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Original Research Article

**Comparison of CPAP preoxygenation versus conventional preoxygenation on duration of safe apnoea time in patients undergoing elective surgery under general anaesthesia**Sushil Chand Verma<sup>1</sup>, Shakti Singhal<sup>2\*</sup>, Ghanshyam Das Singhal<sup>3</sup>, Gunjan Agrawal<sup>4</sup><sup>1</sup> Senior Resident Department of Anaesthesiology, Dr. Ram Manohar Lohiya Hospital New Delhi, India<sup>2</sup> Assistant Professor, Department of Anaesthesiology, G.R. Medical College, Gwalior, M.P., India<sup>3</sup> Associate Professor, Department of Neurosurgery, GIPMER, New Delhi, India<sup>4</sup> Pathology, Private centre, India

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**ABSTRACT**

Anesthesia induction usually leads to apnoea, during apnoea, oxygenation depends on the oxygen reserves stored within the body. While breathing room air these stores are quantitatively low. As we cannot perfectly predict the difficulty in airway management, desirability of maximal preoxygenation is theoretically present for all patients. Induction of general anaesthesia per se as also the use of 100% oxygen during preoxygenation results in the development of atelectasis in dependent lung regions within minutes of anaesthetic induction. Therefore this randomized, controlled study was undertaken to compare the effect of CPAP (continuous positive airway pressure) preoxygenation vs conventional preoxygenation on duration of safe apnoea time in patients posted for elective surgery under general anaesthesia. After obtaining approval from the institutional review board and institutional ethics committee and prior consent from participants, 60 adult patients scheduled for elective surgery under general anaesthesia were randomized into two groups- PEEP group and ZEEP group. Patients in PEEP group were preoxygenated with CPAP of 5 cm of H<sub>2</sub>O with 100% oxygen for five minutes and in ZEEP group no CPAP was used. Duration of safe apnoea time (taken as till Spo<sub>2</sub> reached 94%) and ABG analysis at various time intervals was done for each group. The comparison of normally distributed continuous variables between the groups was performed using Student's t test. Nominal categorical data between the groups were compared using Chi-squared test or Fisher's exact test as appropriate. P value less than 0.05 was considered statistically significant. We found out that the duration of safe apnoea time was significantly longer in PEEP group (408.90 ± 32.73) as compared to ZEEP group (257.70 ± 12.79 s) (P value less than 0.001). PaO<sub>2</sub> after preoxygenation was also significantly higher in PEEP group (416.62 ± 28.72 mmHg) as compared to ZEEP group (367.02 ± 14.29 mmHg) (P value less than 0.001). We concluded that the application of continuous positive airway pressure during preoxygenation is a simple, well tolerated technique that may have advantages especially in those patients in whom difficulty in airway management is anticipated, those who are at increased risk of desaturation such as morbidly obese patients and when assisted ventilation is not applied such as during rapid sequence induction.

**Key words:** Apnoea, factors, Patient

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**INTRODUCTION**

Maintaining tissue oxygenation is of utmost importance in airway management during general anaesthesia.

The period an apneic patient is likely to maintain arterial blood oxygen saturation above 92% is called safe apnoea time.<sup>[1]</sup> Prolonging the safe apnoea time reduces the risk of hypoxic injury in cases of inadvertent delay in intubation. Safe apnoea time depends upon the fraction of oxygen in Functional residual capacity (FRC) of lungs.<sup>[2,3]</sup> To increase the FRC in lungs preoxygenation with 100% oxygen is done prior to induction of anaesthesia, but preoxygenation with 100% oxygen increases the risk of

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atelectasis.<sup>[4-6]</sup> Up to 85–90% of patients develop atelectasis in dependent lung regions within 5 min of induction of general anaesthesia <sup>[7,8]</sup> because pre-oxygenation replaces the nitrogen in lungs with oxygen. Oxygen in contrast to nitrogen is extremely soluble in blood and quickly diffuses in to pulmonary vasculature and enough gas is not left in the alveoli to maintain patency and alveoli collapse.<sup>[9]</sup> Use of low fraction of oxygen during preoxygenation prevents atelectasis<sup>[10]</sup>, but this technique is not recommended because it decreases safe apnoea time.<sup>[11]</sup> The application of Continuous positive airway pressure. CPAP during pre-oxygenation prevents atelectasis despite the use of 100% oxygen<sup>[12,13]</sup> thereby increasing oxygenation and duration of safe apnoea time. It has been shown that normal duration of safe apnoea time after preoxygenation with 100 % oxygen is 8 minutes which can be further prolonged by more than 2 minutes after application of CPAP<sup>[14]</sup>.

There are certain conditions in which we avoid ventilation just before intubation( Non fasting patients, advanced pregnancy , GERD ) because of high risk of aspiration, in these cases the time period to implement definitive airway strategy is very less, by our study we want to find out , Can this time period be prolonged ? Applying CPAP was not a common feature in anaesthesia ventilators 10 years ago, but is now common in modern ones, with this background in mind we aim to study the effect of application of CPAP with 100% oxygen during preoxygenation on duration of safe apnoea time during intubation.

#### AIM AND OBJECTIVE

To compare the duration of safe apnoea time in patients preoxygenated with CPAP and patients preoxygenated conventionally, posted for elective surgery under General anaesthesia

#### MATERIAL AND METHODS

The study will be conducted in the Department of Anaesthesiology, Dr. Baba Saheb Ambedkar Medical College and Hospital; New Delhi.

##### Study design: Randomized controlled study

We will recruit a total of 60 adult patients of age between 18-40 years of either sex for our study. Sample size calculation was based on duration of safe apnoea in patients preoxygenated (primary outcome). With reference to previous study, the mean  $\pm$  SD was calculated as  $496.56 \pm 71.68$  s versus  $273.00 \pm 69.31$  s in patients receiving CPAP and no CPAP respectively.<sup>[19]</sup> Based on these values, and using  $\alpha=0.05$  and  $\beta=0.1$ (Power 90%) for a study design incorporating two groups of equal size, a sample size of 5 patients per group was required. But we will be taking 30 patients per group during the study period.

The formula for calculated sample size is given below  
 $n = (\sigma_1^2 + \sigma_2^2) \cdot [Z_{1-\alpha/2} + Z_{1-\beta}]^2 (M_1 - M_2)^2$

Where

M1 = Mean of the Outcome variable (duration of safe apnoea ) in CPAP group

M2 = Mean of the Outcome variable (duration of safe apnoea ) in no CPAP group

$\sigma_1$  = SD of the Outcome variable (duration of safe apnoea ) in CPAP group

$\sigma_2$  =SD of the Outcome variable (duration of safe apnoea ) in no CPAP group

Z  $1-\alpha/2$  and Z  $1-\beta$  are probability of two error.

Inclusion criteria:

- Age group 18-40 years of either sex.

- ASA grade 1 .

- BMI grade 18.50-24.99.

- Posted for elective surgery under general anaesthesia , requiring intra-arterial line insertion.

##### Exclusion criteria

1. Patients with SPO2 less than 97% on room air.

2. Non ambulant for > 24 hours.

3. Haemoglobin < 10 g%.

4. Mallampatti class III ,IV.

5. Patients with history of obstructive sleep apnoea.

6. Patient with history of coronary artery disease, cerebrovascular disease, Intra cranial hypertension, epilepsy, severe pulmonary disease.

7. Contraindications to the use of Succinyl choline hydrochloride .

Written informed consent will be obtained from all the patients. After a thorough pre-operative evaluation the patients will be randomly allocated into two groups of 30 patients each, using closed envelope technique.

Group Z – Zero end expiratory pressure group (ZEEP group).

Group P – Positive end expiratory pressure group (PEEP group)

All patients will be fasted eight hours prior to the surgery. In the operation theatre Heart Rate (HR), electrocardiography, Non invasive Blood Pressure (BP), pulse oximetry (SpO<sub>2</sub>) monitoring will be done continuously and additional precaution will be taken to monitor SpO<sub>2</sub> at two sites for patient safety ,we will use the same two devices throughout the study .An intravenous access will be secured. Under aseptic conditions radial artery will be cannulated after local infiltration with 2% lignocaine and the arterial line will be flushed with heparinised saline .baseline values of heart rate, blood pressure, and Spo2 will be recorded and a sample of arterial blood gas (ABG) (first sample) will be taken while the patient is breathing room air. The anaesthesiologist will apply and maintain the position of face mask. Patients in ZEEP group will be preoxygenated conventionally with 100% oxygen for five minutes at the rate of eight liters per minute.

Patients in PEEP group will be given CPAP of 5cm of H<sub>2</sub>O during preoxygenation. Second arterial blood gas sample (ABG) will be taken after 5mins of preoxygenation and SpO<sub>2</sub> will be recorded. Second anaesthesiologist will induce anaesthesia using fentanyl 2 microgram/kg and propofol 2 mg/kg, succinylcholine hydrochloride 2 mg/kg will be used to paralyse the patients. Sixty seconds after administration of Succinylcholine hydrochloride, the anaesthesiologist will perform tracheal intubation using cuffed endotracheal tube (ETT) of appropriate size; the correct position of tube will be checked immediately using fiberoptic visualization. [12] To maintain muscle relaxation patients will be given vecuronium bromide 0.08 mg/kg immediately after tracheal intubation and anaesthesia will be maintained using an infusion of propofol at 50microgram/kg/minute. Tracheal tube will be left open to room air at atmospheric pressure till the SpO<sub>2</sub> reaches 94% in either of the two pulse oximeter monitors or for duration of 8 minutes whichever will be earlier. Third ABG will be taken at this point and patient will be given 100% oxygen till saturation returns to baseline value. We will be monitoring Capnography for evidence of spontaneous breathing, Pulse oximetry for significant desaturation.

#### OBSERVATION

- 1. The duration of safe apnoea will be measured in seconds from the time of administration of succinyl choline hydrochloride to the time when SpO<sub>2</sub> reaches 94% or a duration of 8 minutes has elapsed whichever is earlier.
- 2. Following parameters will be monitored
  - Pulse (P)

- Systolic Blood Pressure (SBP)
- Diastolic Blood Pressure (DBP)
- Mean arterial Pressure (MAP)
- SpO<sub>2</sub>
- Arterial Blood Gas (ABG)
- End tidal CO<sub>2</sub>. (ETCO<sub>2</sub>)

#### Statistical analysis

Statistical testing will be conducted with the statistical package for the social science system version SPSS 17.0. Continuous variables will be presented as mean±SD or median if the data is unevenly distributed. Categorical variables will be expressed as frequencies and percentages. The comparison of continuous variables between the groups will be performed using Student's t test. Nominal categorical data between the groups will be compared using Chi-squared test or Fisher's exact test as appropriate. Non-normal distribution continuous variables will be compared using Mann Whitney U test. For all statistical tests, a p value less than 0.05 will be taken to indicate a significant difference.

#### RESULTS

After obtaining approval from the institutional review board and institutional ethics committee. A total of 60 adult patients of age between 18-40 years were taken for our study, patients were randomly allocated into two groups of 30 patients each, PEEP group and ZEEP group Both group members were equally comparable in age group and there is no significant difference in age group with P value of 0.574 [Figure 1, Table 1]

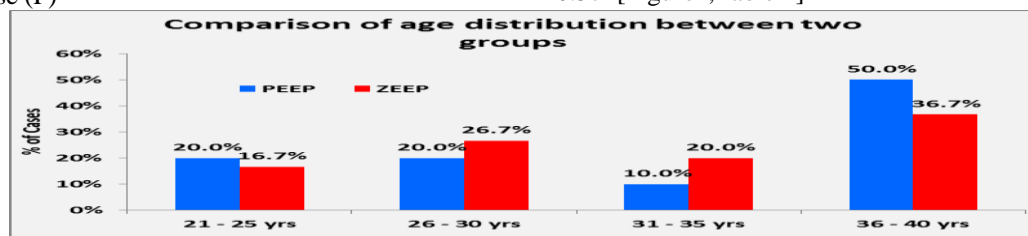


Figure 1: Comparison of mean age between two groups

Table 1: Comparison of mean age between two groups

Age Groups	Groups				P Value
	PEEP		ZEEP		
	Frequency	%	Frequency	%	
21 - 25 yrs	6	20.0%	5	16.7%	0.574
26 - 30 yrs	6	20.0%	8	26.7%	
31 - 35 yrs	3	10.0%	6	20.0%	
36 - 40 yrs	15	50.0%	11	36.7%	
Total	30	100%	30	100%	

Comparison of gender distribution between two groups

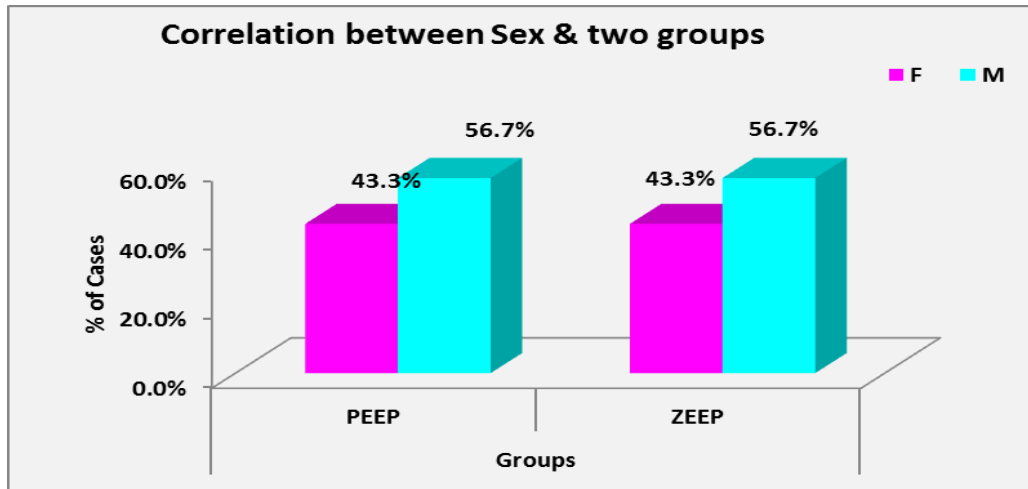


Figure 2: Correlation between sex and two groups

Table 2: Correlation between sex and two groups

Sex	Groups				P Value
	PEEP		ZEEP		
	Frequency	%	Frequency	%	
F	13	43.3%	13	43.3%	1.000
M	17	56.7%	17	56.7%	
Total	30	100%	30	100%	

Both the groups were comparable in gender with P value 1.000 showing no statistical significance in two groups[Figure 2,Table 2]

Comparison of surgical procedure between two groups is shown in Figure 3 and Table 3

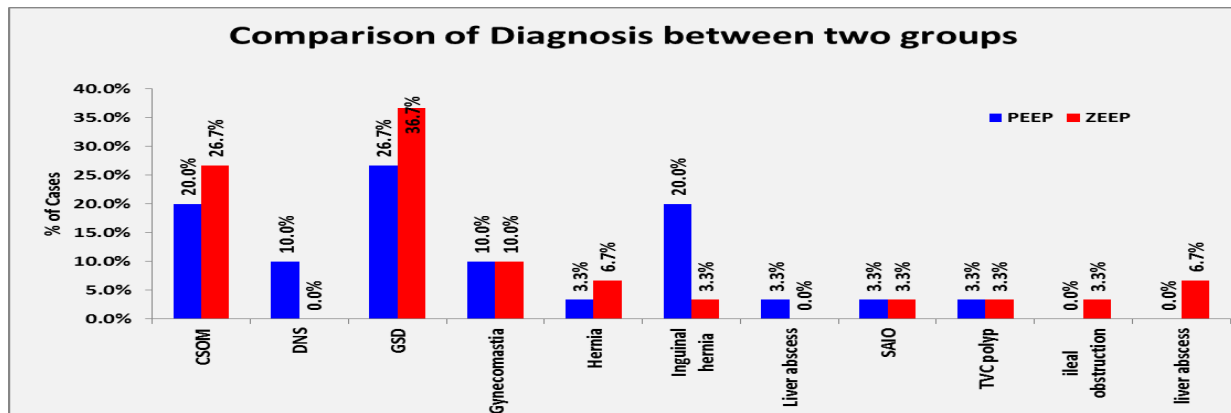


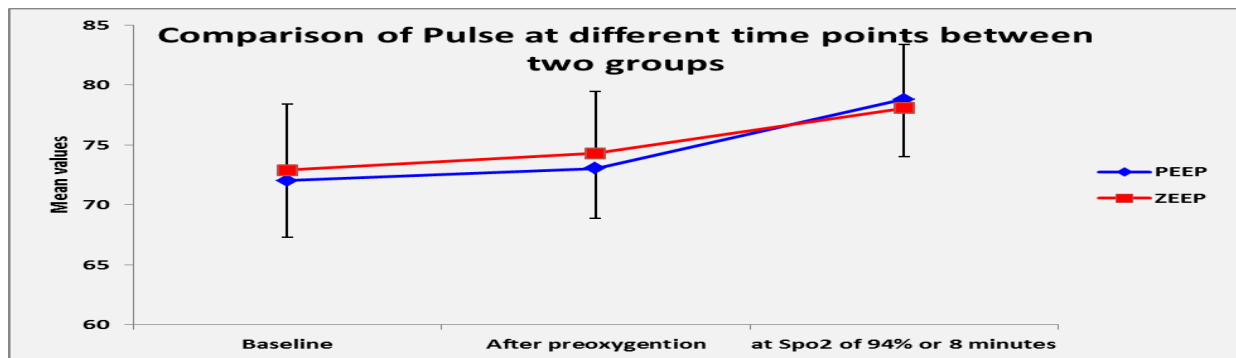
Figure 3: Comparison of diagnosis between two groups

**Table 3: Comparison of diagnosis between two groups**

Diagnosis	Groups				P Value
	PEEP		ZEEP		
	Frequency	%	Frequency	%	
CSOM	6	20.0%	8	26.7%	0.308
DNS	3	10.0%	0	0.0%	
GSD	8	26.7%	11	36.7%	
Gynecomastia	3	10.0%	3	10.0%	
Hernia	1	3.3%	2	6.7%	
Inguinal hernia	6	20.0%	1	3.3%	
Liver abscess	1	3.3%	0	0.0%	
SAIO	1	3.3%	1	3.3%	
TVC polyp	1	3.3%	1	3.3%	
ileal obstruction	0	0.0%	1	3.3%	
liver abscess	0	0.0%	2	6.7%	
Total	30	100%	30	100%	

The surgical procedures performed in two groups were similar and showed no statistical difference (P-Value – 0.308).

Comparison of pulse at various time intervals between two groups is shown in Figure 4 and Table 4.



**Figure 4: Comparison of pulse at various time intervals between two groups**

**Table 4: Comparison of pulse at various time intervals between two groups**

Pulse	PEEP (n=30)	ZEEP (n=30)	P Value
	Mean ± SD	Mean ± SD	
Baseline	72.03 ± 4.74	72.90 ± 5.51	0.516
After preoxygenation	73.03 ± 4.18	74.30 ± 5.18	0.325
at Spo2 of 94% or 8 minutes	78.80 ± 4.79	78.07 ± 5.30	0.576

Mean values of pulse, between two groups were statistically insignificant at various intervals between PEEP and ZEEP group [Figure 5, Table 5]

Comparison of systolic blood pressure at various time intervals between two groups

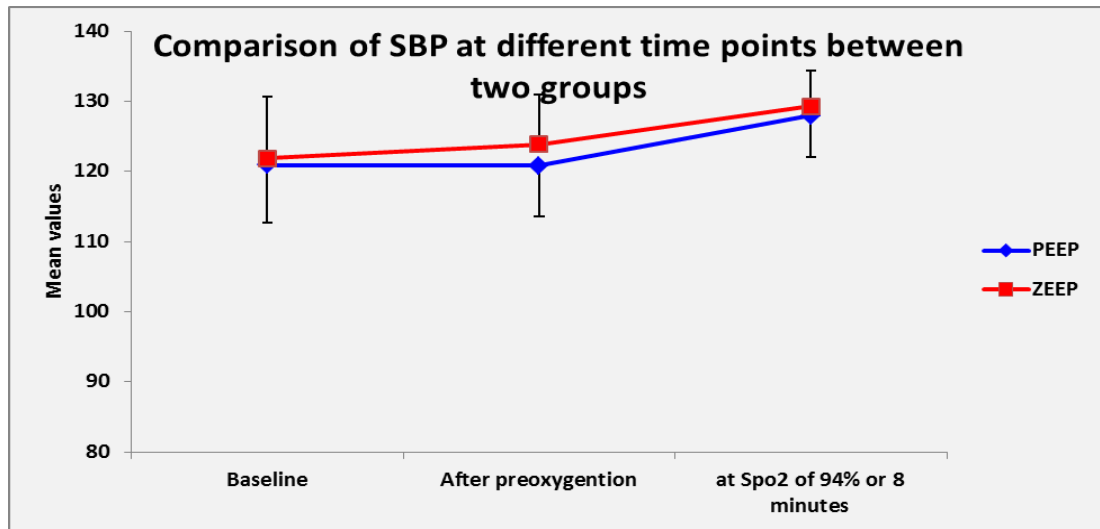


Figure 5: Comparison of systolic blood pressure at various time intervals between two groups

Table 5: Comparison of systolic blood pressure at various time intervals between two groups

Systolic	PEEP (n=30)	ZEEP (n=30)	P Value
	Mean ± SD	Mean ± SD	
Baseline	120.90 ± 8.27	121.87 ± 8.74	0.661
After preoxygenation	120.83 ± 7.21	123.90 ± 7.04	0.101
at Spo2 of 94% or 8 minutes	127.93 ± 5.95	129.27 ± 5.04	0.353

Mean values of systolic blood pressure, between two groups were statistically insignificant at various intervals between PEEP and ZEEP group.

Comparison of diastolic blood pressure at various time intervals between two groups

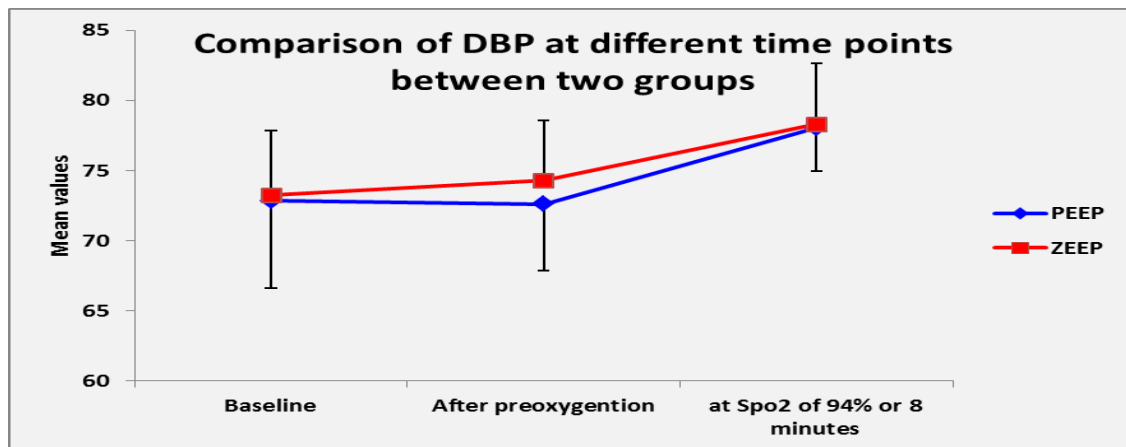


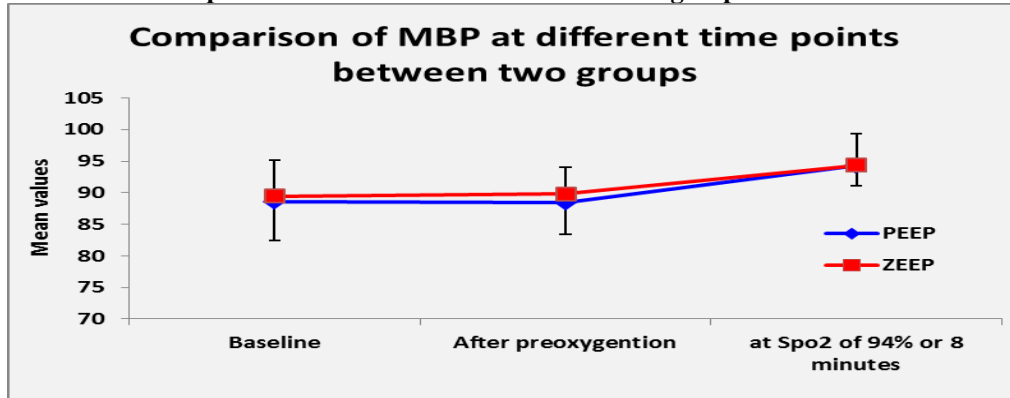
Figure 6: Comparison of diastolic blood pressure at various time intervals between two groups

**Table 6: Comparison of diastolic blood pressure at various time intervals between two groups**

Diastolic	PEEP (n=30)	ZEEP (n=30)	P Value
	Mean ± SD	Mean ± SD	
Baseline	72.83 ± 6.22	73.23 ± 4.64	0.779
After preoxygenation	72.60 ± 4.72	74.27 ± 4.29	0.158
at Spo2 of 94% or 8 minutes	78.03 ± 3.07	78.30 ± 4.36	0.785

Mean values of diastolic blood pressure, between two groups were statistically insignificant at various intervals between PEEP and ZEEP group as in figure 6 and Table 6

**Comparison of mean blood pressure at various time intervals in two groups**



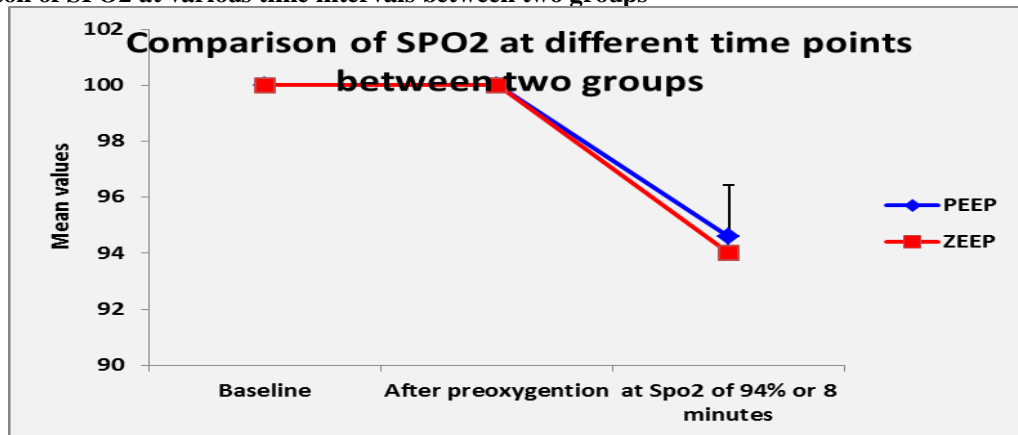
**Figure 7: Comparison of mean blood pressure at various time intervals in two groups**

**Table 7: Comparison of mean blood pressure at various time intervals in two groups**

Mean	PEEP (n=30)	ZEEP (n=30)	P Value
	Mean ± SD	Mean ± SD	
Baseline	88.57 ± 6.13	89.44 ± 5.77	0.570
After preoxygenation	88.37 ± 4.90	89.81 ± 4.19	0.227
at Spo2 of 94% or 8 minutes	94.30 ± 3.21	94.37 ± 4.95	0.951

Mean values of Mean blood pressure, between two groups were statistically insignificant at various intervals between PEEP and ZEEP group in [Figure 7 and Table 7].

**Comparison of SPO2 at various time intervals between two groups**



**Figure 8: Comparison of SPO2 at various time intervals between two groups**

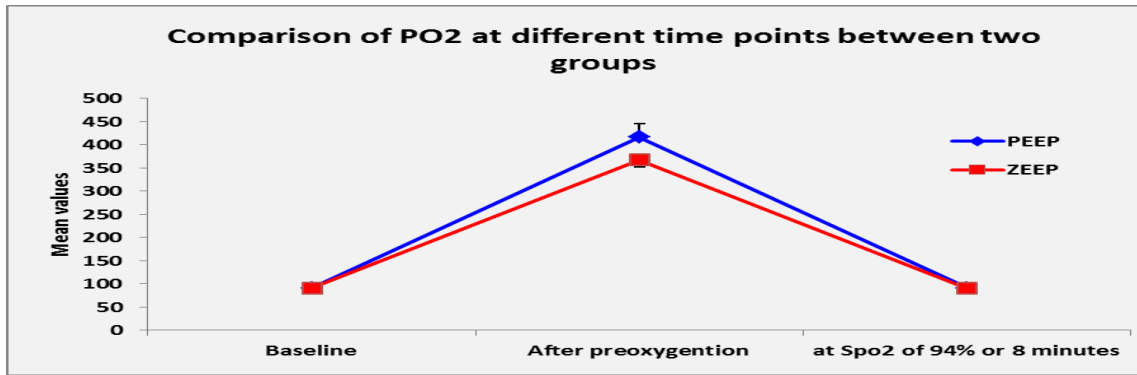


**Table 8: Comparison of SPO2 at various time intervals between two groups**

SPO2	PEEP (n=30)	ZEEP (n=30)	P Value
	Mean ± SD	Mean ± SD	
Baseline	100.0 ± 0.00	100.0 ± 0.00	0.078
After preoxygenation	100.0 ± 0.00	100.0 ± 0.00	–
at Spo2 of 94% or 8 minutes	94.60 ± 1.83	94.00 ± 0.00	–

Baseline Spo2 and Spo2 after preoxygenation were comparable in both the groups. The arterial SpO<sub>2</sub> dropped to 94% within the study period of eight minutes in all 20 patients in the ZEEP group and only 17 out of 20 patients in the PEEP group. The SpO<sub>2</sub> in three patients in the PEEP group remained above 94% during the eight minutes of apnoea that we had defined to be the end point of our study.[Fig 8,Table 8]

Comparison of PO<sub>2</sub> at various time intervals between two group is shown in [Figure 9 and Table 9]

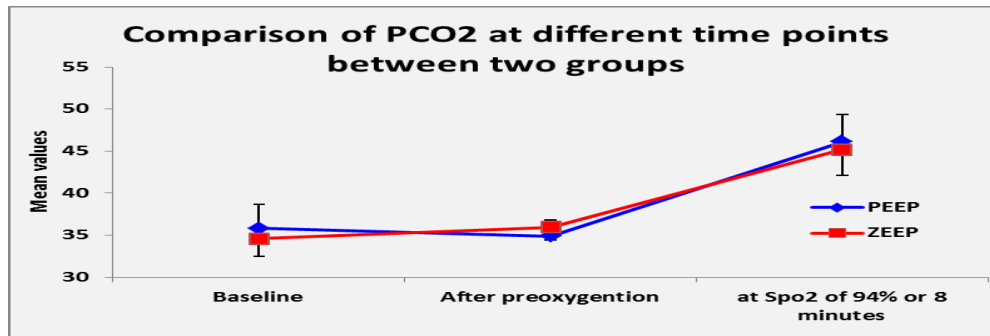


**Figure 9: Comparison of SPO2 at various time intervals between two groups**  
**Table 9: Comparison of SPO2 at various time intervals between two groups**

PO2	PEEP (n=30)	ZEEP (n=30)	P Value
	Mean ± SD	Mean ± SD	
Baseline	90.95 ± 3.91	90.40 ± 3.93	0.591
After preoxygenation	416.62 ± 28.72	367.02 ± 14.29	<0.001
at Spo2 of 94% or 8 minutes	90.45 ± 8.29	89.84 ± 2.81	0.701

The PaO<sub>2</sub> at the start of pre-oxygenation were comparable in both the groups, the PaO<sub>2</sub> measured following pre-oxygenation was 367.02 ± 14.29 mmHg in the ZEEP group and 416.62 ± 28.72 mmHg in the PEEP group. This difference was statistically significant.( P value less than 0.001)

Comparison of PCO<sub>2</sub> at various time intervals between two groups is shown in [Figure 10and Table 10]



**Figure 10: Comparison of PCO2 at various time intervals between two groups**

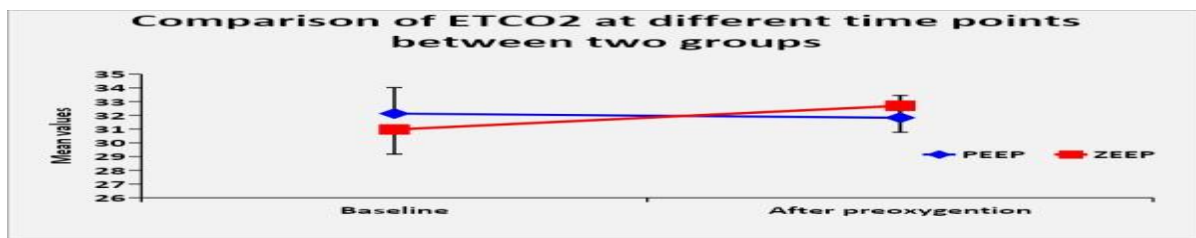


**Table 10: Comparison of PCO2 at various time intervals between two groups**

PCO2	PEEP (n=30)	ZEEP (n=30)	P Value
	Mean ± SD	Mean ± SD	
Baseline	35.83 ± 2.08	34.56 ± 2.87	0.054
After preoxygenation	34.89 ± 1.53	35.93 ± 1.95	0.025
at Spo2 of 94% or 8 minutes	46.11 ± 3.04	45.20 ± 3.24	0.266

The baseline PCO2 was comparable in both the groups. PCO2 after preoxygenation was higher in ZEEP group in comparison to PEEP group (35.93 ± 1.95vs 34.89 ± 1.53) , this difference was statistically significant.(P value 0.025)

Comparison of ETCO2 at various time intervals between two groups is shown in [Figure 11 and Table 11].



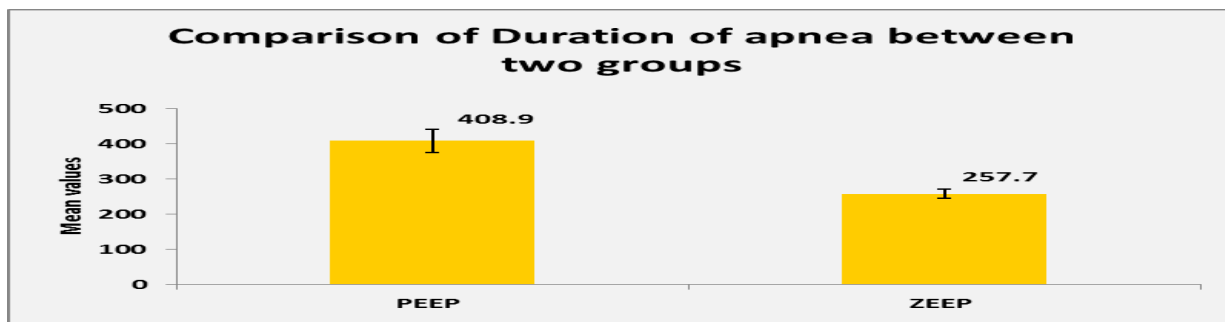
**Fig 11: Comparison of ETCO2 at various time intervals between two groups**

**Table 11: Comparison of ETCO2 at various time intervals between two groups**

ET Co2	PEEP (n=30)	ZEEP (n=30)	P Value
	Mean ± SD	Mean ± SD	
Baseline	32.13 ± 1.89	30.97 ± 1.79	0.017
After preoxygenation	31.83 ± 1.62	32.70 ± 1.93	0.065
At SpO2 of 94% or 8 minutes			

Baseline ETco2 was higher in PEEP group in comparison to ZEEP group (32.13 ± 1.89 vs 30.97 ± 1.79), which was statistically significant. (P value 0.017)

Comparison of duration of safe apnoea time between two groups is shown in [Figure 12 and Table 12]



**Figure 12: Comparison of duration of safe apnoea time between two groups**

**Table 12: Comparison of duration of safe apnoea time between two groups**

	PEEP (n=30)	ZEEP (n=30)	P Value
	Mean $\pm$ SD	Mean $\pm$ SD	
Duration of apnoea	408.90 $\pm$ 32.73	257.70 $\pm$ 12.79	<0.001

The mean and standard deviation of the safe duration of apnea was found to be significantly longer in PEEP group compared to ZEEP group, that is 408.90  $\pm$  32.73 seconds versus 257.70  $\pm$  12.79 seconds. This difference was statistically very significant.

## DISCUSSION

Anesthesia induction usually leads to apnoea, during apnoea oxygenation depends on the oxygen reserves stored within the body which are mainly localized in lungs, red blood cells, plasma and myoglobin. While breathing room air these stores are quantitatively low. Since the probability of difficult airway management cannot be perfectly predicted, an unanticipated cannot intubate, cannot ventilate situation puts the patient at risk of hypoxemia. Preoxygenation with 100% oxygen before induction of anaesthesia increases the margin of safety by increasing oxygen reserves of the body. The normal stores of oxygen in healthy young adult breathing air are approximately 1500 ml, and this may be increased to 3700 ml following preoxygenation with 100% oxygen.<sup>[15-17]</sup> However as demonstrated Reber A et al and Rothen U et al<sup>[4]</sup> in their studies, the use of 100% oxygen in preoxygenation results in atelectasis. During general anaesthesia, up to 85–90% of patients develop atelectasis in dependent lung regions within minutes of induction.<sup>[3]</sup> Atelectasis decreases the functional residual capacity and increases intrapulmonary shunt which accelerates desaturation and increases the risk of hypoxia. Rothen *et al*,<sup>[4]</sup> demonstrated that atelectasis can be prevented by reducing the fraction of inspired oxygen or by avoiding preoxygenation but this reduces the time before which significant hypoxemia occurs. A recent study done by Edmark L *et al*, has shown that oxygen concentrations as high as 80% are sufficient to diminish atelectasis formation compared to 100% oxygen, however the time of non-hypoxic apnoea is decreased by more than 90 seconds.<sup>[18-19]</sup> A previous study by Rusca M et al<sup>[20]</sup> have shown that the application of positive end expiratory pressure throughout the induction of anaesthesia effectively prevents atelectasis formation despite the use of 100% oxygen. In a study conducted by Herriger A *et al*<sup>[1]</sup> Patients who received continuous positive airway pressure during preoxygenation and anaesthesia induction had higher arterial oxygen tensions and tolerated significantly longer duration of apnoea as compared to the patients who did not received such manoeuvres, but the authors could not

distinguish between the effect of continuous positive airway pressure (CPAP) applied during preoxygenation and positive end expiratory pressure (PEEP) applied during mechanical ventilation before tracheal intubation. With this limitation in mind, Sreejit MS and Ramkumar V, conducted a study in which continuous positive airway pressure was applied only during preoxygenation. In this study patients in CPAP group had higher arterial oxygen tensions following preoxygenation they also had significantly longer duration of safe apnoea time. In our study, patients who received continuous positive airway pressure of 5 cm H<sub>2</sub>O had higher arterial oxygen tensions after preoxygenation as compared to the patients who did not receive such manoeuvres (416.62  $\pm$  28.72 mmHg vs. 367.02  $\pm$  14.29 mmHg) with a P value of less than 0.001. In addition they also tolerated longer durations of apnoea in comparison to the group that did not receive CPAP (408.90  $\pm$  32.73 s vs. 257.70  $\pm$  12.79 s) which was statistically highly significant. (P value less than 0.001) Our findings are in agreement with the study conducted by Sreejit MS and Ramkumar V.

In our study we avoided administration of positive pressure breaths after tracheal intubation to confirm position of endotracheal tube because this could have opened the atelectatic areas of lungs and negate the study conditions. Hence patients with anticipated difficult intubation were excluded from our study and for the sake of patient safety only those patients were included in which tracheal intubation could be performed after direct visualization of glottic opening. As we avoided any manoeuvres that could cause alveolar recruitment and reinflate any atelectatic areas that might have occurred during anaesthetic induction, the observed differences between the two groups can be attributed to the application of continuous positive pressure during preoxygenation. In our study baseline values of PaCo<sub>2</sub> was comparable in both the groups, but PaCo<sub>2</sub> after preoxygenation was higher in ZEEP group in comparison to PEEP group 35.93  $\pm$  1.95 vs 34.89  $\pm$  1.53, this difference was statistically significant (P value of 0.025) this finding could be attributed to occurrence of atelectasis in ZEEP after preoxygenation

with 100 percent oxygen which impaired the elimination of carbon dioxide that resulted in higher PaCo<sub>2</sub> values. Previous study done by Sreejit MS and Ramkumar V did not find any correlation between PaCo<sub>2</sub> values after preoxygenation. Baseline value of ETco<sub>2</sub> was higher in PEEP group in comparison to ZEEP group  $32.13 \pm 1.89$  vs  $30.97 \pm 1.79$  this difference was statistically significant ( P value 0.017) this observed difference between the two groups could be assigned to tight fitting of facemask in PEEP group as compared to ZEEP group which avoided entrainment of air and resulted in higher ETco<sub>2</sub> values. In our study there was no correlation between parameters such as age and sex and the duration of non-hypoxic apnoea. This was in agreement with a previous study done by Herriger A et al<sup>[1]</sup> which also found that other than gender, the other parameters showed no correlation to the period of non-hypoxic apnoea. With regard to correlation with gender the same study<sup>[1]</sup> found that females had a tendency towards shorter duration of non-hypoxic apnoea as compared with males in the PEEP group, but this difference was not observed in the ZEEP group. The application of CPAP or PEEP can have potentially deleterious effects on the cardiovascular system, however a study done by Cressy DM *et al*<sup>[18-19]</sup>, using a CPAP of 7.5 cm H<sub>2</sub>O did not find any adverse effects on systolic and diastolic blood pressure . As we have used a CPAP of 5 cm H<sub>2</sub>O during pre-oxygenation, it is unlikely to have produced any significant effects on the heart rate and blood pressure. There was no statistically significant relation in heart rate, systolic blood pressure, diastolic blood pressure or mean arterial pressure in the PEEP group and in the ZEEP group. In summary our study showed that application of continuous positive airway pressure of 5 cm H<sub>2</sub>O during 5 minutes of preoxygenation with 100% oxygen significantly increases the duration of safe apnoea time, this technique can be helpful in increasing the margin of safety in patients with anticipated difficult airway and in cases where rapid sequence induction is desirable.

### Conclusion

This study was undertaken to compare the effect of Continuous positive airway pressure (CPAP) preoxygenation versus conventional preoxygenation on duration of safe apnoea time in patients undergoing elective surgery under general anesthesia. The following conclusions were drawn from the study:

1. The duration of safe apnoea time was found to be significantly longer in patients preoxygenated with CPAP of 5cm H<sub>2</sub>O (PEEP group) in comparison

to patients that were conventionally preoxygenated (ZEEP group). ( $408.90 \pm 32.73$  s vs.  $257.70 \pm 12.79$  s) which was statistically highly significant. ( P value less than 0.001)

2. PaO<sub>2</sub> after preoxygenation was significantly higher in PEEP group compared to ZEEP group ( $416.62 \pm 28.72$  mmHg vs.  $367.02 \pm 14.29$  mmHg) with a P value of less than 0.001, this was statistically significant.
3. PaCO<sub>2</sub> after preoxygenation was found to be higher in ZEEP group in comparison to PEEP group ( $35.93 \pm 1.95$  vs  $34.89 \pm 1.53$ ) this difference was statistically significant .(P value of 0.025)
4. Baseline ETco<sub>2</sub> was higher in PEEP group
5. Facemask tolerability was 100 percent.

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