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Middle ear pressure changes with sevoflurane and propofol-remifentanil

M. Dogan[1], *C. Duger*[2], *I. O. Uysal*[1], *I. Ozdemir Kol*[2] *and S. Yuce*[1]

[1]Department of Otorhinolaryngology, [2]Department of Anesthesiology, Cumhuriyet University, School of Medicine, Sivas, Turkey

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Abstract. *Middle ear pressure changes with sevoflurane and propofol-remifentanil*. The present study aimed to compare the effects of sevoflurane (a commonly used inhalation anesthetic) and intravenous propofol on middle ear pressure (MEP) and determine the more appropriate option for middle ear operations. Fifty-seven American Society of Anesthesiologists risk class I-II patients aged 18-65 years who were not scheduled for ear or tympanic membrane operations were included in the study. The patients were randomly divided into two groups using the sealed envelope method. Propofol (0.2-0.5 mg/kg; Group P) and sevoflurane (1-2%; Group S) were used to maintain anesthesia. Baseline tympanometry was conducted on both ears and recorded before anesthesia was induced. Four additional measurements were performed and recorded at 5, 10, 15, and 30 minutes after induction. All post-induction MEP values were significantly higher than baseline measurements in Group S ($P<0.05$ for all); there were no differences between post-induction and baseline measurements in Group P. At 10, 15, and 30 min post-induction, MEP values were significantly higher in Group S than in Group P ($P<0.05$). Sevoflurane increased MEP values significantly compared with propofol anesthesia. We conclude that propofol can be used more reliably than sevoflurane in middle ear operations.

Introduction

Middle ear pressure (MEP) stability is an important issue during middle ear operations.[1,2] Anesthesia and anesthetic drugs have varying effects on several parts of the human body,[3-6] and many factors may affect MEP during an operation under general anesthesia. Anesthetic agents particularly affect the middle ear area;[4,5] the effects of such agents change based on variables related to the medicine used (e.g., the type of the agent, administrative process, and amount administered), as well as individual and environmental factors. Both inhaled and intravenous (IV) anesthetics cause various effects on MEP.[1,4] Increases in MEP can cause serious complications during middle ear operations; it is desirable for the anesthetic agent used to have the minimum possible effect on MEP, in order to avoid additional problems.[1,2]

The effects of inhalation anesthetics and IV anesthetics on MEP have been compared before. Inhalation anesthetics have been found to cause an undesired increase in MEP during middle ear operations.[4] While published studies have compared various inhalation anesthetics to each other, the present study compares the effects of sevoflurane and propofol on MEP. The aim of the present study was to compare the effects of sevoflurane (a commonly used inhalation anesthetic) and IV propofol on MEP, in order to determine which option is more appropriate for use during middle ear operations.

Materials and methods

After we obtained approval from the institutional ethical committee and written consent from the patients, we enrolled 60 patients (18-65 years old) in the American Society of Anesthesiologists (ASA) I-II risk class who were not scheduled for ear or tympanic membrane operation in the study. Patients with a history of middle ear or tympanic membrane operation, hypertension, diabetes, or mastoiditis were excluded from the study. Patients were randomly separated into two groups of 30 patients each. Group assignments and randomization were conducted during a preoperative examination using the sealed envelope method. No sedation was used before the operation. Patients' mean arterial pressure (MAP), heart rate (HR), and peripheral oxygen saturation (SPO_2) values were monitored and recorded. In all the patients, baseline MEP values were measured in both ears using a tympanometry device (Maico MI 44, USA) and

recorded in the operating room before the induction of anesthesia, while they were awake. In Group S, thiopental sodium 5 mg/kg, fentanyl 1 mcg/kg, and rocuronium 0.6 mg/kg were used to induce anesthesia; in group P, propofol 2 mg/kg, remifentanil 1 mcg/kg, and rocuronium 0.6 mg/kg were used to induce anesthesia. All patients were intubated. The duration of intubation was recorded in minutes. After the induction of anesthesia, Group S patients received 1.25 MAC sevoflurane during maintenance of anesthesia. Group P patients were administered a propofol infusion (0.2-0.5 mg/min) and remifentanil (0.5-1 mcg/kg/min) during maintenance. All patients received 100% O2 during maintenance; N_2O was not administered because it might affect the tympanometric pressure. Three additional tympanometric measurements were conducted and recorded at 5, 10, 15, and 30 minutes of anesthesia induction. An ear nose throat (ENT) physician who was blinded to the study groups collected all tympanometric measurements. Measurements were obtained from both ears of 30 patients in Group P and Group S separately. Data were compared separately for the patients' left and right ears. Tympanometric measurements were determined using a Jerger type A curve on normal MEP ranges between -200 and +200 decapascals (daPa). The total duration of operation was recorded for all patients.

A power analysis was performed to determine the number of patients to be included in the study groups. The analysis led to the decision to include 30 patients in each group; a total sample size of 60 patients was considered statistically appropriate (α=0.01, β=0.20, 1- β=0.80). The power of the test was p=0.80467. The data were analyzed statistically using SPSS software (version 14.0). Mann-Whitney U (inter-group) and Wilcoxon tests (intra-group) were used to analyze the data. P-values <0.05 were considered statistically significant.

Results

A total of 57 patients were included in the study after two patients in Group P (n=28) and one patient in Group S (n=29) were excluded because we were unable to conduct the measurements correctly during the study period. When the patients' demographic data and duration of operation and intubation were compared, no differences were observed (Table 1). The groups also did not differ regarding HR, MAP, or SPO2 recorded during the operation.

MEP values at 5, 10, 15, and 30 minutes were significantly higher than the baseline measurements obtained before induction in Group S (p<0.05 for all). In contrast, there was no difference between the post-induction and baseline values in Group P (Figures 1, 2).

When the groups' MEP values of both ears were compared, no differences were observed between the values obtained at baseline and at 5 minutes post-induction; however, the MEP values at 10, 15, and 30 minutes were significantly higher in Group S than in Group P (Figures 1, 2).

Discussion

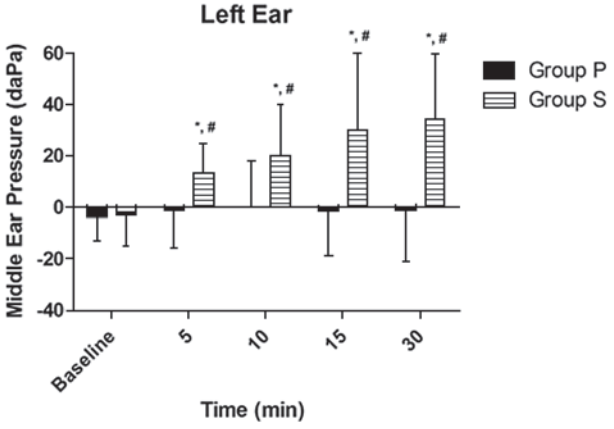
This study compared inhaled sevoflurane with the totally intravenous anesthesia (TIVA) propofol regarding their effects on MEP measurements. Propofol was not associated with MEP changes, in

Table 1

Demographic characteristics and duration of operation

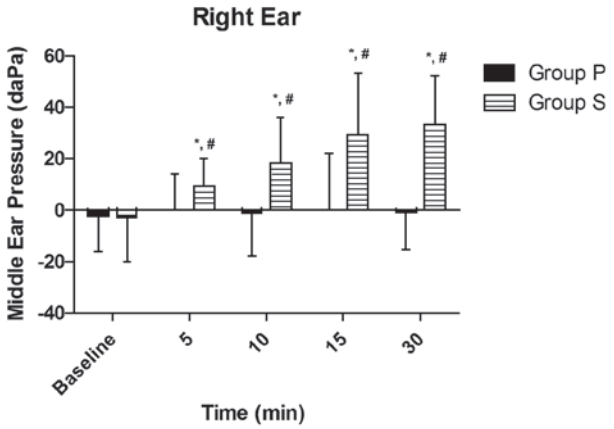
	Group P (n=28)	Group S (n=29)	P
Age, years	43.59±12.1	43.62±11.2	0.902
Women/Men	14/14	13/16	0.973
Height, cm	165.72±9.1	167.46±9.6	0.317
Weight, kg	76.9±11.8	78.2±12.3	0.562
ASA class I/II	10/18	9/20	0.928
Duration of operation, min	52.5±17.1	53.1±17.3	0.919

Note. Sex and ASA class data are presented as n.
Age, height, weight, and duration of operation data are presented as mean ±SD.



* p<0.05 compared with baseline values.
# p<0.05 compared with Group P.

Figure 1
Middle ear pressure values of left ears



* p<0.05 compared with baseline values.
# p<0.05 compared with Group P.

Figure 2
Middle ear pressure values of right ears

contrast to sevoflurane. Therefore, propofol may be a safer anesthetic than sevoflurane in the context of middle ear surgeries.

It is important to note any changes in MEP during an operation because pressure changes during middle ear surgery can result in serious complications, such as hemotympanium, tympanic membrane rupture, displacement of tympanic membrane graft, and temporary or persistent hearing loss.[1] During tympanostomy tube surgery of an ear with effusion, an increase in MEP may cause the disappearance of effusion and improper tube positioning.[4,7] For these reasons, it is important to use an anesthetic agent that has the least possible effect on MEP during middle ear operations.

Inhalation anesthetics cause an increase in MEP compared with IV anesthetics.[2,4,8] Jellish *et al*.[9] compared IV propofol-fentanyl and propofol-remifentanil with standard inhalation anesthetics during middle ear surgeries and reported that IV anesthetics had more hemodynamic and clinical advantages. Ozturk *et al*.[4] found that sevoflurane increased MEP similar to other inhalation agents and reported that TIVA with propofol is safer than sevoflurane anesthesia during middle ear operations. Although the results of the study of Ozturk *et al*.[4] appear similar our present findings, there is an important difference: they studied children (4-11 years old), while our study included adult patients (18-65 years old).

Karabiyik *et al*.[8] observed no pressure differences in a study in which they used TIVA with propofol-alfentanil. They concluded that TIVA decreased the problems associated with inhalation anesthetics during these operations.

Contrary to the studies reporting that IV anesthetics have advantages during middle ear surgeries and minimal effect on MEP, a comparison of IV anesthetics and inhalation anesthetics by Chinn *et al*.[10] stated that they have similar intraoperative and hemodynamic effects and that the use of short-acting inhalation anesthetics (e.g., isoflurane and desflurane) could obtain excellent results. In contrast to this rare finding, it is generally reported in the literature that IV anesthetics are more advantageous for the middle ear than inhalation anesthetics. Under these circumstances, preferring IV anesthetics over inhaled anesthetics during middle ear operations is the correct decision.

A study by Albera *et al*.[11] that evaluated the effects of sevoflurane and propofol on cochlear blood circulation found that sevoflurane had a higher protective effect on inner ear microcirculation. Several studies evaluating the effects of inhalation anesthetics have obtained different results.[12-15] Similarly, miscellaneous studies have revealed that IV anesthetics have more positive results than inhalation anesthetics.[2,4,11]

Inhalation anesthetics easily pass to the middle ear during anesthesia maintenance and increase MEP. In a 2007 study that focused on desflurane's effects on MEP, Ozturk *et al*.[15] observed that desflurane increased MEP significantly. Acar *et al*.[1] compared the effects of desflurane and isoflurane

and found that isoflurane increased MEP significantly compared with desflurane.

In conclusion, sevoflurane increased MEP values significantly compared with propofol anesthesia. We conclude that propofol can be used more reliably than sevoflurane during middle ear operations.

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Dr. Mansur Dogan
Department of Otorhinolaryngology
Cumhuriyet University, School of Medicine
Sivas, Turkey
E-mail: mansurdogan@hotmail.com