Original Research Article

A randomized controlled clinical trial to compare Hemodynamic Responses to Endotracheal Intubation and Ventilation with Supraglottic Jet Ventilation in Minor Laryngeal Surgeries

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Abstract

Background: Laryngeal surgeries tend to produce intense cardiovascular stimulation perioperatively during laryngoscopy, intubation and surgical manipulations. An unobstructed view of airway for surgeon and providing effective ventilation and oxygenation are important goals. A non-intubation technique for maintaining airway patency and ventilation presents a challenging situation for anesthesiologists.**Aim of the Study** : To compare hemodynamic responses to endotracheal intubation and ventilation with supraglottic jet ventilation in minor laryngeal surgeries. **Materials and Methods :**The study was conducted at Government ENT Hospital , Koti , Hyderabad, Telangana State, under Osmania Medical College during 2014-2016, the Institutional Ethics committee has approved study,60 patients belonging to both genders in age group of 20-75 years were included in the study and randomly divided into two groups of equal numbers based on ventilation technique used Group E-Endotracheal intubation and ventilation , Group S-Supraglottic jet ventilation , intraoperatively Mean arterial blood pressure, Heart rate and Oxygen saturation (SpO_2) were recorded at predetermined time intervals till end of procedures, incidence of adverse events were noted , all procedures lasted for 20 minutes. **Results*:*** Intraoperatively Mean arterial blood pressure and Heart rate were significantly lower in Group S ('p' value < 0.0001) when compared to Group E.**Conclusion*:*** Hemodynamic stability was better with Supraglottic jet ventilation when compared to endotracheal intubation and ventilation in minor laryngeal surgeries.

Keywords: Apnoeic oxygenation, Endotracheal intubation, General Anesthesia, Laryngeal surgery, Supraglottic jet ventilation

Introduction

Anesthesia for laryngeal surgeries presents a challenge as the airway is shared between surgeon and anesthesiologist with surgeon desires for immobile and unobstructed view of surgical field and maintaining airway patency,effective ventilation and oxygenation are anesthesiologist concerns.Various intubation and non-intubation techniques are adopted during laryngeal surgery which include endotracheal intubation and ventilation, spontaneous breathing[1], apnoeic oxygenation[2,3]and jet ventilation[4].General anesthesia with muscle relaxation[5]provides an immobile surgical field and is desired in laryngeal surgeries. Challenge for anesthesiologist is providing a tubeless surgical field , as use of even small diameter micro laryngoscopy(MLT) tubes obstructs surgeon's view. Douglas Sanders[4] introduced a venturi jet injector technique as a means of jet ventilation to achieve goal of ventilation and an unobstructed surgical access. Supraglottic jet ventilation (SJV) is a minimally invasive technique which maintains ventilation and adequate oxygenation during laryngeal surgeries , it is reported to be safely used for a maximum duration of 45mins[6].It also provides a reliable means for oxygenation in difficult airways with Cormack-Lehane-III patients. Anesthesia for laryngeal surgeries ideally requires general anesthesia with muscle relaxation[8–10] because of extreme stimulation caused by rigid metal bronchoscope and working instruments. General anesthesia[7] reduces coughing, provides excellent working conditions maintains airway patency, ensures adequate ventilation and oxygenation[8],shortens duration of procedure[9] amnesia and patient comfort are assured. Direct laryngoscopy during laryngeal surgery causes stimulation of laryngeal pressure receptors resulting in adverse cardiovascular responses and complications. Jet ventilation avoids intubation, extubating and cardiovascular responses are minimized .In present study we compared hemodynamic responses to endotracheal intubation and ventilation with supraglottic jet ventilation in minor laryngeal surgeries.

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Materials and Methods

The study was conducted at Government ENT Hospital, Koti , Hyderabad ,Telangana state under Osmania Medical College during 2014 -2016 . Institution Ethics Committee has approved study which included 60 patients in age group of 20-75 years belonging to ASA I, II class scheduled for minor laryngeal surgeries (Vocal nodule and Vocal polyp excision, Epiglottic cyst excision , Vocal cord Leukoplakia removal and Direct Laryngoscopy and Bronchoscopy (Diagnostic and Therapeutic) etc., under general anesthesia. Patients were explained about procedure and written informed consent obtained from all the patients.

Exclusion criteria : Pregnancy, Kidney or Hepatic disease, Chronic medication with NSAIDS or Sedatives , H/o Alcohol consumption and /or drug abuse.

Patients were randomized into two equal groups using simple randomization method based on type of ventilation technique used, Group S(n-30)- Supraglottic jet ventilation, Group E(n-30)- Endotracheal intubation and ventilation . Patients were advised NPO for at least 8 hours and no pre-op sedation. On arrival at operating room iv access was secured on left forearm, ECG, NIBP, SpO_2 were connected and preoperative vitals were recorded. In both groups general anaesthesia included Glycopyrrolate 5µg/kg i.v,Ondansetron 0.1mg/kg i.v.,Fentanyl 1µg/kg i.v.preoxygenation with 100% oxygen, Propofol 2-2.5 mg/kg induction, tracheal intubation facilitated by 2 mg kg^{-1} i.v. succinylcholine. Group S - ventilated with Sanders jet injector attached to proximal end of rigid bronchoscope with 100% O2 at about 100 to 150 cycles per minute. Group E - intubated with 5.5 ID cuffed Microlaryngeal tubes ,ventilated with O2: N2O ::40% :60% and atracurium 0.5mg/kg, for neuromuscular blockade in both group patients , all procedures lasted for 20min , at end of procedure neuromuscular blockade antagonized and Group E patients were extubated , Group S patients were ventilated using bag and mask. Intraoperatively Mean arterial pressure Heart rate and SpO2 were recorded at predetermined time intervals T_1-before induction,T_2-immediately after induction,T_3-time of intubation/start of SJV,T_4-5min,T_5-10min,T_6-15min ,T_7- At extubation) and T_8-10minutes after surgery , adverse events cough, bradycardia, laryngospasm and desaturation were noted. Hypertension (rise in MAP >20% of preinduction value) was treated with esmolol.

Patients were transferred to post anesthesia care unit and observed by a person who was unaware to type of ventilation technique used intraoperatively and mean arterial pressure , heart rate and oxygen saturation were recorded till recovery. Adverse events like sore throat, pain, postoperative nausea and vomiting were treated accordingly and all patients were interviewed about recall of anesthesia.

Statistical Analysis

Intraoperative data was entered in Microsoft excel spread sheet and Statistical analysis was done using Statistical Package for Social Sciences version 20.Descriptive statistical analysis was done continuous measurements are presented as Mean & Standard Deviation and categorical measurements are presented as percentages.Significance level is assessed at 0.05**.** Two tailed independent Student t test was been used to find out significance on a continuous scale , Chi square test was used to find out significance on a categorical scale between two groups respectively.

Results

A total of 60 patients were recruited in this study demographic profile of patients found no significant differences between two groups and carried no effect on study. Total Anaesthesia and operation time was comparable between two groups ,Group S - 15± 6.1 min and Group E- 16.2 ± 7.3 min and Group S 10.0 ± 5.6 min and Group E 11.7 ± 5.1 min respectively.

Table 1: Demographic distribution of study groups

Study groups	Gender	Frequency	%	Age		
				No.	Mean±S.D.	'p' value
Supraglottic jet Ventilation(Group S)	M:F	15:15	50: 50	30	56.70±5.503	0.924
Endotracheal Intubation(Group E)	M:F	15:15	50: 50	30	56.57±5.224	
Total		60	100	60		

Demographic profile of study patients distributed in each study group are comparable and statistically insignificant(p >0.05).

Table 2: Comparison of MAP in study groups

Mean Arterial Pressure	Group S (Mean ±S.D.)	Group E(Mean ±S.D.)	'p' value
T_1	87.31±3.518	85.83±7.812	0.3512
T_2	86.61±3.606	84.31±7.755	0.1462
T_3	95.91±4.611	105.21±10.749	0.0001
T_4	94.06±5.963	124.96±7.814	<0.0001
T_5	93.86±6.936	117.11±6.939	<0.0001
T_6	92.56±6.621	110.16±8.288	<0.0001
T_7	91.03±4.802	118.06±6.847	<0.0001
T_8	89.86±4.166	99.91 ±7.155	<0.0001

The difference in Mean Arterial Pressures in both study groups is statistically highly significant from T_3(starting supraglottic jet ventilation) to postoperatively (T_8),'value <0.0001.

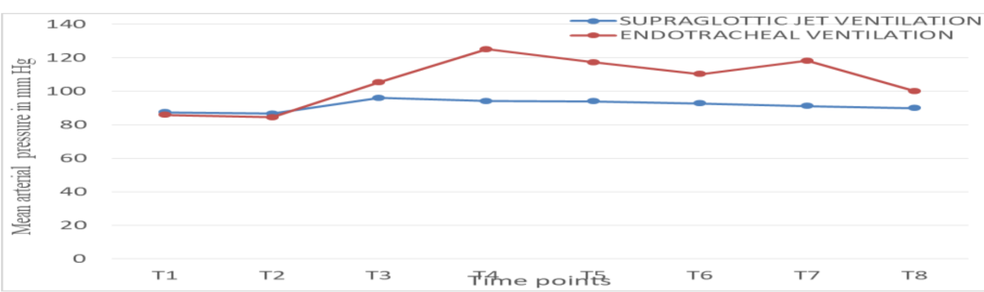


Fig 1: Comparison of MAP in Two groups

Table 3: Comparison of MEAN HR in Two groups

Heart Rate	Group S (Mean ±S.D.)	Group E (Mean ±S.D.)	'p' value
T_1	79.81±6.069	81.01±5.729	0.4342
T_2	77.11±5.761	79.43±5.654	0.0752
T_3	85.26±7.404	96.06±9.024	< 0.0001
T_4	84.53±6.574	116.60±12.316	<0.0001
T_5	84.56±6.657	109.90±9.030	<0.0001
T_6	61.76±5.697	100.96±9.908	<0.0001
T_7	79.16±6.159	109.46±9.665	<0.0001
T_8	79.50±6.134	90.26 ±6.538	<0.0001

The difference in heart rate in study groups is statistically insignificant at T1,T2 (p>0.05) and statistically highly significant (p<0.0001) from T3 to T8.

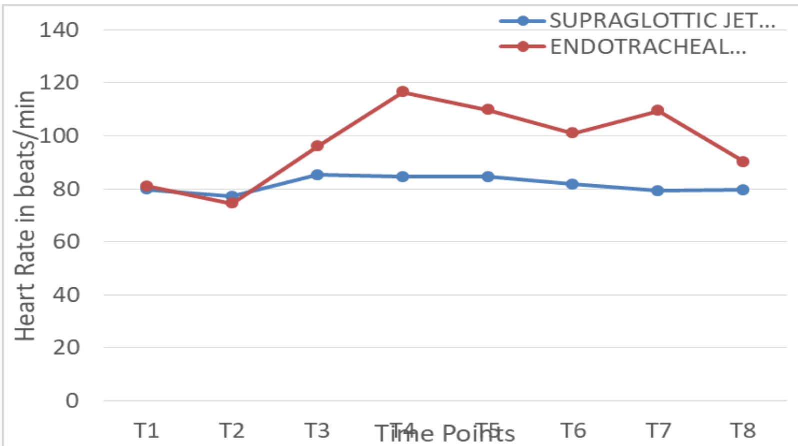
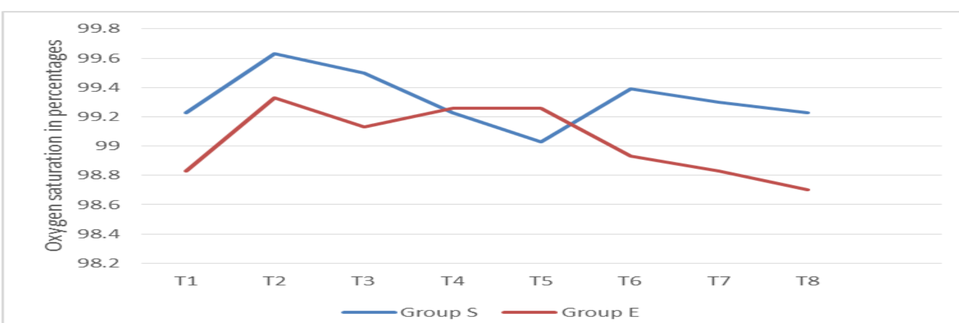


Fig 2: Comparison of MEAN Heart rate in Two groups

Table 4: Comparison of Saturation (S_aO_2) between two groups

Saturation (S_aO_2)	Group S (Mean ± S.D.)	Group E (Mean ± S.D.)	'p' value
T_1	99.23±0.727	98.83±0.746	0.0398
T_2	99.63±0.490	99.33±0.711	0.0620
T_3	99.50±0.629	99.13±.0.860	0.0621
T_4	99.23±0.678	99.26±0.784	0.8746
T_5	99.03±0.889	99.26±0.944	0.3353
T_6	99.30±0.651	98.93±1.048	0.1059
T_7	99.30±0.749	98.83±0.912	0.0332
T_8	99.23±0.678	98.70±0.836	0.0091



Graph 3: Comparison of oxygen saturation in two groups

Intraoperatively mean arterial pressure and saturation levels were recorded and presented in tables and graphs , baseline mean arterial pressure (MAP) and heart rate were comparable between the study groups (Group S : 87.3±3.518; GroupE:85.83±7.812) and (Group S:

79.8±6.069,Group E: 81±5.729) respectively . Anesthesia induction was uneventful in both groups. Mean arterial pressure (Group S : 86.6±3.606;Group E : 84.3±7.755) and Heart rate (Group S: 77.1±5.761;Group E: 74.43±5.654) immediately after induction were comparable, difference in MAP from time of start of jet ventilation till 10 minutes postoperatively, between group S (95.9±4.611, 94.06±5.965,93.86±6.936 , 92.56±6.621, 91.03±4.801 , 89.86±4.165) and group E(105.2±10.750,124.96±7.814,117.1±6.939, 110.16± 8.288,118.06±6.847,99.9±7.155) , was statistically highly significant p<0.0001,intraoperatively heart rates in group S (85.26±7.405, 84.53±6.574 ,84.56±6.657 , 81.76±5.697 , 79.16±6.159 , 79.5±6.134) were compared with group E (96.06± 9.025 , 116.6±12.316 , 109.9±9.031,100.96±9.908, 109.46±9.665 , 90.26± 6.538) difference is highly significant p<0.0001from T_3toT_8 intervals.Thus increase in MAP and HR is significantly higher with endotracheal intubation and ventilation than with supraglottic jet ventilation. Oxygen Saturation levels intraoperatively from time points T1 to T6 between group S were comparable with group E(98.83±0.746, 99.33± 0.711, 99.13±0.860,99.26±0.784,99.26±0.944,98.93±1.048)and statistically insignificant and difference is significant p<0.05 at T7 & T8 time intervals Group S (99.3±0.749 , 99.23±0.678) , Group E (98.83± 0.912 , 98.7±0.836) respectively. No adverse events were observed in both study groups.

Discussion

The present clinical trial compared hemodynamic responses between endotracheal intubation and ventilation with supraglottic jet ventilation in elective minor laryngeal surgeries under general anaesthesia Douglas Sanders technique made it possible to provide tubeless anaesthesia in minor laryngeal surgeries. Manual jet ventilation can be provided via a Sanders-type injector (providing a 4 atm fixed pressure) or Manujet device (VBM-Medical; providing a controlled pressure of 0–4 atm).

It was followed by introduction of intratracheal(percutaneous, Spoerel 1971)[10],supra-glottic(Barr 1971) [11], and translaryngeal (Spoerel1973)[12] jet ventilation techniques .Supraglottic jet ventilation[13] can be provided via a rigid bronchoscope with jet ventilator attachment , ventilation and oxygenation is dependent on surgeons ability to align jet with airway during surgery and maintain airway patency, during jet ventilation driving pressure is initiated at low levels to limit pressure related complications.Sanders adapter was attached to proximal end of bronchoscope connected to oxygen supply pipeline by means of a pressure regulator and hand-held on/off valve to control ventilation frequency. Oxygen was delivered at pressure of 50 lb/in^2 in a jet through a 0.035-in diameter nozzle inside lumen of bronchoscope, each jet ensures rapid delivery of oxygen in a pulsatile manner into trachea , contributes to tidal volume leading to an exchange of gases , allows ventilation without use of valves and it may increase functional residual capacity of lungs[14].The pause between each jet delivery allowed passive expiration, adequacy of ventilation is assessed by chest wall movements and confirmed with blood gas analysis , an adaptation of a wide-bore side-arm allows inhalational anesthetics being delivered to patients. Automated devices, such as Mistral or Monsoon (Acutronic Medical Systems), are superior as they include a range of safety features along with control of fraction of inspired oxygen (FiO2), potential for humidification and ETCO2 measurement via a side port which facilitates ventilation adjustments accordingly. During jet ventilation sufficient outflow of gases should be ensured to avoid gas trapping and barotrauma related morbidity and mortality [15,16].Gas exchange in low-frequency jet ventilation (LFJV) is achieved by means of convective ventilation or bulk flow (i.e. mass flow of gases into and out of lung) in a similar manner to spontaneous respiration. Alveolar ventilation V_A generated is calculated by formula: $V_A= f \times (V_T – V_D)$,

V_T (tidal volume) ,V_D (dead space), f -ventilatory rate.

Laryngoscopy and Endotracheal intubation and extubation are noxious stimuli which produce reflex sympathetic stress response in the form of augmented cardiovascular reflexes as tachycardia and hypertension and raised intracranial pressure which are detrimental for patients with cardiovascular and cerebrovascular diseases. In present study SJV resulted in increase in mean arterial pressure (MAP) and heart rate was 8 mmHg and 6 beats/min (approx..) compared with 39 mmHg increase in MAP , 35 beats/min increase in heart rate with endotracheal intubation and ventilation respectively , these hemodynamic changes with endotracheal intubation can result in morbidity and mortality in elderly patients with coronary artery disease. Oxygenation was well maintained intraoperatively in both groups,adverse effects like sore throat , hoarseness of voice were more frequent in intubated patients.Demet Altun et al[17] reported use of infraglottic jet ventilation for excision of postintubation granuloma, it was concluded jet ventilation allows effective gas exchange,optimal surgical view,adequate oxygenation and stable hemodynamics the same results were observed in our study.A case report of anaesthetic management of Myasthenia gravis with subglottic stenosis scheduled for direct laryngoscopy and bronchoscopy by Hesham A.Elsharkawy *et al*, under general anesthesia,jet ventilation was used with 40 psi pressure,14–18 jets/min, which resulted adequate chest rise and oxygen saturation 94%- 99% and MAP 70-80 mmHg thus highlighted advantage of jet ventilation . Michael Barakate[18]published a study on Anaesthesia for microlaryngeal surgery and impact of subglottic jet ventilation(2010) in all 332 patients it was observed subglottic ventilation provides optimal surgical access, facilitates safe airway management with no adverse anesthesia outcomes the same effects were demonstrated in our study.Franklin L.Scamman[19] investigated efficacy and safety of SJV for laryngeal laser surgery and concluded SJV was effective and safe. Oberg and Sjôstrand studied effects of high-frequency ventilation technique on arterial blood pressure regulation[20] in animals and observed that blood pressure was minimally altered by high- frequency positive pressure ventilation. These studies demonstrated effectiveness of supraglottic jet ventilation the same observations were made in our study and results were statistically significant A number of studies published on hemodynamic effects of HFJV,confirmed improved hemodynamic tolerance of increased intrathoracic pressure with HFJV. SJOV maintained effective oxygenation in obese individuals with shorter Oxygen Saturation Falling Time (OSFT)[21], defined as time taken for decrease in patient's SpO2 to 90% after 100% inhaled oxygen and denitrogenation,same observations were made in our study. Amanda Hu et al reported a series of 552 patients over a 10-year period. Patients were subjected to subglottic jet ventilation for microlaryngeal surgery and concluded jet ventilation is a safe alternative to endotracheal intubation in effective ventilation and oxygenation which coincide with results and observations of this study .Trindade O et al studied pulmonary and hemodynamic effects of conventional vs high-frequency jet ventilation in piglet model of meconium aspiration , results suggest that HFJV allows more effective ventilation and adequate oxygenation at low peak inspiratory pressures with no adverse hemodynamic changes. All above studies and case series results have confirmed effectiveness of supraglottic jet ventilation which are in line with results of this study in maintaining adequate ventilation and oxygenation which support the results of our study.

Conclusion

Supraglottic jet ventilation maintains a better hemodynamic stability when compared to endotracheal intubation and ventilation in patients undergoing minor laryngeal surgeries and results are statistically significant ('p' value 0.0001).

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