SUPRAGLOTTIC JET VENTILATION VERSUS CONVENTIONAL ENDOTRACHEAL VENTILATION IN MINOR LARYNGEAL SURGERIES

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ABSTRACT

Any attempt at intubation will cause many cardiovascular responses and the major concern during this time is to attenuate the same. Similar response is seen during procedures on Larynx in microlaryngeal surgery which produces an intense cardiovascular stimulation during suspension laryngoscopy and intubation.

AIM OF STUDY

Supraglottic jet ventilation versus conventional endotracheal ventilation in minor laryngeal surgeries. To evaluate the haemodynamic response in supraglottic jet ventilation and conventional intubation in minor laryngeal surgeries.

METHODS

Patients were randomised to 2 Groups: 30 patients in each group; Group A - in whom supraglottic jet ventilation was planned and Group B - in whom endotracheal intubation was planned.

RESULT

The haemodynamic response in terms of increase in MAP and HR is significantly more with endotracheal intubation than with supraglottic jet ventilation.

CONCLUSION

Our study showed that supraglottic jet ventilation showed a better haemodynamic stability when compared to conventional endotracheal intubation in patients undergoing minor laryngeal surgeries. Statistical scores were also in favour of the patients treated with supraglottic jet ventilation based on the p values.

KEYWORDS

Jet Ventilation, Supraglottic Ventilation, Laryngeal Surgeries, Endotracheal Ventilation.

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INTRODUCTION: In otolaryngeal surgeries where the airway is shared between anaesthesiologist and the surgeon especially in cases performed on the airway, different types of challenges are faced. The requirement for optimal access to the operation field is often in conflict with the anaesthetist's and the surgeon regarding the method to ventilating the patient. The ventilation techniques have been modified to find a reasonable compromise between the needs of both parties. These include spontaneous breathing and topical anaesthesia,[1] endotracheal intubation with a narrow cuffed tube, apnoeic oxygenation.[2,3] or intermittent apnoea.[4,5] No one technique is satisfactory and acceptable for all the procedures. The operating field may not remain sufficiently quiet to meet the requirements of microscopic surgery in patients breathing spontaneously.

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Access to the operation field may be impaired in intubated patients, even when low diameter microlaryngoscopy tubes (MLT) are used for insertion of the laryngoscope. Sanders in 1967 developed the technique which in principle is use of jet ventilation in the airway.[6] Oxygen could be injected intermittently at physiological frequencies in order to oxygenate the patient and remove CO_2. Most certainly long term results of endolaryngeal procedures performed under general anaesthesia are better with any form of jet ventilation (JV) than with conventional ventilation (CV) through intubation tubes. Procedures are shorter and sick leave may be shorter after JV than after CV. Moreover, cardiovascular response to intubation and extubation were avoidable with jet ventilation, thereby, maintaining haemodynamic stability. Complications with JV are avoidable when safety rules are followed, which is obviously easier in an experienced team than when doing occasional cases. Unfortunately, comparisons of JV techniques with each other or with conventional ventilation are rare, perhaps because of the associated difficulties of measuring lung volume changes during JV, or simply because of the obvious advantages of jet ventilation in airway surgery.

This randomised study was conducted to compare the haemodynamic changes and postoperative complications between supraglottic jet ventilation and conventional endotracheal ventilation in minor laryngeal surgeries.

MATERIALS AND METHODS: The study carried out in Government ENT Hospital Osmania Medical College Hyderabad, was approved by the institutional ethical committee and all the participants gave written informed consent for this study. This trial was conducted in adult inpatients aged between 20 and 75 years. They were American Society of Anaesthesiologists (ASA) classification 1 and 2 scheduled for minor laryngeal surgeries under general anaesthesia. Preoperative exclusion criteria were pregnancy, kidney or hepatic disease, chronic medication with analgesic or sedative drug, or history of alcohol or drug abuse.

Patients were randomised to 2 groups: 30 patients in each group; Group A - in whom supraglottic jet ventilation was planned and Group B - in whom endotracheal intubation was planned. Patients fasted at least 8 hours before the operation and did not receive any preoperative sedative drug. On arriving at the operating room, standard monitoring, including electrocardiography, non-invasive arterial blood pressure, and peripheral pulse oximetry were applied.

The patients in both the groups were premedicated with Inj. Glycopyrrolate 5 µg/kg IV, Inj. Ondansetron 0.1 mg/kg IV, Inj. Fentanyl 1 µg/kg IV. Preoxygenation was done with 100% Oxygen for 3 minutes. They were induced with Inj. Propofol 2 to 2.5 mg/kg bodyweight. Tracheal intubation was facilitated with Inj. Succinylcholine 2 mg/kg IV. Group A were ventilated using Sanders jet ventilator attached to the proximal end of conventional rigid wall bronchoscope with 100% O2 at about 100 to 150 cycles per minute. Group B were intubated with small sized (5/5.5 ID) cuffed microlaryngeal tubes and ventilated with 60% N2O+40% O2. In both the groups, neuromuscular blockade was maintained intraoperatively with Inj. Atracurium 0.5 mg/kg IV. The procedures lasted for a short duration of 15-20 minutes. At the end of surgery, patients were reversed with Inj. Neostigmine 50 µg/kg and Inj. Glycopyrrolate 10 µg/kg bodyweight. Group A patients were ventilated using bag and mask and Group B patients were extubated when the patients were conscious and breathing adequately.

Noninvasive blood pressure, heart rate and peripheral oxygen saturation (SpO2) were recorded before induction of anaesthesia (T1), immediately after induction (T2), at the time of intubation/start of supraglottic jet ventilation (T3), thereafter every 5 minutes for the next 15 to 20 minutes of the surgery (T4: 5 min., T5: 10 min., T6: 15 min. after start of surgery), at the time of extubation (T7) and postoperatively 10 minutes after surgery (T8). Moreover, the incidence of adverse events cough, laryngospasm, and bradycardia were noted. Hypertension and hypotension were determined by a change in mean arterial pressure >20% of pre-induction value, bradycardia and oxygen desaturation. Hypotension was treated with ephedrine 5 mg boluses while hypertension and tachycardia (HR>100 beats/min.) were managed with esmolol.

Patients were observed in the recovery area by an investigator who was blinded to the anaesthesia technique used. The haemodynamic parameters and oxygen saturation were recorded till complete recovery. Any adverse events like sore throat, pain, dizziness, postoperative nausea and vomiting were assessed and treated accordingly till the discharge of the patient. Patients were asked whether they had any recall of the induction or maintenance periods.

STATISTICAL ANALYSIS: Data was entered in Microsoft Excel and analysis was done using SPSS version 20. Descriptive statistical analysis was done. Results on continuous measurements are presented as Mean & Standard Deviation. Results on categorical measurements are presented as Percentages. Significance is assessed at 5% level of significance.

Student 't' test: (Independent, two tailed) Used to find out the significance of study parameters on a continuous scale between two groups.

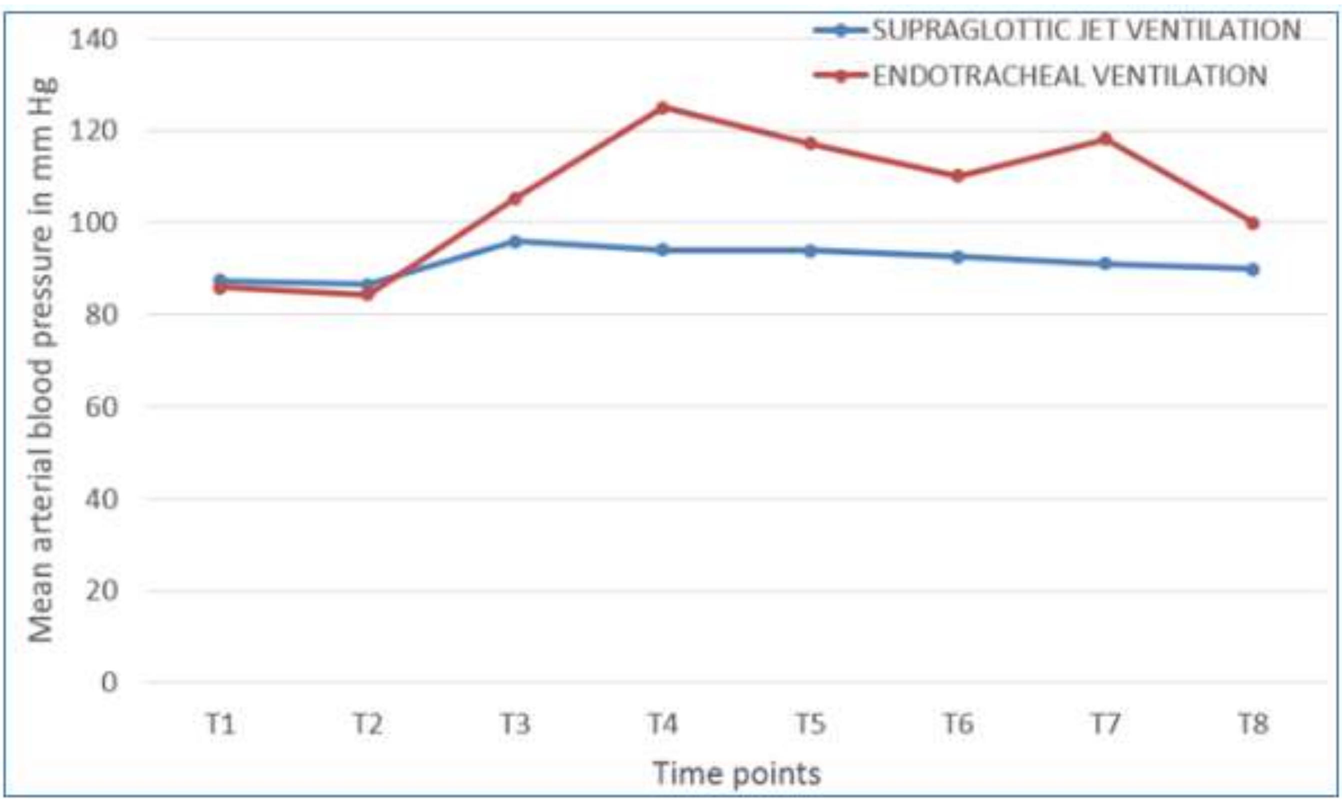
Chi-square test: Used to find out the significance of study parameters on a categorical scale between two groups.

OBSERVATION AND RESULTS: Group A consisted of 30 members with equal male and female distribution. These patients were ventilated by supraglottic jet ventilation. Group B consists of 30 members, 15 members male and 15 members female sex. These patients were ventilated by conventional endotracheal intubation. MAP, HR, and peripheral oxygen saturation (SpO2) were recorded at each time point as follows: T1 = preoperative baseline, T2 = at the time of induction, T3 = at the time of start of jet ventilation/intubation and T4, T5, T6 = 5, 10, 15 min. after start of surgery, T7 = at the end of anaesthesia and T8 = 5 min. after operation (Post-operative value) value. MAP, HR, SPO2 were compared between the 2 groups, group A and B between various time points T1-T9 and were found to be statistically significant as $p<0.05$.

Parameter	Drug	N	Mean	Std.Deviation	P value
MAPT1	Supraglottic Jet Ventilation	30	87.3	3.518	0.3512
	Endotracheal Ventilation	30	85.83	7.812	
MAPT2	Supraglottic Jet Ventilation	30	86.6	3.606	0.1462
	Endotracheal Ventilation	30	84.3	7.755	
MAPT3	Supraglottic Jet Ventilation	30	95.9	4.611	0.0001
	Endotracheal Ventilation	30	105.2	10.749	
MAPT4	Supraglottic Jet Ventilation	30	94.06	5.965	<0.0001
	Endotracheal Ventilation	30	124.96	7.814	
MAPT5	Supraglottic Jet Ventilation	30	93.86	6.936	<0.0001
	Endotracheal Ventilation	30	117.1	6.939	
MAPT6	Supraglottic Jet Ventilation	30	92.566	6.621	<0.0001
	Endotracheal Ventilation	30	110.16	8.288	
MAPT7	Supraglottic Jet Ventilation	30	91.03	4.802	<0.0001
	Endotracheal Ventilation	30	118.06	6.847	
MAPT8	Supraglottic Jet Ventilation	30	89.86	4.166	<0.0001
	Endotracheal Ventilation	30	99.9	7.155	

Table 1: Comparison of MAP in Two Groups

The above table shows the (MAP) Mean Arterial Pressures of both the study groups at various time points from T1 to T8. It can be seen that the difference in MAP between two study groups at T1, T2 is not statistically significant ($p>0.05$) but from T3 to T8 is statistically significant. ($p<0.05$).



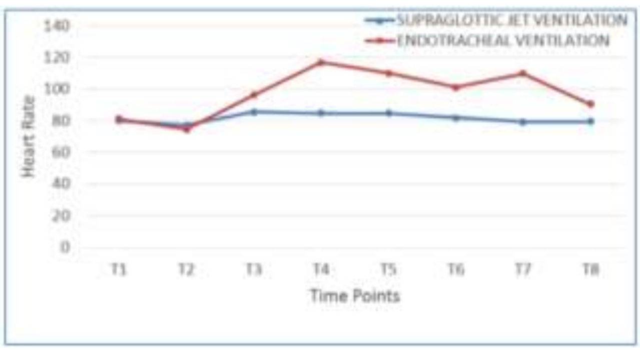
Graph 1: Comparison of MAP in Two Groups

Graphical representation of mean MAP during the various time intervals between T1 to T9 in the study Group A and Group B.

Parameter	Drug	N	Mean	Std.Deviation	P value
HRT1	Supraglottic Jet Ventilation	30	79.8	6.069	0.4342
	Endotracheal Ventilation	30	81	5.729	
HRT2	Supraglottic Jet Ventilation	30	77.1	5.761	0.0752
	Endotracheal Ventilation	30	79.43	5.654	
HRT3	Supraglottic Jet Ventilation	30	85.26	7.404	<0.0001
	Endotracheal Ventilation	30	96.06	9.024	
HRT4	Supraglottic Jet Ventilation	30	84.53	6.574	<0.0001
	Endotracheal Ventilation	30	116.6	12.316	
HRT5	Supraglottic Jet Ventilation	30	84.56	6.657	<0.0001
	Endotracheal Ventilation	30	109.9	9.030	
HRT6	Supraglottic Jet Ventilation	30	81.76	5.697	<0.0001
	Endotracheal Ventilation	30	100.96	9.908	
HRT7	Supraglottic Jet Ventilation	30	79.16	6.159	<0.0001
	Endotracheal Ventilation	30	109.46	9.665	
HRT8	Supraglottic Jet Ventilation	30	79.5	6.134	<0.0001
	Endotracheal Ventilation	30	90.26	6.538	

Table 2: Comparison of Mean HR in Two Groups

The above table shows the heart rate of both the study groups at various time points from T1 to T9. It can be seen that the heart rate difference between two study groups at T1, T2 is not statistically significant (p> 0.05) but from T3 to T8 is statistically significant (p <0.05).



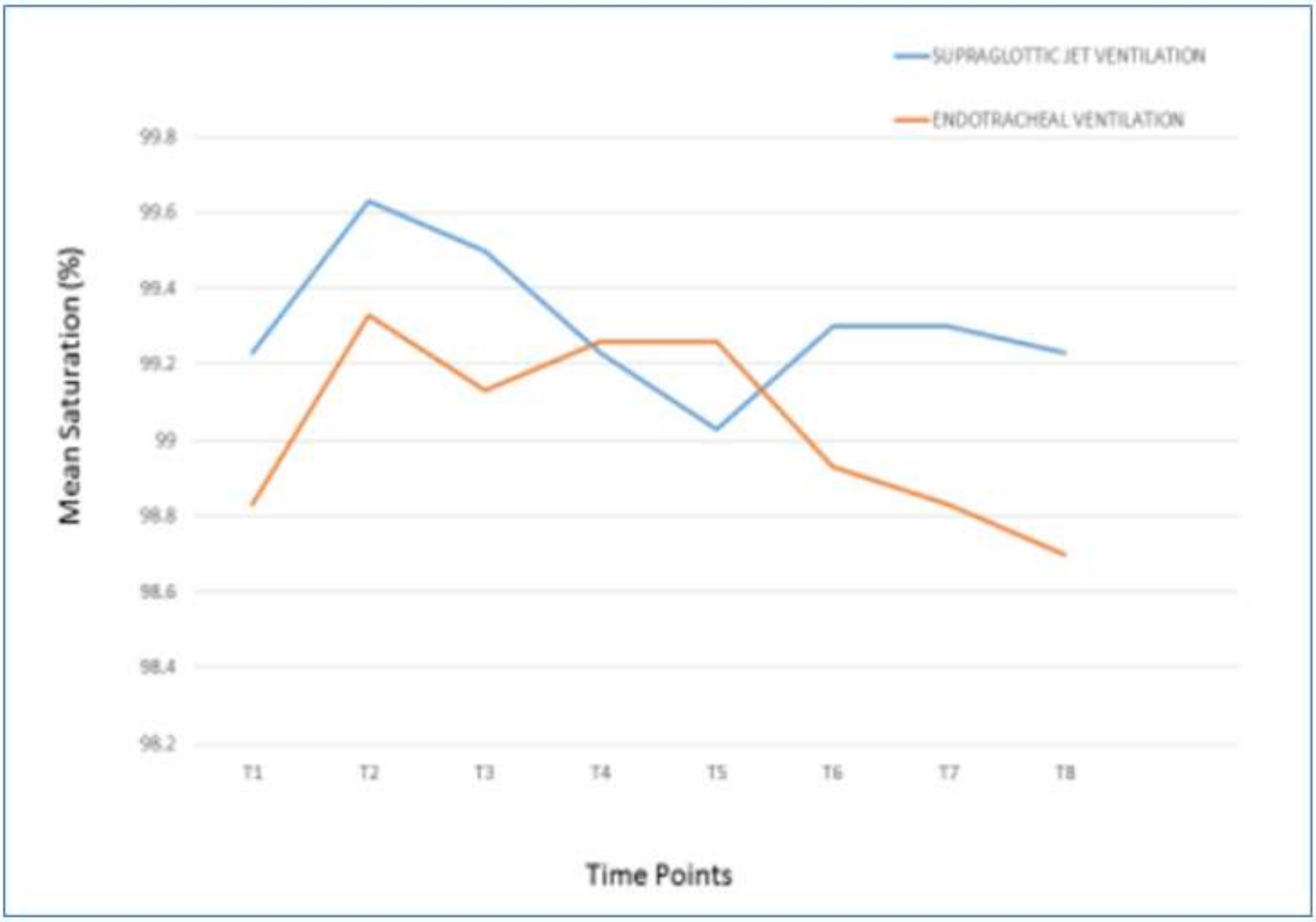
Graph 2: Comparison of Mean HR in Two groups

Graphical representation of mean heart rate during the various time intervals between T1 to T9 in the study Group A and Group B.

Parameter	Drug	N	Mean	Std.Deviation	P value
ST1	Supraglottic Jet Ventilation	30	99.23	0.727	0.0398
	Endotracheal Ventilation	30	98.83	0.746	
ST2	Supraglottic Jet Ventilation	30	99.63	0.490	0.0620
	Endotracheal Ventilation	30	99.33	0.711	
ST3	Supraglottic Jet Ventilation	30	99.5	0.629	0.0621
	Endotracheal Ventilation	30	99.13	0.860	
ST4	Supraglottic Jet Ventilation	30	99.23	0.678	0.8746
	Endotracheal Ventilation	30	99.26	0.784	
ST5	Supraglottic Jet Ventilation	30	99.03	0.889	0.3353
	Endotracheal Ventilation	30	99.26	0.944	
ST6	Supraglottic Jet Ventilation	30	99.3	0.651	0.1059
	Endotracheal Ventilation	30	98.93	1.048	
ST7	Supraglottic Jet Ventilation	30	99.3	0.749	0.0332
	Endotracheal Ventilation	30	98.83	0.912	
ST8	Supraglottic Jet Ventilation	30	99.23	0.678	0.0091
	Endotracheal Ventilation	30	98.7	0.836	

Table 3: Comparison of Mean Saturation in Two groups

The above table shows the ST (Saturation) of both the study groups at various time points from T1 to T9. It can be seen that the difference between the two study groups from T1 to T6 is not statistically significant ($p>0.05$), T7 to T8 is statistically significant ($p<0.05$).



Graph 3: Comparison of Mean Saturation in Two Groups

Graphical representation of the mean saturation levels during the various time intervals between T1 to T9 in the study Group A and Group B.

RESULTS: A total of 60 patients were recruited in this study. After initiation of the study, 30 patients were assigned to group D and the other 30 patients were assigned to group P. The characters of subdivided groups found no significant differences between the two groups except for the weight which was an incidental finding and carried no effect on the study. Total anaesthesia time was 15±6.1 min. in group A and 16.2±7.3 min. in group B, and operation time was 10.0±5.6 min. and 11.7±5.1 min. in group A and B, respectively. These were comparable between the two groups.

Changes of haemodynamic variables and saturation levels are presented in the tables and graphs. The two groups were comparable with respect to baseline mean arterial pressure (Group A: 87.3±3.518; Group B: 85.83±7.812) and heart rate (Group A: 79.8±6.069, Group B: 81±5.729). Induction of anaesthesia was smooth and uneventful in both the groups. Mean arterial pressure (Group A: 86.6±3.606; Group B: 84.3±7.755) and Heart rate (Group A: 77.1±5.761; Group B: 74.43±5.654) immediately after induction were also comparable between two groups, when MAP for group A (95.9±4.611, 94.06±5.965 , 93.86±6.936, 92.56±6.621, 91.03±4.802, 89.86±4.166) was compared with group B (105.2±10.749, 124.96±7.814, 117.1±6.939, 110.16±8.288, 118.06±6.847, 99.9±7.155) from the time of start of jet ventilation and intubation respectively till 10 minutes postoperatively, it was found to be statistically significant $p <0.05$. (Highly significant $p<0.0001$).

Similarly when Heart rates of group A (85.26±7.404, 84.53±6.574, 84.56±6.657, 81.76±5.697, 79.16±6.159, 79.5±6.134) was compared with group B (96.06±9.024, 116.6±12.316, 109.9±9.030, 100.96±9.908, 109.46±9.665, 90.26±6.538) from the time of start of jet ventilation and intubation respectively till 10 minutes postoperatively, it was found to be statistically significant $p <0.05$. (Highly significant $p<0.0001$). MAP and HR decreased after induction and increased at the start of jet ventilation/intubation in both the groups. Mean MAP changed by 4.8±1.8 in group A (Supraglottic jet ventilation), 21.3±19.36 in group B (Intubation). Mean HR changed by 4.35±3.86 in group A (Supraglottic jet ventilation), 22.90±19.3 in group B (Intubation).

Therefore, the haemodynamic response in terms of increase in MAP and HR is significantly more with endotracheal intubation than with supraglottic jet ventilation. Saturation levels from time points T1 to T6 of group A (99.23±0.727, 99.63±0.490, 99.5±0.629, 99.23±0.678, 99.03±0.889, 99.3±0.651) was comparable with group B (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 found not to be statistically significant as p>0.05. Though the saturation levels at time points T7 and T8 of Group A (99.3±0.749, 99.23±0.678) when compared to Group B (98.83±0.912, 98.7±0.836) are found to be statistically significant as p<0.05, it has no clinical significance. No episodes of respiratory depression or oxygen desaturation were observed in either group.

DISCUSSION: Sanders' approach was adapted to different needs, including laryngoscopy.[7,8] for emergency use by needle access to the trachea, for routine transtracheal ventilation.[9] and for translaryngeal jet ventilation.[10] using small bore catheters. The present study investigated the haemodynamic responses and postop complications with supraglottic jet ventilation and endotracheal intubation in patients undergoing minor laryngeal surgeries. Our results suggested that the patients ventilated by supraglottic jet ventilation had better intraoperative haemodynamic stability than those ventilated by endotracheal intubation during microlaryngeal surgery. Mean arterial pressure was more stable with supraglottic jet ventilation compared with endotracheal intubation. Supraglottic jet ventilation was associated with an increase of approximately 8 mmHg in mean arterial pressure. In contrast, the increase in mean arterial pressure with endotracheal intubation was approximately 39 mmHg. This difference is particularly of more significance in elderly patients with coronary artery disease. In the present study, heart rate differed significantly between the groups intraoperatively. Supraglottic jet ventilation was associated with an increase of approximately 6 beats/min. in heart rate. In contrast, the increase in heart rate with endotracheal intubation was approximately 35 beats/min.

Laryngoscopy and Endotracheal intubation produce reflex sympathetic stimulation and are associated with raised levels of plasma catecholamines, hypertension, tachycardia, myocardial ischaemia, depression of myocardial contractility, ventricular arrhythmias and intracranial hypertension. These responses may be particularly deleterious in patients with hypertension, IHD, myocardial dysfunction and raised intraocular and intracranial pressure. These responses, also occur during tracheal extubation and suction. There was no significant difference in peripheral oxygen saturation levels between both the groups. Adequate oxygenation was maintained in both the groups intraoperatively. Postoperative complications like sore throat, hoarseness of voice was more frequently seen in intubated patients. Intrapulmonary air trapping may occur due to obstruction when surgical instruments are introduced. Although per definition not applied supraglottically, JV through a bronchoscope resembles ventilation through a laryngoscope. However, as a consequence of a more distal injector position and a narrower diffuser tube than in a laryngoscope, the entrainment fraction is likely to be less than in true supraglottic JV.

LIMITATIONS OF SUPRAGLOTTIC JET VENTILATION:

1. Supraglottic techniques require the airway to be maintained during the procedure by the surgeon, and the quality of ventilation can be impaired by malalignment of the jet with the airway during attempts to access the operative site.
2. There is also greater vocal cord movement when compared to the other techniques and a risk of blowing debris into the airway.
3. It is not possible to monitor PAWP or end-tidal CO2 (ETCO2) with the supraglottic approach.
4. Rapid increase in airway pressure.
5. No control of FiO2.

Demet Altun, Eren Yılmaz, Bora Başaran, Emre Çamcı: Surgical Excision of Post-intubation Granuloma Under Jet Ventilation, 201 Studies have determined that infraglottic technique is more effective than supraglottic technique as it provides ventilation below the level of vocal cords and causes minimal movement in the cords.[11] Blowing of blood and tissue particles to the upwards and outside with expiratory airflow appears to be another advantage of the technique. Klein U et al[12,13] successfully used the infraglottic ventilation in the treatment of laryngeal lesions and in taking biopsy from vocal cords and observed no related complications such as hypoxia, hypercapnia, or barotrauma. In the present case as well, infraglottic jet ventilation was performed and the granuloma was excised under precise surgical view by means of a thin catheter.

Performing supraglottic technique as the other option was reported in a 50-case series that underwent microlaryngeal surgery for tracheal stenosis.[14] In that series, successful airway management was provided and need for intubation due to hypoxia was reported in only one case. Amanda Hu, has used effectively the subglottic ventilation. He previously reported a series of 552 patients over a 10-year period with no major complications. This is a continuation of that series with an additional 5 years of cases. Study Design: Retrospective consecutive case series. Patients who were ventilated with the HMJT for microlaryngeal surgery at the University of Washington Medical Center over a 15-year period (1995–2010) were identified from the Voice Disorders database. Although subglottic ventilation via an HMJT is a safe alternative to traditional endotracheal intubation in an appropriately selected population, practitioners should remain vigilant about the known complications.

In 1969, Ihra G, Hieber C, Schabernig C, Kraincuk P, Adel S, Plöchl W, Aloiy A. Supralaryngeal tubeless combined high-frequency jet ventilation for laser surgery of the larynx and trachea.[14] used a high-frequency ventilation technique to ventilate experimental animals in which they were studying arterial pressure regulation. They used high-frequency positive pressure ventilation rather than spontaneous breathing, mainly because with the former, respiration-synchronous blood pressure variations and respiratory cardiac arrhythmia could be eliminated. In addition, they found that the functional properties of the blood pressure regulation system remained qualitatively comparable when spontaneous breathing was switched to high frequency positive pressure ventilation. These preliminary results suggested that blood pressure was minimally altered by high frequency positive pressure ventilation. This review focuses on the comparative haemodynamic effects of conventional mechanical ventilation and HFJV.

SUMMARY AND CONCLUSION: A total of 60 patients between the age group of 20-75 years were included in the study. They were ASA 1, 2 or 3 and scheduled for the minor laryngeal surgeries under general anaesthesia. Patients were randomised in to 2 groups as group A and group B to receive supraglottic jet ventilation and conventional endotracheal ventilation respectively. The p value between the 2 study groups is 0.0001 which is highly statistically significant. Our study showed that supraglottic jet ventilation showed a better haemodynamic stability when compared to conventional endotracheal intubation in patients undergoing minor laryngeal surgeries. Statistical scores were also in favour of the patients treated with supraglottic jet ventilation based on the p values.

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