

Outcome of Conventional Method for Achieving Standard Endotracheal Cuff Pressure in Patients undergoing Endotracheal Intubation

Shahzada Irfan, Mubeen Ikram, Hassan Nasir Minhas, Sami Wahid, Bilal Humayun Khan Durrani, Mirza Hamid Beg, Hafiz Asad Saeed*

Department of Anesthesia, Combined Military Hospital Kharian/National University of Medical Sciences (NUMS) Pakistan,
*Department of Medicine, Combined Military Hospital Nowshera/National University of Medical Sciences (NUMS) Pakistan

ABSTRACT

Objective: To measure endotracheal cuff pressure by conventional versus instrumental method in patients undergoing endotracheal intubation

Study Design: Prospective longitudinal study.

Place and Duration of Study: Department of Anesthesia, Combined Military Hospital, Kharian Pakistan, Jan to Jul 2023

Methodology: Patients undergoing elective surgery under general anesthesia were included in the study. Endotracheal (ETT) cuff inflation was done using the conventional syringe method, a 10 ml syringe in Group-A and a 20 ml syringe in Group-B after intubation. Patients with difficult intubation, high risk of aspiration, facial trauma, anatomical laryngotracheal abnormality, and emergency cases were excluded. Cuff pressure was measured using an aneroid manometer, adjusted, and compared in both groups. ETT cuff pressure of 20-30cm of H₂O was taken as normal.

Results: Two hundred and twenty patients undergoing elective surgery under general anesthesia were included, with 122(55.4%) males and 98(44.5%) females, and a mean age of 46.22±10.38 years. There was no statistical difference in gender, BMI, and ASA class among participants of both groups in which the ETT cuff was inflated using a 10ml or 20ml syringe. The mean baseline ETT cuff pressure was 35.45±3.10 cm of H₂O. 96(87.3%) participants in the 10ml syringe group and 109(99.1%) participants in the 20ml syringe group had cuff pressure >30 cm of H₂O ($p<0.05$) Positive correlation was found between cuff pressure and syringe size (Pearson coefficient; +0.401, $p<0.005$).

Conclusion: ETT cuff inflation by conventional syringe method is unreliable and can be harmful. Instrumental cuff inflation and pressure monitoring are suggested for more accurate pressure.

Keywords: Cuff Pressure, Endotracheal Intubation, Endotracheal Tube, Manometer.

How to Cite This Article: Irfan S, Ikram M, Minhas HN, Wahid S, Durrani BHK, Beg MH, Saeed HA. Outcome of Conventional Method for Achieving Standard Endotracheal Cuff Pressure in Patients undergoing Endotracheal Intubation. *Pak Armed Forces Med J* 2026; 76(2): 164-168.

DOI: <https://doi.org/10.51253/pafmj.v76i2.10999>

This is an Open Access article distributed under the terms of the Creative Commons Attribution License (<https://creativecommons.org/licenses/by-nc/4.0/>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

INTRODUCTION

Endotracheal intubation, a procedure to protect the airway due to pathological cause or for ventilation during surgical procedures requiring general anesthesia for positive pressure ventilation and to prevent aspiration of gastric contents.¹ The major function of ETT is to maintain airway for ventilation, lung isolation, whereas for the ETT cuff, it is providing a seal between ETT and tracheal wall preventing air leakage, maintaining adequate oxygen delivery and preventing aspiration of gastric and pharyngeal contents.² Usually, high-volume-low-pressure cuffed ETT are used for endotracheal intubation with standard normal cuff pressure of 20-30 cm of H₂O to make an airtight seal to minimize post intubation complications.^{3,4} Intubation complications are more common in emergency intubations with unmonitored cuff inflation as stated by Royal College of

Anesthetists (RCoA) and the Difficult Airway Society (DAS) in 4th National Audit Project 2011 that 25% major airway complications within hospital setup occurred in emergency intubations done in Emergency Department (ED) or ICUs.⁵

Over-inflation of ETT cuff (pressure >30 cm of H₂O) cause catastrophic consequences as it leads to continuous tracheal tissue hypoxia and ischemia, mucosal damage, laryngeal nerve palsy, trachea ulceration, stenosis and necrosis.⁶ Similarly, under inflation of ETT with cuff pressure <20 cm of H₂O leads to air leakage, inadequate and poor lung ventilation, de-recruitment and aspiration of oropharyngeal secretions leading to aspiration pneumonia.⁷ Thus, adequate cuff pressure provides adequate ventilation, alveoli recruitment, prevention of air leakage and aspiration as well as post-extubation complications.^{8,9}

The purpose of conducting this observational study was to assess the efficacy of conventional method of measurement of ETT cuff pressure in

Correspondence: Dr Shahzada Irfan, Department of Anesthesia, Combined Military Hospital, Kharian Pakistan

Received: 05 Oct 2023; revision received: 13 Dec 2023; accepted: 14 Dec 2023

comparison to cuff pressure measurement using aneroid manometer, following cuff inflation by standard 10ml and 20 ml syringe.

METHODOLOGY

This was a prospective longitudinal study was conducted in the Department of Anesthesiology, Combined Military Hospital, (CMH) Kharian Pakistan, from Jan to Jul 2023, following approval from Institutional Ethical Review Committee (IEC-Ref-2/dte01/01/23).

Inclusion Criteria: Patients of either gender, age between 20-60 years, undergoing planned elective surgery under general anesthesia (GA), American Society of Anesthesiologist (ASA) class I and II were included.

Exclusion Criteria: Patients with a BMI >30, emergency intubations, facial or neck trauma, anticipated or pre-existing anatomical laryngotracheal pathology, patients undergoing head and neck, maxillofacial surgery, or surgery in prone positioning, underlying vocal cord paralysis or thyroid disease were excluded.

A sample size of 196 was calculated using Stat Calc-Epi Info by CDC using a prevalence of 55% of ETT cuff pressure being >30 cm of H₂O ± 6.5 cm of H₂O (SD).¹⁰

A total of 350 patients were screened and analyzed for inclusion in study and after initial screening and scrutiny, 220 patients fulfilling inclusion criteria were recruited using non-probability consecutive sampling, after obtaining informed consent. For final analysis purpose, patients in which ETT cuff was inflated using 10ml syringe were kept in Group-A and in which 20ml syringe was used by technician were kept in Group-B (Figure).

Pre-anesthesia assessment of all patients was done along with segregation as per ASA class. All patients were admitted in ward one day prior to surgery and kept nil per oral (NPO) after midnight as per standard operating guidelines. In OT for general anesthesia and endotracheal intubation, intravenous fentanyl (1-1.5 mcg/kg) was given by anesthetist, followed by induction using propofol (2.5mg/kg) and atracurium (0.5mg/kg) while endotracheal intubation being done using appropriate size cuffed ETT (7-7.5 in females and 8-8.5 in males). ETT cuff was inflated by anesthesia technician using 10ml or 20ml syringe followed by bulb pressure assessment by manual palpation. ETT secured and baseline cuff pressure was measured using aneroid manometer, noted and adjusted 20-30cm of H₂O by anesthetist. ETT cuff pressure were noted in all study participants along with ASA class and syringe used.

Maintenance anesthesia was done with air, oxygen, isoflurane and atracurium. Baseline ventilator parameters were adjusted according to patient’s age, gender weight, disease and 0% leak was confirmed after cuff pressure adjustment. Patients were extubated after surgery and observed in recovery room till complete weaning off from effects of general anesthesia with neuro-muscular recovery. All patients were shifted to respective wards and followed up for post-extubation airway complications. The incidence of airway complications including sore throat, hoarseness of voice, pain and dysphagia endotracheal intubation was noted in all patients and compared in both groups in final analysis.

Variables like patient’s age, gender, BMI, ASA class, syringe used for cuff inflation, baseline cuff pressure by manometer, post extubation incidence of airway complications were noted in all patients for analysis. Categorical data were presented as frequency and percentage whereas continuous variables as Mean±SD. Data were analyzed using Statistical Package for Social Sciences version 23 (SPSS). Normality of data was tested by Kolmogorov-Smirnov test. Correlation between syringe size and ETT cuff pressure was assessed by Pearson correlation coefficient. Chi-square and t-test were used to check for association between variables and compare means respectively, and a *p*-value of ≤0.05 was considered as statistically significant.

RESULTS

A total of two hundred and twenty (n=220) patients undergoing elective surgery under general anesthesia



Figure: Patient Flow Diagram (n=220)

were included in study, with 122(55.4%) male and 98(44.5%) females, and a mean age of 46.22±10.38 years. There was no statistical difference in gender, BMI and ASA class among participants of both groups in which ETT cuff was inflated using 10ml or 20ml syringe. 10ml syringe was used in 110(50%) patients for cuff inflation including 67(60.9%) ASA-I and 43(39.1%) ASA-II patients. Similarly, 20ml syringe was used in 110(50%) patients for cuff inflation with 64(58.2%) ASA-I and 46(41.8%) ASA-II patients (Table-I).

Table-I: Comparison of Baseline Characteristics of Study Groups (n=220)

Basic Parameters		Group-A n=110 n(%)	Group-B n=110 n(%)	p-value
Gender	Male - 122(55.4%)	67(60.9%)	55(50.0%)	0.104
	Female - 98(44.5%)	43(39.1%)	55(50.0%)	
BMI	20-24	59(46.1%)	56(59.8%)	0.712
	25-30	51(54.9%)	54(40.2%)	
ASA Class	Class-I	67(60.9%)	64(58.2%)	0.682
	Class-II	43(39.1%)	46(41.8%)	

ETT cuff pressure was measured after cuff inflated by anesthesia technician and it was noted that mean baseline cuff pressure was 35.45±3.10 cm of H₂O. Ninety-six (87.3%) participants in which cuff was inflated using 10 ml syringe had cuff pressure >30 cm of H₂O, on the other hand 109(99.1%) participants of 20ml syringe group had cuff pressure >30 cm of H₂O with 24(21.8%) participants having cuff pressure >40 cm of H₂O ($p<0.05$). It was noted that use of 20ml syringe for cuff inflation was associated with higher baseline cuff pressure of >31 cm of H₂O in 85(77.3%) and >40 cm of H₂O in 24(21.8%) participants of study (Table-II).

Table-II: Comparison of Range of ETT Cuff Pressure with Syringe Size (n=220)

Syringe Size	Range of ETT Cuff Pressure			p-value
	20-30 cm of H ₂ O (n=15) n(%)	31-39 cm of H ₂ O (n=181) n(%)	>40 cm of H ₂ O (n=24) n(%)	
10ml (n=110)	14 (12.7%)	96(87.3%)	0	0.001
20ml (n=110)	1(0.9%)	85(77.3%)	24(21.8%)	

Correlation of ETT cuff pressure with syringe size was also checked by Pearson correlation coefficient. Positive correlation was found between ETT cuff pressure and syringe size as greater syringe size leads to higher baseline cuff pressure (Pearson coefficient; +0.401, $p<0.05$).

Endotracheal intubation was associated with post-extubation airway complications, which

commonly included pain, sore throat, pharyngitis, hoarseness of voice and dysphagia occurring shortly after extubation. It was noted that 100(90.9%) participants from Group-B had post extubation airway complications as compared to 78(70.9%) participants from group-A. Seventy-four (33.6%) participants had sore throat and 58(26.4%) had pain within 1st day of extubation, which was self-limited and didn't require any medication, whereas 39(17.7%) and 7(3.2%) participants developed hoarseness of voice and dysphagia respectively, which settled within few weeks without any intervention (Table-III).

Table-III: Comparison of Post-Extubation Airway Complications and Syringe Size (n=220)

Syringe Size	Post-Extubation airway complications					p-value
	None (n=42) n(%)	Sore throat (n=74) n(%)	Hoarseness of Voice (n=39) n(%)	Pain (n=58) n(%)	Dysphagia (n=7) n(%)	
10ml (110)	32(29.1%)	31(28.2%)	19(17.3%)	27(24.5%)	1(0.9%)	0.009
20ml (110)	10(9.1%)	43(39.1%)	20(18.2%)	31(28.2%)	6(5.5%)	

DISCUSSION

Current guidelines recommend optimal cuff pressure to be adjusted immediately after passing ETT and cuff inflation.^{11,12} Usually, standard syringe is used for cuff inflation and palpation method is conventionally used to assess cuff pressure. The cuff pressure is strongly related to the size of syringe used. In one study, it was observed that mean cuff pressure using 5ml syringe is lower 21.1 cm of H₂O as compared to 10ml syringe with average cuff pressure of 36.8 cm of H₂O ($p=0.039$). Also, a positive Pearson correlation of 0.471 between syringe size and cuff pressure was noted.¹³ Similarly, in our study it was noted that use of 20ml syringe for cuff inflation was associated with higher baseline cuff pressure of >31 cm of H₂O in 85(77.3%) and >40 cm of H₂O in 24(21.8%) participants of study.

Bulamba et al. conducted a study to measure cuff pressure after using LOR (loss of resistance) syringe and he concluded that there is small chance (1.4%) of getting baseline ETT cuff pressure of <30 cm of H₂O with the use of syringe.¹⁴ In our study, the mean ETT cuff pressure after syringe inflation was noted to be 35.45±3.10. Similar results were shown by Gupta *et al.*, with baseline cuff pressure of 46.21±17.4 cm of H₂O after manual inflation.¹⁵

A similar study was conducted by Khan et al. and published in Saudi Journal of Anesthesiology which concluded that overall incidence of ETT cuff pressure above standard range in 100 studied participants was

69% with 52% (26/50) in the group using a 10 ml syringe and 86% (43/50) in group using 20 ml syringe for cuff inflation.¹⁶

Post-extubation, there is risk of airway complication due to endotracheal intubation which commonly includes sore throat, hoarseness of voice. Incidence of airway complication was showed by Park et al. in conventional cuff inflation method, where 63% developed sore throat, 42% had hoarseness of voice and 12% had dysphagia.¹⁷

Brodsky *et al.*, explained that the most prevalent post-extubation complications included dysphagia (43%), pain (38%), coughing (32%), sore throat (27%) and hoarseness (27%).¹⁸ Similarly, in this study it was noted that 100(90.9%) participants in which 20ml syringe was used had post-extubation airway complications as compared to 78(70.9%) participants in which 10 ml syringe was used. Hence, it was observed that there were high chances of self-limiting airway complications using a larger syringe.

Hence, it has been observed in this study and other studies that conventional palpation method is not suitable for ETT cuff pressure assessment as it could lead to complications if the pressure remained persistently high. Instrumental methods, including using aneroid manometer should be utilised by anesthetists and technicians for optimal range cuff pressure.

LIMITATIONS OF STUDY

The most important limitation of this study was being single center study and limited sample size. The impact of ASA class III or IV, BMI >30, emergency intubations were not observed in current study. Further studies including randomized control trails (RCTs) are needed with larger sample sets covering multi centers for more authentic results are needed for authentic results prior to making any conclusion and widespread implementation on general population.

CONCLUSION

Conventional palpation method following cuff inflation by syringe is associated with higher cuff pressure which could lead to increased risk of complications. Instrumental technique with aneroid manometer is recommended and preferable method for ETT cuff pressure measurement after syringe inflation to maintain standard cuff pressure.

ACKNOWLEDGEMENT

Authors are thankful to all colleagues and operation theatre staff for assistance in intubations and data collection. In addition, we extend our gratitude to patients, OT technicians, residents and consultants.

Conflict of Interest: None.

Funding Source: None.

Authors' Contribution

Following authors have made substantial contributions to the manuscript as under:

SI & MI: Data acquisition, data analysis, critical review, approval of the final version to be published.

HNM & SW: Study design, data interpretation, drafting the manuscript, critical review, approval of the final version to be published.

BHKD, MHB & HAS: Conception, data acquisition, drafting the manuscript, approval of the final version to be published.

Authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

REFERENCES

1. Kumar CM, Seet E, Van Zundert TCRV. Measuring endotracheal tube intracuff pressure: no room for complacency. *J Clin Monit Comput* 2021; 35(1): 3-10. <https://doi.org/10.1007/s10877-020-00501-2>
2. Pandit JJ, Irwin MG. Airway management in critical illness: practice implications of new Difficult Airway Society guidelines. *Anaesthesia* 2018; 73(5): 544-548. <https://doi.org/10.1111/anae.14270>
3. Higgs A, McGrath BA, Goddard C, Rangasami J, Suntharalingam G, Gale R, et al. Guidelines for the management of tracheal intubation in critically ill adults. *Br J Anaesth* 2018; 120(2): 323-352. <https://doi.org/10.1016/j.bja.2017.10.021>
4. Wallace S, McGrath BA. Laryngeal complications after tracheal intubation and tracheostomy. *BJA Educ* 2021; 21(7): 250-257. <https://doi.org/10.1016/j.bjae.2021.02.005>
5. Downing J, Yardi I, Ren C, Cardona S, Zahid M, Tang K, et al. Prevalence of peri-intubation major adverse events among critically ill patients: A systematic review and meta analysis. *Am J Emerg Med* 2023; 71: 200-216. <https://doi.org/10.1016/j.ajem.2023.06.046>
6. Gaspar MTDC, Maximiano LF, Minamoto H, Otoch JP. Tracheal stenosis due to endotracheal tube cuff hyperinflation: a preventable complication. *Autopsy Case Rep* 2019; 9(1): e2018072. <https://doi.org/10.4322/acr.2018.072>
7. Russotto V, Myatra SN, Laffey JG, Tassistro E, Antolini L, Bauer P, et al. Intubation Practices and Adverse Peri-intubation Events in Critically Ill Patients From 29 Countries. *JAMA* 2021; 325(12): 1164. <https://doi.org/10.1001/jama.2021.1727>
8. Touman AA, Stratakos GK. Long-Term Complications of Tracheal Intubation. In: Erbay RH, editor. *Tracheal Intubation* [Internet]. InTech; 2018 [cited 2023 Sep 20]. Available from: <http://www.intechopen.com/books/tracheal-intubation/long-term-complications-of-tracheal-intubation>
9. Ahmed RA, Boyer TJ. Endotracheal Tube. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2023 [cited 2023 Sep 20]. Available from: <http://www.ncbi.nlm.nih.gov/books/NBK539747/>
10. Gilliland L, Perrie H, Scribante J. Endotracheal tube cuff pressures in adult patients undergoing general anaesthesia in two Johannesburg academic hospitals. *South Afr J Anaesth Analg* 2015; 21(3): 81-84. <https://doi.org/10.1080/22201181.2015.1056504>

Endotracheal Cuff Pressure

11. Coppadoro A, Bellani G, Foti G. Non-Pharmacological Interventions to Prevent Ventilator-Associated Pneumonia: A Literature Review. *Respir Care* 2019; 64(12): 1586–1595. <https://doi.org/10.4187/respcare.07127>
 12. Aziz MF. Advancing Patient Safety in Airway Management. *Anesthesiology* 2018; 128(3): 434–436. <https://doi.org/10.1097/ALN.0000000000002075>
 13. Holyszko A, Levin L, Feczko J, Krawczyk S, Tariman JD. How to Prevent Endotracheal Tube Cuff Overinflation: “5 for 25.” *AANA J* 2021; 89(2): 147–154.
 14. Bulamba F, Kintu A, Ayupo N, Kojjo C, Ssemogerere L, Wabule A, et al. Achieving the Recommended Endotracheal Tube Cuff Pressure: A Randomized Control Study Comparing Loss of Resistance Syringe to Pilot Balloon Palpation. *Anesthesiol Res Pract* 2017; 1–7. <https://doi.org/10.1155/2017/2032748>
 15. Gupta P, Tandon S, Dhar M, Agarwal A, Pathak S, Prabakaran P. A prospective observational study on changes in endotracheal tube cuff pressure and its correlation with airway pressures during various stages of robotic pelvic surgeries. *J Anaesthesiol Clin Pharmacol* 2022; 38(2): 270. https://doi.org/10.4103/joacp.JOACP_325_20
 16. Khan MU, Khokar R, Qureshi S, Al Zahrani T, Aqil M, Shiraz M. Measurement of endotracheal tube cuff pressure: Instrumental versus conventional method. *Saudi J Anaesth* 2016; 10(4): 428–431. <https://doi.org/10.4103/1658-354X.179113>
 17. Park JH, Lee HJ, Lee SH, Kim JS. Changes in tapered endotracheal tube cuff pressure after changing position to hyperextension of neck: A randomized clinical trial. *Medicine* 2021; 100(29): e26633. <https://doi.org/10.1097/MD.00000000000026633>
 18. Brodsky MB, Akst LM, Jedlanek E, Pandian V, Blackford B, Price C, et al. Laryngeal Injury and Upper Airway Symptoms After Endotracheal Intubation During Surgery: A Systematic Review and Meta-analysis. *Anesth Analg* 2021; 132(4): 1023–1032. <https://doi.org/10.1213/ANE.0000000000005276>
-