Middle Ear Pressure and Factors Affecting It in Intubated Patients Hospitalized in Intensive Care

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Abstract

Objective: To assess the probable agents affecting middle ear pressure in intubated patients hospitalized in intensive care units with various diagnoses.

Methods: Middle ear pressure of 38 patients hospitalized in intensive care units within our faculty hospital was measured using portable tympanograms and acoustic reflectometry. The mode of the device to which each patient was attached and patients’ blood pressure, Glasgow Coma Score, and additional disease parameters other than admission diagnosis were recorded. All data collected were subjected to statistical analysis to determine whether or not they affected middle ear pressure.

Results: Septal deviation, survey, and mode of automatic respiratory device emerged as factors affecting middle ear pressure (odds coefficient 4.796, 3.745, 2.557, respectively, with 95% CI). Although aged over 60, additional disease and nasogastric tube also compromised middle ear pressure; the levels involved were not statistically significant.

Conclusion: Middle ear pressure in patients hospitalized in intensive care units may change, particularly after the seventh day. This may particularly involve septal deviation, survey, and mode of automatic respiratory device, and tympanograms and reflectometry may be added to the patient-monitoring protocol in terms of changes in middle ear pressure.

Key Words: Middle ear pressure, intubation, intensive care

Introduction

Patient monitoring and treatment are important for patients in intensive care units, and they require a multidisciplinary approach. Because these patients, who are mostly attached to respiratory devices, can not communicate, some organs, like the ears, may be ignored while monitoring life-threatening respiratory, cardiac, and cerebral activities. In this case, hearing loss may become functional and complicated and lead to vital problems, like brain abscess (1).

Otitis media (OM) is a pathology that is common among children but rare in adults. The Eustachian tube’s being shorter and horizontal and less mature in children than in adults can be considered one of the causes of this frequent incidence (2, 3). As for adults, only nasopharynx tumors; secondary problems, such as rhinosinusitis; and persistent otitis media existing since childhood years can lead to middle ear pressure and effusion (4). Although otitis media decreases with antibiotic therapy, the occurrence rate of intracranial complications, such as meningitis and brain abscess, is quite high, as are extracranial complications, like hearing loss and tinnitus (5, 6).

While acute OM or middle ear effusion (MEE) occurs at a rate of 25%-43.3% in intensive care patients, this ratio increases to 80%, especially in the patients with nasal intubation (3, 7). In intensive care patients, effusion is affected by factors, including nasogastric intubation, age, and consciousness status, in addition to changes in the middle ear (7). The number of studies related to these factors is limited. In addition, there is no prospective study that has been conducted with multiple factor analysis, including supportive factors except gender, the mode of the artificial ventilation device, septal pathology, whole blood, blood pressure, and hospitalization diagnosis. Consequently, our purpose in this study is to evaluate middle ear pressure and the factors affecting this pressure in intubated patients hospitalized in the intensive care units due to various diagnoses.
Methods
After ethics committee approval was received for this study from the ethics committee of Dicle University Faculty of Medicine (Ethics committee: 17.12.2012/33), 38 patients hospitalized with various diagnoses in the intensive care units of surgery, internal medicine, neurology and anesthesiology in Dicle University Medical Faculty Hospital between the years of 2012 and 2013 were intubated, and the presence of middle ear pressure and effusion was investigated. Before examining the patients and measuring middle ear pressures, written informed consent was obtained from the families. Otoscopic examinations of patients were performed. If there was a plug in the external auditory canal, it was removed with clar head light and port-cotton or curette, and then, the structure and flexibility of the tympanum was assessed with pneumatic otoscopy. On the 1st, 7th, and 14th days after intubation, middle ear pressure was measured with a portable tympanogram, named MT10, and acoustic reflectometry (Intacoustic, DIC 5610, Assens, Denmark), and the appearance of the tympanum was assessed with otoscopy.

Type A and spectral gradient angle above 95 degrees were evaluated as normal ear examination.

Middle ear effusion is characterized by the occurrence of fluid concentration in the posterior tympanum, with type B tympanogram and spectral gradient being lower than 70 degrees. Type C is in tympanic cavities, in which peak values are negative in consistency with negative pressure, and it is characterized by spectral gradient lower than 70 degrees.

The patients who were younger than 18 years, who had otitis media and underwent ear operation in their medical histories, and who had head and neck tumors, particularly in the nasopharynx, were excluded from the study. Other patients apart from these conditions were included in the study.

Moreover, ages, genders, and diagnoses of the patients; presence of accompanying additional diseases; intubation and nasogastric tube numbers; and mode of the respiratory devices were identified. The survey of the patients was evaluated with Glasgow Coma Scale and then recorded.

Statistical Analysis
Descriptive statistics of continuous variables were demonstrated in the values of mean and standard deviation (SD). Discrete variables were converted into crosstables and analyzed with Yates corrected chi-square test. The mean values of the variables were evaluated with student’s t-test. Odds coefficients for the risk variables, such as intubation catheter, Glasgow Coma Scale, nasogastric catheter, septal pathology, age, whole blood, and mode of respiratory device, were measured with binary logistic regression method. While applying the method, all variables were included in the model, and backward method was implemented for analysis. The hypotheses were bilateral, and the value of p≤0.05 was considered to be statistically significant. Statistical analyses were performed using SPSS 15.0 for Windows (SPSS Inc., Chicago, IL, USA).

Results
The mean age of the patients was 58.8±21.5 years. Of them, 25 were female and 13 were male. The relationship between gender and middle ear pressure variables was not found to be significant (p=0.343) (Table 1). The factors affecting middle ear pressure were septal deviation, survey, and mode of respiratory device. Odds coefficients in the confidence interval of 95% were 4.796, 3.745, and 2.557, respectively, which were significant and effective (Table 2). Respiration rate, blood pressure, Glasgow Coma Scale, application of nasogastric catheter, and number of nasogastric catheters were not statistically significant (p>0.05) (Table 3).

It was observed that middle ear pressure (MEP) began to change negatively as of the 5th-7th days, and it reached the maximum level in 7-10 days. The mean intubation time was 15-152 days (mean: 44 days). Following these negative pressure changes in the middle ear beginning from the 7th day, effusion began to occur on the 14th day. In 8 of these patients, effusion was detected in both ears simultaneously. Twelve patients did not have effusion and negative pressure. Six patients had unilateral effusion. In 12 patients, negative pressure was found, which varied between -100 and -400 daPa (Table 4). In 6 of 8 patients with bilateral effusion, both septal deviation and nasogastric catheter were found. Although 10 of 12 patients having only negative pressure had a nasogastric catheter, they were the patients who...
Deterioration of the general medical condition (survey) was the factor affecting middle ear pressure (odds risk factor 3.745). Apart from mechanical factors influencing middle ear pressure, gas absorption, posture, and especially disruption of the microcirculation system of the middle ear can have a role in this result (10). Mode of respiratory device, in accordance with the general medical condition (odds risk factor 2.557), is an important determinant in the formation of middle ear pressure. In our study, we found controlled mandatory ventilation, in which the initiation, maintenance, and completion of inspiration was machine-controlled, as the most common mode associated with hypoventilation. Moreover, mechanical ventilation usually leads to moderate hypocapnia and inhibits spontaneous respiration. Hypocapnia affects middle ear pressure in a negative way (9). The second cause is that the patient’s loss of consciousness or intake of sedative drugs contributes to the nasopharyngeal tube dysfunction by influencing the neuromuscular system or disrupting swallowing function, which causes negative middle ear pressure and effusion (7, 9). In our study, middle ear pressure changed in intubated patients, and OM or MEE developed in the presence of an additional factor.

Intubation lasting for more than 14 days and clouding of consciousness contributed to the formation of middle ear effusion. This result shows the significance of the duration of irritation and edema in the nasopharynx. In the study conducted by Lin et al. (7), after the 7th day, which was considered prolonged intubation, OM developed only in 1 patient. In the patients intubated for 14 days and longer, OM occurred on the 10th day. Their results support those in our study. Similarly, Hsiung et al. (11) reported that the frequency of middle ear pressure decreased from 46% to 22% in the patients for whom intubation was replaced by tracheotomy.

Age over 60 years can improve the existing pathology by affecting the resistance of many body functions. However, we observed that this became more evident in the cases having a poorer general condition. Detection of effusion in 8 of 20 patients was good, they were extubated early.

Despite the fact that those aged over 60 years constituted a greater risk group, this risk was not statistically significant (p>0.05). In 8 of the patients older than 60 years, MEE (middle ear effusion) occurred.

Twenty-two patients were intubated approximately after the 21st day, and MEP was disrupted in all of them except 2 patients. Of 10 patients who had a nasogastric catheter, 3 patients displayed unilateral MEP and 2 displayed bilateral MEP. In 5 of these patients, MEP was not affected. Moreover, no statistical relationship was detected between intubation tube number and MEP (p>0.05).

**Discussion**

The results of this study revealed that middle ear pressure was influenced, and the incidence rates of OM and MEE were high in intubated patients hospitalized in the intensive care unit for more than 14 days who underwent septum deviation and had poor general medical condition. This made us think that possible local and systemic causes of endotracheal intubation emerged as the result of insufficient mechanical and metabolic ventilation by mucosal hypoxia. Both Christensen (3) and Cavaliere (6) stated that Eustachian tube dysfunction and migration of pathogenic flora from the nasopharynx to the middle ear had a role in the pathology of middle ear pressure. Eustachian tube dysfunction can make middle ear pressure negative and can cause aspiration of nasopharyngeal material. There are some factors affecting the mechanism of Eustachian tube dysfunction. First, in intubated patients, mechanical ventilation (air flow dynamic change) increases the mucus viscosity by influencing mucociliary function and thus creates secretion accumulation or drainage impairment (3, 6). Moreover, mechanical ventilation usually leads to moderate hypocapnia and inhibits spontaneous respiration. Hypocapnia affects middle ear pressure in a negative way (9). The second cause is that the patient’s loss of consciousness or intake of sedative drugs contributes to the nasopharyngeal tube dysfunction by influencing the neuromuscular system or disrupting swallowing function, which causes negative middle ear pressure and effusion (7, 9). In our study, middle ear pressure changed in intubated patients, and OM or MEE developed in the presence of an additional factor.

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the tympanum and middle ear pressure by otoscopy and tympanometry are also important for intensive care patients. Further studies including larger populations and long-term monitoring are needed on this issue.

**Ethics Committee Approval:** Ethics committee approval was received for this study from the Ethics Committee of Dicle University Faculty of Medicine. (17.12.2012/33)

**Informed Consent:** Written informed consent was obtained from relatives of the patient who participated in this study.

**Peer-review:** Externally peer-reviewed.


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