High Flow Oxygen: A Primary Oxygenation Technique for Endolaryngeal Airway Surgery

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ABSTRACT

Objectives: To demonstrate the safety and efficacy of high-flow oxygen as a primary oxygenation technique for endolaryngeal balloon dilation procedures.

Design: Retrospective review of prospectively collected data for 27 patients in 2014.

Setting: Study conducted at a tertiary care institution.

Participants: This study included patients (18 years) requiring endoscopic laryngeal dilation airway surgery in the operating room at a tertiary academic center. Patients were randomized to either high-flow oxygen or intermittent jet ventilation based on surgeon's preference.

Main Outcome Measures: Oxygen saturation, carbon dioxide levels, and duration of procedure were compared between patients undergoing endoscopic laryngeal balloon dilation procedures with either high-flow oxygen or jet ventilation. Statistical analysis was conducted using univariate analysis. Multivariate analyses were conducted to control for confounding factors such as patient characteristics and the type of surgery.

Results: Nineteen (70%) patients received high-flow oxygen, and eight (30%) received intermittent jet ventilation. Minimum oxygen saturation percentage was higher in the high-flow oxygen group (98.31±1.89) than in the jet ventilation group (92.25±4.92; p<0.01), and surgical duration was shorter with high-flow oxygen (19.95±7.71) than with jet ventilation (34.62±7.31 minutes; p<0.01). Maximum carbon dioxide levels and complication rates were similar for the two techniques.

Conclusion: This feasibility study demonstrated that high-flow oxygen is a viable alternative to intermittent jet ventilation, and may be used as a primary method of oxygenation for short-duration endolaryngeal airway surgeries. Benefits include a clear operative view, reduced risk of hypoxia, and reduced operative time, without risk of barotrauma or pneumothorax.

INTRODUCTION

Endoscopic laryngeal airway surgeries are often challenging owing to difficult exposure and narrow operative field. Frequently during these procedures, the nasal trumpet is removed for portions of the case to provide a clear view of the operative field; however removal results in periods of apnea. Airway management in such cases requires clear communication between surgeon and anesthesiologist, in order to optimize surgical visualization and oxygenation effectively.

Methods of ventilation for such cases include endotracheal tube ventilation, subglottic and supraglottic jet ventilation, or intermittent apnea with an endotracheal tube or jet ventilation. Each method has a potential impact on oxygenation, operative visualization, procedure length, and operative risks such as hypoxia, hypercarbia, and barotrauma.

Insufflation of oxygen through a face mask, oral airway or nasal cannula, has been successfully used to oxygenate patients who have suffered out-of-hospital cardiac arrest or continuous positive airway pressure in pediatric patients with obstructive sleep apnea; however, there are no reports of its use for endolaryngeal airway surgery.1,4

Given the lack of jet ventilation equipment in some of our operating rooms, we applied the technique of high-flow oxygen into our practice for endolaryngeal procedures, especially balloon dilation procedures of the subglottis and trachea. To evaluate its safety and efficacy as a primary oxygenation technique, we conducted a retrospective review of our high-flow oxygen experience. We compared procedure duration with like cases that underwent intermittent jet ventilation. Our goals were to maintain similar safe levels of oxygen saturation while limiting hypercarbia as is done with active ventilation during intermittent jet ventilation.

METHODS

Study Design

Patients >18 years who required an endolaryngeal balloon dilation surgery in the operating room at a tertiary academic center were included in the study. Two surgeons performed all procedures, using either high-flow oxygen or intermittent jet ventilation based on surgeon’s preference. All procedures were planned outpatient surgeries.

Surgical Technique

For participants in the high-flow oxygen group, a size 26-28 French nasal trumpet (Teleflex, Research Triangle Park, NC; Fig. 1a) was placed through the left nasal cavity, attached to the anesthesia circuit (Fig. 1b) with a size 5.0 or 6.0 endotracheal tube adaptor, and connected to 100% oxygen at a flow rate of 15-20 L/min. A laryngoscope was positioned to expose the larynx and placed in suspension. While the distal aperture of the nasal trumpet was visualized in the oropharynx during placement of the laryngoscope (Fig. 1c), it was positioned cranial to the distal aperture of the suspended laryngoscope. High-flow oxygen was administered through the nasal trumpet into the oropharynx, around the distal aperture of the laryngoscope, and through the trachea, allowing passive oxygenation of the lungs.

Patients in the jet ventilation cohort underwent intermittent subglottic jet ventilation with 100% FiO2 delivered via a jet needle. Anesthesiologists controlled the jet ventilation without any rate or pressure parameters other than direct visualization of adequate chest rise and fall and oxygenation of patient. An oxygen saturation level of 98% was used in all patients to trigger jet ventilation during periods of apnea and limit hypoxia.

Outcome measures included minimum O2 saturation, maximum CO2 level, and procedural duration. At the end of the procedure, patients were bag-mask ventilated in order to alleviate any hypercarbia that might have been present. The lowest levels of O2 saturation and highest levels of carbon dioxide during the procedure were documented for each patient. Duration was measured in minutes and was defined as the time from the beginning to end of surgery operating. Complications from surgery were recorded.

Statistical Analysis

Data were compared between groups using Mann-Whitney U or Fisher Exact tests. Multivariate analyses, specifically multiple regression analyses, were also conducted to control for confounding factors such as patient characteristics (age, sex, race, and body mass index [BMI]), and the type of surgery.

RESULTS

Twenty-seven patients who underwent endoscopic laryngeal balloon dilation surgery, of which 19 (70%) were performed using high-flow oxygen, while the remaining 8 (30%) underwent intermittent jet ventilation.

Univariate analyses revealed mean minimum oxygen saturation was significantly lower in the jet ventilation group (92.25±4.92) than in the high-flow oxygen group (98.31±1.89; Table 1). The mean duration of surgery in the jet ventilation group was significantly longer (34.62±7.31 minutes) than the high-flow oxygen group (19.95±7.71 minutes; Table 1). Minimum oxygen saturation levels decreased as procedural length increased for both groups (Fig. 3).

DISCUSSION

• This is the first study demonstrating the use of high-flow oxygen for endolaryngeal surgery.

Benefits of Technique:

• HFO results in higher minimum O2 saturation levels compared to continuous jet ventilation.

• HFO can provide additional time during difficult laryngoscopy under apneic conditions to facilitate resident education during laryngoscopy of the difficult exposure patient.

• HFO can be used in hospitals without jet ventilation equipment or sufficient expertise.

The equipment needed to set up a high-flow oxygen circuit includes a nasal trumpet, endotracheal tube adaptor, and anesthesia circuit, all of which can be found in most operating rooms.

Study Limitations:

• Small patient sample size as well as unequal distribution of patients between the two techniques.

• Observed time difference may not be solely due to our HFO ventilation method. It is possible that the co-morbidities of our patients played a role in the observed time difference.

• If continuous jet ventilation was used in place of intermittent jet ventilation, oxygen saturation levels and time difference may normalize with high-flow oxygen.

Recommendation:

• Appropriately selected candidates for high-flow oxygen could allow for shorter case times while providing when compared to intermittent jet ventilation.

CONCLUSIONS

• High-flow oxygen can provide sufficient oxygenation for entire endolaryngeal airway cases in carefully selected patients.

• Carefully selected patients include: patients who are non-smokers; patients who have a BMI < 30 and patients who do not have underlying lung disease.

• Surgical benefits include a clear view of the larynx/trachea, a reduced risk of hypoxia without increased risk of hypercarbia and reduced operative time.

• This technique may be used with readily available operative room equipment.

• This technique provides greater opportunity for resident teaching and training.

REFERENCES