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Original Research Article

Comparative Study of Endotracheal Tube Cuff Pressure Changes During Laparoscopic and Open Abdominal Surgeries under General Anaesthesia

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Abstract

Background: Endotracheal tube (ETT) cuff pressure (CP) monitoring is essential during general anaesthesia to prevent airway complications associated with overinflation and underinflation of the cuff. Laparoscopic surgeries, particularly those involving pneumoperitoneum and positional changes, are associated with significant physiological alterations that may influence ETT cuff pressure. Elevated cuff pressure may compromise tracheal mucosal perfusion and increase postoperative airway morbidity.

Aim: To compare changes in endotracheal tube cuff pressure during laparoscopic surgeries performed in head-up and head-down positions with open abdominal surgeries.

Materials and Methods: A prospective comparative study was conducted in the Department of Anaesthesiology at a tertiary care teaching hospital over a period of 21 months. A total of 150 adult patients undergoing elective abdominal surgeries under general anaesthesia were included and divided equally into three groups: Group A – open abdominal surgeries, Group B – laparoscopic surgeries in head-up position, and Group C – laparoscopic surgeries in head-down position. Endotracheal tube cuff pressure was adjusted to 25 cm H_2O after intubation using an aneroid cuff manometer and serial measurements were obtained intraoperatively. Postoperative airway complications including sore throat, throat pain, hoarseness of voice, and blood-streaked expectoration were assessed.

Results: Baseline demographic characteristics were comparable among the three groups. Mean cuff pressure increased progressively in all groups; however, the increase was significantly greater in laparoscopic procedures, especially in head-down position. At 60 minutes, mean cuff pressures were 25.2±0.5 cm H_2O in Group A, 28.2±0.6 cm H_2O in Group B, and 30.2±1.5 cm H_2O in Group C ($p=0.004$). Postoperative sore throat and throat discomfort were more frequent in Group C compared to Groups A and B.

Conclusion: Laparoscopic surgeries, especially those performed in Trendelenburg position, are associated with significant increases in endotracheal tube cuff pressure. Continuous intraoperative cuff pressure monitoring and periodic adjustment are recommended to minimize postoperative airway complications.

Keywords: Endotracheal tube cuff pressure, Laparoscopic surgery, Pneumoperitoneum, Trendelenburg position, General anaesthesia, Postoperative sore throat.

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Introduction

Endotracheal intubation is an essential component of airway management during general anaesthesia [1]. The cuff system of the endotracheal tube plays a critical role in preventing aspiration, ensuring adequate ventilation, and minimizing leakage of anaesthetic gases [2]. Maintenance of optimal cuff pressure is important because both overinflation and underinflation can result in serious complications [3]. The recommended safe cuff pressure range is between 20 and 30 cmH2O. Pressures above this threshold can impair tracheal mucosal blood flow and lead to ischemia, ulceration, stenosis, recurrent laryngeal nerve palsy, and tracheoesophageal fistula formation. Conversely, inadequate cuff pressure may predispose patients to aspiration and inadequate ventilation [4-5]. Laparoscopic surgeries involve carbon dioxide insufflation, increased intra-abdominal pressure, and positional changes such as

Trendelenburg or reverse Trendelenburg positioning [6]. These factors alter respiratory mechanics by increasing intrathoracic pressure and reducing pulmonary compliance. Consequently, cuff pressure may rise during surgery [7].

Although laparoscopic procedures are associated with reduced postoperative pain, shorter hospital stay, and faster recovery compared to open surgeries, the physiological changes induced during laparoscopy may increase airway-related complications if cuff pressure is not adequately monitored [8-10].

Previous studies have demonstrated that cuff pressure frequently exceeds recommended safe limits during laparoscopic surgeries, especially in prolonged procedures and in surgeries requiring steep Trendelenburg position [11-12]. However, limited comparative data exist regarding cuff pressure variations among open abdominal surgeries, laparoscopic surgeries in head-up position, and laparoscopic surgeries in head-down position.

This study was therefore undertaken to evaluate and compare endotracheal tube cuff pressure changes among these groups and to assess associated postoperative airway complications.

Aim and Objectives

Aim: To compare endotracheal tube cuff pressure changes during laparoscopic surgeries with head-up and head-down positions and during open abdominal surgeries.

Primary Objective

- To compare the intraoperative changes in endotracheal tube cuff pressure among patients undergoing open abdominal surgery, laparoscopic surgery in head-up position, and laparoscopic surgery in head-down position.

Secondary Objectives

- To assess postoperative airway complications such as sore throat, throat pain, hoarseness of voice, and blood-streaked expectoration.
- To correlate cuff pressure changes with duration of surgery and patient positioning.
- To determine whether increased cuff pressure is associated with postoperative airway morbidity.

Materials and Methods

This prospective comparative observational study was conducted in the Department of Anaesthesiology of a tertiary care teaching hospital from November 2024 to July 2025. The study included patients undergoing elective abdominal surgeries under general anaesthesia. The sample size was calculated based on findings from previous studies, considering an alpha error of 0.05 and a study power of 90%. A minimum of 45 patients was required in each group; therefore, 50 participants were recruited per group to account for potential exclusions, resulting in a total sample size of 150 patients.

Participants were allocated into three groups based on the type of surgical procedure and patient positioning. Group A consisted of patients undergoing open abdominal surgeries (n = 50), Group B included patients undergoing laparoscopic surgeries performed in the head-up position (n = 50), and Group C comprised patients undergoing laparoscopic surgeries performed in the head-down position (n = 50).

Patients aged between 18 and 60 years, belonging to either gender, classified as American Society of Anesthesiologists (ASA) Physical Status Grade I or II, scheduled for elective abdominal surgery under general anaesthesia, and willing to provide written informed consent were included in the study. Patients with chronic obstructive pulmonary disease, bronchial asthma, upper airway pathology, difficult airway, anticipated difficult intubation, requirement of more than two attempts at laryngoscopy, conversion of laparoscopic surgery to an open procedure, or those undergoing emergency surgeries were excluded from the study.

Prior to commencement, approval was obtained from the Institutional Ethics Committee. Written informed consent was obtained from all participants after explaining the study objectives and procedures. Confidentiality of patient information and anonymity of study participants were strictly maintained throughout the study period.

Methodology

All patients underwent a comprehensive preoperative assessment that included detailed history taking, clinical examination, airway assessment, baseline laboratory investigations, determination of American Society of Anesthesiologists (ASA) physical status grading, and calculation of body mass index (BMI). On arrival in the operating room, standard ASA monitoring was instituted, including continuous electrocardiography (ECG), pulse oximetry (SpO_2), non-invasive blood pressure (NIBP), end-tidal carbon dioxide ($EtCO_2$), and mean arterial pressure (MAP) monitoring.

All patients received a standardized anaesthetic protocol. Premedication consisted of intravenous glycopyrrolate 0.005 mg/kg, ondansetron 0.15 mg/kg, and fentanyl 2 µg/kg. Preoxygenation was performed with 100% oxygen for 3 minutes. Anaesthesia was induced using intravenous propofol at a dose of 2–2.5 mg/kg followed by succinylcholine 2 mg/kg to facilitate endotracheal intubation. Polyvinyl chloride high-volume, low-

pressure cuffed endotracheal tubes were used for airway management. Female patients were intubated with endotracheal tubes of internal diameter 7.0–7.5 mm, while male patients received tubes of internal diameter 8.0–8.5 mm. Following intubation, cuff pressure was adjusted and maintained at 25 cmH_2O using a Portex aneroid cuff manometer.

Anaesthesia was maintained with a mixture of oxygen, nitrous oxide, and sevoflurane. Neuromuscular blockade was achieved with atracurium administered as a loading dose of 0.4–0.5 mg/kg intravenously, followed by maintenance doses of 0.08–0.1 mg/kg intravenously every 30 minutes as required. Endotracheal tube cuff pressure was measured immediately after intubation to establish the baseline value, after patient positioning, following carbon dioxide insufflation, at 5-minute intervals throughout the intraoperative period, and at the time of extubation.

Postoperatively, all patients were evaluated in the Post Anaesthesia Care Unit (PACU) and again at 12 hours after surgery for airway-related complications. The assessed outcomes included postoperative sore throat, throat pain, hoarseness of voice, and blood-streaked expectoration. These findings were documented and compared among the three study groups.

Tools and Investigation Methods: The study utilized a Portex aneroid cuff pressure manometer for accurate measurement and monitoring of endotracheal tube cuff pressure throughout the perioperative period. Standard anaesthesia workstations equipped with multiparameter monitors were used for intraoperative patient management. Continuous monitoring included pulse oximetry for oxygen saturation measurement and capnography for assessment of end-tidal carbon dioxide levels, in addition to other routine physiological parameters.

All patients underwent a standardized preoperative evaluation that included relevant laboratory and radiological investigations. These comprised a complete blood count, renal function tests, and blood glucose estimation. Cardiopulmonary assessment was performed using a chest radiograph and electrocardiogram (ECG). In addition, COVID-19 screening was carried out for all patients according to the prevailing institutional protocol to ensure patient and healthcare worker safety during the study period.

Statistical Analysis: The collected data were entered into Microsoft Excel and subsequently analyzed using Statistical Package for the Social Sciences (SPSS) version 19.0. Quantitative variables were summarized using mean and standard deviation, while qualitative variables were expressed as frequencies and percentages. The Chi-square test was used to assess associations between categorical variables. Comparisons between two independent groups were performed using the independent samples t-test, whereas comparisons among the three study groups were carried out using one-way analysis of variance (ANOVA). A p-value of less than 0.05 was considered statistically significant for all statistical analyses.

Results

Demographic Characteristics: The study included 150 participants equally distributed among three groups. Baseline demographic characteristics such as age, gender, body weight, body mass index, and duration of surgery were statistically comparable among all groups.

Table 1: Baseline Demographic Characteristics of Study Participants

Parameter	Group A	Group B	Group C	P value
Mean age (years)	44.7±10.4	39.9±13.1	42.0±13.1	0.144
Male gender (%)	56	62	62	0.779
Mean weight (kg)	75.7±14.2	78.3±13.4	76.9±16.2	0.680
Mean BMI	24.7±2.4	25.3±1.9	24.6±2.1	0.371
Mean duration of surgery (min)	122.7±31.7	109.5±28.3	116.7±27.9	0.084

The demographic variables among Groups A, B, and C were statistically comparable (Table 1), indicating homogeneity of study participants.

Intraoperative Cuff Pressure Changes: Baseline cuff pressure was standardized at 25 cmH2O in all groups. Following pneumoperitoneum and positional changes, cuff pressure progressively increased in laparoscopic surgery groups.

Table 2: Comparison of Mean Cuff Pressure after Position Change

Group	Mean Cuff Pressure (cmH2O)
Group A	25.3±0.4
Group B	27.2±1.2
Group C	28.4±1.5

Although cuff pressure increased in all groups after positioning, the increase was greatest in Group C undergoing

laparoscopic surgery in Trendelenburg position.

Table 3: Comparison of Mean Cuff Pressure during First Hour of Surgery

Time Interval	Group A	Group B	Group C	P value
5 min	25.1±0.8	27.2±0.8	28.3±1.7	0.389
15 min	25.1±0.5	27.3±0.8	28.4±1.3	0.632
30 min	25.2±0.5	27.6±1.1	28.6±1.2	0.673
45 min	25.5±0.3	27.8±0.7	29.2±1.8	0.042*
60 min	25.2±0.5	28.2±0.6	30.2±1.5	0.004*

***Statistically significant.**

A significant increase in cuff pressure was observed after 45 minutes, particularly in Group C (Table 3). By 60 minutes, cuff pressure exceeded the recommended safe upper limit in Group C.

Postoperative Airway Complications: Postoperative airway complications were more common in laparoscopic groups, particularly Group C.

Table 4: Postoperative Airway Complications among Study Groups

Complication	Group A	Group B	Group C	P value
Sore throat	8%	16%	28%	0.018*
Hoarseness	4%	8%	18%	0.031*
Throat pain	6%	14%	24%	0.027*
Blood-streaked expectoration	2%	4%	10%	0.041*

Postoperative sore throat and hoarseness were significantly more common in patients undergoing laparoscopic surgeries in Trendelenburg position.

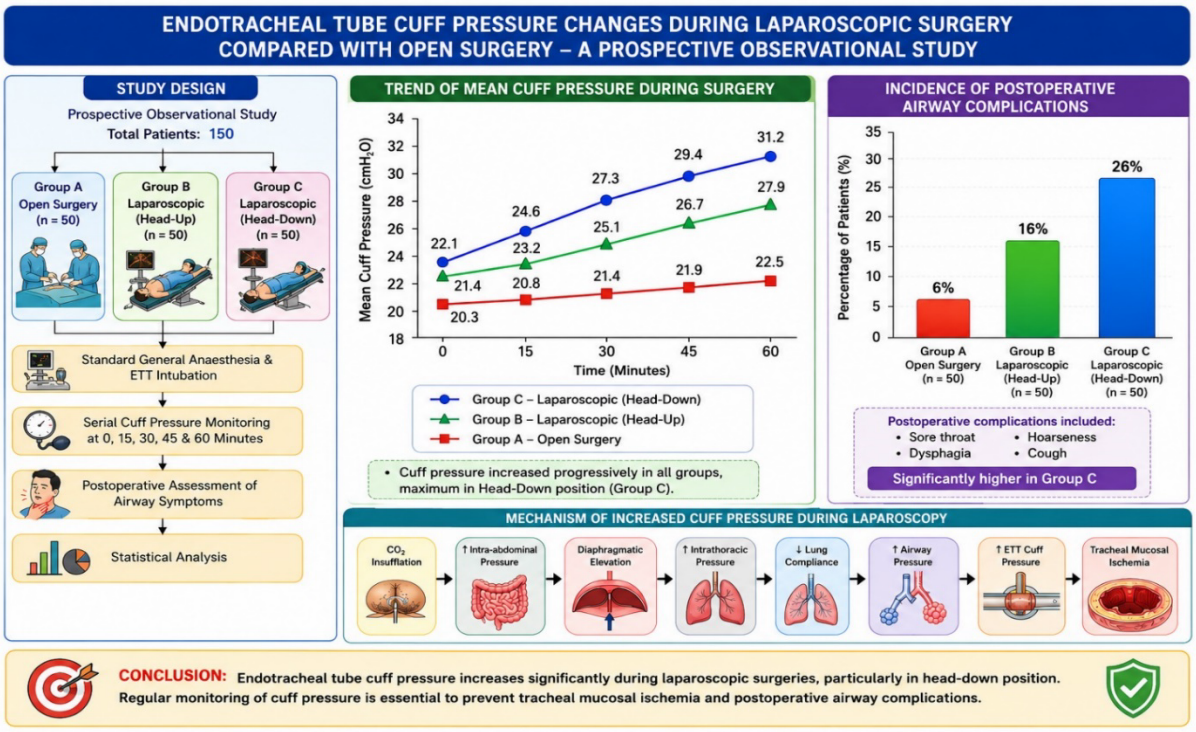

Figure 1: Composite infographic showing the study design, trend of mean endotracheal tube cuff pressure during surgery, incidence of postoperative airway complications, and the mechanism of increased cuff pressure during laparoscopic surgeries. The figure demonstrates progressive elevation of cuff pressure during laparoscopic procedures, particularly in head-down position, resulting in increased postoperative airway morbidity.

The present study demonstrated a progressive increase in endotracheal tube cuff pressure during laparoscopic surgeries when compared to open abdominal surgeries. The increase was more pronounced in laparoscopic surgeries performed in head-down (Trendelenburg) position. As illustrated in Figure 1, Group C patients showed the highest rise in cuff pressure throughout the intraoperative period, with cuff pressures approaching and exceeding the recommended upper safety limit of 30

cmH2O by the end of surgery. Group B patients undergoing laparoscopic surgeries in head-up position also demonstrated elevated cuff pressures, whereas Group A patients undergoing open surgeries showed minimal variations in cuff pressure.\n\nThe incidence of postoperative airway complications including sore throat, hoarseness, dysphagia, and cough was significantly higher in the laparoscopic head-down group, as shown in Figure 1. The graphical representation also highlights the physiological mechanism responsible for increased cuff pressure during laparoscopic surgery. Carbon dioxide pneumoperitoneum increases intra-abdominal pressure, leading to diaphragmatic elevation, increased intrathoracic pressure, reduced lung compliance, and elevated airway pressure, ultimately resulting in increased endotracheal tube cuff pressure and tracheal mucosal ischemia (Figure 1).\n\nThe study methodology illustrated in Figure 1 outlines patient allocation into three groups, serial cuff pressure monitoring at specified intervals, and postoperative assessment of airway symptoms. These findings emphasize the importance of continuous cuff pressure monitoring during laparoscopic surgeries, especially procedures performed in Trendelenburg position, to minimize postoperative airway complications.

Discussion

Maintenance of optimal endotracheal tube cuff pressure remains an important aspect of airway management during general anaesthesia. Excessive cuff pressure compromises tracheal mucosal perfusion and contributes to postoperative airway morbidity [13].

The present study demonstrated that laparoscopic surgeries, especially those performed in Trendelenburg position, are associated with significant increases in cuff pressure compared to open abdominal procedures [14].

In this study, cuff pressure progressively increased following pneumoperitoneum and positional changes [15]. The greatest rise was observed in Group C, where cuff pressure exceeded 30 cmH2O by 60 minutes. Similar findings were reported by Yıldırım et al., who observed significantly higher cuff pressure during laparoscopic procedures compared with open abdominal surgeries [16-17].

The physiological mechanisms responsible for increased cuff pressure include elevated intrathoracic pressure, reduced pulmonary compliance, cephalad displacement of the diaphragm, and increased airway pressures associated with carbon dioxide insufflation [18-19].

Yu Wu et al. also reported significant increases in cuff pressure after creation of pneumoperitoneum, particularly in surgeries performed in head-down position. Likewise, Geng et al. demonstrated higher cuff pressure values during laparoscopic surgeries when compared with laparotomy [20].

The present study also found significantly higher postoperative sore throat and hoarseness in laparoscopic surgery groups. Similar observations were made by Lakhe et al. and Mogal et al., who reported increased postoperative airway complications associated with elevated cuff pressure during laparoscopic surgeries [21-22].

Our findings emphasize the importance of continuous cuff pressure monitoring during prolonged laparoscopic procedures. Pilot balloon palpation alone is unreliable and frequently results in cuff overinflation[12,23].

Puthenveettil et al. demonstrated that manometer-guided cuff inflation significantly reduced postoperative sore throat compared with clinical estimation methods. Das et al. also recommended routine cuff pressure monitoring to reduce airway complications [24-25].

The strengths of the present study include prospective design, equal group allocation, and serial cuff pressure measurements. However, the study has certain limitations. The sample size was relatively modest, and surgeries of varying duration and types were included. Furthermore, postoperative symptoms were assessed subjectively.

Future studies involving larger populations and continuous automated cuff pressure monitoring systems may provide further insights into optimal airway management strategies.

Conclusion

Laparoscopic surgeries are associated with significant increases in endotracheal tube cuff pressure compared to open abdominal surgeries. The increase is most pronounced in surgeries performed in Trendelenburg position. Elevated cuff pressure is associated with increased postoperative airway complications including sore throat, hoarseness, and throat discomfort. Routine intraoperative cuff pressure monitoring using a manometer is strongly recommended during laparoscopic procedures, especially prolonged surgeries involving pneumoperitoneum and positional changes.

Recommendations

- Routine cuff pressure monitoring should be implemented during all laparoscopic surgeries.
- Cuff pressure should be maintained within 20–30 cmH2O.
- Periodic adjustment of cuff pressure should be performed during prolonged surgeries.
- Automated cuff pressure regulation devices may help reduce airway complications.
- Avoidance of excessive Trendelenburg positioning may reduce cuff pressure rise.

References

1. Seegobin RD, van Hasselt GL. Endotracheal cuff pressure and tracheal mucosal blood flow. Br Med J. 1984;288:965-968.
2. Sole ML, Su X, Talbert S, et al. Evaluation of an intervention to maintain endotracheal tube cuff pressure within therapeutic range. Am J Crit Care. 2011;20:109-117.
3. Braz JRC, Navarro LH, Takata IH, Nascimento Júnior P. Endotracheal tube cuff pressure: need for precise measurement. Sao Paulo Med J. 1999;117(6):243-247.
4. Al-metwalli RR, Ismail SA, Mowafi HA, et al. Pressure changes in the endotracheal tube cuff during laparoscopic surgery. Anaesthesia. 2011;66:1105-1110.
5. Yıldırım ZB, Uzunköy A, Cigdem A, Ganidagli S, Ozgonul A. Changes in cuff pressure of endotracheal tube during laparoscopic and open abdominal surgery. Surg Endosc. 2012;26:398-401.
6. Park SJ, Kim BG, Oh AH, et al. Effects of pneumoperitoneum and Trendelenburg position on cuff pressure. J Clin Anesth. 2013;25:292-296.
7. Geng G, Li W, Huang S. Endotracheal tube cuff pressure changes during gynecologic laparoscopic surgery. J Int Med Res. 2014;42:1040-1047.
8. Lakhe G, Sharma SM, Singh A. Cuff pressure changes during laparoscopic cholecystectomy and postoperative sore throat. Kathmandu Univ Med J. 2017;15:25-30.
9. Mogal SS, Dangat LH, Borse PR. Effect of nitrous oxide on cuff pressure during laparoscopic surgeries. Indian J Anaesth. 2018;62:352-357.
10. Rosero EB, Ozayar E, Eslava-Schmalbach J, et al. Relationship between airway pressure and cuff pressure. Anesth Analg. 2018;127:120-125.
11. Puthenveettil N, Rajan S, Paul J, Kumar L. Effect of manometer-guided cuff inflation on postoperative sore throat. Indian J Anaesth. 2018;62:46-51.
12. Ganason N, Sivanaser V, Rashid AM. Influence of cuff pressure on postoperative airway complications. Med J Malaysia. 2019;74:45-50.
13. Kwon Y, Kim EJ, Lee JH. Relationship between pneumoperitoneum time and cuff pressure changes. Korean J Anesthesiol. 2019;72:112-118.
14. Nethra SS, Suresh V, Kiran S. Pressure controlled versus volume controlled ventilation and cuff pressure changes. Indian J Clin Anaesth. 2020;7:144-149.
15. Chauhan P, Sharma R, Singh M. Comparison of cuff pressure changes between laparoscopic and open cholecystectomy. J Anaesthesiol Clin Pharmacol. 2020;36:88-93.
16. Fenta E, Demissie M, Gebremedhn E. Prevalence of postoperative sore throat after general anaesthesia. BMC Anesthesiol. 2020;20:1-7.
17. Narendra HR, Kumar P, Reddy S. Cuff pressure changes during laparoscopic procedures under nitrous oxide anaesthesia. Indian J Anaesth. 2020;64:331-336.
18. Sahin S, Yildirim M, Oksuz H. Saline versus air insufflated endotracheal tube cuffs during laparoscopic surgery. J Clin Monit Comput. 2021;35:701-708.
19. Saxena D, Mehta S, Kothari N. Routine monitoring of cuff pressure in laparoscopic bariatric surgery. Obes Surg. 2022;32:1650-1656.
20. Das S, Kumar A, Dutta A. Importance of cuff pressure monitoring in intubated patients. Indian J Crit Care Med. 2015;19:220-224.
21. Kim HC, Yoo YC, Lee JH. Effect of patient positioning on cuff pressure changes. Anesth Pain Med. 2015;10:52-58.
22. Balakrishnan S, Kumar P, Mathew S. Subjective assessment of cuff pressure inflation by anaesthesiologists. J Clin Diagn Res. 2016;10:UC01-UC04.
23. Koşar O, Aydın T, Ersoy M. Effect of nitrous oxide on cuff pressure and postoperative sore throat. Turk J Anaesthesiol Reanim. 2017;45:140-145.
24. Kang SH, Kim YS, Kim HJ. Comparison of laryngeal mask airway protector and endotracheal tube. Medicine (Baltimore). 2019;98:e14976.
25. Sole ML, Su X, Talbert S. Endotracheal tube cuff pressure management. Am J Crit Care. 2011;20:109-117.