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Original Research Article

Influence of head rotation on ease of mask ventilation: a randomized crossover study

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ABSTRACT

Background: Mask ventilation is an essential part of airway management. Head rotation increases the cross-sectional area of upper airway and improves upper airway patency.
Methods: A prospective crossover study in 40 patients aged 18-69, ASA physical status I, II, III and who needed general anesthesia with tracheal intubation were selected, divided into two groups of 20 each, group I and Group II. When apnea was achieved after standard general anaesthesia, mask ventilation was performed using pressure-controlled ventilation, peak inspiratory pressure 15 cm of water, 10 breaths per minute, I:E ratio 1:2. Face mask held by two hands. Group I patients received mask ventilation with the head in a neutral position for one minute, after which the head was turned to the right for one minute and the head is returned to the neutral position for one minute. In group II patients, mask ventilation was performed from right lateral position to neutral position to right lateral position. In each position, airway pressure, compliance and expiratory tidal volume were measured.
Results: There was no statistically significant difference between groups with respect to demographic data. The mean expiratory tidal volume was high in head rotation than neutral position (469.545±120.09 ml vs. 397.815±86.03 ml) p value <0.05. A statistically significant (p value=0.045) seen with respect to compliance which was slightly higher in head rotation (35.83) than neutral position (29.31).
Conclusions: Head rotation to the lateral position increases the expiratory tidal volume and compliance significantly as compared to head in neutral position and improves mask ventilation after induction of anaesthesia.

Keywords: Mask ventilation, Head rotation, Pressure controlled ventilation, Peak inspiratory pressure

INTRODUCTION

Mask ventilation is an essential part of airway management especially after induction of general anaesthesia. In conscious individuals, the maintenance of upper airway patency relies significantly on the interplay between baseline muscle tone and the activation of pharyngeal reflexes, which engage pharyngeal muscles during the inspiratory phase.[1] However, after induction of general anesthesia the efficacy of these reflexes were compromised, consequently jeopardizing upper airway patency and potentially leading to obstruction at critical sites such as the soft palate, epiglottis, and tongue.[2] The influence of head posture on upper airway patency has long been acknowledged, prompting the exploration of various methods to stabilize and ensure upper airway patency. Among these methods, the triple airway maneuver comprising the head tilt-chin lift, jaw thrust and open mouth techniques has been employed.[3-5] Nonetheless, challenges arise when the practical application of these maneuvers becomes intricate due to surgical interventions or examinations that impede their implementation. Several previous studies investigated the efficacy of head position on upper airway patency, none of them studies with respect to head rotation.[6,7] It is uncertain whether head rotation improves airway patency and efficacy of mask ventilation on anaesthetized subjects. Head rotation increases cross sectional area of upper airway and did not decrease pharyngeal critical closing pressure.[8,9] Thus aim of this study was that head rotation during mask ventilation reduces upper airway obstruction, improves compliance and expiratory tidal volume.

METHODS

This study was conducted after getting institutional ethical committee approval. Patients between 18 to 69 years of age with BMI 18.5-35 kg/m^2, ASA physical status I,II,III and who require general anaesthesia with tracheal intubation were enrolled in the study. Patients with limited head and neck movements, facial abnormalities, gastric outlet obstruction, gastro-esophageal reflux disease, obstructive sleep apnea and not willing to participate in this study were excluded. The patients were randomized into 2 groups of 20 each, using a computer-generated random number, Group I and Group II. After a thorough pre-anaesthetic evaluation, patient was given a detailed explanation of the procedure, informed and written consent was obtained. After shifting the patients into operating room, standard monitoring (electrocardiogram, noninvasive arterial blood pressure, and pulse oximetry) were applied and intravenous cannula was inserted. A flow sensor placed between face mask and breathing circuit to measure respiratory parameters. The study procedure began with pre oxygenation with 100% oxygen by open circuit at 10 liters/min via standard face mask. Standard induction of anesthesia was done with Fentanyl (1-2 µg/kg), Thiopental sodium (3-5mg/kg) and relaxed with Atracurium (0.5mg/kg). Upon achieving apnea, mask ventilation was done with PCV, PIP of 15cm of water, 10 breaths per minute, I:E ratio 1:2. Face mask held in place with two hands. For group I patients, mask ventilation was performed with neutral head position for one minute followed by head turned to right lateral position for one minute and head back to neutral position for one minute. For group II patients, mask ventilation was carried out in right lateral position to neutral position to right lateral position. At each position, airway pressure (cm H_2O), compliance and expiratory tidal volume (ml) were measured.

Statistical analysis

The statistical analysis aimed to determine the significance of the influence of head rotation on peak airway pressure, compliance, and expiratory tidal volume during mask ventilation. All data were analyzed using the IBM SPSS (Statistical Package for the Social Sciences). Descriptive statistics were computed to summarize the characteristics of the study population and the measured variables. Mean and standard deviation were calculated for continuous variables such as age, weight, and height. The normality of the data distribution was assessed using the Shapiro-Wilk test. This test was conducted to determine whether the data were normally distributed or not. If the assumption of normality was met, parametric tests were applied; otherwise, non-parametric alternatives were considered. Comparative Analysis, the influence of head rotation on peak airway pressure, compliance, and expired tidal volume, a repeated measures analysis of variance (ANOVA) was performed. In case of significant differences identified by the ANOVA, post hoc tests were conducted to further explore these differences. Bonferroni correction was applied to adjust for multiple comparisons, $p<0.05$ was considered statistically significant.

RESULTS

A total of 40 patients were included in this study and none of them were excluded from the final analysis. Demographic data is summarized in (Table 1), there were no statistically significant differences found with respect to age, height, weight and mouth opening between the two groups.

Table 1: Demographic data and mouth opening between two groups.

Variables	Group I (N=20) Mean±SD	Group II (N=20) Mean±SD	P value
Age (years)	43.90±14.98	39.37±13.50	0.323
Height (cm)	160.76±11.13	154.79±9.4	0.074
Weight (kg)	61.52±8.67	61.16±14.71	0.925
Mouth opening (cm)	4.429±0.4	4.368±0.62	0.72

The (Table 2) provides an overview of the key respiratory parameters measured during the study for each minute, the expiratory tidal volume (VTe), Compliance (C) and peak airway pressure (PAW) in neutral and head rotation position. In the first minute, expiratory tidal volume, compliance and peak airway pressures were slightly higher in head rotation than in neutral position but were not statistically significant. In the second minute, the expiratory tidal volume in head rotation (469.54 ml) is higher than in neutral position (397.81 ml) and p value 0.025 which was statistically significant. A statistically significant (p value 0.045) seen with respect to compliance which was slightly higher in head rotation (35.83) than neutral position (29.31). In the third minute, expiratory tidal volume, compliance and peak airway pressures are slightly higher in head rotation than in neutral position but they were statistically insignificant.

DISCUSSION

The fundamental method in managing the airway is through mask ventilation. Following the administration of intravenous anaesthetic drugs, mask ventilation becomes essential to ensure proper ventilation and prevent any potential airway obstructions. This serves as the primary means of ventilation before proceeding with tracheal intubation or the placement of any airway apparatus.[10]

Table 2: Peak airway pressures (PAW, cm H_2O), compliance ©, expiratory tidal volume (VTe ml) between two groups.

Variables (each min.)	Group I (N=20) Mean±SD	Group II (N=20) Mean±SD	P value
PAW1	15.555±1.64	16.86±3.81	0.173
C1	29.42±9.57	36.335±14.64	0.082
VTe1	421.865±89.16	475.905±122.95	0.096
PAW2	16.405±3.56	16.055±2.21	0.692
C2	35.835±10.48	29.315±8.48	0.045
VTe2	469.545±120.09	397.815±86.03	0.025
PAW3	16.48±2.46	16.55±3.85	0.746
C3	30.395±9.42	34.31±10.54	0.384
VTe3	418.865±178.61	446.095±115.28	0.392

Notably, its significant use comes into play as a rescue technique for ventilation in situations where tracheal intubation encounters challenges or is unsuccessful, or in cases of multiple failed attempts. The present study aimed to compare expiratory tidal volume, compliance and peak airway pressure during mechanical ventilation in the neutral position and head rotation among 40 patients. The demographic data presented in Table 1 suggests that there were no statistically significant differences in age, height, weight, ASA grading, and mouth opening between two groups. This is crucial as it minimizes the potential confounding effects of these variables on the study outcomes. The results of this study contribute to our understanding of how patient positioning, specifically head rotation, affects the efficiency of mask ventilation during positive pressure ventilation procedures. During inspiration, a non-sedated, spontaneously breathing patient dilates the oropharyngeal pharynx by contracting the genioglossus muscle and elevating the tongue off the pharyngeal wall in a coordinated reflex. Unfortunately, this reflex genioglossus activity is abolished after induction of anaesthesia. In supine position, general anesthesia may promote obstruction of the oropharynx by the tongue, soft palate, and pharyngeal musculature as their tone decreases.[11] Ono et al, Zhang et al studies two- and three-dimensional configuration of oropharynx in head rotated position and lateral recumbent position in awake patients concluded that significant increase in antero-posterior diameter in retro-glossal and retropharyngeal region. These findings were in correlation to our study after giving muscle relaxation.[12,13] The results of this study were comparable to what was previously described in an earlier study by Taiga et al concluded that head rotation of 45° in anaesthetised apnoeic adults significantly increases the efficiency of mask ventilation compared with the neutral head position. Head rotation may be possible to cause shift of soft tissue out of submandibular space leading to decrease in airway obstruction thereby increasing the efficacy of face mask ventilation.[14,15]

Limitations

Limitations of current study were; The mask leaks, Since we studied with paralyzed individuals, the results cannot be applied to non-paralyzed individuals. We only tested the effect of turning the head to the right, but not to the left. We evaluated in an optimized neck and jaw position, so the results cannot be applied to patients with difficulties neck and jaw movements and the sample size was relatively small, and a larger cohort may provide more robust conclusions.

CONCLUSION

Head rotation to the lateral position increases the expiratory tidal volume and compliance significantly as compared to head in neutral position and improves mask ventilation after induction of anaesthesia.

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