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**Research Article**

# Evaluation of laryngoscopic view, intubation difficulty and sympathetic response during direct laryngoscopy in sniffing position and simple head extension: a prospective and randomized comparative study

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## ABSTRACT

**Background:** Airway management is critical to the care of patients and direct laryngoscopy is the mainstay of airway management. Despite the proliferation of difficult airway devices, sniffing position for laryngoscopy remains the gold standard and ideal position. This prospective, randomized and single-blind study was done to evaluate and compare the laryngoscopic view, complexity of intubation and sympathetic response during laryngoscopy in sniffing position and simple head extension.
**Methods:** One hundred and twenty patients, aged 20-50 years with American Society of Anesthesiologists (ASA) status 1 and 2 undergoing general anesthesia requiring orotracheal intubation were randomized into two groups. Group A used sniffing position and group B was put in simple head extension. Glottis visualization was assessed using Cormack and Lehane grade and ease of intubation was assessed on intubation difficulty scale. Laryngoscopic sympathetic response in two positions was also assessed.
**Results:** Both the groups were comparable in demographic profiles. Glottic visualization and intubation difficulty score were better and statistically significant in sniffing position as compared to simple head extension. Although, sympathetic response was lower in sniffing position as compared to simple head extension, it was statistically insignificant.
**Conclusion:** Sniffing position provided better glottis visualization and intubation difficulty score and increased the success rate of intubation as compared to simple head extension.

**Keywords:** Laryngoscopy, Endotracheal Intubation, Glottis

## INTRODUCTION

Direct laryngoscopy is the mainstay of airway management, and despite the proliferation of difficult airway devices, alternative methods of intubation are used extremely infrequently in all settings. Proper positioning of the head and the neck is prerequisite for optimizing the laryngeal view during direct laryngoscopy. Its importance has been recognized since Kirstein[1] first described the procedure in 1895. Inadequate positioning may result in prolonged or failed tracheal intubation attempts because of the inability to visualize the larynx.

There is a large discrepancy between the incidence of difficult laryngoscopy ranging from 5% of multiple attempts and 18% of poor laryngeal view to the rate of failed laryngoscopy ranging from less than 0.4% in the emergency department to 0.05% in the operating room. In most instances, difficult laryngoscopy correlates with poor laryngeal exposure. So the 'Sniffing Position'[2] has been traditionally recommended for a long time as the optimal position for direct laryngoscopy. Direct laryngoscopy can also be performed with the head in simple extension. Advocates of the sniffing position maintain that it aligns the oral, pharyngeal and laryngeal axes, allowing the line of vision to fall directly on the laryngeal inlet. Concerns about the anatomical soundness of the "Three Axes Alignment Theory"[3] (TAAT) laid by Bannister and Macbeth initially, were raised, however, during the last decade. Subsequently, the superiority of the sniffing position over other head and neck positions was also questioned. Furthermore, it was found that elevating the head higher than what is needed for a conventional sniffing position may improve laryngeal exposure in some patients. The paucity of clinical research that attempted to investigate the optimal head position for direct laryngoscopy is surprising, considering the frequency with which the technique is performed and the complications that may result from difficult laryngeal visualization.

This study was carried out to evaluate the laryngoscopic view and intubating conditions in sniffing position compared with the simple head extension during direct laryngoscopy in patients undergoing general anesthesia for elective surgeries. The complexity of intubation was assessed using a quantitative score-"The Intubation Difficulty Score".[4] The predictive factors associated with improvement of glottis visualization by the sniffing position maneuver and the sympathetic response to intubation in sniffing position and simple head extension were also studied.

## METHODS

In this randomized and comparative study, 120 patients, aged 20-50 years, ASA physical status 1and 2, scheduled for elective surgical procedures under general anesthesia, requiring orotracheal intubation were included. The patients with known or anticipated difficult airway (thyromental distance <6 cm, limited neck mobility, limited mouth opening, Mallampati score 3 and 4, facial deformity and abnormality of mouth, larynx, pharynx or tongue), patients who required rapid sequence induction due to high risk of aspiration and obese patients with body mass index (BMI) >30 kg/m$^2$ were excluded from the study. Patients were given a comprehensive explanation regarding the study and written informed consent was obtained prior to the procedure.

They were randomly allocated in two groups of 60 each, according to the position to be used for laryngoscopy using a computer based randomization. Group A= sniffing position, Group B= simple head extension. Details regarding patient's clinical history and physical examination were noted. History of previous difficult tracheal intubation reported by the patient or documented in their previous anaesthetic records were noted. Pathological conditions associated with difficult tracheal intubation like Malformation of the face, acromegaly, cervical rheumatism with limitation of neck movements, tumours of the airway and diabetes mellitus with 'stiff joint syndrome 'were also noted. Clinical symptoms of airway pathology like dyspnoea related to compression of the airway, dysphonia, dysphagia and previously documented sleep apnoea syndrome were noted.

Pre-operative airway assessment was done. Mouth opening was measured by asking the Patients to open their mouth as wide as possible and the interincisor gap (cm) was measured with the mouth fully opened in the midline. A value of less than 3.5cm was considered predictive of intubation difficulty. Hyomental and thyromental distance were measured along a straight line from the hyoid and thyroid notch respectively to the lower border of the mandibular mentum with the head in full extension. A value of less than 4.5cm and 6.0 cm respectively were considered to be associated with difficult intubation. Sternomental distance was measured along a straight line from the mentum to the sternal notch with the head in full extension. A value of less than 12cm was considered to be associated with difficult intubation. Protrusion of mandible was assessed by asking the patients to prognath, with mandible subluxation graded as positive, if the patient could bring the lower incisors forwards in front of the upper incisors, as none if the lower incisors and upper incisors were tip-to-tip, and as negative if the patient was unable to perform these manoeuvres. The amplitude of neck and head movement was measured as described by Wilson et al.[5] This requires that the subject fully extends the head and neck. A pencil is placed flat on the forehead and the patient is asked to fully flex while the observer measures the change of angle in reference to a fixed point. This is then divided into $<80^0$ and $>80^0$.

To assess modified mallampati class,[6-7] the patient was seated in front of the observer with the head in neutral position, mouth wide open and maximum protrusion of the tongue without phonation. The visibility of oropharyngeal structures was classified, Mallampati class I and II were considered to predict simple intubation whereas Mallampati class III and IV were considered to be predictors of difficult intubation and were excluded from the study. Class I : Visualization of the soft palate, fauces, uvula, anterior and posterior pillars. Class II : Visualization of the soft palate, fauces and base of uvula. Class III: Visualization of the soft palate and base of uvula. Class IV : Visualization of hard palate only. Body mass index was calculated as the weight in kilograms divided by the square of the height in meters. Obesity was defined as a body mass index greater than 30 kg/m$^2$.Preoperative investigations were done based on surgical procedure, physical status and age of the patients. Patients were fasted for at least six hours prior to the surgery. Patients were given alprazolam 0.25 mg previous night.

On arrival in the operation theatre, an intravenous line was secured in all patients and electrocardiography, noninvasive blood pressure monitoring and pulse oximetry were started. Midazolm 0.05 mg/kg and glycopyrrolate 0.005 mg/kg were administered intravenously. The patients in group A (Sniffing position) patients were placed supine and a noncompressible cushion of 8 cm height was placed under the head. At the time of laryngoscopy, the head was extended on the atlanto- occipital joint maximally. Group B (simple head extension) patients were placed supine without the cushion. The head was extended maximally on the atlanto- occipital joint at the time of laryngoscopy. The standard induction technique was applied to all the patients. They were preoxygenated for three minutes and induction was done with fentanyl 2 µg/kg, and Propofol 2 mg/kg. Neuromuscular block was achieved with succinylcholine 1.5 mg/kg i.v. and intermittent positive pressure ventilation was maintained with 100% oxygen using a magill circuit for one minute. Laryngoscopy was done in all the patients using macintosh laryngoscope blade size -3 to ensure the consistency of the technique. Glottic visualization during laryngoscopy was assessed using modified Cormark and Lehane classification (without optimal external laryngeal manipulation).[8] External laryngeal manipulation was permitted after evaluation in order to facilitate endotracheal intubation.

After noting the grade of laryngoscopy, tracheal intubation was performed with endotrcheal tube (7.0-7.5 mm for females and 7.5-8.0 mm for males) and the “Intubation difficulty scale”[4] based on the seven parameters was recorded and was used to asses difficulty in intubation. Intubation difficulty scale was defined as :- $N_1$: 0-no supplementary attempt required, 1- any supplementary attempt required; $N_2$ : 0- no supplementary operator required, 1- any supplementary operator required; $N_3$: 0- no alternative intubation technique used, 1- any alternative intubation technique used; $N_4$ : 0- Cormack and Lehane Grade 1, 1- Cormack and Lehane Grade 2, 2- Cormack and Lehane Grade 3, 3- Cormack and Lehane Grade 4 ; $N_5$ : 0- no subjectively increased lifting force required during laryngoscopy, 1- Subjectively increased lifting force required during laryngoscopy; $N_6$ : 0- no optimal external laryngeal manipulation required, 1- optimal external laryngeal manipulation required; $N_7$ : 0- Vocal cords abducted, 1- Vocal cords adducted. Intubation difficulty score (IDS) is the sum of $N_1$ to $N_7$ : Score 0= No difficulty at all, Score 1-5= Mild difficulty, Score >5= Moderate to severe difficulty.

Sympathetic stimulation in terms of heart rate and mean arterial pressure was noted 5 minute before induction, at the time of laryngoscopy, 5 min after laryngoscopy and 10 min after laryngoscopy. Rest of anaesthesia was continued as per standard protocol. Anaesthesia was maintained with N2O: O2::50%:50% supplemented with isoflurane (0.6-1.0%) and atracurium as and when required. At the end of surgery, residual neuromuscular block was reversed with neostigmine (0.05mg/kg) and glycopyrrolate (0.01mg/kg). All the patients were extubated and shifted to post anesthesia care unit. Complications, like fall of peripheral oxygen saturation and dysrrhythmias during laryngoscopy, were also noted.

Statistical analysis was done using Unpaired t-test for the age, body mass index, mouth opening, hyo- mental distance, thyro- mental distance and sterno- mental distance, mean blood pressure and heart rate. Chi square test was applied for sex and assessing statistical significance of modified Mallampati grade, glottic visualization grade and intubation difficulty score. P value of <0.05 was considered to be significant.

## RESULTS

The patients in both the groups were comparable in terms of age, sex, BMI, interincisor gap, hyomental distance, thyromental distance and sternomental distance (p > 0.05) (Table-1). Both the groups were also comparable with regard to Mallampatti class (p>0.05) (Table 1). There were no patients in class 3 and 4, as they were excluded from the study. Laryngoscopy was possible in all the patients and glottic visualization grade based on cormack and lehane classification was found to be superior in group A as compared to group B and statistically significant (p<0.04) (Table 2).

**Table 1: Demographic profile and airway parameters in two groups.**

| Group | Age (years) | Sex (M/F) | BMI (kg/m²) | IID (cm) | HMD (mm) | TMD (mm) | SMD (mm) | Mallam-patti grade (1/2) |
|---|---|---|---|---|---|---|---|---|
| A | 31.28±8.04 | 31/29 | 22.87±2.49 | 60.90±2.04 | 55.18±3.21 | 84.96±2.68 | 165.56±4.95 | 52/8 |
| B | 30.90±6.89 | 32/28 | 23.73±3.02 | 60.36±2.19 | 55.36±3.70 | 84.55±3.02 | 165.23±5.11 | 46/14 |
| P value | 0.780 | 0.85 | 0.091 | 0.160 | 0.776 | 0.345 | 0.720 | 0.157 |

Values are expressed as mean±standard deviation. BMI=body mass index, IID=interincisor gap, HMD=hyomental distance, TMD=thyromental distance, SMD=sternomandibular distance.

**Table 2: Comparison of laryngoscopic difficulty in two groups.**

| Cormack and Lehane grade | Group A | Group B |
|---|---|---|
| Grade I | 50 | 38 |
| Grade II | 08 | 18 |
| Grade III | 02 | 04 |
| Grade IV | 00 | 00 |

P value (0.04*)=significant

Comparison of intubation difficulty score between two groups demonstrated no statistically significant difference except in N3, which implies alternative technique required for intubation and N4 which implies the laryngoscopic view (Cormack and Lehane grade). More patients in Group B had N3 score of one (n=31) as compared to Group A (n=16) (p <0.05).Similarly, there were fewer patients in Group B (n=29) than Group A (n=44) with N3 score of zero (p <0.05). The P value was 0.005 for N3 variable in two groups which was highly significant. Laryngoscopic view (Cormack and Lehane grade) was better in Group A with more patients having a N4 score of zero (n= 50) as compared to Group B (n=38). Similarly, there were more patients in Group B (n=18) as compared to Group A (n=08) with N4 score of one. Also, more patients in Group B (n=4) had N4 score of two as compared to Group A (n=2). No patients in either group had N4 score of three. The total intubation difficulty score determining the ease of tracheal intubation was superior in Group A than in Group B (P value = 0.04). [Table 3]

Intubation difficulty score of 0 corresponding to easy intubation was observed in 38 (63.33%) patients in group A as compared to 28 (46.67%) patients in group B (p<0.05). Intubation difficulty score of 1-5 corresponding to mild difficulty was seen in 13 (21.67%) patients in group A and 18 (30.0%) patients in group B (p<0.05). Intubation difficulty score corresponding to moderate to severe difficulty was noted in 9 (15.0%) patients in group A and 14 (23.33%) patients in group B (p>0.05) (Table 4). This implies that the glottis visualization has improved with the use of sniffing position and the ease of tracheal intubation was better in sniffing position as compared to simple head extension.

**Table 4: Comparison of intubation difficulty score in two groups.**

| Intubation difficulty score | Group A ( n=60) | Group B (n=60) | P Value |
|---|---|---|---|
| 0 | 38(63.33%) | 28(46.67%) | <0.05 |
| 1-5 | 13(21.67%) | 18(30.0%) | <0.05 |
| >5 | 9(15.0%) | 14(23.33%) | >0.05 |
| Total | 60 | 60 | |

Although the rise in heart rate (Table 5) and mean blood pressure (Table 6) in response to laryngoscoy and intubation was lesser in group A as compared to group B, but this difference was not statistically significant. Thus, none of the two positions were statistically advantageous over other for attenuating the sympathetic response to laryngoscopy.

**Table 3: Comparison of intubation difficulty scale variables in two groups.**

| | $N_1$ | | $N_2$ | | $N_3$ | | $N_4$ | | | | $N_5$ | | $N_6$ | | $N_7$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 2 | 3 | 0 | 1 | 0 | 1 | 0 | 1 |
| Group A n=60 | 60 | 00 | 59 | 01 | 44 | 16 | 50 | 08 | 02 | 00 | 49 | 11 | 35 | 25 | 59 | 01 |
| Group B n=60 | 58 | 02 | 56 | 04 | 29 | 31 | 38 | 18 | 04 | 00 | 40 | 20 | 27 | 33 | 60 | 00 |
| P value | 0.154 | | 0.171 | | 0.005** | | 0.04* | | | | 0.061 | | 0.144 | | 0.315 | |

*=significant, **=highly significant

**Table 5: Comparison of heart rate in two groups**

| | 5 min prior to propofol administration | At the time of laryngoscopy | 5 min after laryngoscopy | 10 min after laryngoscopy |
|---|---|---|---|---|
| Group A n=60 | 89.66 ± 6.85 | 106.48 ± 7.90 | 100.68 ± 7.54 | 94.38 ± 6.51 |
| Group B n=60 | 88.96 ± 6.44 | 106.61 ± 8.55 | 99.93 ± 8.30 | 93.95 ± 7.26 |
| P value | 0.566 | 0.808 | 0.606 | 0.731 |

Values are expressed as mean ± standard deviation

**Table 6: Comparison of mean blood pressure in two groups.**

| | 5 min prior to propofol administration | At the time of laryngoscopy | 5 min after laryngoscopy | 10 min after laryngoscopy |
|---|---|---|---|---|
| Group A n=60 | 95.36+ 6.55 | 107.10+ 5.91 | 103.38+ 5.67 | 98.83+ 5.57 |
| Group B n=60 | 96.23+ 5.26 | 107.90+ 6.06 | 103.8+ 5.07 | 99.56+ 5.06 |
| P value | 0.422 | 0.527 | 0.675 | 0.454 |

Values are expressed as mean ± standard deviation.

## DISCUSSION

Intubation difficulty is commonly identified as a risk factor for morbidity and mortality.[9] Difficult tracheal intubation is defined by the American Society of Anaesthesiologists (ASA)[10] (1993) as when proper insertion of the endotracheal tube by conventional laryngoscopy requires more than three attempts, or more than ten minutes." The sniffing position is universally recommended for oro-tracheal intubation in the operating room. Samsoon GL[7] provided the first analysis of anatomical factors involved in laryngoscopy. According to him, the solution to the ease of intubation was to attain adequate depth of anesthesia and muscle relaxation. Conventional laryngoscopy and intubation requires a direct view of structures of larynx.

Jackson[2] was first to emphasize the importance of position of head for laryngoscopy and intubation. The classical rationale for sniffing position is that the alignment of the mandibular axis, pharyngeal axis, and laryngeal axis is facilitated, permitting successful direct laryngoscopy. This alignment may be hypothetically obtained by flexing the neck on the chest and by elevating the head approximately 7–10 cm with a pad under the occiput (shoulders ordinarily remaining on the table). This head position resembles a person 'sniffing the morning air'. According to the theory, to bring the mandibular axis in line with both the pharyngeal and laryngeal axis, the head must also be extended on the neck (extension of the junction of the spine and skull (atlanto-occipital joint). This maneuver appears to be the fundamental step before direct laryngoscopy.

It is widely believed that in the sniffing position the oral, pharyngeal, and laryngeal axes are brought more nearly into a straight line. However Adnet et al.[11] in 2001, using magnetic resonance imaging, found that it is not possible to achieve anatomic alignment of the laryngeal, pharyngeal, and the mouth axes as based on the three axes alignment theory neither in the neutral, simple head extension, nor the sniffing position. Whereas, Takenaka et al.[12] in his radiological study showed that 'sniffing position' provided greater occipito-atlanto-axial extension angle, increased the submandibular space and facilitated vertical alignment of the mandible, tongue base and larynx.[12] These studies involved non-anaesthetized volunteers, and the laryngoscopy was not performed. Placing the patient in the sitting position does not align the anatomic airway axes and application of a force with a laryngoscope blade is required to facilitate direct vision for the laryngoscopist.[12]

Chou HC[13] in 2001 further investigated the concepts of three axes and concluded that there is only involvement of two axes "oral and pharyngeal" and "the tongue". All these studies however pointed out that the angle between laryngeal axis and the line of vision was decreased in sniffing as well as simple head extension position. Thus these positions are comparable among themselves but better than neutral position.

Our study was done to validate the benefit of the systematic use of sniffing position as compared to simple head extension for patients undergoing surgeries under general anesthesia with endotracheal intubation. In our study both groups did not differ demographically, parameters of airway assessment did not differ statistically, the blade size was standardized for consistency and both the groups were comparable regarding mallampatti grade distribution.

Our finding correlates well with the study done by Singhal et al.[14] in 2008. They found that Intubation difficulty score was better in patients with sniffing position as compared to simple head extension. They found that both the groups were comparable as regards to seven variables of intubation difficulty score except for N3 variable which included alternative intubation techniques like change of position, change of blade, or use of stylet. Our results are similar to their observation with P value for N3 variable being 0.005 which is statistically highly significant. They noted that there was no statistically significant difference regarding glottic visualization grade (N4) variable in two groups. Contrary to their study, we found a statistically significant difference in glottis visualization grade (N4) in two groups, with N4 being better in sniffing position as compared to simple head extension (P value=0.04).

The results of our study were also contrary to the study done by Adnet et al.[15] in 2001, where they compared the "sniffing position" with simple head extension for laryngoscopic view in elective surgery. They found no significant advantage of the sniffing position over simple head extension in terms of laryngoscopic view (with the exception of obese patients and those with limited extension). The sniffing position improved glottic exposure (decreased the Cormack and Lehane grade) in 18% of patients and worsened it (increased the Cormack and Lehanegrade) in 11% of patients, in comparison with simple extension. The Cormack and Lehane grade distribution was not significantly modified between the two groups. But in our study, we found that glottic visualization grade was better in sniffing position as compared to simple head extension. We found a P value of 0.04 ($N_4$) between the two groups which is statistically significant.

Bhattarai et al.[16] in 2011 compared sniffing position with simple head extension for visualization of glottis during direct laryngoscopy in 400 patients. They found that glottis visualization is clinically better in sniffing position but not statistically significant (P value >0.05). Intubation difficulty score was statistically better in sniffing position as compared to simple head extension (P value <0.05).

The present study also correlates to a study done Manasi Ambardekar et al.[17] in 2008 on 300 adult patients comparing sniffing position with simple head extension for laryngoscopic view in elective surgical patients. They noted that the use of sniffing position for direct laryngoscopy was associated with an improvement in laryngoscopic view in 14.33% of the patients when compared with simple head extension (p< 0.025).

The present study has also tried to assess a quantitative score-"the intubation difficulty score" that can be used to evaluate the complexities of intubation. It is an objective scoring system, which is a function of seven parameters. Although increased number of attempts (N1) is the parameter most frequently described in association with difficult intubation, introduction of second operator (N2) or abandoning one technique for another (N3) suggest a difficulty, perhaps more so than a simple additional attempt. As such changing operator or techniques implies two additional points, one for the change and other for the additional attempt.The quality of laryngoscopic attempt is quantified using Cormack and Lehane classification. Intubation difficulty score is partly influenced by glottis exposure (N4). However poor visualization of glottis is not always associated with a difficult intubation, thus the laryngoscopic quality alone is not an adequate measure of difficulty, but forms an important component of the intubation difficulty score. Increased lifting force and optimum external laryngeal manipulation (OLEM) are frequently used to improve the glottic exposure (N5 andN6). This score considers these two factors, which tend to further emphasize the importance of quality of glottis visualization. Finally the status of the glottic exposure N7 will be affected by laryngospasm and cough, both of which have been identified as increasing the difficulty of intubation.

The results of our study are supported by the studies of Singhal et al.[14], Adnet et al.[15], Bhattari et al[16] and Ambardekar et al.[17] in terms of intubation difficulty score in two groups. All these studies suggest that sniffing position offers more ease of tracheal intubation than simple head extension. We found laryngoscopic view to be better in sniffing position as compared to simple head extension. The above mentioned studies also suggest that the laryngoscopic view is better in sniffing position as compared to simple head extension in difficult intubation situations like long standing diabetes mellitus, sleep apnea, loose upper incisors and tumors of the airway etc. We excluded these patients from our study and found laryngoscopic view to be better in sniffing position in normal patients as well.

Our study also evaluated the sympathetic response to laryngoscopy in the two positions. Although, the rise in heart rate and mean blood pressure in response to laryngoscopy and intubation was lesser in sniffing position as compared to simple head extension, the difference was not statistically significant. Theoretically, this is supported by the fact that, in sniffing position, glottic visualization as well as ease of intubation was better as compared to simple head extension. So, less of manipulation was obviously required for glottic view and intubation in sniffing position, thus reducing the sympathetic response. The limitations of our study were that despite standard anesthetic induction and use of muscle-relaxant before direct laryngoscopy, there was no neuromuscular monitoring device to monitor the depth of neuromuscular blockade to confirm that the pharyngeal and laryngeal muscles were adequately relaxed and ideal intubating conditions had been achieved. It was also impossible to blind the laryngoscopist to the intubation positions. There were a limited series of patients and only macintosch blade was used.

## CONCLUSION

To conclude, this study showed the sniffing position when compared to simple head extension provides a better glottis visualization score and has increased the success rate of tracheal intubation. Hence, the universal practice of sniffing position for laryngoscopy and intubation in anaesthesiology teaching cannot be abandoned. There was no significant difference in the changes in mean blood pressure and heart rate in the two groups in response to laryngoscopy and intubation.

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