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Clinical Notes

Design rationale and intended use of a short optical stylet for routine fiberoptic augmentation of emergency laryngoscopy☆

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Abstract Patient safety in emergency airway management has traditionally relied upon prediction of difficult laryngoscopy and alternative intubation devices. Unfortunately, screening tests for difficult laryngoscopy have poor predictive value, and alternative devices are often not suitable for emergency airways. RSI performed with hit or miss repetitive laryngoscopy followed by delayed deployment of rarely used rescue devices is inherently hazardous. First pass success with laryngoscopy should be a benchmark of quality and patient safety in emergency airway management. By making a commitment to minimally modify practice and expand our skill set, fiberoptic augmentation of every laryngoscopy can promote patient safety through the avoidance of repetitive laryngoscopy and esophageal intubation. This article presents the design rationale and intended use of a new short optical stylet for the routine augmentation of emergency direct laryngoscopy.

1. Background

In emergency airway management, repeat laryngoscopy (>2 attempts), esophageal intubation, and intubation failure are all associated with significant morbidity and mortality [1]. The traditional approach to promoting patient safety with RSI has involved prediction of laryngoscopy difficulty and promotion of alternative means of intubation.

Unfortunately, prediction of laryngoscopy difficulty has poor predictive value even in elective circumstances, and basic screening tests cannot be applied to two thirds of emergency patients [2-4]. Direct laryngoscopy is fundamentally dependent upon the base of the tongue and the epiglottis, areas not visible by external assessment. Unpredicted failed laryngoscopy can result from pathology in this area, such as lingual tonsilar hyperplasia [5].

Time constraints and logistic challenges inherent to emergency airways also make it difficult to use alternative devices. Flexible fiberoptic intubation, the principal method of alternative intubation in elective anesthesia, works poorly in noncooperative patients and with bleeding, emesis, or significant secretions. It is also slow, demands considerable technical expertise, and it is especially challenging in supine patients without muscular tone (ie, after RSI and failed laryngoscopy).

Rescue devices that are used only in cases of failed laryngoscopy will be used infrequently. For emergency

☆ The author is the inventor of the Levitan FPS scope described in this article and has a royalty agreement with Clarus Medical (Minneapolis, Minn), the manufacturer of the device. The author is also the inventor of the Airway Cam Direct Laryngoscopy Video System used to record Fig. 5.

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providers to acquire repeat experience with an alternative device, they must abandon their standard practice of direct laryngoscopy. Practicing in actual emergency cases is awkward for providers and potentially hazardous to the patient.

Apart from logistic and skill acquisition issues with alternative devices for intubation, there is a fundamental timing and sequence problem with their deployment. Alternative approaches are typically attempted only after prolonged and unsuccessful laryngoscopy efforts. Persistence of laryngoscopy attempts (>2) is a common element in poor outcomes and is associated with a 7 times greater risk of hypoxemia, regurgitation, and cardiac arrest [1,6].

The Levitan FPS (First Pass Success) stylet (Clarus Medical, Minneapolis, MN) is a short malleable optical stylet designed to fiberoptically augment direct laryngoscopy. It is a shorter, streamlined version of the Shikani Optical Stylet [7]. It requires no imaging screen or power connection. Its length mimics a standard malleable stylet. It is intended for use in every laryngoscopy, replacing a standard stylet for shaping and handling of the tracheal tube. In easy direct laryngoscopy, the fiberoptic view provides immediate visual confirmation of intratracheal placement. In situations of poor glottic exposure, however, it can be used for fiberoptic-guided intubation within the time frame of inserting a standard stylet.

In addition to its primary use as a laryngoscopy adjunct, the FPS can be used without a laryngoscope (adjusting its malleable stylet to a more extreme bend angle), it can provide fiberoptic intubation through a supraglottic airway, and it can be placed alongside a previously placed tracheal tube to verify tube position.

2. Design and light sources

The malleable steel stylet portion of the device encloses optical and light-transmitting fiberoptic fibers that connect to an eyepiece and a removable light source (Fig. 1). The stylet is approximately 30 cm long and ends at a fitting that accepts the 15-mm connector of a tracheal tube. On the right side of this tube fitting is a small hole for a removable oxygen connector. This permits blowing oxygen through the connector and out the distal end of the tracheal tube, keeping the tip of the scope clear during the procedure. Inferior to the tube fitting is the attachment point for the light source, which can be either a standard fiberoptic illuminated laryngoscope handle, or a specially designed miniature light-emitting diode (Figs. 1 and 2).

Fig. 1 The FPS scope with the miniature LED light source held in a pencil grip manner. The LED is turned on and off by rotation of the round knob below the eyepiece. Full counterclockwise rotation unscrews the cap entirely to change the N-sized battery.

3. Preparation for use

The FPS stylet tip should be positioned approximately 1 cm within the distal end of the overlying tracheal tube. Unlike flexible scopes, which are placed in advance of the tube, this recessed positioning keeps blood and secretions from obscuring the stylet lens. An additional means of keeping the tip clear is by blowing oxygen through the tube at 5 to 10 L/min via the side hole noted above.

The short length of the FPS, which makes it functional as a laryngoscopy adjunct, requires that tracheal tubes be trimmed to 27.5 to 28 cm to achieve the correct stylet position (Fig. 3). Although any tube larger than 6 mm inner diameter (ID) can be used, the ideal tube has a straight cut tip. Some tubes have a shrouded or rounded tip that can obscure the lateral visual field of the stylet tip. The plastic connector (and tracheal tube) may need to be rotated on the tube fitting when using shrouded tipped tubes.

The stylet should be given a straight-to-cuff shape with a 35° bend at the proximal tube cuff (Fig. 4). This straight-to-cuff shaping gives the tube and stylet better maneuverability within the mouth and hypopharynx. This shape also permits simultaneous visualization of the tube tip and target (glottic opening) under direct vision [8]. Beyond a 35° bend, the tip of the tracheal tube, after insertion through the vocal cords, can catch on the tracheal rings and prevent tube passage [9].

4. Intended use as a laryngoscopy adjunct

For most of the laryngoscopies in which laryngeal landmarks are easily seen, the FPS stylet and overlying tube (held in the right hand) are introduced like any other stylet, but immediate intratracheal placement can be fiberoptically observed upon final passage.

In difficult or impossible laryngoscopy, when fiberoptic visualization is needed for intubation, the FPS tip is positioned under direct vision until it is close to, but below and away from, the tip of the epiglottis (Figs. 5 and 6).

It is critical to know the position of the tip, and to be off of the mucosa, before switching from direct vision to the fiberoptic eyepiece. Novices may find it easiest to rest the tube and scope against the dentition for maintaining this starting position. The scope should never be blindly advanced under the epiglottis; otherwise, the tip will likely lie against the mucosa and obscure the fiberoptic view.

With the scope held in the starting position (off the mucosa and with enough distance to have a perspective on

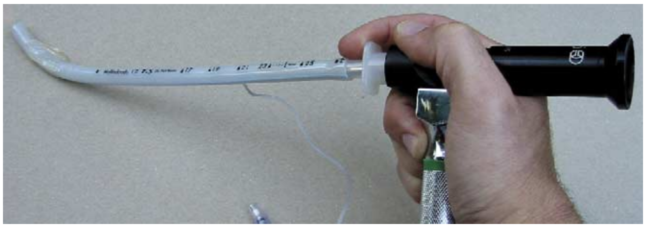

Fig. 2 The FPS scope attached to a mini-laryngoscope handle (fiberoptic, green line, Sun-Med, Largo, Fla). Note handgrip position with scope in first web space and index finger over the top of the instrument.

the epiglottis), the operator then moves his head to bring his dominant eye to the eyepiece. The transition from direct sighting to fiberoptic viewing involves minimal movement (Fig. 7). Under fiberoptic view, directing the stylet under the epiglottis edge and into the trachea can be quickly achieved while keeping the target in continuous fiberoptic sight (Fig. 5). The right corner of the mouth (away from the central incisors) is used to tilt the stylet backward and direct the tip upward as needed.

A prior study using this technique in epiglottis-only views (with a longer optical stylet) achieved successful tracheal placement with a mean time of 9 seconds [10,11].

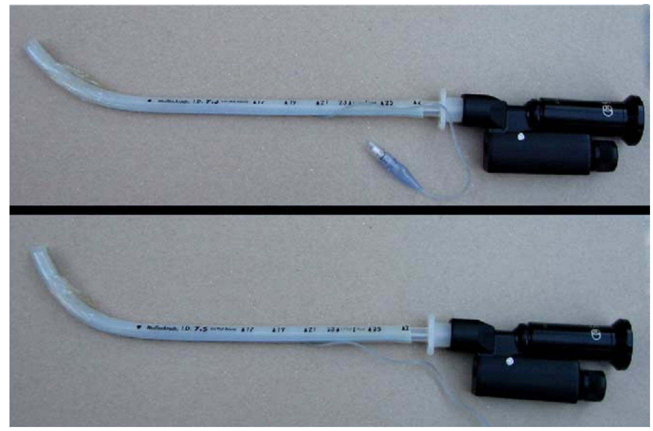

Fig. 4 Comparative bend angles of FPS scope when used as a laryngoscopy adjunct (straight-to-cuff, 35° bend angle, above) vs more extreme bend angle when used without a laryngoscope (70° bend, see Fig. 8).

Whether the FPS scope is used for confirmation of placement or to fiberoptically navigate to the glottis, once the stylet passes through the vocal cords under fiberoptic guidance, the laryngoscope is put down. The left hand then slides the tube off the stylet to the proper depth by rotating the tube clockwise off of the stylet. This helps prevent the

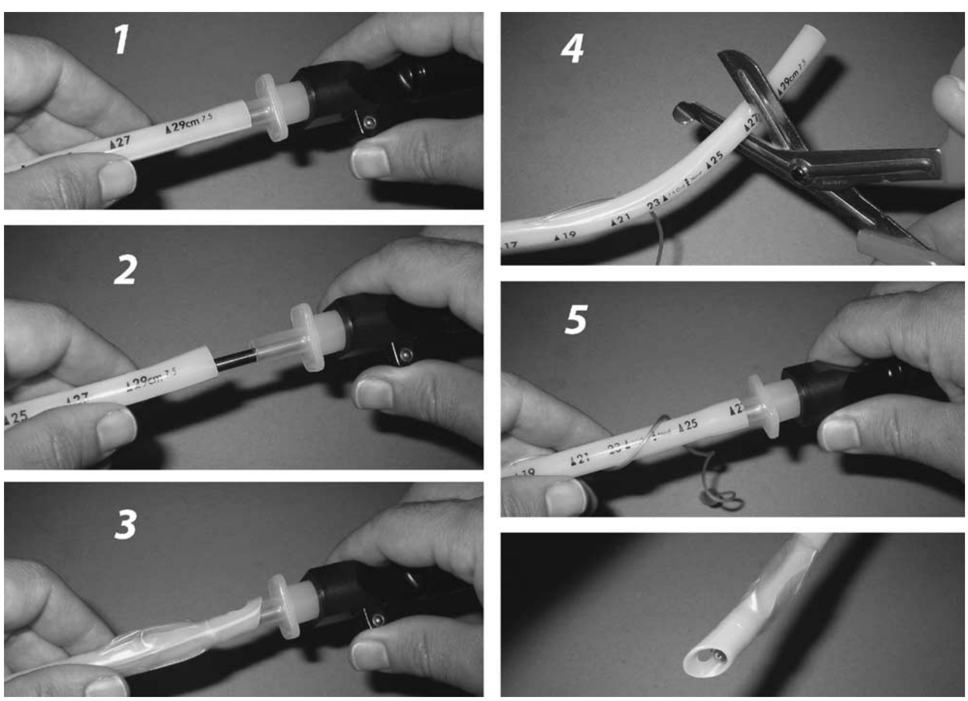

Fig. 3 Cutting an oral nasal length (>30 cm) tracheal tube to fit the FPS scope. 1, Tracheal tube and 15-mm plastic connector are connected to hub of FPS scope. 2, Plastic connector is separated from tracheal tube and tube is withdrawn. 3, Tube is flipped over and reinserted with the distal tip over the plastic connector. 4, The excess portion of the tracheal tube is cut using a pair of trauma shears. The tip of the scope can be felt and seen under the tube (although not visible in this photograph); cut should be approximately 1 cm away from the scope tip. 5, Tube is flipped again and replaced onto scope. Note centimeter markings at base of tube compared with first image. Final image shows tip of stylet recessed within the tip of the tube. Most tubes can just be cut at 27.5 to 28 cm.

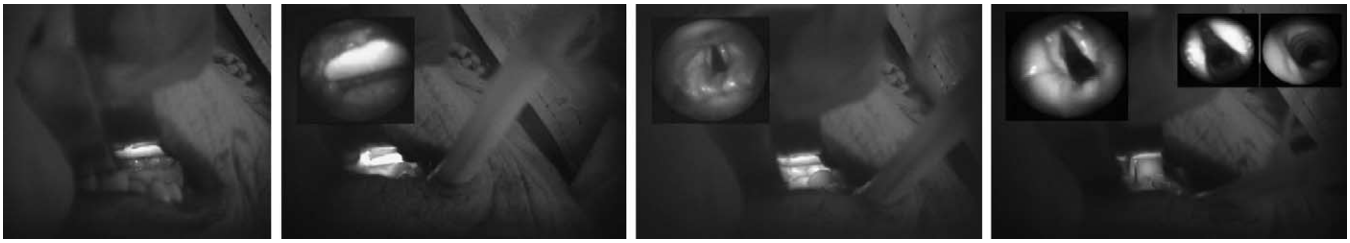

Fig. 5 FPS scope when used as a laryngoscopy adjunct. The direct laryngoscopy video system (Airway Cam Tech, Inc, Wayne, Pa) shows the direct laryngoscopy view. An endoscopic camera affixed to the FPS stylet shows the views through the eyepiece. The epiglottis and posterior cartilages are seen in image to the far left. When the scope is very close to the epiglottis, it has a distorted and enlarged appearance. In the third image, the FPS is in the starting position, away from and slightly below the epiglottis edge. In the last image, the scope is advanced toward and through the vocal cords. Small inset pictures show the fiberoptic views, including the vocal cords and tracheal rings.

tip and left-facing bevel of the tube from catching on the tracheal rings. After the tube is advanced to the correct depth, the stylet is withdrawn, the cuff inflated, and the tube secured in the usual fashion.

5. Use of the FPS stylet during laryngoscopy when the epiglottis is not seen

Direct laryngoscopy does not afford a view of the epiglottis between 1 of 300 and 1 of 1500 laryngoscopies [12-14]. In such situations, the FPS can be guided into the hypopharynx by following the curvature of the laryngoscope blade until the epiglottis comes into fiber-optic view. Using a laryngoscope is very advantageous with fiberoptic instrumentation because it helps create a wide navigable channel.

Alternately, the FPS stylet can be given a more extreme bend angle (approximately 70° at the proximal tube cuff) and used without a laryngoscope [7]. The left hand lifts the jaw and tongue and the stylet is rotated into the mouth (by the right hand) following a strict midline approach. The eyepiece is used continuously from initial insertion (Fig. 8). The tip of the device should not be pressed against the tongue while the device is rotated into the hypopharynx; an assistant helping with a jaw thrust or pulling the tongue upward with a gauze pad may make it easier to stay off of the mucosa and identify landmarks.

6. Comparison to a tube introducer (aka bougie)

The tube introducer has been reported to be effective in difficult laryngoscopy, but fiberoptic guidance is much more successful when intubating epiglottis-only views [15]. The FPS stylet brings the advantage of fiberoptic guidance to such situations with the insertion speed and simplicity of a standard stylet. Unlike the flexible scope or tube introducer, the rigidity of the FPS stylet permits direct lifting of the epiglottis as needed.

7. Comparison to flexible and other rigid or malleable stylets

The FPS cannot be used for fiberoptic nasal intubation, but its shorter length and rigid nature makes it much easier

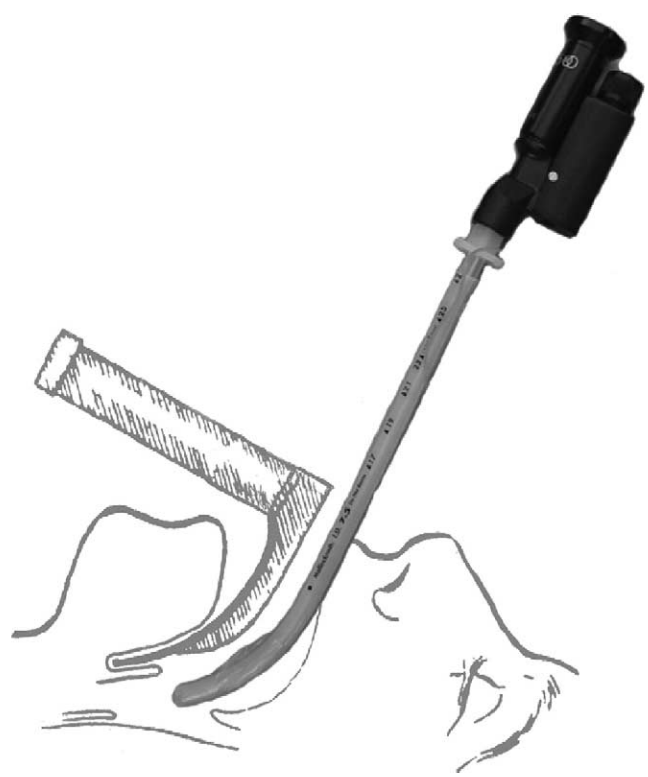

Fig. 6 Cross-sectional drawing showing the proper starting position, with the tip away from and slightly below the epiglottis. After the scope is placed into this position under direct sight, the scope should not move. The operator moves his or her head to the eyepiece for fiberoptic viewing.

Fig. 7 Transitioning from direct laryngoscopy and initial scope insertion to fiberoptic viewing through the eyepiece.

to manipulate via the oral route than an intubating (60 cm) flexible scope. Flexible scopes must be held at full arm length; otherwise, turning movements on the eyepiece and base are not transmitted to the distal tip. Using a flexible scope, the distance of fiberoptic navigation from the mouth to the vocal cords is as long as 16 cm, whereas through the nose it can be 21 cm [16]. By comparison, the FPS as a laryngoscopy adjunct is positioned under direct view in proximity to the epiglottis, reducing the distance of fiberoptic navigation to only 2 to 3 cm.

Compared with longer fiberoptic stylets such as the Bonfils Scope (nonmalleable, 40° angle, length 40 cm, Karl Storz Endoscopy, Culver City, CA) or the Shikani Stylet (malleable, length 38.5 cm, Clarus Medical, Minneapolis, MN), the shorter length of the FPS stylet (30 cm) allows the device to mimic the procedural handling of a standard stylet.

8. Cleaning and sterilization

The FPS can be cleaned in a variety of cold sterilization solutions. There is no working channel, so the scope does not require special cleaning procedures. This is in contrast to working channels in flexible scopes that have been associated with transmission of tuberculosis, *Pseudomonas*, and other serious infections [17].

9. Cost considerations

As of January 2006, the cost of the FPS was approximately one fifth the cost of a 60-cm flexible scope, and without the high risk of breakage and associated repair costs.

10. Conclusion

The current approach to the emergent, unanticipated difficult airway—an airway cart with rarely used alternative devices deployed only after laryngoscopy failure—is problematic for emergency physicians and other practitioners. By combining a malleable stylet that has fiberoptic capability with every direct laryngoscopy, emergency physicians can expand their expertise with fiberoptic instrumentation and intubation, yet stay close to their routine practice. Each airway with an optical stylet provides an opportunity for handling the device and acquiring fiberoptic experience. Should fiberoptic visualization actually be required for intubation, it is available immediately, positioned a few centimeters from the larynx. The difficult or impossible direct

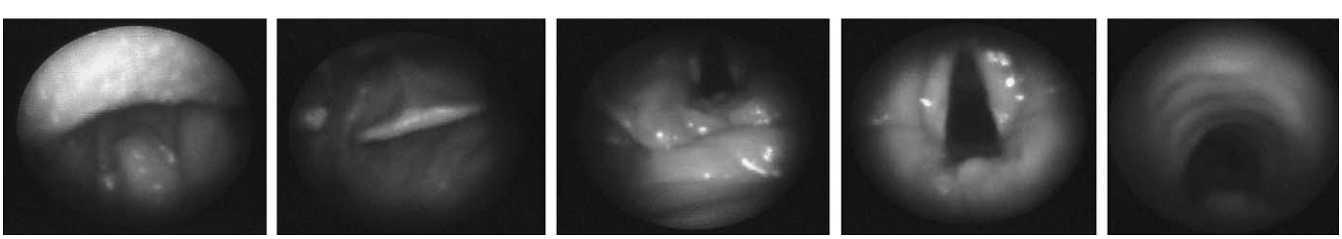

Fig. 8 Sequence of landmarks seen through the eyepiece when used without a laryngoscope. Tongue and uvula, epiglottis edge, posterior larynx, glottic opening, tracheal rings, and flat posterior wall of trachea (from left to right).

laryngoscopy can end on first pass without resorting to serial "rescue" techniques that endanger the patient.

According to the Society for Academic Emergency Medicine, "Health care quality is the application of 'best practice' to achieve optimal outcome for every patient" and "measuring health care quality starts with defining opportunities for improvement and defining actionable steps" [18]. First pass laryngoscopy success should be a defined benchmark of quality in emergency airway management. By making a commitment to minimally modify practice, fiberoptic augmentation of every laryngoscopy can promote patient safety and increase provider confidence managing emergency airways.

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