



Maintaining optimal endotracheal tube cuff pressure with pressure gauge reduces the frequency of postoperative airway complications during endoscopic cervical spine surgery

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ABSTRACT

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Background: Endotracheal cuff, when inflated to extremely high pressures lead to tracheal ischemia due to reduced tracheal blood supply while faulty ventilation and aspiration of gastric content or accidental extubation can occur when underinflated. In this study we evaluate the effects of maintaining fixed optimal cuff pressure (25 cmH₂O) during endoscopic anterior cervical spine surgeries, in terms of postoperative airway complications.

Methodology: In our study 100 cases were scheduled to undergo elective anterior cervical spine surgeries under general anesthesia (GA). These cases were divided into two groups according to cuff inflation technique. In Group P (study group), endotracheal tube cuff (ETTc) was inflated with air syringe by senior anesthesiologist. Cuff pressure was estimated by feel of pilot balloon and by absence of audible air leak. Later endotracheal tube cuff pressure (PETTc) was recorded and monitored every 30 min by Portex™ Cuff Inflator pressure gauge. In Group C (control group), ETTc was inflated by attaching with Portex™ Cuff Inflator pressure gauge and pressure was sustained at 25 cmH₂O till patient remains intubated. Both groups were observed for development of any airway complications at 24 hours post-extubation.

Results: There was insignificant differences in age, sex, height, weight, basal metabolic index (BMI), and end tidal CO₂ (EtCO₂), surgery duration and duration of endotracheal intubation in both groups. Mean measured PETTc was 31.25 ± 6.78 mmHg after fixing the EET in Group P. The frequency of postprocedural cough and sore throat in Group P was significantly higher than in the control Group. Data was expressed in Mean ± SD. A statistically significant rise in PETTc in Group P was found at different interval of time.

Conclusion: We concluded that maintaining optimal cuff pressure with cuff inflator pressure gauge is effective in minimizing postoperative common airway complications. Additionally use of personal judgement of estimating PETTc is not reliable and hence should be discouraged.

Key words: Endotracheal tube; Endotracheal tube, cuff pressure; Surgery, Cervical spine, Postoperative complications; Airway

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INTRODUCTION

Endotracheal intubation is an integral part of

modern anesthesia practice in operation theatre for delivering general anesthesia and intensive care unit for ventilatory support. Cuffed ETT

use is always safe than uncuffed ETT¹ as it is the trachea from leakage of gas or secretions around it.² Traditional old method of palpating pilot balloon and absence of audible leak are still used in many institutes for estimation of PETTc, which should be restricted to 25 cmH₂O (20-30 cmH₂O) for uninterrupted tracheal mucosal blood supply thereby preventing mucosal ischemia, ulceration, necrosis, trachea-esophageal fistula.^{3,4} The manual method of inflating the ETTc is associated with higher complication rate.⁵ In order to avoid complications (cough, sore throat, hoarseness) pressure of cuff must be kept within limit. This study was conducted to assess the significance of controlling and maintaining PETTc in lowering endotracheal intubation related airway complications such as cough sore throat and hoarseness of voice.

METHODOLOGY

This double blind randomized, prospective study was carried out in 100 patients of ASA grade I and II of either sex, aged 20-60 y undergoing endoscopic anterior cervical spine surgeries, under general anesthesia. Ethical committee approval and written informed consent were taken. Exclusion criteria were cases with history of cough, sore throat and hoarseness preoperatively, patients with previous airway surgery or tracheostomy, patients with predicted difficult intubation, and patients with inherent voice disorders.

These patients were randomly divided into two groups (50 each) according to cuff pressure estimation techniques. Group P: Traditional technique of ETTc inflation was used. Air injected into the cuff with air syringe and cuff pressure was estimated by touching pilot balloon and by absence of the audible air leak. Immediately, endotracheal tube cuff pressure was documented and checked every 30 minutes. In Group C: Endotracheal tube cuff was inflated by attaching Portex™ Cuff Inflator pressure gauge and pressure was sustained at 25 cmH₂O throughout the surgery.

All patients were premedicated with inj glycopyrrolate 0.2 mg I/M half an hour before surgery and inj midazolam 1mg I/V just before induction. In the operating rooms, standard monitors like ECG, non-invasive arterial pressure, EtCO₂, arterial oxygen saturation (SpO₂) were attached. Routine antibiotics and inj dexamethasone 8mg IV

was given to all patients at the start of anesthesia. Cases were induced with standard general anesthesia technique, with inj fentanyl 2 µg/kg, inj propofol 2 mg/kg and inj vecuronium 0.1 mg/kg. IPPV was done with 100% oxygen for 3 min. With gentle laryngoscopy oral endotracheal intubation was done with appropriate size high volume low pressure single use PVC ETT (for males internal diameter 8-8.5 mm and for females 7-7.5 mm) were used in all patients. Anesthesia was maintained with O₂:N₂O (33:66%), isoflurane and maintenance dose of vecuronium. EtCO₂ levels were maintained at 30-35 mmHg during the operations. All patients were positioned supine with neck extended over a rolled towel under the shoulders and a small head ring was placed under the forehead for stability. On conclusion of surgery patients were reversed and extubated successfully. All these patients were inspected for airway complications (cough, sore throat and hoarseness of voice) at 24 h postextubation and results were documented. The recorded observations in both groups were subjected to statistical analysis using repeated measure ANOVA test. Statistical significance was accepted as insignificant and significant at p > 0.05 and p < 0.05 respectively.

RESULTS

Table 1 shows the demographic data of two groups. Both groups were comparable demographically in respect to age, sex, height, weight, BMI, EtCO₂, duration of intubation and duration of surgery.

Table 2 shows the comparative PETTc levels at different time intervals in both of the groups. Mean ETTc level increased with passage of time and remained higher throughout the observation time in Group P in comparison to Group C, where cuff pressure was maintained at 25 cmH₂O throughout the observation. The recorded observations in both

Table 1: Demographic and anatomic characteristics

Parameter	Group P (Mean ± SD)	Group C (Mean ± SD)	p value
Age (years)	34.22 ± 1.8	36.06 ± 1.01	0.804
Male : Female (M:F)	32:18	35:15	
Weight (kg)	51.86 ± 2.1	56.6 ± 3	0.176
Height (cm)	159.8 ± 2.4	162.8 ± 2.6	0.54
EtCO ₂ (mmHg)	32.62 ± 2.23	31.82 ± 1.98	2.09
BMI	21.13 ± 1.67	20.21 ± 1.98	1.12
Duration of surgery (min)	131 ± 76	131 ± 80	0.89
Duration of intubation(min)	168 ± 81	162 ± 72	0.40

p > 0.05 was considered statistically insignificant

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groups were subjected to statistical analysis using ANOVA test and posthoc Bonferroni test. Statistical significance was accepted as insignificant and significant at $p > 0.05$ and $p < 0.05$ respectively.

Table 3 shows the frequency of cough, sore throat, and hoarseness of voice observed in Group P and Group C.

Table 2: Endotracheal tube pressures at different time periods during surgery [Data given as cmH₂O]

ETTc pressure	Group P Mean ± SD	Group C (Mean ± SD)	p value
Baseline	31.25 ± 6.78	25 ± 0	.032
30 min	31.64 ± 6.66	25 ± 0	.033
60 min	31.77 ± 5.59	25 ± 0	.033
90 min	32.91 ± 7.02	25 ± 0	.034
120 min	33.42 ± 7.65	25 ± 0	
150 min	33.96 ± 7.67	25 ± 0	
180 min	34.26 ± 6.09	25 ± 0	.034

Table 3: Airway complications at 24 h post extubation [Data given as n (%)]

Airway complications	Group P	Group C	p value
Cough	8 (16)	5 (10)	0.002
Sore throat	12 (24)	2 (4)	0.0012
Hoarseness of Voice	2 (4)	0	0.53

$p < 0.05$ statistically significant

DISCUSSION

Being important part of modern general anesthesia technique endotracheal intubation is needed for mechanical ventilation, can be traumatic, can cause bleeding, nerve injury and various difficult postoperative outcomes such as cough, sore throat and hoarseness of voice. The percentage of sore throat is as much as 30% to 55% which is most noticeable 24 h postextubation.⁷ Apart from other causative factors, tracheal-tube size, cuff design and contribution of cuff pressure remains to be clarified.⁸ When PETTc is inadvertently high to exert tracheal wall pressure exceeding mucosal capillary perfusion pressure (30 cmH₂O), this ischemic area may develop edema with resultant sore throat, hoarseness, nerve palsy, tracheal stenosis, tracheoesophageal fistula and obstruction on extubation.⁹ Hence observing and controlling PETTc of below 30 cmH₂O has been accepted to prevent tracheal morbidity.^{10,11} Based on previous studies the recommended optimal cuff pressure range

is approximately 20 to 30 cmH₂O, which ensures ventilation, prevents aspiration of secretions¹⁴ and ensures a good tracheal perfusion.^{12,13,14,15,16}

Though N₂O can accelerate increase in cuff pressure after diffusing into ETTc during general anaesthesia,^{16,17} but study done by Nguyen Tu²⁸ and Priebe²⁹ concluded that it is not N₂O that only increases the incidence of tracheal lesions but rather the non-monitored, unregulated cuff pressure played an important role. We had used N₂O in both the groups to avoid discrepancies in results. With the invention of Brandt Anesthesia tube, risk of postoperative sore throat was reduced by 15% as compared to the Mallinckrodt tube (60%).¹⁸ This study suggested that limiting cuff pressure may minimize the frequency of postoperative sore throat.

Though it is suggested that PETTc should be checked routinely once intubated, still it is not in practice.¹⁹ Routinely it is assessed by anesthesiologists using the pilot balloon palpation method. In our study we compared this palpation method with cuff pressure device. Sole et al.¹³ described only 54% cases could be estimated within optimal range of cuff pressure of 15-25 mmHg by anesthesiologists. According to Svenson et al.²⁰ by using palpation method PETTc was noted to be higher than 30 mmHg in 58% of patients.

Hyperextended neck positioning after intubation during anterior cervical spine surgery itself is a risk factor for tracheal mucosal damage and even produce more damage when associated with high PETTc will automatically leads to severe postoperative airway complications. Further with the application of retractors on anterior wall of neck during surgery, the PETTc increases significantly and remained high during the retractors application. Patients intubated with high-volume, low-pressure cuffed endotracheal tube, need cuff pressure monitoring for constant control of the PETTc. Automatic cuff pressure monitor gives better assessment of cuff pressure. Non availability of automatic cuff pressure monitor mandates the use of manually adjusted cuff pressure gauge throughout the study. Simply by attaching the pressure monitor to the end of pilot balloon, we can directly measure and adjust the PETTc. N₂O diffusion into the cuff,²² raised intrathoracic pressure,²³ and inadvertent manual over inflation of the cuff when using an air syringe²⁴ have been studied as causes of raised ETT cuff pressure.

Seegobin and van Hasselt¹⁰ described adverse effects of increased cuff pressure changes on tracheal mucosal blood flow. There is total obliteration of blood flow at greater than 50 cmH₂O of cuff pressure.

The study done by MC Hardy and F Chung²⁵ reported 14.4% of prevalence of sore throat in study group similar to our study. In our study, 24% and 4% cases, developed sore throat in study group and in control group respectively. They also noticed that sore throat was more prevalent in women (17%) than in men (9%) basically because ETT being a tighter fit in women. In another study of Suzuki et al.²⁶ demonstrated that the presence of sore throat at 24 hours after extubation was significantly decreased in the low cuff pressure group (<20 cmH₂O) as compared to the high pressure group (25-40 cmH₂O). This finding was also consistent with the study of AbOzer²⁷ who found that incidence was lower in the control group 24 h postoperatively.

Another study was carried out by Jian Hua et al.⁸ also concluded postoperative hoarseness, blood streaked expectoration and sore throat was increased with duration of endotracheal intubation. They study hypothesized the reason for hoarseness was not above or below glottis, it was basically vocal cords edema due to presence of ETT and traumatic contact in the glottis. There was no difference found in cough incidence between two groups which is against our finding. Our findings were consistent with the finding of study by Ab Ozer.²⁷

Combes X et al.¹² after carrying out a study suggested that traditional method of palpating balloon and estimating cuff pressure is no longer reliable method and would lead to higher complaints by patients postoperatively which support our finding that incidence of complications are higher in study group.

Lopa Trivedi et al.³ also showed that anesthesiologist's personal experience of assessing cuff pressure could not be recommended over a manometer for cuff pressure measurements. Certainly use of manometer reduced chances of postoperative airway symptoms.

Our study strongly confirms all previous reports that PETTc determined manually is not consistent, fluctuating and increased with endotracheal intubation period and result in tracheal mucosal damage which leads to airway complications.

LIMITATIONS

As with many studies our study is also not devoid of limitations. Because of non-availability of automatic pressure gauge device, we used manual adjustable Portex™ cuff pressure gauge which had to set at same pressure (25 cmH₂O) throughout the surgery, still calibrations bias remained unclear. Secondly, a larger group of patients and a prolonged follow-up of the cases for more than 24 h could have been better with more reliable results.

CONCLUSION

Regular monitoring of tracheal tube cuff pressure to maintain within a recommended range reduces the frequency of postoperative airway complications. Personal judgement on keeping the cuff pressure within optimal range cannot be reliably trusted.

Conflict of interest: None declared by the authors

Author contribution:

RM: Concept, conduction of study, literature search, statistical analysis
MS: Concept, literature search, statistical analysis, manuscript editing
MM: Concept, conduct of study, literature search, statistical analysis

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