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# The effect of desflurane on postoperative olfactory memory

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**Abstract. – OBJECTIVE: In this study, we investigated the effects of desflurane 6%, on olfactory memory.**

**PATIENTS AND METHODS: This is a prospective clinical study performed with 40 patients aged 18-60 who had elective surgery and American Society of Anesthesiologists (ASA) physical status I-III. The Brief Smell Identification Test (BSIT) was used for evaluating patients' olfactory memories before and after the surgery. Patients received standard general anesthesia protocol and routine monitoring. For induction, 1.5 mg/kg of fentanyl, 2 mg/kg of propofol, and 0.5 mg/kg of rocuronium bromide were administered. Anesthesia was maintained with the inhalational of anesthetic desflurane (6%). The scores are recorded 30 minutes before the surgery and when the Aldrete Recovery Score reached 10 in the postoperative period. Preoperative and postoperative results were compared and *p*-values <0.05 were considered statistically significant.**

**RESULTS: The patients' mean age was 41.1±12.0. Preoperative total correct answer rate to odorous substances was 92.7%, and postoperative rate was 92.1%. Percentage of the odor substance identification by the patients revealed no statistically significant difference when pre and post-operative rates have been compared (*p*-value >0.05).**

**CONCLUSIONS: We have observed for the first time in the literature that general anesthesia using desflurane (6%) did not affect short-term olfactory memory. Further studies will be necessary to confirm our findings with larger sample size.**

Key Words:
Anaesthetics volatile, Desflurane, Olfactory memory, Smell.

## Introduction

Inhalation agents are prevalently used for every kind of surgical procedure. This condition is important in that they enable short-term and reliable recovery in addition to complete recovery of complex physiological events. The olfactory sense is one of the indispensable functions of human beings, which effect the quality of life. Despite reports indicating deleterious effects of inhalation agents on amnesia, taste and olfactory memory, this assertion has not been clinically proved so far[1]. In the literature, the occurrence of anosmia has been reported as 4%, being more frequent in advanced ages[2].

Olfactory impulses are perceived in the regio olfactoria of the nose and then these impulses are transported into bulbus olfactorius in the brain. From there, they are transmitted via tractus olfactorius and stria olfactorius (medialis, lateralis, intermedia) into the olfactory cortex. Olfactory memory is situated in piriform cortex, amgydala and entorrhinal cortex[3-5]. Smell is the only one of the five senses, which is transmitted directly into cortical areas from bulbus without passing through thalamus[6].

Among volatile anesthetics, desflurane is known for its annoying and keen odor[7]. Besides it suppresses somatosensory evoked potentials in humans[8]. Because of this characteristic feature, its impact on cognitive functions has been reported in many studies performed[9,10].

There is an experimental study examining the effects of desflurane on olfactory memory, but clinical trials are not available yet. In this work, we investigated the effects of desflurane 6% on olfactory memory.

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### Patients and Methods

Ethical approval was provided by the Clinical Ethical Committee of the University (No: 2014/65-226) for this prospective study. All participants provided a written informed consent and the research was conducted in accordance with the ethical principles described by the Declaration of Helsinki. This clinical study was performed on 40 American Society of Anesthesiologists (ASA) physical status I-III patients between 18 and 60 years of age undergoing a planned elective minor surgery. Patients with nasal infections and structural abnormalities (rhinitis, polyp, deviation), alcohol and substance addiction, congenital, neurological, endocrinologic and psychiatric diseases, chronic inflammatory diseases, syphilis, tuberculosis and diabetes, history of head trauma and cases whose operations lasted less than 40 min, but longer than 120 min were excluded from the study.

Forty-five minutes before the operation, the patients were brought into the recovery room and Brief Smell Identification Test (BSIT) (Turkish version) was performed on patients so as to evaluate olfactory memory. In line with the explanations on the head space of the BSIT test booklet, the test procedure was carefully described to the patients. BSIT test booklet consists of 12 pages. Beneath the label sticked on each page of the booklet, names of the four different odors, indicated with a, b, c and d are written. The upper face of the label was scratched with a sharp tipped pencil and the patient was requested to smell the odor. The patients were also asked to tick the item indicating the perceived smell or the item closest to the perceived smell. This procedure was repeated for all pages and the responses obtained were recorded.

The patients taken into the operating room were monitorized via measurement of noninvasive blood pressures, electrocardiography and pulse oximetry. Intravenous access site was opened and standard general anesthesia was applied. For induction, 1.5 mg/kg fentanyl and 2 mg/kg propofol were administered. Following achievement of adequate muscle relaxation with rocuronium bromide (0.5 mg/kg), tracheal intubation was performed. Respiration rate was set so as to achieve a tidal volume of 6-8 ml/kg and end-tidal volume of $CO_2$ 35-45 mmHg and the patient was connected to a mechanical ventilator. Anesthesia was maintained with 6% desflurane in a mixture of 50% $N_2O/O_2$ Following intubation, heart rate (HR) and mean arterial pressure (MAP) were measured and recorded at certain intervals. The patient was decurarized using atropine sulfate (0.015 mg $kg^{-1}$) and neostigmine (40 mcg $kg^{-1}$) and when an adequate depth of respiration was achieved, the patient was extubated. The patient was brought into the recovery room and BSIT test was repeated when the Aldrete Recovery score was attained 10 points which enabled evaluation of olfactory memory.

**Table I.** Demographics and clinical characteristics of the patients.

| | |
|---|---|
| Number of patients (n) | 37 |
| Gender (Male/Female) | 13/24 |
| Age | 41.1±12.0 |
| Weight | 166.3±6.7 |
| Height | 77.2±13.3 |
| Duration of surgery (min) | 69.0±27.0 |
| ASA 1-2-3 | 20/15/2 |
| | |
| Type of surgery | |
| Abdominal surgery | 14 (%37,8) |
| Orthopedic surgery | 14 (%37,8) |
| Herniated disc surgery | 9 (%24,4) |

### Statistical Analysis

Data analysis was performed using the Statistical Package for the Social Sciences (SPSS 15.0, SPSS Inc., Chicago, IL, USA) program. Descriptive variables were shown in the form of mean ± standard deviation and a paired samples t-test was used for their analysis (age, height, weight, HR, MAP and duration of surgery). Goodman and Kruskaltau were tested with analysis of BSIT points. The results were considered statistically significant for a $p$-value < 0.05.

## Results

In a prospective study where enrollment of 40 patients in the study was planned, one patient who declined and two patients whose operative times exceeded normal operative times were not included in the study. Therefore, the study was completed with 37 patients. The demographic and clinical characteristics are given in Table I ($p$-value >0.05).

The patients' average preoperative and intraoperative HR were 84.4±14.9 and 76.0±14.1, respectively ($p$-value >0.05); while, the mean preoperative and intraoperative MAP were 95.9±14.6 and 80.6±13.7, respectively ($p$-value >0.05). In the evaluation of olfactory memory, BSIT scores me-

asured before surgery were considered as a baseline and compared with the BSIT scores measured, when the postoperative Aldrete score became 10. No statistically significant difference was observed in the correct odor answer ratio between the preoperative and postoperative periods ($p$-value >0.05) (Table II).

The rate of correct answers of patients to the BSIT test was found as 92.7% before the operation, this rate was 92.1% after the operation. Patients experienced difficulty in recognizing the smell of "leather". The ratio was 78.4% in the preoperative period and post-operatively 75.7%.

## Discussion

This study has demonstrated that the use of desflurane does not affect olfactory memory. Olfactory memory is very important for the maintenance of daily physiological functions and its contribution to the quality of life. By this means, stimuli coming from the environment are perceived, favorable or unfavorable experiences are transmitted into the brain. Decreased (hyposmia), lack of (anosmia) perception of smell or its alteration (dysosmia) increase patient's distress[1]. Correct perception of smell requires intactness and proper functioning of all components of smell. The first step in the perception of smell involves entry of smell molecules into the olfactory region after passing through the nasal cavities. They dissolve in mucus on olfactory epithelium and get in contact with olfactory receptor cells. By this means chemical information about smell molecules creates an action potential in smell receptor cells which is transported via olfactory nerve into smell centers in the brain with the resultant perception of smell[11,12]. This complex structure is influenced by many factors which might lead to olfactory dysfunction. Among them structural abnormalities, allergic rhinitis and nasal polyps, infections, metabolic disorders as cystic fibrosis, tumors, neurological disorders as Parkinson disease and multiple sclerosis, endocrinologic disorders as diabetes mellitus and hyperthyroidism, congenital diseases, traumas as nasal fractures, various drugs, psychiatric problems, chemical gases, industrial dusts and smoking can lead to this condition[13,14].

In the evaluation of olfactory function, tests which assess the patients' ability to perceive smell are frequently used. BSIT which was prepared in consideration of cultural differences is one of these tests[15]. This test which is also known as the Cross-Cultural Smell Identification Test (CC-SIT) involves 12 different odors[16]. Bilgi et al[17] evaluated postoperative olfactory memory and function following isoflurane anesthesia using BSIT which is a standardized smell test and reported that this drug did not effect short-term olfactory memory. Doty et al[18] indicated sensitivity and specificity of BSIT as 82 percent. In the present study, we used Turkish version of BSIT which evaluated cultural and regional differences in our country.

Volatile anesthetics are generally well tolerated by the patients, however though rarely unexpected complications can be seen. These agents demonstrate their effects via gamma-aminobutyric acid (GABA), glutamatergic and adrenergic neuro-

**Table II.** Preoperative BSIT score and postoperative BSIT score when it reaches 10 of Aldrete score.

| Item No | Odor | PreoperativeNo (%) | Postoperative Aldrete scores 10 No (%) | $p$-value |
|---|---|---|---|---|
| 1 | Mint | 36 (97.3) | 36 (97.3) | |
| 2 | Banana | 35 (94.6) | 34 (91.9) | |
| 3 | Clove | 36 (97.3) | 35 (94.6) | |
| 4 | Leather | 29 (78.4) | 28 (75.7) | |
| 5 | Strawberry | 33 (89.2) | 34 (91.9) | |
| 6 | Pine | 36 (97.3) | 35 (94.6) | |
| 7 | Cinnamon | 34 (91.9) | 35 (94.6) | $p$-value>0.05 |
| 8 | Soot | 35(94.6) | 35 (94.6) | |
| 9 | Lemon | 34 (91.9) | 34 (91.9) | |
| 10 | Soap | 37 (100) | 36 (97.3) | |
| 11 | Baby powder | 35 (94.6) | 36 (97.3) | |
| 12 | Rose | 32 (86.5) | 31 (83.8) | |
| Total | Correct identification | 412 (92.7) | 409 (92.1) | |

transmitter system Increase in intracranial pressure is known to effect memory and learning functions[19,20]. As is seen with other volatile anesthetics, desflurane decreases cerebrovascular resistance leading to an increase in cerebral blood flow and intracranial pressure[21,22]. It has been demonstrated that desflurane decreases cerebrovascular resistance particularly via 1 MAC leading to increase in intracranial pressure[23]. Also, desflurane also suppresses evoked somatosensory evoked potentials[8]. Our purpose of using desflurane in our study was to investigate the impact of the drug on the increase in intracranial pressure and somatosensory potentials and the extent of its reflection on olfactory memory.

Michael et al[24] examined the effects of five inhalation anesthetics on learning abilities and memory of rats. They reported that relatively higher doses of sevoflurane, halothane and desflurane have negative effects on learning, while 0.44% desflurane has adverse and significant effects on memory. They also indicated that amnesic effect is milder that of nitrous oxide and stronger than that of other inhalation anesthetics. Callaway et al[25] investigated dose-dependence of desflurane anesthesia in rats. They showed that the effects of desflurane on learning and memory were age- and dose-dependent. However, in the present study, we have found that the use of desflurane at clinical doses (6% MAC) has not any effect on olfactory memory during the early postoperative period.

In the literature, a small number of clinical data are available about the impact of the anesthetic agents and technique (general, regional or neuroaxial) on olfactory memory. Demirhan et al[26] investigated the impact of anesthetic technique on olfactory function and reported that spinal anesthesia did not effect olfactory memory. However, some experimental studies[27] have indicated that among general anesthetic drugs, fentanyl and propofol depressed olfactory response. Volatile anesthetic drugs have been blamed to cause olfactory dysfunction; however, this assertion has not been proved clinically. In the literature 2 cases[28,29] of postanesthetic anosmia have been reported so far. Kontantinidis et al[28] reported the presence of anosmia in a 60-year-old female patient who had undergone urological surgery. The patient received general anesthesia using fentanyl, propofol and sevoflurane and reported that the development of anosmia might stem from the direct impact of sevoflurane on olfactory epithelium with resultant peripheral type olfactory dysfunction. In the present study, following desflurane use, in none of the patients anosmia was observed in the short-term.

Limitations of our study can be enumerated as scarcity of our patient population, lack of investigation of both use of various doses of desflurane for longer periods and also their postoperative long-term effectiveness.

## Conclusions

We have observed for the first time in the literature that general anesthesia using desflurane (6%) did not affect short-term olfactory memory. Further studies will be necessary to confirm our findings with larger sample size.

### Conflicts of interest

The authors declare no conflicts of interest.

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