minutes. Inter Quartile range IQR of apnea time IQR = (15 -14 = 1 minutes). There was only one patient who had desaturation below 90% for two minutes and picked up after 2 minutes with bag and mask ventilation. An average apnoea time of 15 min and no patients developed any major cardiac event or other adverse events suggestive of carbon dioxide toxicity. When chi-square was used to see the association between apnea time and the total duration of SpO_2 >90%, it was found to be statistically significant (p value=0.02).The mean duration of surgery was 15.31±1.20 minutes. The mean duration of anesthesia was 22+-2.5 minutes. The apena time was comparable in both the studies.

Joshua peter *et al* 2019 [27] conducted retrospective a study with 28 adult patients, who were posted for phonolaryngeal/trachea-bronchial surgery which less than 60 min. The Mean age group included 40±15 years. The ASA status was between I to III, and the mean BMI was 30 (23 - 32). THRIVE (transnasal humidified rapid-insufflation ventilatory exchange) was used for Preoxygenation: HFNO(high flow nasal oxygen cannula) at 30 L/min with FiO2 of 1.0 was started for 3 min then, was increased to 50-70 L/min with FiO2 of 1.0. Anaesthetic induction utilized midazolam, propofol target-controlled infusions (TCI) and remifentanil TCI. Muscle relaxant (rocuronium) was given at induction to allow the peak effect to be reached before laryngoscopy. The apnea time was (IQR) [range]: 37 [22–65] minute. They reported no intra/postoperative complications. There was no desaturation below 90% in various otolaryngological procedures, including rigid laryngoscopies, endoscopic tracheal-bronchoscopies, and transoral laser microsurgery.

In our study we had used Airvo 2 technique for preoxygenation with flow rate at 30litre/min for 5 minutes at fio2 1.0 for preoxygenation was used. Induction was done with inj propofol and ketamine and then flow rate increase to 60 litr/min at Fio2 of 1 was continued. Single dose of short acting muscle relaxant Inj succinylcholine was used. Mean apnea time was 14.64±1.51 minutes. The confidence interval of apnea time in study subjects ranged between 14.199 – 15.081 minutes. Inter Quartile range IQR of apnea time IQR = (15 -14 minutes). There was only one patient who had desaturation below 90% for two minutes and picked up after 2 minutes with bag and mask ventilation. An average apnoea time of 15 min and none of the patients developed any major cardiac. When chi-square was used to see the association between apnea time and the total duration of SpO_2 >90%, it was found to be statistically significant (p value=0.02).

Lucy Theodore *et al* 2019 [28] Conducted a retrospective case series study with 56 adult patients, who were posted for micro laryngoscopy with injection laryngoplasty, micro laryngoscopy with biopsy, micro laryngoscopy with KTP laser use, panendoscopy with biopsy, oesophageal

dilatation, subglottic stenosis dilatation, and stapling of a pharyngeal pouch. The Mean age group included 60±17 years. The ASA status was between I to III, and the mean BMI was 26 (23 - 30). Among 25 patients, 10 patients had benign laryngeal conditions, 10 patients had obstructive sleep apnea, 6 patients had malignant conditions, and 9 patients had airway compromised conditions. THRIVE (transnasal humidified rapid-insufflation ventilatory exchange) was used for Preoxygenation: HFNO(high flow nasal oxygen cannula) at 40 L/min with FiO2 of 1.0 was started for 5 min then, was increased to 70 L/min with FiO2 of 1.0. All patients had received total intravenous anesthesia with opioid analgesia and propofol infusion. Neuromuscular blockade (rocuronium, vecuronium or mivacurium) for apnea was utilized. The apnea time was (IQR) [range]: 23 [5–40 (20 to 28)] minute. Rescue bag and mask ventilation or intubation was required in 12 cases.

In our study the total number of patients was 45 adults. The mean age was 26.24±9.33years ranging between 18-62 years. Majority 30 of the patients were males, and the rest 15 were female patients. Most of 45, 40 patients belonged to ASA status one followed by 05 patients with ASA status two. We had used airvo 2 technique for preoxygenation flow rate at 30litre/min for 5 minutes at fio2 1.0. Induction with inj propofol fentanyl ketamine and single dose of short acting muscle relaxant Inj succinylcholine then flow rate increase to 60litr/min at fio2 1. Mean apnea time was 14.64±1.51 minutes. The confidence interval of apnea time in study subjects ranged between 14.199 – 15.081 minutes. Inter Quartile range IQR of apnea time IQR = (15 -14 minutes).

There was only one patient who had desaturation below 90% for two minutes and picked up after 2 minutes with bag and mask ventilation. An average apnoea time of 15 min and none of the patients developed any major cardiac event or other adverse events suggestive of carbon dioxide toxicity. When chi-square was used to see the association between apnea time and the total duration of SpO_2 >90%, it was found to be statistically significant (p value=0.02). Hence statically significant with respect to our observation.

Limitations of our study

This was observational study. No randomization was done for any therapeutic regimen. The study population was 45 cases only. With the use of AIRVO 2 maximum flow capacity of 60litres/minutes can be achieved which cannot exceed above 60 L/min. This study is a single center study. In our study majority were between age group of 18 to 20 younger population compare to other studies where many were elderly patients. The mean age was 26.24±9.33years ranging between 18-62 years.

So from our study it is seen that apneic oxygenation with HFNC is an acceptable alternative technique for the performance of short-duration laryngeal and tracheal surgery without the presence of a tracheal tube. This improve surgical access and reduce overall procedure time due to least interference for other method of ventilation. Oxygen saturation is also maintained above 90% till 16 minutes and safe apneic window can be achieved without any adverse events. More research and comparative studies and clinical trials are needed to establish the ideal use of this technique in various study populations.

Conclusion

In airway assessment cases with the use of Airvo2 as HFNC and preoxygenation with 30liter/min and post induction 60 liters/minutes with oxygen Fio2 100%. We found that maximum apnea time was 16 minutes. All patients maintained SpO_2 more than 90% for a period of upto 20 minutes. Mean apnea time was 14.64±1.51 minutes. The confidence interval of apnea time in study subjects ranged between 14.199 – 15.081 minutes. With chi-square test association between apnea time and

the total duration of SpO_2 > 90%, it was found to be statistically significant (p value=0.02). Single dose of muscle relaxant succinylcholine was used. So we conclude that HFNC provides optimal working space to the surgeons and avoids desaturation and interferences with bag and mask ventilation without any adverse event up to apnea time of 14.64±1.51minutes and short-duration laryngeal and tracheal surgeries are possible without the need of endotracheal tube for oxygenation with use of HFNC.

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