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Endotracheal Tube Cuff Inflation Pressure awareness and response to education among anesthesia technicians

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ABSTRACT

Objective: Cuffed endotracheal tubes are used to ensure ventilator compliance and prevent pulmonary aspiration in mechanically ventilated patients. At cuff pressures greater than 40 cmH2O, mucosal irritation, ulceration, hemorrhage, tracheal stenosis, and tracheoesophageal fistula can occur due to increased perfusion pressure of the tracheal mucosa and submucosa. In this study, we compare the awareness of cuff pressure among anesthesia technicians working in the operating room.

Materials and Methods: All anesthesia technicians received a seminar on cuff pressure. An attempt was made to determine the difference between cuff pressures measured before and after the seminar.

Results: A positive correlation was found when the cuff pressure measurement was compared with the first measurement after the training (Cor. Coef.= 0.376). At the first measurement, the mean cuff pressure was 82 cmH20, the lowest pressure was 27, and the highest was 223. At the measurement after completion of the training, the mean pressure was 50, the lowest pressure was 26, and the highest pressure was 105. The difference between the two measurements was statistically significant (p=0.000). Before training, only four technicians (7.40%) inflated below the recommended confidence interval (30 cm H2O), while the remaining 50 technicians (92.6%) inflated above this limit. After training, 11 technicians could inflate below the confidence interval. A statistically significant increase was observed ($p < 0.05$).

Conclusion: Measuring the cuff pressure of the endotracheal tube was essential to avoid possible complications. Educational seminars on this topic and the provision of cuff meters can avoid these problems.

Keywords: cuff pressure, anesthesia, technician, endotracheal tube

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INTRODUCTION

Cuffed endotracheal tubes are used to ensure ventilator compliance and prevent pulmonary aspiration in mechanically ventilated patients. The pressure generated by the inflated cuff is transmitted directly to the tracheal wall around the cuff (1). At cuff pressures greater than 40 cmH2O, mucosal irritation, ulceration, hemorrhage, tracheal stenosis, and tracheoesophageal fistula can occur due to increased perfusion pressure of the tracheal mucosa and submucosa (2).

Most hospitals do not routinely measure endotracheal tube cuff pressure, and cuff palpation has not detected high cuff pressures (3). Measurement of cuff pressure is a simple and reproducible method to evaluate the pressure exerted on the tracheal mucosa. Some suggest that the minimum cuff pressure required to provide an adequate seal and reduce the risk of aspiration is 25 cmH2O (4).

Even when inflated to the minimum occlusion pressure, "low-volume, high-pressure" endotracheal tube cuffs often cause high tracheal pressures and cause clinically significant tracheal ischemia and necrosis. Despite using high-volume, low-pressure cuffs, some patients experience tracheomalacia, tracheal stenosis, and tracheoesophageal fistula with the risk of tracheal ischemia from the cuff (5).

Cuff pressure measurement is not performed routinely in our country. Many physicians measure cuff pressure only subjectively. First, the swelling and stiffness of the cuff balloon are checked. Some physicians adjuste the pressure to the air leak from the ventilator and the pressure stabilized where the air leak was stopped. However, most physicians do not know how high or low the cuff pressure they set is. In this study, we compare the awareness of cuff pressure among anesthesia technicians working in the operating room of Erzincan Binali Yıldırım University Mengücek Gazi Training and Research Hospital and the pressure they apply after cuff pressure training with previous values.

MATERIAL and METHODS

After obtaining approval from the university ethics committee, all anesthesia technicians were interviewed, and verbal consent was obtained. The technicians were randomized by name. High-volume and low-pressure endotracheal tubes of the same brand and different sizes were used for all intubations, which were selected according to the patient. Patients with emergency surgery and difficult intubation were excluded from the study. Immediately after intubation, the technician inflated the cuff and fixed the tube according to his method. Subsequently, the pressure of the tracheal cannula cuff was measured with a control inflator (VBM medizintechnik. Industriegebiet Wittlensweiler, Farinastrabe 4, D729290, Freudenstadt, Germany). This device measures the cuff pressure on the pilot balloon and allows the pressure to be changed by inflating or deflating the balloon (6). The cuff pressure is measured in cmH2O, with lower and upper ranges of 20 and 30 cmH2O, respectively. The same observer took all measurements during the inspiratory phase of positive pressure ventilation. Patient demographics (including age and sex) were recorded.

After the initial measurement pressures of all anesthesia technicians were recorded, a seminar on cuff pressure was held. The seminar explained what a cuff pressure is, how it is set, what complications are caused by cuff pressures that are too high or too low, and what modern cuff pressure measurements look like. Then, in addition to demographic data, a questionnaire was used asking;

1- How many years he had been working,

2- When he last intubated,

3- How he set the cuff pressure,

4- Whether he was already aware of the cuff pressure,

5- whether he used a cuff pressure monitor and

6- what contribution the seminar made to his awareness of cuff pressure.

After the seminar, the cuff pressures applied by all anesthesia technicians after intubation were measured and recorded.

Statistic: The Statistical Package for Social Sciences (IBM SPSS Statistics) for Windows, version 26, was used for statistical analysis (IBM Corp., Armonk, NY, USA). The Shapiro–Wilk test for normality was used for quantitative data. The mean and standard deviation (SD) of the normally distributed data were calculated, and the groups were compared using the paired t test. Frequencies were used to summarize qualitative data, and Pearson's chi-square test was used to assess relationships. A $p < 0.05$ was used to assess the significance of statistical tests.

RESULTS

A total of 54 anesthesia technicians with a mean age of 33.68 ± 8.11 years were included in the study. Twenty-two of them were male, and 32 were female. The seniority was two technicians less than one year, 1-5 years 10, 5-10 years, and over ten years 21 technicians (**Table-1**).

A positive correlation was found when the cuff pressure measurement after training was compared with the first measurement (Cor. Coef.= 0.376). At the first measurement, the mean cuff pressure was 82 cmH20, the lowest pressure was 27, and the highest was 223. At the measurement after completion of the training, the mean pressure was 50, the lowest pressure was 26, and the highest pressure was 105. The difference between the two measurements was statistically significant (p=0.000). This observed difference did not differ by age, gender, or seniority.

Before training, only four technicians (7.40%) inflated below the recommended confidence interval (30 cm H2O), while the remaining 50 technicians (92.6%) inflated above this limit. After training, 11 technicians could inflate below the confidence interval. A statistically significant increase was observed ($p < 0.05$).

Survey questions and technician responses have been shown in **Table 2**.

Compared to the responses in the questionnaire about the cuff measurement method, there was no difference between the groups in terms of cuff inflation pressures. While there was no significant difference in the first measured pressure between technicians who had previously received cuff pressure training and those who had not, there was a significant difference in the pressures measured after training (p=0.013). The inflation pressures did not differ between those who had prior cuff pressure complications and those who did not. Inflation pressures did not differ between those who were frequently intubated and those who were not intubated for a long time. The inflation pressures did not differ between technicians who had previously used a cuff device and those who had not. There was no difference between the first and last inflation pressures between those who reported that their awareness had increased after training and those who reported no difference.

Table-1. Demographic data

Age			Gender	Frequency	Percent %
Min	18		Male	22	40,7
Max	51		Female	32	59,3
Mean	33,68				
Std. Dev.	8,11				
Professional experience			**Last intubation time**		
	Freq.	**Percent %**		**Freq.**	**Percent %**
Less than 1 year	2	3,7	0-7 Days	21	38,9
1-5 years	10	18,5	7-15 Days	6	11,1
5-10 years	21	38,9	15-30 Days	9	16,7
over 10 years	21	38,9	Over 30 Days	18	33,3

Table 2. Survey questions and answers

Last intubation time	Freq.	Percent %	How do you set the cuff pressure?	Freq.	Percent %
0-7 Days	21	38,9	**Palpation**	27	50,0
7-15 Days	6	11,1	**Tube specification**	15	27,8
15-30 Days	9	16,7	**Leakage control**	12	22,2
Over 30 Days	18	33,3	**Total**	54	100,0
Have you received cuff pressure before?			**If you have a cuff measuring device, do you use it in your routine?**		
No	44	81,5	**No**	49	90,7
Yes	10	18,5	**Yes**	5	9,3
Have you had any complications related to cuff pressure after intubation?			**Did your awareness of cuff pressure increase after this briefing?**		
	Freq	**Perc %**		**Freq.**	**Perc. %**
None	27	50,0	**None**	10	18,5
Sore throat	4	7,4	**Slightly increased**	16	29,6
Horseness	13	24,1	**İncreased a lot**	28	51,9
Bronchospasm	10	18,5			

DISCUSSION

This study aimed to investigate the cuff pressure applied by anesthesia technicians at Erzincan Binali Yıldırım University Mengücek Gazi Training and Research Hospital before and after cuff pressure awareness and cuff pressure training. The cuff pressures measured after training were significantly lower than those before, which was associated with improved cuff pressure safety. This situation was reported by Sayed Siyamdoust et al. (7). This result was similar to the results of his study. However, this study found that the safety of cuff pressure was increased in anesthesiologists after training.

Several factors influence the pressure measurement in the endotracheal tube cuff, including cuff diameter, thickness, compliance, shape, filling substance (air or water for specific procedures), and head and neck posture. Several parameters, such as tube type, cuff shape, and filling material, can affect the pilot balloon's tone and thus the palpation approach's reliability (8). Using a manometer may cause underestimation of the recorded ETT cuff pressure. Because of the internal manometer chamber and pressure equalization, air leaks when the external balloon is connected to the manometer (9). In our study, high-volume, low-pressure endotracheal tubes of the same brand were used in all patients.

The cuff pressure of the endotracheal tube should be maintained between 25 and 30 cm H2O (10). Although the safe perfusion pressure varies from case to case to ensure capillary perfusion, it is defined as 25 cm H2O.

Blood flow in the tracheal mucosa is interrupted at pressures greater than 30 cm H2O and can completely stop at 45 cm H2O (11). In their in vitro work, Seegobin and Hasslet (12) suggested that the cuff pressure should not exceed 30 cm H2O. Inada et al. (13) studied the variation in balloon pressure at different airway pressures. They found that the balloon pressure was less than 34 cm H2O at an airway pressure of 20 cm H2O in men and 25 cm H2O in women. They noted that this pressure corresponds to perfusion pressure but that tracheal ischemia may occur due to other factors, such as hypotension, which lowers perfusion pressure.

Several methods have been developed to ensure proper cuff inflation, including the minimal leakage technique, minimal occlusion volume, inflating the ETT cuff to a minimal pressure level, inflating the cuff with a stethoscope, and the conventional technique of inflating the cuff with an indeterminate volume of air (14). The minimal leakage approach determines how much air is pumped into the cuff based on the amount required to detect a tiny end-inspiratory leak by auscultating the front of the chest (17). In our study, 50% of technicians reported using the palpation method, 27% used the characteristics of the tubes, and 22% used the air leak method. Although this method has been inadequate, the ETT pilot balloon is tested for approximation pressure by palpation.

This method estimates the pressure in the cuff. It has been shown to overinflate the cuff in 30-98% of cases, depending on the type of ETT used and the population studied (15). Saraçoğlu et al. (16) found no significant relationship between anesthesiologist experience and adequacy of ETT cuff pressure when patients were instructed to inflate the cuff to the level they considered appropriate(17)(17)(17) manually. Bulamba et al. (18) suggest using a loss-of-resistance syringe as an alternative to simple palpation. A 7 mL plastic syringe with a luer-slip closure introduces air into the pilot balloon, and the plunger of the loss-of-resistance syringe can be passively withdrawn until it stops.

CONCLUSION

Measuring the cuff pressure of the endotracheal tube was essential to avoid possible complications. In our country, routine cuff pressure measurement is not yet applied in all centers. Measurement with simple manometers is essential to avoid complications. Despite the many intubations in daily anesthesia practice, anesthesia technicians still do not go beyond traditional methods. Educational seminars on this topic and the provision of cuff meters can avoid these problems.

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