TITLE: Use of High Flow Nasal Cannula during Sedation of Morbidly Obese Patients in the Endoscopy Suite

Authors:
Jay Berger MD/ PhD
Elizabeth Vue MD

BACKGROUND

Obesity defined as a body mass index (BMI) of > 30 kg/m2 has been identified as an independent predictor of sedation-related complications in patients undergoing sedation for gastro endoscopic procedures [1,2,3]. A recent survey estimated that in 2011-2012 34.9% of adults in the United States were obese (BMI > 30kg/m2) and 6.4% were extremely obese (BMI >40%kg/m2)[1]. Several physiologic changes occur, as a patient's BMI increases from the normal range to the extremely obese range. Respiratory physiology in morbidly obese patients is altered; specifically, the additional weight of the chest causes a decrease in chest wall motion and lung compliance. The decrease in compliance increases the work of breathing andcauses the development of ventilation to perfusion mismatching [4].

In addition to physiologic changes, increasing obesity also causes anatomical changes that affect the respiratory system. The high incidence of obstructive sleep apnea in obese patients can interfere with gas exchange during

endoscopic procedures requiring chemical sedation by causing airway obstruction[5]. The effect positional changes have on oxygen saturation is amplified in obese patients[6]. The physiologic and anatomic changes associated with obesity not only necessitate an increased vigilance when monitoring these patientsreceiving deep sedation, but also commonly require airway manipulation to ensure proper oxygenation and ventilation.

The delivery of anesthesia used for obese patients for gastrointestinal procedures does not significantly differ from what is used in healthy patients. Patients often receive deep sedation, a state in which patients are not easily arousable, but are responsive to noxious stimuli. Typically sedation during endoscopic procedures is maintained with an intravenous anesthetic such as Propofol; however, the choice of anesthetic used is operator dependent and should be personalized to the patient's medical history[7]. Regardless of thelevel of sedation, patients undergoing endoscopic procedures are typically provided with supplementary oxygenation via nasal cannula or face mask when a higher concentration of oxygen is required[8,9]. As a means to maintain ventilation in cases complicated by airway obstruction, physical maneuvers such as a chin lift or jaw thrust may be performed, adjuncts such as oral and nasal airways may be placed, and lastly active positive pressure ventilation may be delivered via bag valve mask (BVM), laryngeal mask airway (LMA), or endotracheal tube (ETT)[8]. The use of

high flow nasal cannula (HFNC) to deliver oxygen to morbidly obese patients is expected to decrease the need for the aforementioned interventions by producing a low level of positive end expiratory pressure (PEEP) that will prevent airways from collapsing.

HFNC is a device that delivers gas through an air/oxygen blender generating flows up to 60 L/min, which is significantly greater than 1-6 L/min flow used with standard nasal cannulas[5]. The enhanced flow delivered via HFNC has several physiological consequences, which can potentially benefit obese patients. One benefit of HFNC is that it can provide PEEP, which is uncommon in open system methods of oxygen delivery[5]. Studies have shown a significant increase in positive pharyngeal pressure and subsequent increases in end expiratory lung volume with the use of HFNC, especially in patients with increased BMI[6]. The added PEEP helps prevent alveolar collapse, enhancing ventilation and oxygen delivery. By increasing the amount oxygen reserve in patients' lungs, the frequency and length of oxygen desaturation caused by the sedation should be decreased; thereby decreasing the requirement of more invasive airway interventions. Another benefit of HFNC is that the high flow rate is able to prevent a build up of CO_2 by washing CO_2 out of the airway dead space[5]. Outcomes that support improvement in oxygenation and ventilation from use of HFNC include a decrease in respiratory

rate and decrease in accessory muscle use during respiration, andincreases in the PaO_2 andthe $PaO_2/Fi0_2$ ratio[10].

The actual FiO_2 that low flow systems such as nasal cannulas deliver is usually lower than predicted. As flow rates increase, the actual FiO_2 deliveredmore closely approaches the predicted value. Using high flow oxygen will, therefore, give an anesthesiologist a better estimate of the concentration of oxygen that is delivered to the patient[5].The air delivered via HFNC is both humidified and heatedto body temperature, thereby decreasing airway irritation and the incidence of bronchoconstriction, which is more common when cold dry air is used[7].

The numerous benefits of HFNChasmade it a valuable tool to assist in ventilation and oxygenation for patients in the intensive care setting.In theory, HFNC, addresses many of the respiratory complications that occur as a consequence of morbid obesity during sedation for medical procedures. We hypothesize that the use of HFNC during gastro endoscopic procedures requiring sedation in extremely obese (BMI >40 kg/m2) patients will improve ventilation and oxygenation and decrease the need for airway manipulation and increasing FiO_2 levels during the procedure.

OUTCOMES

The primary endpoint is to assess the effects of HFNC on maintaining ventilation and oxygenation. This will be ascertained through the need for airway manipulations such as chin lift and jaw thrust to the placement of airway adjuncts such as oral or nasal airways.

In addition, the need for an increased FiO2 will be recorded. Secondary endpoints will include the lowest and mean pulse oximetry readings, TcCO2, TcO2, and the change in these values from the beginning to the end of the procedure. Additional end points will record interruption or aborting of the procedure secondary to difficulties managing the patient's airway. Both groups will be placed on supplemental oxygen via nasal cannula and transported to the recovery room for observation prior to discharge. Pulse oximetry readings will be followed for an hour every 15 minutes after the completion of the procedure in the recovery room to assess for desaturation. Participants will also be evaluated on how they feel prior to discharge.

MATERIALS AND METHODS:

STUDY POPULATION

Participants are eligible for the study if they are greater than 18 years of age and are scheduled for an elective ambulatory upper and/or lower endoscopy under sedation in the gastrointestinal suite at the Moses Campus of the Montefiore

Medical Center. Participants must have a BMI greater than or equal to 40 kg/m^2. Inclusion in the study will be voluntary without monetary compensation. Participants will be excluded if they are less than 18 years of age,pregnant, have severe respiratory failure (hypercapneic and/or hypoxemic), use home oxygen at baseline, have a tracheostomy, or the procedure is an emergency. Patient selection will be obtained by reviewing the GI suite schedule a few days ahead of time screening for patient with a BMI greater than 40.

The patient's chart will then be reviewed during the normal anesthesia pre-operative assessment for criteria that would exclude the patient from the study. If no exclusion criteria are found, the patient will be contacted by phone and the study will be explained and the patient verbally consented. On the day of the procedure or if possible prior to the procedure the patient will sign written consent. The patients will be consented by a member of the study team.

STUDY DESIGN

Eligible patients will be randomized into two groups of thirtypatients each[11, 12]. The experimental group will receive oxygen via HFNC at 50 lpm and FiO_2 of 0.35 for the procedure. The control group will receive oxygen via nasal cannula at 5lpm(approximately an FiO_2 of 0.35) for the procedure.Each participant will receive monitored anesthesia care (MAC) with moderate sedation with Propofol.

A loading dose of 1 mcg/kg ideal body weight followed by an infusion starting at 125 mcg/kg/min and titrated to desired level of sedation. At the discretion of the Anesthesiologist the patient may receive 50 to 100mcg of Fentanyl IV PRN. All patients will be monitored using standard American Society of Anesthesiologists monitors, which include continuous EKG, heart rate, pulse oximetry, and non-invasive blood pressure monitoring. Monitoring end tidal carbon dioxide (ETCO2) to insure adequate ventilation by capnographyduring moderate sedation can be problematic, due to movement of the cannula or patient preference for mouth breathing preventing adequate uptake of expired gas for analysis. In addition, the high flow rates of the HFNCprevent the measurement of ETCO2. Ventilation will be monitored in both groups by observing chest movement and by ECG derived respiratory signals[13]. In addition, transcutaneous CO2 (TcCO2)and O2 (TcO2) levels will be monitored throughout the procedure.

Airway maneuvers required to aid in ventilation or oxygenation during the sedation portion of the procedure will be recorded and are classified as chin lift maneuver, airway insertion, increased FiO2, active ventilation, and lastly aborting of procedure or intubation. Chin lift maneuver is characterized by lifting of the chin or jaw-thrust maneuver in order to improve ventilation and/or oxygenation. Insertion of an oral or nasal airway helps insure patency of the airway by preventing obstruction by the tongue. Increased FiO2 will be achieved by

placement of face-mask over the patient's mouth and nose, airway patency can be helped by applying a low level of positive pressure. If oxygenation and/or ventilation continues to be problematic active ventilation can will be performed. The last classification is for any procedure that is aborted early due to respiratory complications or if the patient requires general anesthesia and intubation in order to insure proper ventilation/ oxygenation.

This is a pilot study, so a small number of patients per group was initially chosen. The number of patients in each group is based on our clinical observation while caring for patients in the endoscopy suite. The analysis of the outcome data, the proportion of patients requiring additional airway support, will be analyzed utilizing chi-square analysis. Current clinical practice at our hospital varies, the use of HFNC is a physician preference. Even though it is considered as a standard of care, not all Anesthesiologists are experienced using it. If the Anesthesiologist assigned to the case is not familiar with or not comfortable with HFNC, the patient will be excluded from the study. Although MAC sedation utilizing a nasal cannula for oxygenation is routinely performed, a significant number of morbidly obese patients are electively intubated and placed under general anesthesia for these endoscopic procedures. Patients that are endotracheal intubated will be excluded from the study. The research portion of the study is randomly assigning the

patients into one of two groups, every thing else follows the standard of care at our hospital.

RANDOMIZATION

This is a randomized controlled study. Anesthesia research office that is not part of the patient's routine clinical care will generate the randomization list. Envelope containing computer generated randomized allocations will be given to the research team. Randomization envelopes will only be open 30 minutes prior to the procedure. To maintain the proper concealed allocation the research team will maintain a randomization sheet with randomization number, subject initials, time and date of the procedure.

As all data is to remain anonymous and to be reported in aggregate (any value less than 1% will be aggregated with the most similar group (including diagnosis and age), we anticipate minimal physical, psychological risks to individual patients.

Data will remain de-identified and no personal identifiers will be queried unless an outlier is found. Subsequent to review by the research team any outliers that cannot be excluded will receive a chart review. For chart review the IRB code will be kept in the desk of and used exclusively by the principle investigator. Following identification by the principal investigator,charts of outliers may be

reviewed for verification of number of opiate prescriptions. This data will be reconfirmed in the anonimized database/spreadsheet.

STATISTICAL ANALYSIS

Sample size calculation

Primary objective of this study is to evaluate theeffects of HFNC on maintaining ventilation and oxygenation in the two groups. For the purpose of this study if a patient is getting 5or more air way manipulations such as chin lift and jaw thrust or any other direct interventions to maintain the ventilation and oxygenation will be categorized into the group need for additional support to maintain ventilation and oxygenation. According to our clinical audit when using the standard of care nasal cannula 90% of the patients required additional support for maintaining ventilation and oxygenation. HFNC is now been routinely used in our ORs. We have observed that in majority of the patients when HFNC was used the need for additional airway manipulations were minimal when compared to the regular oxygen cannula. For the purpose of this pilot study sample size calculations are based on the assumptions that 90% of patients using regular cannula will require additional airway manipulations while only 55% in the HFNC group requires the same. Based on a two-sided alpha of 0.05 and Type II error of 20% to achieve a statistically

significant difference between the two groups we need to study 25 patients in each group, a total of 50 patients. Additionally, we plan to increase our sample size by 10% to accommodate for attritions.

Analysis plan

All the analysis will be intention-to-treat analysis. Standard descriptive statistics will be used to explain demographic and clinical characteristics (age, gender, type of surgery, pre-entry medications, ASA status, surgeon, co- morbidities, etc.). The analysis plan assumes that the primary outcome of the trial the proportion of patients requiring addition airway support will be analyzed using the chi-square analysis. Percentage of patients requiring FiO2 will also be analyzed using chi-square analysis. For all continuous monitoring measurements such as TcCO2 and TcO2 the measurements will be averaged for first 5 minutes before the start of any procedure activities and this measurement will serve as the baseline measurement. For all subsequent measurements every 15 minute measurements will be averaged and a delta value will be created comparing it to the baseline. The delta value created will be compared between the two groups.

CONCLUSION:

In the past decade, the obesity epidemic has resulted in a growing need for novel approaches to improve patient safety when receiving anesthesia. First shown

in the pediatric critical care literature and more recently in the adult critical care literature, HFNChas been shown to be useful in treating both hypoxic and hypercapnic respiratory failure. This pilot study will investigate the utility of HFNC in insuring ensuring adequate ventilation and oxygenation of extremely obese patients during endoscopy procedures requiring sedation. Our hypothesis is that HFNC will allow for improved and safer ventilation of extremely obese patients undergoing sedation, improving the quality of care for this specific patient population.

REFERENCES:

1. Berzin T, Sanaka S, and Barnett S, et al. A prospective assessment of sedation-related adverse events and patients and endoscopist satisfaction in ERCP with anesthesiologist-administered sedation. Gasstroenterol 2011; 73: 710-7.

2. Nishimura M. High-flow nasal cannula oxygen therapy in adults. Journal of intensive care 2015;3:15.

3. Corley A, Caruana LR, Barnett AG, Tronstad O, Fraser JF. Oxygen delivery through high-flow nasal cannulae increase end-expiratory lung volume and reduce respiratory rate in post-cardiac surgical patients. British journal of anaesthesia 2011;107:998-1004.

4. Kabon B, Nagele A, Reddy D, et al. Obesity decreases perioperative tissue oxygenation. Anesthesiology 2004;100:274-80.

5. Tufik S, Santos-Silva R, Taddei JA, Bittencourt LRA. Obstructive Sleep Apnea Syndrome in the Sao Paulo Epidemiologic Sleep Study. Sleep Medicine 2010;11:441-6.

6. Vaughan RW, Wise L. Intraoperative arterial oxygenation in obese patients. Annals of surgery 1976;184:35-42.

7. Standards of Practice Committee of the American Society for Gastrointestinal Endoscopy, Lichtenstein DR, Jagannath S, et al. Sedation and anesthesia in GI endoscopy. Gastrointestinal endoscopy 2008;68:815-26.

8. Wani S, Azar R, Hovis CE, et al. Obesity as a risk factor for sedation-related complications during propofol-mediated sedation for advanced endoscopic procedures. Gastrointestinal endoscopy 2011;74:1238-47.

9. Amornyotin S. Sedation-related complications in gastrointestinal endoscopy. World J GastrointestEndosc 2013;5:527-33.

10. Sztrymf B, Messika J, Bertrand F, et al. Beneficial effects of humidified high flow nasal oxygen in critical care patients: a prospective pilot study. Intensive care medicine 2011;37:1780-6.

11. Haines D, Bibbey D, and Green J. Does nasal oxygen reduce the cardiorespiratory problems experienced by elderly patients undergoing endoscopic retrograde cholangiopancreatography. Gut 1992;33:973-5.

12. Rigg J, Watt T, Tweedle D, et al. Oxygen saturation during endoscopic retrograde cholangiopancreatography: a comparison of two protocols of oxygen administration. Gut 1994;35:408-11

13.Helfenbein E, Fioozabadi R, Chien S, et al. Development of three methods for extracting respiration from the surface ECG: A review. J Electrocardiol 2014;47:819-25.