

Upper airway obstruction during midazolam/nitrous oxide sedation in children with enlarged tonsils

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Abstract

Purpose: The purpose of this nonrandomized, case-control study was to examine the incidence and severity of upper airway obstruction (UAO) in children with enlarged tonsils during inhalation of nitrous oxide (N_2O).

Methods: Following premedication with oral midazolam, 0.5 mg/kg, measurements were collected during a 3-minute control period followed by 3 minutes of breathing 50% N_2O in oxygen. An unblinded anesthesiologist held a facemask over the child's mouth and nose without supporting the head or neck, or attempting to maintain airway patency. Every 20 seconds, the degree of airway obstruction was graded as none, partial, or complete. Twenty-five children presenting for tonsillectomy and 25 controls without enlarged tonsils participated.

Results: During 50% N_2O inhalation, 14 children (56%) in the tonsillectomy group, and four children (16%) in the control group demonstrated partial UAO. One child in the tonsillectomy group with partial UAO developed hypoxemia (SpO_2 72%). One child in the tonsil group developed complete UAO during inhalation of 50% N_2O .

Conclusion: Children who receive sedation with oral midazolam and 50% N_2O inhalation may exhibit significant UAO, especially in the presence of enlarged tonsils. Pre-sedation physical exams should evaluate the presence of tonsil size during examination of the mouth and airway. (*Pediatr Dent* 20:5 318–320, 1998)

In pediatric dentistry, it is common practice to use a combination of inhaled N_2O with systemic sedatives to achieve anxiolysis and/or analgesia.²⁻⁴ The effects of N_2O on ventilatory parameters has been described in intubated pediatric patients⁵ but little is known about its effects on upper airway patency during sedation or general anesthesia in nonintubated patients. In a previous publication, we demonstrated that children who inhaled 15–60% N_2O following midazolam premedication had no evidence of UAO despite progressing beyond “conscious” sedation at 30%.⁶

Pediatric anesthesiologists commonly find that children with hypertrophic tonsils have an increased incidence of UAO during induction of general anesthesia for tonsillectomy. A recent publication by

Fishbaugh et al., confirmed the potential for airway obstruction in sedated children with enlarged tonsils during a neck flexion maneuver.¹ Furthermore, the pediatric literature contains a report of a child with hypertrophic tonsils who developed significant upper airway obstruction associated with chloral hydrate sedation.⁷

In this study, we sought to determine if children with enlarged tonsils were at an increased risk of developing significant UAO during sedation with orally administered midazolam and 50% N_2O inhalation. We compared the incidence of UAO in a group of children with enlarged tonsils (presenting for tonsillectomy) and a control group consisting of children without enlarged tonsils presenting for other types of elective surgery.

Methods

The Research Subject's Review Board of the University of Rochester approved this study. The procedures, possible discomforts or risks, as well as possible benefits were explained fully to the parents of the children involved, and their verbal and written consent was obtained prior to the investigation. The study group consisted of children about to undergo elective tonsillectomy for hypertrophic tonsils and a control group consisted of healthy children, without a history of enlarged tonsils or nighttime snoring, undergoing other types of elective surgical procedures. There was no attempt to verify the absence of enlarged tonsils in the control group other than history. Exclusion criteria included the presence of congenital facial anomalies or the presence of an upper respiratory infection. All children were premedicated with oral midazolam, 0.5 mg/kg, 15–30 min prior to induction of anesthesia. Upon entering the operating room the usual monitors (precordial stethoscope, electrocardiograph, pulse oximeter, automated blood pressure device) were attached, and the child was placed supine with the head resting on a small folded blanket in the neutral position.

Study protocol

The study protocol consisted of two consecutive stages of measurements: 1) 3-min control period (F_1O_2 100%) and 2) 3 min of 50% N_2O /50% O_2 inhalation (determined by end-tidal monitoring) after which halothane was added to complete the induction of general

anesthesia. During this sequence, all children had continuous airway management by the same experienced pediatric anesthesiologist who held the facemask with an effective tight seal over the child's mouth and nose. The facemask was held in place such that there was no direct physical contact with the patient which could have altered the shape or patency of the airway. Children were allowed to move their heads freely from side to side with the facemask present if they desired. Every 20 s the anesthesiologist managing the airway graded the degree of UAO as either none, partial, or complete, based on clinical signs and capnography. Clinical signs included visualization of chest rise, hearing stridor, and feeling movement of the ventilation bag. Capnographic signs included loss or diminution of the normal waveform. A research assistant who was present continuously recorded these assessments. Maneuvers to improve the patency of the upper airway (e.g., changing neck position) were attempted only when the patient's oxygen saturation decreased to less than 92% or if complete airway obstruction occurred.

Studies were performed with children breathing through the smallest appropriate facemask connected to a pediatric circle system (Vital Signs, Totowa, NJ) attached to an anesthesia machine (Ohmeda, Madison, WI). During data analysis, UAO assessments were confirmed by respiratory impedance plethysmography (RIP) (Respi-Trace®, Ambulatory Monitoring Inc., Ardsley, NY). The RIP consists of two coils of Teflon-insulated wire sewn onto elastic bands that encircle the rib cage and abdomen. Changes in cross-sectional areas of the rib cage and abdominal compartments alter the self-inductance of the coils and are displayed graphically as waveform patterns. During normal breathing, the chest wall and abdominal cavity expand and contract simultaneously and the patterns obtained with the RIP are synchronous, or "in phase". When UAO occurs, the normal outward movement of the rib cage and abdomen during inspiration is then replaced by asynchronous or even paradoxical motion, in which the rib cage moves inward during inspiration. This phenomenon is referred to as thoracoabdominal asynchrony (TAA). The degree of TAA has been demonstrated to be quantitatively related to the severity of airflow obstruction.⁸ The RIP tracings were not available to the anesthesiologist during the study sequence. The presence of abdominal movements but absence of end-tidal CO₂ confirmed complete UAO. Continuous recordings of SpO₂, P_{ET} CO₂, P_{ET} N₂O, respiratory rate, (Nellcor N-1000, Hayward, CA) and RIP tracings were stored by a computerized data collection system.⁹ The Nellcor N-1000 was internally calibrated with each use. Quantitative calibration of the RIP was not performed.

Statistical analysis

The Wilcoxon's rank-sum test for continuous non-parametric data, and chi-square analysis and Fisher's

exact test for nominal data statistically assessed significant differences between the study and control groups. To determine sample size, we used data from a previous study⁶ which indicated that no children in the control group would have partial UAO during inhalation of N₂O (following midazolam premedication) and, based on our own clinical experience, we expected approximately 50% of children with enlarged tonsils to have partial UAO during N₂O inhalation. No other data exists in this area with which to base a sample size analysis. Using an alpha (Type I) error of 5% and a beta (Type II) error of 20% (power = 0.8), the required sample size was calculated to be 23 patients per group. Statistical calculations were performed by SigmaStat™ for Windows™ (Jandel, San Rafael, CA).

Results

The study population consisted of 25 children presenting for tonsillectomy and 25 presenting for other types of elective surgery who served as controls. Their characteristics are listed in Table 1. The ages, weights, and sex distribution of the groups did not differ.

Occurrences of partial and complete UAO are detailed in Table 2. Following midazolam premedication and prior to inhalation of N₂O, two children in the tonsillectomy group demonstrated partial UAO (both had SpO₂ values > 98%) compared to none in the control group (*P* = NS). During 50% N₂O inhalation, 14 children (56%) in the tonsillectomy group and four children (16%) in the control group demonstrated partial UAO (*P* = 0.005). One child in the tonsillectomy group who had partial UAO developed hypoxemia (SpO₂ 72%). One child in the tonsil group developed complete UAO during inhalation of 50% N₂O.

Discussion

The results of our study extend the observations of Fishbaugh et al.¹ and further emphasize that children with enlarged tonsils are at increased risk for developing airway obstruction after receiving sedation with oral midazolam and N₂O. As a conservative measure, one would have to assume that similar results would be found when using midazolam by other routes of administration (e.g., nasal, rectal). Our results underscore

TABLE 1. PATIENT CHARACTERISTICS

	Study Group	
	Tonsils	Controls
N	25	25
Sex (M/F)	20/5	16/9
Age (yrs) (mean ± SD)	5.0 ± 2.3	6.2 ± 2.3
Weight (kg) (mean ± SD)	24.4 ± 10.9	23.6 ± 7.6

TABLE 2. OCCURRENCES OF UPPER AIRWAY OBSTRUCTION (UAO) BETWEEN STUDY GROUPS.

<i>Midazolam Premedication</i>			
<i>Study Group</i>	<i>UAO</i>		
	<i>None</i>	<i>Partial</i>	<i>Complete</i>
Tonsillectomy	23	2	0
Controls	25	0	0

<i>50% N₂O</i>			
<i>Study Group</i>	<i>UAO</i>		
	<i>None</i>	<i>Partial</i>	<i>Complete</i>
Tonsillectomy	10	14	1
Controls	21	4	0

the importance of a thorough premedication history and physical exam, with particular emphasis on questioning for nighttime snoring, and examination of the airway for tonsillar hypertrophy.

In a previous study, we reported that although the combination of oral midazolam and 30–60% N₂O resulted in a progression from conscious to deep sedation, none of the children studied demonstrated clinically significant UAO.⁶ In that study, however, children with a history of nighttime airway obstruction were purposely excluded. The results of the present study differ in that four children without enlarged tonsils (control group) developed partial UAO. Although it is possible that methodological differences between the studies accounted for this discrepancy, it is more likely that the numbers of patients in each group were sufficiently small, causing small differences to seem more significant.

There are several limitations the reader must keep in mind when interpreting the results of this study. First, the investigator who held the facemask and assessed the degree of airway obstruction knew the group to which the patient belonged and was, therefore, not blinded. Although the degree of bias was minimized by confirmation of UAO during data analysis (using the RIP), it is theoretically possible that this investigator may have unconsciously and subtly altered the position or shape of the child's airway during the study. Blinding the investigator would have been extremely difficult. In our institution, tonsillectomies are routinely performed in a particular operating room and the presence of the surgeon would have unblinded the study. Second, we studied combination therapy. Our results may have occurred because of an additive effect of midazolam and N₂O and may not be applicable to N₂O alone. Finally, and perhaps most important, the conditions under which children receive N₂O and other sedatives during a typical pediatric dental procedure ordinarily differ

from the conditions used in this study. Our patients were supine, with only voice stimulation and facemask application. During a typical dental procedure, the child may lie semirecumbent and might be stimulated by insertion of a mouth prop or injections of local anesthesia. External stimuli will ultimately determine the child's level of consciousness and breathing patterns during sedation and must be continuously assessed by the practitioner with the appropriate monitors and attendant personnel.

Conclusions

1. Children who receive sedation with oral midazolam and 50% N₂O inhalation may exhibit clinically significant airway obstruction, especially in the presence of enlarged tonsils.
2. Pre-sedation evaluations should routinely include questions concerning the presence of nighttime snoring and tonsil size should be assessed during examination of the mouth and airway.

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