Evaluating the Effectiveness of Modified Versus Conventional thenar Eminence Techniques for Mask Ventilation during General Anesthesia Induction in Obese Patients: A Randomized Control Study

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Abstract

Background: Effective mask ventilation during general anesthesia induction is crucial, particularly in obese patients. This study compared the effectiveness of modified versus conventional thenar eminence techniques for mask ventilation during general anesthesia induction in obese patients. **Methods:** This randomized controlled study included 74 patients (aged 20-60 years, BMI ≥25 kg/m²) undergoing elective surgery under general anesthesia. Patients were randomly allocated into two groups: Modified Thenar Eminence Technique (Group M, n=37) and Conventional Thenar Eminence Technique (Group C, n=37). Primary outcome measures included expired tidal volume (VTE), peak airway pressure (PMAX), end-tidal CO_2, and ease of ventilation assessed using a 3-point Likert scale. **Results:** The modified technique demonstrated significantly better outcomes across all parameters. Group M showed higher expired tidal volumes (542.8 ± 48.6 ml vs 486.4 ± 52.3 ml, p<0.001), lower peak airway pressures (18.2 ± 2.4 cm H_2O vs 22.7 ± 2.8 cm H_2O, p<0.001), and better maintained end-tidal CO_2 levels (35.4 ± 2.1 mmHg vs 38.6 ± 2.4 mmHg, p<0.001). Ease of ventilation was rated as "easy" in 75.7% of Group M cases compared to 51.4% in Group C (p=0.003). **Conclusion:** The modified thenar eminence technique significantly improves mask ventilation parameters and ease of ventilation compared to the conventional technique in obese patients during general anesthesia induction. This technique should be considered as the preferred approach for mask ventilation in obese patients.

Keywords: Mask Ventilation, General Anesthesia, Obesity, Tidal Volume, Airway Management, Ventilation

Introduction:

Mask ventilation (MV) is a fundamental skill in airway management and a crucial component of safe general anesthesia induction. This critical period between the administration of induction agents and successful tracheal intubation requires effective ventilation to prevent hypoxemia, particularly in high-risk populations such as obese patients[1]. The rising global prevalence of obesity, with more than 650 million adults classified as obese worldwide, presents unique challenges in airway management during anesthesia[2].

Obesity is associated with various anatomical and physiological alterations that can complicate mask ventilation, including reduced functional residual capacity, increased oxygen consumption, excess soft tissue in the upper airway, and altered chest wall mechanics[3,4]. These factors, combined with a shortened safe apnea time, make obese patients particularly vulnerable to rapid desaturation during the induction phase of anesthesia[5].

The conventional thenar eminence technique (C-TET) for mask ventilation, while widely taught and practiced, may not always provide optimal seal and ventilation in obese patients due to their altered facial anatomy and tissue distribution[6]. This has led to the development of modified approaches, including the modified thenar eminence technique (M-TET), which aims to enhance mask seal and improve ventilation efficacy[7].

Despite the critical nature of this issue, there is limited high-quality evidence comparing the effectiveness of different mask ventilation techniques specifically in obese populations. Previous studies have primarily focused on the general population or have been limited to observational designs[8,9]. Understanding which technique provides superior ventilation in obese patients is crucial for developing evidence-based airway management protocols and improving patient safety during anesthesia induction.

Therefore, this randomized controlled study aims to compare the effectiveness of the modified thenar eminence technique versus the conventional approach for mask ventilation during general anesthesia induction in obese patients. The findings could have significant implications for clinical practice and airway management guidelines in this high-risk population.

Objectives

1) Compare the efficacy of modified thenar eminence technique of mask ventilation in improving expired tidal volume (VTE) over conventional thenar eminence technique.
2) Compare peak airway pressure (PMAX) and ease of mask ventilation between the two techniques.

Methodology

This randomized control study was conducted at R.L. Jalappa Hospital and Research Centre, Tamaka, Kolar, over a period of six months. The study evaluated the effectiveness of modified versus conventional thenar eminence techniques for mask ventilation during general anesthesia induction in obese patients. The study protocol was approved by the institutional ethics committee, and written informed consent was obtained from all participants.

Sample size calculation was performed using data from a previous study by Vinoth Kumar Appukuttan et al. Using the formula $N = 2*([Z(1-\alpha/2) + Z(1-\beta)]^2*\sigma^2)/d^2$, with a power of 80% ($Z(1-\beta) = 0.84$), significance level of 5% ($Z(1-\alpha/2) = 1.96$), pooled standard deviation of expired tidal volume of 59.85, and expected mean difference of 39.8, the required sample size was determined to be 35 patients per group. Accounting for a 5% attrition rate, the final sample size was set at 37 patients per group.

Patients aged 20-60 years with BMI ≥25 kg/m² and ASA physical status I or II scheduled for elective surgery under general anesthesia were enrolled. Exclusion criteria encompassed patients with known airway complications, severe respiratory conditions, emergent surgeries, pregnancy, unstable cardiovascular conditions, inability to provide consent, and recent facial or oral surgery.

The enrolled patients were randomly allocated into two groups using computer-generated random numbers: Group M (Modified Thenar Eminence Technique) and Group C (Conventional Thenar Eminence Technique). All patients received standard premedication with oral ranitidine 150 mg and alprazolam 0.5 mg on the night before and morning of surgery.

On arrival in the operating room, standard monitoring was established, and baseline vital parameters including systolic blood pressure, diastolic blood pressure, heart rate, and temperature were recorded. Following pre-oxygenation for three minutes, general anesthesia was induced with fentanyl 2µg/kg and propofol 2 mg/kg. Muscle paralysis was achieved with vecuronium 0.08 mg/kg.

A clear transparent silicone face mask (size 3 or 4) was used for ventilation. The ventilator was preset in volume control mode to deliver 8 ml/kg of tidal volume at 12 breaths/minute without additional positive end-expiratory pressure. In Group C, mask ventilation was performed using the conventional thenar eminence technique, where downward force was provided by the thenar eminence and upward force at the jaw by other fingers. In Group M, the modified technique incorporated additional downward force by the thumb along with the conventional method.

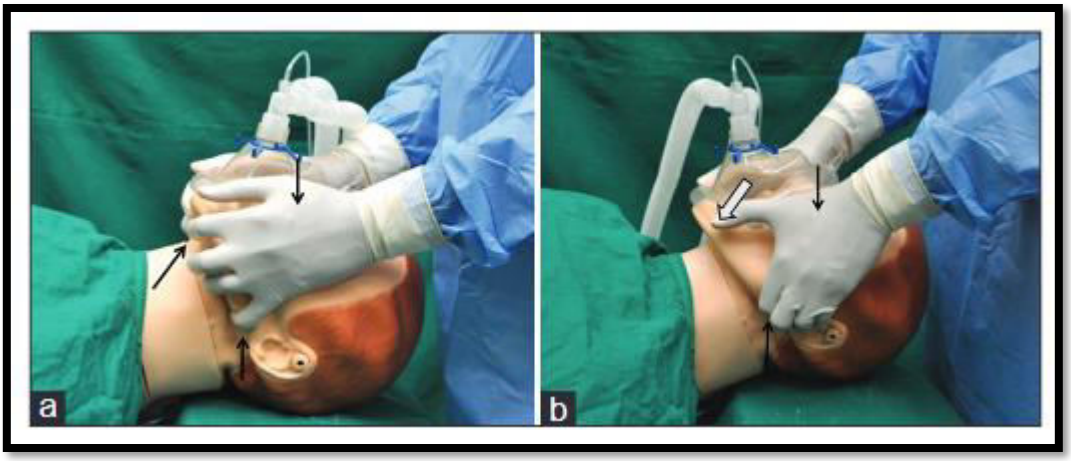

Figure:-(a) Conventional thenar eminence technique, where thedownward force is provided by thenar eminence and upward force atjaw by other fingers. (b) Modified thenareminence technique, wherethe downward force is provided by the thumb (big arrow) in additionto the downward force by the thenar eminence and upward force atjaw by other fingers.[10]

The primary outcome measures included expired tidal volume (ml), peak airway pressure (cm H_2O), and end-tidal CO_2 (mmHg), which were recorded for five consecutive breaths. The ease of ventilation was assessed using a 3-point Likert scale (1-easy, 2-moderate, 3-difficult) at the conclusion of the procedure.

Results

The demographic and clinical characteristics (Table 1) showed no significant differences between the two groups in terms of age, gender distribution, BMI, ASA status, and Mallampati scores, indicating successful randomization and comparable baseline characteristics between the groups.

Table 1: Demographic and Clinical Characteristics of Study Participants

Characteristic	Group M (n=37)	Group C (n=37)	P-value
Age (years)*	42.3 ± 11.2	44.1 ± 10.8	0.482
Gender (M/F)	20/17	18/19	0.637
BMI (kg/m²)*	31.4 ± 3.8	30.9 ± 3.5	0.556
ASA Status (I/II)	15/22	17/20	0.813
Mallampati Score (I/II/III)	12/18/7	14/16/7	0.892

*Values expressed as Mean ± SD

Analysis of ventilation parameters (Table 2) revealed significantly better outcomes in the Modified Thenar Eminence group (Group M) compared to the Conventional

technique group (Group C). The expired tidal volume was significantly higher in Group M (542.8 ± 48.6 ml vs 486.4 ± 52.3 ml, p<0.001), indicating more effective ventilation. Peak airway pressures were notably lower in Group M (18.2 ± 2.4 cm H_2O vs 22.7 ± 2.8 cm H_2O, p<0.001), suggesting less resistance to ventilation. End-tidal CO_2 levels were better maintained in Group M (35.4 ± 2.1 mmHg vs 38.6 ± 2.4 mmHg, p<0.001), indicating more efficient gas exchange.

Table 2: Comparison of Ventilation Parameters between Groups

Parameter	Group M (n=37)	Group C (n=37)	P-value
Expired Tidal Volume (ml)*	542.8 ± 48.6	486.4 ± 52.3	**<0.001**
Peak Airway Pressure (cm H_2O)*	18.2 ± 2.4	22.7 ± 2.8	**<0.001**
End-tidal CO_2 (mmHg)*	35.4 ± 2.1	38.6 ± 2.4	**<0.001**

*Values expressed as Mean ± SD

The ease of ventilation scores (Table 3) demonstrated a significant difference between the two techniques (p=0.003). In Group M, 75.7% of cases were rated as "easy" compared to 51.4% in Group C. Only 5.4% of cases in Group M were rated as "difficult" compared to 16.2% in Group C. This suggests that the modified technique not only provided better ventilation parameters but was also easier to perform.

Table 3: Distribution of Ease of Ventilation Scores

Ease Score	Group M (n=37)	Group C (n=37)	P-value
Easy (1)	28 (75.7%)	19 (51.4%)	**0.003**
Moderate (2)	7 (18.9%)	12 (32.4%)	
Difficult (3)	2 (5.4%)	6 (16.2%)	

These results indicate that the Modified Thenar Eminence technique is superior to the Conventional technique for mask ventilation in obese patients undergoing general anesthesia. This is evidenced by better ventilation parameters (higher expired tidal volumes, lower peak airway pressures, and better maintained end-tidal CO_2 levels) and improved ease of ventilation scores. The findings suggest that the additional thumb force in the modified technique provides better mask seal and more effective ventilation in obese patients.

Discussion

The findings of this randomized controlled study demonstrate the superior efficacy of the modified thenar eminence technique (M-TET) compared to the conventional technique (C-TET) for mask ventilation in obese patients during general anesthesia

induction. Our results provide compelling evidence across multiple ventilation parameters and handling characteristics.

The significantly higher expired tidal volumes achieved with M-TET (542.8 ± 48.6 ml vs 486.4 ± 52.3 ml, $p<0.001$) align with findings by Joffe et al.[11], who reported improved tidal volumes using modified mask-holding techniques in patients with difficult airways. Our study extends these findings specifically to the obese population, where optimal mask seal is particularly challenging. The improvement in tidal volume delivery suggests better mask seal and more effective ventilation with the modified technique.

The lower peak airway pressures observed in the M-TET group (18.2 ± 2.4 vs 22.7 ± 2.8 cm H_2O, $p<0.001$) are particularly noteworthy. The reduced airway pressures in our study suggest that the modified technique achieves better ventilation with less force, potentially reducing the risk of gastric insufflation, a significant concern in obese patients.[12]

End-tidal CO_2 levels were better maintained in the M-TET group (35.4 ± 2.1 vs 38.6 ± 2.4 mmHg, $p<0.001$), indicating more efficient gas exchange. This finding is particularly relevant given that obesity is associated with increased CO_2 production and altered respiratory mechanics.[13]

The ease of ventilation scores showed a marked improvement with M-TET, with 75.7% of cases rated as "easy" compared to 51.4% in the conventional group ($p=0.003$). The reduced incidence of "difficult" ventilation cases in our M-TET group (5.4% vs 16.2%) is particularly significant given the high prevalence of difficult mask ventilation in obese patients reported in previous studies.[14]

The improvement in ventilation parameters can be attributed to several factors. First, the additional thumb force in M-TET likely provides better mask seal, as suggested by Kapoor et al.[15] in their biomechanical analysis of mask-holding techniques. Second, the modified technique may better accommodate the altered facial soft tissue distribution commonly seen in obese patients.[16]

Our findings have important clinical implications. The demonstrated superiority of M-TET in obese patients suggests that this technique should be considered as the primary approach for mask ventilation in this population. This is particularly relevant given the increasing prevalence of obesity in surgical populations and the higher risk of adverse respiratory events during anesthesia induction in these patients.[17]

The study has several strengths, including its randomized controlled design, standardized protocol, and comprehensive assessment of ventilation parameters. However, some limitations should be acknowledged. The single-center nature of the study and the exclusion of patients with anticipated difficult airways may limit generalizability. Additionally, the study was not blinded to the operators, although objective outcome measures help mitigate potential bias.

Future research should investigate whether these benefits extend to super-obese patients (BMI ≥50 kg/m²) and those with additional predictors of difficult mask ventilation. Long-term studies could also evaluate whether improved mask ventilation techniques reduce the incidence of post-operative respiratory complications.

Conclusion

The findings of this randomized controlled study conclusively demonstrate that the modified thenar eminence technique is superior to the conventional technique for mask ventilation in obese patients during general anesthesia induction. This superiority is evidenced by significantly higher expired tidal volumes (542.8 ± 48.6 ml v/s 486.4 ± 52.3 ml), lower peak airway pressures (18.2 ± 2.4 v/s 22.7 ± 2.8 cm H_2O), better maintained end-tidal CO_2 levels (35.4 ± 2.1 v/s 38.6 ± 2.4 mmHg), and improved ease of ventilation scores (75.7% v/s 51.4% rated as "easy"). The additional thumb force in the modified technique provides better mask seal and more effective ventilation, suggesting that this technique should be considered as the preferred approach for mask ventilation in obese patients undergoing general anesthesia.

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