

Non-Invasive Nasally-Applied Positive Airway Pressure Prevents Upper Airway Obstruction and Facilitates Adequate Spontaneous Respiration During Mild, Moderate and Deep Sedation, and General Anesthesia

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Introduction

The syndrome of narcogenic obstructive respiration (SNOR) describes the upper airway obstruction that tends to occur during the induction of anesthesia.^{1,2} Continuous positive airway pressure (CPAP) has been used in anesthetized children.³ We hypothesized that transcutaneous CO₂ determinations would help to confirm that nasal positive airway pressure applied to the mildly sedated patient would safely preserve spontaneous respiration as sedation was deepened to general anesthesia. This study in adult patients is presented as "proof of concept" for application in pediatric patients.

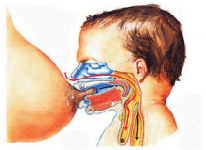
Methods

After Western Institutional Review Board approval and informed consent, ten consecutive cosmetic surgery patients were studied. Data collected were primarily designed to demonstrate the airway constricting effect of tightening the superficial musculo-aponeurotic system (SMAS) during rhytidectomy. General anesthesia was provided using various combinations of isoflurane, propofol, dexmedetomidine and fentanyl. The airway was managed by a NVA® (Nasal Vestibule Airway), a pressure-sealing nasal cannula connected to a standard anesthesia circuit. The pop-off valve and gas flows were adjusted to achieve an airway pressure that would eliminate the stridulous sounds of airway obstruction. All patients were allowed to breathe spontaneously throughout the procedure. Patient monitors included a dial pressure gauge, a SNOR-SCOPE® (circuit stethoscope), and a transcutaneous CO₂ monitor.

Results

Surgery times ranged from 84 to 380 minutes for combined procedures that included rhytidectomy. Two patients with body mass indices of 34 and 38 had liposuction in the prone position. Respiratory rates ranged from 13 to 26 breaths per minute. Arterial pCO₂ derived from transcutaneous measurements ranged from 35 to 49 mm Hg. Oxygen saturations were consistently greater than 92% using an oxygen concentration of 30% or less. The SMAS phase of the rhytidectomy caused stridor in 5 patients which was relieved by increasing airway pressure. In 3 patients airway pressure increased after SMAS without stridor or adjustment as if an increment in airway constriction also increased the pressure needed for gas to escape the pharynx. One patient had no change after the SMAS.

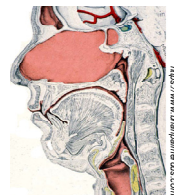
AIRWAY PRESSURE WORKS IN THE NEWBORN AND OTHER "OBLIGATE" NASAL BREATHERS WHERE THE AIRWAY ANATOMY IS DEDICATED TO RESPIRATION AND MOST RESISTANT TO OBSTRUCTION



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AIRWAY PRESSURE WORKS IN THE ADULT WHERE THE MATURED AIRWAY ANATOMY SHARES RESPIRATION WITH SWALLOWING AND SPEAKING AND HAS BECOME SUSCEPTIBLE TO OBSTRUCTION



THEREFORE, AIRWAY PRESSURE SHOULD WORK IN CHILDREN WHERE THE AIRWAY ANATOMY IS AT AN INTERMEDIATE STAGE OF MATURATION, BUT STILL MORE RESISTANT TO OBSTRUCTION



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| Patient number _{Notes} | I ₁ | II ₁ | III ₁ | IV ₁ | Va ₁ | Vb ₁ | VI ₁ | VII ₁ | VIII ₁ | IX ₁ | X ₁ |
|---------------------------------------|----------------|-----------------|------------------|-----------------|-----------------|-----------------|-----------------|------------------|-------------------|-----------------|----------------|
| Pre-SMAS Pressures | | | | | | | | | | | |
| Inspiratory (cmH ₂ O) | 3 | 2 | 1 | 4 | 4 | (5) | 5 | 9 | 4 | 7 | 2 |
| Expiratory (cmH ₂ O) | 8 | 5 | 4 | 5 | 7 | (10) | 8 | 9 | 7 | 14 | 8 |
| Post-SMAS Pressures | | | | | | | | | | | |
| Inspiratory (cmH ₂ O) | 8 | 8 | 8 | 10 | 7 | | 9 | 12 | 10 | 7 | |
| Expiratory (cmH ₂ O) | 12 | 13 | 8 | 15 | 10 | N/A | N/A | 9 | 16 | 20 | 14 |
| STRIDOR post SMAS | YES | YES | NO | NO | YES | N/A | N/A | NO | NO | YES | YES |
| CO ₂ Measured | 45 | 58 | 44 | 48 | 43 | 46 | 48 | 58 | 49 | 55 | 44 |
| CO ₂ Connected to Arterial | 38 | 47 | 35 | 39 | 35 | 39 | 39 | 49 | 40 | 40 | 35 |
| Respiratory Rate | 16 | 26 | 14 | 16 | 21 | 24 | 23 | 13 | 15 | 20 | 16 |

Notes

- 1 Stridor after SMAS was eliminated by adjusting flow rates and pressures
- 2 Airway pressure increased after SMAS without stridor or adjustment
- 3 Returned to surgery and pressures were about the same as ending pressures from previous surgery
- 4 An LMA was inserted in preparation for a rhinoplasty prior to completion of SMAS
- 5 Exhibiting no changes with SMAS

Discussion

We conclude that, even under deep sedation and general anesthesia, the spontaneously breathing adult patient can breath adequately as long as upper airway obstruction is prevented by titrated nasal positive pressure and the respiratory rate is not depressed below 13. Initial experience in pediatric patients (MRI, endoscopy, and dressing change procedures) indicates that pediatric patients have an airway that is well-managed by this technique and, more consistently so than adult patients.

References

1. Cooper R, Noble J: Managing narcogenic obstructed respiration in the aesthetic surgery patient. *Aesthet Surg J* 1999; 19:485-486.
2. Liang Y, Kimbal W, Kacmarek R, Zapol W, Jiang Y: Nasal ventilation is more effective than combined oral-nasal ventilation during induction of anesthesia in adult subjects. *Anesthesiology* 2008; 108:998-1003
3. Suresh D, Purdy G, Wainwright A, Flynn P: Use of continuous positive airway pressure in paediatric dental extraction under general anesthesia. *Br J Anaesth.* 1991 Feb;66(2):200-4