Original Article

The Comparison of Sub-mandibular One-handed Grip Ventilation Technique to CE Technique for Reducing Air Leak in Patient with Potential Difficult Mask Ventilation

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Objective: The most common reason for failure to ventilate with the one-handed CE technique is air leak in patients with difficult mask ventilation. Sub-mandibular one-handed grip is the alternative technique that minimizes air leak. The aim of the study was to compare exhaled volume in sub-mandibular one-handed grip technique to CE technique.

Materials and Methods: Thirty patients who potential air leak during mask ventilation undergoing elective surgery were randomly divided into two groups. Patients in Group 1 were given mask ventilation with CE technique before switching to sub-mandibular one-handed grip technique and patients in Group 2 were given mask ventilation with sub-mandibular one-handed grip technique before switching to CE technique. Exhaled tidal volume, peak airway pressure, heart rate, pulse oximetry were recorded.

Results: Sub-mandibular one-handed grip technique showed lower air leak than the CE technique statistically significant (2.9±1.9 ml/kg vs. 3.9±2.5 ml/kg, $p = 0.01$). Neither patient had experienced oxygen desaturation nor had a change in heart rate in the present study.

Conclusion: The sub-mandibular one-handed grip technique is more effective in reducing air leaks than one-handed CE technique for patients with potential difficult mask ventilation.

Keywords: Difficult mask ventilation, Air leaks during ventilation, Sub-mandibular one-handed grip technique, CE technique

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Face mask ventilation is an important technique for medical personnel to save lives in emergency situations and in procedures performed with sedation[(1)]. The incidence of difficult mask ventilation (DMV) is approximately 5%[(2)] and patients with DMV is divided into face mask cover cannot be fitted to the face which produce air leaks and airway obstruction[(3,4)]. There are several techniques to handle with DMV such as one-handed CE technique, two-handed CE technique and two-handed VE technique. The most common reason for failure to ventilate with the one-handed CE technique is air leak on the side opposite to the stabilizing hand that the two-handed grip reduces the air leak but needs more than one person[(5)].

A sub-mandibular one-handed grip, a sole provider applies pressure on the left and right borders of the face mask during mask ventilation, is the alternative technique that may minimize air leaks. The present study aims to compare the amount of air leak between using sub-mandibular one-handed grip technique to CE technique in patient with DMV.

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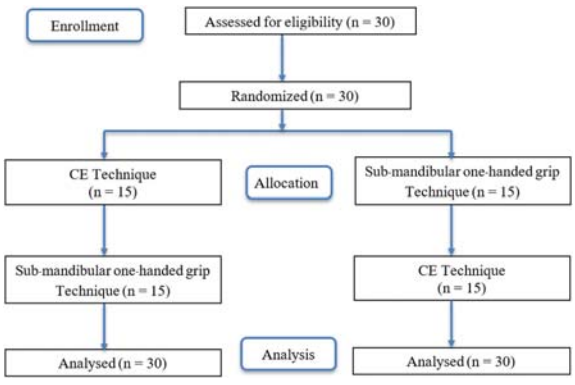
Materials and Methods

Institutional ethics committee approval was obtained for this prospective, randomized study. After obtaining written informed consent, 30 patients who underwent elective surgery which required general anesthesia were enrolled. Inclusion criteria included American Society



CONSORT Flow Diagram.

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of Anesthesiologists (ASA) physical status class I-III, potential air leak during ventilation[3] such as presence of beard, lack of teeth and edentulous. Exclusion criteria were age less than 18 or more than 80 years old, patient with risk of hypoxemia such as lung diseases, history of difficult intubation, risk of aspiration, cervical spine injury, contraindication to succinylcholine, obesity (body mass index more than 30 kg/m^2) and pregnancy. Patients were not allowed to take anything orally 8 hours before surgery.

Patients were randomized by computer generated randomization divided into two groups. The results were kept in individual opaque envelopes and an envelope was opened when each patient arrived in the operating room. Patients in Group 1 were given mask ventilation with CE technique before switching to sub-mandibular one-handed grip technique and patients in Group 2 were given mask ventilation with sub-mandibular one-handed grip technique before switching to CE technique.

In the operating room, electrocardiography (EKG), non-invasive blood pressure and pulse oximetry (SpO_2) were monitored. Patient lay in sniffing position (The pillow is about 10 cm high to flex lower cervical spine and extend atlanto-occipital joint). After preoxygenation with 100% oxygen for 3 minutes, anesthesia was induced with intravenous fentanyl 1 µg/kg and propofol 1 to 2 mg/kg. Intravenous succinylcholine 1.5 mg/kg was administered to facilitate tracheal intubation. After loss of eyelash reflex and train of four from peripheral nerve stimulator showed zero (fully muscle relaxation), oropharyngeal airway was inserted to prevent airway obstruction. Subsequently, one experienced anesthesiologist placed a suitable anesthesia face mask on the patient's face (using the number 3 for woman and number 4 for man), then performed positive pressure ventilation according to group assignment.

In CE technique, the anesthesia provider performed the thumb and index finger form a ''C'' providing anterior pressure over the mask, while the third, fourth, and fifth fingers form an ''E'' to lift the jaw to help lift the patient's chin up to 45 degrees (Figure 1).

In the sub-mandibular one-handed grip technique, the anesthesia provider stood on the left side of the patient. Next, the anesthesia provider placed their fifth finger along the body of the left side of the mandible. The fourth finger was placed along the body of the right side of the mandible. The anesthesia provider rotated clockwise at the hip while keeping their elbow against their body to lift the patient's chin to 45 degrees. This rotational force added strength to the chin-lift maneuver. The anesthesia provider avoided pressing the soft tissue in the submental triangle. The first finger was used to apply pressure to the left border of the face mask, while the second and third fingers were used to apply pressure to the right border of the face mask. In this way, the provider applied pressure to both the left and right borders of the face mask (Figure 2).

The ventilator from Aisys CS^2 anesthetic machine (GE Healthcare) was set with 100% oxygen, tidal volume of 8 ml/kg and respiratory rate 10 times per minute. Exhaled tidal volume, peak airway pressure, heart rate and pulse oximetry in a total of 10 breaths were recorded by an independent observer.

During the mask ventilation, the anesthesia provider did not know exhale tidal volume parameters because of the anesthetic machine set back position of the anesthesia provider. Patient's chest movement was masked with a screen to prevent potential bias from a visual check of ventilation by chest movement.

Each technique takes about 1 minute and when combined, the whole process takes about 2 minutes. Endotracheal tube was placed when finished two techniques mask ventilation. If the patient could not be ventilated or oxygen desaturation fell below 92%, an endotracheal tube was immediately placed, and the study was terminated.

Statistical analysis

The primary outcome was the amount of air leaks between using sub-mandibular one-handed grip technique to CE technique and secondary outcomes were an incidence of patients who had oxygen desaturation and significantly changed in heart rate 20% from baseline. Power analysis revealed that 26 cases were required. From the pilot study estimating tidal volume in the potential air leak patients with CE mask ventilation was 4.7 ml/kg and the standard deviation was 2.4. The difference of 40% was considered significant

Figure 1. Standard CE technique: The thumb and index finger form a ''C'' providing anterior pressure over the mask, while the third, fourth, and fifth fingers form an ''E'' to lift the jaw to help lift the patient's chin up to 45 degrees.

with an α level of 0.05 and β level of 0.2. A possible dropout rate of ten percent was anticipated, 30 patients were required in each technique.

All statistical analyses were performed using SPSS package version 23. Continuous data were reported as mean (±SD) and categorical data were reported as numbers. Nonparametric data were reported as median and interquartile range (IQR). Data between groups were compared using the paired t-test, Mann-Whitney U test, Chi-square test and Fisher's exact test as appropriate. The *p*-value of less than 0.05 was considered statistically significant.

Figure 2. Sub-mandibular one-handed grip: Demonstrating placement of the first finger on the left side of the mask and second and third fingers on the right side of the mask preventing air leak along the right side of the mask. The fifth finger along the inferior border of the left body of the mandible. The fourth finger is placed along the inferior border of the right body of the mandible. This finger placement anchors mask and provide for 45-degrees chin tilt.

Results

A total of 30 patients were eligible and enrolled in the study and no patients were excluded from the analyses. The demographic data were shown in Table 1. The patients in the present study were equal in males and females. Patients were ASA physical status II and III, the average age was 75 years old.

Sub-mandibular one-handed grip technique showed lower air leak than the CE technique statistically significant (2.9±1.9 ml/kg vs. 3.9±2.5 ml/kg, $p = 0.01$) (Table 2).

Neither patient had experienced oxygen desaturation nor had a change in heart rate in this study.

Discussion

DMV has an incidence of 1.5 to 7.8% in the general population[3,4,6] and 16% in edentulous patients[7]. It results in inadequate ventilation characterized by no or reduced perceptible chest movement, oxygen desaturation by pulse oximetry, perception of severe gas flow leak around the mask and an inadequate end-tidal carbon dioxide[3,8]. This indicates that the incidence of DMV is high and providers must prepare for the difficult ventilation situation. In situations without the presence of a second caregiver, patients with risk factors for DMV may be particularly challenging.

Table 1. Demographic data

	n = 30
Gender	
Male	15 (50%)
Female	15 (50%)
ASA physical status	
1	0 (0%)
2	15 (50%)
3	15 (50%)
Potential air leak	
Lack of teeth	15 (50%)
Edentulous	13 (33.3%)
Presence of beard	2 (6.7%)
Age (year)	75 (±4.2)
Weight (kg)	55.5 (±10.9)
Height (cm)	156.9 (±6.8)

Data are mean (±SD) or number

Table 2. Intraoperative mask ventilation

	CE technique (n = 30)	Sub-mandibular one-handed grip technique (n = 30)	*p*-value
Inhaled - Exhaled tidal volume (ml/kg)	3.9±2.5	2.9±1.9	0.01
Heart rate change >10%	0	0	
Oxygen desaturation (SpO_2 <92%)	0	0	

Data are mean (±SD) or number

Mask ventilation is often ineffective in air leak patients for reasons such as lack of teeth or edentulous because of the lack of facial support[9,10]. According to the study design, all patients had predictors of air leak of DMV were included. Our results show that the sub-mandibular one-handed grip can be used as an alternative technique to the traditional one-handed CE grip. The sub-mandibular one-handed grip technique delivered higher tidal volumes and was more effective in reducing air leaks than the CE technique. The familiarity of providers with the sub-mandibular one-handed grip technique mask ventilation can prevent hypoxic episodes in a variety of emergent scenarios.

In a sedated person in the supine position, the soft palate and tongue fall back due to gravity and obstruct the pharyngeal airway. The sub-mandibular one-handed grip technique can not be superior to the CE technique in a patient with airway obstruction in DMV.

The present study used only one anesthesia provider for mask ventilation to decrease personal skill variety for mask ventilation. Anesthesia provider did not see exhaled tidal volume data displaying on the anesthetic machine monitor and did not see the patient's chest movement so he did not try to fit the mask even it showed low tidal volume.

Sub-mandibular one-handed grip technique, anesthesia provider stands on the left side of the patient for ventilation and moves to the head of the patient for intubation. In practice, this technique may not go smoothly if the anesthetic provider cannot intubate and turn to ventilating again.

No patients had experienced oxygen desaturation nor had a change in heart rate in this study because of time to ventilation with both techniques was very short but in the other situation such as obese patient, cannot ventilate for a long time or emergency condition oxygen desaturation or changes in heart rate may be present.

Limitations of the present study must be acknowledged. First, sub-mandibular one-handed grip technique mask ventilation is not a standard technique and if the performers also do not have experience in sub-mandibular one-handed grip mask ventilation this may lead to inadequate ventilation and the outcome may be worse. Second, this study set 40% differences as a clinically significant difference. According to the presented results, the observed expired volume in sub-mandibular one-handed grip technique was not enough to be clinically significant; but in patients with risk of hypoxemia or increased intracranial pressure, it may be affected.

Conclusion

The present study shows that the sub-mandibular one-handed grip technique is more effective in reducing air leaks than one-handed CE technique for patients with potential difficult mask ventilation.

What is already known on this topic?

Patients with difficult mask ventilation are divided into air leaks between mask and face and airway obstruction. The standard one-handed CE technique is usual practice for ventilating general patients. In the patient with potential air leak, the one-handed CE technique may have a problem with inadequate ventilation.

What this study adds?

The sub-mandibular one-handed grip can be used as an alternative technique to delivered higher tidal volumes and was more effective in reducing air leaks than traditional CE technique in patients with potential air leaks.

Potential conflicts of interests

The authors declare no conflicts of interest.

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การศึกษาเปรียบเทียบการช่วยหายใจด้วยหน้ากากเทคนิค Sub-mandibular one-handed grip กับเทคนิค CE ในการช่วยลดภาวะลมรั่วในผู้ป่วยที่มีความเสี่ยงต่อภาวะการช่วยหายใจยาก

เจษฎายุทธ ศักดิ์อรุณชัย, ณัฐพร ติระพัฒน์, ปริฉัตร เคอร์รี่

วัตถุประสงค์: ปัญหาที่เกิดขึ้นบ่อยจากการช่วยหายใจโดยเทคนิค CE ในผู้ป่วยที่ช่วยหายใจยากคือมีลมรั่วระหว่างหน้ากากกับใบหน้าผู้ป่วย การช่วยหายใจเทคนิค sub-mandibular one-handed grip น่าจะเป็นเทคนิคที่ช่วยลดลมรั่วที่เกิดขึ้นได้ การศึกษานี้จึงเปรียบเทียบปริมาตรอากาศของผู้ป่วยจากการช่วยหายใจด้วยเทคนิค sub-mandibular one-handed grip กับเทคนิค CE

วัสดุและวิธีการ: ผู้ป่วยที่มีความเสี่ยงต่อภาวะลมรั่วจากการช่วยหายใจ 30 คนที่มารับการผ่าตัดภายใต้การระงับความรู้สึกใส่ท่อช่วยหายใจ ถูกแบ่งเป็น 2 กลุ่ม กลุ่มที่ 1 ได้รับการช่วยหายใจโดยเทคนิค CE ก่อนแล้วเปลี่ยนเป็นเทคนิค sub-mandibular one-handed grip รวม 15 คน, กลุ่มที่ 2 ได้รับการช่วยหายใจโดยเทคนิค sub-mandibular one-handed grip ก่อนแล้วเปลี่ยนเป็นเทคนิค CE รวม 15 คน เก็บข้อมูลปริมาตรอากาศที่ผู้ป่วยหายใจออก ความดันของทางเดินหายใจ อัตราการเต้นของหัวใจ และค่าความอิ่มตัวของออกซิเจน

ผลการศึกษา: การช่วยหายใจโดยเทคนิค sub-mandibular one-handed grip ลดภาวะลมรั่วมากกว่าการช่วยหายใจโดยเทคนิค CE อย่างมีนัยสำคัญทางสถิติ (2.9±1.9 มิลลิลิตรต่อกิโลกรัมกับ 3.9±2.5 มิลลิลิตรต่อกิโลกรัม, $p = 0.01$) ไม่พบผู้ป่วยมีภาวะค่าความอิ่มตัวของออกซิเจนต่ำหรือการเปลี่ยนแปลงการเต้นของหัวใจทั้ง 2 กลุ่ม

สรุป: การช่วยหายใจโดยเทคนิค sub-mandibular one-handed grip เป็นเทคนิคที่ช่วยลดภาวะลมรั่วเมื่อเทียบกับเทคนิค CE ในผู้ป่วยที่มีความเสี่ยงต่อภาวะการช่วยหายใจยาก