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A COMPARATIVE STUDY OF EFFICACY OF DIFFERENT TYPES OF TWO-HANDED MASK VENTILATION TECHNIQUES IN ANAESTHETISED APNOEIC ADULTS

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ABSTRACT

BACKGROUND: Bag mask ventilation is an important and basic airway management skill. Providing adequate bag mask ventilation in an effective manner can reverse the effect of hypoxia thereby rescuing the patient from potential brain damage as well as death if intubation is impossible. Two handed C-E technique and V-E technique mask ventilation are commonly used for maintaining mask ventilation in apneic patients. In this study we wanted to compare the efficacy of the C-E and V-E techniques of mask ventilation in terms of expired tidal volume.

METHODS: 80 patients of ASA PS I/II posted for general surgeries under general endotracheal anaesthesia were taken for the face mask ventilation study after obtaining written informed consent from them at JSS Medical College and Hospital, Mysuru. Patients were allocated into the C-E and V-E techniques by random computer allocation. They were then preoxygenated with an anatomical face mask with 100% oxygen, and anaesthesia was induced using standard institutional protocol.

RESULTS: There is a significantly higher tidal volume generated for the V-E technique compared to the C-E technique irrespective of the order of ventilation (P value of 0.001), with a mean of 490.82 mL for the C-E and 515.41 mL for the V-E. On comparing average tidal volumes in C-E to V-E order, we found a significantly higher value for V-E than C-E (p-value 0.002). On comparing average tidal volumes in V-E to C-E order, we found a significantly higher value for V-E than C-E (p-value of 0.001). In V-E, we found higher peak inspiratory pressure irrespective of the presentation (p-value of 0.0001).

CONCLUSION: Of the different techniques of two-handed mask ventilation employed, significantly higher tidal volume is generated with the V-E technique in comparison with the C-E technique, and it is concluded that the V-E technique is superior to the C-E technique.

KEYWORDS: C-E Technique, V-E Technique, Two-Handed Mask Ventilation.

INTRODUCTION

Mask ventilation with a bag is a very useful and important airway management skill. It is the means to save the life of an unconscious apneic patient until a definitive airway is secured either by endotracheal intubation or by tracheostomy.[1]
Providing adequate mask ventilation in an effective manner can often prevent and reverse the effect of hypoxia, thereby rescuing the patient from potential brain damage as well as death if intubation is impossible.[2]

In practice, mask ventilation is underappreciated as more effort, energy, and time are put into intubation, though equal importance should be given to both techniques. In the scenario of difficult intubation, face mask ventilation is the next best available alternative, as it is not only non-invasive but also extremely effective.[3]

While providing general anesthesia, airway management usually begins with mask ventilation, for providing pre-oxygenation as well as for assisted ventilation prior to the onset of complete muscle paralysis and between laryngoscopy attempts. Even if the caregiver is not able to intubate, if he is able to successfully mask ventilate the patient, then a potentially grave and life-threatening situation in the form of brain death can be easily avoided.[4]

The conventional teaching of mask ventilation uses one-handed mask ventilation (C-E ventilation). If ineffective, then a two-handed technique is recommended since a two-handed approach provides a better face to mask seal and produces greater tidal volumes. There are two commonly used techniques of two-handed mask ventilation, the C-E technique and the V-E technique.[5]

There are many studies comparing various two-handed mask ventilation techniques and one-handed mask ventilation in the western population.[5-7] However, studies in the Indian population are scarce. Also, most of the studies have been carried out in an obese patient population. We intend to compare the efficacy of two commonly used two-handed techniques, C-E and V-E techniques, in patients with no known predictors of difficult mask ventilation before implementing the same in other difficult mask ventilation situations. Hence this study was taken up.

AIMS AND OBJECTIVES

The aim is to study the efficacy of different types of two-handed mask ventilation techniques in anaesthetised apnoeic adults.

MATERIALS AND METHODS

The study was a comparative, randomized cross over study conducted at the operation theatre of a tertiary health care centre. After approval from the institutional ethics committee, 80 patients of ASA classes 1 and 2 for elective surgery in JSS medical college and hospital were enrolled for the study after taking verbal consent. Computer generated randomization was done. It was conducted from October 2019 to July 2021.

Patients of ASA classes 1 and 2 aged 18–50 years and above presenting for elective surgery requiring general anaesthesia were included in the study.
Patients with anticipated difficult mask ventilation like A) snorters, B) no teeth (edentulous), C) beards, D) obesity, E) age>55 years, patients with ryles tube in situ, pregnant women, emergency surgery, rapid sequence induction and intubation, and patients requiring an awake intubation were excluded from the study.

Patients were allocated into the C-E and V-E techniques by random computer allocation. After shifting to the operating theater, they were connected with an ECG, blood pressure apparatus, pulse oximetry, and capnography. Patients were then premedicated with 4 mg of Ondansetron, 1 mg of midazolam, and 1ug/kg bodyweight of fentanyl intravenously.

Patients were preoxygenated with an anatomical face mask with 6–8 liters/min of 100% oxygen for 3 minutes. Anaesthesia was induced with 2 mg/kg bodyweight of propofol. Patients were paralyzed with 0.1 mg/kg of Vecuronium and administered anaesthesia with advanced anaesthesia workstations. The workstation was preset to pressure control mode with a respiratory rate of 10 breaths per minute, an inspiratory-to-expiratory time ratio (I: E) of 1:2, a Peak Inspiratory Pressure (PIP) of 15 cmH2O and no PEEP. Subjects were started with one ventilation technique (C-E) and then crossed over to another technique (V-E) after one minute.
If the subjects were adequately ventilated, as defined by adequate chest rise and capnography in the first three consecutive breaths, ventilation was continued with the same technique for one minute. If the ventilation was not maintained with the initial technique, then the caregiver shifted to the next technique under study.
If ventilation was not maintained with the second technique also, then airway adjuncts such as oral airways and laryngeal mask airways were kept ready as per protocol for usage, and such patients were excluded from the study. The last five breaths in each technique of mask ventilation were taken into consideration for analysis. The average tidal volume of the last five breaths (breath 6–breath 10) was noted.

Sample Size Estimation

With the confidence interval of 95% and 80% power, considering that the difference in tidal volume between 2 study groups based on a study conducted by Joffe AM, Hetzel S et al. was 55,[8] standard deviation of the population being studied was 176[8]. Sample size was calculated using the formula,

$$N = \frac{(Z_\alpha + Z_B)^2 \times \sigma^2}{(d)^2}$$

$$= \frac{(1.96+0.84)^2 \times (176)^2}{(55)^2}$$

$$=80$$

Z_α = The probability of falsely rejecting a true null hypothesis (α)=0.05, Z_α=1.96
Z_β = The probability of failing to reject a false null hypothesis (β)= (0.80), Z_β=0.84
σ = The standard deviation of the population being studied was 176[8]
d = The size of the effect that is clinically worthwhile to detect was 55[8]

Substituting all these values we will get a sample size of n=80. Patients were allotted into 2 groups based on randomization. Group C received mask ventilation via the C-E technique followed by the V-E technique. Group V received mask ventilation via the V-E technique followed by the C-E technique.

Statistical Analysis

Data was entered into a Microsoft Excel data sheet and was analyzed using SPSS 22 version software. Descriptive statistical methods used in this study are 1) mean 2) standard deviation 3) frequency and 4) percentage. Inferential statistical methods used here are: 1) chi-square test 2) 'T' test—independent samples.

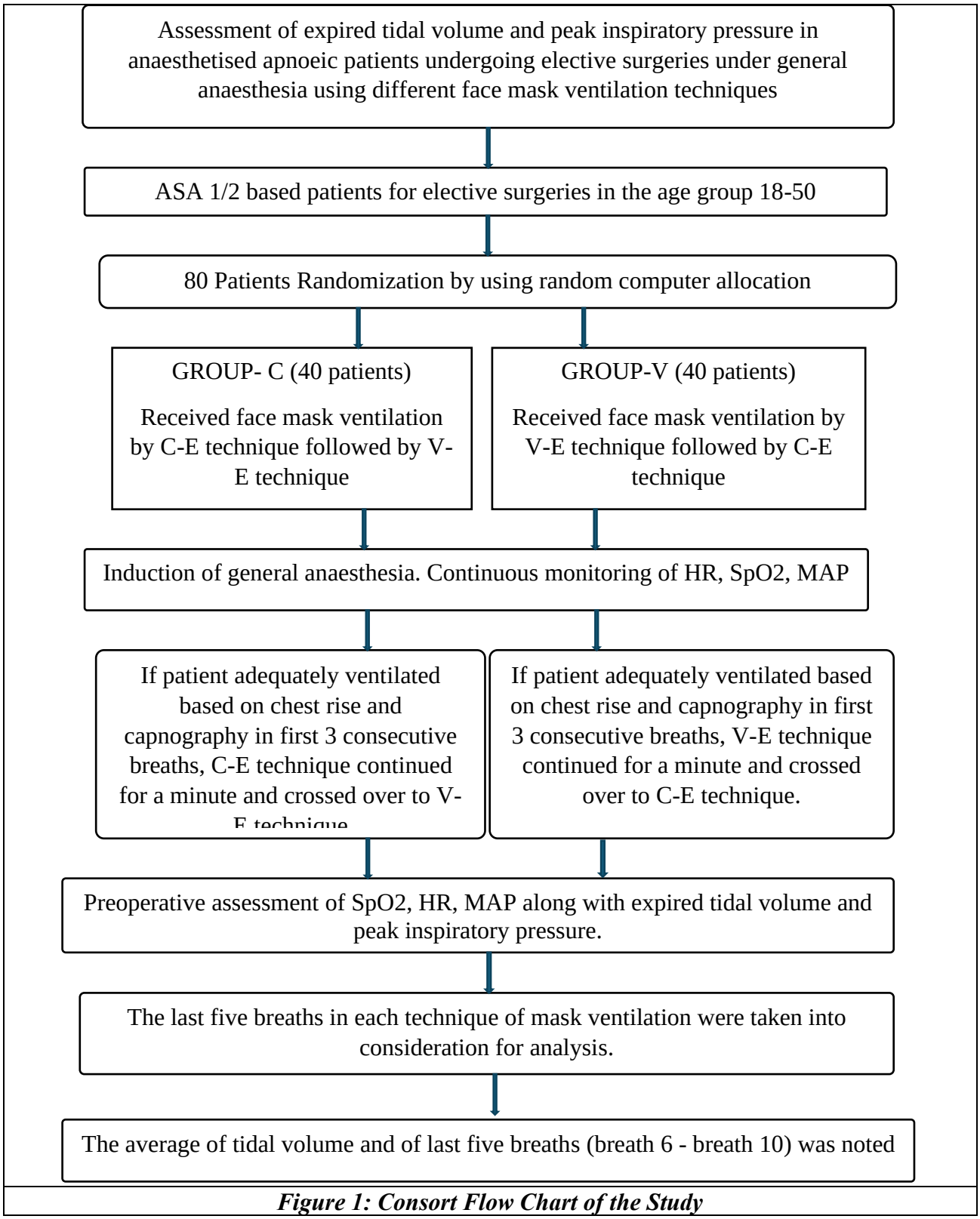

Figure 1: Consort Flow Chart of the Study

RESULTS

			Group		Total
			C-E-> V-E	V-E->C-E	
Ages	<20	Count	4	2	6
		% Within group	9.8%	5.1%	7.5%
	21-30	Count	12	9	21
		% Within group	29.3%	23.1%	26.2%
	31-40	Count	11	12	23
		% Within group	26.8%	30.8%	28.8%
	41-50	Count	11	10	21
		% Within group	26.8%	25.6%	26.2%
	51-60	Count	3	6	9
		% Within group	7.3%	15.4%	11.2%
Total		Count	41	39	80
		% Within group	100.0%	100.0%	100.0%

Table 1. Age Wise Comparison

			Group		Total
			C-E-> V-E	V-E->C-E	
Gender	Male	Count	15	12	27
		% Within group	36.6%	30.8%	33.8%
	Female	Count	26	27	53
		% Within group	63.4%	69.2%	66.2%
Total		Count	41	39	80
		% Within group	100.0%	100.0%	100.0%

Table 2. Gender Wise Comparison in Face Mask Ventilation

Group Statistics					
	Group	N	Mean	Std. Deviation	Std. Error Mean
Base_HR	C-E-> V-E	41	77.5854	8.52049	1.33068
	V-E->C-E	39	76.1026	7.74187	1.23969
Base_MAP	C-E-> V-E	41	82.1951	6.82722	1.06623
	V-E->C-E	39	85.4359	8.28694	1.32697
Base_SPO2	C-E-> V-E	41	99.9268	.26365	.04118
	V-E->C-E	39	99.9487	.22346	.03578

Table 3. Comparison of Heart Rate, Mean Arterial Pressure and Oxygen Saturation in Facemask Ventilation Techniques

Independent Samples Test	T-Test for Equality of Means			
	T	df	Sig. (2-tailed)	Mean Difference
Base_HR	.813	78	.418	1.48280
Base_MAP	-1.913	78	.059	-3.24078

Base_SPO2	-.400	78	.691	-.02189

Table 4: P-Values of Heart Rates, Mean Arterial Pressure and Oxygen Saturation

Here p-values of heart rate, mean arterial pressure, and oxygen saturation are >0.05. So there is no significant association between heart rates, mean arterial pressure, oxygen saturation and face mask ventilation techniques, as the p-values of each one of them are respectively >0.05.

Descriptive Statistics				
	Group	**Mean**	**Std. Deviation**	**N**
CE_Tidal_Vol	C-E-> V-E	458.2128	148.48698	39
	V-E->C-E	522.6250	97.81621	40
	Total	490.8266	128.74738	79
VE_Tidal_Vol	C-E-> V-E	486.6205	142.71652	39
	V-E->C-E	543.4900	94.02595	40
	Total	515.4152	123.13441	79

Table 5: Mean Expired Tidal Volumes in Different Face Mask Ventilation Techniques in toto

Here the total mean expired tidal volume generated in the C-E technique was 490 ml and the total mean expired tidal volume generated in the V-E technique was 515 ml with a mean difference of 25 ml.

Tests of Within-Subjects Effects					
Measure: Measure_1					
Source	**Type III Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**
Change	23970.666	1	23970.666	27.115	.000
Change * group	561.721	1	561.721	.635	.428
Error(change)	68070.359	77	884.031		

Table 6: P-Value of Means of Total Expired Tidal Volumes

Here the p-value of the mean expired tidal volumes of different face mask ventilation techniques was significant as it was less than 0.05.

Irrespective of the order of the ventilation, we find higher tidal volume for the V-E technique compared to the C-E technique. P-value of 0.000 means expired tidal volume in V-E of 515 ml vs. mean expired tidal volume in C-E of 490 ml with a p-value less than 0.05.

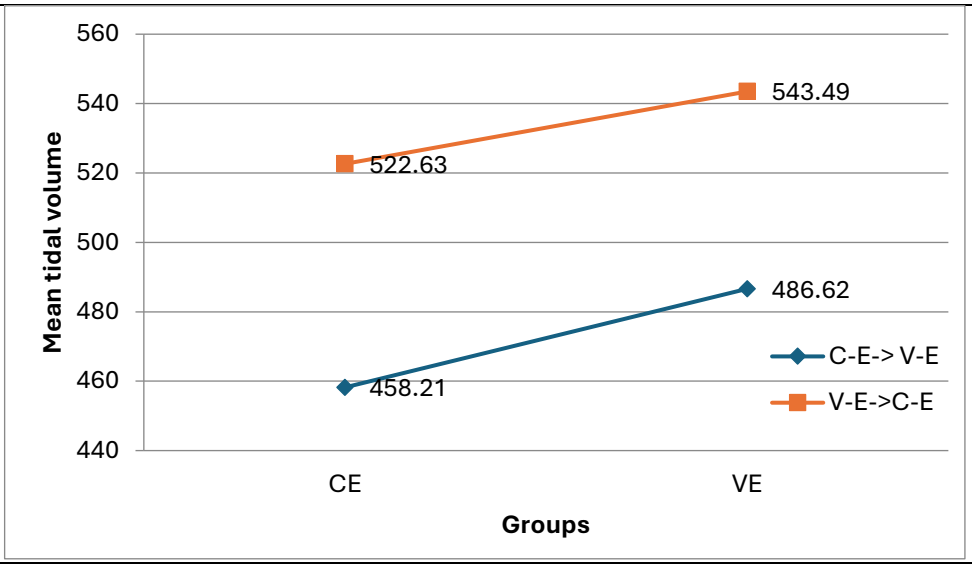

Figure 2: Line Graph of Mean Tidal Volumes Generated in C-E and V-E Techniques in C-E to V-E Order and V-E to C-E Order

In C-E technique average comparison to V-E technique average comparison in C-E to V-E order, we find significantly higher tidal volume generation for V-E technique more than C-E technique with 486 ml in V-E and 458 ml in C-E and a significant p-value of 0.002.
Similarly, in V-E technique average comparison to C-E technique average comparison in V-E to C-E order, we find significantly higher tidal volume generation for V-E technique than C-E technique, with 543 ml in V-E and 522 ml in C-E and a significant p-value of 0.000.

DISCUSSION

Compared with one-handed ventilation, 2-handed approaches provide better seal[8,9] and produce greater tidal volumes[10,11] but require an additional provider or a machine to deliver the positive-pressure breaths.[12] Setting peak pressures to 20 cm H2O decreases the risk of inadvertent gastric insufflation. Although newer evidence suggests that 15 cm H2O may cause less gastric insufflation, it might not be high enough to produce effective mask ventilation when difficult mask ventilation is encountered.[13,14]
Jaw thrust displaces the mandible[15,16,17] increasing the retrolingual and retropalatal spaces by pulling the tongue anteriorly, although this benefit may be less present in the obese patient.
Through our study, we wanted to observe whether our study outcomes were favorably similar to those studies carried out previously elsewhere in the world, predominantly in the western population world, as studies conducted in the Indian population are scarce.
Since most of the mask ventilation studies were on obese patients of the western population, we intended to compare the efficacy of two commonly used two-handed face mask ventilation techniques-C-E and V-E-in patients with no known predictors of difficult mask ventilation before implementing the same in other difficult mask ventilation situations. The outcome we were expecting was the V-E technique to be superior to the C-E technique based on the results of previous studies. This study was conducted on patients of age groups 18-50 under ASA (American Society of Anaesthesiologists) class I/II who were posted for elective surgeries under general anesthesia in our tertiary care hospital
Many studies have proved that two-handed mask ventilation is definitely better than single handed mask ventilation in providing a better tidal volume to the patient as well as giving a tight seal to the airway to prevent air leakage while doing the procedure.

In our study also, caregivers reported less finger fatigue with the two-handed V-E mask ventilation technique as it provided better grip when compared with the two-handed C-E mask ventilation technique, like the previous parent studies done elsewhere.

Demography

In the current study, the age distribution among the study population was 36.15±10.93 years in Group-C and 37.07±11.49 years in Group-V. The difference was not significant statistically (p = 0.711). There is no significant association between different age groups and different face mask ventilation techniques, as the p-value was >0.05.

Similarly gender-wise, in group C (C-E followed by V-E), there were 15 males and 26 females, and in group V (V-E followed by C-E), there were 12 males and 27 females. Total: 27 males and 53 females. The difference was not statistically significant (p = 0.641). There is no significant association between face mask ventilation techniques and gender groups, as the p-value was >0.05.

Baseline Parametres

The baseline mean heart rate of group C was 77 bpm, and the mean heart rate of group V was 76 bpm. The difference was not statistically significant (p = 0.418). There is no significant association between the heart rates and different face mask ventilation techniques, as the P-value was more than 0.05.

The baseline mean arterial pressure of group C was 82 mmHg, and the mean arterial pressure of group V was 85 mmHg. The difference was not statistically significant (p = 0.06). There is no significant association between mean arterial pressures and different face mask ventilation techniques, as the P-value is more than 0.05.

The mean oxygen saturation of group C was 99%, and the mean oxygen saturation of group V was also 99%. The difference was not statistically significant (p = 0.69). There is no association between oxygen saturation and different face mask ventilation techniques, as the p-value is more than 0.05.

So, the mean difference between 2 groups for baseline heart rate, mean arterial pressure, and oxygen saturation is statistically non-significant, as the p-value >0.05 for each of them, respectively, as per the data of our study.

Similar results of baseline parameters were obtained in the study conducted by Fei, Blair, Rice, Edwards, and others in 2017. There were no significant differences in hemodynamic parameters between the two face mask ventilation groups during that study period.[5]

Expired Tidal Volume

Expired tidal volume was measured using different face mask ventilation techniques after anaesthesia induction. The data generated in our study revealed that the total mean expired tidal volume generated in the C-E technique was 490 ml vs. the total mean expired tidal volume generated in the V-E technique was 515 ml, with a mean significant difference of 25 ml. The P-value of the mean total expired tidal volumes of different face mask ventilation techniques is significant as it is less than 0.05. Irrespective of the order of the ventilation, we find higher tidal volume for the V-E technique compared to the C-E technique. P-value of 0.001.

The data of our study shows that average tidal volumes generated in C-E to V-E order were higher for the V-E technique than the C-E technique, with 486 ml in V-E and 458 ml in C-E with a significant p-value of 0.002.

Similarly in V-E to C-E order, we got data that shows significantly higher tidal volume generation for the V-E technique than the C-E technique, with 543 ml in V-E and 522 ml in C-E with a significant p-value of 0.001.

In 2013, Hart, Reardon, and others conclusively proved that two-handed mask ventilation is definitely better than single-handed mask ventilation in providing a better tidal volume to the patient as well as giving a tight seal to the airway. Exhaled tidal volume in mL and proximal peal flow pressures in cmH20 were measured and recorded. Both two-handed ventilation techniques were more effective than the one-handed technique.[8]

Volume measurements revealed that the one-handed C-E technique yielded a median of 428.4 mL (interquartile range [IQR] 309.7–497.6), the two-handed C-E technique yielded a median of 550.8 mL (IQR 514.3–560), and the two-handed V-E technique yielded a median of 538 mL (IQR 518–555) ($p<0.001$). PIP used by Hart and Reardon were 55 cmH20. Peak pressure measurements revealed a median of 54.6 cm H2O (IQR 43.1–62.5) for the one-handed C-E technique, 66 cm H2O (IQR 64–68.2) for the two-handed C-E technique, and 66.6 cm H2O (IQR 65.2–68.4) for the two-handed V-E technique ($p<0.001$).

The results from the comparative study done in 2014 by Otten, Michael, and others of bag-valve-mask hand sealing techniques by different face mask ventilation approaches showed that two-handed mask ventilation techniques resulted in higher tidal volumes. Two-handed C-E technique (median difference 47%; 95% CI 34% to 62%) and modified 2-handed V-E technique (median difference 56%; 95% CI 29% to 65%) resulted in significantly higher median expired tidal volume percentages.[18]

We also studied whether one technique can be used as a rescue technique for the other if the care provider develops fatigue. We found that it is feasible and effective to change over between the two techniques. Though the C-E technique provides less tidal volume than the V-E technique, interchanging techniques causes no clinical compromise in oxygen saturation.

CONCLUSIONS

Face mask ventilation is an increasingly relevant and lifesaving procedure that is noninvasive and easy to perform with practice for the caregiver in anaesthetised apneic patients in general surgery as well as in patients desaturating quickly in intensive care units as well as in an outpatient department provided there is a mask and oxygen port there.

Our single-center randomized comparative cross-over study suggests that if two-handed mask holding for ventilation is done properly with head tilt, chin lift, and jaw thrust for generating good expired tidal volumes along with satisfactory oxygen saturation after the induction of general anesthesia, it can be effective in decreasing the perioperative hypoxic events.

A larger-scale, well-designed multi-center clinical study involving a greater number of patients, is needed to further study the efficacy of preoperative two handed face mask ventilation techniques.

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