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Original Research Paper

Anaesthesiology

"ENDOTRACHEAL TUBE CUFF PRESSURE MONITORING USING PREFIXED VOLUME AIR VERSUS MANOMETER IN GENERAL ANAESTHESIA"

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ABSTRACT **Background And Objective:** The endotracheal tube (ETT) cuff seals the airway, preventing leakage and aspiration of pharyngeal contents into the trachea during ventilation. The Endotracheal tube cuff (ETT) endorses effective mechanical ventilation by ensuring a seal within the subglottic tracheal structures. Maintaining an appropriate intracuff pressure is critical for optimal mechanical ventilation, avoiding difficulties caused by under inflation or over inflation of the cuff. The purpose of this study is to compare the ETT cuff pressure and its variation with the prefixed volume air method of cuff inflation and employing a pressure manometer in terms of cuff pressure variation, under inflation, and over inflation. **Methods:** This study included 100 adult patients over the age of 18 who underwent elective surgery. Patients were randomized using prospective comparative study into 2 groups of 50 each: Group A - cuff inflated by Prefixed volume air; Group B - cuff inflated by pressure manometer. Cuff pressures were monitored on a regular basis. Under inflation of an ET tube cuff is defined as a cuff pressure less than 25 cm H2O and over inflation as a cuff pressure greater than 35 cm H2O. **Results:** The cuff pressure assessed at different time intervals was statistically significant in this study. At each interval, the cuff pressure in Group B was within the safe range. Patients in Group A, on the contrary hand, had cuff pressures that were above the normal range. **Conclusion:** Routine use of cuff pressure manometer at regular intervals helps to maintain cuff pressure at a safe range and prevents abnormal variations in mechanically ventilated patients in elective surgeries.

KEYWORDS : *Cuff Pressure; Endotracheal Tube (ETT); prefixed volume air; Cuff Pressure Manometer*

INTRODUCTION:

ETTs are devices that are used to secure the airway in order to provide general anaesthesia and mechanical ventilation. It is standard anaesthetic equipment in the operating room. It shields the patient's airway against gastric contents aspiration and facilitates positive pressure ventilation during anaesthesia. [1]

The various functions of ET tubes are as follows: Minimizing aspiration, Isolates the lung, allows provision of clear surgical field during general anaesthesia, monitors laryngeal nerve damage during surgery, prevents airway fires during laser surgery.

The ET tubes have a low-pressure cuff which adjusts to the shape of trachea. The traditional method of using air as cuff inflation medium is used. A liquid may be useful to inflate cuff in preventing the rise in pressure, other inflation methods are with saline, lignocaine is used, it may diffuse through the cuff and may cause anaesthesia of the mucosa.[1] Nitrous oxide, routinely used anaesthetic gas readily diffuses inside the cuff thereby increasing the cuff pressure.

The cuff pressures has to be maintained between 25 to 35 cm H2O, to minimize air leaks and to prevent injury/ ischemia. As underfilling of cuff causes loss of tidal volume and overfilling of the cuff may cause injury/ischemia of the tracheal mucosa.[2]

Hyperinflation of the cuff causes tracheal mucosal lesions leading to sore throat, coughing, hoarseness which results in discomfort after extubation. Cuff pressure measurements may deviate from the normal values by about 20 to 30 percent.[3]

Various method are included to measure cuff pressure which includes minimal leak technique, minimal occlusive volume technique, finger palpation technique, predetermined volume technique and direct intra cuff pressure monitoring by pressure manometer.[2-4]

A cuff pressure of more than 35 cm of water for 15 minutes can induce histological evidence of tracheal mucosal lesions.[5] Hence monitoring of the ET tube cuff pressure is necessary in anaesthesia practice

OBJECTIVES:

1)To measure the ET tube cuff pressure with prefixed volume of air for cuff inflation and using a analogue manometer to inflate the cuff. 2)Incidence of under inflation. 3) Incidence of over inflation. 4)Incidence of variation in cuff pressure.

METHODOLOGY:

The study was a prospective comparative study conducted 100 adults aged above 18 years undergoing surgeries under general anaesthesia from September 2020 to August 2022 in Chigateri General Hospital and Bapuji Hospital attached to J.J.M. Medical College, Davangere and are randomly divided into 2 groups.

1. Group A - cuff inflated by prefixed volume method (50 cases).
2. Group B- cuff inflated by pressure manometer (50 cases)

Inclusion criteria:

Adults above 18 years of ages, Both sexes, Surgeries under general anaesthesia.

Exclusion criteria:

Patients having contra indication for semi recumbent position, Patient not willing to give consent, Admitted to ICU, Patients with airway deformities.

After obtaining institutional ethical committee clearance and written consent from the patient caregivers – patients will be randomly allocated into either Group A or Group B.

Patients are mechanically ventilated and intubated before elective surgeries under general anaesthesia are randomly selected into Group A and Group B (50in each).

In Group A patients are intubated in elective surgeries under general anaesthesia, ET tube cuff inflated using **pilot balloon by blind method** with an air volume that they believed to be correct based on previous experience.

In Group B patients are intubated in elective surgeries under general anaesthesia, ET tube cuff inflated from **pilot balloon using analogue manometer**, cuff of a standard adult ET tube inflated with air until pressure reached 25 cm H2O.

Underinflation of cuff is defined as cuff pressure less than 20cm H2O and overinflation is defined as cuff pressure more than 30cm H2O. The size of ET tube cuff and ventilator settings were recorded in both the groups. Both groups are monitored over a period of 48hours, 6th hourly and data recorded accordingly.

Statistical Analysis:

Categorical data will be represented in the form of frequency and percentage. Association of variables will be assessed with Chi Square test. Quantitative data will be represented as Mean & Sd. Comparison will be done with unpaired *t*-Test. P value of <0.05 was considered statistically significant. IBM SPSS Version 22 for windows will be used for analyzing the data.

RESULTS

In the present study, most common age group in the study was more than 50 years as a whole. The next common age groups was 51-60 years, followed by 31-40 years and 21-30 years.

Table 1: Age distribution of the participants in both the groups

Age	Group A		Group B	
	Count	%	Count	%
≤ 20	2	4	0	0
21-30	7	14	2	4
31-40	21	24	10	20
41-50	13	26	17	34
51-60	11	22	14	28
> 60	5	10	7	14
Total	50	100	50	100

Chi Square test P=0.289, Not Sig

The mean age of the participants in the Group A was 44.18 years with the standard deviation of around ±14.18 years. This was almost closer to the Group B where the mean age was 46.28 years with the standard deviation of around ±11.60 years. On analysis, there was no statistically significant difference between the Age groups.

Sex distribution of the participants in both groups:

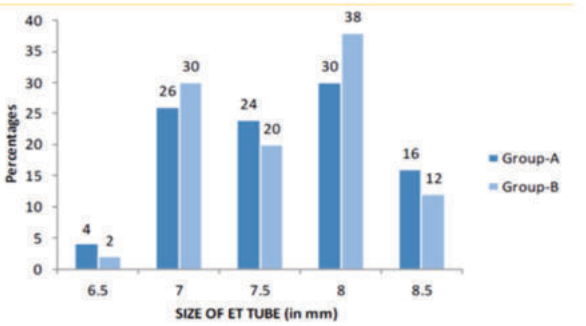
In present study, majority of the participants were Females as a whole, and even in case of each group, which accounted for about 50% and 54% in the Group A and Group B respectively. Remaining 50% and 46% in the Group A and Group B respectively were males. On analysis, there was no statistically significant difference between the groups

Distribution of participants based on mallampatti grading in both the groups:

In this study, majority of the participants were comes under MP 2 grading ,in case of each group which shows Group A was 46% and Group B majority of participants comes under MP 1 which accounts for 40%,remaining 12-16% under MP 3 grading and 2% under MP 4 grading, there was no statistical significant difference between the groups.

Table 2: Distribution of participants - Size Of ETT

Size of ET Tube (in mm)	Group A		Group B	
	Count	%	Count	%
6.5	2	4	1	2
7	13	26	15	30
7.5	12	24	10	20
8	15	30	18	38
8.5	8	16	6	12
Total	50	100	50	100



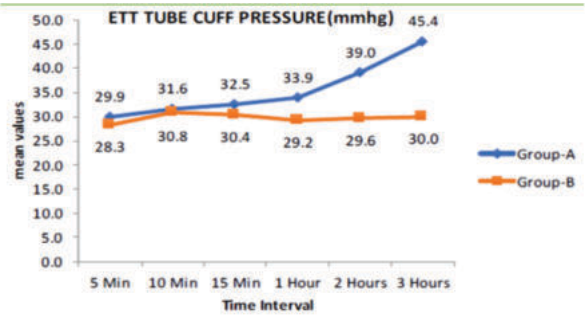
Graph 1: Distribution of participants based on size of ETT (in mm) in both the groups

In this study, majority of the participants lies under ETT size 8.0mm, even in case of two groups each account for 30% and 38% in group A and group B respectively, remaining 26-30% participants under ETT size 7.0mm, 20-24% under ETT size 7.5mm 12-16% under ETT size 8.5mm and 2-4% under ETT size 6.5mm.

Table 3: Distribution of participants based on cuff pressure in both the groups

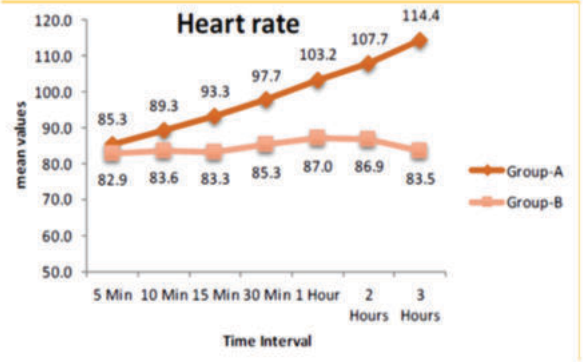
Time interval	Group A		Group B		Unpaired T Test	
	Mean	Std D	Mean	Std D	P value	Significance
5 min	29.9	5.3	28.3	3.0	0.08	NS
10 min	31.6	5	30.8	3.4	0.342	NS
15 min	32.5	5.0	30.4	3.2	0.01	S
1 Hr	33.9	4.7	29.2	2.6	0.001	HS
2 Hrs	39	5.5	29.6	3.1	0.001	HS
3 Hrs	45.4	6	30	3.3	0.001	HS

NS=Not Sig, S=Sig, HS=Highly Sig



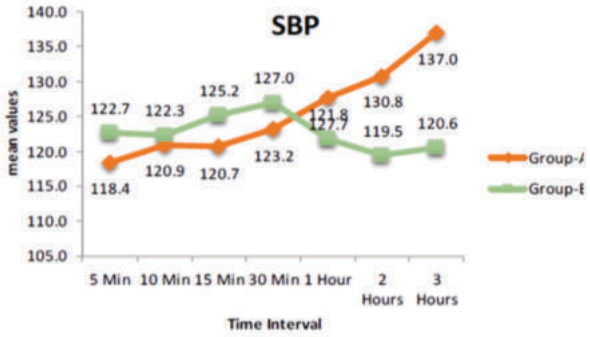
Graph 2: Distribution of participants based on cuff pressure in both the groups

The cuff pressure observed was in the safe range in the Group B, at each interval. On the contrary, the cuff pressure of the patients in the Group A, was at a high pressure range. The findings were statistically significant with p value 0.001.



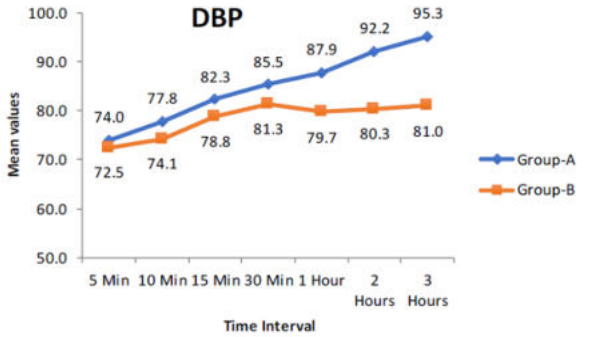
Graph 3: Distribution of participants based on heart rate at different time interval.

The heart rate observed was in the safe range in the Group B, at each interval. On the contrary, the heart rate of the patients in the Group A, was at a high range. The findings were statistically significant with p value 0.001.



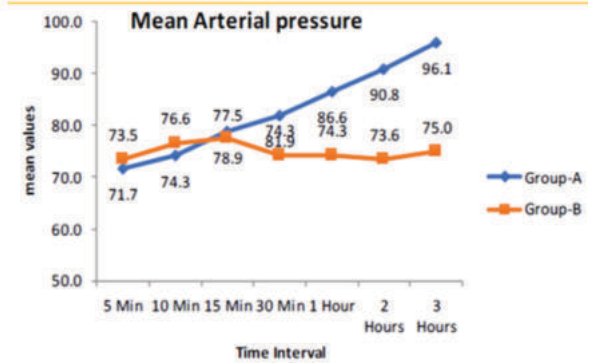
Graph 4: Distribution of participants based on systolic blood pressure (SBP) at different interval of time

In the present study, the SBP observed was in the safe range in the Group B, at each interval. On the contrary, the SBP of the patients in the Group A, was at a high range. The findings were statistically significant in prolonged surgeries more than 3hours with p value 0.001.



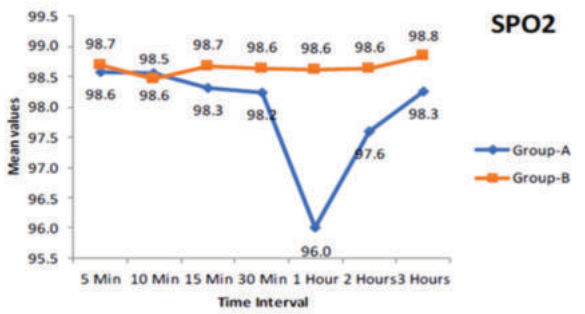
Graph 5: Distribution of participants based on Diastolic blood pressure (DBP) at different interval of time

In the study group, parameter like Diastolic blood pressure (DBP) taken as intraoperative monitor and compared at different interval of time, we found that DBP measured at different interval of time was statistically significant. The DBP observed was in the safe range in the Group B, at each interval. On the contrary, the DBP of the patients in the Group A, was at a high range. The findings were statistically significant in prolonged surgeries more than 3 hours with p value 0.001



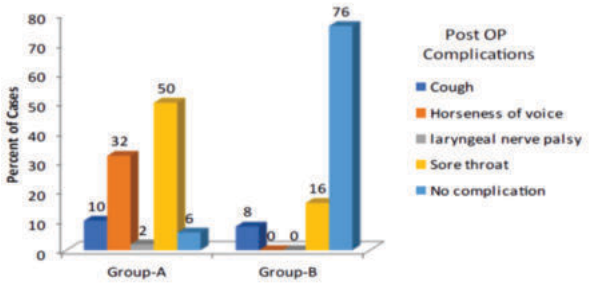
Graph 6: Distribution of participants based on mean arterial pressure (MAP) at different interval of time

In the study group, parameter like Mean arterial pressure (MAP) taken as intraoperative monitor and compared at different interval of time, we found that MAP measured at different interval of time was statistically significant. The MAP observed was in the safe range in the Group B, at each interval. On the contrary, the MAP of the patients in the Group A, was at a high range. The findings were statistically significant in prolonged surgeries more than 3 hours with p value 0.001.



Graph 7: Distribution of participants based on SPO2 at different interval of time

In the present study, parameter like SPO2 taken as intraoperative monitor and compared at different interval of time, we found that SPO2 measured at different interval of time was statistically significant. The SPO2 observed was in the safe range in the Group B, at each interval. On the contrary, the SPO2 of the patients in the Group A, was at a high range. The findings were statistically significant in prolonged surgeries with p value 0.001.



Graph 8: Distribution of participants based on post op complications

In present study, comparing post operative complications between two groups shown that post operative complications like sore throat is 50%, hoarseness of voice 32%, cough 10%, laryngeal nerve palsy 2% in group A, while in group B it shown that 76% with no complications as seen in table 12 and graph 10.

DISCUSSION:

Selecting the appropriate size of tracheal tube requires an understanding of normal tracheal dimensions. The size of the tracheal tube is a key modifiable factor in the incidence of postoperative complications, but selecting the correctly-sized tube is difficult due to the wide variability in tracheal dimensions within populations. [6]

The endotracheal tube size ("give me a 6.0 tube") refers to its internal diameter in millimeters (mm). The average size of the tube for an adult male is 8.0, and an adult female is 7.0, though this is somewhat an institution dependent practice. [7]

In the present study, the endotracheal tubes are selected based on standard formula. Ideal tube in average adult female is 7.5mm internal diameter and adult males is 8.5mm internal diameter. However, there is great variation in sizes and shapes of trachea in adults. However in the present study, majority of the participants lies under ETT size 8.0mm which is in pace with the study by Karmali S, Rose P.

Cuff pressure should be maintained around 25 to 35cmH2O, 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.[8,9]

The suggested[10] "safe" pressure to prevent aspiration and leaks past the cuff is 25cm H2O as capillary perfusion is not impaired.[3,11] However, after an in vitro study, Seegobin and Hasselt recommended that cuff inflation pressure not exceed 30cm H2O. It is essential to maintain cuff pressures in the range of 20-30cm of H2O.[12]

Airway complications like epithelial necrosis (with fistula formation), tracheomalacia, laryngeal inflammation and stenosis have been reported with high cuff pressures Abubaker J, *et al*.[13]

Sengupta *et al*.,[14] in their study showed that a cuff pressure of 20-30cms of water is produced by injecting a volume of air of 2-4 ml and also stated that 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. Therefore Using standardized instruments to measure cuff pressures might help increase safety by decreasing the possibility of injury resulting from endotracheal intubation.[14,15,16]

In present study we have measured the cuff pressure at 5min 10min 15min 30min 1hour 2hour intervals upto 3 hours. We found that there is a statistically significant relation in all time frames.

Kumar CM, *et al* [15] stated that despite known problems, regular measurement of cuff pressure is not routine, Adequate pressure in the ETT cuff is of paramount importance, as both over-inflation as well as under-inflation are associated with clinically significant complications. It is desirable during anaesthesia to use a continuous in-built intracuff pressure measurement technique.

In present study interventions was effective in maintaining cuff pressure within an optimal range, continuous monitoring of cuff pressure is feasible, accurate and safe.

Jain MK, Tripathi CB, *et al*., stated that endotracheal tube cuff pressure was significantly high when endotracheal tube cuff was inflated manually. The known complications of high endotracheal tube cuff pressure can be avoided if the cuff pressure controller device is used and manual methods cannot be relied upon for keeping the pressure within the recommended levels.[15,17]

Bulamba F, *et al* [18] concluded that the instrumental method was superior to pilot balloon palpation at administering pressures in the recommended range. In comparison with our study conclusion remains same as instrumental method is superior in maintaining intraoperative cuff pressure and it also avoids post operative complications.

CONCLUSION:

Routine use of cuff pressure manometer to inflate the ET tube cuff and monitor the same at regular intervals maintains the pressure at normal range of 25-35 cm H2O. The cuff pressure manometer reduces the complications related to ET tube cuff and abnormal variations in the cuff pressure in the long term surgeries and post-surgical complications so the ET tube cuff pressure manometer should be considered as regular monitoring equipment in all long term surgeries

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