

Middle Fingertip to Rascette Line Measurement Novel Approach to Endotracheal Tube Depth for Filipinos: A Pilot Study*

Joel P. Cabañas, MD¹

ABSTRACT

A predetermined endotracheal tube depth prior to intubation ensures correct tube placement relative to the carina. The objective of this study was to determine if the topographic measurement from the middle fingertip (MFT) to Rascette line (RL) or "wrist line" correlates with acceptable endotracheal tube (ET) depth during orotracheal intubation. This was a prospective, analytical cross-sectional pilot study of 54 adult Filipino patients who underwent general anesthesia with orotracheal intubation. The middle fingertip to Rascette line measurement was utilized as the basis for endotracheal tube depth with ET secured on the right corner of the mouth. After intubation, a chest x-ray was performed to measure the distance from the endotracheal tube tip to the carina. The study showed that the average middle fingertip to Rascette line measurement among Filipinos was 18.79cm (± 1.08) which resulted in 85.19% of patients with ET tip to carina within the acceptable distance of 2-5cm, with a mean value of 3.17cm. The mean MFT to RL measurement in females was 18.28cm and 19.81cm in males. The mean distance of ET tip to carina in females was 2.91cm and 3.66cm in males. There was a significant positive correlation between the middle fingertip to Rascette line measurement and height. This study also documented the total length from the right corner of the mouth to carina, by adding middle fingertip to Rascette line measurement and the distance from ET tip to carina, resulting in a mean value of 23.46cm (± 2.06) in males and 21.19 cm (± 1.73) in females. In conclusion, middle fingertip to Rascette line measurement is an acceptable

technique to determine individualized endotracheal tube depth during orotracheal intubation. This topographic measurement resulted in 96.29% of ET tip ≥ 1 cm above the carina.

Keywords: *middle fingertip, Rascette line, middle fingertip to Rascette line measurement, orotracheal intubation*

INTRODUCTION

Endotracheal intubation is the gold standard for airway management and most commonly performed procedures in the field of anesthesiology, emergency medicine and, critical care.¹ One of the fundamental responsibilities of an anesthesiologist is to establish airway patency during general anesthesia to ensure adequate ventilation and oxygenation.² One of the major concerns during intubation is incorrect placement and inappropriate depth of endotracheal tube (ET) within the airway associated with serious complications which can lead to morbidity and mortality. Over-insertion may result in endobronchial intubation, one-lung ventilation, and collapse of the other lung which may finally result in hypoxia.³ Unintended bronchial intubation accounts for 4% of the adverse respiratory events in pediatric patients and 2% among the adult population. On the other hand, under-insertion of the tube may inappropriately place the inflated cuff over the vocal cords leading to vocal cord trauma, laryngeal nerve compression, and inadvertent extubation.⁴ Therefore, determining the correct depth of endotracheal tube is crucial and should be individualized.

*1st Place, 2022 Philippine Medical Association Original Research Presentation, May 20, 2022

¹From West Visayas State University Medical Center, Iloilo City

There are several methods of estimating optimal endotracheal tube length in orotracheally intubated adult patients. This includes auscultation for bilateral breath sounds along with symmetrical chest expansion⁵, and palpation of the cuff at the suprasternal notch.⁶ However, auscultation alone is still inadequate for assessing the actual depth of endotracheal tube insertion⁷ and it cannot rule out endobronchial tube placement. Chest radiography has been commonly used to confirm proper positioning of the endotracheal tube tip post-intubation. Although fiberoptic bronchoscopy (FOB) is the definitive way of confirming the position of the endotracheal tube tip, it requires expertise to handle, not routinely available in the operating theater, and is costly.⁴

The standard insertion tube depth for orotracheal intubation is 21cm for women and 23cm for men (21/23 rule) among Caucasians.⁸ Such rough estimations however can lead to inadvertent endobronchial intubation especially among Filipinos with expected shorter tracheal length. Individualized measurement of endotracheal tube length provides optimal tube depth, avoids malpositioning and significantly limits tube adjustment after successful intubation. At present, there has been no data on the optimal endotracheal tube depth among Filipinos. The general objective of the study is to determine if the middle fingertip to Rascette line measurement correlates with acceptable endotracheal tube depth during orotracheal intubation. Specifically, the study aims; 1) To determine the average tube length of patients undergoing orotracheal intubation. 2) To determine if there is a significant difference in the tube length between males and females. 3) To determine if the topographic measurement from the middle fingertip to Rascette line will result in equal breath sound on auscultation, symmetrical chest rise, oxygen saturation of 98-100%, and normal end-tidal carbon dioxide (ETCO₂) levels. 4) To determine if topographic measurement from middle fingertip to Rascette line will result in endotracheal tube tip positioned above the carina. 5) To determine if topographic measurement from the middle

fingertip to Rascette line could provide an acceptable measurement of endotracheal tube length after orotracheal intubation without repositioning.

MATERIALS AND METHODS

Study Design

This was a prospective, analytical cross-sectional pilot study design.

Study Setting

This study was conducted at the Operating Room Complex of the said institution.

Population and Sampling Technique

A total of 54 adult Filipino patients, 19 years old and above, admitted as service accommodation, either for emergency or elective surgery, under general anesthesia via orotracheal intubation through direct laryngoscopy or video laryngoscopy. The respondents were selected purposively for the conduct of research regardless of gender. Due to the recent pandemic there has been a large decline in the number of operations. The latest census was an average of 20 cases of intubation per month, a total of 240 estimated cases for 2020. With the increasing cases of COVID-19 in the community, the operation of elective cases in the institution where the study was conducted was temporarily suspended from August to September 2021. This dramatically decreased the number of possible participants of the study because almost 90% of study participants were from elective surgery cases. Thus, this research was amended into a pilot study with 54 sample size study participants and was approved by the Unified Research Ethics Review Committee.

Inclusion Criteria: American Society of Anesthesiologists (ASA) 1 to 3 adult Filipino patients under service accommodation, 19 years and above of either sex, scheduled either for emergency or

elective surgery under general anesthesia via orotracheal intubation through direct laryngoscopy or video laryngoscopy. All patients who were included in the study had negative RT-PCR results for Covid-19.

Exclusion Criteria: Patients who refused to be part of the study and those who did not sign the informed consent were excluded. Patients categorized as American Society of Anesthesiologists (ASA) 4 to 6, with severe anatomical defects of the face, neck and upper airway were part of exclusion criteria. Patients who will undergo nasotracheal intubation, and with findings of pneumothorax or atelectatic lungs prior to intubation were also excluded. Pregnant patients and those with hand deformities from trauma, burns or amputations were excluded. Patients scheduled for operation at the Covid Operating Room were not included in the study. Patients for bronchoscopy or fluoroscopy-guided brush biopsies performed in the operating room were excluded. Patients who are mentally ill due to psychological or developmental disorders who could not give his/her consent were also excluded from the study.

DATA COLLECTION PROCEDURE

The researcher was the one who performed the procedural steps in measuring middle fingertip to Rascette line of all study participants using the same calibrated measuring T-square (see Appendix 1 and 2).

Preoperative Procedure: A standard preoperative evaluation form, approved and registered with the Quality Assurance Office, was administered to the patient by the anesthesiologist in-charge. The assessment was done by the researcher based on the inclusion and exclusion criteria. Once qualified, the patient was invited by the researcher to participate in the study. As the patient agreed, the consent form either in English or Hiligaynon was explained to the patient and once amenable was made to affix his/her signature.

At the time of surgery, the patient was positioned on the operating table with the head in a neutral position provided with appropriate head support or pillow. ASA standard monitors such as non-invasive blood pressure (NIBP), electrocardiogram (ECG), pulse oximeter, and capnography (if available) were provided to the patient. Oxygen at 2 liters per minute via nasal cannula was delivered to the patient while preparing for induction.

The anesthesiologist in-charge chose the estimated endotracheal tube size for females from 6.0mm, 6.5mm and 7.0mm internal diameter (ID). As for male patients, the ET size ranged from 7.0mm, 7.5mm, 8.0mm and 8.5mm ID. The size of the endotracheal tube used corresponds to the estimated size of the little finger of each patient.

Induction of Anesthesia: Preoxygenation with 100% oxygen via fitted face mask for 3- 5 minutes was performed prior to induction of general anesthesia for elective cases. For emergency operations where, rapid sequence induction (RSI) was warranted, the anesthesiologist in-charge preoxygenated the patient by instructing him/her to have 8 breaths with full inhalation and exhalation (maximum capacity breath) for 60 seconds or 4 full breaths in 30 seconds. Adequate preoxygenation was essential to provide an increased length of time before oxygen desaturation occurs in an apneic patient while the anesthesiologist was securing the airway.

The anesthesiologist in-charge decided on his/her preferred anesthetic medication for induction, appropriate for the clinical status of the patient. Once the patient was paralyzed and the condition was appropriate for intubation, laryngoscopy was performed using video laryngoscope C-MAC D-blade (Karl Storz) or Macintosh blade size 3 or 4.

The anesthesiologist in-charge of performing the intubation made sure that the pre-

determined tube measurement is at the level of the patient's right corner of the mouth. Once the identified level of the tube was on the right corner of the mouth, the anesthesiologist halted further tube insertion. The anesthesiologist also ensured that the ET cuff has passed through the vocal cords. The assistant anesthesiologist performed 5 point auscultation to assess for bilateral and equal breath sounds at the same time observing bilateral chest rise. Monitoring with capnography if available to confirm endotracheal tube placement was observed with the presence of 6 consecutive waveforms. Pulse oximetry reading was also documented within 1 minute after tube placement. Endotracheal tube cuff inflation was done using an appropriate volume of air. The endotracheal tube was secured using a surgical plaster on the right corner of the mouth while maintaining the head and neck in a neutral position.

Post-Intubation: Post intubation chest radiograph using a portable x-ray machine was done to measure the distance of the endotracheal tube tip relative to the carina. Fiberoptic bronchoscopy was not utilized to confirm ET tip location in this study because it is an aerosol generating procedure. The acceptable distance of ET tip to carina in this study was between 2-5cm. If the post-intubation x-ray reading of the tube to carina distance was not within the acceptable value, the anesthesiologist in-charge will deflate the cuff and adjust the tube until the acceptable ET tip to carina distance (2-5cm) was reached. The measured ET to carina distance after tube adjustment was also recorded in the data collection form. Collected data underwent review for completeness of information needed and was secured in a brown envelop at the office of the Department of Anesthesiology.

DATA PROCESSING AND ANALYSIS

Data were analyzed using SPSS version 22 and presented as mean $\pm$ SD, number of patient and

percent. Continuous variables (such as age, height, weight, ET tip to carina distance, middle fingertip to Rascette line measurement) were presented as mean $\pm$ SD. Categorical variables (Mallampati Class, patients needing ET repositioning, patients with clear breath sounds after intubation) were presented as absolute number (n) and percentage (%). Mann-Whitney U and Wilcoxon W test was used to analyze the statistical difference between males and females with an alpha value set at 0.01. Pearson correlation plot was also utilized to analyze the correlation between middle fingertip to Rascette line and height.

ETHICAL CONSIDERATIONS

Confidentiality was strictly observed with regards to personal information gathered from study participants. Data gathering and data handling were done in accordance with the Data Privacy Act of 2012. The data collection started after approval from the Unified Research Ethics Review Committee (URERC). Only the researchers directly involved in this study and the statistician have access to the actual data collected for statistical analysis. The data was stored in a password-protected laptop of the researcher and the statistician. After 5 years the data and forms will be discarded.

RESULTS

A total of 54 underwent operation from March 2021 to September 2021 consented to take part in the study. Out of 54 patients, 10 underwent an emergency operation and 44 were under elective surgery. Overall, 6 (11.11%) patients were categorized as ASA 1, 32 (77.78%) ASA 2 and 6 (11.11%) were ASA 3. There were

36 (66.67%) female and 18 (33.33%) male patients who participated in the study with ages 19 to 69 years old. The standing height of patients ranged from 147 to 175cm.

Overall, the average middle fingertip (MFT) to Rascette line (RL) measurement was 18.79cm

(± 1.08). In males it ranged from 17cm to 21cm with a mean value of 19.81cm (± 0.99) while in female patients it ranged from 17cm to 20cm with a mean value of 18.28cm (± 0.70).

The Mann-Whitney U and Wilcoxon W test output shows that there was a significant difference in the mean rank of middle fingertip to Rascette line between male and female with $p=0.000$ (alpha value = 0.01)

All patients who underwent intubation had symmetrical chest expansion, equal breath sounds, with oxygen saturation of 99 to 100%. Capnography monitoring was only used to 24 (44.44%) patients because there was only one monitor available in the operating theater. This was used by another patient when 30 (55.56%) of study participants without capnography monitoring underwent an operation. Single attempt intubation was successfully performed using a Macintosh blade or video laryngoscope D-blade.

Utilizing the MFT to RL measurement resulted to the distance of endotracheal tube (ET) tip to the carina with a mean value of 3.17cm (± 1.25). This was within the acceptable range of 2-5cm to ensure safe ET placement in the trachea. Using the predetermined MFT to RL measurement as ET depth for intubation, resulted in a mean distance of the ET tip to carina of 2.91cm (± 1.22) in females and 3.66cm (± 1.36) in males.

Out of 54 patients, 46 (85.19%) had ET tip 2-5cm from the carina which is the acceptable distance without tube repositioning. However, 6 (11.11%) and 2 (3.7%) patients had endotracheal tubes <2cm and >5cm away from the carina respectively. Using the MFT to RL measurement, 52 out of 54 patients (96.29%) had ET tip positioned ≥ 1 cm above the carina, while 1 patient with ET tip directly at the carina and 1 patient with right mainstem endobronchial intubation. The farthest distance of the ET tip from the carina in the study measures 6.1cm.

Using the Pearson correlation plot, there was a significant relationship between middle fingertip to Rascette line measurement and height of patients as seen in Figure 1 below. It can be observed that middle fingertip to Rascette line measurement and height were significantly related with covariance (5.034) and correlation (0.756) values were both positive. Thus, taller patient tends to have longer MFT to RL measurements.

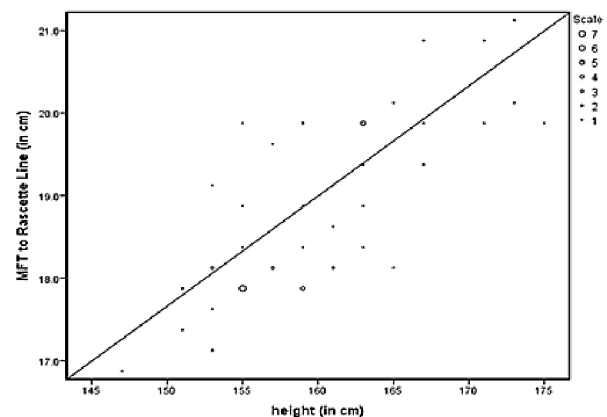


Figure 1. Correlation of middle finger tip to Rascette line and height using Pearson correlation plot.

In addition, this study also documented the entire length from the right corner of the mouth to the carina. This was derived by adding the middle fingertip (MFT) to Rascette line (RL) measurement and the distance from the ET tip to the carina (see Appendix 3). The distance from the right corner of the mouth to carina in male patients ranged from 21.1 to 26.1cm with a mean value of 23.46cm (± 2.06) as shown in Figure 2. While in females it ranged from 17.5 to 24.4cm with a mean value of 21.19 cm (± 1.73) in Figure 3. Mann-Whitney U and Wilcoxon W test output shows that there was a significant difference in the mean rank of the distance from the right corner of the mouth to carina between male and female with $p=0.000$ (alpha value = 0.01).

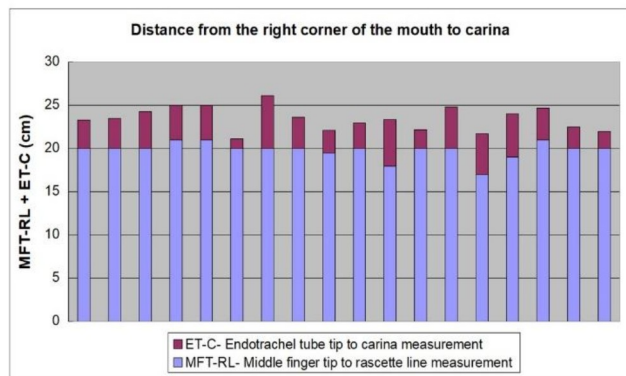


Figure 2. Total distance from the right corner of the mouth to carina among Filipino male patients.

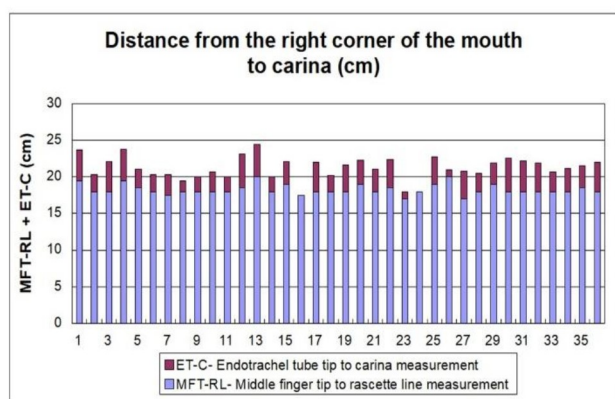


Figure 3. Total distance from the right corner of the mouth to carina among Filipino female patients.

Furthermore, Figure 4 shows that there was a significantly high degree of correlation between the distance from the right corner of the mouth to carina and the height of patients with $p=0.000$ (alpha value = 0.01). The covariance (6.903) and correlation (0.612) values were both positive which shows that taller patients tend to have a longer distance of measurement from the right corner of the mouth to carina. Thus endotracheal tube depth should be individualized because the risk of endobronchial intubation is higher among female and shorter patients.

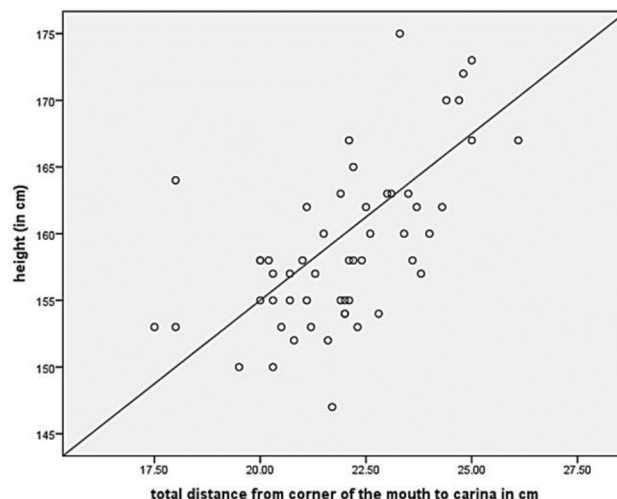


Figure 4. Correlation of distance from the right corner of the mouth to carina and height using Pearson correlation plot.

Endotracheal intubation is a primary technique in securing the airway and ensuring adequate ventilation of patients for surgery under general anesthesia. Proper positioning of endotracheal tube (ET) tip in relation to carina remains a concern. This pilot study was the first to provide data on acceptable endotracheal tube depth during intubation among adult Filipinos using middle fingertip to Rascette line as a topographic measurement.

In this prospective, analytical cross-sectional pilot study, out of 54 adult intubated patients, the mean middle fingertip (MFT) to Rascette line (RL) measurement was 18.79cm (± 1.08). Utilizing the MFT to RL measurement as a basis for predetermined endotracheal tube depth, 85.19% of patients had an acceptable distance of ET tip to carina within 2-5cm. The mean distance of the endotracheal tube tip to carina in this study was 3.17cm (± 1.25) with the patient in a neutral supine position.

The average endotracheal tube (ET) depth in females was shorter at 18.28cm (± 0.70) compared to 19.81cm (± 0.99) in males. After intubation, chest x-ray was performed to measure the distance of ET tip

relative to the carina. The mean distance from ET tip to carina was shorter in females which is 2.91cm and 3.66cm in males. In this study, 85.19% (46) of patients had an acceptable ET tip of 2-5cm away from the carina which is considered safe. The remaining 11.11% (6) patients had ET tip <2cm and 3.7% (2) >5cm away from the carina. Out of 6 patients with ET tip <2cm, 1 female patient with ET tip at the right mainstem bronchus, 1 female patient with ET tip directly at the carina, 4 patients with ET tip 1-1.5cm from the carina (1 male, 3 females). For two patients with ET to carina distance of >5cm, it was 1 male with 6.1cm and 1 female with 5.4cm distance. These findings suggest that the middle fingertip to Rascette line measurement is about 96.29% accurate in estimating the position of the ET tip ≥ 1 cm above the carina.

The result of our study is comparable to the study done by Techanivate et. al⁶, on 100 adult Thai patients utilizing the Chula formula which is $4\text{cm} + (\text{patient height in cm} / 10\text{cm})$ to calculate ET depth. In their study, the mean ET depth was 19.6cm in females and 20.8cm in males. The mean distance from the ET tip to carina was 3.0cm in females and 4.1cm in males measured through fiberoptic bronchoscopy. The mean distance from the vocal cords to the upper border of the ET cuff was 4.6 cm in females and 4.5 in males. This study has 99% accuracy in estimating the proper position of orotracheal tube provided there is a known height of the patient for the formula. However, in our study, the distance of vocal cords from the upper border of ET cuff was not possible to measure through chest x-ray.

The use of standard 21/23cm rule for endotracheal depth was studied in 83 Caucasian patients by Roberts et. Al.⁹ This resulted in 97% acceptable ET placement, with a mean distance of ET tip from carina of 3.45cm for females and 4.1cm for males. For Filipinos with shorter stature, the use of the 21/23 cm rule could possibly result in endobronchial intubation to several patients. Ong et al,¹⁰ reported in their study that using the 21/23 rule

in Asian populations increases the risk of endobronchial intubation. According to Sitzwolk et al,¹¹ the use of 21/23 conventional methods for ET depth will result in deep intubation and recommended that the depth of ET from the central incisor should be 20cm in females and 22cm in males. Park et al,¹² reported that ET depth is safe at 20cm for Korean males and 18cm for females, whereas Varshney et al,¹ reported that the ET depth in the Indian population was 20.26cm for males and 18.23 for females secured from the right corner of the mouth. Hence, endotracheal tube depth should be individualized considering the ethnicity and height of patients accompanied by a thorough physical examination, clinical assessment and appropriate monitoring.

Amos et al,¹³ analyzed 708 intubated ICU patients admitted in Ng Teng Fong General Hospital Singapore and found out that in all ethnic groups (Chinese, Malay, Indian, etc) the average ET depth was 22cm, while 21cm in females and 22cm in males. In this study, ET tip to carina distance was 2-5cm in 58.7%, >5cm in 26.6%, 2cm in 12.4% and 2.3% had endobronchial intubation. Their mean ET depth was longer compared to our study which was 18.79cm among Filipinos, 18.28cm in females and 19.81 in males. The large difference is probably due to different ethnic groups that were included in their study population.

Topographic measurement of the middle fingertip to rascette line as an estimate of endotracheal tube depth resulted in all patients with symmetrical chest expansion, bilateral clear breath sounds and oxygen saturation of 99-100%. Repositioning was done to 8 patients (2 males, 6 females) with of ET tip to carina distance of <2cm and >5cm away. This was to ensure that the patients ET tip was within the acceptable range of 2-5cm away from the carina. However, there were still 2 female patients with ET tips both estimated less than 2cm because 1 had an initial ET tip directly close to the carina and 1 had right mainstem endobronchial intubation. In these 2 patients, ET was pulled out 1cm

only because of the fear that ET cuff would accidentally pass beyond the VC and the risk of dislodge may occur. Repeat chest x-ray was not done to 8 patients who underwent tube repositioning. There was no occurrence of perioperative airway events to all study participants and all patients were immediately extubated post-operatively. Brunel et al,¹⁴ reported that in 5% with mainstem bronchial intubations, half of these patients still present with equal bilateral breath sounds on auscultation. This is possible especially if the Murphy's eye of the ET tube faces towards the contralateral mainstem bronchus. Endobronchial intubation was more common in females than in males and frequently occur during emergency intubations.

Based on Pearson correlation coefficient analysis, there was a positive relationship between middle fingertip to Rascette line measurement and height. Taller patients tend to have longer middle finger tip to Rascette line measurement. Endotracheal tube depth directly correlates to the height of the patient. Varshney et al,¹ found that the upper airway length has significant correlation with height, arm span and vertebral column length ($p < 0.01$). Therefore, shorter patients require more vigilant and careful evaluation during endotracheal intubation.

Our study also documented the entire length from the right corner of the mouth to carina. With the patient in a neutral supine position, this can be derived by adding the middle fingertip to Rascette line measurement and the measured distance from the endotracheal tube tip to carina. The distance from the right corner of the mouth to carina in male patients ranged from 21.1 to 26.1cm with a mean value of 23.46cm (± 2.06) and in females, it ranged from 17.5 to 24.4cm with a mean value of 21.19 cm (± 1.73). This is comparable to the study done by Kumari et al,¹⁵ where they used a fiberoptic bronchoscope to measure the distance from the lip to carina which was 21.3cm in females and 22.9cm in males. Varshney et al,¹ reported that the distance

from lip to carina was 21.62 cm (± 1.34) in females and 24.32cm (± 1.81) in males.

Our study had some limitations. The study was not able to document the distance from the vocal cord to the proximal border of the ET cuff because the cuff was not visible under the chest x-ray. The distance from the vocal cord to the proximal border of the cuff should be adequate to avoid critical incidents of inadvertent extubation and compression of recurrent laryngeal nerve. The study was not able to reach its original sample size of 80 patients due to a lack of study participants. Admission of elective cases for surgery was put on hold temporarily for almost 2 months due to the surge of Covid-19 cases. The investigators decided to amend the research into a pilot study and extend its duration for data collection. The amendments were approved by the Unified Research Ethics Review Committee.

The present study confirms the applicability and reliability of the middle fingertip to Rascette line measurement as an estimate of endotracheal tube depth. A simple method such as this to determine appropriate tube depth for intubation could help avoid endotracheal tube malpositioning. The recommended lengths of the ET for orotracheal intubation have been proposed based on patient height and suggested formulas for which vary with different ethnic populations.

In conclusion, middle fingertip (MFT) to Rascette line (RL) measurement is an acceptable technique to determine endotracheal tube (ET) depth during orotracheal intubation. The mean airway distance is shorter among Filipino population with an average endotracheal depth of 18.28cm (± 0.70) for females and 19.81cm (± 0.99) for males. The success rate of properly positioned ET tip ≥ 1 cm above the carina is 96.29% in the present study, with 85.19% within the acceptable ET tip to carina distance of 2-5cm. Height positively correlates with the MFT to RL measurement at the same time with the total length from the right corner of the mouth to carina. Using

the MFT to RL measurement provides individualized ET depth and prevents malpositioning during intubation. This technique may be useful during emergency intubations particularly in settings where a chest x-ray is not readily available to assess the level of the endotracheal tube tip in the trachea.

Further study is suggested using a larger sample size or in a multi-center, with an equal number of male and female study participants, would be helpful in establishing the effectiveness of this technique. It is also recommended to expand study participants including the pediatric population 18 years old and below for they are at higher risk of endotracheal tube malpositioning. The use of fiberoptic bronchoscopy would be essential if further studies would include determining the distance of the vocal cords to the proximal border of the endotracheal tube cuff. Middle fingertip to Rascette line measurement is also recommended to study its applicability for endotracheal tube depth with other races.

REFERENCES

1. Varshney M, Sharma K, Kumar R, and Varshney PG. Appropriate depth of placement of oral endotracheal tube and its possible determinants in Indian adult patients. *Indian Journal of Anaesthesia* 2011;55:488-93. Accessed: September 28, 2016.
2. Ronald Miller et al, *Miller's Anesthesia*, 8th ed, 2015, Elsevier Saunder, pp 533.
3. Bong-Jae Lee, Bong-Jae Lee, Jae-Woo Yi, Jun Young Chung, Dong-Ok Kim, and Jong-Man Kang. Bedside Prediction of Airway Length in Adults and Children. *American Society of Anesthesiologists, Anesthesiology* 2009; 111:556-60. Accessed September 2009.
4. Sudipta Mukherjee, Manjushree Ray, Rita Pal. Bedside prediction of airway length by measuring upper incisor manubrio-sternal joint length. *Journal Anaesthesiology Clinical Pharmacol.* 2014 Apr-Jun; 30(2): 188-194.
5. Bo-Rum Choi,¹ Song-Yi Lee,¹ Jun-Young Chung,² Sung-Wook Park,¹ Wha Ja Kang,¹ and Jong-Man Kang. Comparison of two topographical airway length measurements in adults. *Korean Journal Anesthesiology.* 2012 Nov; 63(5): 409-412. [PubMed].
6. Anchalee Techanivate ¹, Kanya Kumwilaisak, Sunsanee Samranrean. Estimation of the proper length of orotracheal intubation by Chula formula. *Journal of the Medical Association of Thailand.* 2005 Dec;88(12):1838-46. [PubMed].
7. Keiko Yao,et al. A Formula for Estimating the Appropriate Tube Depth for Intubation. *Anesthesia Prog.* 2019 Spring; 66(1): 8-13. [PubMed]
8. Goodman LR, Conrardy PA, Laing F, Singer MM. Radiographic evaluation of endotracheal tube position. *AJR Am Joentgenol.* 1976;127:433-4. [PubMed]
9. James R. Roberts MD, Michael Spadafora MD, David C. Cone MD, EMT. Proper Depth of Placement of Endotracheal Tubes in Adults Prior to Radiographic Confirmation. *Academic Emergency Medicine.* 1995; 2; 20-24.
10. Ong Kc, A'Court GD, Eng P, Ong YY. Ideal endotracheal tube placement by referencing measurements on the tube. *Annals of the Academy of Medicine, Singapore;* 1996 Jul;25(4):550-2
11. Sitzwohl C, Langheinrich A, Schober A, et al. Endo-bronchial intubation detected by insertion depth of endotra-cheal tube, bilateral auscultation, or observation of chest movements: Randomized Trial. *BMJ.* 2010;341:c5943.
12. Sunwoo Park, Changwon Kim, Ilyoung Jung; Metric Study of Upper Airway and Trachea in Normal Korean Adults using Fiberoptic Bronchoscopy: Study of endotracheal tube fixation positioning in adults. Department of Anesthesiology, Korea Cancer Center Hospital, Seoul, Korea; *Korean Journal of Anesthesiology* 1996;31(6):733-738.
13. Amos Lal et al, Ideal Length of Oral Endotracheal Tube for Critically Ill Intubated Patients in an Asian Population: Comparison to Current Western Standards. *Cureus.* 2018 Nov; 10(11): e3590. Accessed November 14,2018.

14. Brunel W, Coleman DL, Schwartz DE, Peper E, Cohen NH. Assessment of routine chest roentgenograms and the physical examination to confirm endotracheal tube position: Chest, 1989 Nov;96(5):1043-5. [PubMed]
15. Kumari S, Prakash S, Mullick P, Guria S, Girdhar KK. Clinical Implications of Vocal Cord-Carina Distance and Tracheal Length in the Indian Population. Turkish Journal of Anaesthesiology and Reanimation, 2019; 47(6): 456-63.

APPENCIDES

Appendix 1. Rascette line or Wrist line



Appendix 2. Middle finger tip to Rascette line measurement



Appendix 3. Total distance from the right corner of the mouth to carina

