

Original Article

Effect of laryngoscopy on middle ear pressure during anaesthesia induction

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Abstract: Aims: The procedure of laryngoscopic orotracheal intubation (LOTI) has many impacts on several parts of the body. But its effect on middle ear pressure (MEP) is not known well. The purpose of this study is to evaluate the MEP changes subsequent to insertion of endotracheal tube with laryngoscope. Subjects and methods: 44 patients were included in this study with a normal physical examination of ear, nose and throat. A standard general anaesthesia induction without any inhaler agent was performed to the all patients. The MEP measurements for both ears were applied under 1 minute; before induction (BI) and after intubation (AI) with a middle ear analyzer. Also hemodynamic parameters were recorded before induction and after intubation. Results: Of the 44 patients were 25 women and 19 men with a 43.5 ± 15.1 mean age. A statistically significant rise in MEP was seen in all patients subsequent to insertion of endotracheal tube ($P < 0.05$). Mean right MEPs were BI: -9.5 and AI: 18.5 daPa. Also mean left MEPs were BI: -21.7 and AI: 29.1 daPa. The amount of increases in left and right MEPs were 50 daPa and 27 daPa, respectively. 20% increase in systolic blood pressure and 19% increase in diastolic blood pressure were determined after intubation. The mean heart rate was 76/min before intubation, whereas it was 102/min after intubation with a 34% increase. Conclusion: In this study bilateral significant increases in MEP were determined subsequent to LOTI. Possible factors affecting MEP may be auditory tube, size and type of the blades, drugs and face masking time. But on the other hand in our opinion cardiovascular and haemodynamic response to LOTI has the most impact over the middle ear mucosa with mucosal venous congestion.

Keywords: Middle ear pressure, laryngoscopy, intubation, endotracheal tube, adult

Introduction

Laryngoscopic orotracheal intubation (LOTI) has several side effects during anaesthesia management as a time-limited procedure. After laryngotracheal irritation rapid sympathetic discharge leads to a prominent cardiovascular response with hypertension and tachycardia [1]. Otherwise performing LOTI can cause changes in intraocular and intracranial pressure [2, 3]. These stress responses can be very diverse in relation to the patient health status and presence of coexisting diseases [4]. Increase in middle ear pressure (MEP) may cause some undesirable clinical outcomes. MEP changes may lead postoperative intractable nausea and vomiting [5]. Furthermore rupture of membranes, and even facial nerve dam-

ages may occur as a result of significant and longterm increases in MEP [6, 7].

The effect of LOTI on MEP isn't known sufficiently like its other effects. In this study it was aimed to determine the effect of LOTI on MEP during anaesthesia induction.

Subjects and methods

The study was performed on 44 adult American Society of Anaesthesiologists' (ASA) classification I-II patients aged between 18 to 60 years after obtaining approval of the ethics committee of the institution. Patients were included into the study after a normal otomicroscopic examination for both ears and a normal airway evaluation. Exclusion criteria for participants

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Table 1. Middle ear pressure changes with statistical analysis

Time	Middle Ear Pressures (daPa)		p
	Right	Left	
Before induction	-9.52±28.3	-21.75±59.55	>0.05
After intubation	18.59±87.35	29.14±32.7	>0.05
p	<0.05*	<0.001*	

Paired t-test was used to compare right and left middle ear pressures (MEP) in different times. All values are given as mean±standard deviation. *P<0.05 were considered statistically significant.

included any evidence of ear pathology, infection, history of trauma to the head and ear, use of any medication for an ear disease and anticipated difficult airway.

After a 6-h preoperative fast, intravenous midazolam (0.1 mg/kg) was used for premedication 15-30 minutes prior to induction in the operating theatre. Electrocardiogram, non-invasive blood pressure, end tidal CO₂ and oxygen saturation were performed for monitorization. A standard anaesthesia was performed to the all patients in the supine position. After preoxygenation propofol 2.5 mg/kg and fentanyl 2 mcg/kg were used during induction. Rocuronium with a rapid sequence intubation dose (1.2 mg/kg) was performed before tracheal intubation to minimize the effect of masking time. When train-of-four (TOF) value was zero, approximately 30-45 seconds after masking, LOTI was performed by an experienced specialist within 30 seconds. During masking period FiO₂ value was 1 and flow was 5 l/min without any inhaled agent.

A middle ear analyzer (mi 34, Maico diagnostics) at tympanometry mode was used for measurements of both ears intratympanic pressures before induction (BI), and after intubation (AI). All measurements were performed by the same assistant. Also systolic blood pressures and pulse rates were recorded before induction and after intubation. Demographic datas were collected, including age, weight, gender and ASA class. During supine position the head was positioned on an adult head ring gel. The operating table position was the same during all measurements to ensure a uniform procedure. A maximum of 1 minute was allowed between the two ears measurements to provide closer measurement time.

The MEP measurements for right and left ears in all positions were compared using paired t-test.

A value of p<0.05 was considered statistically significant.

Results

Of 44 patients were 19 males (43.2%) and 25 females (56.8%). The average age was 43.5±15.1 years with range between 19-60 years. The mean weight was 73.53±12.76/kg.

Statistical analyzes were performed for both middle ears before and after intubation and also for difference between the two middle ears.

After intubation a significant increase was observed for both MEPs and the increase was higher in the left MEP (29.1 daPa) than the right MEP (18.5 daPa). The BI - AI comparison was statistically significant for both ears (P<0.05). The amount of increases in left and right MEPs were respectively 50 daPa and 27 daPa. Comparison of MEP between the both ears was not significantly different before and after intubation (P>0.05) (**Table 1**).

Changes in haemodynamic values such as heart rate and blood pressure were similar with MEP increases. A close relationship was obtained between haemodynamic parameters and MEP response. But statistical analysis of the haemodynamic parameters was not significant (P>0.05). Before intubation mean systolic blood pressure was 121 mmHg for all patients and mean diastolic blood pressure was 71 mmHg. After intubation mean systolic blood pressure was 146 mmHg and mean diastolic pressure was 85 mmHg (**Table 2**).

Approximately 20% increase in systolic blood pressure and 19% increase in diastolic blood pressure were detected after intubation. The mean heart rate was 76/min before intubation, whereas it was 102/min after intubation with a 34% increase.

Discussion

Airway manipulations such as laryngoscopy, endotracheal intubation and insertion of airway devices, may lead to multiple side effects even in experienced hands. These complications can occur early and late period of the procedure. Most of them related to the trauma of the devices to the tissues such as the eyes, facial

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Table 2. Statistical summary of the haemodynamic parameters

Time	Heart rate (bpm)	Systolic blood pressure (mmHg)	Diastolic blood pressure (mmHg)
Before induction	76±12	121±19	71±8
After intubation	122±21	146±24	85±12
p	>0.05	>0.05	>0.05

All values are given as mean±standard deviation.

soft tissues, tooth, cervical spine, larynx and pharynx. Other the most known complications are periglottic edema, laryngeal function abnormalities and infections those can be seen after extubation [8]. While there are many reports related to the these adverse situations, our study is the first to investigate the effect of LOTI on MEP during general anaesthesia induction. Our estimation before starting the study was to detect an increase in the MEP during anaesthesia induction. The results and statistical analysis were found in line with the expectations. Pressure increases started with induction of anaesthesia and reached the highest values after intubation. Hereafter the possible factors those affect the MEP will be discussed. Likely factors include; effect of ET, increase in the pressure of the mucosal veins due to venous congestion, effect of inhaler agents and transmucosal gas exchange. Although the mechanisms responsible for increases in the MEP are not exact, some factors may provide critical perspectives. These factors are associated with manipulation of the laryngoscope in the airway and insertion of the endotracheal tube into the trachea. In addition to these, ventilation time with mask and induction drugs may have low-level roles in MEP increases.

According to Benumof, a procedure with six components is needed for 'best attempt' respectively: experienced expert, relaxed muscles, most suitable position of airway, external laryngeal assistance, blade with appropriate size and type [9]. Even if the togetherness of all these components is present, a rise may occur in the MEP during laryngoscopy or after endotracheal intubation. LOTI leads to intense changes in cardiovascular and haemodynamic status due to tissue irritation in supraglottic region and the trachea. Also procedures in the airway generate hypertension and tachycardia as a result of the response of the cardioaccelerator nerves and sympathetic ganglia [10, 11]. On the other hand the effects of LOTI occur in the brain with changes in electroencephalo-

graphic waves and rise in cerebral blood flow [12]. Increase in the mucosal volume of the middle ear is one of the accepted mechanisms about MEP changes. [13]. As a result of all the above an increase in venous pressure occurs in the middle ear mucosa, consequently an increase occurs in MEP.

Auditory tube (AT); other probable cause for the increase, has an apparent role on MEP regulation in healthy individuals. Its function is connection the rhinopharynx and the middle ear by the action of the tensor veli palatini muscle (TVP) and regulation of MEP balancing during swallowing [14]. The function of AT was showed by Pau et al in healthy persons [15]. During anaesthesia induction function of AT have to be blocked due to effect of muscle relaxant over the TVP which is a striated muscle. The study of Ghadial et al could constitute a basis for this conjecture [16]. They have used botulinum toxin to paralyse the TVP and have determined a reduction in MEP. Eventually AT has a minimal share in MEP regulation in our study. Another issue about AT is the mechanical effect of the laryngoscope. When laryngoscope is placed along the airway, an impact consists on the tissues around the nasopharyngeal. This pressure of laryngoscope may result with AT opening. The increase in the right MEP was higher than the left MEP. This difference suggests the effect of laryngoscope. Because while performing LOTI, it was placed on the left along the airway. Currently all these are suppositions and if a research is applied with an appropriate imaging technique during LOTI, the answers to the many questions will be reached.

The type of blade has an effect on haemodynamic response. The study of Nishiyama et al provides an insight about this topic. They have reported that use of curved blades result lesser haemodynamic response than do straight blades [17]. In this study curved blades were used during procedure. Maybe effect of the use of a straight blade can alter the increases in the

haemodynamic and also in the MEP. In addition to this aspect tracheal tube placement is more irritant than mechanical pressure of the laryngoscope [18]. Its effect on the haemodynamic response may be more compared to the blades effect. To minimize the effect of the tracheal tube placement, 7.5 mm and 8.0 mm tubes were used in the study.

The duration of masking may have an effect on increase with air pressure degree. Lin et al study give some idea about pressure severity [19]. They have measured MEP with AT function under different air pressures with continuous positive airway pressure mask. They have found a direct proportional relationship with air pressure and MEP increase. In another article no apparent impact on MEP was found among different airway devices [20]. But studies are needed about face masking time effect on MEP which is 3-5 minutes.

Theoretically, a gas exchange across the tympanic membrane is likely, but in an experimental study it was found that its level could be negligible [21].

In conclusion, pressure changes in the middle ear seen in this study were probably the result of cardiovascular and haemodynamic response to LOTI over the middle ear mucosa with mucosal venous congestion.

Disclosure of conflict of interest

None.

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