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Research Article

THREE MINUTES TIDAL BREATHING – A GOLD STANDARD TECHNIQUE OF PRE-OXYGENATION FOR ELECTIVE SURGERIES.

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ABSTRACT

Pre-oxygenation is a time honoured ritual carried out in a variety of circumstances. Various methods of pre-oxygenation have been proposed and followed worldwide with vaviable success. The purpose of this study was to evaluate the need for pre-oxygenation prior to the induction of general anaesthesia and also compare the effects of two techniques of pre-oxygenation, on peripheral oxygen saturation.

Hundred ASA grades I and II patients in the age group of 20 – 40 years were studied under two equal groups. Group I received pre-oxygenation for three minutes and in Group II patients were assigned for four maximal breaths pre-oxygenation techniques. The lengths of time interval of apnoeic period i.e; the time taken for oxygen saturation to decrease to 90% level on pulse oximeter were compared using unpaired't' test.

In our study, after comparing the times for desaturation to oxygen saturation level of 90% during apnoea in both the methods, it was found that the mean time to desaturation in four maximal breaths method was 110.40 ± 30.27 seconds. The mean time to desaturation the three minutes method was 281.70 ± 18 seconds.The differences between the two methods was significant statistically. (P less than 0.05).

Pre-oxygenation for three minutes prior to induction of general anaesthesia with normal breathing is an effective and safe method of pre-oxygenation.

INTRODUCTION

Administration of 100% Oxygen before a rapid sequence induction of anaesthesia is recommended to prevent hypoxia during induction. This pre-oxygenation is particularly important if difficulty with manual ventilation of the lungs or intubation of the trachea is anticipated. Traditionally pre-oxygenation for three minutes or longer is the routine practice. However Gold et al have challenged the need for a full three minutes of pre-oxygenation, suggesting that pre-oxygenation with four maximal inspirations was equally effective. In this study, we examine whether the two techniques provide comparable protection against hypoxia when apnoea follows the induction of anaesthesia.

METHODS

With approval from the ethical committee, we obtained the informed written consent from 100 subjects undergoing elective surgery. All subjects were ASA I & II in whom no difficulties with airway management were anticipated. Subjects randomly assigned to the three minute technique were instructed to breathe normally for as long as possible from the time the face mask was applied and those subjects assigned to the four maximal breaths technique were previously instructed as well as equally trained to take four maximal deep breaths as soon as the face mask was applied.

The subjects were premedicated only with anticholinergic drugs and then brought to the operating room. An intravenous line was setup and baseline pulse rate, blood pressure and oxygen saturation was recorded. All subjects were administered 100% oxygen through a tight fitting face mask attached to a circle system flushed with oxygen and through which oxygen at rate of 10 litres per minute was flowing.

After the appropriate period of pre-oxygenation, anaesthesia and paralysis were induced with Injection Thiopental Sodium at 4.0mg/kg and Injection Succinylcholine at 1.5mg/kg.With the onset of apnoea, the facemask was removed and no attempts were made to move patients head or jaw.

Thiopental Sodium and Succinylcholine top up doses were planned as and when required in the dose of 1 mg/kg and 0.5 mg/kg respectively to maintain the apnoea.

On pulse oximeter, Arterial oxygen saturation (SaO_2) was recorded at the following points: Prior to administration of oxygen (on air).

At the end of pre-oxygenation period. Then after removal of mask at every 15 seconds interval until oxygen saturation decreases to 90% level.

The lungs were then ventilated with 100% oxygen. In both the above mentioned study groups, the length of time interval of apnoeic period i.e; the time taken for oxygen saturation to decrease to 90% level on pulse oximeter were compared using unpaired t-test. A p-value of <0.05 was considered statistically significant.

RESULTS

Age, height, weight, sex, preoperative haemoglobin were similar in the two groups as was the time from administration of thiopentone sodium until onset of apnoea. Arterial oxygen saturation was 99-100% in all subjects after pre-oxygenation. The time for SaO_2 to decrease to 90% was significantly longer with the 3 minutes technique as compared to four maximal breaths technique.

Table 1: Saturation % (SaO_2) After Pre-Oxygenation

Groups	N	Mean	Standard deviation
I	50	95.34	19.46
II	50	95.30	19.46

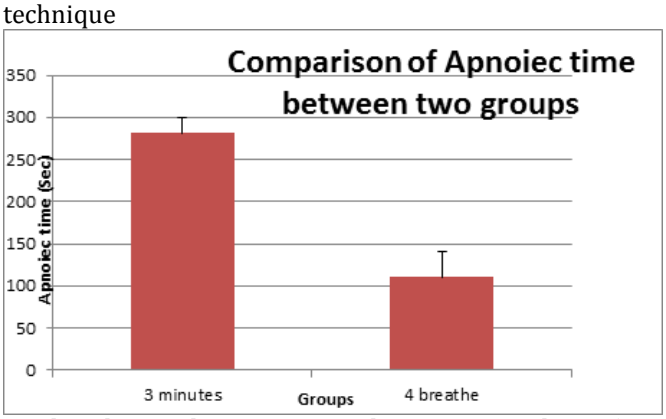
Interpretation: The difference is not statistically significant.
Arterial oxygen saturation was 99 to 100% in all subjects after pre-oxygenation.

Table 2: Apnoeic Period In Seconds

Groups	N	Mean	Standard Deviation	P value
I	50	281.70	18	
II	50	110	30.27	**0.001**

Unpaired t test is applied. P value is significant if less than 0.05.

The apnoeic period, i.e; the time for SaO_2 to decrease to 90% was significantly longer with the three minutes technique as compared to four maximal breaths technique



Graph 1: Showing that apnoeic period in 3 minutes technique(6secs) is longer as compared to 4 maximal breaths(2secs) pre-oxygenation technique. Complications like problems with airway interventions and any deterioration in the patients hemodynamic parameters were nil.

DISCUSSION

Pre-operative oxygenation is a time honoured technique and has become a standard practice used by the anaesthesiologist who are about to carry out a procedure on the upper airway that necessitates the patient being apnoeic for a while and thus at the risk of hypoxia. During pre-oxygenation, the patient breathes 100% oxygen via face mask before induction while fully conscious, nitrogen is washed out of the lungs, haemoglobin becomes fully saturated, some oxygen gets dissolved in the plasma and total oxygen stores build up which delays the onset of arterial desaturation and hypoxemia during apnoeic period. Several studies have demonstrated that most subjects are optimally oxygenated after three minutes of normal tidal volume breathing of 100% oxygen using oxygen flow of 10 litres per minute through standard breathing systems, the traditional method of pre-oxygenation.

However in certain clinical situations like full stomach, foetal distress, unco-operative patients, it may be impractical to pre-oxygenation for three minutes. Thus, in these situations, shorter methods of pre-oxygenation were tried as an alternative.

Drummond and Park demonstrated that patients who breathed air before the induction of anaesthesia with thiopental and succinylcholine and whose lungs were not ventilated after receiving these drugs, developed hypoxemia within 60 seconds. To increase the oxygen reserve and thus to prevent hypoxia during induction of anaesthesia, 100% oxygen is often administered to the patient.

Traditionally, three to five minutes of pre-oxygenation has been recommended to ensure an adequate oxygen reserve during induction of anaesthesia. Three minutes is used because of the observation by Hamilton and Eastwood[1] that denitrogenation of the lungs is more than 95% complete in three minutes or less in subjects breathing through a circle system with a fresh gas flow of 4 litres per minute.

Pre-oxygenation for five minutes was recommended by Dillon and Darsie to prevent hypoxemia after administration of thiopentone; however they did not examine whether shorter periods were sufficient.

Gold MI demonstrated in awake patients that pre-oxygenation with either five minutes of breathing at normal rates and tidal volume or four maximally deep breaths, produced comparable increase in arterial oxygen tensions and oxygen content.

Subsequently, Norris and Dewan compared three minutes and four breaths pre-oxygenation in pregnant women underlying caesarean section and found that oxygenation of maternal and foetal blood was compared with the two techniques. However, the duration of apnoea in these subjects was not reported and was presumably short.

Because, of the challenge by Gold to three minutes pre-oxygenation technique, Gambee considered to compare three minutes to four maximal breaths pre-oxygenation technique in normal healthy volunteers and realised that, the patients rendered apnoeic after pre-oxygenation with four maximal breaths had more rapid onset of and a more variable time to, arterial oxygen desaturation than did patients pre-oxygenated for three minutes. He recommended that three minutes pre-oxygenation method for the patients in whom a prolonged period of apnoea might occur after induction of anaesthesia.

Similarly, Valentine studied period of apnoea between three minutes pre-oxygenation and four maximal breaths in elderly individuals and suggested that three minutes pre-oxygenation offers more protection against hypoxia as compared to four maximal breaths.

Mc. Carthy compared apnoeic period between four deep breaths and normal tidal breathing for variable minutes and recommended that pre-oxygenation period of at least 2 minutes should be employed before rapid sequence intubation. The above mentioned observations

made by Gambee, Valentine and Mc. Carthy in their independent studies are in favour of observations made in our study.

Khandrani and Prashant studied the reduction in SaO_2 values after one minute of apnoea following after traditional method of pre-oxygenation in their independent studies and concluded that three to five minutes pre-oxygenation technique is the best method of pre-oxygenation as it provides maximum safe period before the hypoxia sets in after induction of general anaesthesia. These observations are also in favour of our study.

In our study, we estimated oxygen reserve by measuring the time required for arterial desaturation to occur after induction of anaesthesia.

Other investigators have estimated oxygen reserve indirectly by measuring PaO_2. However, at the completion of pre-oxygenation, factors other than PaO_2 may influence oxygen reserve. For example, if a patients lung volumes is below functional residual capacity, which is more likely to occur with the four breaths technique because these patients may actively exhale immediately before the onset of apnoea.

Another example, is when patients airway remains patent, elastic recoil of the chest might result in entrainment of air, diluting the oxygen content of the lungs, thus decreasing the oxygen reserve.

In our study, after comparing the times for desaturation to oxygen saturation level of 90% during apnoea in both the methods, it was found that the mean time to desaturation in four maximal breaths method was 110.40 ± 30.27 seconds. The mean time to desaturation the three minutes method was 281.70 ± 18 seconds. The difference between the two methods was significant statistically. (P less than 0.05)

This difference in results between the two methods can have several possible explanations:

First, as demonstrated by Hamilton and Eastwood[1], it is likely that the inspired oxygen concentration was lower in the four maximal breaths group than in the three minutes group because of the rebreathing characteristics of a circle system.

Secondly, in four maximal breaths technique, minute ventilation would markedly exceed the fresh gas flow of 10 litres per minute. Consequently rebreathing of expired gas will occur, decreasing the inspired oxygen concentration. In contrast, in subjects using three minutes technique, minute ventilation would be lower than fresh gas flows and inspired gas would be 100% oxygen. This would result in a higher alveolar Po2 and higher oxygen reserve.

Thirdly, the four maximal breaths technique depends on patient's cooperation and patient's skills, which would decrease its reliability.

Additional possibility can be an incomplete denitrogenation of the functional residual capacity in the four maximal breaths technique. As the aim of pre-oxygenation is wash out of nitrogen contained in the functional residual capacity, the completeness of pre-oxygenation depends on completeness of denitrogenation.

This shows that even though both methods were successful in increasing the saturation values after pre-oxygenation to similar levels, the time to desaturation were significantly different and significantly higher in the three minutes pre-oxygenation group. Hence, the four maximal breaths method is rendered less effective than the three minutes method.

SUMMARY & CONCLUSION

In both the groups, lengths of time interval of apnoeic period were compared. We found that similar arterial oxygen saturation values were attained in both the methods after pre-oxygenation but oxygen saturation decreased more rapidly in patients pre-oxygenated with four breaths technique compared with those pre-oxygenated for three minutes.

As evident in observations made in our study, healthy patients undergoing routine anaesthetic induction may receive some protection against hypoxia with four maximal breaths of oxygen; patients in whom a prolonged period of apnoea are needed after induction of anaesthesia as in anticipated difficult airway, obese patients, elderly patients; should probably breathe oxygen for at least three minutes before the administration of anaesthetic drugs, for increased safety.

Thus, we conclude that a full three minutes of pre-oxygenation with normal breathing is an effective and safe method of pre-oxygenation.

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