Comparison of Orotracheal versus Nasotracheal Fiberoptic Intubation Using Hemodynamic Parameters in Patients with Anticipated Difficult Airway

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Abstract

Background: Both nasal and oral routes can be used for fiberoptic intubation. Often it leads to hemodynamic disturbances, which may have a significant effect in patients with limited cardiopulmonary reserve as well as with cerebrovascular diseases. Aims: The aim of the study was to evaluate whether there is a clinically relevant difference between the circulatory responses to oral and nasal fiberoptic intubation.

Settings and Design: This was a prospective, randomized, and comparative study. Materials and Methods: In this study, a total of 90 patients with the American Society of Anesthesiologist physical status I and II of either sex in the age group of 18–60 years and having anticipated difficult airway (DA) posted for elective surgery under general anesthesia were randomly allocated into two groups. Patients underwent fiberoptic intubation via either oral or nasal route under sevoflurane anesthesia with bispectral index guidance. Heart rate (HR), systolic blood pressure (SBP), diastolic blood pressure (DBP), mean arterial pressure (MAP), time taken to intubation, and need of maneuver were measured.

Statistical Analysis Used: All the analyses were carried out on SPSS 16.0 version (Inc., Chicago, USA). Mean and standard deviation were calculated. The test of analysis between two groups was done by unpaired t-test. Results: Demographic and DA characteristics were similar in both the groups. Significantly ($P < 0.01$) lesser alteration in HR, SBP, DBP, and MAP was seen in oral fiberoptic intubation when compared to nasal fiberoptic intubation in the early phase of postintubation. Time taken to intubation was also significantly ($P < 0.01$) lesser in the oral route compared to the nasal route. Conclusions: Oral fiberoptic intubation causes less hemodynamic alteration and takes less time in comparison to nasal fiberoptic intubation.

Keywords: Anticipated difficult airway, bispectral index, hemodynamics, route of fiberoptic intubation, sevoflurane

INTRODUCTION

In modern anesthesia practice, difficult airway (DA) continues to challenge anesthesiologists. DA includes difficult mask ventilation, difficult intubation, or both. Fiberoptic-guided intubation is considered as “gold standard” of DA management and has a definite place in the DA algorithms of various professional bodies.[1,2]

Awake fiberoptic intubation of the airway can be achieved safely with a variety of techniques. However, inhalational induction with the maintenance of spontaneous ventilation has been suggested as a method to facilitate intubation when difficulty is anticipated or there is an allergy to local anesthetic agents or awake intubation attempt has failed due to inadequate oropharyngeal or laryngeal airway anesthesia or there is lack of patient cooperation or due to operator’s inexperience.[3,4]

This technique avoids the use of neuromuscular blocker and also maintains an adequate depth of anesthesia, which is essential to prevent bucking, laryngospasm, and, bronchospasm and also decreases hemodynamic alterations during fiberoptic intubation. We used this technique in all patients during fiberoptic intubation.

Bispectral index (BIS) was used to monitor the depth of anesthesia.[5,6]

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Both nasal and oral routes can be used for fiberoptic intubation. Often, it is done either awake or under mild sedation, invariably leading to hemodynamic disturbances. The effect on hemodynamic parameters may vary depending on the route of intubation chosen: oral or nasal. Fluctuation in hemodynamic parameters will have a significant effect in patients with limited cardiopulmonary reserve as well as with cerebrovascular diseases. Despite the obvious differences in the sympathetic stimulation caused by nasal or oral intubations, there are very few studies available that compare hemodynamic responses between oral and nasal fiberoptic intubation.

The present study was designed to investigate whether there is a clinically relevant difference between the circulatory responses to fiberoptic oral intubation and fiberoptic nasal intubation when carried out by experienced practitioners in anticipated DA patients receiving general anesthesia.

**Materials and Methods**

**Study design and settings**

It was a prospective randomized control trial. The study was conducted at a tertiary care center hospital between February 2016 and July 2017.

**Methods**

Ethical committee approval was obtained from the institute’s ethical committee (IEC No. 56/15). Informed consent in local language was obtained from each patient prior to inclusion in this study.

**Inclusion criteria**

The American Society of Anesthesiologist physical status classes I and II of either sex in the age group of 18–60 years and having anticipated DA posted for elective surgery under general anesthesia were included in the study.

**Exclusion criteria**

Patient who refused to give consent, patients having reactive airway disease, current upper airway or chest infection, history of epistaxis, nasal or oral mass, and history of nasopharyngeal or oral surgery or any bleeding disorder, patients with hypertension, heart disease, and use of medications known to affect blood pressure and heart rate (HR), or patients with morbid obesity and pregnancy were excluded from the study.

The record was kept of all patients evaluated for inclusion and of patients who chose to withdraw from the study.

**Sample size estimation**

Sample size estimation was done to evaluate the difference in the hemodynamic variable, measured through rate-pressure product (RPP). We hypothesized that if a minimum difference of 10% in RPP is observed at the time of induction in both these groups, we would be able to say that the difference in the hemodynamic variable in both these groups is statistically significant. Using 9600 as the normal mean RPP (HR = 80 and systolic blood pressure [SBP] = 120) and 1500 as the standard deviation (SD) for RPP, we needed to allot 40 patients to each group to be able to test the above hypothesis with a confidence of 0.95 and power of 0.8. To account for dropouts, we decided to recruit 45 patients in each of both the groups, making a total sample size of 90 patients.

Using computer-generated random number table, 90 patients were randomly allocated in equal proportion into two study groups of 45 each:

- Group O = Oral fiberoptic intubation group (n = 45)
- Group N = Nasal fiberoptic intubation group (n = 45).

Blinding was not possible in this study as the operator was aware of route of intubation used in this study.

The primary outcome measures were hemodynamic parameters measured as SBP, diastolic blood pressure (DBP), mean blood pressure (MBP), HR, and RPP.

The secondary outcome measure was the ease of intubation (measured as the time taken to intubate and need of maneuver).

A thorough preoperative evaluation including a complete airway evaluation to predict difficult laryngoscopy and intubation using Benumof’s 11 parameters analysis was performed. Of 11 parameters of Benumof’s analysis [Table 1], patients with ≥2 positive parameters were included in the study.

All patients followed common standard fasting guidelines of minimum 6 h, and tablet ranitidine 150 mg in the night before surgery and early in the morning was used as anti-aspiration prophylaxis.

In the operation theater, after achieving intravenous (i.v.) access, all monitoring devices (non invasive blood pressure, HR, electrocardiography, and pulse oximetry) were attached and monitored. After explaining to the patient, the skin of the forehead was cleaned with an alcohol swab and dried with gauze before application of the disposable BIS sensor strip (BIS Quatro, Covidien, USA) on the forehead in accordance to the manufacturer’s instructions and connected to the BIS monitor.

**Table 1: Benumof’s 11-parameter analysis**

| Airway parameter                        | Suggestion of difficult intubation |
|----------------------------------------|-----------------------------------|
| Inter-incisor gap                      | <3 cm                             |
| Back teeth                             | Prominent “overbite” maxillary teeth |
| Length of upper incisors               | >1.5 cm                           |
| Voluntary protrusion of the mandibular teeth anterior to maxillary teeth | Inability to extend mandibular incisors anterior to maxillary incisors |
| Mallampati class                       | Grade 3 or 4                       |
| Palate configuration                   | Highly arched or very narrow       |
| Thyromental distance                   | <6 cm or <3 ordinary finger breadths |
| Compliance of mandibular space         | Stiff, indurated or occupied by mass |
| Neck length                            | Short                             |
| Neck thickness                         | Thick                             |
| Head-and-neck movement                 | Cannot touch the chin to chest or cannot extend the neck |

*Benumof, Hagberg’s. Airway Management. 3rd ed. Philadelphia: Saunders; 2013. p. 223
In Group O, the operator stood at the leg end on the right side of the patient with the monitor placed at the head end of the patient to introduce the flexible fiberoptic device. Ovassapian airway was used to guide the scope in this group.

In Group N, the operator stood at the head end of the patient with a monitor at leg end of the patient to introduce the flexible fiberoptic bronchoscope. In this group, a relatively wider clear nostril passage was selected for fiberoptic insertion.

Before induction, the baseline values of SBP, DBP, mean arterial pressure (MAP), and HR were noted.

The monitor for measurement of blood pressure was changed to continuous mode with a response time of 1 min. Patients were preoxygenated with 100% oxygen for 3 min. Patients were premedicated with i.v. midazolam 0.02 mg.kg\(^{-1}\) and i.v. fentanyl 1 µg.kg\(^{-1}\) as boluses. The patient’s head was placed in a neutral position. Breathing circuit was primed with sevoflurane 8% and 100% O\(_2\) with a fresh gas flow of 8 L.min\(^{-1}\) for 1 min, and then, patients were instructed to take deep breath through the mask. Inhalational induction of anesthesia was initiated with sevoflurane 8% and titrated to reach the targeted BIS of 35 ± 5 and maintained within the target range for 2 min. The patient’s spontaneous ventilation was maintained.

A flexometallic cuffed endotracheal tube with an internal diameter of 7.0–7.5 mm was used in this study. Before intubation, the endotracheal tube was adequately lubricated with water-based jelly and threaded over a fiberoptic bronchoscope of 5.5 mm diameter (the same size of scope was used in all patients).

During intubation, airway maneuver if needed was done by a trained assistant, who applied jaw thrust when asked by the operator. After the glottis was visualized, the fiberoptic bronchoscope was passed between the vocal cords and downward through the middle of the trachea to avoid mucosal injury. Care was taken to ensure that the tip of the bronchoscope was not advanced too deep into the trachea (usually no more than 6 cm below the glottis) to avoid stimulation of the carina. The endotracheal tube was railroaded over the flexible fiberoptic bronchoscope. After the endotracheal tube was placed into the trachea and its appropriate position was confirmed, the fiberoptic bronchoscope was gently removed.

All fiberoptic intubations were performed by the same person who has experience (more than 100 of oral and nasal each) in both the methods to avoid operator bias in this study.

After intubation, the endotracheal tube was connected to the breathing circuit of anesthesia workstation. Anesthesia was maintained with 40% O\(_2\) and 60% N\(_2\)O with sevoflurane.

Hemodynamic parameters (SBP, DBP, MAP, and HR) and RPP (HR × SBP) were recorded at the following time points: (i) after a stabilization period of 10 min in operation theatre (baseline), (ii) after anesthesia induction, (iii) after intubation, (iv) further every minute for next 5 min, and (v) at 10 min postintubation.

The intubation time (the time from the introduction of the fiberscope into the mouth or nose till the connection of endotracheal tube to the breathing circuit) and need of any maneuver were recorded by the assistant.

After induction, a fresh gas flow of 2 L.min\(^{-1}\) was used. Sevoflurane vaporizer dial setting was adjusted to maintain target BIS 35 ± 5. Ventilator settings were adjusted to maintain E\(_{\text{CO}2}\) levels of 35–40 mmHg. During the observation period of 10 min, no manipulations (including the movement of head and skin preparation of the operating field) were allowed on the patient to prevent any further stimulation.

Appropriate nondepolarizing neuromuscular blocker was given postobservation period following which skin preparation and surgery were carried on.

**Statistical analysis used**

The results are presented in frequencies, percentages, and mean ± SD. The Chi-square test was used to compare the categorical variables between the groups. Unpaired t-test was used to compare the continuous variables between the groups. The repeated measures of analysis of variance were used to find the effect of time and time to group’s interaction in the change in the hemodynamic parameters. \(P < 0.05\) was considered significant. All the analyses were carried out on SPSS 16.0 version (IBM Inc., Chicago, IL, USA).

**Results**

A total of 108 patients were assessed for this study [Figure 1], of which 10 patients were excluded as not meeting the inclusion criteria and 8 refused to participate in the study.

There was no dropout of the study.

Demographics and Benumof’s DA parameters were analyzed using Chi-square test and found to be comparable between two groups [Table 2].

There was no significant \(P > 0.05\) difference in the HR, SBP, DBP, and RPP at the baseline and after intubation between the two groups.

HR was found to be significantly \(P < 0.01\) lower in patients of Group O than Group N from intubation till 5 min. The repeated measures of analysis of variance revealed that there was a significant effect of time \(P < 0.05\) and time to group interaction \(P < 0.05\) in the change in HR [Table 3].

Both SBP and DBP were found to be significantly \(P < 0.01\) lower in patients of Group O than Group N from intubation till 4 min.

On comparing MAP between both the groups, it was found to be significantly \(P < 0.01\) lower in Group O from intubation till 4 min [Table 4].

RPP was found to be significantly \(P < 0.01\) lower in patients of Group O than Group N from intubation till 4 min [Table 5].
The mean intubation time was 34.47 (±4.57) s in the oral group, whereas in the nasal group, it was 52.02 (±6.89) s. On statistical analysis using Student’s unpaired t-test, it was found to be significantly (P = 0.001) lower in patients of Group O than Group N.

Jaw thrust maneuver was required in 77.8% of the patients of Group O, whereas in the Group N, it was required in only 44% of the cases, and this difference was also found to be statistically significant (P = 0.01).

SpO2 values were similar in both the groups across all time periods.

**DISCUSSION**

This study was carried out to evaluate whether there is a clinically relevant difference between the circulatory responses to oral versus nasal fiberoptic intubation in patients with anticipated DA receiving general anesthesia.

As the depth of anesthesia at the time of intubation could influence the cardiovascular intubation response,[12-14] we also standardized the induction technique using a sevoflurane induction agent under the guidance of BIS system in this study. We chose BIS value of 35 ± 5 on the basis of previous studies. Oberer et al. found that BIS-assigned hypnosis level of 40 provided better intubation conditions and lesser laryngeal reflexes in both the groups compared with an assigned hypnosis level of 60.[15] Schneider et al. reported that BIS values of 50–60 were inadequate to prevent awareness reaction to intubation during propofol/alfentanil anesthesia in adults.[16] All the above studies suggest that a BIS value higher than 40 may not provide the most ideal conditions for intubation and hence may increase the risk for airway complications.

Maintaining cardiovascular stability is of utmost importance during intubation, especially in patients with limited cardiopulmonary reserve.

In our study, we found significantly lower HR in the oral fiberoptic group compared to the nasal fiberoptic group at intubation and at 1, 2, 3, 4, and 5 min post intubation respectively. HR recovered to the baseline value by 3 min in the oral group, whereas in the nasal group, it took 5 min.
SBP, DBP, and MAP were significantly lower in Group O as compared to Group N at intubation and at 1, 2, and 3 min postintubation, respectively. All these pressures recovered to the baseline after 2 min in Group O, whereas in Group N, baseline values were attained at 3 min.

This may be because nasal intubation is a more invasive airway procedure in comparison to oral intubation as the nasal passage is longer and narrower than the oral cavity, which produces greater mechanical stimulation of the upper airway and thus leading to more vigorous activation of the sympathetic nervous system.

Our findings are comparable to that of Shibata et al., who in their study observed that the cardiovascular responses to oral fiberoptic intubation are less severe than those to the nasal approach.\(^\text{[17]}\)

While Fletcher et al. in their study done on patients who were on mechanical ventilation using either an oral or a nasal tracheal tube following cardiac surgery found that there were no differences in HR as well as arterial pressure between the oral and nasal groups.\(^\text{[17]}\)

Xue et al. reported that both fiberoptic orotracheal intubation and fiberoptic nasotracheal intubation resulted in significant increases in blood pressure, HR, and RPP compared to baseline and postinduction values.\(^\text{[18]}\) However, the time required to reach the maximum values of SBP and HR was significantly longer in the fiberoptic nasotracheal intubation group than in the fiberoptic orotracheal intubation group.

The difference of results in our study and study by Xue et al. might be due to the use of 2% lidocaine gel, which was applied for lubrication of the nasal passage. It could have produced topical nasal anesthesia, blocking the mechanical stimuli to the nasal cavity and attenuating the hemodynamic responses to nasal intubation.

Smith and Grewal in their observed study that the hypertensive response to nasal intubation of the trachea under general anesthesia is significantly greater and more sustained than that of oral intubation similar to our study.\(^\text{[19]}\)

RPP is an index of myocardial oxygen consumption.\(^\text{[20]}\) A value exceeding 22,000 is commonly associated with myocardial ischemia.\(^\text{[21]}\) The maximum increase in RPP was at intubation in both the groups. RPP was found to be significantly \((P < 0.01)\) lower in patients of Group O than Group N from intubation till 4 min. At intubation, RPP was 13,648 in Group O and 16,500 in Group N. A higher value of RPP in Group N signifies higher myocardial oxygen demand with this technique in comparison to oral fiberoptic intubation which can be of significance in patients with poor pre-existing myocardial perfusion.

The average time taken for oral fiberoptic intubation was 34.4 (±4.57) s, whereas in nasal fiberoptic intubation, it was 52.02 (±6.89) s. We found longer intubating time with the nasal fiberoptic group in comparison to the oral fiberoptic group. Longer intubating time may also have contributed to significant hemodynamic alterations due to prolonged sympathetic stimulation.

Our findings are comparable to that of Xue et al., who in their study reported that the mean (SD) intubation time was significantly longer in the Group O – 53.2 (8.5) s than in the Group N – 34.5 (8.9) s; \(P < 0.05\).

Jaw thrust maneuver was required in 77.8% of the patients of Group O, whereas in Group N, it was required in only 44% of the cases, and this difference was found to be statistically significant.

Based on the above two observations, it can be inferred from this study that although maneuver was required more in oral intubation in comparison to nasal fiberoptic intubation still, oral fiberoptic intubation required less time in comparison to the nasal route.

In both the groups, none of the patient developed bradycardia, hypotension, desaturation, bronchospasm, laryngospasm, recall of unpleasant memories, postoperative sore throat, postoperative painful nose, and tissue injury except four patients of Group N who had a nasal bleed, which is a well-described common complication of nasal fiberoptic intubation. It was treated successfully with conservative management.
The nasal passage has been the preferred route for fiberoptic intubation in clinical practice owing to ease of keeping the fibrescope in the midline. This study can change this practice, especially in patients who have compromised cardiopulmonary reserve.

**Limitation of the study**
This study was a preliminary trial. The results of this study need to be corroborated by conducting a large multicenter randomized clinical trial.

Moreover, in our study, we have chosen to do oral fiberoptic intubation from patient’s caudad end. Future study comparing oral fiberoptic intubation from cephalad versus caudad approach can further explore the preferred position of the operator.

**Conclusions**
In spite of the increased requirement of maneuver in oral fiberoptic intubation, it was associated with less time taken and lesser complications in terms of local injury and provided more stable hemodynamic parameters compared to nasal fiberoptic intubation.

Hence, oral fiberoptic intubation would be a safer route in comparison to nasal fiberoptic intubation in patients with anticipated DA who can poorly tolerate sympathetic responses.

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**Conflicts of interest**
There are no conflicts of interest.

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