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Endotracheal Tube Cuff Pressure Changes in Mechanically Ventilated Patients Undergoing General Anaesthesia with O2, N2o & Other Inhalation Agents in Elective O. T. & in Intensive Care Unit Set-Up with O2 and Air - A Prospective Observational Study

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Abstract: ***Laryngotracheal morbidity is frequent with tracheal intubation under general anesthesia. Excessive endotracheal tube cuff pressure may impair the tracheal mucosal perfusion and can cause tracheal damage. With recent advances, monitoring the cuff pressure and adjusting the cuff pressure to an acceptable level, the intraoperative and post-extubation morbidity can be minimized in patients undergoing surgeries under general anesthesia and mechanically ventilated patients in ICU as well. Aim: To observe endotracheal tube cuff pressure, change in Mechanically ventilated patients undergoing General Anaesthesia with O2, N2O & others inhalation agents in elective O. T. & in ICU set-up with O2 and air. Objectives: 1) The volume of air required to produce appropriate cuff pressure. 2) To confirm the changes in the cuff pressure by using cuff pressure manometer. 3) To study the effect of different position on cuff pressure (GA with supine & prone; Mechanically ventilated in ICU with supine & propped up position.) 4) To study the effect of different sizes of ETT on cuff pressure. 5) Any post-extubation related morbidity. Inclusion Criteria: 1) Age group of 18 to 60 years of both gender 2) Surgery under General Anaesthesia with O2, N2O & other inhalation agents in Elective O. T & duration of Surgery more than 1 hr. 3) Patients intubated in ICU with O2 & Air and Mechanically ventilated for more than 1hr. Exclusion Criteria: 1) Contra Indication to the use of nitrous oxide in OT-group. 2) Surgery and mechanically ventilated patients in ICU less than one hr. Material and Methods: This is a prospective observational study conducted after obtaining approval from the institutional ethical committee, at Fakhruddin Ali Ahmed Medical College And Hospital, in 100 patients of age 18-60 years undergoing elective surgeries under GA and mechanically ventilated patients in ICU. We conducted this study in fifty patients in each group [OT Group and ICU Group] who were eligible for the study criteria and underwent Intubation & MV in GA and MV patients in ICU. The Portex cuff pressure manometer has been used to monitored ETT cuff pressures. OT Group: 50 patients who underwent surgery under GA, were considered. Standard induction and maintenance for general anaesthesia was followed as per Hospital protocol. Cuff pressure was measured immediately after intubation following inflation with predetermined volume of air & adjust the cuff pressure to an acceptable level of mean mucosal perfusion pressure using Portex cuff pressure manometer. The volume of air withdrawn from endotracheal tube cuff to maintain therapeutic cuff pressure range were noted. Subsequent measurement was taken every 30 mins interval & last reading just before deflate the endotracheal tube cuff for extubation. Therefore, the association between the volume of air removed and cuff pressure was studied. ICU Group: 50 patients who were eligible for this study, underwent intubation & MV in ICU. Similarly, ETT cuff pressures were measured immediately after intubation. Volume of air removed as necessary to adjust cuff pressure to an acceptable level of mean mucosal perfusion pressure and noted. Subsequent reading was taken every 30mins, 1hr, 1.30 hrs and so on. This group were followed for next 24 hrs for any rise in cuff pressure using Portex manometer.***

Keywords: tracheal intubation, cuff pressure monitoring, general anaesthesia, mechanically ventilated patients, post-extubation morbidity

1. Introduction

Tracheal intubation (TI) are now essential for maintaining airway stability in severely sick patients receiving mechanical ventilation and during surgical operations.[1] There are several advantages in employing a cuff ETT e. g. protection of airway against stomach aspiration, administration of anesthetic gases, positive end-expiratory pressure (PEEP), positive pressure breathing and reduction in the risk of airway damage from repeated laryngoscopy. Furthermore, when we inflate the cuff, tracheal mucosa' pressure is directly correlated with the pressure in the cuff.[2] The pressure range between 20 and 30 cm H2O is advised for ETT cuffs.[3] This restricted range guarantees that cuff pressure is both high which is adequate to close the airway and adequately low to preserve the perfusion pressure of the tracheal capillaries. Twenty to thirty cm H2O is ideal ETT cuff pressure.[4] Excessive pressure inside the ETT cuff causes ischemic alterations of tracheal mucosa and exerts pressure on surrounding tissues, potentially leading to severe consequences including paralysis of the vocal cord, harm to the recurrent larynx, tracheal stenosis, and tracheal rupture. Alternatively,

inadequate cuff pressure may lead to microaspiration or a large leak surrounding the ETT.[5, 6] (Park, Dobrin). According to Shaikh, many anesthesiologists advise adjusting the ETT cuff pressure to the proper setting.[7] However, studies on the impact of the cuff pressure of ETT change among cases who are mechanically ventilated (MV) undergoing General Anaesthesia (GA) elective O. T. & in ICU are limited in the Indian settings. Such a study will help us to know whether by adjusting the ETT cuff pressure the accepted level by ET Cuff Pressure Manometer can minimize intraoperative and post-extubation morbidity in cases undergoing GA and MV patients in ICU. When the cuff is inflated over thirty cm H_2O, capillary perfusion is compromised, which harms the tracheal mucosa.[8] Complete tracheal blood flow restriction occurs at pressures higher than 50 cm H_2O.3 Severe cuff over-inflation may sometimes result in severe side effects including tracheal hemorrhage, long-term problems such fistula development or tracheal stenosis or even rupture.[9] An observational research found that cuff pressure consistently less than 20 cm H_2O was independently linked with the occurrence of VAP.[10] Lizy et al evaluated how adult patients' cuff pressure was affected by changes in their body posture. A total of twelve individuals by sixteen locations equaled 192 measurements. With all 16 modifications, there was a substantial variation in cuff pressure (P <.05). There were no pressures below the lower limit (20 cm H2O). Among 40.6% of all the assessments, the pressure was higher than the top limit of thirty centibars H2O. The top goal limit was at least once surpassed in each position. Significant variation within the readings of patients was observed (P<0.05).

2. Results and Analysis

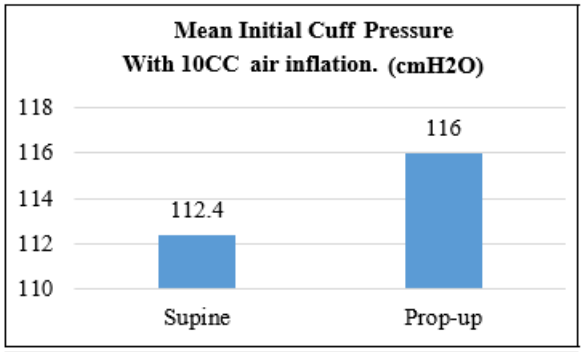
ICU Group:
All patients in ICU group had ETT cuff pressure ranging from 20 to 30 cm H_2O at 30 minutes after intubation.

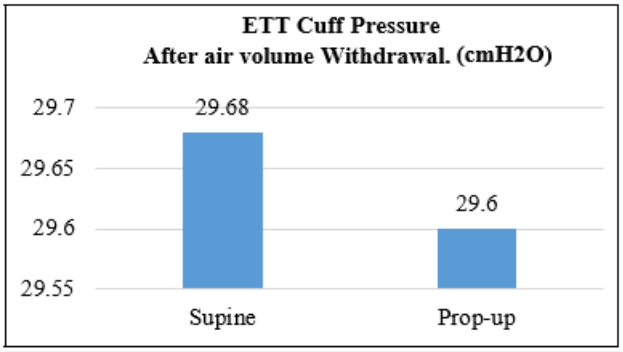
Nil post-extubation morbidity was reported by the patients in the ICU group.

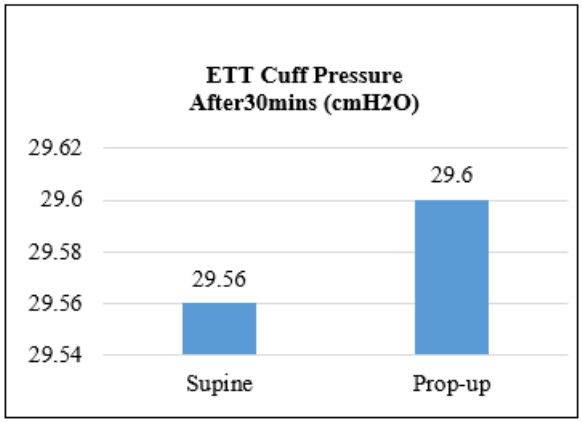
The average (SD) of ETT size was 7.44 (0.44) mm. The average (SD) of Initial Cuff Pressure with 10CC air inflation was 112.76 (7.88) cm H2O

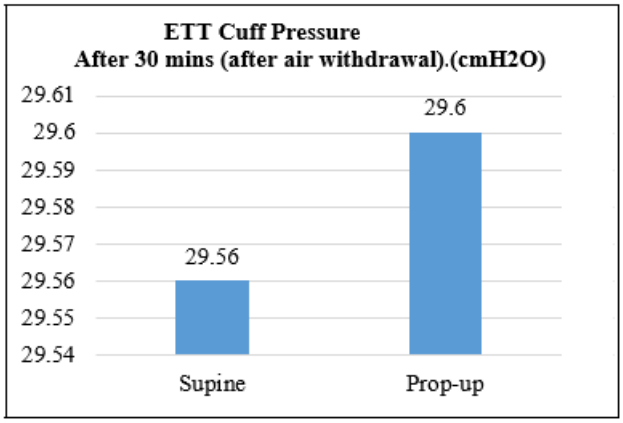
The average (SD) of Initial air volume withdrawal was 1.49 (0.3)

CC.
The average (SD) volume of air required for appropriate cuff pressure was 8.51 (0.3) cc.
The average (SD) ETT cuff pressure after air volume withdrawal was 29.67 (0.75) cm H2O
The average (SD) ETT Cuff Pressure after 30 minutes was 29.56 (0.84) cm H2O.
The average (SD) ETT cuff pressure after 30 minutes was 29.56 (0.84) cm H20.
The association between patient position and cuff pressures at different time points was not significant.









ETT Cuff Pressure &Volume Withdrawal:

	Mean	SD	Median	IQR
ETT Size (mm)	7.44	0.44	7.50	7, 7.625
Initial Cuff Pressure with 10CC air inflation. (cmH2O)	112.76	7.88	118.00	110, 118
Air Volume Withdrawal (CC)	1.49	0.30	1.50	1.3, 1.7
Vol of Air require for appropriate cuff pressure (CC)	8.51	0.30	8.50	8.3, 8.625
ETT Cuff Pressure After air volume withdrawal. (cmH2O)	29.67	0.75	30.00	30, 30
ETT Cuff Pressure After30mins (cmH2O)	29.56	0.84	30.00	30, 30
Air Vol Withdrawal (CC or ml)	0.00	0.00	0.00	0, 0
ETT Cuff Pressure after 30 mins. (cmH2O)	29.56	0.84	30.00	30, 30

Group Statistics: ICU Group:

	Position	N	Mean	Std. Deviation	P value
Initial Cuff Pressure With 10CC air inflation. (cmH2O)	Supine	45	112.40	8.153	0.115
	Prop-up	5	116.00	3.742	
ETT Cuff Pressure After air volume Withdrawal. (cmH2O)	Supine	44	29.68	.740	0.852
	Prop-up	5	29.60	.894	
ETT Cuff Pressure After30mins (cmH2O)	Supine	45	29.56	.841	0.920
	Prop-up	5	29.60	.894	
ETT Cuff Pressure After 30 mins (after air withdrawal). (cmH2O)	Supine	45	29.56	.841	0.920
	Prop-up	5	29.60	.894	

OT- Group:

All patients in OT group had ETT cuff pressure >30 cm H2O at 30 minutes after intubation. While 8% of the patients had mild irritation or throat pain, 4% had sore throat as post-extubation morbidity. The average (SD) of ETT size was 7.25 (0.42) mm.

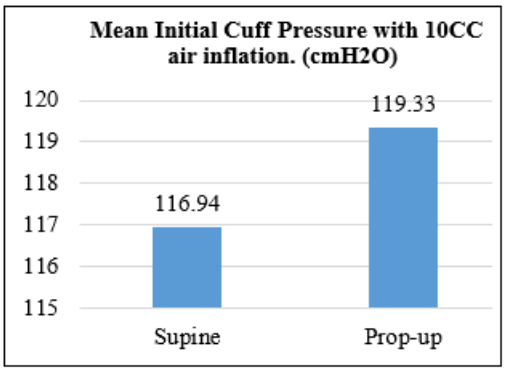
The average (SD) of Initial Cuff Pressure with 10CC air inflation was 117.08 (5.03) cm H2OThe average (SD) of Initial air volume withdrawal was 1.54 (0.28) CC. The average (SD) volume of air required for appropriate cuff pressure was 8.45 (0.28) cc. The average (SD) ETT cuff pressure after air volume withdrawal was 29.60 (0.81) cm H2O. The average (SD) ETT Cuff Pressure after 30 minutes was 67.36 (10.87) cm H2O.

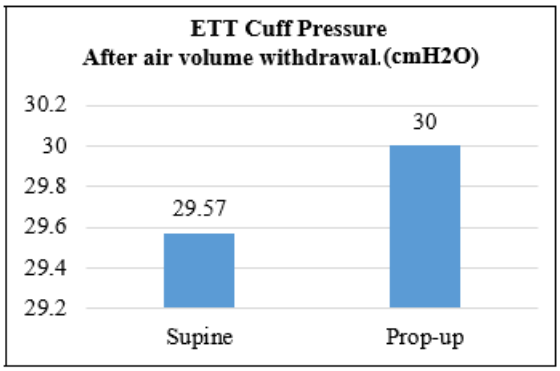
The average (SD) air volume withdrawal was 0.36 (0.13) cc.

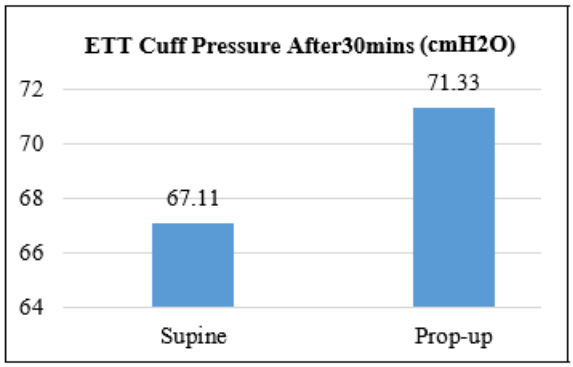
The average ETT cuff pressure after 30 minutes was 29.42 (0.95) cm H2O. OT patients with prone position had a significantly higher cuff pressure at initial, after air withdrawal initially as well as after 30 minutes than the supine patients.

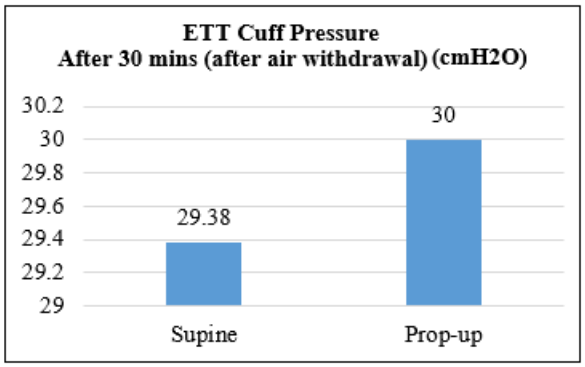
Post Extubation Related Morbidity-OT Group:

Any post-extubation morbidity	Frequency	Percent
Mild irritation in the throat	1	2.0
Mild Throat pain	1	2.0
Mild Throat pain, Irritation.	2	4.0
Sore Throat.	2	4.0









Group Statistics-OT Group:

Group Statistics					
	position	N	Mean	Std. Deviation	p value
Initial Cuff Pressure With 10CC air inflation. (cmH2O)	Supine	47	116.94	5.156	0.039
	Prone	3	119.33	1.155	
ETT Cuff Pressure After air volume Withdrawal. (cmH2O)	Supine	47	29.57	.827	0.001
	Prone	3	30.00	.000	
ETT Cuff Pressure After30mins (cmH2O)	Supine	47	67.11	11.095	0.358
	Prone	3	71.33	6.110	
ETT Cuff Pressure After 30 mins (after air withdrawal). (cmH2O)	Supine	47	29.38	.968	<0.001
	Prone	3	30.00	.000	

There was also a significantly higher cuff pressure at 30 minutes into the surgery (mean=67.4) than at the baseline (mean=29.6). ($p<0.001$) The difference also persisted within the patients who were in supine position, who showed significantly higher cuff pressure at 30 minutes into the surgery (mean=67.1) than at the baseline (mean=29.6). ($p<0.001$).

Correlation between cuff size and cuff pressures at various time points
Correlation was found to be not significant between cuff size and cuff pressures at various time points.

While all patients in ICU group maintained the ETT cuff pressure between 20 and 30 cm H2O at 30 minutes after the intubation, all patients in OT group showed an increased in the cuff pressure beyond 30 cm H2O.

Group * ETT cuff pressure at 30min					
			ETT cuff pressure at 30min		p value
			20-30	>30	
Group	ICU	Frequency	50	0	<0.001
		Percent	100.0%	0.0%	
	OT	Frequency	0	50	
		Percent	0.0%	100.0%	
Total		Frequency	50	50	
		Percent	50.0%	50.0%	

3. Conclusion

- Prospective observational research was undertaken among 50 patients undergoing surgery with GA and 50 patients who were intubated in ICU to observe ETT cuff pressure change.
- Among the ICU group, majority were males (54%). Average age-49.20 years
- Majority were in supine position (90%) in ICU group
- ETT cuff pressure ranged from 20 to 30 cm H2O at 30 minutes after intubation in all ICU patients
- Patient position and cuff pressures at various time points in ICU group showed no association
- The average air pressure in the cuff at baseline (29.7) and 30 minutes (29.6)
- Cuff size and cuff pressures at various time points in ICU group showed no correlation
- In the OT group, majority were females (62%). Average age-40.34 years
- Majority were in supine position (94%) in OT group
- All patients in OT group had ETT cuff pressure >30 cm H2O at 30 minutes after intubation.
- OT patients with prone position had a significantly higher cuff pressure at initial, after air withdrawal initially as well as after 30 minutes than the supine patients.
- There was also a significantly higher cuff pressure at 30 minutes into the surgery (mean=67.4) than at the baseline (mean=29.6).
- Cuff size and cuff pressures at various time points showed no correlation
- All patients in ICU group maintained the ETT cuff pressure ranging from 20 to 30 cm H2O at 30 minutes after the intubation, but all patients in OT group showed an increased in the cuff pressure beyond 30 cm H2O.

Overall, mechanically ventilated patients in the OT settings had a significant rise in the cuff pressure during 30 minutes following the initiation of the procedure. Monitoring the cuff pressure and using withdrawal method enables us to manage the cuff pressure within the therapeutic limits in ICU and OT settings. The rise in cuff pressure beyond the therapeutic range was significantly high in OT group compared with ICU group. Cuff size was not correlated with cuff pressure in OT and ICU patients. Further, multi-centric studies incorporating multiple points of monitoring and positioning needs to be undertaken in the future to improve the validity and wider applications of our findings.

4. Limitations

- Research had been undertaken in a single institute, hence the external validity of the findings are limited
- Inter-observer bias might occur since the various anaesthetists have performed the procedures
- Lack of continuous measurement of cuff pressures. Multiple other sub-positions of the patients were not assessed which could have provided more granular level association between positions and cuff pressure changes.

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