ORIGINAL ARTICLE

A simple, innovative way to reduce rhinitis symptoms after sedation during endoscopy

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BACKGROUND: Supplemental oxygen is routinely given via nasal cannula (NC) to patients undergoing moderate sedation for endoscopy. Some patients complain of profuse rhinorrhea and/or sneezing after the procedure, which results in additional medical costs and patient dissatisfaction.
OBJECTIVES: To determine the causal relationship between the route of oxygen delivery and troublesome nasal symptoms, and to seek possible solutions.
METHODS: Patients (n=836) were randomly assigned to one of the three following groups: the NC group (n=294), the trimmed NC (TNC) group (n=268) and the nasal mask (NM) group (n=274). All received alfentanil 12.5 µg/kg and midazolam 0.06 mg/kg, and adjunct propofol for sedation. Supplemental oxygen at a flow rate of 4 L/min was used in the NC and TNC groups, and 6 L/min in the NM group. The incidence of nasal symptoms and hypoxia were assessed.
RESULTS: The incidence of rhinitis symptoms was significantly higher in the NC group (7.1%) than in the TNC (0.4%) and NM (0%) groups (P<0.001). The incidence of hypoxia was lower in the NC group (3.1%) (P=0.040). All hypoxia events were transient (ie, less than 30 s in duration). On spirometry, the mean value of the lowest saturation of peripheral oxygen was found to be significantly lower in the NM group (96.8%) than in the NC group (97.7%) (P=0.004).
CONCLUSIONS: Trimming the NC or using NMs reduced the incidence of rhinitis symptoms; however, the incidence of hypoxia was higher. Further investigation regarding the efficiency of oxygen supplementation is warranted in the design of novel oxygen delivery devices.

Key Words: *Endoscopy; Nasal cannula; Rhinitis; Supplemental oxygenation*

Un moyen simple et novateur de réduire les symptômes de rhinite après la sédation pour l'endoscopie

HISTORIQUE : Des suppléments d'oxygène sont systématiquement administrés au moyen d'une canule nasale (CN) aux patients qui subissent une sédation modérée en vue d'une endoscopie. Certains patients se plaignent d'une rhinorrhée profuse ou d'éternuements après l'intervention, ce qui accroît les coûts médicaux et l'insatisfaction des patients.
OBJECTIFS : Déterminer le lien causal entre la voie de livraison de l'oxygène et les symptômes nasaux dérangeants et chercher des solutions possibles.
MÉTHODOLOGIE : Les chercheurs ont divisé aléatoirement les patients (n=836) entre les trois groupes suivants : groupe de CN (n=294), groupe de CN taillée (CNT, n=268) et groupe de masque nasal (MN, n=274). Tous les patients ont reçu 12,5 µg/kg d'alfentanil et 0,06 mg/kg de midazolam, ainsi que du propofol d'appoint pour la sédation. Les groupes de CN et de CNT ont reçu des suppléments d'oxygène à un débit de 4 L/min, et le groupe de MN, à un débit de 6 L/min. Les chercheurs ont évalué l'incidence de symptômes nasaux et d'hypoxie.
RÉSULTATS : L'incidence des symptômes de rhinite était beaucoup plus élevée dans le groupe de CN (7,1 %) que dans ceux de CNT (0,4 %) et de MN (0 %) (P<0,001). L'incidence d'hypoxie était plus faible dans le groupe de CN (3,1 %) (P=0,040). Tous les cas d'hypoxie étaient transitoires (moins de 30 s). À la spirométrie, la valeur moyenne de la saturation d'oxygène périphérique la plus basse était considérablement plus faible dans le groupe de MN (96,8 %) que dans le groupe de CN (97,7 %) (P=0,004).
CONCLUSIONS : La taille de la CN ou le recours au MN réduisait l'incidence de symptômes de rhinite, mais l'incidence d'hypoxie était plus élevée. D'autres recherches s'imposent au sujet de l'efficacité des suppléments d'oxygène afin de concevoir de nouveaux dispositifs de livraison d'oxygène.

According to guidelines of sedation and anesthesia in gastrointestinal endoscopy, the routine administration of supplemental oxygen has been shown to reduce the magnitude of oxygen desaturation during endoscopic procedures (1). The American Society of Anesthesiologists' (ASA) Task Force recommends that supplemental oxygen be considered for moderate sedation, and should be administered during deep sedation unless specifically contraindicated for a particular patient or procedure (2). To avoid interrupting endoscopic procedures, supplemental oxygen is routinely administered via nasal cannula (NC) at a flow rate of 4 L/min to patients undergoing moderate sedation in the Cancer and Health Screening Section, Koo Foundation Sun Yat-Sen Cancer Center, Taipei, Taiwan. We noticed that symptoms of rhinitis, mainly profuse rhinorrhea and/or sneezing, developed in some patients during their emergence from sedation in the recovery room and persisted for hours to days, which resulted in patient complaints, increased medical costs, longer hospital stay or even visits to local clinics after leaving our hospital.

Patients experienced discomforts such as drying of nasal mucosa and dry throat, and a decreased ability to expectorate. Patients may also experience decreased forced expiratory volume in 1 s after using NC at a high flow rate without humidification for a long duration (3-8). While at a low flow rate (4 L/min or lower), nasal symptoms are minor and, among these symptoms, drying of nasal mucosa is the most common, affecting approximately 40% of patients (5). Supplemental oxygenation via NC without humidification is justified when oxygen flow rates are low (ie, 4 L/min or lower) or the duration of NC use is short (two or fewer days) (3-4). Furthermore, because there is no significant difference in patient discomfort with or without humidification, the high costs of humidification can be avoided. In contrast to what was described in other surveys (3-8), the symptoms of profuse rhinorrhea or sneezing experienced by our patients using NCs seemed to be more severe and occur more frequently.

To the best of our knowledge, there is no study describing the occurrence of nasal discomfort such as rhinorrhea and/or sneezing after

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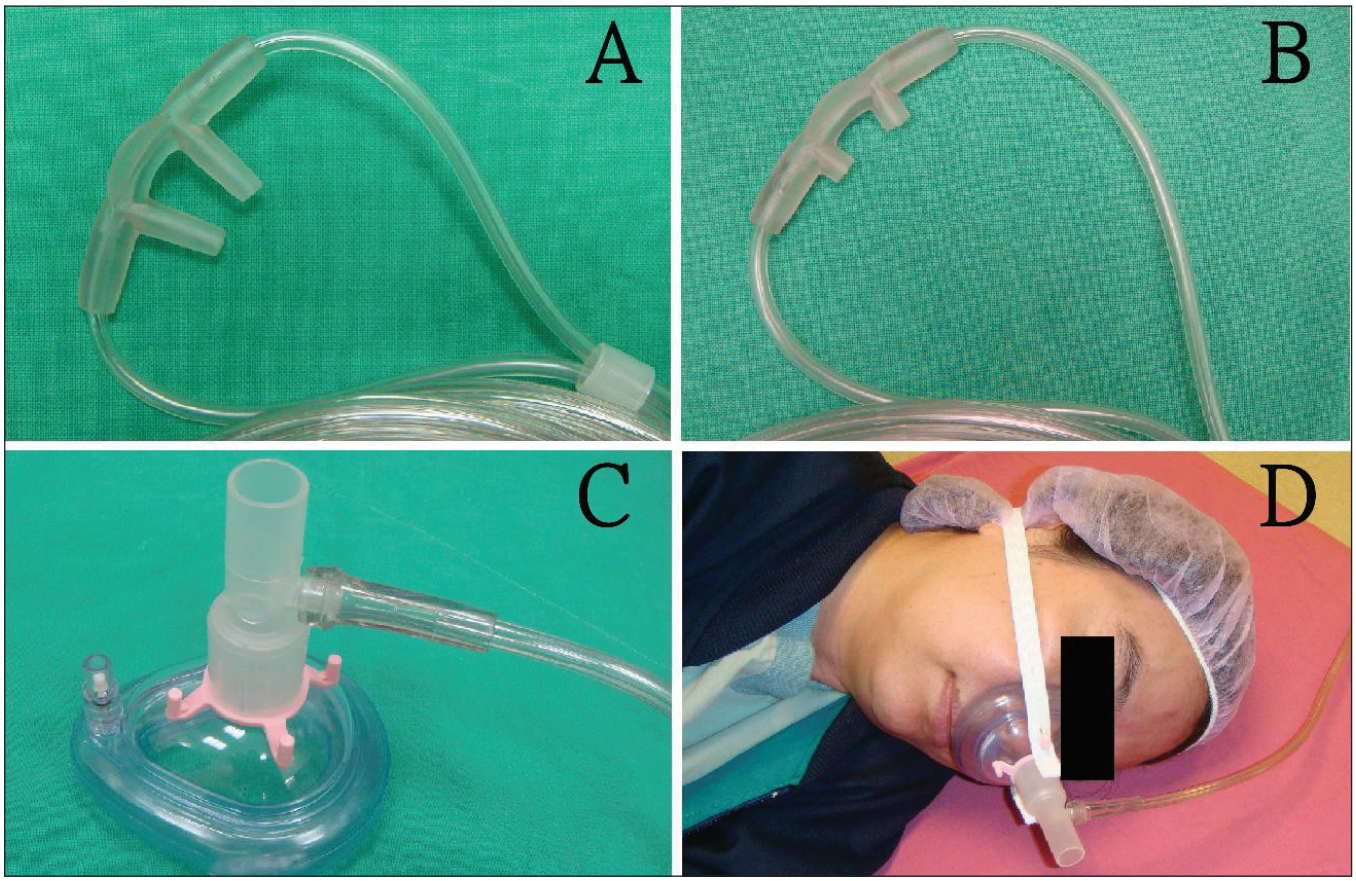

Figure 1) A *Nasal cannula (NC) with 10 mm prongs used in the NC group.* **B** *NC with 2 mm prongs used in the trimmed NC group.* **C** *In the nasal mask group, an air-cushioned anesthesia mask (size 1) was connected to one end of a straight adapter, with the other end open to air. The side hole of the adapter was connected to an oxygen supply tube. A resuscitation bag (PMR 2, Nellcor Puritan Bennett, USA) was connected to the open end of the adapter in case of hypoxia.* **D** *Nasal mask secured with a head strap*

sedation and supplemental oxygenation during short procedures such as an endoscopy. To provide better quality of care, we conducted the present study to compare conventional NC, trimmed NC and nasal masks (NMs) to determine the cause and incidence of nasal symptoms, and the safety of each apparatus.

METHODS

Patients with physical status I to II according to ASA guidelines were recruited and scheduled for endoscopy, which included both esophagogastroduodenoscopy and full-length colonoscopy performed in the health screening department. Individuals with upper airway infection, obstructive sleep apnea syndrome, nasal septal deviation, rhinosinusitis, nasal polyposis or symptoms of rhinitis on the day of the scheduled procedure were excluded.

Subjects were randomly assigned to one of three groups according to the oxygen delivery apparatus (Figures 1A to 1C). Assessments were performed in one of three examination rooms, all of which were maintained at the same temperature (24°C to 25°C) and humidity (50% to 60% relative humidity). These three apparatuses were assigned alternately to each room on a weekly basis. Seven endoscopists performed both the esophagogastroduodenoscopy and colonoscopy for all subjects. They rotated everyday among the three endoscopy suites based on the same schedule in any given week during the research. The subjects were randomly assigned to each room by a staff member of the health screening department who was not involved in the endoscopic procedures, patient sedation or the present study.

Subjects in the NC group were given oxygen at a flow rate of 4 L/min via conventional Softip nasal cannula (GaleMed, I-Lan, Taiwan) with two prongs 10 mm long (Figure 1A) inserted into nares. Subjects in the trimmed NC (TNC) group were given oxygen at a flow rate of 4 L/min via Softip nasal cannula with two prongs trimmed to a length of 2 mm (Figure 1B) with the truncated prongs inserted into the nares. The cannulae used in the NC and TNC groups were secured to the patients' cheeks with tape. Subjects in the NM group were given oxygen at a flow rate of 6 L/min via air-cushioned anesthesia masks (size 1, ShineBall, Tao Yuan Hsien, Taiwan) for children (Figure 1C). The mask was applied to cover the nose and connected to a straight airway adapter at one end with the other end open to room air. In case of hypoxia, a resuscitation bag (PMR 2, Nellcor Puritan Bennett, USA) was applied to the adapter's open end to assist ventilation manually. The side hole of the adapter was connected to tubing for oxygen supply (Figure 1D). The mask was secured with a head strap. Oxygen was supplied from a wall-mounted Amico flowmeter (Amico Corporation, Canada) for all subjects.

Hypoxic events were recorded when the saturation of peripheral oxygen (SpO_2) fell to lower than 90%. When the SpO_2 was trending downward, the apparatus was first checked to see whether it was in place and, if it was not, a head tilt manoeuvre was performed. When these two steps failed to maintain SpO_2 above 90%, the oxygen flow rate was increased to 10 L/min. A resuscitation bag was applied to patients in the NM group for assisted manual ventilation. An anesthetic mask (size 2) was applied to the nose of subjects in the NC or TNC groups who required a larger reservoir. Transient hypoxia was defined as a hypoxic event that lasted 30 s or less, while prolonged hypoxia was defined as a hypoxic event with a duration exceeding 30 s.

All subjects were sedated with intravenous alfentanil 12.5 μg/kg and midazolam 0.06 mg/kg. An adjunct intravenous infusion of propofol was given at an incremental dose of 10 mg and titrated to effect. Following

TABLE 1
Baseline characteristics of study subjects in the three groups

Characteristic	Group: Nasal cannula (n=294)	Trimmed nasal cannula (n=268)	Nasal mask (n=274)	Entire cohort (n=836)	P
Age, years (mean ± SD)	50.3±10.1	50.4±10.2	48.8±9.8	49.9±10.0	0.110
Female sex, n (%)	138 (46.9)	125 (46.6)	111 (40.5)	374 (44.7)	0.229
History of allergy, n (%)	70 (23.8)	53 (19.8)	67 (24.4)	190 (22.7)	0.552
Duration of procedure, min (mean ± SD)	18.0±5.4	18.9±6.6	18.6±6.5	18.4±6.2	0.499
Value of the lowest SpO_2, % (mean ± SD)	97.7±3.2	97.0±3.9	96.8±4.1	97.2±3.8	0.011
Lowest SpO_2, % (range)	80–100	80–100	75–100	–	–
Subjects with hypoxia, n (%)	9 (3.1)	21 (7.8)	18 (6.6)	48 (5.7)	0.040
Subjects with symptoms of rhinitis, n (%)	21 (7.1)	1 (0.4)	0 (0)	22 (2.6)	<0.001

SpO_2 Saturation of peripheral oxygen

TABLE 2
Nasal symptoms observed following endoscopic procedures requiring sedation and nasal oxygen supplementation

Nasal symptoms	NC (n=294)	TNC (n=268)	NM (n=274)	Total (n=836)
None	273 (92.9)	267 (99.6)	274 (100)	814 (97.3)
Sneezing	2 (0.7)	0 (0)	0 (0)	2 (0.2)
Rhinorrhea	8 (2.7)	1 (0.4)	0 (0)	9 (1.1)
Sneezing + rhinorrhea	10 (3.4)	0 (0)	0 (0)	10 (1.2)
Sneezing + rhinorrhea + tearing	1 (0.3)	0 (0)	0 (0)	1 (0.1)

Data presented as n (%). NC Nasal cannula; NM Nasal mask; TNC Trimmed NC

the procedure, subjects were transferred to the recovery room without these apparatuses and were monitored by an anesthetist who was not involved in the endoscopic procedure or sedation. All subjects were observed in the recovery room for 1 h and released from the department thereafter. The presence of profuse rhinorrhea or sneezing observed by the anesthetist or voiced by the subjects was recorded. Demographic data and allergy history were collected, as was the lowest SpO_2 in each subject; the incidence of hypoxia and rhinitis symptoms were subsequently calculated. Self-reported history of allergic rhinitis or asthma were defined as a positive history of allergy. The present study was approved and monitored by the Institutional Review Board of the Koo Foundation Sun Yat-Sen Cancer Center.

Numerical data were presented as mean ± SD. The Student's unpaired *t* test, one-way ANOVA and χ^2 tests were used to test for differences among the subgroups. Multivariate logistic regression analysis was used to define the independent factor. A two-tailed P<0.05 was considered to be statistically significant. All calculations were performed using SAS version 9.1 (SAS Institute, USA).

RESULTS

A total of 1199 subjects who were eligible to receive sedation and supplemental oxygen for endoscopy were evaluated. Of these, 197 did not meet the inclusion criteria due to upper airway infection, obstructive sleep apnea syndrome, nasal septal deviation, rhinosinusitis, nasal polyposis or symptoms of rhinitis on the day of the procedure; 72 did not meet the inclusion criteria on account of their physical status being higher than II according to the ASA guidelines. Of the remaining 930 subjects, 866 consented to the study after receiving information about the study; 30 subjects were excluded from analysis due to incomplete data collection. The final study cohort comprised 294 subjects in the NC group, 268 subjects in theTNC group and 274 subjects in the NM group. The study was performed over four months – July to October 2009.

The characteristics of the subjects are summarized in Table 1. Age (range 22 to 80 years), sex distribution, allergy history and duration of the procedure did not differ significantly among the three groups.

The incidence of hypoxia in the TNC group was significantly higher than in the other two groups (P=0.040). All of the hypoxia events were transient (ie, persisted for 30 s or less) and easily reversible. The mean value of each patient's lowest SpO_2 was significantly higher in the NC group than in the other two groups (P=0.011). The severity of hypoxia appeared to be worse in the NM group, with one subject recording an SpO_2 of 75% that was rectified by manual ventilation with a resuscitation bag, which returned the SpO_2 to normal values within 30 s.

The incidence of rhinitis symptoms was significantly higher in the NC group (7.1%) than in the TNC (0.4%) and NM (0%) groups (P<0.001) (Table 1), with no difference between the TNC and NM groups (P=0.500). The incidence of rhinitis symptoms in the overall cohort was 2.6%. Among these subjects, most experienced profuse rhinorrhea with or without sneezing or tearing (Table 2). Two subjects developed only minor symptoms (sneezing). All of these subjects were referred to an otorhinolaryngologist for evaluation and treatment. Sex (P=0.945), history of allergy (P=1.00), duration of procedure (P=0.956), mean value of the lowest SpO_2 (P=0.805) and hypoxia (P=0.494) had no impact on the occurrence of rhinitis symptoms (Table 3).

A comparison of the incidence of hypoxic events and incidence of sneezing and/or rhinorrhea among endoscopists' practices revealed no significant differences (P=0.567 and P=0.167, respectively). Multivariate logistic regression analyses were used to determine whether different endoscopists actually contributed to bias in hypoxia events, or the incidence of sneezing and/or rhinorrhea. After adjusting for the endoscopist variable, the NC group still showed a significantly lower incidence of hypoxia than the TNC group (OR=0.635; P=0.031), while there was no difference between the NM and TNC groups (P=0.483). Furthermore, the incidence of sneezing and/or rhinorrhea in NC group was significantly higher than in the TNC group (OR=4.427; P=0.004), while there was no difference between the NM and TNC groups (P=0.964).

DISCUSSION

Our study demonstrated that two innovations of oxygen delivery for sedation during endoscopy – NMs and trimmed NC – markedly reduced the incidence of nasal symptoms compared with oxygen delivery using conventional NC. In the comparison between the NC and TNC groups in which the same oxygen flow rate was used, trimming the nasal prongs to 2 mm in the TNC group significantly reduced the incidence of rhinorrhea and/or sneezing. Using NMs with a higher oxygen flow rate in the NM group also demonstrated a remarkable effect on lowering the incidence of rhinorrhea and/or sneezing.

The mechanism of nasal symptoms following oxygen supplementation for endoscopy sedation is unclear and has rarely been studied previously. Because history of allergy had no impact on the occurrence of rhinorrhea and/or sneezing in our study, these symptoms were likely nonallergic reactions. Nonallergic rhinitis encompasses a wide range of diagnoses and a heterogeneous group of subjects, and is believed to

be related to mast cell activation and autonomic stimuli (9). Some individuals have a known trigger such as cold air, certain drugs, food or hormones, while the etiology in others is unknown. Usually the diagnosis is made through a process of exclusion. Given the frequent complaints of chill in the examination rooms and the great resemblance between our patients' symptoms and those of the cold-air rhinitis patients (9-13), we investigated the temperature of the oxygen delivered. The ambient temperature of the examination rooms was 24°C to 25°C, with a relative humidity of 50% to 60%. In contrast to the subfreezing temperature of oxygen used in cold air provocation testing, the temperature of the oxygen at the distal end of the tubing delivered from the wall-mounted flowmeter was 24.3°C, which is far warmer than the frigid air that induces cold air rhinitis. Although lacking a control arm of subjects using NC without supplemental oxygen in this cohort due to ethical reasons, we believe that the nature of the profuse rhinorrhea and/or excessive sneezing in our cohort is not likely to be cold-air rhinitis because different incidences of rhinitis were shown in patients using different apparatuses while receiving the same dry medical air from the wall flowmeter under the same room conditions.

We considered the possibility of rhinitis symptoms being provoked by mechanical irritation of the nasal prongs in the setting of moderate sedation during endoscopy. The incidence was as high as 7.1% when traditional NCs were used. However, the underlying mechanism is still unclear. It is believed that the response of the nose to mechanical or chemical stimuli are neuronal reflexes mediated by nociceptive C-fiber neurons (14-16). Studies (17,18) have shown the effects of mechanical or noxious stimuli on the nasal symptoms of subjects with nonallergic rhinitis with undefined etiology.

Nevertheless, the NC group showed results superior to the TNC and NM groups with respect to the incidence of hypoxia. The overall incidence of hypoxia among the three groups was 5.7%. All subjects experiencing hypoxia recovered within 30 s without clinical sequelae. In a study with a small sample size (n=30 in each arm) (19), hypoxia was shown to be a common problem during endoscopy with or without sedation, and that sedation significantly increased the incidence of hypoxia. However, hypoxia was completely abolished by supplemental oxygenation at a flow rate of 4 L/min via NC in that study. In contrast to the study in which a single drug (midazolam) was used (19), our combined use of midazolam and alfentanil for synergism, and adjunctive use of propofol may have resulted in a higher proportion (3.1%) of subjects experiencing hypoxia in the NC group.

The efficiency of oxygen supply appeared to be worse in the NM group than in the NC group. The NM group consumed more oxygen (6 L/min versus 4 L/min), and the mean SpO_2 was significantly lower than in the NC group (P=0.004). This may have been due to the design of the apparatus in the NM group, with an adapter open to room air for the convenience of connection with a resuscitation bag in case of hypoxia. Although ideal sealing on the nose could be achieved by inflating an air-cushioned anesthesia mask (size 1) and securing it with a head strap, positive pressure could not be produced because oxygen could escape freely through the open end of the adapter. The severity of hypoxia, in terms of the range of the lowest SpO_2, appeared to be worse in the NM group, although all of the subjects experiencing hypoxia returned to normoxia within 30 s after the head tilt manoeuvre and/or resuscitation bag application. To determine an adequate minimum flow rate, more studies investigating the efficiency of oxygen delivery and possible carbon dioxide rebreathing in this novel design is warranted.

There was a statistically significant difference in the mean value of each patient's lowest SpO_2 between subjects in the NC and TNC groups (P=0.018). The ranges of the lowest SpO_2 were parallel in these two groups. The incidence of hypoxia was significantly higher in the TNC group (7.8%) than in the NC group (3.1%) (P=0.012). The problem frequently encountered in the TNC group was that the location of the trimmed NC prongs were easily shifted. The anesthetist must pay close attention to keep them in place during the procedure. This may have contributed to the high incidence of mild and transient hypoxia.

TABLE 3
Association between the occurrence of rhinitis symptoms and sex, history of allergy, duration of procedure and saturation of peripheral oxygen (SpO_2)

	Symptoms		
	No (n=814)	Yes (n=22)	P
Female/male (n/n [%/%])	364/450 (97.3/97.4)	10/12 (2.7/2.6)	0.945
History of allergy, yes/no (n/n [%/%])	185/629 (97.4/97.4)	5/17 (2.6/2.6)	1
Duration of procedure, min (mean ± SD)	18.5±6.1	18.5±7.1	0.956
SpO_2, % (mean ± SD)	97.2±3.8	97.4±4.5	0.805
Hypoxia, yes/no (n/n [%/%])	46/768 (95.8/97.5)	2/20 (4.2/2.5)	0.494

There were some limitations in the present study. We recognize that the pattern of breathing was not considered as a variable for practical reasons. Our subjects were sedated and kept their mouths open for a significant duration of the procedure. Strohl et al (20) showed that the inhalation of air in through the nose and out through the mouth induces an increase in nasal airway resistance compared with inhalation and exhalation both through the nose. Without the 30% recovery of water during exhalation through the nose, the stimulus of cold, dry air could be amplified. The probable breathing pattern in our subjects with inhalation of air through the nose and out through the mouth could have contributed to the discomfort reported. The objective of the present study was to determine the causal relationship between the route of oxygen delivery and troublesome nasal symptoms. We did not use any scoring system to comprehensively evaluate the severity and all dimensions of nasal symptoms because most subjects were not sufficiently lucid to be assessed thoroughly during their recovery from sedation. This may have underestimated the occurrence of rhinitis if it was so mild that the subject could tolerate it and/or the anesthetist was not able to notice it. We recognized the possibility of additional ventilatory disturbances occurring even before the development of hypoxia during the procedure than we detected by monitoring hypoxia alone. First, we used oxygen saturation detected by oximetry to monitor ventilatory function. However, oxygen saturation is relatively insensitive to the earliest signs of hypoventilation because significant changes in the arterial partial pressure of oxygen may occur with little alteration in oxygen saturation (1). Second, because the gastroenterologists and their assistants have access to subjects' cephalic sites, monitoring of ventilatory function by patient observation was not feasible for the anesthetist. Third, we did not use capnography, even though it is recommended by the ASA for patients whose ventilation cannot be observed directly during moderate sedation for early detection of respiratory depression (2).

CONCLUSION

We have shown that NC prongs 10 mm in length and an oxygen flow rate of 4 L/min directed into the nares could induce rhinitis symptoms in the setting of healthy subjects receiving moderate sedation for endoscopy. Trimming the NC prongs to 2 mm in length or using NMs significantly reduced the incidence of rhinorrhea and/or sneezing. However, the incidence of hypoxia, although transient and mild, was higher in subjects using NMs or trimmed NC. Additional studies will be needed to determine the efficacy of these novel routes of oxygen supplementation.

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