



OBJECTIVE AND SUBJECTIVE EVALUATION OF ENDOTRACHEAL TUBE CUFF PRESSURE BETWEEN DIFFERENT LEVELS OF ANESTHESIA EXPERIENCES

FARKLI ANESTEZİ DENEYİM DÜZEYLERİ ARASINDA ENDOTRAKEAL TÜP KAF BASINCININ OBJEKTİF VE SUBJEKTİF DEĞERLENDİRMESİ

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Abstract

Objective: After endotracheal intubation (ETI), the endotracheal tube cuff (ETTc) should be inflated at sufficient pressure to function, and high pressure should be avoided to prevent complications. In our study, the effect of professional experience on the estimation of ETTcP by palpation is investigated.

Method: The study included 75 adult patients with physical status I-III of the American Society of Anesthesiology (ASA) scheduled for ETI. Anesthesia residents were divided into two groups of 20, each with 1 month to 1 year of experience (Group 1) and those with more than 4 years of experience (Group 2). After the ETI, one participant in both groups was asked to inflate the ETTc to an estimated 25 cm H₂O by cuff palpation. Then the actual ETTcP was measured with a manometer.

Results: The median ETTcP value was 42,00 cm H₂O in Group 1 and 32,00 cm H₂O in Group 2, ($p=0.012$). Although the data of both groups were significantly higher than the target value, the values obtained in Group 1 were further away from Group 2 ($p<0.001$, $p<0.001$).

Conclusion: Professional experience has no effect on the correct estimation of the ETTcP. It is more convenient to measure the actual pressure to avoid undesirable effects of ETTcP outside the target.

Keywords: Airway management, anesthesia assistants, endotracheal intubation, general anesthesia, mechanical ventilation, medical professionalism.

Öz

Amaç: Endotrakeal entübasyon (ETI) sonrası endotrakeal tüp kaf (ETTc), işlevini yerine getirebilmesi için yeterli basınçta şişirilmeli, komplikasyonları önlemek için ise yüksek basınçtan kaçınılmalıdır. Çalışmamızda mesleki deneyimin manuel palpasyonla endotrakeal tüp kaf basıncı (ETTcP) tahminine etkisi araştırılmaktadır.

Yöntem: Çalışmaya ETI planlanan, Amerikan Anesteziyoloji Derneği (ASA) fiziksel durumu I-III olan, 75 erişkin hasta dahil edildi. Anestezi asistanları 1 ay-1 yıl arasında deneyimi olanlar (Grup 1) ve 4 yıldan fazla deneyimi olanlar (Grup 2) şeklinde 20'şer kişilik iki gruba ayrıldı. ETI sonrası, her iki gruptan da bir katılımcıdan ETTc'yi manuel kaf palpasyonu yöntemiyle tahminen 25 cm H₂O'ya kadar şişirmesi istendi. Sonra ETTcP'nin gerçek değeri manometre ile ölçüldü.

Bulgular: Grup 1'de median ETTcP değeri 42,00 cm H₂O, Grup 2'de 32,00 cm H₂O idi ($p=0.012$). Her iki grubun verileri hedef değerden anlamlı derecede yüksek olmakla birlikte, Grup 1'de elde edilen değerler Grup 2'den daha uzaktı ($p<0.001$, $p<0.001$).

Sonuç: Mesleki deneyim ETTcP değerinin doğru tahmini üzerinde etkili değildir. Hedef değer dışında ETTcP'nin istenmeyen etkilerini önlemek için gerçek basıncın ölçülmesi daha uygundur.

Anahtar kelimeler: Havayolu yönetimi, anestezi asistanları, endotrakeal entübasyon, genel anestezi, mekanik ventilasyon, tıbbi mesleki deneyim.

Introduction

Airway safety in general anesthesia and intensive care unit is usually provided by endotracheal intubation (ETI). After ETI, the endotracheal tube cuff (ETTc) should be inflated to sufficient pressure both to prevent regurgitation of oropharyngeal secretions into the trachea and to provide the required tidal volume in mechanical ventilation.¹ On the other hand, high ETT cuff pressures (ETTcP) should be avoided due to the risk of sore throat, hoarseness², laryngeal nerve palsy³, tracheal damage, stenosis^{4,5}, and tracheoesophageal fistula⁶.

In order to prevent complications, it has been recommended to measure ETTcP with a manometer and keep it between 20-30 cm H₂O values.^{1,7} However, in daily practise, the manometer may not always be readily available and instead of the actual measurement of ETTcP, various methods are used to estimate it.⁸ In one study, it was reported that professional experience had a positive effect on the estimation of ETTcP, while in others it was reported that such an effect did not exist, and care for cuff pressure decreased as experience increased.⁹⁻¹²

In our study, it was aimed to compare the estimates of endotracheal tube cuff pressure by pilot balloon palpation method of anesthesia assistants with different professional experiences in the same patient.

Methods

After the approval of the local ethics committee and informed written consent of all patients, 75 patients aged 18-75 years, with physical status I-III of the American Society of Anesthesiology (ASA) scheduled for ETE under general anesthesia, were included in the study. Patients with a history of emergency surgeries, head and neck surgeries, difficult intubation, double lumen tube intubation, nasal intubation, tracheotomy, and gastroesophageal reflux, and anatomical laryngotracheal anomalies were not included in the study. Anesthesia residents were divided into two groups of 20, each with anesthesia experience between 1 month and 1 year (Group 1), and those with more than 4 years (Group 2). After premedication of the patients with an appropriate dose of iv midazolam, anesthesia induction was performed with iv 2-3 mg propofol, 1µg/kg fentanyl, and 0.6 mg/kg rocuronium. After 3 minutes, the patients were intubated using the conventional intubation technique with a Macintosh laryngoscope. Internal diameter of 7.5 mm for female patients and 8.0 mm ETT for male patients (Bıçakçılar, Turkey) was used. Cuff leak control was performed before intubation. Following intubation, one participant was asked to inflate the ETTc with air to an estimated 25 cmH₂O by manual cuff palpation using a 10 mL syringe, with group priority determined by the sealed envelope system. Direct pressure measurement was then made with a cuff manometer calibrated for cmH₂O attached to the ETT pilot balloon. The participant was not informed about the actual pressure of the cuff. Then the air in the cuff was completely deflated and the same procedure was repeated with the participant from the other group. In cases where the cuff pressure was above 30 cmH₂O or below 20 cmH₂O, the pressure was brought to normal limits. During the study, patients were in a supine, head and neck neutral position.

Statistical Analysis

Statistical analysis was done with IBM SPSS 20.0 (IBM Corp., Armonk, NY, USA) package program. Normal distribution was evaluated with the Kolmogorov-Smirnov test. Numerical variables were given as mean±standard deviation and median (25th-75th percentile). Categorical variables were given as frequency (percentage). Since the assumption of normal distribution was not provided, dependent sample comparisons were made with the Related Samples Wilcoxon Signed Rank test. One Sample Wilcoxon Signed Rank test was used for single sample tests. In the testing of two-sided hypotheses, $p < 0.05$ was considered sufficient for statistical significance.

Results

The demographic characteristics of the patients and the data on airway and ETI intervention are presented in Table 1.

Table 1. Demographic characteristics of patients and characteristics of airway and ETI procedure

Parameters	Mean±SD
Age (years)	53.08±15.25
Height (cm)	170.65±8.97
Weight (kg)	79.25±13.90
BMI kg/meter ²	27.29±5.79
	n(%)
Gender F/M, n(%)	34(45.3) / 41(54.7)
ASA 1/2/3 n(%)	13(17.3) / 36(48.0) / 26(34.7)
Cormach-Lehane, 1/2/3/4 n(%)	21(28.0)/37(49.3)/12(16.0)/5(6.7)
Mallampati, 1/2/3/4 n(%)	23(30.7)/38(50.7)/13(17.3)/ (1.3)
Intubation attempts 1/2/3/4 n(%)	61(81.3)/11(14.7)/ 2(2.7) / 1(1.3)

SD: Standart deviation **ASA:** American Society of Anesthesiologists score

When the values of the two groups were compared, the median ETTcP value was 42.00 cmH₂O (32.00-56.00) in Group 1 and 32.00 cmH₂O (28.00-42.00) in Group 2, the difference was statistically significant ($p=0.012$). Although the data of both groups were significantly higher when compared to the target value, the values obtained in Group 1 were farther from the target ($p < 0.001$, $p < 0.001$; $p=0.012$) (Table 2).

Table 2. Comparison of ETTcP values between groups

ETTcP (cmH ₂ O)	Group 1 (n=75)	Group 2 (n=75)	<i>p</i> *
Median	42.00	32.00	0,012
(IQR)	(32.00-56.00)	(28.00-42.00)	
Min-max	10-120	8-120	
<i>p</i> **	<0.001	<0.001	

IQR: Interquartile Range **ETTcP:** Endotracheal tube cuff pressure
*Statistically significant difference between groups according to ETTcPs; **: Statistically significant difference from the default value (25 cmH₂O) for each group

There were estimated ETTcP values below the target value by 16.0% in Group 1 and 17.3% in Group 2. Measurements above the target value were 84% in Group 1 and 87% in Group 2 (Table 3).

Table 3. Distribution of ETTcP values between groups

ETTcP (cmH ₂ O)	Group 1 n (%)	Group 2 n (%)
8-20	5 (6.7)	6 (8.0)
21-24	7 (9.3)	7 (9.3)
25	0	0
26-30	5 (6.7)	19 (25.3)
31-50	33 (44.0)	30 (40.0)
51-120	25 (33.3)	13 (17.3)

ETTcP: Endotracheal tube cuff pressure

Discussion

According to the results of our study, the estimated ETTcP values were much higher than the target in both groups, regardless of experience.

ETTcP should be between values that will ensure the delivery of the predicted mechanical ventilation tidal volume, prevent the regurgitation of secretions accumulated on the cuff, and not impair tracheal perfusion. It has been reported that pressures above 30 cmH₂O cause a decrease in blood flow in the tracheal mucosa, and a complete cessation of mucosal blood flow at values above 50 cmH₂O.⁷ When the cuff pressure falls below 20 cmH₂O, the risk of ventilator-associated pneumonia increases fourfold.^{13,14} It has been shown that the range of 20 to 30 cmH₂O is optimal to prevent tracheal damage and aspiration.^{9,15} Therefore, we set the target value as 25 cmH₂O in the middle of the two values.

Various factors such as ETTc diameter, thickness, shape, the material from which it is produced, the material used for inflation (air or water), and the position of the head and neck affect the ETTcP.^{16,17} We used ETTs with cylindrical cuffs made of polyvinylchloride inner diameter of 8.0 cm for male patients and 7.5 cm for female patients, and filled the cuff with air. We measured all patients immediately after intubation, with the patient in the supine and head neutral position. Tracheal diameter, airway anatomy, body temperature, hemodynamic status, and therapeutic interventions may also affect ETTcP.^{18,19} For this reason, we decided to examine practitioners with different experiences on the same patient in our study.

ETTcP can be measured with manometer-like instruments or can be estimated with some techniques.²⁰ Due to the heavy workload, the use of a cuff manometer for the measurement of ETTcP in intensive care units or the operating room has been replaced by the experience of anesthesia personnel.^{10,21} The inflation method, minimal occlusive volume technique, minimal leak technique, predetermined volume technique, and palpation technique are some of the methods for estimating ETTcP.²² Although the palpation technique is the most commonly used method due to its practicality, it has a low accuracy margin due to the physical differences between ETTs and the relative pressure of ETTcP between the two fingers and variations among the assessors.²³⁻²⁵

In one of the studies investigating the relationship between professional experience and clinical prediction, experienced anesthetists and surgeons were found to be more accurate in estimating blood loss during surgery²⁶, while in another study comparing dermatome detection after block between anesthesiologists with different experiences, no significant difference was found between the participants.²⁷ Similarly, the results of studies examining the relationship between ETTcP estimation and professional experience were also different. Some studies have reported that professional

experience does not contribute to the correct estimation of ETTcP^{8,10-12}, while others have reported that experience alone is important, although not sufficient⁹. In one study, it was shown that experienced anesthetists inflated the ETTc at higher pressures²⁸, and in another study, those with less experience inflated at higher pressures¹². In the second study, it was reported that anesthetists with less professional experience achieved high ETTcP due to the fear of insufficient ventilation. In our study, as in Çolak *et al.*¹², ETTc was inflated with higher pressures in novice residents. Interestingly, Çolak *et al.*¹² reported that the importance of experience for establishing the correct cuff pressure decreased in the following years. Different results of studies investigating the relationship between ETTcP estimation and professional experience may be due to methodological differences. For example, Ozer *et al.*¹⁰ compared anesthesia technicians, anesthesia assistant doctors and anesthesiologists, and anesthesia technicians under 2 years, and anesthesia assistants under 3 years were defined as novices. In one study, anesthesia assistants were classified as less than 2 years, 2 to 10 years and over 10 years²⁸, while in another study, anesthesia assistants were classified as 1,2,3 and 4 years¹². Some of the studies are clinical^{8,10,12} and some are experimental studies¹¹. As a result of all studies, the clear recommendation is to measure the true value with a manometer instead of estimating ETTcP.⁸⁻¹² For immediate detection and rapid correction of deviations from pressure ranges, ETTcP should be continuously monitored²⁹ and readjusted to normal values when necessary³⁰.

As a result, anesthesia experience has no effect on the correct estimation of the ETTcP value. In order to prevent undesirable effects of ETTcP below or above the target value, it is more appropriate to measure it with a manometer instead of estimating it.

Limitations

The limitation of our study is that it was conducted with a small number of participants and patients.

Conflict of Interest

The authors declare that they have no conflicts of interest.

Compliance with Ethical Statement

This study was approved by the institutional review board and the local ethics committee of our institution (KAEEK 2021/01.02.).

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Author Contributions

Study idea/Hypothesis: TÇ; Study design: TÇ; Data preparation: EÖÇK, NNY; Data analysis: TÇ, EÖÇK, SB; Literature search: TÇ, EÖÇK; Manuscript writing: TÇ, EÖÇK

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