ORIGINAL ARTICLE ASIAN JOURNAL OF MEDICAL SCIENCES

# Changes in endotracheal tube cuff pressure with the changes in peak airway pressures during total laparoscopic hysterectomy and pelvic surgeries. A prospective and observational study

**Sami Ullah Mujoo[1], Sifna Tahir[2], Umera Ikram[3]**

*[1]Assistant Professor, [2]Lecturer, Department of Anesthesiology and Critical Care, [3]Post Graduate Resident, Department of Pathology, Government Medical College, Srinagar, Jammu and Kashmir, India*

Submission: 22-01-2023 Revision: 22-03-2023 Publication: 01-07-2023

## ABSTRACT

**Background:** The abdominal insufflation and changes in endotracheal tube (ETT) cuff pressure due to creation of pneumoperitoneum and changes in patient positioning during laparoscopic abdominal surgeries have not been explored thoroughly. **Aims and Objectives:** The aim of our study was to see the changes in ETT cuff pressures during creation, maintenance, release of pneumoperitoneum, and during surgical positioning. **Materials and Methods:** A total of 60 patients were finally taken for study. Written informed consent was taken for participation in the study as well as consent for surgery. Inclusion criteria were patients of age above 30 years, American society of anesthesiology physical status 1 and 2, patients undergoing total laparoscopic hysterectomy requiring trendelenburg positioning. Exclusion criteria were patients with pre-existing pulmonary or cardiac disease, patients with pre-existing vocal cord palsy, goitre or any other airway or thoracic pathology, pregnant or lactating females, BMI more than 25 or <18.5. Changes of cuff and airway pressures before and after abdominal insufflation in supine position and after head-down or head-up positioning were analyzed and compared. **Results:** Baseline cuff pressure after manual inflation was 28.85 ± 11.4 cm $H_2O$. Significant correlation was observed between change in cuff pressure and increase in peak airway pressure at the end of the surgery ($P<0.05$). Serial measurements of ETT cuff pressure, peak airway pressure, and $ETCO_2$ were significantly increased compared to baseline ($P<0.05$). **Conclusion:** Pneumoperitoneum in Trendelenburg position increases ETT cuff pressure probably due to increase in airway pressure. Therefore, it seems advisable to include routine monitoring of ETT cuff pressure. Objective adjusted measurement of cuff pressure and airway pressures is recommended for such surgeries.

**Key words:** Endotracheal tube cuff pressure; Laparoscopic hysterectomy; Trendelenburg positioning; Pneumoperitoneum

**Access this article online**

**Website:** http://nepjol.info/index.php/AJMS

**DOI:** 10.3126/ajms.v14i7.51701

**E-ISSN:** 2091-0576

**P-ISSN:** 2467-9100



## INTRODUCTION

Laryngotracheal complications are common after endotracheal intubation.[1] Tracheal arterial capillary perfusion decreases when cuff exerts pressure >30 cm of $H_2O$, causing tracheal ischemia.[2]

Now a days, laparoscopic surgery is becoming popular as it is a minimal invasive surgery with multiple advantages.[3] Laparoscopic surgery is performed under general anesthesia with mechanical ventilation. Pneumoperitoneum is created.[4] (IAP 10–12 mmHg) there are several significant respiratory system changes during laparoscopic surgery.

**Address for Correspondence:**
Dr. Sami Ullah Mujoo, Assistant Professor, Department of Anesthesiology and Critical Care, Government Medical College Srinagar, Jammu and Kashmir, India. **Mobile:** +91-9596533468. **E-mail:** samimujoo@gmail.com

Pneumoperitoneum and head low position elevate intrathoracic pressure changes pulmonary compliance and causes increase in airway pressure.[5,6] Sustained over inflation of endotracheal tube (ETT) cuff increases risk of post-operative complications.[7-9]

During elective surgeries, due to changes in ETT cuff pressures, it may lead to pressure on recurrent laryngeal nerve and tracheal mucosa which can cause ischemia, mostly in longer duration of surgeries. This may lead to symptoms like sore throat, hoarseness of voice, ulceration, nerve palsy, and subglottic stenosis.[10] Using cuff manometer (AG CUFFILL), a range of 20–30 cm $H_2O$ is considered to be safe although in many hospitals, this is still done by manual palpation and "feel" of the pilot ballon.[1,5,11]

Studies have shown that when inflated manually, it leads to higher cuff pressures as compared to use of cuff pressure monitors or automated pressure controllers with less pressure side effects.[11,12] Laparoscopic pelvic and hysterectomy surgeries involve long duration of pneumoperitoneumand trendelenburg position. These changes lead to increase in cuff ETT pressures.[4] It has been found that there is direct effect between cuff pressure changes and increase in airway pressure. Numerous other factors have also been studies in relation to patient positioning, body mass index, duration of pneumoperitoneum, and use of nitrous oxide.[13]

The aim of our study was to see the changes in ETT cuff pressures during creation, maintenance, release of pneumoperitoneum, and during surgical positioning. The primary objective was to assess the effect of change in ETT cuff pressure with the increase in peak airway pressure and with End tidal $CO_2$ during total laparoscopic hysterectomy (TLH) and pelvic surgeries.

### Aims and objectives

The aim of our study was to see the changes in ETT cuff pressures during creation, maintenance, release of pneumoperitoneum, and during surgical positioning.

## MATERIALS AND METHODS

A prospective and observational study was conducted on patients posted for elective TLH and pelvic surgeries. A total of 60 patients were finally taken for study. Written informed consent was taken for participation in the study as well as consent for surgery. Inclusion criteria were patients of age above 30 years, American society of anesthesiology physical status 1 and 2, patients undergoing TLH requiring trendelenburg positioning. Exclusion criteria were patients with pre-existing pulmonary or cardiac disease, patients with pre-existing vocal cord palsy, goiter or any other airway or thoracic pathology, pregnant or lactating females, and BMI more than 25 or <18.5.

After selection of study participants and obtaining consent, a thorough pre-anesthethic checkup was done. All patients were kept fasting for 6 h as per latest guidelines. On the day of surgery, a safety check list was done. On arrival in the operation theater, all patients were laid on the operating table and after securing intravenous lines, all patients were pre-medicated with Inj. Pantop 40 mg, Inj. Glycopyrrolate (0.01 mg/kg), Inj.Fentanyl (1–2 mcg/kg). Minimum mandatory monitoring (ECG, NIBP, and $SPO_2$) was started. Anesthesia was induced with Inj. Propofol (1–2 mg/kg), Inj. Atracurium (0.5 mg/kg) and trachea was intubated with 7.5 mm ID (Portex) in all female patients. The ETT cuff (Polyvinyl chloride) was inflated by a theatre technician or a resident guided by AG Cuffill syringe. Baseline cuff pressure was measured and adjusted to 25 cm of $H_2O$. Other baseline values of peak airway pressures and end tidal $CO_2$ ($ETCO_2$) were also measured on Anesthesia workstation Draeger Fabius. Maintenance was with Sevoflurane, air, and oxygen along with maintenance dose of fentanyl and atracurium. Nitrous oxide was not used. Cushioned straps were applied to chest and arms so that the patients were firmly supported on the operating table.

Baseline ventilator parameters were set after intubation before pneumoperitoneum insufflation (tidal volume 8 mL/kg, respiratory rate 16 mL/min, PEEP of 5 cm $H_2O$. Changes were made in the ventilator settings only when there was increase in $ETCO_2$ above 45 mmHg and peak airway pressure above 40 cm $H_2O$. The degree of head down tilt was fixed at 35° and the intra-abdominal pressure was set at 12 mm Hg unless airway pressures exceeded the set limit. Those who required change of set parameters were excluded from the study. All values were recorded (ETT cuff pressure, peak airway pressure and $ETCO_2$) 5 min after establishing pneumoperitoneum, 5 min after final head down position and lastly, 5 min before releasing pneumoperitoneum and return to normal horizontal position. The trachea was extubated at the end of the operation after patient was fully awake and responding to verbal commands.

### Statistical analysis

All statistical calculations were done using computer programs Microsoft Excel 2007 (Microsoft Corporation, Washington, USA) and Statistical Package for the Social Science (SPSS); SPSS Inc., Chicago, IL, USA) version 21. $P<0.05$ was considered statistically significant. Data were statistically described in terms of mean (±SD), frequencies (number of cases), and percentages when appropriate.

The data were entered in MS Excel and were analyzed using SPSS Version 20 and Epi info version 7.2. Levene's Test for Equality of Variances was used and equal variances were assumed within the groups. Independent sample test (Unpaired t-test) was used to test equality of means. *Post hoc* analysis was done using Tuckey's test by considering 5% margin of error (α). P<0.05 was considered as significant.

## RESULTS

Baseline characteristics of all 60 patients undergoing TLH and pelvic surgeries are presented in Table 1 (P>0.05).

Significant increase in cuff pressure, $ETCO_2$, and peak airway pressure at different time intervals was observed at various time intervals of pneumoperitoneum and head down position across the surgery (P<0.0001) Table 2.

Five of the total 60 patients were complication free postoperatively. In the rest five patients, the only complication found was sore throat immediate in postoperative period which resolved over next 24 h without any active intervention (Table 3).

## DISCUSSION

Maintenance of adequate ETT cuff pressure is not only important to avoid ventilatory leak during mechanical ventilation but also important to prevent aspiration especially for patients in head-down position.[14,15] Conversely, several postoperative complications such as such as cough, sore throat, hoarseness, and blood-streaked expectorations are associated with excessive ETT cuff pressure.[16,17]

In terms of the goals of our study, the primary finding of our study was that the ETT cuff pressure increases with creation of pneumoperitoneum by abdominal insufflation with $CO_2$ and intraoperative patient position changes, especially the head-down position. The ETT cuff pressure increased from 25±0.2 cm $H_2O$ at the start to a maximum of 33.24±3.5cm $H_2O$.

The study by Baysal et al., recorded the ETT cuff pressures in laparoscopic patients to be consistently higher at all points of recording as compared to patients operated openly.[18]

In the present study, significant increases in cuff pressure were observed at various time intervals of pneumoperitoneum and head down position across the surgery. Similar trends were observed by Wu et al., who conducted their study on patients undergoing elective laparoscopic colorectal tumor resection and laparoscopic cholecystecomy comparing it to open abdominal surgery. The cuff pressure increased from 26±3 to 32±6 cm $H_2O$ in laparoscopic cholecystecomy patients and from 27±3 to 33±5 cm $H_2O$ in laparoscopic colorectal tumor resection after insufflation (P<0.001). The headdown tilt further increased cuff pressure from 33±5 to 35±5 cm $H_2O$ (P<0.001).[4] Findings of Rosero et al.,[10] are also in keeping with the above findings, in their study on adult obese patients undergoing elective laparoscopic gynecologic procedures. The peak airway pressures significantly increased from 23.2±0.84 cm $H_2O$ before peritoneal insufflations (phase 1) to 32.1±0.46 cm $H_2O$ after peritoneal insufflations and Trendelenburg positioning (phase 2), (P<0.0001). ETT cuff pressures also increased

**Table 1: Baseline characteristics of study population**

| Variables | Mean n=70 | SD |
|---|---|---|
| Age | 51.21 | 10.4 |
| Body height (cm) | 158.4 | 7.1 |
| Body weight (kg) | 62.5 | 11.3 |
| BMI (kg/m$^2$) | 24.1 | 2.4 |

**Table 2: Comparison of ETT cuff pressure, $ETCO_2$, and peak airway pressure at different time intervals among the study population**

| Measured parameter | Mean±SD | P-value |
|---|---|---|
| Cuff pressure (cm $H_2O$) | | |
| Baseline (adjusted to 25 cm $H_2O$) | 25±0.2 | 0.76 |
| 5 min after pneumoperitoneum | 28.85±2.1 | (P<0.0001) |
| 5 min after head down | 33.6±3.1 | (P<0.0001) |
| 5 min prior to pneumoperitoneum release | 33.24±3.5 | (P<0.0001) |
| Peak airway pressure (cm $H_2O$) | | |
| Baseline | 15.57±0.1 | 0.65 |
| 5 min after pneumoperitoneum | 24.06±1.4 | (P<0.0001) |
| 5 min after head down | 27.77±2.3 | (P<0.0001) |
| 5 min prior to pneumoperitoneum release | 25.25±2.9 | (P<0.0001) |
| End tidal $CO_2$ (mm Hg) | | |
| Baseline | 32.82±0.2 | 0.81 |
| 5 min after pneumoperitoneum | 34.25±1.8 | (P<0.0001) |
| 5 min after head down | 36.77±2.9 | (P<0.0001) |
| 5 min before pneumoperitoneum release | 35.2± | (P<0.0001) |

**Table 3: Incidence of airway related complications**

| Complications | Frequency | % |
|---|---|---|
| Sore throat | 5 | 8.33 |
| Hoarseness | 0 | 0 |
| Stridor | 0 | 0 |
| Change in voice | 0 | 0 |

P=0.453

significantly from 29.6±1.30 cm $H_2O$ during phase 1–35.6±0.68 cm $H_2O$ during phase 2, (P<0.0001).

On looking into the correlation between the intraoperative ETT cuff pressure changes and the presence of post-operative complications, we could not find any significant relation between the same. Direct questioning was used to find out the presence or development of any airway related complications such as sore throat and hoarseness of voice at various points of time (immediately after extubation, in the recovery, and in the ward if any complication was present) and follow-up of the patients was done till 24 h after the procedure to detect any complication or its resolution. There was no significant association between the occurrence of complications and the changes in intra cuff pressure (P>0.05).

### Limitations of the study

Firstly, duration of surgery was relatively short:inclusion of longer surgeries would provide further relation between cuff pressure and airway pressures.Secondly,analysing variables like BMI,degree of head down tilt was not within the scope of the study.

## CONCLUSION

Significant increase in ETT cuff pressure is caused by changes in body position like head down and effect of pneumoperitoneum.There exists a significant relation between the change in cuff pressure and increase in airway pressure,which appears to be more significant as the surgery prolongs.In this context, strict monitoring and management of airway pressures and adjustment of cuff pressure using a manometer is essential and advised,especially for these type of surgeries.

## ACKNOWLEDGMENT

Government Medical College Srinagar.

## REFERENCES

1. Yildirim ZP, Uzunkoy A, Cigdem A, Ganidagli S and Ozgonul A. Changes in cuff pressure of endotracheal tube during laparoscopic and open abdominal surgery. Surg Endosc. 2012;26(2):398-401.
   https://doi.org/10.1007/s00464-011-1886-8.
2. Gerges FJ, Kanazi GE and Jabbour-Khoury SI. Anesthesia for laparoscopy: A review. J Clin Anesth. 2006;18(1):67-78.
   https://doi.org/10.1016/j.jclinane.2005.01.013
3. Casati A, Valentini G, Ferrari S, Senatore R, Zangrillo A and Torri G. Cardiorespiratory changes during gynaecological laparoscopy by abdominal wall elevation: Comparison with carbon dioxide pneumoperitoneum. Br J Anaesth. 1997;78(1):51-54.
   https://doi.org/10.1093/bja/78.1.51
4. Wu CY, Yeh YC, Wang MC, Lai CH and Fan SZ. Changes in endotracheal tube cuff pressure during laparoscopic surgery in head-up or head-down position. BMC Anaesthesiol. 2014;14:75.
   https://doi.org/10.1186/1471-2253-14-75
5. Rauh R, Hemmerling TM, Rist M and Jacobi KE. Influence of pneumoperitoneum and patient positioning on respiratory system compliance. J Clin Anesth. 2001;13(5):361-365.
   https://doi.org/10.1016/s0952-8180(01)00286-0
6. Seegobin RD and van Hasselt GL. Endotracheal cuff pressure and tracheal mucosal blood flow: Endoscopic study of effects of four large volume cuffs. Br Med J (Clin Res Ed). 1984;288(6422):965-968.
   https://doi.org/10.1136/bmj.288.6422.965
7. Christensen AM, Willemoes-Larsen H, Lundby L and Jakobsen KB. Postoperative throat complaints after tracheal intubation. Br J Anaesth. 1994;73(6):786-787.
   https://doi.org/10.1093/bja/73.6.786
8. McHardy FE and Chung F. Postoperative sore throat: Cause, prevention and treatment. Anaesthesia. 1999;54(5):444-453.
   https://doi.org/10.1046/j.1365-2044.1999.00780.x
9. Zuccherelli L. Postoperative upper airway problems. Southern Afr J Anaesth Analgesia. 2003;9(2):12-16.
10. Rosero EB, Ozayar E, Eslava-Schmalbach J, Minhajuddin A and Joshi GP. Effects of increasing airway pressures on the pressure of the endotracheal tube cuff during pelvic laparoscopic surgery. Anaesth Analg. 2018;127(1):120-125.
    https://doi.org/10.1213/ane.0000000000002657
11. Jain MK and Tripathi CB. Endotracheal tube cuff pressure monitoring during neurosurgery-manual vs. Automatic method. J Anaesthesiol Clin Pharmacol. 2011;27(3):358-361.
    https://doi.org/10.4103/0970-9185.83682
12. Coelho RD, De Paiva TT and Mathias LA. *In vitro* evaluation of the method effectiveness to limit inflation pressure cuffs of endotracheal tubes. Rev Bras Anaestesiol. 2016;66(2):120-125.
    https://doi.org/10.1016/j.bjane.2014.06.012
13. Mogal SS, Baliarsing L, Dias R and Gujjar P. Comparison of endotracheal tube cuff pressure changes using air versus nitrous oxide in anesthetic gases during laparoscopic abdominal surgeries. Braz J Anaesthesiol. 2018;68(4):369-374.
    https://doi.org/10.1016/j.bjan.2018.01.011
14. Tay HS and Chiu HH. Acid aspiration during laparoscopy. Anaesth Intensive Care. 1978;6(2):134-137.
    https://doi.org/10.1177/0310057X7800600206
15. Young PJ, Rollinson M, Downward G and Henderson S. Leakage of fluid past the tracheal tube cuff in a benchtop model. Br J Anaesth. 1997;78(5):557-562.
    https://doi.org/10.1093/bja/78.5.557
16. Ratnaraj J, Todorov A, McHugh T, Cheng MA and Lauryssen C. Effects of decreasing endotracheal tube cuff pressures during neck retraction for anterior cervical spine surgery. J Neurosurg. 2002;97(2 Suppl):176-179.
    https://doi.org/10.3171/spi.2002.97.2.0176
17. Liu J, Zhang X, Gong W, Li S, Wang F, Fu S, et al. Correlations between controlled endotracheal tube cuff pressure and post-procedural complications: A multicenter study. Anesth Analg. 2010;111(5):1133-1137.
    https://doi.org/10.1213/ANE.0b013e3181f2ecc7
18. Baysal Z, Uzunkoy A and Cigdem A. The effect of laparoscopic cholecystectomy on the endotracheal tube cuff pressure. Surg Endosc Other Interv Tech. 2011;25:S69.

**Authors' Contributions:**
**SUM**: Definition of intellectual content, Literature survey, Prepared first draft of manuscript, implementation of study protocol, data collection, data analysis, manuscript preparation and submission of article.
**ST**: Concept, design, clinical protocol, manuscript preparation, editing, and manuscript revision; Design of study, statistical Analysis and Interpretation;
**UI**: Review Manuscript; Literature survey and preparation of Figures.

**Work attributed to:**
Government Medical College Srinagar.

**ORCID ID:**
Sami Ullah Mujoo - https://orcid.org/0009-0005-8199-2607
Sifna Tahir - https://orcid.org/0009-0008-7569-3864
Umera Ikram - https://orcid.org/0009-0008-5787-0222

**Source of Support:** Nil, **Conflict of Interest:** None declared.