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Comparison of preoxygenation in supine position versus 15^0 head up tilt to look for duration of non-hypoxic apnoea in non-obese healthy adults

Yoganarasimha N[1,*], Shashank MR[2], Raghavendra TR[3], Radha MK[4]

[1]Associate Professor, Sapthagiri Institute of Medical Sciences, Bangalore, Karnataka, [2]Assistant Professor, [3]Associate Professor, [4]Professor & HOD, Dept. of Anaesthesiology, Adichunchanagiri Institute of Medical Sciences, Mandya, Karnataka

***Corresponding Author:**
Email: yogabmc98@yahoo.co.in

Abstract

Purpose: Preoxygenation increases oxygen reserves and duration of apnoea without desaturation (DAWD), thus it provides valuable additional time to secure the airway. Although conventional preoxygenation can provide time, atelectasis occurs in the dependent areas of the lungs immediately after anaesthetic induction. Therefore, alternatives such as positive end-expiratory pressure (PEEP) and head-up tilt during preoxygenation have been explored. We compared the conventional preoxygenation technique in Group I with 15^0 head up tilt in Group II in non-obese individuals for non-hypoxic apnoea duration

Materials & Methods: Sixty patients scheduled for various elective surgical procedures belonging to ASA Grade I and ASA Grade II were included in study. The study was designed to be a double blind randomized controlled study. Anaesthesia was induced with Inj. Thiopentone 5mg/kg IV till the loss of eyelash reflex. Adequacy of mask ventilation was confirmed. Inj. Rocuronium 0.9mg/kg IV was given. The patient was disconnected from the breathing system. The duration of apnoea was recorded as from the time of administration of rocuronium to the time the SpO_2 falls to <95% as measured by pulse oximetry, when at this point the patient was be reconnected to the breathing system and mask ventilation was commenced with 100% inspired oxygen, then intubated, and proceed with proposed surgery. Results: The demographic data were comparable. Non-hypoxic apnoea duration was higher with group II 423.1±51.71s compared to group I 284±29.51 seconds (P = <0.0001). There were no adverse outcomes or events

Conclusion: Preoxygenation is clinically and statistically more efficacious and by inference more efficient in the 15º head-up position than with conventional technique in non-obese healthy adults.

Keywords: Preoxygenation, Apnoea, Supine, Head-up tilt, DAWD (Duration of Apnoea without Desaturation)

Introduction

Failed airway is the anaesthesiologist's nightmare.(1) Every individual is at potential risk for developing a "CANNOT INTUBATE- CANNOT VENTILATE" situation following anaesthetic induction.(1)

Preoxygenation which is routine administration of 100% oxygen to the conscious individual before induction of general anesthetic,(2) increases oxygen reserves & duration of apnoea without desaturation (DAWD).(3) Building up of oxygen reserves assumes greater significance as this provides a longer duration of non-hypoxic apnoea should one be faced with an unanticipated difficult airway.

Although conventional preoxygenation can provide time, atelectasis occurs in the dependent areas of the lungs immediately after anaesthetic induction. Patients undergoing routine induction of anaesthesia who are found to be difficult to ventilate may also be at risk of developing hypoxemia. The induction of anaesthesia is associated with a variable period of apnoea, which lasts until mechanical ventilation of the lungs begins or until the patient resumes spontaneous ventilation.(4) During this time the body's continuing requirements for oxygen are supplied from the functional residual capacity (FRC).(4,5) If intubation proves difficult, prolongation of the apnoeic period may place the patient at risk of hypoxemia.

Apnoea following administration of an induction agent or neuromuscular blocking drugs can lead to fall in arterial oxygen saturation (SpO_2) to 80% within 1 min in healthy subjects breathing air before induction. Preoxygenation in adults increases total body oxygen stores from an estimated 1.2L before oxygenation to 3.2 L at 1 min and 4.8 L at 3 min. This increase in oxygen reserve delays the onset of arterial oxygen desaturation during apnoea with a concomitant avoidance of the risk of tissue hypoxia and its sequel.

Patients with an adequate respiratory drive should receive preoxygenation for 3 minutes or take 8 breaths, with maximal inhalation and exhalation. The morbidly obese patient benefits from head-elevated position during preoxygenation and from nasopharyngeal oxygen delivery after induction. In pediatric cases (wt<20kgs) pre oxygenation can be effectively done through Jackson Rees circuit.

Since, comparison study between Supine and with 15^0 head up tilt has not been studied, we compared the duration of non-hypoxic apnoea in non-obese healthy adults with supine position and 15° head up tilt.

Materials and Methods

This study was conducted in our institute over a period of 6 months. The study had the approval of the institutional ethical committee and written informed consent was obtained from all the participants.

Sixty patients scheduled for various elective surgical procedures belonging to ASA Grade I and ASA Grade II were included in study. The study was designed to be a double blind randomized controlled study.

Sixty patients scheduled for various elective surgical procedures were divided into 2 groups 30 patients each.

Group I – The patients were preoxygenated in supine position.

Group II- The patients were preoxygenated in 15° head up tilt. Head up tilt was given after measuring with the help of protractor.

Preanaesthetic evaluations were done on the evening before surgery. A routine preanaesthetic examination was conducted.

All patients were premedicated with Tab. Alprazolam 0.5 mg HS and Tab. Ranitidine 150mg HS at bed time the previous day.

On arrival in the operating room, IV line was secured; fluid dextrose with normal saline was started. The patients were connected to multi-channel monitor which records heart rate (HR), non-invasive blood pressure (NIBP), end-tidal carbon dioxide ($ETCO_2$) and oxygen saturation (SpO_2).

The baseline blood pressure, HR and through by side stream capnograph ETCO2 were recorded from the same non-invasive monitor, cardiac rate and rhythm was also monitored from a continuous display from lead II. Inj. Glycopyrolate 0.2 mg IV was given as pre-medication. No other pre-medication were given.

A clear face mask was held in position by the anaesthetist to achieve an airtight seal. Patients were preoxygenated for 3 minutes in supine and 15° head-up tilt with 10L/min of O_2 flow with Bain's circuit with 2 L reservoir bag.

Induction of anaesthesia: Anaesthesia was induced with Inj. Thiopentone 5mg/kg IV till the loss of eyelash reflex. Adequacy of mask ventilation was confirmed. Inj. Rocuronium 0.9mg/kg IV was given. The patient was disconnected from the breathing system vitals were monitored and recorded; ETCO2 recorded zero baseline as the patient was apnoeic. The duration of apnoea was recorded as from the time of administration of rocuronium to the time the SpO_2 falls to < 95% as measured by pulse oximetry, when at this point the patient was be reconnected to the breathing system ETCO2 was recorded and mask ventilation was commenced with 100% inspired oxygen vitals noted, then intubated, and proceed with proposed surgery.

Results

The demographic data were analysed using ANOVA test. The observed data were analysed using unpaired student 't' test. All data are presented as mean ± standard deviation. Based on p value, the result is stated as significant or not significant.

It was observed that the end tidal carbon dioxide ($EtCO_2$) during baseline, induction, after rocuronium administration in both groups was comparable and differences were statistically not significant. But $EtCO_2$ when the SpO_2 fell at 94% was much higher in Group I when compared to Group II which was statistically significant (Table 1 and Fig. 1).

Table 1: End Tidal Carbon dioxide

	Baseline	Induction	After Rocuronium	At SpO_2 94%
Group I	33.1±1.45	33±1.50	33.1±1.50	39.7±1.49
Group II	34±2.92	33.7±2.20	33.2±1.57	37.1±2.06
P value	0.06	0.08	0.37	<0.0001

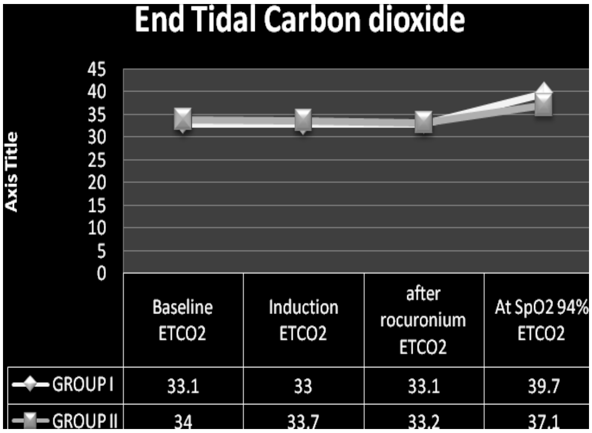

Fig. 1: Graph depicting $EtCO_2$

It was observed that the base line, induction and after administration of rocuronium saturation values were comparable among the two groups and were statistically not significant. The time taken for fall of SpO_2 to 94% in both groups showed a statistically significant difference, in Group I it was 284.5±29.51 seconds when compared to Group II which was 423.1±51.71 seconds which was statistically significant i.e. P value <0.0001(Table 2, Fig. 2).

It was observed that the heart rate and mean arterial pressure during baseline, induction, after rocuronium administration & when SpO_2 fell at 94% in both groups were comparable and differences were statistically not significant.

Table 2: Time for SpO_2 to fall 94%

	Group I	Group II	P value
Time in seconds	284.5±29.51	423.1±51.71	<0.0001

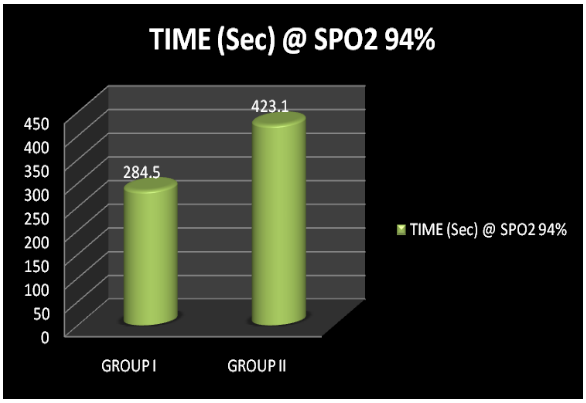

Fig. 2: Graph depicting SpO_2

Discussion

In this modern era of complex anaesthetic practice which has become increasingly protocol driven and a team working on an insistent theme, it is easy to overlook basic aspects of clinical practice.

But random events do trigger exploration of basic issues both critical to patient safety and also being highly complex issues like preoxygenation and still more controversial matter like optimal duration of preoxygenation. A call for preoxygenation to be considered essential in avoiding adverse outcomes when faced with difficulty in ventilation and the dilemma facing the profession in defining and mandating a standard duration of preoxygenation were the leading factors for this research work.[6]

The induction of general anaesthesia is associated with variable periods of apnoea. In this context, pre oxygenation is a fundamental component of safe general anaesthesia. In assessing how much the oxygen stores can be filled and conversely how much denitrogenation is needed, there are a number of factors to be considered. These include the oxygen consumption of the patient, the size of the FRC, the fresh gas flow rate, inspired oxygen concentration and the breathing system used.[7]

Techniques of monitoring preoxygenation have focused on measurements of indices reflecting its efficacy or efficiency. Measurement of end tidal concentrations of one or more of the relevant gases (oxygen, nitrogen or both), observations of arterial saturation using pulse oximetry, blood gas analysis to monitor PaO_2, use of mass spectrometry or merely observing movement of the reservoir bag on the breathing system reflect the efficiency of preoxygenation.[8,9,10]

But the decline of haemoglobin saturation of oxygen during apnoea is the only equation which depicts oxygen content of the arterial blood is:

CaO_2 = SaO_2 X Hb X 1.31 + 0.003 X PaO_2

Where,

CaO_2= Oxygen content of the blood

SaO_2 = Haemoglobin saturation

PaO_2 = Partial pressure of O_2 in mmHg

0.003 = Solubility co-efficient of oxygen

1.31 = Oxygen binding capacity of haemoglobin

If we observe this equation, it is clear that the contribution of saturation is more important than the contribution of PaO_2 in determining oxygen content of the blood. Thus measure of fall in saturation is a more appropriate measure of efficacy of pre-oxygenation.

As many factors can cause rapid arterial haemoglobin desaturation of oxygen during apnoea, the need to maximally pre-oxygenate before induction is essential.

In our study we compared the effects of preoxygenation in supine and head up 15º position of preoxygenation on peripheral oxygen saturation to arrive at an optimal position for preoxygenation.

In this study, it was observed that, there was no statistical differences in mean age, gender, BMI, heart rate, mean arterial pressures. But it was observed that baseline heart rate in both groups I & II was 76.7±5.95 & 75.6±5.90 respectively and heart rate at the end of SpO_2 94% 97.2±4.70 & 99.4±5.81 respectively. It was also observed that baseline mean arterial pressure in groups I & II was 85.8±1.98 & 84.9±2.36 respectively and mean arterial pressure at the end of SpO_2 94% was 100.8±2.52 & 101.2±3.98 respectively showing significant statistical significance between baseline and the end of 94% saturation in both heart rate and mean arterial pressure showing sympathetic stimulation and stimulation of renin angiotensin aldosterone system during the period of apnoea.[11-12]

In this study, it was observed that, at the end of apnoea time taken for fall of SpO_2 to 94% in both groups showed a statistically significant difference, in Group I it was 284.5±29.51 seconds when compared to Group II which was 423.1±51.71 seconds which was statistically significant. It was also observed in our study that End tidal carbon dioxide ($EtCO_2$) at the end of SpO_2 to 94% in both groups showed a statistically significant difference; in Group I it was 39.7±1.49 when compared to Group II 37.1±2.06 which was statistically significant.

The results in our study correlate well with those obtained in the study conducted by Ramkumar V et al[1] They observed that at the end of desaturation to 94% in supine position time was 364±83 seconds and 283 (243-322) seconds respectively when compared to 20º head up position time was 452±71 seconds and 386 (343-429) seconds respectively. And Lane S et al[4] performed a randomized controlled trial of patients preoxygenated in a 20-degree head-up position versus a control group that was left supine. After 3 minutes of preoxygenation, the patients received sedation and muscle relaxation and were then allowed to decrease their saturation from 100% to 95%. The head-up group took 386 seconds to reach this saturation versus 283 seconds in the control group.

Altermatt et al[13] examined specifically preoxygenation in obese patients (body mass index 35).

This randomized controlled trial compared safe apnoea times in intubated patients who received preoxygenation in a sitting position compared with those preoxygenated while lying flat. After rapid sequence induction of anesthesia, the trachea was intubated and the patient was left apnoeic and disconnected from the anesthesia circuit until SpO2 level decreased from 100% to 90%. Using the time taken for desaturation to 90% as the outcome, the patients preoxygenated in a sitting position took 214 seconds to desaturate versus 162 seconds for patients preoxygenated while lying flat.

Haemoglobin becomes fully saturated early in the oxygenation process, making observation of a SpO_2 of 100% an unsuitable end-point for completion of preoxygenation. The gains in oxygen storage in the latter minutes of preoxygenation mainly result from increased quantities of dissolved oxygen within the plasma and body tissues. This explains the superior efficacy (the duration of apnoea before arterial oxygen desaturation occurs) of standard preoxygenation over alternative methods of preoxygenation aimed at improving efficiency (the time required to reach a chosen endpoint of preoxygenation) such as the use of a limited number of vital capacity breaths.(14,15,16)

Conclusion

Based on the observations from this study, we conclude that preoxygenation is clinically and statistically more efficacious and by inference more efficient in the 15º head-up position than in the supine position, without detriment to the grade of intubation. Fall in peripheral oxygen saturation is delayed significantly after preoxygenation in 15º degree head up position when compared to supine position.

Conflict of interest: None

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