Kocatepe Tıp Dergisi
Kocatepe Medical Journal
24:89-95 / Ocak 2023 Sayısı

ARAŞTIRMA YAZISI / RESEARCH ARTICLE

NAZAL CERRAHİLERDE MİNİMAL, DÜŞÜK VE YÜKSEK AKIMLI ANESTEZİNİN VÜCUT SICAKLIĞI VE DOKU OKSİJENLENMESİ ÜZERİNE ETKİLERİ

THE EFFECTS OF MINIMAL, LOW AND HIGH FLOW ANESTHESIA ON BODY TEMPERATURE AND TISSUE OXYGENATION IN NASAL SURGERIES

Gül KESİMAL, Leyla KAZANCIOĞLU, Hızır KAZDAL, Şule BATÇIK, Tolga KOYUNCU

Recep Tayyip Erdoğan Üniversitesi Tıp Fakültesi, Anesteziyoloji ve Reanimasyon Ana Bilim Dalı

ÖZET

AMAÇ: İntraoperatif yüksek taze gaz akışı istemsiz perioperatif hipotermi (İPH) oluşumuna neden olabilir. Bu nedenle anestezi iklimini iyileştiren düşük ve minimal akımlı anestezi yöntemleri uygulanmaktadır. Elektif nazal cerrahi geçiren hastalarda minimal, düşük ve yüksek akımlı anestezinin vücut sıcaklığı ve doku oksijenasyonu üzerine etkisini araştırmayı amaçladık.

GEREÇ VE YÖNTEM: Prospektif randomize kontrollü çalışmaya hipotansif anestezi altında, elektif nazal cerrahi planlanan 18-60 yaş, ASA 1-2, operasyon süresi 1-4 saat olan 92 hasta dahil edildi. Hastalar, Grup1(0.5L dk^{-1}), Grup2(1L dk^{-1}) ve Grup 3(2L dk^{-1}) olarak ayrıldı.Hastaların demografik ve operatif verileri, preoperatif bekleme odası sıcaklığı, intraoperatif ameliyathane sıcaklığı, intraoperatif vücut sıcaklığı, anestezi solunum devresi nemi ve sıcaklığı, doku oksijen satürasyonu, 0.,15.,30.,60.,90.,120.,150. Dakika(dk) ve postoperatif dönemde titreme, Aldrete skoru, derlenme ünitesindeki oda sıcaklığı ve vücut sıcaklıkları kaydedildi

BULGULAR: Hastaların tümünde perioperatif hipotermi gelişti (p=0.001). Her üç gruptada timpanik sıcaklıklar benzerdi(p>0.05). Alt grup karşılaştırmasında Grup 1'in StO_2 60. dk değerinin Grup 2'ye göre yüksekti (p=0,046). Grup 1'in doku oksijen düzeyi (StO_2) 90.dk değerinin grup 2 ve 3'ten yüksek olduğu istatistiksel olarak anlamlı olduğu belirlendi (p=0.013, p=0.013). Grup 1'in StO_2 120.dk değerinin grup 3'ten yüksek olması istatistiksel olarak anlamlıydı (p=0,008). Grup 1'de postoperatif Aldrete skoru diğer iki gruba göre anlamlı derecede yüksek bulundu(p=0.002, p=0.002). Vücut sıcaklığı ile ameliyathane oda sıcaklığı,postoperatif derlenme oda sıcaklığı arasında korelasyon saptandı(r=.446, p<0.05; r=.531, p<0.01).

SONUÇ: Minimal, düşük ve yüksek akımlı anestezi uygulamalarında hipotansif anestezi ile elektif nazal cerrahi uygulanan tüm hastalarda istemsiz perioperatif hipotermi gelişti. Tüm gruplarda vücut sıcaklıkları, nem ve anestezi devresinin sıcaklığının benzer olduğu gözlendi. Minimal akımlı anestezi grubunda doku oksijen saturasyonu ve postoperatif derlenme ünitesinde Aldrete skoru daha yüksek bulundu. Minimal akımlı anestezi uygulamaları İPH önlemek için iyi bir alternatif olabilir.Ancak düşük akımlı anestezi tekniklerinin doku düzeyindeki etkileri için daha fazla çalışmaya ihtiyaç olduğunu düşünmekteyiz.

ANAHTAR KELİMELER: Oksijen satürasyonu, Düşük akımlı anestezi, Minimal akımlı anestezi, Hipotermi

ABSTRACT

OBJECTIVE: Intraoperative high fresh gas flow may cause Inadvertent perioperative hypothermia (IPH). For this reason, low and minimal flow anesthesia methods that improve the anesthesia climate are applied. We aimed to investigate the effects of minimal, low and high flow anesthesia on body temperature and tissue oxygenation in patients undergoing elective nasal surgery.

MATERIAL AND METHODS: Prospective randomized controlled study included 92 patients aged 18-60 years, ASA1-2 operation time 1-4 hours, scheduled for elective nasal surgery under hypotensive anesthesia. The patients were divided into Group 1 (0.5$Lmin^{-1}$), Group 2 (1$Lmin^{-1}$) and Group 3 (2 $Lmin^{-1}$). Demographic and operative data of the patients, preoperative waiting room temperature, intraoperative operating room temperature, intraoperative body temperature, anesthesia breathing circuit humidity and temperature, tissue oxygen saturation, 0th, 15th, 30th, 60th, 90th, 120th, 150thmin and postoperative shivering, Aldrete score, room temperature and body temperatures in the recovery unit were recorded.

RESULTS: Perioperative hypothermia developed in all patients (p=0.001). Tympanic temperatures were similar in all three groups (p>0.05). In the subgroup comparison, it was found that the tissue oxygen saturation (StO_2) 60 th min value of Group1 was higher than Group 2 (p=0.046). It was found statistically significant that the StO_2 90 th min value of Group1 was higher than that of Group 2 and 3 (p=0.013, p=0.013). It was statistically significant that the StO2 120th min value of Group1 was higher than Group 3 (p=0.008).In Group1, postoperativeAldrete score was found to be significantly higher than the other two groups(p=0.002, p=0.002). A correlation was found between operating room temperature, postoperative recovery room temperature, and body temperature(r=.446, p<0.05;r=.531, p<0.01).

CONCLUSIONS: Inadvertent perioperative hypothermia developed in all patients who underwent elective nasal surgery with hypotensive anesthesia in minimal, low and high flow anesthesia applications. It was observed that body temperatures, humidity and the temperature of the anesthesia period were similar in all groups. Tissue oxygen saturation was higher in the minimal flow anesthesia group and Aldrete score was higher in the postoperative recovery unit. Minimal flow anesthesia applications can be a good alternative to prevent IPH. However, we think that more studies are needed for the effects of low-flow anesthesia techniques at the tissue level.

KEYWORDS: Oxygen saturation, Low-Flow anesthesia, Minimal-Flow anesthesia, Hypothermia

Geliş Tarihi / Received: 12.02.2021
Kabul Tarihi / Accepted: 28.05.2022
Yazışma Adresi / Correspondence: Dr. Leyla KAZANCIOĞLU
Recep Tayyip Erdoğan Üniversitesi Tıp Fakültesi, Anesteziyoloji ve Reanimasyon Ana Bilim Dalı
E-mail: leyla.kazancioglu@erdogan.edu.tr
Orcid No (Sırasıyla): 0000-0001-5663-4510, 0000-0002-3833-0692, 0000-0002-0759-4716, 0000-0003-1110-6786, 0000-0002-0019-9684
Etik Kurul / Ethical Committee: Recep Tayyip Erdoğan Üniversitesi Etik Kurulu (23.12.2016 /39).

INTRODUCTION

Inadvertent perioperative hypothermia (IPH) is frequently observed in patients undergoing general anesthesia. IPH is a decrease in body temperature below 36ºC from the preoperative period to the postoperative period (1). Factors such as cold operating room, intravenous fluids and irrigation solutions, and heat lost from the surgical field cause hypothermia. High flow, dry and cold respiratory system air applied during general anesthesia may increase incidence of hypothermia.

During general anesthesia, dry and cold air disrupts mucociliary activity in the lungs and may cause postoperative lung problems. Therefore, low and minimal flow anesthesia is an alternative to high flow anesthesia to maintain the temperature and humidity of respiratory gases (2). Low-flow anesthesia is less costly and less harmful to the environment. Complications can be noticed earlier as a result of careful patient follow-up (3). On the other hand, low-flow anesthesia may cause hypoxemia due to insufficient oxygen alarms in anesthesia devices (4). In nasal surgeries, hypotensive anesthesia is used to increase surgical vision. IPH with hypotension causes peripheral vasoconstriction. This event results in peripheral perfusion impairment. Although there was no change in core temperature with peripheral cooling in human volunteer studies; Significant decreases in tissue oxygen saturation (StO_2) were detected with peripheral vasoconstriction (5). Lambert et al. found some inconsistencies in the follow-ups of end-tidal carbon dioxide ($EtCO_2$), peripheral oxygen saturation (SpO_2) and StO_2 in patients who were sedated. Patients with respiratory depression who used supportive airway measures had greater changes in StO_2. Therefore, they concluded that StO_2 may be more sensitive than SpO_2 (6). In our study, we aimed to investigate the effects of high, low and minimal flow anesthesia methods on body temperature and StO_2 in patients who underwent hypotensive anesthesia and had elective nasal surgery.

MATERIALS AND METHODS

Patients (n:92) who were planned for nasal surgeries under hypotensive anesthesia were included the study. Patients whose physical status was American Society of Anesthesiologists (ASA) classification 1-2 and who were planned for an operation time of 1-4 hours were included in the study. In this prospective, controlled study, patients were randomized using the 30-person Research Randomizer program. Chronic obstructive pulmonary disease, decompensated diabetes mellitus, coronary and peripheral artery disease, congestive heart failure, thyroid dysfunction, significant anemia, alcohol-drug addiction, patients during pregnancy and lactation, those with signs of active infection, body temperature>37.5ºC and <35.5ºC, body mass index (BMI) other than 19-27, patients who could not be measured reliably by infrared tympanic membrane thermometer were excluded from the study.

Anesthesia Management

Standard perioperative follow-up procedure was applied to the patients. Premedication was not applied. Intravenous (iv) cannula was placed in the operating room. Before anesthesia induction, tympanic membrane temperature measurements were made with a braun thermoscan 5 ear thermometer. Demographic and operative data such as age, gender, BMI of the patients (duration of anesthesia, duration of operation, iv total fluid administered), preoperative waiting room temperature and intraoperative operating room temperature were recorded. As standard monitoring, systolic/diastolic arterial blood pressure, three-lead electrocardiography, SpO_2, StO_2 and tissue hemoglobin index (THI) monitoring were performed with the In Spectra™ StO_2 Spot Check Model 300 (Hutchinson, USA) device using the NIRS method over the probe attached to the left thenar region. A Dräger Primus anesthesia device was used. TFA 30.5013 Digital Thermo-Hygrometer was placed at the end of the intubation tube. The temperature and humidity of the gases in the system were measured and recorded. Device calibration, CO_2 absorber (Sorbo-Lime) replacement, breathing circuit and disposable filter replacement were performed for each patient. Before induction, patients were preoxygenated with 100 % O_2 for 3 minutes (min). Anesthesia induction remifentanil loading dose 1 µg kg-1 (30 seconds), propofol 2 mg kg^{-1}, rocuronium bromide 0.6 mg kg^{-1} were administered iv. Endot-

racheal intubation was performed. TFA 30.5013 Digital Thermo-Hygrometer was connected to the end of the intubation tube and the humidity and temperature values of the circuit were measured. With mechanical ventilation settings in volume-controlled mode, 6mL kg^{-1} tidal volume and 5 cmH_2O positive end-expiratory pressure were applied according to ideal body weight. Respiratory frequency was set to be in the range of $EtCO_2$ 35-45 cmH_2O. For minimal flow anesthesia, denitrogenation was applied for 10 min after induction, and a high flow of 4 L min^{-1} was applied for depth of anesthesia. The patients were divided into 3 groups as Group 1: minimal flow anesthesia (0.5L min^{-1}), Group 2: low flow anesthesia(1L min^{-1}) and Group 3: high flow anesthesia (2L min^{-1}). After reducing the flows, FiO_2 values were adjusted as 40 % in the low and high flow group and 50% in the minimal flow group. When the inspiratory O_2 value approached 30, the rate was increased to 10 %. Nitrous oxide was not used.

Anesthesia was maintained with controlled hypotension, desflurane MAC 4-5 and remifentanil 0.25-0.5 µg kg^{-1} min^{-1} iv infusion with a mean arterial pressure (MAP) of 60-65 mmHg. It was planned to discontinue the remifentanil infusion if the baseline value of MAP decreased more than 30%, and if no increase in blood pressure was observed, 10 mg iv ephedrine was administered. It was planned to interrupt the remifentanil infusion if the heart rate (HR) fell below 45 beats min^{-1}, and if the pulse rate did not increase, 1 mg of iv atropine was administered. Intraoperative HR, SpO_2, MAP, $EtCO_2$, body temperature, anesthesia breathing circuit humidity and temperature, StO_2 and THI values of the patients at 0th(post intubation), 15th, 30th, 60th, 90th, 120th, 150th min recorded. The vaporizer was turned off 10 min before the end of the surgery, and the flow was increased to 6L min^{-1} at the end of the surgery. For decurarization, patients were administered 15 µg kg^{-1} iv atropine and 50 µg kg^{-1} iv neostigmine. Extubation was performed with the return of spontaneous breathing and protective reflexes. In the postoperative period, shivering score, Alderete score, room temperature in the recovery unit and body temperature of the patients in the recovery unit were recorded.

Ethical Committee

This study was conducted after obtaining Recep Tayyip Erdoğan University Non-Interventional Clinical Research Ethics Committee, dated 23.12.2016 and decision number 2016/39.

Statistical Analysis

NCSS (Number Cruncher Statistical System) 2007 (Kaysville, Utah, USA) software was used for statistical analysis. While evaluating the study data, the distribution of the data was evaluated with the Shapiro-Wilk Test, as well as the descriptive statistical methods (Mean, Standard Deviation, Median, Frequency, Ratio, Minimum, Maximum). Chi-Square test was used for group comparisons of qualitative data. Kruskal-Wallis test and Friedman test were used to compare the quantitative data with three or more groups that did not show normal distribution. One Way ANOVA test was used for the comparison of three or more groups with normal distribution of quantitative data. Bonferonni corrector was used to determine the differences. Wilcoxon test was used for comparison of quantitative data between two periods that did not show normal distribution. Significance was evaluated at the $p<0.05$ level. Spearman's test was used for correlation analysis, $p<0.05$ level was evaluated as significant.

RESULTS

One hundred two patients were included in the study. 10 patients were excluded from the study because they did not meet the study criteria. Data from 92 patients were analyzed **(Figure 1).**

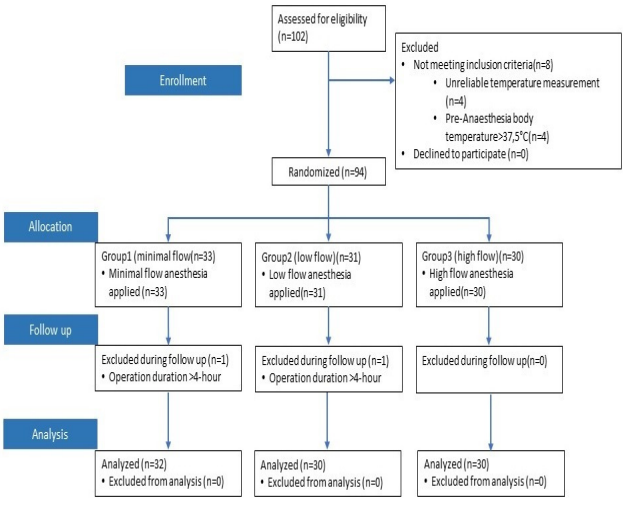

Figure 1: Consort Flow Diagram

The mean age of the patients was 37.8 ± 14.4 years, and the mean BMI was 24.42 ± 2.34 kg m^{-2}. The mean room temperature in the operating room was 20.86 ± 2.21 °C. The mean anesthesia time was 114.82 ± 47.6 min, and the operation time was 110.87 ± 46.36 min. In comparisons between groups, the mean scores of age, weight, height, BMI and ASA scores were similar in all three groups (p>0.05). It was statistically notable that the anesthesia and operation time of group 1 were higher than those in group 2 (p=0.008, p=0.038;respectively). Aldrete score of Group1 was statistically significantly higher than Group 2 and 3 (p=0.002, p=0.002;respectively), **(Table 1)**.

Table 1: Demographic and operative characteristics of patients [mean±standard deviation, number (%)]

	Group 1 (n = 32)	Group 2 (n = 30)	Group 3 (n = 30)	p
Age (year)	38.59±14.2	35.53±15.74	37±13.58	0.641
Gender				
Female	9 (%28.1)	18 (%60)	10 (%33.3)	0.024*
Male	23 (%71.9)	12 (%40)	20 (%66.7)	
Weight (kg)	73.9±11.3	69.8±9.6	72.2±9.2	0.317
Height (cm)	173.3±8.3	169.2±7.8	171.8±8.9	0.170
BMI(kg m^{-2})	24.5±2.8	24.3±2.5	24.4±1.7	0.317
ASA I/II (n)	17/15	12/18	13/17	
Anesthesia Duration(min)	132.06±48.99	101.87±41.49	109.37±47.86	0.025*
Operation Duration(min)	126.5±47.31	99.2±41.02	105.87±47.24	0.038*
Total iv fluid infusion (mL)	1689.06±336.43	1523.33±316.7	1555±372.4	0.060
Aldrete skoru	9.69±0.47	9.3±0.47	9.3±0.47	0.002**

Kruskal Wallis Test, *p<0.05, **p<0.01
(ASA: American Society of Anesthesiologists score, BMI: body mass index, min:minute, iv:intravenous)

The tympanic temperature at the 120th min value differed statistically between the groups (p=0.036). In the subgroup comparison, it was found statistically significant that the tympanic temperature 120th min value of group1 was lower than that of group 2 (p=0.033) **(Table 2)**.

Table 2: Intraoperative tympanic temperature values (mean ± standard deviation)

	Group 1 (n=32)	Group 2 (n=30)	Group 3 (n=30)	p
0th min	36.87±0.37	36.89±0.57	36.88±0.42	0.982
15thmin	36.41±0.46	36.58±0.42	36.55±0.37	0.245
30thmin	36.31±0.43	36.46±0.54	36.44±0.41	0.386
60thmin	36.3±0.53	36.45±0.45	36.4±0.42	0.474
90thmin	36.26±0.49	36.33±0.57	36.42±0.49	0.620
120thmin	36.11±0.54	36.67±0.43	36.36±0.5	0.036*
150thmin	35.96±0.63	36.47±0.49	36.47±0.33	0.080

OneWay ANOVA Test, *p<0.05, **p<0.01, (min:minute)

The StO_2 15th min value of group1 was higher than group 2 was found to be statistically notable (p=0.033). In the subgroup comparison, it was found statistically significant that the StO_2 60th min value of Group 1 was higher than that of Group2 (p=0.046). It was found statistically significant that the StO_2 90th min value of group1 was higher than that of groups 2 and 3 (p=0.013, p=0.013;respectively). It was statistically significant that the StO_2 120th min value of group 1 was higher than group 3 (p=0.008) **(Table 3)**.

Table 3: Intraoperative StO2 values (mean ± standard deviation)

	Group 1 (n=32)	Group 2 (n=30)	Group 3 (n=30)	p
0thmin	89.25±5.32	87.4±5.89	86.5±6.2	0.168[b]
15thmin	90.13±5.01	86.47±6.93	87.43±4.71	0.033*[b]
30thmin	90±4.87	87.13±6.59	87.27±4.83	0.071[b]
60thmin	90.09±4.91	86.9±4.87	87.27±5.44	0.028*[b]
90thmin	90.4±4.75	86.41±5.73	83.82±8.33	0.011*[a]
120thmin	91.42±5.04	88.78±5.19	86.18±7.26	0.021*[a]
150thmin	92.23±3.32	89.43±5.35	90.5±4.97	0.472[a]

OneWay ANOVA Test (b), Kruskal Wallis Test (a), *p<0.05, **p<0.01
(min:minute)

A notable correlation was found between the operating room temperature and the tympanic temperature at the 150th min (r=.446, p<0.05). A significant correlation was found between the recovery room temperature and the body temperature in the recovery room (r =.531, p<0.01).

DISSCUSSION

All of our patients who underwent elective nasal surgery under hypotensive anesthesia developed IPH. It was determined that body temperature was associated with operating room temperature and postoperative recovery room temperature. It was observed that minimal, low and high flow anesthesia applied in our study did not have a significant effect on body temperature. However, it was found that StO_2 and Aldrete score at the time of admission to the postoperative recovery unit were higher in patients who underwent minimal flow anesthesia. Today, IPH occurs frequently during anesthesia applications. Its incidence is approximately 40-70% (7,8). In our study, IPH developed below 36 °C in all of our patients. Despite the use of modern methods (low and minimal flow anesthesia) and equipment, IPH is a problem. It is recommended to apply modern warming techniques to the patients from the preoperative period to the postoperative period. Aksu et al. investigated the incidence of postoperative hypothermia in the operating room of Kocaeli University. The body temperatures of the patients who were operated for one month were measured tympanically. The operating room temperatures were kept at an average of 23 °C. However, they emphasized that since room temperatures can be changed manually, there may be temperature changes in terms of surgeon and employee comfort. The incidence of

hypothermia was found to be 45.7% ; 2.7% of the patients were found to be hypothermic in the preoperative period. In addition, the time taken for the patients in the recovery unit to reach the discharge criteria was found to be approximately 10 minutes longer than in normothermic patients (9). Wang et al. evaluated patient temperatures in living donor hepatectomy operations at different operating room temperatures. They compared the two groups in which the room temperatures were maintained as 19-21°C and 24 °C. They found a difference of at least 0.5 °C between nasopharyngeal measurements of body temperatures (10). In another study, age-related differences in thermoregulation were investigated in a warm operating room environment. It was concluded that an operating room temperature of around 26 °C would prevent IPH (11). Our operating room temperatures were in a wide range between 17-24 °C and IPH developed in our patients. The correlation between the operating room temperature and the measured tympanic temperatures supports the importance of room temperature in line with the literature. Considering the cost and difficulty of active warming methods, higher operating room temperatures may be a cost-effective method to maintain patients' body temperature. Reducing fresh gas flow (FGF) rates is the most basic method to improve the airway climate. If high FGF is required, monitoring of anesthesia circuit equipment will be required along with methods such as active or passive heating of the circuit (12). According to Kleeman, inadequate airway conditioning and damage to the tracheobronchial epithelium are preventable complications of anesthesia (2). The aim is to preserve the mucociliary physiology (13). Therefore, the risk of postoperative atelectasis may increase with decreased gas exchange in the lungs (14, 15). In patients undergoing general anesthesia, passive, active humidification or low-flow anesthesia is recommended to maintain the physiological temperature and humidity of inspired gases. There are no exact values for the temperatures and absolute humidity of the inspired gases during mechanical ventilation. However, the American Respiratory Care Association reported that a heated humidifier should be used to provide 34-41°C inhaled gas temperature and 33-44 mgH_2O/L water vapor in the Y part of the circuit for an intubated patient (16). Choi et al. evaluated the differences in heat and moisture content of gases inspired by low-flow anesthesia using four different anesthesia machines. They concluded that there is no difference between breathing circuit temperature and humidity in low and high flow anesthesia, but some anesthesia machines are superior (17). In tympanoplasty cases where Lafçı et al. applied low (1L/min^{-1}) and high(6L/min^{-1}) flow desflurane anesthesia; A significant increase was found in the anesthesia circuit temperature and humidity parameters in the low flow group (18). Bengtson et al. (19) using 0.5 L/min^{-1}(minimal), 2L/min^{-1}(high) and 5L/min^{-1}(very high) FGF, found that there was sufficient humidification at 2L/min^{-1} (high) and below. When the flow is increased to 5 L/min (too high), the humidity did not rise to a sufficient level. Johanson et al (20). The effect of heat and moisture exchange filters on humidity and body temperature in low flow anesthesia was investigated. While the circuit temperature and humidity were maintained with heat and humidity exchange filters, no significant difference was found in all groups in tympanic measurements after 120 minutes of anesthesia (20). It is noteworthy that the FGF compared in the above-mentioned studies are quite different from each other. For example, when comparing 2L/min^{-1} to 5 L/min^{-1} FGF, it is not surprising that the results are different. In our study, high FGF was limited to 2 L/min^{-1}, as methods suitable for modern anesthesia practice were compared. The fact that there was not much difference between our fresh gas flows was effective in the result. Therefore, we think that the circuit temperature and humidity are similar between the groups.

Biological, clinical and cellular effects of low flow anesthesia applications continue to be investigated. There are also studies evaluating these effects of low flow anesthesia. In a study investigating the effects of minimal and high flow anesthesia on cerebral oxygenation, it was observed that the effects of both flows were similar (21). Low and high flow anesthesia with desflurane was compared in adult tympanomastoidectomies. It has been reported that

low-flow anesthesia improves pulmonary function and mucociliary clearance (22). In another study, adults undergoing thyroidectomy were given low-flow anesthesia with desflurane. A significant increase in plasma nitric oxide values occurred 24 hours after the operation (23). There are studies in the literature that follow low-flow anesthesia methods with FiO_2 values. Kim J et al. reported that under low-flow anesthesia, the inspired oxygen concentration in 180 min could be maintained at values of approximately 30 % and above in patients weighing less than 90 kg (24). Microperfusion from the tissue-level cellular effects of low-flow anesthesia; The patient's hemodynamic data can be evaluated using parameters such as lactate, StO_2 and microdialysis(25 - 27). Kaufner et al. (28) evaluated the effect of short-term preheating in ovarian cancer surgery with the microdialysis method. They reported that it may cause a better preserved microperfusion with increased tissue oxygenation in patients. In our study, we used StO_2 to evaluate the hypoxia risk of low-flow anesthesia management and the effects of peripheral vasoconstriction due to IPH. In our minimal flow anesthesia group, the StO_2 value was higher than the other groups. We interpreted this anesthetic method as improving tissue oxygenation in contrast to hypoxia concerns.

IPH developed in all patients who underwent elective nasal surgery with hypotensive anesthesia in minimal, low, and high flow anesthesia applications. It was observed that body temperatures, humidity and temperature of the anesthesia period were similar. However, tissue oxygen saturation and aldrete score in the postoperative recovery unit were higher in the minimal flow anesthesia group. Minimal flow anesthesia may be a good alternative to prevent IPH. Contrary to hypoxia concerns, we believe that these methods can be applied safely; however, more studies are needed for the effects of low-flow anesthesia technique at the tissue level.

Our study limitations; there are various nasal surgeries applied in otolaryngology. Surgical field bleeding, surgery and anesthesia duration are variable in different nasal surgeries. If one type of nasal surgery were preferred, it would be more reliable to evaluate the effects on intraoperative body temperature and StO_2. As stated in the literature, the importance of operating room temperature still seems to be the most effective way to maintain body temperature. The fact that our operating room temperatures have a wide range of 17-24°C may also have eliminated the difference in body temperature between patient groups.

In our study, tobacco use, which is closely related to the respiratory physiology of the patients, was standardized and not questioned. Tobacco use may also have an effect on patients' hemodynamic parameters and StO_2.

Due to the high cost, there were not enough heaters in our hospital. Patients could be standardized in terms of warming application methods.

Our study was presented orally at the "5th National Health Sciences Congress" (18 - 21 December 2021 Antalya ISBN: 978-625-8423-05-1).

REFERENCES

1. Bilgin H. Inadverdent Perioperative Hypothermia. Turkish J. Anesth. Reanim. 2017;45(3):124–6.

2. Kleemann PP. Humidity of Anaesthetic Gases with Respect to Low Flow Anaesthesia. Anaesth Intens Care.1994;22(4):380-2.

3. Nunn G. Low-flow anaesthesia. Contin. Educ. Anaesth. Crit. Care Pain.2008;8, 1–4.

4. Hendrickx JFA, De Wolf AM, De Hert S. O2, anybody? Eur J Anaesthesiol. 2015;32(6): 371–3.

5. Lima A, van Genderen ME, Klijn E, Bakke J, van Bommel J. Peripheral vasoconstriction influences thenar oxygen saturation as measured by near-infrared spectroscopy. Intensive Care Med.2012;38(4): 606–11.

6. O'Brien-Lambert A, Driver B, Moore JC, et al. Using Near Infrared Spectroscopy for Tissue Oxygenation Monitoring During Procedural Sedation: The Occurrence of Peripheral Tissue Oxygenation Changes With Respiratory Depression and Supportive Airway Measures. Acad. Emerg Med. 2016;23(1): 98–101.

7. Yi J, Yongjin L, Shiyuan X, et al. Intraoperative hypothermia and its clinical outcomes in patients undergoing general anesthesia: National study in China. National study in China. PloS One. 2017;12(6): 0177221.

8. Sagiroglu G, Ozturk GA, Baysal A, et al. Inadvertent perioperative hypothermia and important risk factors during major abdominal surgeries. Journal of College Physicians Surgeons Pakistan. 2020;30(2):123-8.

9. Aksu C, Kus A, Gurkan Y, et al. Survey on Postoperative Hypothermia Incidence In Operating Theatres of Kocaeli University. Turkish Journal of Anesthesiology Reanimation . 2014; 42(2): 66-70.

10. Wang CS, Chen CL, Huang CJ, et al. Effects of Different Operating Room Temperatures on the Body Temperature Undergoing Live Liver Donor Hepatectomy. Transplantation Proceedings. 2008;40(8): 2463–65.

11. El-Gamal N, Elkassabany N, Frank SM, et al. Age-Related Thermoregulatory Differences in a Warm Operating Room Environment (Approximately 26°C). Anesth Analg. 2000;90(3):694–98.

12. Baum J, Zueckner K, Hölscher UM, et al. Klimatisierung von Narkosegasen bei Einsatz unterschiedlicher Patientenschlauchsysteme. Anaesthesist. 2000; 49(5):402–11.

13. Plotnikow GA, AccoceM, Navarro E, et al. Humidification and heating of inhaled gas in patients with artificial airway. A narrative review. Rev Bras Ter Intensiva. 2018 ;30(1):86-97.

14. Bisinotto FMB, Braz JRC, Martins RHG, et al. Tracheobronchial consequences of the use of heat and moisture exchangers in dogs. Canadian Journal of Anesthesia. 1999 ;46(9): 897-903.

15. Barbet JP, Chauveau M, Labbe S, et al. Breathing dry air causes acute epithelial damage and inflammation of the guinea pig trachea. Journal of Applied Physiology. 1988 ;64(5): 1851-57.

16. Restrepo RD, Walsh BK. Clinical Pratice Guideline. Humidification During Invasive and Noninvasive Mechanical Ventilation: Respiratory Care. 2012;57(5):782-88.

17. Choi YJ, Min SH, Park JJ, et al. Comparison of the temperature and humidity in the anesthetic breathing circuit among different anesthetic workstations. Medicine Baltimore. 2017;96(25):7239.

18. Lafçı A, Öztürk L, But A. Timpanoplasti Operasyonlarında Yüksek Akımlı ve Düşük Akımlı Desfluran Anestezisinin Karşılaştırılması. Türk Tıp Dergisi. 2011 5(1):12-21.

19. Bengston JP, Bengston A, Sonander H, et al. Humidity of the Bain and circle systems reassessed. Anesthesia and Analgesia. 1989;69(1):83-86.

20. Johansson A, Lundberg D, Luttropp HH. The effect of heat and moisture exchanger on humidity and body temperature in a low-flow anaesthesia system. Acta Anaesthesiologica Scandinavica. 2003;47(5):564-68.

21. Kazancıoğlu L, Batçık Ş, Erdivanlı B, et al. Comparison of the effects of minimal and high-flow anaesthesia on cerebral perfusion during septorhinoplasty. Turk J Anaesthesiol Reanim. 2019;47(1):12-6.

22. Bilgi M, Göksu S, Mızrak A, et al. Comparison of the effects of low-flow and high-flow inhalational anaesthesia with nitrous oxide and desflurane on mucociliary activity and pulmonary function tests. European Journal of Anaesthesiology. 2011;28(4): 279-83.

23. Kalaycı D, Dikmen B, Kaçmaz M, et al. Plasma levels of interleukin-10 and nitric oxide in response to two different desflurane anesthesia flow rates. Revista Brasileira de Anestesiologia. 2014;64(4):292-98.

24. Kim J, Kang D, Lee H, et al. Change of inspired oxygen concentration in low flow anesthesia. Anesth Pain Med. 2020;15(4):434–40.

25. Kazancioglu L, Batcik S, Arpa M, et al. Dynamic thiol/disulphide balance in patients undergoing hypotensive anesthesia in elective septoplasties. International Journal of Clinical Practice. 2021;75(11): 14838.

26. Batçık Ş, Kazancıoğlu L, Arpa M et al. The effect of minimal-flow and high-flow hypotensive anesthesia on oxidative stress. Middle Black Sea Journal of Health Science. 2021;7(2):221-29.

27. Kozanhan B, Eğilmez Aİ, Tok Cekmecelioglu B, et al. Novel oxidative stress biomarker in sepsis: dynamic thiol-disulfide homeostasis. Cukurova Medical Journal. 2020;45(1):63-70.

28. Kaufner L, Niggemann P, Baum T, et al. Impact of brief prewarming on anesthesia-related core-temperature drop, hemodynamics, microperfusion and postoperative ventilation in cytoreductive surgery of ovarian cancer: A randomized trial. BMC Anesthesiology. 2019;19(1):1-10.