ORIGINAL RESEARCH PAPER

Anesthesia

ARTERIAL DESATURATION DURING INDUCTION OF ANAESTHESIA WITH DIFFERENT TECHNIQUES OF PREOXYGENATION

KEY WORDS: Induction, Hypoxia, Preoxygenation, Hemodynamic stability.

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ABSTRACT

Surgeries on upper airways are at high risk of developing hypoxia during induction. Oxygenating them preoperatively is a preferred technique to overcome it. Different techniques have been described for avoiding hypoxia. We have studied six different techniques of preoxygenation in a study conducted at tertiary centre. A study was conducted on 90 healthy ASA Grade I and II patients.3 min and 5 min tidal volume breathing and four vital capacity breaths were compared. Safety margin and vital parameters were assessed by ventilating the patient during apnoea. Though 3-5 min ventilation is considered as gold standard technique, Four vital capacity ventilation is useful during emergency.

INTRODUCTION:

Preoxygenation is a technique used by anaesthesiologists to carry out a procedure on the upper airway that allows the patient to remain apnoec for a while, without risk of hypoxia.

Following induction there is a rapid reduction in functional residual capacity (FRC) that results in airway small airways closure , particularly in dependant parts of lung. This in its turn results into collapse of some alveoli not being ventilated at all (True shunt). Ventilation/perfusion (V/Q) mismatch is also increased as a consequence. Hypoventilation may occur during anaesthesia due to airway obstruction and use of volatile anaesthetics, opioids and some sedatives. Hypoventilation and a decreased inspired oxygen concentration will cause a reduction in alveolar Po_2.

The stores of oxygen in the body are small and would be unable to sustain life for more than a few minutes. The amount of oxygen in the blood depends on the blood volume and haemoglobin concentration. The amount of oxygen in the lung is dependent on the lung volume at FRC and the alveolar concentration of oxygen.FRC is about 3 lit in adults.

Preoxygenation involves the breathing of 100% oxygen for three minutes through an anaesthetic circuit with a facemask firmly applied to the face. This is the time required to replace the nitrogen in the FRC with oxygen using normal tidal ventilation. Although FRC falls on induction of anaesthesia the extra oxygen contained within the FRC provides an essential store of oxygen for periods of apnea, which may be required during rapid sequence induction or difficult intubation. Pre oxygenation is especially indicated in patients with small FRC like pregnancy, obesity & infants or a low haemoglobin concentration where smaller oxygen stores desaturate more rapidly.Inspite of these facts many a times preoxygenation is avoided due to busy operating list or holding a mask is a labour intensive task for anaesthetist. Many patients find the tightly held mask very cumbersome and uncomfortable.

Various studies have been performed to cut short the period preoxygenation during emergency .Hudson face mask has also been used successfully as against tightly fitting mask. Different parameters like minimum end tidal N_2 fraction,maximum arterial O_2 tension, time taken for Hb to desaturate to certain level after anaesthesia induced apnoea are used to study the efficacy and efficiency of various preoxygenation techniques.

Pulse oxymetry is the most relevant measure of preoxygenation being sensitive, noninvasive and widely used. Thus to emphasize the importance and necessity of preoxygenation the study was planned for different techniques of preoxygenation compared by using pulse oxymetry.

AIMS AND OBJECTIVES:

1. To compare the efficiency of 3 minute tidal volume breathing which is considered as a " gold standard", with 5 min tidal volume breathing as well as four vital capacity breaths technique for preoxygenation.
2. To study whether ventilation during apnoea is necessary or not and whether it adds to the safety margin.
3. To study the effects on vital parameters during induction with varying techniques of preoxygenation.

MATERIAL & METHODS:

This study was carried out after obtaining the ethical committee approval.

90 Adult healthy patients of either sex of ASA grade I-II, of age 18 – 55 yrs undergoing surgery were included in the study. Patients with extremes of age & weight, ASA Grade III, IV, patients with difficult airway, altered physiologic conditions like pregnancy patients with systemic disorders , were excluded from the study.

Patients were divided in three groups of 30 each:

- **GROUP I -** received preoxygenation for 3 mins. (n=30)
- **GROUP II -** received preoxygenation for 5 mins. (n=30)
- **GROUP III –** received preoxygenation in the form of 4 vital capacity breaths. (n=30)

Each group was further subdivided into two subgroups as A and B.

- Group I (A) **-** received preoxygenation for 3 mins & ventilation during apnea in the form of 4 maximal chest inflations with 100% oxygen with Bains circuit.
- Group I (B) **-** received preoxygenation for 3 mins but no ventilation during apnea.
- Group II(A) **–** received preoxygenation for 5 mins & ventilation during apnea in the form of 4 maximal chest inflations with 100% oxygen with Bains circuit.
- Group II(B) – received preoxygenation for 5 mins but no ventilation during apnea
- Group III(A)- received preoxygenation in the form of 4 vital capacity breaths & ventilation during apnea in form of 4 maximal chest inflations with 100% oxygen with Bains circuit.
- Group III(B) **–** received preoxygenation in form of 4 vital capacity breaths but no ventilation during apnea

Thorough preoperative evaluation was done and NBM status was confirmed. Multipara monitor was attached for heart rate ,Pulse oximeter , NIBP and ECG. Heart rate ,Sp02, and BP were recorded on room air ventilation preoperatively. IV line was secured & crystalloid was started . 250 ml of fluid was administered before induction. Premedication was administered with Inj Medazolam 0.02mg/kg IV and Inj Pentazocine 0.3mg/Kg IV and again pulse rate, blood pressure & oxygen saturation were recorded 5 minutes after premedication.

In Grp I A= Preoxygenation was done with 3 min with normal tidal volume breaths using 8 lit/min flow with bains circuit. After induction 4 maximal chest inflations were given during apnoea.

In Grp I B=Though preoxygenation was done with 3 min,no ventilation was given to patient during apnoea.

In Grp II A= Preoxygenation was done with 5 min with normal tidal volume breaths using 8lit/min flow with bains circuit. After induction 4 maximal chest inflations were given during apnoea.

In Grp II B= Though preoxygenation was done with 5 min,no ventilation was given to patient during apnoea.

In Grp III A=Preoxygenation was done with four vital capacity breaths using 8lit/min flow with bains circuit. After induction 4 maximal chest inflations were given during apnoea.

In Grp III B= Though preoxygenation was done with four vital capacity breaths ,no ventilation was given to patient during apnoea

All patients were induced with Inj Thiopentone sodium 5mg/Kg.and Inj Succinylcholine 2mg/Kg IV. Patients were then intubated and the time was noted for O_2 saturation to fall upto 90% before starting IPPV with Bains circuit. All patients were maintained with Inj Atracurium 0.6mg/Kg IV.Following observations were done in all groups:

- Vitals like PR, SBP,DBP & SPO2 were noted in pre and postinduction phases.
- Time was taken as 0hrs when patient becomes apnoic after induction.
- Time required for SpO_2 to fall to 90% was noted.

RESULTS

Pulse rate,systolic blood pressure ,diastolic blood pressure and SpO_2 were observed and ststistical tests like Chi square test,Paired t test, unpaired t test and test of analysis for varience (ANOVA) were applied for statistical significance.Value of $p<0.05$ was considered significant and $p<0.001$ was considered as highly significant. Patients were compared for age ,sex and weight and were found to be statistically nonsignificant.

Table 1: Mean preoperative PR,SBP,DBP,&SpO_2

Parameter	IA	IB	II A	II B	III A	III B
PR	81.93	85.40	83.93	87.80	84.73	86.27
SBP	123.60	121.07	120.60	122.00	120.50	119.60
DBP	77.00	75.87	75.80	74.67	77.16	74.60
SpO2	98.67	98.27	98.53	98.07	98.40	98.13

Preoperative vitals in all the 6 groups were compared and were found to be statistically insignificant.

Table 2: Mean PR,SBP,DBP,&SpO_2 after premedication

Parameter	IA	IB	IIA	IIB	IIIA	IIIB
PR	85.60	88.93	86.83	90.50	89	89.13
SBP	119.83	117.40	118.40	117.87	117.50	114.83
DBP	75.33	76	75.33	75.33	76.83	73.93
SpO_2	97	96	97	97	97	97

Table shows significant increase in pulse rate.Fall in SBP and DBP was observed though statistically insignificant.($p>0.05$)

Table 3: Mean PR,SBP,DBP,&SpO2 after ventilation during apnoea.

Prameter	IA	IB	II A	II B	III A	III B
PR	101.40	ND	100.37	ND	107.27	ND
SBP	112.27	ND	111.20	ND	107.00	ND
DBP	73.93	ND	71.87	ND	73.46	ND
SpO_2	100	ND	100	ND	100	ND

ND=Not Done.

Patients in Grp IA,IIA,IIIA were ventilated during apnoea with 100% O2.The pulse rate was increased than baseline in above groups which was statistically significant ($p<0.001$)

The systolic and diastolic blood pressure showed statistically significant change as compared with baseline ($p<0.001$);but no significant change was observed after induction.

Table 4: Mean PR,SBP,DBP,&SpO2 after intubation.

Parameter	IA	IB	II A	II B	III A	III B
PR	116.93	117.73	112.40	117.20	120.97	119.03
SBP	133.33	137.27	137.20	138.33	139.03	136.33
DBP	88.20	92.60	90.20	90.70	93.20	90.43
SpO2	100	100	100	100	100	100

Pulse rate after intubation was significantly increased as compared to baseline. The systolic and diastolic blood pressure was also increased ($p<0.001$) However no change was observed in SpO2

Table 5: Mean time for SpO2 to fall to 90%

Group	IA	IB	IIA	IIB	IIIA	IIIB
Timein sec	255.67	254.67	277.77	269.00	237.33	232.00

Time for SpO2 to fall to 90% was compared among the groups. The time was comparable in group IA and IIB($p>0.05$).Time was significantly higher in groups IIA and IIB($p<0.05$) .Among all the groups time was quite low and comparable in group IIIA and IIIB.

Discussion

Administration of oxygen to conscious patient before induction of anaesthesia or before carrying out procedure on upper airway that necessiates patient to remain apnoic is called preoxygenation.It provides maximum time to tolerate apnoea in 'cannot ventilate cannot intubate' situation. During preoxygenation , 100% O_2 is supplemented via face mask.As a result nitrogen is washed out called denitrogenation and alveolar tension rises to more than 400mm of Hg to be utilized during apnoea.Almost 95% denitrogention can be achieved within 2-3 min of breathing oxygen with flow of 5lit /min and normal tidal volume[1].

Alveolar PO_2 is a balance between oxygen supplied by breathing system and that used by metabolic processes in the body. Hypoventilation and a decreased inspired oxygen concentration will therefore cause reduction in alveolar Po_2

If the PaO_2 falls to less than 60mmHg the aortic and carotid body chemoreceptors respond by causing hyperventilation and increasing cardiac output through sympathetic nervous system stimulation. This normal protective response to hypoxia is reduced by anaesthetic drugs and this effect may even extend to postoperative period.

Breathing 100% oxygen causes a large increase in the total stores as the FRC fills with oxygen. The major component of the store is now in the lung and 80% of this oxygen can be used without any haemoglobin desaturation. When FRC iscompared on breathing air with breathing 100%O_2 ,it is observed that in lungs it goes to 3000ml from 450ml;in blood it rises from 850ml to950ml,whereas in tissues it goes from 250ml to 300ml.The total increase of O2 store from 1550 ml to 4250ml is quite significant.

The need for preoxygenation was emphasized in1995 by Dillon and Darsie[2] .The occurance of arterial oxygen desaturation after induction of patients was observed by them in patients who were not preoxygenated.

The technique of preoxygenation is particularly important in situations like full stomach patients, difficult intubation, obese patients, elderly patients with decreased functional residual capacity. Benumof [3] in his study has shown that 4 vital capacity breaths for 30 sec are sufficient to maintain adequate oxygen stores in alveolar and arterial spaces. Various markers have been studied for efficacy of preoxygention.Baraka[4] in his study has taken maximum arterial oxygen tension as a surrogate marker as PaO_2

does not give any idea about venous and tissue oxygen content.EtCO_2 is the best and real time marker for preoxygenation .A breath by breath analysis is a sensitive indicator of poor mask fit [5].

We have choosen pulse oxymetry in our study being sensitive and reliable indicator of oxygen saturation in noninvasive manner. It is capable of providing early warning of desaturation and subsequent hypoxemia[6].

Some limitations were observed during this study viz a)Paediatric patients and neonates or infants are more prone for hypoxia due to higher oxygen consumption and presence of fetal haemoglobin respectively. b)Elderly patients have age related degenerative changes and decrease pulmonary reserves[7].c) Obese patients have decreased FRC and restrictive type of lung disease making them prone for hypoxia[8].Hence these patients were excluded from our study. After premedication we observed rise in heart rate due to increased levels of catecholamines by pentazocine, whereas decrease in blood pressure was due to reduction in systemic vascular resistance by medazolam .In a study conducted by Sandhya et al[9] six different methods of preoxygenation viz. 1 min, 2 min, 3 min preoxygenation, 4 vital capacity breaths and 4 manual compressions during induction were studied .They found that 2min 3min and 4 vital capacity breaths were effective in protecting apnoea during induction with haemodynamic stability whereas rest two methods were less effective.

Preoxygenation and ventilation during apnoea gives definite protection from hypoxia and offers haemodynamic stability during induction. Preoxygenation with and without IPPV during apnoea are equally effective in preventing desaturation during induction.It gives added oxygen reserve too. However in compramised or difficult intubation and elderly as well as obese patients peoxygenation for 3-5 min with ventilation during apnea is beneficial as they may require more time for intubation. In our study, the groups in which ventilation was done during apnoea showed nonsignificant increase in HR,SBP,DBP with SpO_2 100%. However rise in HR,SBP,DBP was statistically significant in GRP III A and B than in any other group.The time for fall in saturation to 90% was comparable in IA and IB but significantly higher in IIA and IIB

Generally 3-5 min preoxygenation is a gold standard for elimination of nitrogen upto 90-95% but in addition to it we found that 3 and 5 min tidal volume breathing technique gives significantly sufficient time for haemoglobin desaturation as compared to 4 vital capacity breaths.

Conclusion

Thus it can be concluded that preoxygenation fo 3 to 5 min before induction with ventilation during apnea offers sufficient time for oxygen desaturation with remarkable hemodynamic stability. However 4 vital capacity breaths in 30secs technique is useful in emergency cases.

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