ORIGINAL RESEARCH PAPER

Volume-7 | Issue-6 | June-2018 | PRINT ISSN No 2277 - 8179

INTERNATIONAL JOURNAL OF SCIENTIFIC RESEARCH

ENDOTRACHEAL TUBE CUFF PRESSURE MONITORING DURING GENERAL ANAESTHESIA – A COMPARISION BETWEEN MANUAL VS. AUTOMATIC METHOD.

Anesthesiology

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ABSTRACT

Background: Inflation and assessment of the endotracheal tube cuff pressure is often not appreciated as a critical aspect of endotracheal intubation. Appropriate endotracheal tube cuff pressure, endotracheal intubation seals the airway to prevent
aspiration and provides for positive-pressure ventilation without air leak.

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 ETTc pressure is not reliable it hence should be discouraged.

KEYWORDS

Endotracheal tube; Endotracheal tube cuff pressure; Maxillofacial Surgery, Postoperative complications; Airway.

Introduction

For delivery of general anesthesia securing airway and ventilating the patients by placement of endotracheal tube is done commonly in operation theaters and in the ICUs. Use of cuffed tube and checking the ETT cuff pressure by traditional methods as palpating the pilot balloon and hearing the disappearance of the audible air leak . ETTc pressure should be not more than 25 cm of H_2O (20-30 cm of H_2O) to maintain tracheal mucosa perfusion and to prevent mucosal ischemia, tracheal necrosis, rupture, stenosis, laryngeal nerve palsy and tracheoesophageal fistula. The use of N_2O intraoperatively may increase ETTc pressure . Without any evidence-based data, its been believed that trained clinicians were able to determine proper ETTc pressures or overinflated ETTc by palpating the pilot balloon.

We evaluated whether a trained anesthesiologists inflated ETTc appropriately and could keep the pressure within the permissible limit of 20-30 cm of H_2O using manual methods or a cuff pressure monitor connected to the lock of ETT pilot balloon. This pressure was set at 25 cm of H_2O and then monitored hourly. We also compared this group of patients with another group whose cuff was inflated by an automatic cuff pressure controller and the cuff pressure was set at 25 cm H_2O throughout the surgery. Appropriate endotracheal tube cuff pressure, endotracheal intubation seals the airway to prevent aspiration and provides for positive-pressure ventilation without air leak.

Materials and Methods

After obtaining the institutional ethical committee clearance and written consent of patients, 60 patients were randomly selected of either sex and age between 20 and 50 yrs of ASA grade I/II and MPG I/II. All the patients were posted for any surgeries under general anesthesia. Correlations between manual methods of assessing the pressure by an experienced anesthesiologists with at least 5-years experience in anaesthesia and assessment with maintenance of the pressure within the normal range by the automated pressure controller device were done in 60 patients who were divided into two groups. In Group M (30 Patients) endotracheal tube cuff was inflated manually by a trained anesthesiologist and checked for its pressure hourly by cuff pressure monitor till the end of surgery. In Group C(30 Patients) endotracheal tube cuff was inflated by automated cuff pressure controller and pressure was maintained at 25-cm H2O throughout the surgery.

High volume, low pressure cuff, single use, oral Portex tube with internal diameter of 7.0-8.5 mm were used in all patients. The safe cuff pressure in our study protocol was taken as 25-30 cm of H_2O. This ETTc pressure was measured by highly sensitive and accurate VMB cuff controller (Cuff controller digital 0-99 cm H_2O). Repeated measure ANOVA was applied.

After induction of anesthesia with propofol and administration of atracurium, oral endotracheal intubation was done with appropriate size ETT by an anesthesiologist with at least 5-year experience. After this ETTc pressure was recorded and monitored hourly. In group C, ETTc was inflated by attaching with automatic cuff pressure controller and pressure was maintained at 25 cm H_2O throughout the surgeries. Patients were maintained on oxygen + nitrous oxide (1:2), isoflurane, fentanyl and vecuronium.

All the descriptive statistics were calculated for all the variables by applying repeated measure ANOVA test to verify that whether the ETT pressure is significantly different in all the groups or not. All the statistical analysis was carried out on PASW 18 software.



Image -1 Shows The Picture of VMB cuff controller (Cuff controller digital 0-99 cm H_2O)

Image -2 Shows The Mechanism how VMB cuff controller works (Cuff controller digital 0-99 cm H_2O)

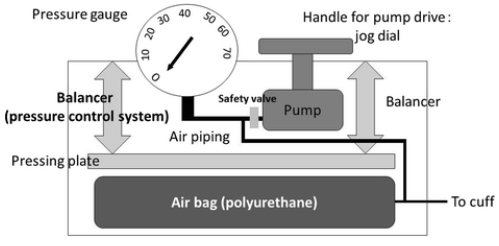


Table-1

Variables	Group M Mean ± SD (n=30)	Group C Mean ± SD (n=30)
Age	42.430 ± 9.830	45.650 ± 9.640
Sex M:F	23:27	24:26
Weight	54.612 ± 8.160	56. 548 ± 8.408
Height	160.061 ± 6.030	160.134 ± 6.024
BMI	21.364 ± 3.154	22.130 ± 2.674
EtCo2	32.108 ± 1.683	32.654 ± 1.654
Tidal Volume	450.400 ± 70.660	455.650 ± 71.660
Airway pressure	18.768 ± O.468	18.587 ± 0.342
Air leak from the side of ETT	NIL	NIL

Table 1 shows the demographic data of the two groups. The groups were comparable demographically in respect of age, sex, weight, height and BMI. The EtCO2 level, tidal volume and airway pressure were also comparable. There was no case of air leak from side of ETTc in the two groups. Mean duration of surgery was 3 hrs.

Table-2

ETTc pressure	N	Group M (Mean ± SD)
Manual pressure (cm H_2O) Baseline	30	50.98 ± 10.640
Pressure set after measuring by cuff pressure monitor (cm H_2O)	30	25.000 ± 00
ETTc pressure after 1 hours	30	25. 548 ± 0.408
ETTc pressure after 2 hours	30	26.134 ± 0.024
ETTc pressure after 3 hours	30	27.130 ± 0.674

Table 2 shows the average ETTc pressure in both groups along with their standard deviation (SD). In group M, average manual pressure at baseline was much higher than that measured at later points of time. Mean ETTc pressure increased with passage of time.

In group C, ETTc pressure of 25 cm H_2O was maintained constantly, so there was no need of statistical calculations. Group M and group C could not be compared as one group was constant. As ETTc pressure on the same subjects was measured repeatedly at different point of time, the repeated measure analysis of variance technique was applied to find out the overall difference in ETTc pressure level measured at different point of time. After having significant different result from repeated measure ANOVA, the multiple comparisons analysis with Bonferroni correction test was applied to compare each time measured pressure with constant pressure. ETTc pressure were categorized into two groups on the basis of mean value of $EtCO_2$ (<21 and ≥21), tidal volume (<450 and ≥450) and airway pressure (<18 and ≥18) each and taken into consideration as factors at time of conducting repeated measure ANOVA to measure the interaction effect. Before interpreting the repeated measure ANOVA result, the assumption of sphericity (the l\/evel of dependence between pairs of groups is roughly equal or not) may be verified with Mauchly's test statistics. In our present study, the assumption of sphericity has been violated ($P = 0.000$) and estimate of sphericity (e-value) is less than 0.75, so Greenhouse-Geisser correction has been taken into consideration for repeated measure ANOVA result.

Table-3

Complications	Group M (n=30)	Group C (n=30)
Sore throat	8	4
Cough	6	3
Horseness of voice /laryngeal nerve palsy	1	0

Table 3 shows the incidence of postoperative complications. The main complications seen were sore throat, cough and hoarseness of voice. The rate of incidence of complications was higher in group M. No incidence of tracheal stenosis or aspiration pneumonitis was observed.

Cuff pressure should be maintained within25 cm H_2O in critically ill intubated and mechanically ventilated patients.When ETTc pressure exceeds the capillary perfusion pressure of the tracheal mucosa, mucosal blood flow is obstructed lead to severe, even fatal injury including tracheal pain or stridor.Other complications of overinflation of the cuff include nerve palsy,tracheoesophageal fistula, tracheal wall damage subglottic scarring or stenosis and hoarseness. Under-inflation of ETTc is associated with inadequate delivery of prescribed tidal volume and aspiration of secretions.Pressures greater than 40 cm H_2O have been reported in 92% of postoperative patients after nitrous oxide anesthesia and in 46% of patients receiving other anesthetics.The suggested "safe" pressure to prevent aspiration and leaks past the cuff is 25 cm H_2O as capillary perfusion is not impaired.However, after an *in vitro* study, Seegobin and Hasselt recommended that cuff inflation pressure not exceed 30 cm H_2O.It is essential to maintain cuff pressures in the range of 20-30 cm of H_2O.The precise pressure at which an individual may experience impaired or obstructed tracheal mucosal blood flow will depend upon numerous factors, most importantly the blood pressure.Other important factors to avoid damage include adjusting cuff inflation for altitude, correct positioning of the patient's head and neck during intubation, avoiding infection involving the patient's secretions, preventing severe respiratory failure, and avoiding prolonged intubation.Endotracheal suctioning, coughing and positioning affect ETTc pressure.

In patients undergoing for GA using high-volume, low-pressure ETT, use of automated cuff pressure monitor enables effective continuous control of the ETTc pressure. This effective control of cuff pressure, however, did not result in any difference with regard to tracheal mucosal damage. The severity of tracheal damage is related to the duration of intubation. In a study of 93 patients, Sengupta *et al* observed that in 27% cases, ETTc pressure exceeds 40 cm H_2O irrespective of experience of anesthesia providers. We have demonstrated a higher incidence of ETTc pressure exceeding the safe limit as our safe limit was more conservative (25 cm H_2O).

Our study demonstrates that even experienced anesthesiologists were unable to inflate an ETTc to a safe pressure limit. The manual methods as palpation of pilot balloon and disappearance of audible air leak are inaccurate methods to assess adequate ETTc pressure and most of the time it resulted in ETTc pressure more than the safe limit. The inability of clinicians to determine ETTc pressure by the traditional standard method of palpation of the pilot balloon has been addressed by other investigators.Availibility of standardized instruments like automated cuff pressure monitors to asses ETTc cuff pressures might help in increasing safety by decreasing the possibility of injury resulting from endotracheal intubation. This technique may also prove helpful to measure ETTc pressure in intubated patients while transportation by air ambulance in VIP or emergency cases as on high altitudes the gases pressure changes from sea level to high altitudes .

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