Spontaneous Ventilation During Balloon Dilation of Subglottic Stenosis in a Pregnant Woman

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Introduction

Subglottic stenosis (SGS) is defined as a narrowing of the subglottis and most commonly affects females between 20 and 40 years of age. As idiopathic SGS tends to affect women of reproductive-age, the management of the disease during pregnancy is affected by the natural progression of the disease as well as expected mechanical and physiologic respiratory changes related to pregnancy: increased oxygen consumption, decreased functional residual capacity, and increased minute ventilation.

Supraglottic jet ventilation is a standard approach for airway management in patients with symptomatic SGS, but it carries the risk of barotrauma resulting in pneumothorax or pneumomediastinum and is limited by patient chest wall compliance.

Transnasal humidified rapid insufflation ventilatory exchange (THRIVE) is an emerging technique that can be used in apneic or spontaneously ventilating patients. THRIVE has been described in intentionally apneic pregnant women undergoing balloon dilation for severe SGS, but there are no reports of THRIVE during general anesthesia while maintaining spontaneous respiration for balloon dilation of SGS in pregnancy.

A Primer on Subglottic Stenosis

Definition: A narrowing of the subglottis, defined as the area from just below the vocal folds to the top of the first tracheal ring, mostly comprising the cricoid

Most commonly affects **females between 20 and 40 years of age**.

Etiologies: congenital, idiopathic, and acquired (trauma, endotracheal intubation, or granulomatosis with polyangiitis)

Management: Endoscopic dilations, steroid injections, possibly open techniques including cricotracheal resection or tracheostomy

Outcomes: Dependent on patient and disease factors.

References

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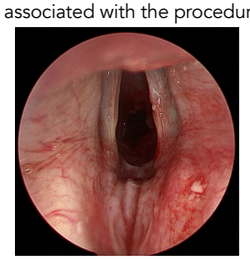
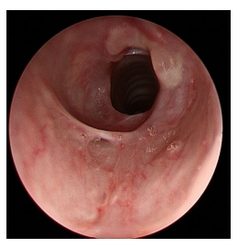
Patel A, Anaesth 2015.
Scholz A, Br J Anaesth 2008.

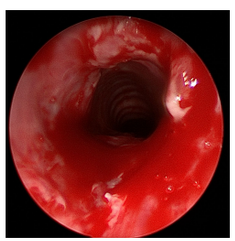
Case Description

A 30 year old 96 kg G1P0 female with history of idiopathic subglottic stenosis (iSGS), GERD, and Crohn's disease presented with increasing shortness of breath throughout pregnancy. Surgical history included 3 prior direct laryngoscopies (DL) with balloon dilation.

Progressive shortness of breath was initially attributed to her gravid state, but worsening symptoms in the second trimester prompted in-office laryngoscopy, revealing worsening stenosis. The patient was scheduled for microsuspension direct laryngoscopy with balloon dilation. Multidisciplinary planning included otolaryngology, maternal fetal-medicine (MFM), and anesthesiology, and the procedure was planned for 27 6/7 weeks' gestation. All parties agreed to continuous fetal monitoring given the viability of the fetus as well as the risk of hypoxemia and hypercarbia associated with the procedure.


Pre-dilation supraglottic


Pre-dilation subglottic


Post-dilation subglottic

On the day of surgery, the patient had markedly audible breathing but was able to speak in complete sentences. Airway examination was reassuring. The patient's MFM, otolaryngologist, and anesthesiologist agreed upon a plan with contingencies based on both maternal and fetal status.

Prior to transfer into the operating room, the patient was given a bolus of dexmedetomidine 0.5 mcg/kg followed with an infusion of 0.4 mcg/kg/hr. All infusion dosing was based on ideal body weight (60 kg). Once in the operating room, standard monitors were applied along with oxygen via transnasal humidified rapid insufflation ventilatory exchange (THRIVE) at 20-30 L/min. An infusion of propofol was slowly titrated (50-125 mcg/kg/min) and was administered concomitantly with remifentanil (0.08-0.1 mcg/kg/min). Very close communication occurred between otolaryngology and anesthesiology teams to evaluate depth of anesthesia.

On initial DL, the patient was noted to move non-purposefully. Movement resolved with intermittent boluses of ketamine (total 30 mg), and spontaneous respiration was maintained (8-10 breaths per minute). Vital signs remained stable throughout the procedure (oxygen saturation 98-100%, heart rate 75-102 beats per minute, and mean arterial pressure 65-82 mmHg). Successful microsuspension direct laryngoscopy, radial cuts, and balloon dilation were performed by otolaryngology. Tidal volumes were not able to be monitored due to the suspension, however at the conclusion of the procedure a mask was placed and tidal volumes were noted to be 600-900 mL with first post-procedural breath revealing ETCO2 of 39 mmHg.

Following the procedure, the patient recovered well and had an uneventful delivery.

What is THRIVE and how does it work?

THRIVE (Fischer and Paykel Healthcare, Auckland, New Zealand) stands for Transnasal Humidified Rapid Insufflation Ventilatory Exchange. It can deliver very high flow rates of humidified oxygen via nasal cannula.

Proposed benefits include:
1. Increased supplemental oxygen delivery
2. Respiratory support through decreased dead space and positive airway pressure

Spontaneously breathing patients typically inspire 20-40 L/min. With typical nasal cannula oxygen flow rates of around 2-4 L/min, room air is entrained, diluting the FiO2 to around 25-30%. THRIVE allows for higher flow rates such that little room air is entrained and FiO2s of up to 95-100% are possible.

When high flow rates are used, positive airway pressure is maintained. This allows for CO2 washout (even during apnea) and the diffusion of oxygen into alveoli (replacing what has been absorbed). Airway resistance and work of breathing are also reduced.

THRIVE (Fischer and Paykel)

Discussion

THRIVE is an emerging technique for the management of both SGS and pregnant patients. We report the novel management strategy for the balloon dilation of a pregnant patient with subglottic stenosis utilizing THRIVE during general anesthesia with spontaneous respiration to avoid complications associated with neuromuscular blockade and hypercapnia.

Intentional apnea utilizing neuromuscular blockade has some drawbacks: maternal hypoxia and/or hypercarbia, failed tracheal intubation, and neonatal depression secondary to altered maternal respiratory physiology. Combining THRIVE with spontaneous ventilation during the procedure increases the likelihood of maintaining maternal oxygen and carbon dioxide levels, avoiding the increased risk of fetal acidosis that can be associated with hypercarbia during intentional apnea.