Secrets of Flexible Fiber-Optic Intubation
Pearls for Success in Unusual Circumstances

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Nothing is more satisfying than the successful application of one’s inherent knowledge to unusual patient circumstances, while staying out of trouble and avoiding court appearances. Anesthesiology, intensive care, and emergency department personnel know that the key to “being all that you can be” is practice and the ability to adapt.

Airway management caregivers value being expert in the use of a bare minimum of alternative airway devices, including flexible fiber-optic bronchoscopes (fiberscopes), also known as flexible endoscopes, employing video chips. This article offers fiber-optic pearls beyond straightforward intubation while promoting management comfort and protecting the equipment.

For example, the use of fiber-optic devices provides several benefits to patients during tracheostomies: locating the trachea for surgical assistance, reducing the incidence of tracheostomy complications, and treating adverse results of tracheostomies.

Transillumination of the fiber-optic light from within the trachea provides assistance in locating its anterior rings (the tip of the fiberscope is placed beyond the distal end of a preexisting airway). Surgeons will see a glow at skin level or during deeper tissue dissection (Figure 1).

It might seem implausible that a surgeon cannot locate the trachea, but it does happen. I once had an extremely large, morbidly obese patient who presented...
for elective open tracheostomy. The surgery was to provide relief for his diagnosis of malignant sleep apnea, which had been resistant to all other forms of therapy. In anticipation of an awake fiber-optic intubation (FOI), we performed bilateral glossopharyngeal nerve blocks (2 mL of 3% lidocaine atomizer spray per side), bilateral percutaneous superior laryngeal nerve blocks (3 mL of 1% lidocaine), and a transtracheal injection of 4% lidocaine. FOI went smoothly. Unfortunately, even with easily seen transillumination, the surgical team could not find the trachea after 3 hours. (The team leader said the transtracheal injection was impossible, although the patient had coughed while it was being administered.)

**TECHNIQUE**

In intubated patients or those receiving a supraglottic airway (SGA), the fiberscope can be inserted with the aid of an in-line fiberscope swivel adapter to permit continued ventilation (Figure 2). To prevent impaired ventilation and hypercarbia from potentially excessive “intra-airway” fiberscope bulk, the relationship between the diameter of the fiberscope and that of the secured preexisting or intended airway device must be carefully selected (Figure 3). This step is especially important if the patient has a condition highly sensitive to this possibility, such as increased intracranial pressure. If desired, a preemptive spray of intratracheal lidocaine through the suction or working port of the fiberscope reduces reaction to intratracheal stimuli from either extension of the fiberscope tip or surgical manipulations.

The fiberscope is situated within the secured airway device until its tip lies beyond the end of the device, at least 2 to 3 cm below the second tracheal ring, according to the surgical team’s intended incision site. It should be safeguarded in this position and powered on intermittently as needed for transillumination. Once the surgical team has physically located the trachea, the fiberscope should be protected by withdrawal as much as possible, while still allowing visualization of the impending surgical entry. If the preexisting airway is an endotracheal tube (ETT), the fiberscope is withdrawn immediately proximal to the tip of the ETT. (Note that a light wand also can provide transillumination, but does not have benefits associated with fiberoptic visualization.)

Anterior midline neck pressure on the proposed access point into the trachea often can be perceived by the caregiver, who is observing the fiberscope image. Once the surgical instrument is seen entering into the trachea, this action is reported to the surgeons and the fiberscope and ETT can be partially withdrawn 1 to 2 cm. Winkler et al found that of 71 patients undergoing percutaneous dilation tracheostomy (PDT) in the ICU, 18% had paramedian punctures that were corrected to midline after fiberscope guidance. Similarly, false passages from the tracheostomy tools are unlikely during fiberscope assistance.

Whether blade incision for open tracheostomy or needle for PDT, direct observation of tracheal impact is associated with fewer serious surgical complications. In a study of 76 patients undergoing PDT with or without use of a fiberscope, Berrouschot et al found an equivalent rate of perioperative complications among patients treated with a fiberscope (7%) and those in the nonfiberscope group (6%). More severe complications,
however, were significantly less frequent in the fiberscope group (2.5%) than in the non-fiberscope group (8%). These included perforation of the pars membranacea or posterior tracheal wall (3), intratracheal hemorrhage (3), tension pneumothorax (2), mediastinal emphysema (1), and death (1). One patient in the fiberscope group experienced a laceration and 2 experienced intratracheal hemorrhages.

As the Berrouschot et al study demonstrated, a fiberscope on occasion can be used to treat tracheostomy complications: Two of the patients who experienced fiberscope-observed intratracheal hemorrhage were treated with fiberscope flushing and aspiration of the accumulated blood.

The lower rate of severe complications associated with FOI has been shown to lower costs. Carillo et al reported a reduction in costs of $1,750 in PDT under fiberscope guidance compared with surgical tracheostomy. Use of a fiberscope can be economical in other scenarios as well, such as determining the position of an ETT and to prevent complications from intubations that are too shallow or too deep.

Clinicians have a definite need beyond clinical signs and counting off ETT distance marks for determining the position of the tube. This need is particularly acute in longer-term intubation patients, as many studies have noted. In small children, diagnosing ETT position is particularly important because it is far from accurately assessed with these parameters. Malposition occurs frequently. Harris et al found that despite normal clinical signs in 257 children ages 6 months to 12 years, up to 18% had errantly placed ETTs. In children under 1 year of age, the incidence was 35%. Although 95% of patients had successful ETT repositioning after a single chest x-ray, the other 5% needed readjustment during continuous fluoroscopy. The question arises, “Is there some other method that is just as effective?” and the answer is “Yes!”

Vigneswaran compared the accuracy of a fiberscope and chest x-ray in 20 high-risk premature and full-term infants. Surprisingly, infants undergoing x-ray were more likely to experience large drops in oxygen saturation during the radiographs. This effect was thought to result from alterations in the position of the head and ETT. On the other hand, the group observed with fiberscopes—a subset of patients with secretions—experienced higher airway pressures and likely increased work of breathing, and significant but lower drops in oxygenation. The one advantage in this subset of patients was the ability to suction with the fiberscope. A comparison study between fiberscope and x-ray detection by O’Brien et al involving 25 adults also found equal accuracy in determining the distance of the ETT from the carina and laryngeal areas.

Fiberscope examination is similar in cost to chest x-ray and considerably less than fluoroscopy. Use of a fiberscope also has the benefit of avoiding radiation. Although a single chest x-ray only incurs approximately 6 mrem, repeated x-rays or fluoroscopy may result in many times this degree of exposure. A fiberscope may be more advantageous than x-ray if urgency is a factor, as the fiber-optic examination can provide instantaneous results and can be used multiple times if circumstances dictate. In the event that a particular technique is unavailable or its use is technically problematic for determining distances, the opposite approach should be chosen.

Figure 3. The “transillumination-assisted technique” permits greater passage of ventilation (red arrows) when less fiberscope bulk occupies the airway, as shown in frames A and B, in contrast to C and D.
TECHNIQUE

In infants, the tip of the ETT should be at least 2 cm above the carina, but no more than an additional 1.5 to 2 cm margin above that mark. In adults, the ETT tip generally should be at least 4 cm, and up to an additional 6 to 10 cm above the carina (Figure 4). Because of variations in sex, age, height, race, and other factors, these distances are not absolute, and other possible causes of malposition should be considered.

Another advantage of this type of examination is gaining experience in fiberscope practice; a fiberscope also can be selected for examining patients with increased airway pressures, unexplained drops in oxygen saturation, secretions, and poor positioning of an SGA.

In the pediatric population, as with adults, successful FOI often hinges on the availability and functionality of equipment. For a small patient, when the only available fiberscope is too large, all is not lost. This fiberscope can still complete intubation by serving as a means of inserting a long guidewire into the trachea. To accomplish wire delivery, the fiberscope must have a suction or working channel (Figure 5). Any flexible Teflon-coated guidewire can be used if its specifications correspond to the dimensions of the fiberscope channel (usually 0.032-0.038 inch [0.81-0.97 cm] in diameter) and it is at least 20 cm longer than the scope (usually 110-150 cm).

Figure 4. Endotracheal tube distance to carina measured by fiberscope.

Figure 5. Wire extending from working channel.
be useful if the patient requires FOI but the only available pediatric fiberscope is ultrathin and lacks a working channel for the administration of local anesthetic to prevent laryngospasm.

**Technique**

The larger fiberscope is inserted for laryngoscopy and, after visualizing the glottis, local anesthesia is sprayed through the working channel onto the vocal cords. Seconds later, following the onset of local anesthesia after removing the fiberscope, FOI is performed with the ultrathin device.

Can use of a fiberscope eliminate blind airway management methods, such as blind nasal intubation, ETT exchanges, and insertions of SGAs? Perhaps it is a little radical to advocate fiberscope deployment to eliminate these airway techniques because they often are simple, effective, and cheap. Rather than taking on all the worldwide airway practitioners who advocate these methods, here are some alternatives for circumstances where risks can be reduced, success rates can definitely be improved, and a fiberscope can rescue blind ventures.

**Eliminating Blind Nasal Intubation**

Any patient with prohibitive anatomy for oral intubation, and nasal passages too small to admit an ETT over a fiberscope, may still require nasotracheal intubation (Figure 6). A blind nasal intubation might be deleterious considering trauma and edema from the unseen ETT tip.

**Technique**

In this situation, a smaller ETT plus a side-by-side fiberscope technique can be employed (Figure 7). After administration of topical medication including vasoconstrictors, an appropriately sized, lubricated ETT is inserted into one nasopharyngeal passage. A fiberscope is advanced through the other passage until the vocal cords appear at a distance far from the periglottic region. From this viewpoint, the operator can instruct an assistant to slowly feed the ETT forward until it enters between the vocal cords.

If the tip of the ETT seems to be directed too posteriorly, the assistant can inflate the ETT cuff, pushing the tip off the posterior pharyngeal wall toward the glottis (Figure 8). The assistant can then slowly deflate the cuff while keeping the tip at the glottis for tracheal intubation until the signal to advance it is given. If the ETT goes astray (anteriorly, laterally, or posteriorly), other maneuvers are activated, including pressure on the thyroid cartilage, neck flexion, neck extension, or ETT rotation, during which time the assistant withdraws or advances the ETT as directed.

**Alternative Technique**

Despite having no oral entry for airway devices due to severely abnormal anatomy, some patients have retromolar areas that allow a fiberscope to squeak through (Figure 9). This permits a modified “side-by-side technique.” If large enough, it may even admit an ETT-loaded fiberscope for FOI.

**Eliminating Blind ETT Exchanges**

Blind ETT exchanges often succeed with the insertion of a Cook AEC down the old ETT, followed by removal of the tube and attempts to railroad a new ETT over the catheter. However, during this process, the disaster of airway loss is quite possible. ETT exchange frequently involves a patient with a difficult airway or low tolerance for lost ventilation. Any preexisting ETT may have softened and bent in the
A leaky cuff often is reinflated with more and more air over time, and the tip of the ETT may migrate upward into the periglottic area, away from the trachea. Blind insertion of a catheter in these situations does not guarantee it will end up in the correct location in the respiratory tract. McLean et al found a 13.8% incidence of failure of blind ETT exchange in an analysis of 1,177 patients. Pneumothorax occurred at a rate of 1.5%; of those, 75% occurred in cases of difficult exchange.

**Technique**

For adults, the blind technique can be changed to perhaps just having a small cataract. Gauze availability and testing of a pediatric fiberscope through a well-lubricated Aintree catheter (4.7 mm internal diameter) is mandatory. Similar to the AEC, ventilation via the Aintree is possible. Sedation helps prevent bucking. The old ETT must be at least 6.5 mm in diameter. The catheter-loaded fiberscope is inserted through the old ETT with the scope tip leading the way (Figure 10). Nonvisualization of the trachea may indicate extubation and the need for airway rescue. Otherwise, once the carina is seen, the Aintree is railroaded close to it. The fiberscope and ETT are removed while securing the catheter. A new ETT-loaded fiberscope is placed within the catheter until nearing the carina. The ETT is secured while removing the catheter and fiberscope.

**Figure 8.** Effect of endotracheal tube cuff inflation during fiber-optic assisted nasotracheal intubation.

**Figure 9.** Fiberscope entering deeply into retromolar space.

**Figure 10.** Fiberscope within an Aintree catheter, within an endotracheal tube.
ALTERNATIVE TECHNIQUE

A wire-loaded fiberscope is advanced through the old ETT. After leaving only the wire by the carina, a new ETT-loaded fiberscope can be threaded over it to situate the ETT at an appropriate depth, after which fiberscope and wire are extracted.

Eliminating Difficult SGA Placement

This technique is particularly useful for anticipated problematic placement of an SGA. It can be performed in any asleep or awake patient. Preparation includes complementary SGA and fiberscope sizes and a well-lubricated fiberscope (Figures 11 and 12).

TECHNIQUE

Different approaches are possible. Prepared devices can be loaded to keep the fiberscope tip protected just prior to the exit point of the SGA and prevent outward movement of the fiberscope. An assistant opens the patient’s mouth widely and applies tongue pull and neck extension, if permissible. The SGA is inserted according to manufacturer’s recommendations. After initial mouth entry, fiberscopic observation is used to locate periglottic anatomy and the SGA is positioned. If the glottis is not found, the SGA can be pulled back a bit and the fiberscope can be extended out of the SGA while one assistant stabilizes the airway and another performs jaw thrust. Once periglottic structures have been identified, the SGA is railroaded over the fiberscope. After its positioning is visually inspected, the fiberscope is withdrawn.

ALTERNATIVE TECHNIQUE

Obviously, some of these approaches can be used for ETT intubation through the SGA if there is an interest in eliminating the blind part of an intubating laryngeal mask airway (LMA Fastrach, Teleflex) or other trans-SGA intubation. The caveat is that the success rate of Fastrach intubation changes from 97% after 3 blind attempts to almost 100% with a fiberscope.

Conclusion

Each of the many devices for airway management requires practice to enable ease of use. When recalling the early months of residency, the common laryngoscope was perhaps the hardest to master. With determination, expertise with a flexible fiberscope is readily attainable. Once the barrier of apprehension is eliminated, the elation from success in difficult situations—when it really makes a difference to the patient—is extraordinary.

References