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INFLUENCE OF HEAD AND NECK POSITION ON OROPHARYNGEAL SEAL PRESSURE AND VENTILATION USING BASKA MASK IN ANAESTHETIZED PARALYSED PATIENTS: A PROSPECTIVE RANDOMIZED CLINICAL TRIAL

Anaesthesiology

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ABSTRACT

Background: Changes in the shape of the pharynx with head and neck movement can alter the forces transmitted to the cuff along the airway device during ventilation which may lead to displacement of the device and airway leak. This study was designed to determine the effect of different head and neck positions on the oropharyngeal seal pressure and ventilation score using Baska mask in anaesthetized paralyzed patients.

Methods: In this randomized prospective clinical trial, Baska mask was inserted in 35 anesthetized paralyzed patients, planned for various elective surgical procedures. The position of the head and neck was changed randomly from neutral to flexion (45^0 flexion of neck), extension (45^0 extension of neck) and lateral rotation (90^0 rotation of neck towards left). Oropharyngeal seal pressure, ventilation score, peak inspiratory pressure, expiratory tidal volume and end tidal carbon dioxide were measured in all positions.

Results: As compared to neutral position, oropharyngeal seal pressure and peak inspiratory pressure were significantly higher during flexion and lower during extension but similar during lateral rotation of head and neck. Expiratory tidal volume and end tidal carbon dioxide did not change significantly with change of head and neck position. Ventilation score was comparable in all positions.

Conclusion: Effective ventilation is possible in all positions of head and neck using Baska mask in anaesthetized paralysed patients. However, caution should be taken in the extreme flexion of head and peak inspiratory pressures need to be monitored

KEYWORDS

INTRODUCTION

Supraglottic Airway Devices (SGA), being less invasive in nature, are used extensively during general anaesthesia instead of tracheal intubation. The Baska mask is a new generation novel supraglottic airway device. In addition to many features of other supraglottic airway devices, this Mask has number of innovations.[1] The characteristic feature of Baska mask is that the airway pressure is transmitted intermittently to the flexible structural element of the cuff so that it inflates with each positive pressure inspiration and deflates with expiration thus forming a perfect seal, reducing the leakage and also making Intermittent Positive Pressure Ventilation (IPPV) very efficient.[2]

Changes in the shape of the pharynx with head and neck movement can alter the forces transmitted to the cuff along the airway device during ventilation which may lead to displacement of the device and airway leak.[3] The primary aim of this study was to determine the effect of different head and neck positions namely, neutral, flexion, extension, and lateral rotation on the oropharyngeal seal pressure and ventilation score using Baska mask in anaesthetized paralyzed patients. The secondary aims were to assess the changes in the peak inspiratory pressure, expiratory tidal volume and end tidal carbon dioxide according to the different head and neck positions.

MATERIAL AND METHODS

This study was a prospective randomized trial conducted at a tertiary level armed forces referral hospital in India. The study was approved by the institutional ethics committee of the hospital. All patients with age 18–60 years, American Society of Anaesthesiology (ASA) grade I or II undergoing general anaesthesia for elective surgical procedures of less than 02 hour of duration were included in the study. The surgery types included a wide range of elective minor gastrointestinal, urologic, gynaecologic, plastic and onco-surgery procedures. Exclusion criteria included patents with body mass index >30 kg/m2, limiting neck mobility due to cervical spine disease, anticipated difficult airway, gastro-oesophageal reflux disease, oral cavity pathology, pregnancy and major cardiopulmonary comorbidity. All the patients included in study were counselled about nature of study and the procedure involved.

All the patients underwent standard preanesthetic check-up and assessment. The demographic data like age, sex, body weight, height, body mass index, size of device used and ASA status were recorded in a predefined proforma. Fasting protocol as per standard guidelines was used for all the procedures. On arrival to the operating room, mandatory standard monitoring lines (Electrocardiography (ECG), pulse oximetry and Non-invasive Blood Pressure (NIBP) recording) were connected to the patient. Size of Baska Mask was selected according to patient weight: size three for patients weighing between 30 to 50 kg, size four for 50 to 70 kg, size five for 70 to 100 kg. Venous access was secured with 18G/20G cannula. Induction of anaesthesia was conducted in the supine position with the head in the neutral position, using fentanyl and propofol in doses of 1.5 µg/kg and 2 mg/kg, respectively. Inhalational anaesthetic as sevoflurane, using sevoflurane vaporizer dial settings between 1% and 3%, is also used to increase the depth of anaesthesia. After confirming the loss of consciousness, non-depolarizing muscle relaxant as intravenous atracurium in dose of 0.5 mg/kg was used for muscle relaxation before intubation. Bag and Mask ventilation was performed using 100% oxygen at 6-8 litre/min. After 03 minutes of mask ventilation, Baska mask lubricated with jelly was inserted into the patient's mouth as per technique recommended by the manufacturer.[4] Successful placement of mask was confirmed with appearance of square-wave capnography and symmetrical bilateral chest lift. Volume controlled mode of mechanical ventilation was used for ventilation through Baska Mask. Various manoeuvres used in case of inadequate ventilation included change of head and neck position, repositioning of Baska Mask and use of different size of the device. If the ventilation still remained inadequate after all these manoeuvres, Baska mask was removed, endotracheal intubation was performed and patient was excluded from the study group.

Anaesthesia was maintained with sevoflurane in air and oxygen mixture targeting Minimum Alveolar Concentration (MAC) of 0.8% to 1.2%. Muscle relaxation was maintained with atracurium using incremental doses of 0.1 mg/kg. Oropharyngeal seal pressure was measured as the pressure of aneroid manometer attached to the breathing circuit, at which the airway pressure had reached equilibrium, when the pressure-limiting valve of the anaesthesia breathing system was closed and the fresh gas flow rate was fixed at 3 litres per min.[5] Airway pressure was limited to the maximum value of 40 cm H_2O.

The ventilation score was calculated based upon three criteria: no leakage with an airway pressure of 15 cm H_2O; bilateral chest excursion with a peak inspiratory pressure of 20 cm H_2O; and a square-wave capnogram; each item was scored 0 or 1 point. Thus, the maximum total score was 3 when all three criteria were present.[6,7]

Effect of head and neck position on effectiveness of ventilation using

Baska mask was evaluated by measuring oropharyngeal seal pressure, ventilation score, peak inspiratory pressure, expiratory tidal volume and end tidal carbon dioxide in the different positions. These parameters were first recorded in neutral position (when line joining the superior orbital margin and the external ear canal with the top of the shoulder is vertical) and then recorded for each patient in a random order, in different head and neck positions including flexion (45^0 flexion of neck), extension (45^0 extension of neck) and lateral rotation (90^0 rotation of neck towards left). Readings were taken 01 minute after repositioning of head and neck. Sequence of randomization for the order of evaluation in different positions, was generated using free online Research Randomizer program (https://www.randomizer.org). At the end of surgery, neuromuscular blockade was antagonized with 0.05 mg/kg neostigmine and 0.01 mg/kg glycopyrrolate. Baska Mask was removed after the regain of consciousness and complete recovery.

STATISTICS

Sample Size: - The assumptions for calculating the sample size were considered as minimum 80% power and 5% significance level (significant at 95% confidence level). With assumption of requirement of 0.05 precision and with detection of standard deviation of 15% of the mean from a pilot survey, sample size was estimated as 35. The Type I error probability associated with the test was 0.05.

Statistical analysis: - Statistical analysis was done by using descriptive and inferential statistics using Paired t-test to test the relative change with respect to change in head & neck position. Paired t-test was used for analysis of oropharyngeal seal pressure, peak inspiratory pressure, expiratory tidal volume and end tidal carbon dioxide at different head and neck positions. P-value less than 0.05 was considered as significant at 95% confidence level. The statistical software SPSS 24.0 was used in the analysis.

Mean and standard deviation were calculated for the demographic (age, weight, height and BMI) and other continuous variables. For the categorical variables (gender, ASA status, size of device used), numbers and percentages were calculated.

RESULTS

Demographic data of patients was shown as Table 1. All parameters as oropharyngeal seal pressure, peak inspiratory pressure, expiratory tidal volume, ventilation score and end tidal carbon dioxide at different head and neck positions as flexion, extension and lateral rotation, were compared with the same parameters at the neutral position. There was significant difference between the values of oropharyngeal seal pressure at neutral position (mean 27.94 cm H_2O) and flexion position (mean 30.86 cm H_2O, p<0.001) at 99% confidence interval (Table 2). Similarly, significant difference was also observed between the values of oropharyngeal seal pressure at neutral position and extension position (mean 25.83 cm H_2O, p<0.001) at 99% confidence interval (Table 2). However, there was non-significant difference between neutral and lateral positions as p-value is greater than 0.05 (Table 2). Oropharyngeal seal pressure was significantly increased in flexion position and significantly decreased in extension position as compared to neutral position. However, no significant change was observed in oropharyngeal seal pressure with lateral rotation of neck.

Peak inspiratory pressure was significantly increased during flexion of head and neck (mean 19.43 cm H_2O, p<0.001) and decreased during extension (mean 17.06 cm H_2O, p value=0.02) as compared to neutral position (mean 17.51 cm H_2O) (Table 2). However, peak inspiratory pressure was comparable between neutral and lateral positions without any significant change (Table 2). Expiratory tidal volume and end tidal carbon dioxide did not change significantly with change of head and neck position (Table 2). Ventilation score was comparable in all positions (Table 3).

Table 1: Descriptive Statistics

Age (yr)	40.40+/-11.64
Sex (M/F)	6(17.2)/29(82.8)
Weight (kg)	64.26+/-7.69
Height (cm)	163.60+/-5.96
BMI (kg/m2)	23.90+/-2.03
ASA Class (I/II)	20(57.1)/15(42.9)
Size of Device used (3/4/5)	3(8.6)/26(74.3)/6(17.1)

Data shown are Mean+/-SD or number (percentage).
BMI – Body Mass Index, ASA - American Society of Anaesthesiologists.

Table 2: Oropharyngeal Seal Pressure and Ventilation Parameters

Position	Oropharyngeal Seal Pressure (cm H2O)		Peak Inspiratory Pressure (cm H2O)		Expiratory Tidal Volume (ml)		End Tidal Carbon Dioxide (mm Hg)	
	Mean+/-SD	p Value	Mean+/-SD	p Value	Mean+/-SD	p Value	Mean+/-SD	p Value
Neutral	27.94+/-1.3		17.51+/-1.12		460.23+/-19.09		30.37+/-1.31	
Flexion	30.86+/-1.5	<0.001	19.43+/-1.07	<0.001	461.74+/-17.44	0.126	30.60+/-0.91	0.103
Extension	25.83+/-1.34	<0.001	17.06+/-1.41	0.002	462.20+/-18.29	0.146	30.31+/-0.99	0.797
Lateral Rotation	27.97+/-1.07	0.86	17.69+/-1.11	0.083	461.89+/-18.15	0.146	30.17+/-.89	0.303

P value is in comparison with neutral position; *P*<0.05 is considered significant

Table 3: Ventilation Score

Ventilation score	Neutral	Flexion	Extension	Lateral Rotation
3	35	33	34	35
2	0	2	1	0
1	0	0	0	0
0	0	0	0	0
3/2/1/0	35/0/0/0	33/2/0/0	34/1/0/0	35/0/0/0

DISCUSSION

The primary objective of this study was to determine the effect of different head and neck positions on the oropharyngeal seal pressure and ventilation score using Baska mask. We have demonstrated in this study that oropharyngeal seal pressure was affected with flexion or extension of the neck during surgery. When compared with neutral position, oropharyngeal seal pressure was higher during flexion and lower during extension of head and neck. Peak inspiratory pressure was also increased with flexion and decreased with extension in comparison to neutral position. However, both parameters as oropharyngeal seal pressure and peak inspiratory pressures were not affected with lateral rotation of head and neck.

Presence of high oropharyngeal seal pressure and low peak inspiratory pressure is the safety pre-requisite for the use of any supraglottic airway device during positive pressure ventilation. In our study, peak inspiratory pressure was increased in flexion position but the ventilation was still not affected as evidenced by the comparable expiratory tidal volume and end tidal carbon dioxide between neutral and flexion position. Oropharyngeal seal pressure was decreased in extension position but it was still adequate to maintain the effective ventilation during extension.

With the comparison of ventilation score at different head and neck positions, it was also found that effective ventilation can be achieved with Baska mask in any position of the head and neck. Maintenance of ventilation in all positions was also evident from unaffected expiratory tidal volume and end tidal carbon dioxide by any change of position.

Various studies were done to evaluate the effects of head and neck position on ventilation with different supraglottic airway devices such as I-gel, Proseal Laryngeal Mask Airway (PLMA), Standard laryngeal mask airway, Flexible laryngeal mask airway, Baska mask, Streamlined Liner of Pharyngeal Airway (SLIPA™), Laryngeal Tube Suction (LTS), Cobra Perilaryngeal Mask Airway (Cobra PLA), Supreme Laryngeal Mask Airway (SLMA) and air-Q® SP airway.[3, 7-13] Rehab and Yasser compared the oropharyngeal leak pressure of Streamlined Liner of Pharyngeal Airway (SLIPA™) with Baska mask at various positions of the head and neck.[10] They concluded after comparing the ventilation score that effective ventilation can be maintained with both devices irrespective of head and neck position. They also found while using Baska mask in different head and neck positions that oropharyngeal leak pressure was significantly high during flexion and lower during extension. We demonstrated similar results showing the same effects of different head and neck positions on the ventilation. In contrast to study of Rehab and Yaser, we had also demonstrated the expiratory tidal volume and end tidal carbon dioxide at different positions using Baska mask.

Mishra and Nawaz et al. compared the effect of head and neck position on the oropharyngeal leak pressures, cuff position and ventilation scores between ProSeal Laryngeal Mask Airway and I-gel.[3] Compared with neutral position, oropharyngeal leak pressure was significantly higher with flexion and lower with extension but similar with lateral rotation of head and neck, in both groups. Similar to our study, it was also concluded that effective ventilation can be achieved with both ProSeal LMA and I-gel in neutral, flexion, extension and lateral rotation (left) of head and neck.

Sanuki et al. investigated the effect of different positions of head and neck on the leak pressure and ventilation score using I-gel.[7] Oropharyngeal leak pressure increased significantly with flexion and decreased with extension, but was not affected with lateral rotation. In contrast to our study, ventilation score was adversely affected with flexion in comparison to neutral position. We evaluated in our study that ventilation was not compromised with flexion of head and neck using Baska mask. Hence Baska mask can safely be used in the patients in whom the head and neck is flexed.

It was suggested by Isserles and Rozenberg in their study that longitudinal tension in the anterior pharyngeal muscles of neck is released by neck flexion allowing them to settle down onto the mask to form a better seal during flexion.[14] Anteroposterior diameter of pharynx is also reduced with the flexion of neck.[15] During extension of neck, anteroposterior diameter of pharynx is increased due to raised hyoid and inlet of larynx, resulting in reduction of airway seal pressure in comparison to neutral position.

The study has several limitations. First, the investigator could not be blinded to the different positions of the head and neck. As all the measured parameters were clearly defined in this study, results were unlikely to have skewed due to lack of blinding. Other similar studies using different airway devices were also conducted in unblinded fashion. Second, fibreoptic assessment was not done for the cuff position of Baska mask at different head and neck positions. Third, as the study was conducted in anaesthetized and paralyzed patients, results could not be applicable to the spontaneously breathing patients.

CONCLUSION

Based on the results of this study, we conclude that oropharyngeal seal pressure is increased in flexion and decreased in extension as compared to the neutral position of head and neck. Effective ventilation is possible in all positions of head and neck using Baska mask in anaesthetized paralysed patients. However, caution should be taken in the extreme flexion of head and peak inspiratory pressures need to be monitored.

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