Comparing the effects of desflurane and isoflurane on middle ear pressure

Confronto tra gli effetti del disflurano e dell’isoflurano sulla pressione dell’orecchio medio

B. ACAR, S. DEGERLI1, S. SAHIN1, R.M. KARASEN
Department of Otorhinolaryngology; 1 Department of Anaesthesiology and Reanimation, Kecioren Training and Research Hospital, Ankara, Turkey

SUMMARY

The aim of this study was to determine middle ear pressure changes during the operation performed under anaesthesia induced by isoflurane or desflurane. This was a prospective, case–control study. A total of 38 children with no middle ear pathology scheduled for inguinal hernia surgery were included in the study. Group I (n = 22) received isoflurane and Group II (n = 16) received desflurane. Baseline tympanometry was performed before the anaesthesia on both ears, and tympanometry was repeated 5, 10 and 15 minutes after the administration and 10 and 30 minutes after the withdrawal of anaesthetic agents. Data were analyzed using the Mann-Whitney U (inter-group) and the Wilcoxon test (intra-group) procedures. The mean middle ear pressure values in the 44 ears of the 22 children in group I and the 32 ears of the 16 children in Group II did not show any significant difference before the anaesthesia by either anaesthetic agent (p > 0.05). Increase in the mean middle ear pressure values at the 5th and 10th minute of the operation was significant different between both groups (2.84 and 5.80 daPa for isoflurane; 59.06 and 72.81 daPa for desflurane; p ≤ 0.05). Desflurane is more increased than isoflurane on intra-tympanic pressure and isoflurane may be used more safely than desflurane in middle ear operations. The low effect of isoflurane on intra-tympanic pressure can be explained by the high blood/gas partition coefficient compared to desflurane.

KEY WORDS: Middle ear surgery • Middle ear pressure • Inhalant anaesthesia • Isoflurane • Desflurane

INTRODUCTION

In middle ear surgical procedures, preferred anaesthetic agents may be important to change the middle ear status, haemo-tympanum, serous otitis, temporary or permanent hearing loss, may dislocate tympanic membrane grafts, or may cause failure in the ossicular chain 1-4. Therefore, the anaesthesiologist should use an anaesthetic agent that would result in a minimal intra-tympanic pressure. Middle ear pressure (MEP) variations due to inhalant anaesthesia have been reported by several investigators. Previous investigations have mostly been performed with nitrous oxide, halothane, sevoflurane, desflurane and total intravenous anaesthetics with propofol 5-7. These studies have suggested that most anaesthetic agents cause an increase in middle ear pressure. Desflurane is a volatile anaesthetic agent with low solubil-
ity that allows rapid induction and fast emergence from anaesthesia. Another volatile anaesthetic, isoflurane, also has a higher solubility than desflurane. The aim of this study was to investigate MEP changes during inguinal hernia surgery performed under anaesthesia induced by either isoflurane or desflurane.

Material and methods
After having obtained the approval from the Institutional Review Board, 38 children (age range 2-13 years) undergoing elective inguinal hernia surgery were enrolled in the study. Content was obtained from the parents or legal guardians of the patients, and approval was obtained from children older than 7 years after explanation of the study rationale. Physical ENT examinations were then carried out on each participant.

Exclusion criteria
Exclusion criteria were as follows:
1) nasal septal deviation;
2) adenotonsillar hypertrophy;
3) otoscopic evidence of a perforated tympanic membrane or other middle-ear pathology, such as effusion;
4) a flat tympanogram, or absence of acoustic reflexes at 1 kHz with contra-lateral stimulation.

The patients were equally divided and randomly assigned to one of two groups. All patients received an anaesthetic composed of thiopental 5 mg/kg, fentanyl 3 μg/kg iv for induction of anaesthesia, and rocuronium bromide 0.6 mg/kg for intubation. After intubation, the maintenance anaesthesia was provided for group I (10 female, 12 male) by isoflurane 2-3%, and for group II, (8 female, 8 male) desflurane 6-9%. Fresh gas flows were 5 litres/minute in a 50% air/oxygen mixture. Neither group received inhalation induction. The patients had an oro-gastric tube to decompres the stomach.

Tympanometric functions were performed by an audiometrist using a TympStar Version 2 Middle Ear Analyzer (Grason Stadler) clinical impedance meter Denmark to check the standard immittance screening of the middle ear of the patient. Tympanometric tests were determined using a Jerger type A curve on normal middle ear pressure ranges between -100 and +50 decapascals (daPa).

Baseline tympanometry reading was performed on each ear just before the anaesthesia in supine position. For both groups, tympanometric measurements were assessed 5, 10 and 15 minutes after administration and 10 and 30 minutes after withdrawal of the anaesthetic agents. Statistical analyses were performed using the SPSS 15.0 for Windows. The data were analyzed using the Mann-Whitney U (inter-group) and Wilcoxon tests (intra-group). P values < 0.05 were considered significant.

Results
There were no demographic or surgical differences between groups as far as concerns sex, operation time, and duration of anaesthesia (p > 0.05), except for age. The patient demographics are shown in Table I. No significant difference was found between the MEP values of the two groups before the anaesthesia (p > 0.05). Mean MEP values in the desflurane group, at pre-operative measurements were -0.16 ± 39.1 daPa and they increased to 59.06 ± 74.4 daPa and 72.81 ± 79.8 at the 5th and 10th minute of sur-

Table I. Patient demographics.

|                      | Isoflurane group (n = 22) | Desflurane group (n = 16) | p    |
|----------------------|---------------------------|---------------------------|------|
| Sex (Female/Male)    | 10/12                     | 8/8                       | 0.697|
| Age (yrs)            | 4 ± 2.0                   | 8.91 ± 4.0                | 0.002|
| Operation time (min) | 32.45 ± 13.6              | 32.55 ± 10.4              | 0.933|
| Anaesthesia duration (min) | 40.55 ± 12.9            | 39.73 ± 10.0              | 0.750|

Table II. Middle ear pressure values in isoflurane and desflurane group (daPa)±SD.

|                        | Isoflurane group (n = 44) | Desflurane group (n = 32) | p     |
|------------------------|---------------------------|---------------------------|-------|
| Pre-operative          | -3.64 ± 47.7              | -0.16 ± 39.1              | 0.912 |
| 5th minute intra-op.   | 2.84 ± 79.3               | 59.06 ± 74.4              | 0.014 |
| 10th minute intra-op.  | 5.80 ± 63.2               | 72.81 ± 79.8              | 0.003 |
| 15th minute intra-op.  | 31.36 ± 85.6              | 82.03 ± 80.3              | 0.069 |
| 10th minute post-op.   | 23.52 ± 76.3              | 67.34 ± 83.5              | 0.004 |
| 30th minute post-op.   | 13.06 ± 60.8              | 46.56 ± 82.8              | 0.012 |

SD: standard deviation.
gery, respectively. All these measurements were significantly higher than the starting value (p < 0.05). Compared to desflurane, in the isoflurane group, there was no significant increase (p > 0.05). At the 5th and 10th minute intra-operatively and 10th and 30th minute post-operatively, there was a significant elevation in MEP in the desflurane group compared to the isoflurane group (p < 0.05). The data are presented in Table II.

Discussion

In recent years, selective γ-aminobutyric acid (GABA) antagonists – desflurane, halothane, isoflurane – were used as volatile anaesthetic agents. Volatile agents are frequently used in general anaesthesia practice without complications. Inhalation anaesthetics are less expensive, simpler to use, and offer comparable intra-operative conditions to intravenous anaesthesia techniques. However, they continue to have adverse effects on intratympanic pressure. Anaesthesia with desflurane is associated with a faster emergence and maintenance of a stable surgical field with mild controlled hypotension. Previous studies have demonstrated that desflurane may increase the MEP, which is consistent with our results. These findings have raised concerns that using volatile anaesthetic agents may aggravate MEP in middle ear surgical procedures. We found that desflurane is associated with a greater increase in the MEP levels when compared with isoflurane. Isoflurane is a selective GABA_A antagonist. With regard to intra-tympanic pressure effects, it should be stated that experience with isoflurane is more limited than with other anaesthetic agents.

The increase in MEP levels after anaesthesia was seen to be significantly higher in the desflurane group than in the isoflurane group. MEP levels after desflurane anaesthesia were elevated in the intra-operative fifth and tenth minute and post-operative tenth and thirtieth minute; however, there was an increase in MEP levels compared to after isoflurane anaesthesia.

Conclusion

The results from this study have shown that isoflurane has a lower effect compared to desflurane, on intra-tympanic pressure. Isoflurane has an MEP taming effect, in middle ear surgery, and may be preferred if control of MEP is a concern. Further experimental studies are required to prove the diffusion of inhaled anaesthetics to the middle ear.

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Address for correspondence: B. Acar M.D., Department of Otorhinolaryngology, Kecioren Training and Research Hospital, Pınarbaşı mahallesı Sanatoryum caddesi Ardahan sok.no:1 Kecioren 06310, Ankara, Turkey. Fax: +90 312 356 90 22. E-mail: drbaranacar@gmail.com