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ORIGINAL ARTICLE

Effect of endotracheal tube cuff pressure on development of ventilator associated pneumonia

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Purpose: Ventilator associated pneumonia may cause prolonged hospital stay and mortality. The aim of this study was to detect the effect of endotracheal tube cuff pressure on ventilator associated pneumonia.
Methods: Patients who were intubated in ICU after admission in Gaziantep University Hospital from March 2008 to October 2008 were evaluated. Immune suppression, malignancy, witnessed aspiration before intubation, cerebrovascular accident and younger than 18 years old patients were excluded from the study. Patients were randomised to low-normal and high-normal cuff pressures; prospectively. Cuff pressures were set at 20 cm H2O or 30 cmH2O and measured once in every four hours and adjusted if necessary. National Nosocomial Infection Surveillance System criteria were used for VAP diagnosis.
Results: 196 patients were intubated during the study period. Of these patients twenty six reached inclusion criteria and randomised to groups of low-normal and high-normal endotracheal cuff pressures. Median cuff pressure at low-normal group was 18.2 (16.0-21.4) cmH2O and it was 22 (20.1-24.8) cmH2O in high-normal group (p=0.02). There was microbial growth in 75% of tracheal aspirate cultures. Empiric antibiotic treatment was sufficient in only 12.5% of patients based on the results of antibiogram. The incidence of VAP was 41.7% (64 in 1000 ventilator days) in the low-normal group and 21.4% (41 at 1000 ventilatory day) in the high-normal group (p=0.27). All patients with VAP were died. Mortality rates between two groups were similar (p=0.56).
Discussion: We suggest that higher ET cuff pressures might be an important measure to prevent VAP in subjects hospitalized in ICU. However, optimum numbers for ET cuff pressures and the frequency of cuff pressure measurements should be detected in further studies.

Keywords: VAP, cuff pressure, intensive care.

Endotrakeal tüp kaf basınçlarının ventilatör ilişkili pnomoni gelişimine etkisi

Amaç: Ventilatör ilişkili pnömoni (VİP) entübasyon sırasında pnömonisi olmayan invaziv mekanik ventilasyon desteğindeki hastalarda endotrakeal entübasyondan en erken 48 saat sonra gelişen hastane kökenli pnömonidir. Mekanik ventilatördeki hastaların %9-27'inde VİP gelişmektedir. VİP'deki mortalite %24-50 arasında değişmektedir. Subglottik sekresyonların hasta tarafından aspire edilmesi VİP için majör risk faktörüdür. Kaf basıncının 20-30 arasında tutulması trakeobronşiyal mukozal hasara yol açmadan aspirasyonları önlemektedir. Bizim hipotezimiz kaf basıncı 30 cmH2O olarak takip edilen grupta VİP'in daha az görüleceğidir.
Yöntem: Bu çalışma randomize kontrollü bir çalışmadır. Çalışmamıza prospektif olarak 26 hasta alındı. Hastalarımız düşük-normal ve yüksek normal kaf basıncı olmak üzere iki gruba randomize edildi. Daha sonra düzenli olarak kaf basıncı ölçümlerini yapıldı. Randomize edilen gruplardan birincisinin kaf basıncı 20 cmH2O ikinci grubun kaf basıncı 30 cmH2O'da tutulmak üzere 4 saatte bir kez ölçülerek düzenlendi. VİP tanısı için (National Nosocomial Infection Surveillance System) NNIS kriterleri kullanıldı.
Bulgular: Hastaların klinik ve demografik özellikleri arasında anlamlı fark saptanmadı. Kaf basınçları incelendiğinde teknik zorluklardan dolayı hedeflenen kaf basınçlarına ulaşılamadığı, ancak iki grup arasında anlamlı bir fark olacak şekilde, kaf basınçlarının düşük-normal grupta 18.2 (16.0-21.4) cmH2O, yüksek-normal grupta 22 (20.1-24.8) cmH20 olduğu tesbit edildi. Düşük-normal grupta VIP insidansı % 41.7 (1000 ventilatör gününde 64) yüksek-normal grupta ise %21.4 (1000 ventilatör günde 41) olarak tesbit edildi. Sonuçta iki grup arasında VİP insidansı ve mortalite açısından anlamlı fark saptanmadı (p=0.27, p=0.56). VİP gelişen hastaların %75'inde trakeal aspiratta üreme saptandı. Antibiyogram sonuçlarına göre bakıldığında empirik antibiyotik tedavisinin hastaların sadece %12.5'inde yeterli olduğu görüldü. VİP gelişen hastaların yoğun bakım mortalitesinin %100 olduğu saptandı.
Tartışma: Yoğun bakımda yatan hastalarda VİP'i önlemek için daha yüksek endotrakeal kaf basınçlarının önemli bir önlem olabileceğini düşünüyoruz. Ancak endotrakeal kaf basınçları için optimum değerler ve kaf basıncı ölçümlerinin sıklığı ileriki çalışmalarda tespit edilmelidir.

Anahtar kelimeler: VİP, kaf basıncı, yoğun bakım.

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Ventilator associated pneumonia (VAP) is a major cause of prolonged hospitalization and increased morbidity, mortality and care unit's costs in intensive care units (ICU). Therefore it is important to prevent VAP [1-4]. Tracheal tube related strategies in order to prevent VAP development have been studied such as subglottic secretion aspiration, inhibition of biofilm formation [5]. Endotracheal tube (ET) cuffs prevent aspiration of oropharyngeal secretions and avoid VAP, however elevated cuff pressures may damage the poorly perfused tracheal wall. Lower pressures of ET cuff may cause aspiration of oropharangeal secretions but overinflation may produce damage of tracheal wall [6]. Maintaining endotracheal cuff pressure between 20-30 cmH2O to preclude adverse clinical outcomes were recommended in several studies [7,8], however data on VAP incidence with respect to cuff pressure is lacking. How does keeping the cuff pressure at the lower or upper limit changes the incidence of VAP? There is no study in the literature on this subject.

In this study we aimed to evaluate effects of different ET cuff pressures on the development of VAP.

METHODS

Patients older than 18 years who were intubated in ICU after admission in Gaziantep University Hospital from March 2008 to October 2008 were prospectively evaluated. Patients with immune suppression, malignancy, witnessed aspiration before intubation and cerebrovascular accident were excluded from the study. Ethics committee approval was obtained (03-2008/18).

Informed consent was given by first degree relatives of the study population. Subjects were randomized to low-normal and high-normal ET cuff pressure groups within 6 hours of intubation by a random number generating computer program. Cuff pressures were set to 20-22 cm H2O (Group 1, low-normal pressure group) or 30-32 cmH2O (Group 2, high-normal pressure group) manually with a cuff manometer after randomization and checked every 4 hours to adjust when necessary. Demographic variables, APACHE II score, SOFA and CPIS scores were noted [9-11]. Tracheal aspirates were obtained twice a week. Culture results were evaluated in every 48-72 hours and treatment was modified as necessary. Portable chest X-ray was obtained at 14:00 hours every day. Each radiograph was evaluated by two chest physicians blinded to patient groups. National Nosocomial Infection Surveillance System (NNIS) criteria were used for diagnosing VAP [12]. Patient was diagnosed with tracheobronchitis if chest radiograph was normal but purulent sputum, fever and leucocytosis were present. Positive culture results in the presence of normal chest radiograph without any clinical finding compatible with infection were accepted as colonization.

Data was analyzed with using SPSS 16.0 computer software. $p<0.05$ was necessary for statistically significance.

RESULTS

Total number of intubated patients in the ICU was 196 during the study period. Of these patients 26 were included. Twelve patients (8 males) were randomized to low-normal pressure group (Group 1) and 14 patients (8 males) were randomized to high-normal pressure group (Group 2). Demographic and clinical variables of the study population are shown in Table 1. Reasons for exclusion were as follows: 62 patients received invasive mechanical support less than 48 hours, 25 patients had a history of aspiration, 22 patients had malignancy, 22 patients were not randomized within 24 hours, 15 patients had cerebrovascular accident, 12 patients were diagnosed with pneumonia initially, 7 patients were intubated at other facilities, 4 patients had immunsuppression, 1 patient was under 18.

Median cuff pressures of the group 1 and group 2 were 18.2 (16.0-21.4) cm H2O, and 22.0 (20.1-24.8) cm H2O, respectively (p=0.02). VAP developed in 8 of 26 patients, 41.7% of group 1 and 21.4% of group2, but the difference was not statistically significant (p=0.27). Early onset VAP was present in 4 of 8 patients and remaining 4 patients had late onset VAP. Mortality rate of VAP patients were 100%

(p=0.02). APACHE II and SOFA scores were similar between two groups however CPIS score was significantly lower in group 2 (p=0.03). Impact of various clinical properties (age, gender, APACHE-II score, co-morbidities, smoking, biomass exposure, adequacy of empiric antibiotic usage, antiacid treatment, re-intubation, enteral/parenteral feeding, serum albumin level) in VAP development was analyzed by logistic regression analysis.

Table 1. Demographic and clinical variables

Clinical properties	Group 1 (n=12)	Group (n=14)	P
Age (median[IQR])	70.5 (46.8-76.5)	54.0 (33.8-65.5)	0.13@
Gender (n, %)			
Female	4 (33.3)	6 (42.9)	0.62&
Male	8 (66.7)	8 (57.1)	
APACHE-II (median[IQR])	23.50 (18.0-29.8)	19 (15.0-23.0)	0.23@
Reason for hospitalization (n, %)			
Hemodynamic instability	8 (67)	7 (50)	0.39&
Respiratory failure	3 (25)	5 (36)	0.56&
Requirement for monitorization	1 (8)	2 (14)	0.64&
Co-morbidity (n,%)			
COPD	4 (33.3)	4 (28.6)	0.79&
Coronary artery disease	2 (16.7)	1 (7.1)	0.45&
Hypertension	2 (16.7)	2 (14.3)	0.87&
Diabetes mellitus	4 (33.3)	1 (7.1)	0.09&
Smoking (n,%)	5 (41.7)	6 (42.9)	0.95&
Biomass exposure (n,%)	1 (8.3)	2 (14.3)	0.64&
SOFA (median[IQR])	2.3 (2.0-3.2)	4.5 (0.8-6.5)	0.62@
CPIS (median[IQR])	1 (0.0-3.8)	0 (0.0-0.5)	**0.03@**

Simple (univariate) logistic regression analysis showed that higher serum albumin levels were related with low VAP incidence however this effect did not reach statistical significance in multiple (multivariate) logistic regression analysis. The incidence of tracheobronchitis and colonization were similar between groups (Table 2). Tracheal aspirate cultures were positive in six of eight (75%) patients with VAP. Acinetobacter baumanii (n=2), Escherichia coli (n=1), Pseudomonas aeruginosa (n=1), Staphylococcus aureus, (n=1), Candida species (n=1) were detected in culture specimens.

Table 2. Incidence of VAP, tracheobronchitis and colonization

	Group 1 (n=12)	Group (n=14)	P
VAP (n,%)	5 (41.7)	3 (21.4)	0.27&
Tracheobronchitis (n,%)	3 (25)	3 (21.4)	0.83&
Colonization (n,%)	2 (17)	3 (21.4)	0.76&

* & χ-square test

DISCUSSION

VAP was detected approximately two times higher in low-normal cuff pressure group than in high-normal cuff pressure group, however it does not reached statistical significance. Lack of difference in the incidence of VAP between the groups might be due to limited number of cases.
In a previous it has been shown that mean cuff pressure of 25 cm H20 is eefcetive to prevent although there was no difference in mortality between the groups [13]. VAP rate was 41.7% in group 1, while it was 21.4% in group 2 (p=0.27). The median cuff pressure of the group 1 was 18 cm H2O, (16.0-21.4), while it was 22.0 cm H2O (20.1-24.8) in group 2 (p=0.02). Although there was no statistically significant difference between the groups in terms of the figures, VAP rate was almost two times lower in the group with normal-high cuff pressure. Since the number of the subjects included in this study was limited, we believe that our hypothesis of higher cuff pressures are associated with lower VAP rates worth testing in further studies with more subjects included. CPIS is a scoring system that predicts pneumonia [14]. In this study, CPIS scores were calculated on the day of hospitalization of the patients in intensive care unit. This score was found to be higher in group 1 compared to group 2 in consistent with our finding of higher prevalence of VAP in group 1.

Although there was significant difference between the cuff pressures in the two groups, the target cuff pressures were not attained. The mean pressure in group 1 was 18.2 cmH2O, the target was 20 cmH2O. High-normal cuff pressures could not be reached in the second group due to technical difficulties. We suggest that cuff pressure should be set above the desired value initially, with regard to the type of ET tube, and should be checked frequently to determine whether this approach is satisfactory. A survey of 32 ICUs from Spain revealed that only 57% of the centers exercised regular ET cuff pressure monitoring although "adequate" pressure was not reported [8]. In our study because of technical deficiencies intended pressures were not able to be reached. Due to fact that the existing data is limited, optimum cuff pressure and the frequency of measurement to prevent VAP are need to be defined in further studies as well.

Tracheal aspirates were obtained twice a week and pathogens were detected in 75% of cultures. Culture positivity was detected as 22-55% in other studies [15-25]. Higher incidence in our study might be related to prompt transport of specimens in appropriate conditions.

Mortality rate was 100% in patients who developed VAP (n=8) however mortality rate of patients without VAP was 56% (p=0.02). High mortality in VAP patients is thought to be related to high level of resistance of the organisms and delayed initiation of the appropriate antibacterial treatment. Mortality rates did not differ between the groups (75% vs 64.3%, p=0.56). Total mortality rate of 69% is compatible with reports as 24-76% [16, 26-31]. Colonization and tracheobronchitis rates were not different between the two groups in the present study.

Limitations of the study

Main limitation of this study was limited number of study population. On the other hand aimed cuff pressures were not able to be obtained.

CONCLUSION

We suggest that higher ET cuff pressures might be an important measure to prevent VAP in subjects hospitalized in ICU. However, optimum numbers for ET cuff pressures and the frequency of cuff pressure measurements should be detected in further studies.

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