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ENDOTRACHEAL TUBE CUFF PRESSURE MONITORING- MANUAL PALPATION METHOD VS. MANOMETER READINGS

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ABSTRACT
Endotracheal tube (ETT) is commonly used for ventilating the patients in OT during administration of general anaesthesia. The adequate ETT cuff pressure for maintaining tracheal mucosal perfusion should be in the range of 20-30 cmH_2O. So our aim was to compare the endotracheal tube cuff pressure monitoring in general anaesthesia while using finger palpation method OR continuous manometer reading monitoring method, as well as comparision of post operative complications in both methods. 60 patients were randomly selected of either sex and age between 20 and 60 yrs of ASA grade I/II who were posted for routine surgery under general anesthesia. Patients belonging above ASA grade 3 & having any other associated disease were excluded. Our study demonstrates that even experienced anesthesiologists were unable to inflate an ETT cuff 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 ETT cuff pressure and most of the time it resulted in cuff pressure more than the safe limit. So, we concluded that ETT cuff pressure was significantly high when endotracheal tube cuff was checked manually by finger palpation method. Therefore, to avoid the known complications of high endotracheal tube cuff pressure, the use of ETT cuff pressure controller device is strongly recommended for keeping the pressure within the recommended levels.

KEYWORDS: Endotracheal Tube Cuff Pressure, Palpation Method, Manometer Monitoring, 20-30 cmH_2O.

INTRODUTION
Endotracheal tube (ETT) is commonly used for ventilating the patients in OT during administration of general anaesthesia. For the assessment of endotracheal tube cuff (ETTc) pressure, the traditional method includes palpating the pilot ballon & hearing the disappearance of audible air leak under safer anesthetic practice. The adequate ETTc pressure for maintaining tracheal mucosal perfusion should be in the range of 20-30 cmH_2O, so as to prevent mucosal ischemia, tracheal necrosis, rupture stenosis, laryngeal nerve palsy & tracheo-esophageal fistula. The ETTc pressure can increased perioperatively due to nitrous oxide. The experienced anaesthesiologist can even determine proper ETTc pressure by just manually palpating the ETT pilot ballon.

In our study, we assumed whether the experienced anaesthesiologist could inflate ETTc adequately & could keep the pressure within 20-30 cmH_2O, manually. Then we assessed the ETTc pressure using a cuff pressure monitor connected to the valve of the pilot ballon. The ETTc pressure was set at 20 cmH_2O, & it was then monitored at hourly intervals. In our study, this group of patients was also compared with another group, whose cuff was inflated by a cuff pressure manometer, & throughout the study, the cuff pressure was set at 20 cmH_2O.

METHODOLOGY
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 60 yrs of ASA grade I/II. All the patients were posted for routine surgery under general anesthesia. Patients belonging above ASA grade 3 & having higher risk of pulmonary aspiration, patients having any laryngeal disease or surgery, those in whom intubation was difficult (two or more trials), those who used to smoke, patients with a tracheostomy, pregnant patients, full stomach, trauma cases, and with history of hyperactive airway disease were excluded. The study was a prospective observational study by trained anesthesiologists. The anesthesiologists who were responsible for the inflation of the cuff were blinded, as they were unaware of the study.

These patients were divided into two groups: In group M, of 30 patients, ETTc was inflated manually by a trained anesthesiologist and checked for its pressure hourly by cuff pressure monitor; and in group C, of 30 patients, ETTc was inflated by automatic cuff pressure controller and pressure was maintained at 20 cm H_2O throughout the surgeries. High volume, low pressure cuff, single use, oral PVC ETT with internal diameter 7.0-8.5 mm were used in all patients. The safe cuff pressure in our study protocol was taken as any pressure less than 25 cm of H_2O. This ETTc pressure was measured by highly sensitive and accurate Portex cuff manometer.

After induction of anesthesia with propofol and administration of vecuronium, oral endotracheal intubation was done with appropriate size ETT. In group M, for cuff inflation standard technique consisted of ETTc inflation using a syringe to inject air into the cuff and assessment of cuff pressure by palpation of the external pilot balloon and by listening for disappearance of the audible air leak by an anesthesiologist with at least 2-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.

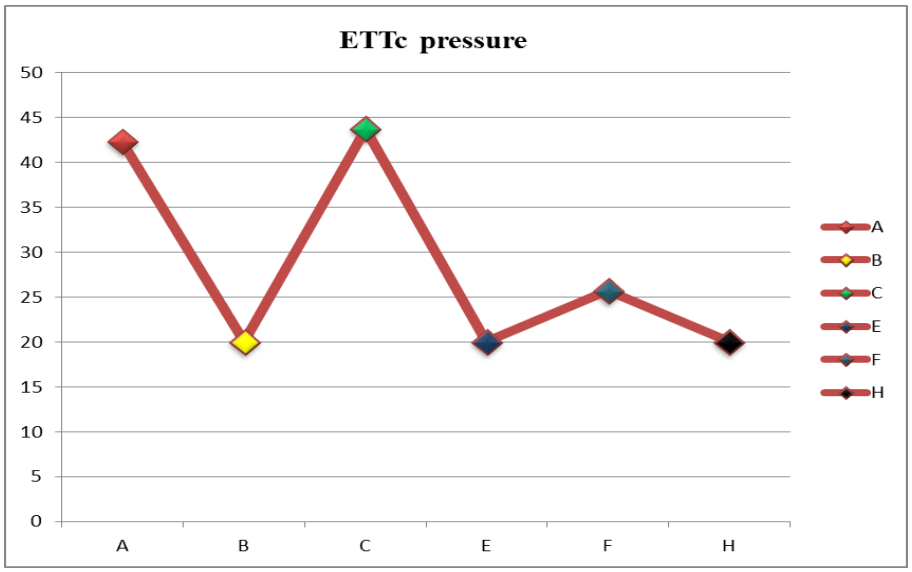
RESULTS

The 2 groups (Group M & Group C) were comparable demographically in respect of age, sex, weight & height. The $EtCO_2$ level, tidal volume & airway pressure were also comparable. There was no case of air leak from side of ETTc in the 2 groups. Mean duration of surgery was 2.34 hours.

We use software SPSS 20.0. Comparision between 2 groups was calculated by ONE WAY ANOVA & p-value is significant if it is less than 0.05. Table shows the average ETTc pressure in both groups along with their standard deviation (SD). In group M, average manual pressure at baseline (measured by finger palpation method) was much higher than that measured at later points of time. Mean ETTc pressure increased with passage of time. ETTc pressure was higher all time in group M in comparison to Group C.

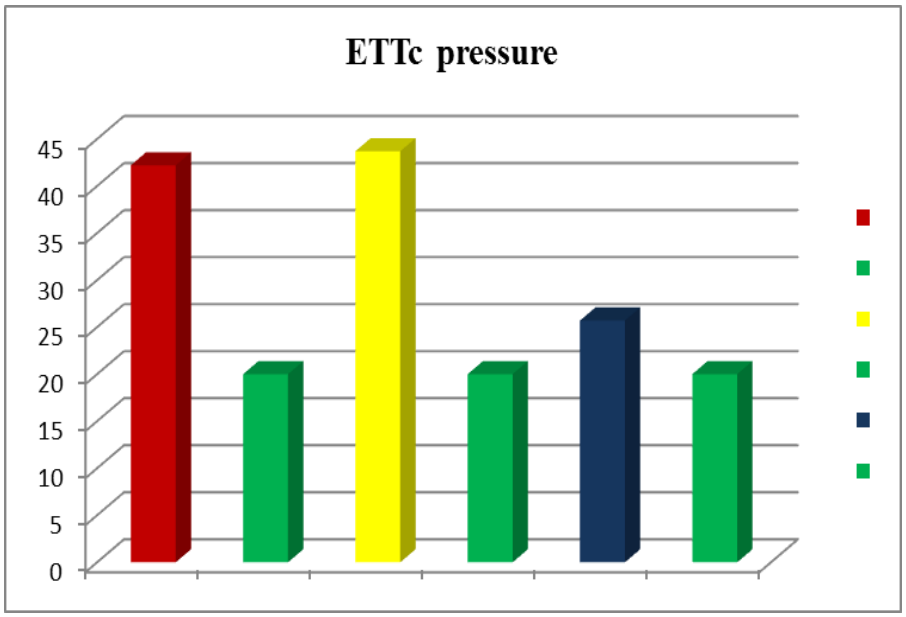
ETT cuff pressure at different time interval

	ETT cuff pressure	N	Group M (Mean ± SD)
A	Manual baseline pressure (in cm of H_2O)	30	42.2 ± 12.4
B	Pressure set after measuring from cuff pressure manometer (in cm of H_2O)	30	20.0 ± 0.0
C	ETT cuff pressure after 1 hour of surgery (in cm of H_2O)	30	43.7 ± 4.8
D	Increase in ETT cuff pressure from 20 cm of H_2O after 1 hour of surgery	30	23.7 ± 4.8
E	Pressure set after measuring from cuff pressure manometer (in cm of H_2O)	30	20.0 ± 0.0
F	ETT cuff pressure after 2 hour of surgery (in cm of H_2O)	30	25.7 ± 2.9
G	Increase in ETT cuff pressure from 20 cm of H_2O after 2 hour of surgery	30	5.7 ± 2.9
H	Pressure set after measuring from cuff pressure manometer (in cm of H_2O)	30	20.0 ± 0.0



	N	Mean	Std. Deviation	F value	P value
0 Hours	30	42.2000	12.41079		
1 Hours	30	43.7333	4.80613	48.288	<0.0001
2 Hours	30	25.7333	2.91173		
Total	90	37.2222	11.29659		

ETTc pressure when filled by finger palpation method



PALPATION VERSUS MANOMETER READINGS

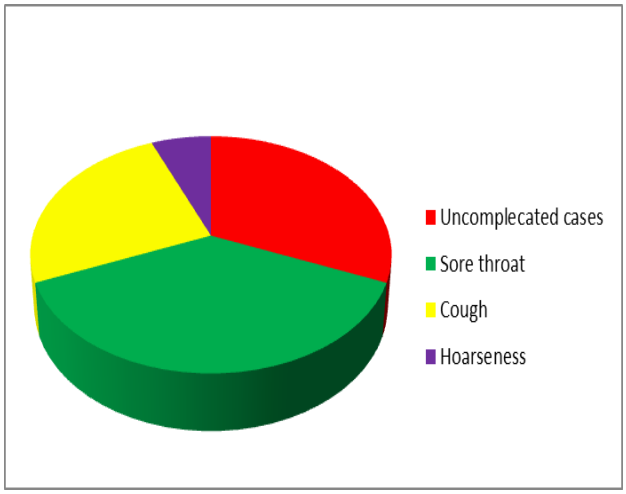
	N	Mean	Std. Deviation	F value	P value
0 Hours	30	22.2000	12.41079		
1 Hours	30	23.7333	4.80613		
2 Hours	30	5.7333	2.91173	48.288	<0.0001
Total	90	17.2222	11.29659		

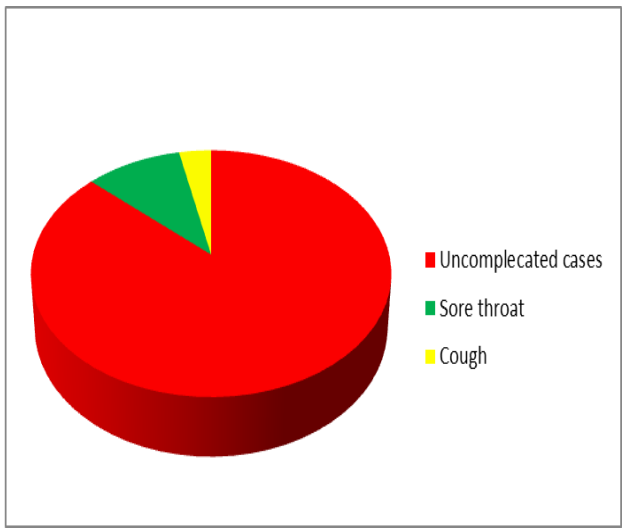
Increase in ETTc pressure from 20cm of H_2O

In group C, as there was constant ETTc pressure of 20 cm H_2O, 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.

Table 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 case of laryngomalacia, tracheomalacia, tracheal stenosis, tracheoesophageal fistula or aspiration pneumonitis was observed.

Post operative complications	Group M (n-30)	Group C (n-30)
Sore throat	12	3
Cough	6	1
Hoarseness of voice	2	0





DISCUSSION

This 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.[1,11,13] Using standardized instruments to measure cuff pressures might help increase safety by decreasing the possibility of injury resulting from endotracheal intubation.[1,15,16]

According to Lomholt N. et al[12], 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.[12]

In a study of 93 patients, Sengupta et al.[14] observed that in 27% cases, ETTc pressure exceeds 40 cm H_2O irrespective of experience of anesthesia providers. They had demonstrated a higher incidence of ETTc pressure exceeding the safe limit as our safe limit was more conservative (25 cm H_2O).

According to Guyton DC, Bernhard WN et al[6], The suggested "safe" pressure to prevent aspiration and leaks past the cuff is 25 cm H_2O as capillary perfusion is not impaired.[3,6]

However, after an *in vitro* study, Seegobin and Hasselt[9] recommended that cuff inflation pressure not exceed 30 cm H_2O.[9] It is essential to maintain cuff pressures in the range of 20-30 cm of H_2O.[12] 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.[13] 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.[3,12,13]

According to Hoffman R. et al[4], Cuff pressure should be maintained around 25 cm H_2O in critically ill intubated and mechanically ventilated patients.[3,4] When ETTc pressure exceeds the capillary perfusion pressure of the tracheal mucosa, mucosal blood flow is obstructed lead to severe, even fatal injury[5,6] including tracheal pain or stridor.[5,7] Other complications of overinflation of the cuff include nerve palsy,[3] tracheoesophageal fistula,[8] tracheal wall damage,[9] subglottic scarring or stenosis and hoarseness. Under-inflation of ETTc is associated with inadequate delivery of prescribed tidal volume and aspiration of secretions.[10,11] Pressures greater than 40 cm H_2O have been reported in 91% of postoperative patients after nitrous oxide anesthesia and in 45% of patients receiving other anesthetics.[11]

CONCLUSION

Endotracheal tube cuff pressure was significantly high when endotracheal tube cuff was checked manually by finger palpation method. Therefore, to avoid the known complications of high endotracheal tube cuff pressure, the use of ETT cuff pressure controller device is strongly recommended for keeping the pressure within the recommended levels.

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