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Airway appliances in endoscopy

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Respiratory obstruction is a frequent consequence of sedation due to the collapsibility of the velopharynx. Several approaches are available to eliminate this obstruction, including CPAP, mandibular advancement, nasal airways, and laryngeal mask airways. Practical approaches to the use of these measures are described.

Respiratory compromise is one of the most common complications associated with sedation for endoscopy. Although the reasons for this are numerous, principal among these is respiratory obstruction. Airway appliances are useful in overcoming obstruction, and facility with these devices has traditionally been a core component of anesthesia training programs. Despite this, many anesthesia providers rely on nasal cannulae and green masks for sedation, and resolve obstruction only after it occurs, or use endotracheal intubation and general anesthesia when less invasive options exist. Gastroenterologists often have limited exposure to airway appliances during training and are uncomfortable treading in an area that they associate with general anesthesia. The purpose of this article is to clear the air, both figuratively and literally, on this topic.

Background

The natural state of the upper airway is to collapse; airway patency is the result of action of the pharyngeal dilator muscles acting to open the velopharynx. The resting tone of these muscles is decreased in both natural sleep and by sedation.[1] Although there are important differences between sleep and sedation, many common features can be observed.[2] Thus, adaptation of measures that are effective in management of sleep apnea may prove useful in managing obstruction produced by sedation. Whereas such measures may be effective in managing obstruction, simple screening tools for obstructive sleep apnea may be ineffective in stratifying patients at risk for obstruction during endoscopy.[3]

A key concept in airway obstruction is that of the Starling resistor. As shown in Figure 1, two rigid tubes (the nasopharynx and trachea) are connected by a collapsible segment, the velopharynx. When the pressure in the velopharynx falls below the surrounding tissue pressure, the airway collapses and resistance becomes infinite. The pressure at which this collapse occurs is termed the *critical pressure*, or P_{crit}. The lower the P_{crit}, the less collapsible the airway. Three approaches to overcoming the tendency of the airway to collapse are illustrated in Figure 1: increasing the intramural pressure (Figure 1A), decreasing the extramural pressure (Figure 1B), and bypassing the collapsible segment.

Natural sleep will increase P_{crit}, thus, all agents that produce a sleep-like state will increase this value. The impact of a drug on P_{crit} is an important measure of the safety of that drug for sedation.[4] Mechanoreceptors present in the pharynx produce a local reflex that increases the force of contraction of the genioglossus, restoring airway patency. Additionally, hypoxia is a potent stimulus for arousal, increasing ventilatory drive and terminating sleep. The significant differences between sleep and sedation are the tendency of sedatives, particularly propofol, to disrupt the local reflex producing pharyngeal dilation[5] and a reduced response to acute hypoxia.[6] Although, at equivalent levels of light sedation, little difference between the effect of propofol and midazolam can be demonstrated,[7] there may be a greater tendency to push propofol to deep sedation. The level of propofol associated with a P_{crit} of zero (spontaneous airway collapse) straddles the line of loss of consciousness,

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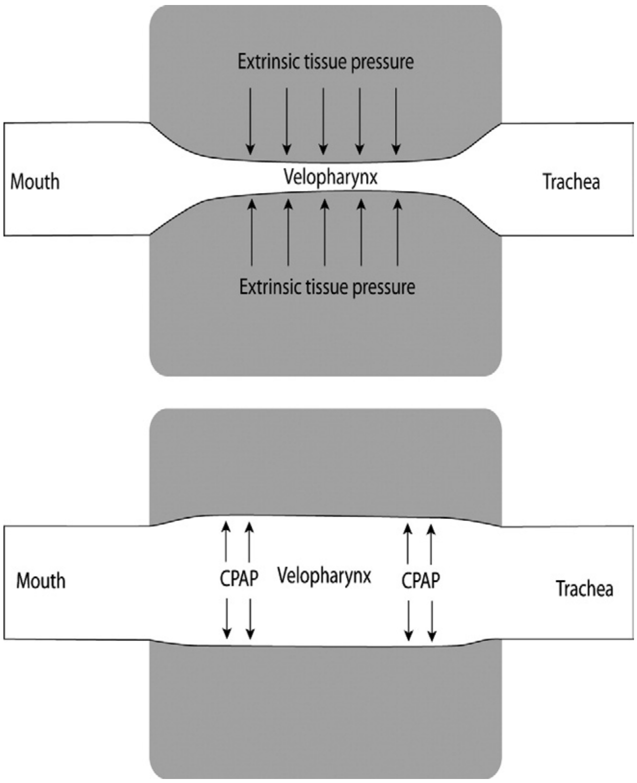

Figure 1 Airway collapse in the velopharynx.

which may create the false impression that it is possible to routinely provide deep sedation with propofol without airway compromise.

Measures to increase intramural pressure

Application of continuous positive airway pressure (CPAP) in sufficient quantities can generally overcome obstruction associated with propofol.[8] Although application of CPAP is a relatively trivial problem during colonoscopy, during upper endoscopy, obtaining a sealed airway may seem problematic. One airway adjunct that permits application of CPAP during upper endoscopy is the VBM™ endoscopy mask.[9] In a prospective comparison of patients undergoing fiberoptic intubation under propofol sedation, pressure support ventilation via this mask provided fewer episodes of desaturation compared with spontaneous ventilation with nasal insufflation.[10] The mask has also been employed to permit delivery of inhalational anesthetics during upper endoscopy in pediatric patients.[11] In the author's experience using the mask, several practical lessons have been derived. First, the 10-mm membrane should be specified, and the fixation harness should be obtained. Second, considerable drag is created by the membrane, which may be overcome with lubrication. Silicone lubricants, such as EndoLube™, are preferable to water-based products, such as SurgiLube™, which rapidly dries to a thin film. Third, it is often easier to preload the endoscope through the mask, preoxygenate with a standard mask, and once the esophagus has been intubated, fix the mask to the face. Fourth, the masks are sufficiently costly and cumbersome as to be reserved for challenging cases, but familiarity with the mask should be obtained in easy cases.

Measures to decrease extramural pressure

During sedation, tone of the pharyngeal dilator muscles decreases. Strategies to decrease the unopposed extramural pressure are based on optimizing the geometry of the airway. Experienced anesthetists faced with a partially obstructed patient will optimize head position, as supine recumbancy, head flexion, and an open mouth are associated with increased obstruction.[12,13] These measures are often of limited use, as patients are typically in lateral or prone position, but consideration should be given to the beach chair position, particularly in the morbidly obese.

The principal pharyngeal dilator muscle is the genioglossus, which tethers the tongue base to the chin. The chin is stabilized by the facial muscles, which are slack during sleep and sedation. By stabilizing the mandible in advancement, the P_{crit} can be lowered in midazolam sedation,[14] and pharyngeal dimension can be increased during propofol sedation.[15] Mandibular advancement oral appliances are available commercially and may be of use in colonoscopy, but no commercially available device exists that permits upper endoscopy. Mandibular advancement can also be obtained by external jaw thrust; a device that permits this has been recently introduced by Hypnoz Therapeutics.[16] Although this device presumes the patient will be supine, it provides unimpeded access to the mouth and pharynx. This device is depicted in Figure 2.

Measures to bypass the collapsible segment

Although the definitive conduit to bypass the pharynx is an endotracheal tube, it is assumed that the reader is already familiar with this option; therefore, focus is on what are

Figure 2 The jaw elevation device™. (Color version of figure is available online at www.techgiendoscopy.com.)

Figure 3 A simple device for delivering nasopharyngeal high flow oxygen. (Color version of figure is available online at www.techgiendoscopy.com.)

termed supraglottic airway adjuncts. As a generalization, the more effective these devices, the greater a burden they impose on the endoscopist. In simple cases, even a small improvement in P_{crit} can eliminate obstruction, and in truly challenging cases, a supraglottic device may avoid general endotracheal intubation.

Figure 4 The Robertazzi airway positioned directly above the open glottis.

Figure 5 Endoscopic ultrasound performed with nasopharyngeal high flow oxygen.

A simple airway adjunct easily devised from readily available supplies is illustrated in Figure 3. A Robertazzi nasopharyngeal airway, the connector from an endotracheal tube, and the strap from a bite block are assembled to form this device.

The device is typically placed after sedation, although it could be placed with topical anesthesia. The strap is useful in preventing the airway from both falling out and being pushed forward into the nasopharynx. It is important to choose an appropriate size airway; too short an airway will not bypass the velopharynx, and too long might contact the vocal cords or arytenoids with attendant coughing or laryngospasm. Appropriate placement is easily confirmed during intubation, as illustrated in Figure 4.

The device can then be connected to a source of oxygen, such as a Mapleson circuit, as illustrated in Figure 5. The use of this device is depicted in a video in the online supplementary material. (The supplementary video is available online at www.techgiendoscopy.com.)

This system is remarkably effective in reducing the frequency of episodes of oxygen desaturation during endoscopy, but has not been studied in prospective, randomized fashion.

The laryngeal mask airway is another useful airway adjunct. In a series of 80 children undergoing EGD, the laryngeal mask anesthesia (LMA) provided acceptable conditions.[17] In a retrospective study of adults undergoing endoscopic retrograde cholangiopancreatography with anesthesiologists in attendance, patients managed with an LMA had shorter emergence times than those managed with an endotracheal tube, but no difference in procedure times and no difficulty in placement of the endoscope.[18] An advantage of use of the LMA is the ability to position the patient prior to induction of anesthesia; a prospective comparison of airway management in the lateral position demonstrated significantly higher success rates placing LMAs versus endotracheal tubes.[19] When performing endoscopy with the LMA, the endoscopist should seek the tip of the LMA, which sits in the esophagus immediately distal to the glottis. Proper lubrication of the gastroscope, preferably with silicone-based lubricants, is useful in avoiding dragging the LMA out of position.

Although propofol is the mainstay of anesthesiologist-administered sedation in the endoscopy suite, the LMA and VBM endoscopy mask permit the use of volatile anesthetic agents. These agents have significant advantages in situations in which IV access is problematic; the author has performed numerous EGDs with sevoflurane induction and maintenance in patients in whom IV access had been abandoned.

Conclusions

Obstruction of the airway is a predictable consequence of sedation. Although there are certainly individuals in whom such collapse is highly likely, a simple method to stratify patients for risk of this complication has not emerged. Methods for reducing airway collapsibility are available and may permit avoidance of general endotracheal intubation in management of patients requiring deep sedation for endoscopy. Familiarity with these methods should be obtained prior to undertaking high-risk patients.

References

1. Hillman DR, Platt PR, Eastwood PR: The upper airway during anaesthesia. Br J Anaesth 91:31-39, 2003
2. Karan SB, Perlis M, Ward D: Anesthesia and sleep medicine: An opportunity to be mutually informative? Semin Anesth Perioper Med Pain 26:42-48, 2007
3. Khiani VS, Salah W, Maimone S, et al: Sedation during endoscopy for patients at risk of obstructive sleep apnea. Gastrointest Endosc 2009, in press
4. Litman RS: Upper airway collapsibility: An emerging paradigm for measuring the safety of anesthetic and sedative agents. Anesthesiology 103:453-454, 2005
5. Eastwood PR, Platt PR, Shepherd K, et al: Collapsibility of the upper airway at different concentrations of propofol anesthesia. Anesthesiology 103:470-477, 2005
6. Nieuwenhuijs D, Sarton E, Teppema L, Dahan A: Propofol for monitored anesthesia care: Implications on hypoxic control of cardiorespiratory responses. Anesthesiology 92:46-54, 2000
7. Norton JR, Ward DS, Karan S, et al: Differences between midazolam and propofol sedation on upper airway collapsibility using dynamic negative airway pressure. Anesthesiology 104:1155-1164, 2006
8. Hillman DR, Walsh JH, Maddison KJ, et al: Evolution of changes in upper airway collapsibility during slow induction of anesthesia with propofol. Anesthesiology 111:63-71, 2009
9. Available at: http://www.vbm-medical.de/cms/files/p326_endoskopiemaske_2.1-10.06_gb.pdf. Accessed August 16, 2009
10. Bourgain JL, Billard V, Cros AM: Pressure support ventilation during fibreoptic intubation under propofol anaesthesia. Br J Anaesth 98:136-140, 2007
11. Rauch RY, Brener CE: Airway management for pediatric esophagogastroduodenoscopy using an endoscopy mask. Anesth Analg 96:303-304, 2003
12. Ikeda H, Ayuse T, Oi K: The effects of head and body positioning on upper airway collapsibility in normal subjects who received midazolam sedation. J Clin Anesth 18:185-193, 2006
13. Walsh JH, Maddison KJ, Platt PR, et al: Influence of head extension, flexion, and rotation on collapsibility of the passive upper airway. Sleep 31:1440-1447, 2008
14. Inazawa T, Ayuse T, Kurata S, et al: Effect of mandibular position on upper airway collapsibility and resistance. J Dent Res 84:554-558, 2005
15. Kuna ST, Woodson LC, Solanki DR, et al: Effect of progressive mandibular advancement on pharyngeal airway size in anesthetized adults. Anesthesiology 109:605-612, 2008
16. JED: A hands free, jaw elevation device to maintain an open airway. Available at: http://www.hypnozdevices.com/products/products.html. Accessed August 17, 2009
17. Orfei P, Ferri F, Panella I, et al: [The use of laryngeal mask airway in esophagogastroduodenoscopy in children.] Minerva Anesthesiol 68: 77-82, 2002
18. Osborn IP, Cohen J, Soper RJ, Roth LA: Laryngeal mask airway—A novel method of airway protection during ERCP: Comparison with endotracheal intubation. Gastrointest Endosc 56:122-128, 2002
19. McCaul CL, Harney D, Ryan M, et al: Airway management in the lateral position: A randomized controlled trial. Anesth Analg 101: 1221-1225, 2005