Open Access

Original Article

# Effect on Cuff Pressure of Various Endotracheal Tube Cuff Inflation Methods

**Tanveer Ahmed Khan, Muhammad Rashid Iqbal, Chaudhry Raheel Ranjha, Mah Rukh, Hafiz Ahmed Hassam Bhalli, Muhammad Ahmed Raza**

Combined Military Hospital/National University of Medical Sciences (NUMS) Rawalpindi Pakistan

## ABSTRACT

***Objective:*** To compare mean endotracheal tube cuff pressures generated using two endotracheal tube cuff inflation methods; Just-Seal versus Stethoscope-Guided in patients undergoing elective surgery under general Anaesthesia.
***Study Design:*** Quasi-experimental study.
***Place and Duration of Study:*** Anesthesia Department, Combined Military Hospital, Rawalpindi Pakistan, from Jan to Jul 2021.
***Methodology:*** A total of 100 patients undergoing elective surgery under general endotracheal tube anaesthesia between 18–60 years of age of either gender were included. Patients were equally allocated (n=50 each) to two Groups, A (Just Seal Group) and B (Stethoscope Guided Group). In the Group-A method, the air was injected until no air leak could be heard. The pressure was measured using a "Portex cuff pressure manometer". In the Group-B method, a stethoscope bell was placed on the thyroid lamina, and harsh breath sounds were auscultated during ventilation. Cuff was inflated till the sounds changed to smooth sounds. The pressure was measured and then noted down.
***Results:*** Among 100 patients, 39 % were males, and 61 % were females. The mean endotracheal cuff pressure in Group-A was 39.90±3.19 centimetres of water and 28.42±3.52 centimetres of water, with Group-B (*p*-value of 0.001).
***Conclusion:*** Post-intubation cuff pressure measured in patients undergoing elective surgery under general anaesthesia of the just seal group is higher than that in the stethoscope-guided group.

***Keywords:*** Cuff pressure, Stethoscope-guided, Tracheal intubation.

***How to Cite This Article:*** *Khan TA, Iqbal MR, Ranjha CR, Mahrukh, Bhalli HAH, Raza MA. Effect on Cuff Pressure of Various Endotracheal Tube Cuff Inflation Methods. Pak Armed Forces Med J 2022; 72(5): 1762-1765. DOI: https://doi.org/10.51253/pafmj.v72i5.7244*



## INTRODUCTION

Endotracheal Tubes are used in General Anesthesia to maintain oxygenation and are available in different lengths and lumens. The distally present cuff is inflated to maintain a proper seal to keep flow dynamic and prevent aspiration. However, overinflation of the seal can cause cough and throat irritation in most patients.[1] Though there are many causes for post-operative sore throat, for example, female gender, young age, traumatic tracheal Intubation, and prolonged Intubation,[2] not many of these can be altered except for high endotracheal tube (ETT) cuff pressure used to create a seal.[3,4] The seal helps in preventing air leakage and pulmonary aspiration.[5] The anaesthesia safety profile has improved a lot in recent times, decreasing morbidity and mortality. However, the incidence of certain complications is still very high; for example, post-operative sore throat has an incidence from 21% to 71.8%.[6] Though higher pressure would make a better seal, helping to achieve these goals, it is limited by the fact that tracheal capillary blood pressure is approximately 30cm H2O.[1] Studies have shown that if pressures are higher than 30cm H2O, then blood flow to the tracheal mucosa is compromised; it is completely stopped at pressures of 5cm H2O.[7,8,9]

This high cuff pressure is one of the most common causes of tracheal mucosal injuries, which may sometimes lead to severe complications like tracheal erosion and fistula.[10]

The study was conducted further to improve the method for assessment of cuff inflation, especially when pressure measuring devices are not available, and to reduce the pressures generated, and therefore, decrease the complications associated with high cuff pressures; we will compare the inflation pressures by 'Just Seal with Stethoscope Guided Method' for cuff inflation.

## METHODOLOGY

This study was conducted at the Anaesthesia Department, Combined Military Hospital, Rawalpindi Pakistan, from January to July 2021. Permission from the Ethical Review Committee (178/7/21) was taken from the Hospital.

The sample size was calculated using the WHO sample size calculator version 1.0. Sample size was 100,

**Correspondence: Dr Tanveer Ahmed Khan,** Department of Anesthesiology, Combined Military Hospital, Rawalpindi, Pakistan.
*Received: 14 Aug 2021; revision received: 08 Nov 2021; accepted: 26 Nov 2021*

(n=50 per Group), level of significance was kept as (α) 5%, power of the test (1-β) 80%, anticipated population (p1= cuff pressure) 38.8% and test value of population (p2= cuff pressure) 29.64%.[1] Sampling was done using a non-probability consecutive sampling technique.

**Inclusion Criteria:** Patients of either gender, aged 18 to 60 years, ASA Class I or II, undergoing elective surgeries under general anaesthesia requiring endotracheal Intubation, nil per oral for at least 6 hours were included in the study.

**Exclusion Criteria:** Patients requiring regional anaesthesia, obese patients (BMI >30), anticipated difficult Intubation and pregnant females were excluded from the study.

Random allocation of the patients was done into two Groups (Group-A and Group-B), with 50 patients in each Group by lottery method. As per the study protocol, the procedure was properly explained and written informed consent was taken from the patients. In addition, a detailed pre-anaesthesia assessment was done of all the patients a day before surgery.

On the day of surgery, patients were prepared for surgery, standard monitoring was initiated, pre-oxygenation was done, and general anaesthesia was administered as per institutional protocols. General anaesthesia was induced using an IV anaesthetic agent (Propofol 2mg/kg), and relaxation was achieved using IV Atracurium (0.5mg/kg). Once intubating conditions were achieved, cuffed ETT (size 7.5 for males; 7.0 for females) was inserted under direct laryngoscopy.The endotracheal cuff was then filled with air using either of the two approaches mentioned. In the Just-Seal method (Group-A), the cuff was filled with air until no air leak could be heard. The pressure was measured using a "Portex cuff pressure manometer". In the stethoscope Guided method (Group-B), a stethoscope bell was placed on the thyroid lamina, and harsh breath sounds were auscultated during ventilation. Cuff was inflated till the sounds changed to smooth sounds. The pressure was measured and then noted down.

Statistical Package for Social Sciences (SPSS) version 25.0 was used for the data analysis. Mean and standard deviation were calculated for quantitative variables, i.e., age, weight and cuff pressure. Frequency and percentage were considered for qualitative variables, i.e., gender. Groups were compared for the pressure generated using an independent sample t-test. The *p*-value of ≤0.05 was considered statistically significant.

## RESULTS

The mean age of the study population was 42.19±9.61 years. The mean age of patients in Group-A was 42.06±10.13 years, and in Group-B was 42.60±9.45 years, as shown in Table-I.

**Table-I: Age Distribution in Study Groups (n=100)**

| Age (years) | 'Just Seal' Group (n=50) | 'Stethoscope Guided' Group (n=50) |
|---|---|---|
| | n (%) | n (%) |
| 18-40 | 25 (50.0 ) | 25 (50.0) |
| 41-60 | 25 (50.0) | 25 (50.0) |
| Mean±SD | 42.06±10.13 years | 42.60±9.45 years |

Among 100 patients, 39.0% were males and 61.0% were females (Table-II).

**Table-II: Gender-wise Distribution in Study Groups(n=100)**

| Gender | 'Just Seal' Group (n=50) | 'Stethoscope Guided' Group (n=50) |
|---|---|---|
| | n (%) | n (%) |
| Male | 22 (44.0) | 17 (34.0) |
| Female | 28 (56.0) | 33 (66.0) |

We found the mean endotracheal cuff pressure in the Just-Seal method was 39.90±3.19 cm H2O and 28.42±3.52 cmH2O, with the Stethoscope-Guided method (*p*-value=0.001), as shown in Table-III.

**Table-III: Comparison of Endotracheal Tube Cuff Pressures produced by Just-Seal Versus Stethoscope-Guided Method in Study Groups (n=100)**

| | 'Just Seal' Group (n=50) | 'Stethoscope Guided' Group (n=50) | *p*-value |
|---|---|---|---|
| | Mean±SD | Mean±SD | |
| Cuff pressure (cmH2O) | 39.90±3.19 | 28.42±3.52 | 0.001 |

## DISCUSSION

The main aim of endotracheal Intubation is to maintain and secure a definitive airway when there is a risk of danger to airway patency and the chance of aspiration.[11-15] The precise cause of airway symptoms developing after Intubation is yet unknown; however, cuff site mucosal damage is an important causative factor for tracheal damage.[16,17] The post-operative sore throat is usually not because of any infectious process but because of the release of underlying inflammatory mediators, which is evident by the release of mitochondrial DNA. Alzahrani *et al.* suggested a minimum cuff pressure of 25 cm H2O to prevent aspiration and leaks.[9] An increase in cuff pressure of greater than 30 cmH2O can cause a decrease in tracheal capillary

pressure. In addition, it may result in tracheal ischemia depending on the amount of pressure the cuff develops and the total contact time. Hence, a target of 20 to 30 cmH2O of cuff pressure is recommended by most anesthesiologists to prevent such complications.[18] ETT having high volume-low pressure cuffs is preferred due to the risk of possible cuff-related complications . However, it may also have its complications. The methods commonly used for the inflation of the cuff of an endotracheal tube in the clinical setting are; the use of sealing pressure, inflation of the cuff to a specific pressure (25 cm H2O), and another method by cuff pressure estimation by finger palpation.

We have conducted this study to compare mean endotracheal tube cuff pressures generated by using the two endotracheal tube cuff inflation methods, i.e., Just-Seal versus Stethoscope-Guided, in patients undergoing elective surgery under General Anaesthesia. In this study, we have found the mean endotracheal cuff pressure in the Just seal method was 39.90±3.19 cmH2O and 28.42±3.52 cmH2O with the Stethoscope-Guided method (*p*-value of 0.0001). Kumar *et al*. showed that using the Just Seal method of cuff inflation resulted in the generation of higher cuff pressures.[11] The mean pressure in the Just seal method was 38.80cm H2O±5.93 and 29.64cm H2O±1.84, with the Stethoscope guided method (*p*-value of <0.05).[6]

Liu *et al.* observed that the use of the manual balloon palpation method by anaesthetists resulted in a cuff pressure of 30cm H2O in only 69% of the cases.[17] Many pressure-regulating devices have been invented to control ETT cuff pressures, but their accessibility is not common. It has been noted that after three minutes of intubation, there is a drop in cuff pressure. Sole *et al*. have reported a drop in cuff pressure from 21cm of H2O to 17cm H2O over 3 hours, showing the difficulty in maintaining optimal cuff pressure.[16] There is no reliable method to ensure the ETT cuff pressure is inside the suggested range. However, various methods were used to guarantee proper cuff inflation, like minimal leak technique, minimal occlusive volume, inflation of ETT cuff to a minimum pressure level, use of stethoscope-guided cuff inflation and inflation of cuff with an undetermined volume of air.[19,20]

Overinflation of the cuff may have catastrophic outcomes. Stein *et al*. reported that the tracheal mucosal blood stream was lessened at an expanded cuff pressure above 30cm H2O and stopped when the cuff pressure was more than 50cm H2O.[21] It has been seen that, beyond 50cm H2O, blood movement to the tracheal mucosa is obstructed, which may cause severe tracheal diseases, like ulcerations which may lead to tracheal stenosis, rupture and acquired tracheoesophageal fistula.[18] On the other hand, underinflation of the cuff is associated with an increased danger of air escape and aspiration of gastric and oral pharyngeal secretions.[19] If the cuff pressure is kept at less than 20cm H2O, there is an increased chance of aspiration, a major cause of illness, death, extended length of hospital stays, and a surge in hospital care costs. According to this study, the second maximum incidence of main airway-related grave events is caused by aspiration. However, hoarseness, dysphagia, and sore throat are less serious complications that are more prevalent.

## ACKNOWLEDGEMENTS

Authors were highly obliged to the anaesthesia seniors, surgeons, contemporaries and theatre staff for their assistance in effectively conducting this research.

## LIMITATION OF STUDY

An ideal quiet environment may not have been achieved during listening for air leakage and during auscultation for turbulent flow, which may have affected the amount of air injected.

## CONCLUSION

This study concluded that post-intubation cuff pressure measured in patients undergoing elective surgery under general anaesthesia of the 'just seal' group is greater than that in the 'stethoscope-guided' group. Therefore, we recommend that stethoscope-guided cuff pressure measurement be used during tracheal Intubation to decrease the complications associated with high cuff pressures, especially when a manometer is unavailable.

**Conflict of Interest:** None.

**Author's Contribution**

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

TAK: Conception, data acquisition, drafting the manuscript, approval of the final version to be published, MRI & CRR: Drafting the manuscript, data interpretation, critical review, approval of the final version to be published ,M & HAHB: Study design, data analysis, critical review, drafting the manuscript, critical review, approval of the final version to be published.

MAR: Critical review, 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 investi-gated and resolved.

## REFERENCES

1. Borhazowal R, Harde M, Bhadade R, Dave S, Aswar SG. Comparison between Two Endotracheal Tube Cuff Inflation Methods; Just-Seal vs. Stethoscope-Guided. J Clin Diagn Res 2017; 11(6): UC01-UC03.doi:10.7860/JCDR/2017/26301.10017.

2. El-Boghdadly K, Bailey CR, Wiles MD. Postoperative sore throat: a systematic review. Anaesthesia 2016; 71(6): 706-717. doi: 10.1111/anae.13438.
3. Geng G, Hu J, Huang S. The effect of endotracheal tube cuff pressure change during gynecological laparoscopic surgery on postoperative sore throat: a control study. J Clin Monit Comput 2015; 29(1): 141-144. doi: 10.1007/s10877-014-9578-2.
4. Jaensson M, Gupta A, Nilsson U. Gender differences in sore throat and hoarseness following endotracheal tube or laryngeal mask airway: a prospective study. BMC Anesthesiol 2014; 14: 56. doi: 10.1186/1471-2253-14-56.
5. Al-metwalli RR, Al-Ghamdi AA, Mowafi HA, Sadek S, Abdulshafi M, Mousa WF. Is sealing cuff pressure, easy, reliable and safe technique for endotracheal tube cuff inflation?: A comparative study. Saudi J Anaesth 2011; 5(2): 185-189. doi: 10.4103/1658-354X.82795.
6. Baoji H, Rui B, Xiaolin W, Shanshan L, Tianzhu T, Qun X. The Size of Endotracheal Tube and Sore Throat after Surgery: A Systematic Review and Meta-Analysis. PLoS One 2013; 8(10): e74467. doi: 10.1371/journal.pone.0074467.
7. Bernon JK, McGuire CI, Carrara H, Lubbe DE. Endotracheal tube cuff pressures - the worrying reality: a comparative audit of intra-operative versus emergency intubations. S Afr Med J 2013; 103(9): 641-643. doi: 10.7196/samj.6638.
8. Totonchi Z, Jalili F, Hashemian SM, Jabardarjani SR. Tracheal Stenosis and Cuff Pressure: Comparison of Minimal Occlusive Volume and Palpation Techniques. Tanaffos 2015; 14(4): 252–256.
9. Alzahrani AR, Abbasi S, Abahoussin OK, Al Shehri TO, Al-Dorzi, HM Hani, et. al. Prevalence and predictors of out-of-range cuff pressure of endotracheal and tracheostomy tubes: a prospective cohort study in mechanically ventilated patients. BMC Anesthesiol 2015; 15: 147. doi: 10.1186/s12871-015-0132-7.
10. Hedberg P, Eklund C, Högqvist S. Identification of a Very High Cuff Pressure by Manual Palpation of the External Cuff Balloon on an Endotracheal Tube. AANA J 2015; 83(3): 179-182.
11. Kumar RD, Hirsch NP. Clinical evaluation of stethoscope-guided inflation of tracheal tube cuffs. Anaesthesia 2011; 66(11): 1012-1016. doi: 10.1111/j.1365-2044.2011.06853.x.
12. Akhtar IM. Awareness Regarding Application of Endotracheal Tube (ETT) Cuff Pressure Measuring Gauge in Anesthesia Practice; A Critical Step to Avoid Postintubation Tracheal Stenosis in Critically ill Patients on Prolonged Mechanical Ventilator. J Coll Physician and Surg Pak 2016; 26(1): 635.
13. Rami A. Ahmed; Tanna J. Boyer. Endotracheal Tube (ET). StatPearls Publishing; 2020 [Internet] available at: https://www.ncbi.nlm.nih.gov/books/NBK539747/
14. Puyo CA, Peruzzi D, Earhart A, Roller E, Karanikolas M, Kollef MH, et al. Endotracheal tube-induced sore throat pain and inflammation is coupled to the release of mitochondrial DNA. Mol Pain 2017; 13: 1744806917731696. doi: 10.1177/1744806-917731696.
15. Ghafoui HB. Excessive endotracheal tube cuff pressure: is there any difference between emergency physicians and anesthesiologists. Signa Vitae 2012; 7(1): 17–20. doi: 10.22514/SV72.102012.3
16. Sole ML, Su X, Talbert S, Penoyer DA, Kalita S, Jimenez E, et al. Evaluation of an intervention to maintain endotracheal tube cuff pressure within therapeutic range. Am J Crit Care 2011; 20(2): 109-117; quiz 118. doi: 10.4037/ajcc2011661.
17. Liu J, Zhang X, Gong W. Correlations between controlled endotracheal tube cuff pressure and postprocedural complications: a multicenter study. Anesth Analg 2010; 111(5): 1133-1137. doi: 10.1213/ANE.0b013e3181f2ecc7.
18. Sultan P, Carvalho B, Rose B O, Cregg R. Endotracheal tube cuff pressure monitoring: a review of the evidence. J Perioper Pract. 2011; 21(11): 379-386. doi: 10.1177/175045891102101103.
19. Sole ML, Talbert S. Evaluation of an intervention to maintain endotracheal tube cuff pressure within therapeutic range. Am J Critical Care 2011; 20(1): 109–117. doi: 10.4037/ajcc2011661.
20. Cook TM, Woodall N, Frerk C. Major complications of airway management in the UK: results of the Fourth National Audit Project of the Royal College of Anaesthetists and the Difficult Airway Society. Part 1: anaesthesia. Br J Anaesth 2011; 106(5): 617-631. doi: 10.1093/bja/aer058.
21. Stein C, Berkowitz G, Kramer E. Assessment of safe endotracheal tube cuff pressures in emergency care - time for change? S Afr Med J 2011; 101(3): 172-173. doi: 10.7196/samj.4469.


.....