Oxygenation in the Operating Room: A Case Series of High Flow Nasal Cannula Utilization for Patients with Challenging Airways

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Introduction:
We present two cases in which high flow nasal cannula (HFNC) oxygen therapy was successfully used as a preoxygenation technique prior to and throughout induction as well as during attempts at awake fiberoptic intubation in patients with known difficult airways. The cases presented demonstrate HFNC as a valuable tool for patients with disparate pathophysiologic airway challenges.

Case Reports:
A 43 year old woman presented for continued management of metastatic anaplastic carcinoma of the thyroid, previously treated with chemoradiation therapy at an outside facility. Physical exam was consistent with a fixed, prominent neck mass. Imaging showed evidence of metastatic lymphatic, pulmonary, pleural, skeletal, and right temporal lobe lesions. CT scan demonstrated a large heterogeneous thyroid mass with narrowing of the subglottic tracheal lumen to three millimeters. Her situation was further complicated by the development of a tracheoesophageal fistula resulting in aspiration pneumonia. The decision was made to proceed to the operating room for tracheostomy, tracheoesophageal fistula stenting, and palliative tumor debulking. After ten minutes of pre-oxygenation via HFNC oxygen therapy, the oropharynx and vocal cords were topicalized and sedation was administered via propofol and remifentanil infusions. A pediatric bronchoscope was easily passed through the vocal cords with visualization of near complete obstruction in the subglottic space. The obstruction was friable and composed of tumor and native tissue extruding into the lumen of the trachea. An attempt was made to pass the bronchoscope, but visualization proved unsuccessful. The next attempt was made with cautious saline dilation with successful identification of a lumen. The bronchoscope was carefully passed beyond the mass and entered into the main trachea. A 5.0 endotracheal tube was passed beyond the tumor and into the trachea. High flow oxygen therapy remained in place throughout induction and intubation attempts. The airway was secured 22 minutes after initiation of sedation without drop in oxygen saturation below 98%.

A 35 year old man with history of metastatic rectal cancer and central line-related superior vena cava (SVC) stenosis, previously stented, as well as known non-occlusive right upper extremity thrombosis presented for laparoscopic liver resection. His outpatient therapeutic anticoagulation regimen was stopped five days prior in preparation for surgery. On post-operative day one, he developed bilateral upper extremity and facial edema consistent with SVC syndrome. Computed tomography venogram demonstrated worsened upper thoracic venous thrombosis with SVC stent...
occlusion. Heparin infusion was initiated and he was brought to the interventional radiology suite for mechanical thrombectomy and balloon angioplasty. Due to the patient’s symptomatic presentation with inability to lay supine (beyond approximately 45 degrees), awake fiberoptic intubation was planned. Pre-oxygenation via HFNC oxygen therapy was initiated followed by lidocaine topicalization and mild sedation with a remifentanil infusion. The airway was secured 16 minutes later without complication. HFNC remained in place throughout and oxygen saturation remained at 95% or higher throughout induction and intubation (as measured by a probe placed above the obstructed vessel).

Discussion:

HFNC oxygen therapy provides several potential benefits to patients with respiratory failure including delivery of heated, humidified air with a programmable fraction of inspired oxygen and flow rates up to 60 liters per minute along with reducing upper airway resistance and work of breathing. In certain cases, this offers an alternative to noninvasive positive pressure ventilation. Compared to conventional low-flow nasal cannula oxygen therapy, HFNC provides expiratory resistance leading to increased end-expiratory lung volume with increased alveolar ventilation and improved oxygenation. Its use in settings such as the intensive care unit is well known and used frequently to provide improved oxygenation in critically ill patients.

For the anesthesia provider, the use of HFNC as a pre-oxygenation technique that can remain in place during the apneic portion of the intubation procedure may allow for longer apnea times while maintaining normal oxygen saturation in patients with difficult airways who require general anesthesia. This employs the principle of apneic oxygenation which involves continuous alveolar passive oxygenation via an oxygen pressure gradient across pulmonary capillaries, effectively prolonging the safe apneic threshold. Additionally, HFNC may be an effective oxygenation method during laryngeal surgeries where traditional endotracheal intubation must be avoided, therefore eluding higher risk techniques such as jet ventilation or even tracheostomy.

Conclusion:

These cases demonstrate HFNC as another tool to be used by the anesthesiologist in the management of scenarios of known difficult airways where the intubation procedure may be challenging or prolonged. By utilizing the principle of continuous alveolar passive oxygenation, this technique serves to augment ventilation and oxygenation in critically ill patients undergoing procedural interventions. Further research in this area may be indicated to help determine both safety and efficacy in other surgical interventions and pathologic states.

