Doi: 10.5152/TJAR.2020.80

Original Article
General Anaesthesia

Turkish Journal of Anaesthesiology & Reanimation

Passive Release Technique Produces the Most Accurate Endotracheal Tube Cuff Pressure Than Manual Palpation and Minimum Occlusive Volume Technique in the Absence of Manometer

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Cite this article as: Laksono BH, Isngadi I, Wicaksono SJ. Passive Release Technique Produces the Most Accurate Endotracheal Tube Cuff Pressure Than Manual Palpation and Minimum Occlusive Volume Technique in the Absence of Manometer. Turk J Anaesthesiol Reanim 2021; 49(2): 114-7.

Abstract

Objective: This study aimed to compare the accuracy of the endotracheal tube (ETT) cuff pressure of the manual palpation (MP), passive release (PR), and minimum occlusive volume (MOV) techniques.

Methods: This study is a true experiment with simple randomisation. The subjects of this study were 105 patients divided into 3 groups: MP group (n=35), PR group (n=35), and MOV group (n=35). After intubation, ETT cuff inflation was performed using 3 different techniques. The ETT cuff pressure was recorded using a manometer. The data were analysed using the chi-square test, Kruskal-Wallis test, and Mann-Whitney test in the SPSS 20 software.

Results: The mean ETT cuff pressure was 60.2±28.8 cmH_2O in the MP group, 30.4±5.5 cmH_2O in the PR group, and 25.8±9.6 cmH_2O in the MOV group (p=0.000). The PR group had the highest pressure accuracy (77%) (p=0.000).

Conclusion: The PR technique had the highest accuracy and can be used as an alternative ETT cuff inflation technique in the absence of a manometer.

Keywords: Airway management, endotracheal tube cuff pressure, ETT cuff pressure, general anaesthesia, manual palpation, minimum occlusive volume technique, passive release technique

Introduction

Endotracheal intubation is commonly performed in anaesthesia. Intubation prevents the aspiration of the pharynx and gastric contents and also provides positive pressure ventilation. The proximal part of the endotracheal tube (ETT) inserts until it passes through the vocal cords. The distal end part of the ETT is between the vocal cords and carina. The ETT cuff is then inflated with air to form tracheal mucosal seals (1, 2).

Endotracheal intubation often causes several complications when not performed correctly. A failed endotracheal intubation can lead to an airway injury, laryngeal injury, arytenoid dislocation, and hematoma. The ETT cuff pressure (cuff pressure) is the main factor involved in the complication. The ETT cuff pressure must be maintained in the reference range, which is between 20 and 30 cmH_2O. A high-pressure ETT cuff causes air leakage and can lead to ventilator-associated pneumonia (VAP), whereas a low-pressure ETT cuff can cause capillary inhibition, vocal cord dysfunction, and recurrent laryngeal palsy (3).

Some techniques have been used to inflate the ETT cuff. The use of a manometer becomes the standard technique because it is more accurate than other techniques. However, some hospitals in developing countries do not

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Received: 16.10.2019 Accepted: 06.01.2020
Available Online Date: 30.11.2020

have a manometer. Other techniques including the manual palpation (MP) technique, passive release (PR) technique, and minimum occlusive volume (MOV) technique have been used to inflate the ETT cuff in the absence of a manometer (4). The MP technique is widely used in endotracheal intubation, but it has low accuracy. Previous research shows that the pressure accuracy in the MP technique is approximately 6%. The PR technique is performed by inflating the air with a syringe into the ETT cuff. The syringe then releases so that there is a return airflow. The accuracy of the PR technique ranges from 56% to 65%. This technique is widely used in Indonesia (4, 5). The MOV technique is performed by inflating the cuff using a minimum volume air until no air leak is found. Previous research showed that the ETT cuff pressure accuracy of MOV technique ranged from 21.7% to 27.8% (6, 7).

The availability of manometers in Indonesian hospitals is low. Research is needed to identify alternative techniques for inflating the ETT cuff in the absence of a manometer. This study was conducted to compare the accuracy of the alternative ETT cuff inflating techniques such as the MP technique, PR technique, and MOV technique with that of manometers.

Methods

This research is a true experiment with simple randomisation. The study design was approved by the Health Research Ethical Committee of Dr. Saiful Anwar General Hospital (No.400/33/K.3/302/2017). All subjects provided written informed consent to be included in this study. The subjects of the study were 105 patients who underwent surgery under general anaesthesia with endotracheal intubation. The patients were divided into 3 groups: MP group (n=35), PR group (n=35), and MOV group (n=35). The inclusion criteria were as follows: age of 18–78 years and American Society of Anesthesiologists (ASA) physical status I and II. Patients with a high risk of aspiration, who had experienced intubation failure, and who needed N_2O for intubation were excluded from the study. ETT cuff was inflated using the MP, PR, and MOV techniques.

Main Points:

- The ETT cuff pressure is the main factor involved in the airway complications during endotracheal intubation.
- The use of a manometer becomes the standard technique to inflate the ETT cuff because it is more accurate than other techniques.
- Other techniques including the manual palpation (MP) technique, passive release (PR) technique, and minimum occlusive volume (MOV) technique have been used to inflate the ETT cuff in the absence of a manometer.
- Our study found that the passive release (PR) technique had the highest accuracy compares to the manual palpation (MP) technique and minimum occlusive volume (MOV) technique.

In the MP technique, the ETT cuff inflates by giving 5 mL of air using a syringe that connected to the 3-way valve. The resident then palpates the pilot balloon to manage the pressure. After finding the right pressure, the 3-way valve is locked. The MOV technique is performed by inflating the ETT cuff using 8 mL of air. Thereafter, 1 mL of air is reduced gradually until the leakage sound is heard. Afterward, 1 mL of air is added until the air leakage sound is no longer heard. In the PR technique, the ETT cuff is inflated by giving 8 mL of air using a 10-mL syringe connected to the 3-way valve. The syringe is released to form passive return airflow. The 3-way valve is locked after the piston syringe stops moving. The ETT cuff pressure is measured using a manometer. The normal pressure is approximately between 20 and 30 cmH_2O.

Statistical analysis

Data from the study was analysed using the chi-square test, Kruskal-Wallis test, and Mann-Whitney test. Data were analysed using the IBM Statistical Package for the Social Sciences (IBM SPSS Corp.; Armonk, NY, USA), version 20 software (α=0.05 for Kruskal-Wallis test and Mann-Whitney test, α=0.01 for chi-square test).

Results

A total of 105 patients who underwent surgery under general anaesthesia with endotracheal intubation participated in the study. The participant characteristics are presented in Table 1. The mean age of the patients was 43.69 years in the MP group, 42.37 years in the PR group, and 41.94 years in the MOV group (p=0.086). The MP group included 14 men and 21 women. The PR group included 15 men and 20 women. The MOV group included 19 men and 16 women. The mean weight was 57.0 kg for the MP group, 57.4 kg for the PR group, and 58.0 kg for the MOV group. The physical status of the subjects was ASA I and II. All the data were normal and homogeneous.

The mean ETT cuff pressure of the patients was 60.2±28.8 cmH_2O in the MP group, 30.4±5.5 cmH_2O in the PR group, and 25.8±9.6 cmH_2O in the MOV group. There was a significant difference between the group (p=0.000) (Table 2). The ETT cuff pressure was divided into 4 groups: normal pressure, high pressure, very high pressure, and low pressure. The accuracy of normal pressure was 20% in the MP group, 77% in the PR group, and 51% in the MOV group. Very high pressure was only found in the MP group (54%) and low pressure was found in MP and MOV groups (p<0.01) (Table 3).

Table 1. Characteristic of the subjects

Characteristics	Group			p
	MP	PR	MOV	
n	35	35	35	
Age (y)				
Mean	43.69	42.37	41.94	0.086
Median	43 (18-73)	42 (19-66)	41 (18-65)	
Gender, n (%)				
Male	14 (40)	15 (42)	19 (54)	0.447
Female	21 (60)	20 (57)	16 (45)	
Weight (kg)				
Mean	57.0	57.4	58.0	0.581
Median	60 (47-73)	61 (47-75)	59 (46-72)	
Physical status, n (%)				
ASA I (%)	8 (23)	11 (32)	11 (32)	0.657
ASA II (%)	27 (77)	24 (68)	24 (68)	

MP: manual palpation; PR: passive release; MOV: minimum occlusive volume; ASA: American Society of Anesthesiologists.

Table 2. The endotracheal tube cuff pressure

Group	Number of subjects	ETT cuff pressure (mean±SD) cmH_2O	Median	p
MP	35	60.2±28.8	68	0.000
PR	35	30.4±5.5	32.5	
MOV	35	25.8±9.6	30.5	

Kruskal-Wallis test and Mann-Whitney test p<0.05 (significantly different). ETT: endotracheal tube; SD: standard deviation; MP: manual palpation; PR: passive release; MOV: minimum occlusive volume

Table 3. The endotracheal tube cuff pressure accuracy

Group	ETT cuff pressure				p
	Normal, n (%)	High, n (%)	Very high, n (%)	Low, n (%)	
MP	7 (20)	8 (23)	19 (54)	1(3)	0.000
PR	27 (77)	8 (23)			
MOV	18 (51)	9 (26)		8 (23)	

Low pressure: <20 cmH_2O; normal pressure: 20-30 cmH_2O; high pressure: 30-≤50 cmH_2O; very high pressure: >50 cmH_2O. Chi-square test: p<0.01 (significantly different). ETT: endotracheal tube; MP: manual palpation; PR: passive release; MOV: minimum occlusive volume

Discussion

The ETT cuff pressure must be maintained between 20 and 30 cmH_2O (normal pressure). In the event of abnormal pressure, the likelihood of several complications increases. Low pressure of the ETT cuff causes air leakage in positive pressure ventilation. The leakage causes microaspiration and increase the possibility of VAP. The high pressure of ETT cuff (>20–30 cmH_2O) inhibits capillary blood flow and increases tracheal injury and vocal cord dysfunction (3).

This study was conducted to compare the accuracy of ETT cuff inflation with the MP, PR, and MOV techniques with that of manometer. The normal cuff pressure was found in 7 subjects (20%) in the MP group, 27 subjects (77%) in the PR group, and 18 subjects (51%) in the MOV group (p=0.000). The PR group achieved the highest pressure accuracy than the other groups. The MP group had the highest ETT cuff overinflation. In the MP group, 23% of the subjects had high ETT cuff pressure, 54% of the subjects had very high ETT cuff pressure, and 3% of the subjects had low ETT cuff pressure. The high ETT cuff pressure (>40 cmH_2O) is called the critical perfusion pressure, and it is dangerous for the patients. When the ETT cuff pressure is higher than the capillary mucosal perfusion pressure, it leads to the obstruction of the mucosal blood flow (8).

The mean of ETT cuff pressure in each group showed a significant difference. The ETT cuff pressure was 60.2±28.8 cmH_2O in the MP group, 30.4±5.5 cmH_2O in the PR group, and 25.8±9.6 cmH_2O in the MOV group (p=0.000). The air volume inflated using the MP technique is high, indicated by the high ETT cuff pressure (60.2±28.8 cmH_2O). The air pressure has a linear correlation with the air volume that inflates the ETT cuff (9). Right air volume is essential to achieve an accurate ETT cuff pressure. In the MP technique, the air volume is measured using the resident's finger. This technique has a low accuracy because it depends on the resident's experience (2). The accuracy of the ETT cuff in the MP group is about 20%, whereas it was approximately 6% in previous studies (4, 5).

According to the study, the MP technique is not recommended for use. Nevertheless, the MP technique is widely used in Indonesia. However, the accuracy of the MP technique can be increased by doing an adjustment training. When the ETT cuff inflates for 7 times in a row, it will increase the accuracy of ETT cuff pressure (10). However, there are other factors that affect the accuracy of the ETT cuff pressure, for example, the difference in the pilot balloon design and material used (11).

The PR technique is performed by using air from a syringe to inflate the ETT cuff. The syringe then releases so that there is a return airflow. This technique has the highest accuracy among the other techniques (77%). However, the accuracy of this technique is also influenced by the syringe size and the syringe design. Huh et al. (12) compared the accuracy of ETT cuff pressure using a different syringe models. The accuracy was approximately 56% for the 10-mL Portex, 63.2% for the 10-mL Euromed syringe, and 56.5% for the 10-mL Nipro

syringe. This study used 10-mL terumo syringe, and the ETT cuff accuracy was approximately 77%.

The MOV technique is performed by inflating the cuff using a minimum volume of air until no air leak is found (7). In the study, the accuracy of MOV technique was approximately 51%. This technique can be the alternative technique to inflate the ETT cuff in the absence of a manometer. However, a previous study identified certain disadvantages of this technique. The MOV technique can interrupt positive pressure ventilation, cause hyperinflation on cuff reinflation, damage the pilot valve with repetitive use, and lead to aspiration (13).

Conclusion

This study found a significant difference in the ETT cuff pressure and the ETT cuff pressure accuracy. The PR technique can be used as an alternative technique to inflate the ETT cuff in the absence of manometer with the highest ETT cuff pressure accuracy.

Ethics Committee Approval: Ethics committee approval was received for this study from the ethics committee of Dr. Saiful Anwar General Hospital (No.400/33/K.3/302/2017).

Informed Consent: Written informed consent was obtained from patients who participated in this study.

Peer-review: Externally peer-reviewed.

Author Contributions: Concept – B.H.L., I.I.; Design – B.H.L., I.I., S.J.W.; Supervision – B.H.L.; Resources – B.H.L., I.I., S.J.W.; Materials – B.H.L., I.I., S.J.W.; Data Collection and/or Processing – B.H.L., I.I., S.J.W.; Analysis and/or Interpretation – B.H.L., I.I., S.J.W.; Literature Search – I.I., S.J.W.; Writing Manuscript – I.I., S.J.W.; Critical Review – B.H.L., I.I.; Other – B.H.L., I.I., S.J.W.

Conflict of Interest: The authors have no conflicts of interest to declare.

Financial Disclosure: The authors declared that this study has received no financial support.

References

1. Hamburg C, Artine C. Miller's Anesthesia. USA: Saunders; 2015.p.1665-6.
2. Ozer A, Gunduz G, Erhan O. Effects of user experience and method in the inflation of endotracheal tube pilot balloon on cuff pressure. Niger J Clin Pract 2013; 16: 253-7. [Crossref]
3. Finucane BT. Principles of Airway Management. Fourth Edi. New York: Springer; 2011.p.685-725. [Crossref]
4. Mutiara G, Suwarman, Sitanggang RH. Perbandingan Ketepatan Pengukuran Tekanan Balon Pipa Endotrakeal setelah Intubasi antara Metode Palpasi pada Pilot Balon dan Teknik Melepas Spuit secara Pasif. J Anestesi Perioper 2016; 3: 155-64. [Crossref]
5. Park KC, Sohn YD, Ahn HC, Ahn JY, Park SM, Cho KY, et al. Effectiveness, Preference and Ease of Passive Release Techniques Using a Syringe for Endotracheal Tube Cuff Inflation. J Korean Soc Emerg Med 2010; 21: 795-800.
6. Butterworth IVJ, Mackey DWJ. Clinical Anesthesiology. Fifth Edit. USA: Lange; 2013.p.320-2.
7. Totonchi Z, Jalili F, Hashemian SM, Jabardarjani HR. Tracheal stenosis and cuff pressure: Comparison of minimal occlusive volume and palpation techniques. Tanaffos 2015; 14: 252-6.
8. Jain M, Tripathi C. Endotracheal tube cuff pressure monitoring during neurosurgery - Manual vs. automatic method. J Anaesthesiol Clin Pharmacol 2011; 27: 358. [Crossref]
9. Hoffman RJ, Stürmann KM. Linear Correlation of Endotracheal Tube Cuff Pressure and Volume. West J Emerg Med 2009; 10: 137-9.
10. Maboudi A, Abtahi H, Hosseini M, Tamadon A, Safavi E. Accuracy of Endotracheal Tube Cuff Pressure Adjustment by Fingertip Palpation after Training of Intensive Care Unit Nurses. Iran Red Crescent Med J 2013; 15: 381-4. [Crossref]
11. Janossy KM, Pullen J, Young D, Bell G. The effect of pilot balloon design on estimation of safe tracheal tube cuff pressure. Anaesthesia 2010; 65: 785-91. [Crossref]
12. Huh J, Yoon TG, Kwon WK, Joo Y, Kim DK, Hospital BM, et al. Usefulness of new technique using a disposable syringe for endotracheal tube cuff inflation. Korean J Anesth 2009; 56: 513-8. [Crossref]
13. Rose L, Redl L. Minimal occlusive volume cuff inflation: A survey of current practice. Intensive Crit Care Nurs 2008; 24: 359-65. [Crossref]