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International Journal of Current Research
Vol. 10, Issue, 03, pp.67101-67106, March, 2018

INTERNATIONAL JOURNAL OF CURRENT RESEARCH

ISSN: 0975-833X

RESEARCH ARTICLE

A STUDY OF ROLE AND COMPARISON OF TIDAL VOLUME AND DEEP BREATHING TECHNIQUES OF PREOXYGENATION

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ARTICLE INFO

Article History:
Received 21st December, 2017
Received in revised form
19th January, 2018
Accepted 28th February, 2018
Published online 30th March, 2018

Key words:
Preoxygenation,
Hypoxia,
Haemodynamicvariables.

ABSTRACT

Background: This study was envisaged to emphasize the importance and necessity of preoxygenation in all cases before induction. The commonly used 3 minute tidal volume breathing (TV) and 4 deep breaths (DB) in 30 seconds techniques were compared using pulseoximetry. The effect of preoxygenationon vital haemodynamicparameters with these techniques and also the effects, if preoxygenation is not done, were also evaluated.
Material and Methods: This randomized clinical study was done in a tertiary care medical college hospital. Ninety adult patients(18-45 years) of both genders, ASA grade I-II, undergoing elective surgery were included and studied in three groups with 30 patients randomly allocated to each group. Group I-Received no preoxygenation, but ventilation was done during apnoea using AMBU with oxygen 2 liters/minute with 4 maximal chest inflations. Group II-Received preoxygenation with 100% oxygen in the form of 4 vital capacity breaths in 30 seconds and ventilation was done during apnoea with 4 maximal chest inflations of 100% oxygen. Group III- Received preoxygenation with 100% oxygen, for 3 minutes in the form of tidal volume breathing and ventilation was done during apnea with4 maximal chest inflations of 100% oxygen. The pulse, blood pressure and oxygen saturation were recorded before induction, after premedication, after preoxygenation, after induction and intubation. The values were compared statistically using paired and unpaired t-test and one-way analysis of variance test as applicable. A p-value of less than 0.05 was considered as statistically significant at 95% confidence interval.
Results: During induction there was a fall in saturation in patients of Group I with a meanSpO2 after intubation of 94.71% ±3. 61 and the lowest value recorded being 88%. In the Groups II and III, the SpO2 was maintained at a level of 100% throughout induction. There was a rise in pulse and blood pressure after intubation in all the groups as a result of intubation response. The rise in blood pressure in Group I (mean SBP=144.6±16.8, mean DBP=95. 46±11.49) was higher though not significant, as compared to the other two groups. (Mean SBP in Group II=142.63±13.03, mean DBP in Group II=92. 33±23.72, mean SBP in Group III=136.73±8.1, mean DBP in Group III=93. 4±10.16). ($p>0.05$).The vitals started approaching the baseline values and blood pressure reached baseline values significantly faster in preoxygenated groups as compared to Group I ($p<0.05$).
Conclusions: Preoxygenation is a must before induction in all patients. Both 3 minute tidal volume and 4 deep breaths in 30 seconds techniques are equally effective in uncomplicated inductions. Ventilation during apnoea provides added oxygen reserve. Besides protection from hypoxia, preoxygenation contributes to hemodynamic stability.

Citation: Dr. Samina K. Khatib, Dr. Shobha J. Baride and Dr. Syed, S.N. 2018. "A study of role and comparison of tidal volume and deep breathing techniques of preoxygenation", *International Journal of Current Research*, 10, (03), 67101-67106.

INTRODUCTION

Induction of anesthesia is known to be associated with a risk of hypoxia. The oxygen saturation can reach a dangerously low level if induction is complicated by laryngospasm, upper airway obstruction and in situations like aspiration of gastric contents, difficult airway and intubation, obesity, etc. Hence, it is important to preoxygenate the patient before induction. A patient breathing room air will have total oxygen reservoir in the lungs and bloodstream of approximately 1.0 to 1.5 liters

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whereas in an optimally preoxygenated patient, the total oxygen reservoir reaches to 3.5 to 4.0L (Weingart and Levitan, 2012). Oxygen consumption during apnoea is approximately 250ml/minute (3ml/kg per minute); in healthy patients, the duration of safe apnoea is approximately 1 minute compared with approximately 8 minutes when breathing at a high FiO_2 level (Weingart and Levitan, 2012; TanoubiI *et al*., 2009). In spite of importance of preoxygenation, anaesthesiologists tend to neglect this step, possibly because of the perceived lack of time. Holding the an aesthetic mask prevents the anaesthesiologists from carrying out other activities, also many patients may have discomfort with face mask (Hett *et al*., 1994). An overestimation of patient discomfort by the anaesthesiologists may also contribute to the reluctance of using routine preoxygenation (Schlack *et al*., 2001; Kang *et al*., 2010). Generally,3-5 minutes of preoxygenation is considered gold standard, as 90-95% of nitrogen is eliminated (Weingart and Levitan, 2012; Collins, 1993). However other techniques such as 4 full vital capacity deep breaths in 30 seconds and 8 deep breaths in 1 minute are also effective (Weingart and Levitan, 2012; Collins, 1993). Different parameters are used to study the efficacy and efficiency of various preoxygenation techniques like minimum end N2 fraction (El-Khatib *et al*., 2003), maximal arterial oxygen tension (Aouad *et al*., 1999), maximal end tidal O_2 fraction (El-Khatib *et al*., 2003), etc.. Pulse oximetry is considered as the most clinically relevant measure of preoxygenation (El-Khatib *et al*., 2003) and also it reflects its efficiency (Nimmagadda *et al*., 2001). The pulse oximetry is a sensitive, reliable, noninvasive measure of hemoglobin saturation widely used for preoxygenation studies (Nimmagadda *et al*., 2001). In this study the commonly used techniques-3 minute tidal volume breathing and 4 deep breaths in 30 seconds techniques were compared using pulse oximetry and the effect of preoxygenation on hemodynamic variables was evaluated.

MATERIAL AND METHODS

This randomized clinical study was carried out in the operating room of a tertiary care medical college hospital after taking the institutional ethics committee approval. Ninety consenting patients of both genders, ASA grade I-II, in the age group 18-45 years, undergoing elective surgery under general anesthesia were included. Patients at extremes of weight, those with difficult airway, pregnant patients and those undergoing emergency surgery were excluded from the study. Patients in whom laryngoscopy lasted more than 30 seconds and if more than one intubation attempt was needed were also excluded. The patients were randomly assigned to any of the following 3 groups using sealed envelopes (30 patients in each group). Group I-received no preoxygenation but ventilation during apnoea in the form of four maximal chest inflations with oxygen 2 liters /minute. Group II-Received preoxygenation with 100% oxygen in the form of 4 vital capacity breaths in 30 seconds with 4 maximal chest inflations with 100% oxygen during apnoea. Group III-Received preoxygenation with 100% oxygen for 3 minutes in the form of tidal volume breathing and 4 maximal chest inflations of 100% oxygen during apnoea. Pulse oximeter, Noninvasive Blood Pressure Monitor (NIBP), cardioscope were applied. Oxygen saturation was recorded on room air. Baseline pulse rate, blood pressure, was recorded. Intravenous access was secured and Ringer lactate started. Premedication was given with injection Midazolam 0.02mg/kg i.v, and injection Pentazocine 0.3mg/kg i.v. The vitals were recorded 5 minutes after premedication. Preoxygenation was done in patients of group II and III.A Bain's circuit was used with 100% oxygen and the flow rate was kept at 8 liters/minute. A tightly fitting anatomical face mask was used for preoxygenation. Before starting preoxygenation, the circuit was flushed with 100% oxygen and the reservoir bag (2litres capacity) was completely filled with oxygen by occluding the mask with palm and keeping the valve closed. Patients were then instructed to either breathe normally for 3 minutes or to take 4 deep breaths depending on the group to which they were allocated. Patients were then induced with injection Thiopentone 5mg/kg i.v in all groups followed by injection Succinyl choline 2mg/kg.In Group I, the patients were given 4 maximal chest inflations with AMBU bag and mask with oxygen 2 liters/minute. In other groups, ventilation was done during apnoea using 4 maximal chest inflations of 100% oxygen. In each patient, vitals were recorded when patients were taken on table, 5 minutes after premedication, after preoxygenation, after induction, after succinyl choline administration and disappearance of fasciculations, immediately after intubation, and 5 minutes after intubation and ventilation with 50% oxygen, 50%nitrous oxide and halothane. In all cases the time required for laryngoscopy was noted. In each case, the lowest recording of SpO_2 was noted. The time required to achieve 100% saturation after ventilation was noted. The recordings of pulse rate, blood pressure, systolic blood pressure, diastolic blood pressure and oxygen saturation were recorded and statistical analysis was done. The tests, Chi square test, paired and unpaired t-test, ANOVA were applied. The analysis was done with the help of Medcalc Statistical Software version 16.4.3 (Medcalc Software bvba, Ostend, Belgium; https://www. medcalc.org; 2016).

RESULTS

The demographic data and preoperative vitals, of all 3 groups were compared and were found to be comparable (p>0.05). (Table 1)

Table 1. Demographic data

Parameters	Group I (n=30)	Group II (n=30)	Group III (n=30)	P value
Age (years)				
18-25	13	9	13	λ^2=2.503,p=0.644
26-35	8	12	11	
36-45	9	9	6	
Sex				
Male	13	13	12	λ^2=0.09,p=0.955
Female	17	17	18	
Weight (kg)				
40-50	5	7	10	λ^2=2.425,p=0.6582
51-60	14	15	12	
61-70	11	18	18	

Pulse rate changes

(Table 2)In all groups there was a rise in the pulse rate and blood pressure following premedication, induction and intubation as compared to baseline values. After intubation in Group II and III, and after achieving 100% saturation in Group I, patients were given IPPV with 50% oxygen, 50% nitrous oxide and halothane. The pulse and blood pressure values (SBP and DBP) values after intubation were comparable in all groups. (p=0.94 for pulse rate, p=0.06 for SBP, p=0.75 for DBP changes) Five minutes after IPPV, the pulse rate and blood pressure returned close to the baseline values in all the groups. The pulse rate in all patients at this stage was higher than the baseline and the pulse in the group I was higher than that in group II and III but not significant (p=0.1482) and the values of pulse rate in Group II and III were comparable (p=0.94). However, the systolic and diastolic blood pressure values remained significantly higher 5 minutes after intubation in group I as compared to the other two groups. (p=0.004 for SBP and p=0.000 for DBP)

SpO2 changes

(Table 5) The mean baseline SpO_2 values were comparable in all the groups. After premedication a significant fall in Spo2 was recorded in all the groups. Following preoxygenation the values reached 100% in both Group II and III. After induction, there occurred a significant fall in saturation in Group I, with values reaching a mean of 95.13 ±18%, as compared to the baseline SpO_2 ($p<0.001$). However the saturation remained 100% in the preoxygenated groups. There was a further fall in Spo2 in Group I after succinyl choline administration, mean values being 92±3% ($p<0.001$), however no fall occurred in preoxygenated groups.

Table 2. Pulse Rate Recordings (Mean ±Standard Deviation)

Parameters	Group I	Group II	Group III	p-value
Preoperative	84.13 ± 10.37	86.3± 10.16	83.36± 13.1	0.5806
On table	87.63± 12.85	89.96± 11.34	87.13± 11.90	0.6256
5 min after premed	89.06± 11.65	91.06± 11.51	91.93± 11.37	0.6141
After preoxygen	Not done	87.00± 18.81	84.9± 12.59	0.6133
After induction	99.13± 11.84	99.3± 11.31	97.0± 12.42	0.7057
After succinyl choline	105.4± 12.89	106.4± 11.95	106.26± 10.97	0.9404
Before intubation (after ventilation	108.86± 11.96	110.63± 11.98	109.00± 10.65	0.8047
After intubation	122.5± 15.33	123.56± 12.33	123.23± 10.2	0.05
5 min after induction	99.16± 12.83	94.2± 8.69	95.03± 9.24	0.1482

Tukey HSD post –hoc test for pulse rate values 5 minute after intubation:
Group 1 vs. group 2, p=0.1614
Group 1 vs. group 3, p=0.2794
Group 2 vs. group 3, p=0.9489
Comparison between baseline pulse and pulse rate 5 minutes after induction (t-test)
Group 1 p<0.001, group 2, p<0.002, group 3, p=0.002

Table 3. Systolic blood pressure recordings (Mean ± SD)

Parameters	Group I	Group II	Group III	p-value
Preoperative	118.12± 12.87	119.1± 9.83	117.86± 8.77	0.8929
On table	119.56± 10.19	120.73± 13.45	120.33±10.41	0.9223
5 min after premed	117.86± 11.64	116.26± 9.90	118.03±10.49	0.7795
After preoxygen	Not done	115.2± 10.0	116.46±10.65	0.6349
After induction	102.33± 8.18	101.1± 7.20	104.96±8.3	0.161
After succinyl choline	106.2± 7.95	106.06± 5.94	109.1± 7.84	0.1966
Before intubation (after ventilation	108.3± 6.4	109.13± 4.97	111.90± 7.14	0.07
After intubation	144.6± 16.8	142.63± 13.03	136.73± 8.1	0.0595
5 min after induction	125.06± 7.96	117.33± 7.507	117.33±7.507	0.0041

Table 4. Diastolic blood pressure recordings (Mean ± SD)

Parameters	Group I	Group II	Group III	p-value
Preoperative	74.33± 7.4	73.03± 15.44	73.10± 7.14	0.8697
On table	75.73± 6.5	77.2± 7.09	75.11± 8.14	0.5231
5 min after premed	75.73± 6.3	75.36± 6.19	73.77± 7.06	0.3232
After preoxygen	Not done	73.4± 5.84	73.56± 4.54	0.2134
After induction	70.3± 6.1	69.63± 5.22	71.23± 7.08	0.6040
After succinyl choline	71.6± 5.6	72.96± 5.17	72.00± 6.18	0.6349
Before intubation (after ventilation	73.1± 5.4	73.86± 6.49	74.1± 5.01	0.7759
After intubation	95.46± 11.49	92.33± 23.72	93.4± 10.16	0.7524
5 min after induction	83.7± 7.99	75.83± 6.68	76.2± 6.46	0.000

Tukey HSD post-hoc test for DBP
Group I vs. Group 2, p=0.0001
Group I vs. Group 3, p=0.0003
Group 2 vs. group 3, p=0.9776

Table 5. SpO2 recordings (Mean ±standard deviation)

Parameters	Group I	Group II	Group III	p-value
Preoperative	98.33± 0.711	98.13± 0.59	98.22± 0.54	0.4577
On table	98.26± 0.86	98.11± 0.61	98.33± 0.78	0.5189
5 min after premed	96.62± 1.03	97.00± 1.01	96.56± 0.89	0.2217
After preoxygen	Not done	100	100	
After induction	95.13± 1.8	100	100	0.000
After succinyl choline	92.00± 3.0	100	100	0.000
Before intubation (after ventilation	97.7± 2.46	100	100	0.000
After intubation	94.7± 3.16	100	100	0.0000
5 min after induction	100	100	100	

Tukey HSD post hoc test
Group I Vs Group II, P=0.000
Group I Vs Group III, p=0.000

None of the patients recorded values below 90% till these stages. After ventilation with 33% oxygen (AMBU bag with oxygen 2litres /minute), there occurred a rise in SpO_2levels, which rose to basal preoperative levels with mean 97.7±2.46%. However, there occurred a fall in SpO_2 values after intubation in Group 1 ($p<0.001$). The SpO_2 remained at 100% throughout induction and intubation in the preoxygenatedgroups. The time period required for intubation was recorded in all the groups and was comparable ($p>0.05$). (Table 6)

Five minutes after intubation

(Table 5) Pulse rate, SBP and DBP in all groups started approaching the baseline values.

Table 6. Mean time for intubation in seconds

Groups	Time (seconds) Mean ± SD
Group I	22.19 ± 10.1
Group II	19.79 ± 10.1
Group III	22.77 ± 10.4

P value =0.49

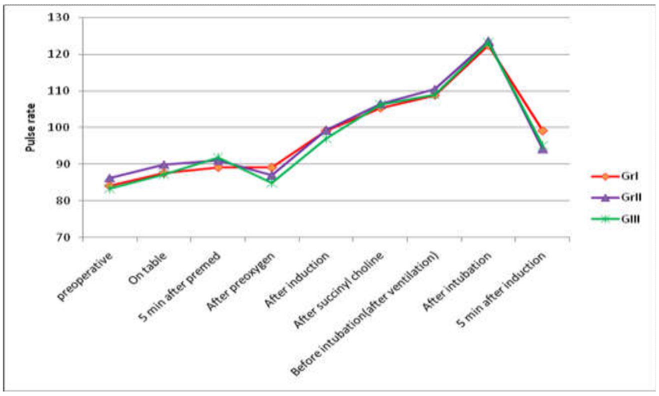

Fig. 1. Pulse rate changes

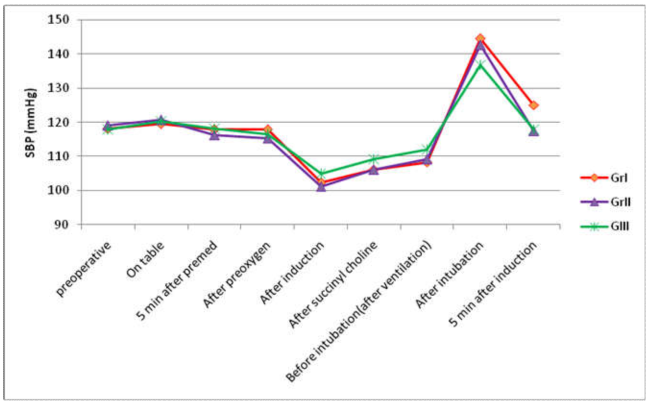

Fig 2. Systolic blood pressure changes

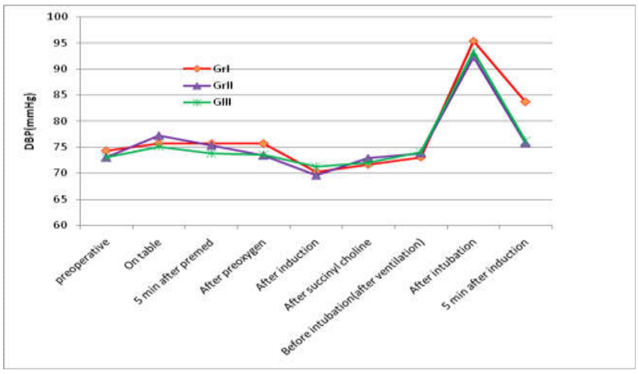

Fig. 3. Diastolic blood pressure changes in the groups

At this stage the pulse rate in Group I (125.06±7.97) was higher than in Groups II (117.33±7.50) and III (117.93±12.80) respectively, though not significant statistically (p=0.148). There was no significant difference in pulse rate values in Groups II and III. (p=0.94) Similarly, mean SBP and DBP in all groups started approaching the baseline BP. The mean SBP (125.06±7.96) and DBP (83.7±7.99) in group I were significantly higher (p=0.0041 for SBP, P=0.000 for DBP) than in group II (SBP=117.33±7.507, DBP=75.83±6.68) and group III (SBP=117.93±12.8, DBP=117±12.8). There was no significant difference in BPs as compared to baseline in Group II (p=0.517) and III (p=0.9804), whereas it was significantly higher in Group I as compared to the baseline (p=0.0148)). SpO_2 was 100% at this stage in all the groups. Thus, preoxygention helps to keep the vital parameters stable and they return to baseline earlier after induction of anesthesia.

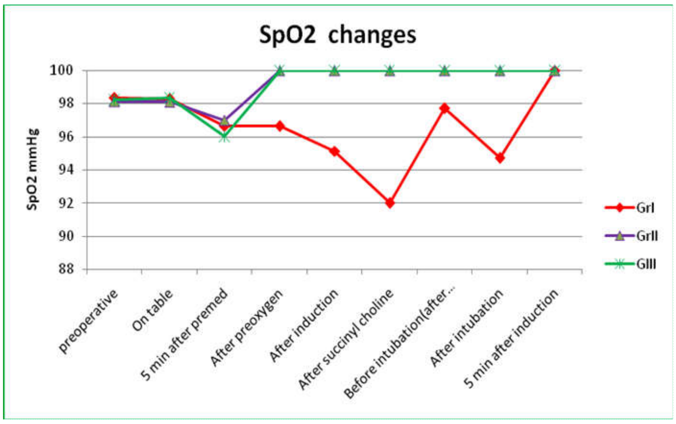

Fig. 4. SpO2 changes

DISCUSSION

Preoxygenation is a well-recognized technique to increase the oxygen reserves and thereby delay the onset of hypoxia duringapnoea. Prior studies (Drummond and Park, 1984; Thorpe and Gauntlett, 1990) indicate that apnoea for one minute in an individual breathing normal ambient air, will decrease arterial oxygen saturation to 85% and in some cases to less than 80%.Preoxygenation can be done by many techniques and more commonly 3 minute tidal volume technique and 4 deep breaths in 30 seconds technique are used. Denitrogenation ofthe lungs is more than 95% complete in approximately 3 minutes onsubjects breathing fresh gas flow of 5 liters/minutewith a tight fitting mask with sufficient fresh gas flow (10-12 liters/minute) to avoid rebreathing (Donati, 2009; Hamilton and Eastwood, 1955). Benumof (Benomof *et al*., 1999) has shown by mathematical calculation that in order to maintain adequate oxygen stores in alveolar and arterial spaces, four deep breaths in 30 seconds are adequate. Pulse oximetryhas been used in our study as it is a sensitive and reliable indicator of oxygen saturation, non-ivasive, readily available, cost effective and also provides pulse rate monitoring besides showing oxygen saturation (Laycock and McNicol, 1988; Dorsch and Dorsch). General anesthesia is known to alter arterial oxygenation. Reduction in FRC, closure of small airways and associated ventilation perfusion mismatch are some of the causes for fall in SpO_2 after induction in adults (Laycock and McNicol, 1988). Also the sedative premedication contributes to the respiratory depression of the inducing agent. There was no fall in saturation in Group II and III where preoxygenation was done. There occurs further fall in saturation in Group I following succinyl choline because of neuromuscular blockade and apnoea caused thereby. But saturation was maintained in Group II and III. Ventilation during apnoea is routinely done in elective cases, unless there are contraindications. Ventilation provides two potential benefits during the onset phase of muscle relaxation: ventilation and increased oxygenation through alveolar distension and reduction in shunting. During apnoea it was decided to give 4 Intermittent Positive Pressure Ventilation (IPPV) breaths based on mathematical calculation by Benumof (Benomof, 1999) as explained before. In Group I, ventilation during apnoea helped increase the SpO_2 to baseline values that in Group II and III it was maintained at 100%. During intubation there was a significant increase in pulse rate and blood pressure in view of intubation response. The mean pulse rates in all three groups were comparable to each other in all the groups. The rise in SBP and DBP in the Group I was significantly more than that in Groups II and III. This shows that preoxygenation and ventilation during apnoea definitely contributed to haemodynamic stability. In a study by Khandrani *et al*. in which patients were studied in 4 groups, the first group was not preoxygenated, while the other three were preoxygenated using different preoxygenation techniques. It was observed that the mean heart rate and blood pressure were about 20% higher in patients who were not preoxygenated as compared to the other study groups. However, in our study the pulse rate values were comparable in all the three groups. But five minutes after intubation and ventilation with anesthetic gases, the value started approaching the baseline values faster in preoxygenated groups as compared to Group I. There was significant fall in SpO_2 values in Group I (mean SPO_2 =94.71±3.61). The lowest SpO_2 value was 88%, but nevertheless was never less than lower safe limit of 85%. When patients desaturate below this level, their status is on the steep portion of the oxyhaemoglobin dissociation curve and can decrease to critical levels of oxygen saturation (<70%) within moments (Weingart and Levitan, 2012). Desaturation to below 70% puts patients at risk for dysrhythmia, haemodynamicdecompenastion, hypoxic brain injury, death (Weingart and Levitan, 2012). Our study included only ASA grade I and II patients, but the acceptable limit of SpO_2 is likely to be crossed in ASA grade II onward patients, where it can prove dangerous. Hence, the importance of preoxygenation in compromised patients. Thus preoxygenation and ventilation during apnoea gave definite protection from hypoxia. Basrur *et al*. (18) have ventilated the patients during apnoea with either 100%, 50%, or 33% oxygen without doing preoxygenation. The group that was not preoxygenated but ventilated during apnoea with 33% oxygen showed fall in saturation during induction. This is similar to our findings in Group I. In a study by Sanjay *et al*. (2004), it has been demonstrated that in patients who had not received preoxygenation, there was a fall in saturation to a mean of 77±3.26%. Unlike, our study, they had not ventilated the patients during apnoea leading to marked desaturation below safe limits. After intubation and after saturation reached 100% in Group I, the patients were given IPPV with 50% oxygen, 50% nitrous oxide and halothane for 5 minutes and again pulse rate, blood pressure, SpO_2 were recorded. Blood and pulse rate started approaching baseline values in all groups. The pulse rate settled closer to baseline earlier in all the groups but in group I the blood pressure values (SBP and DBP) were significantly higher than the baseline values as well as higher than the values in group II and III. This shows the early settlement of vitals in preoxygenated patients. Thus, preoxygenation not only protects from hypoxia but also contributes to definite haemodynamic stability to the patients especially after intubation. Also the vitals settle earlier in these patients. Now that the importance of preoxygenation is proved beyond doubt the further step is to compare which technique is better. A number of studies (Baraka *et al*., 1999; Nimmagadda *et al*., 2001; Rajpet *et al*., 2004; Robbins, 2003; Dennis, 1987) have shown that 4 DB is less efficient as compared to 3 minute tidal volume breathing. All of them have explained the decreased efficiency of 4 DB technique by the fact that minute volume in these patients exceeded the fresh gas flow, causingrebreathing and decreased inspired oxygen concentration. On the contrary, in patients on 3 minute tidal volume breathing, minute volume could be lower than fresh gas flow and inspired gas would be 100% resulting in higher PaO_2 and oxygen reserve. Baraka (Baraka *et al*., 1999) also explained that N_2concentration decreased to less than 4% within 3 minutes of tidal volume breathing of 100% oxygen. Also 4 deep breaths cause rapid arterial saturation without a significant increase in oxygen stores and hence the rapid onset of desaturation during apnoea. Gambee *et al.* (1987) attributes the decreased efficiency of 4 DB technique to rebreathing characteristics of circle system. Benumof (Benomof, 1999) attributes decreased efficiency of 4DB technique to nitrogen rebreathing and second cause is that tissue and venous component need more than 30 seconds to fill with oxygen. Besides, another disadvantage of 4DB as explained by Nimmagadda (Nimmagadda *et al*., 2001) are hypocapnia causing a shift of the oxygen dissociation curve to left, increased oxygen consumption, nausea, dizziness etc. Our observations are similar to Sandhya *et al.* (Sandhya *et al*., 2001) who have shown that 2-3 minute tidal volume breathing and 4 deep breath techniques are equally effective in protecting against apnoea during induction. Like them we have used Bain's circuit with flow rate 8 liter/minute and there was no fall in saturation during induction in patients preoxygenated with either of the two techniques. Sandhya *et al*. (Sandhya *et al*., 2001) have attributed this to Bain's circuit used for preoxygenation. According to them, it causes minimal rebreathing during DB technique and hence equal efficacy to 3 minute tidal volume breathing. Gold and Muravchick (Gold and Muravchick, 1981) have shown that both the techniques (3 min tidal volume breathing and 4 deep breath technique) produce comparable PaO2 and identical CaO_2 (arterial oxygen content) after preoxygenation. Ginimuge and Kamat (Ginimuge and Kamat, 2016) have also demonstrated the efficacy of 4 DB technique. Some authors (Tanoubi *et al*., 2009) recommend not using 4 DB technique, instead they recommend the 8 DB technique. However, the 8 DB technique has its own disadvantages. Patient's cooperation is required, it may cause hypocapnia, dizziness and a shift of the oxygen hemoglobin dissociation curve to left (Nimmagadda *et al*., 2001). Hence, 4 DB technique does have a role, especially in emergency cases where minimum time is permissible for induction. Thus, both 3 minute TV and 4 DB techniques are equally effective in preventing hypoxia during uncomplicated induction of healthy subjects. The limitation of our study is that we have not used the measures of effectiveness for comparing the two preoxygenation techniques such as Duration of Apnoea Without Desaturation (DAWD) (Tanoubi *et al*., 2009) which is the most direct method to evaluate the effectiveness of preoxygenation using pulse oximetry. We did not measure this because we wanted to demonstrate and evaluate the effectiveness of the two techniques during routine induction procedures. Also, we could not have studied the effect of preoxygenation on vital parameters if DAWD was measured. In such a situation, the other measures such as end tidal nitrogen fraction, end tidal oxygen fraction could have been measured to compare the effectiveness of the two techniques. But these were not available in our institute.

Conclusion

We conclude that preoxygenation with 100% oxygen with the correct method is a must before induction of anesthesia in elective as well as emergency surgeries, in healthy as well as in compromised patients. Both the above said techniques are equally effective in uncomplicated inductions. However, in compromised patients, anticipated difficult intubation, elderly and obese cases, 3 minute tidal volume breathing should be preferred. Preoxygenation alone or in combination with ventilation during apnoea can be used if the latter is not contraindicated because of conditions like full stomach, emergency cases, etc. Ventilation during apnoea provides added oxygen reserve through alveolar distension and reduction in shunting. Vital parameters remain more stable in patients who are preoxygenated. This is an additional virtue of pre-oxygenation, the importance of which cannot be neglected.

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