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The Eschmann Tracheal Tube Introducer Is Not Gum, Elastic, or a Bougie

To the Editor:—We read with interest the article by Brimacombe *et al.*[1] in which the authors demonstrated the superiority of the Eschmann introducer–guided technique of *ProSeal™* LMA (The Laryngeal Mask Company, Ltd., San Diego, CA) insertion over digital and introducer tool techniques. The authors are to be commended for their study, but we are concerned that the Eschmann endotracheal tube introducer was referred to as a *gum elastic bougie*. The gum elastic bougie is a urinary catheter that was originally used for dilation of urethral strictures. This catheter was used as an endotracheal tube introducer (to facilitate difficult tracheal intubation) by Sir Robert R. Macintosh[2] in 1949. Inspired by Macintosh's report, Venn[3] designed the currently used introducer in the early 1970s. He was then the anesthetic advisor to the British firm Eschmann Bros. & Walsh, Ltd. of Shoreham-by-Sea, West Sussex, United Kingdom, which accepted the design in March 1973.[3] The material of the newly designed introducer was different from that of a gum elastic bougie in that it had two layers: a core of tube woven from polyester threads and an outer resin layer. This provided more stiffness but maintained the flexibility and the slippery surface. Other differences were the length (the new introducer was 60 cm, which is much longer than the gum elastic bougie, thus facilitating endotracheal tube railroading over it) and the presence of a 35° curved tip, permitting it to be steered around obstacles.[4,5] The Eschmann endotracheal tube introducer went into production shortly after design acceptance in 1973, and all three design differences (material, length, and curved tip) have contributed throughout the years to the reported success with its use and widespread popularity.[6] As has been previously pointed out by Viswanathan *et al.*[4] in a review article, the Eschmann endotracheal tube introducer is not made of gum, is not elastic, and is not used as a bougie. Because of these differences between the two devices in design and function, we strongly recommend that the Eschmann endotracheal tube introducer should no longer be referred to as a *gum elastic bougie*.

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Unassisted Gum Elastic Bougie–guided Insertion of the *ProSeal*™ Laryngeal Mask Airway

To the Editor:—We read with interest the article by Dr. Brimacombe *et al.*[1] regarding the new insertion technique of the *ProSeal™* laryngeal mask airway (PLMA; Laryngeal Mask Company North America, San Diego, CA). The authors describe a gum elastic bougie (GEB)–guided insertion technique and demonstrate that the new insertion technique is more frequently successful than the (manufacturer-recommended) digital or introducer tool techniques. The GEB-guided insertion technique—a Seldinger technique— optimizes the PLMA insertion attempt: The mask easily negotiates the palatopharyngeal interface without folding over and is directed into the esophagus. In addition, the drain tube is aligned with the esophagus, optimizing orogastric tube insertion.

A potential disadvantage of the GEB-guided technique is that an assistant is needed to stabilize the PLMA at the proximal end while the intubator feeds 5–10 cm of GEB in the esophagus.

We describe an unassisted GEB-guided insertion technique of the PLMA and comment on our clinical experience. We modified the original approach[1] to perform the unaided technique:

1. The PLMA was primed by inserting the GEB in the drain port such that 22 cm of the GEB was protruding from the distal end of the drain tube. This was realized by aligning the first GEB marking to the proximal end of the drain tube.
2. The GEB and PLMA were held as a unit with the dominant hand (fig. 1). The straight end of the GEB was inserted into the esophagus 5–10 cm under visualization during a gentle laryngoscopy.
3. After the removal of the laryngoscope, the PLMA was positioned at the mouth opening. Before advancing the PLMA, the GEB position was confirmed by inserting an extra 3–5 cm into the esophagus.
4. Using the standard digital technique, the PLMA was inserted over the GEB with the dominant hand while the GEB was stabilized with the nondominant hand.

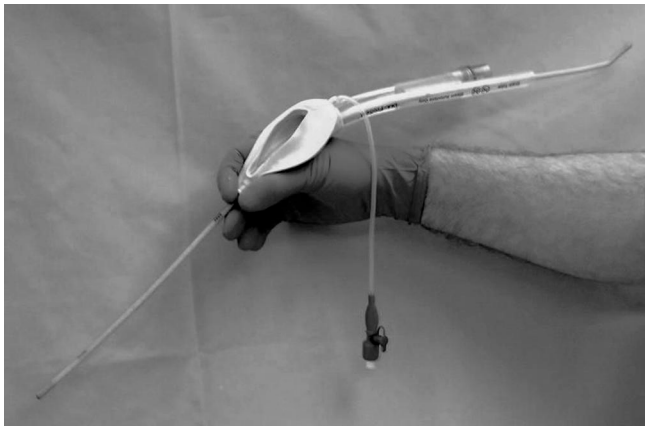

Fig. 1. The dominant hand holds the *ProSeal*™ laryngeal mask and the distal gum elastic bougie as a unit.

We used this technique in 10 successive male patients (American Society of Anesthesiologists physical status I or II; age, 20–80 yr)

scheduled to undergo orthopedic procedures for which intubation was not required. We inserted the PLMA in the first attempt and confirmed effective ventilation by the same criteria as Brimacombe *et al.*

A gentle laryngoscopy does not usually allow visualization of the esophagus. The insertion of the GEB behind the larynx is blind and defined by the ability to feed the desired length of GEB without resistance. In our group, we marked the straight end of the GEB at 5 and 10 cm with a sterile marker and confirmed under direct visualization that the GEB was inserted close to or at the 10-cm mark. Misplacement of the GEB occurred in one patient outside this group when less GEB length was protruding from the PLMA and less than 5 cm was inserted retrolaryngeal. In this case, the tip was inserted in a perilaryngeal elastic structure (pyriform sinus), and the malposition was diagnosed before PLMA insertion as a failure of the GEB to advance ("elastic resistance" in step 3). We consider this step necessary because oropharyngeal tissues recover to their original features after laryngoscopy and may pull the GEB out of the esophagus a couple of centimeters. From the initial straight shape during laryngoscopy and insertion, the GEB assumes a curved shape during PLMA insertion because it molds to solid oropharyngeal structures (hard palate, posterior pharynx).

A limitation of our technique is the fact that the nondominant hand may be used during PLMA insertion to extend the head or for a jaw lift. In these cases, the GEB cannot be stabilized without an assistant and may be further inserted in the esophagus with the PLMA. Our technique must be validated in a large group of patients.

The assisted and unassisted GEB-guided PLMA techniques may be used in critical situations when an unexpected difficult airway is encountered or an optimized first insertion attempt is preferred.[2] The GEB-guided PLMA technique has relevance as a teaching tool for the PLMA index finger technique because the smooth ride assured by the GEB should be reproduced with the standard insertion attempt.

The PLMA is a versatile device both in the operating room and outside the operating room. It was used as a rescue airway in an obstetric patient,[3] in a patient with lingual tonsillar hyperplasia,[4] in obese patients,[5] in the intensive care unit,[6] and in patients with manual in-line stabilization.[7] The GEB-guided PLMA techniques warrant further research regarding GEB esophageal insertion in a patient with full stomach, the interaction with cricoid pressure, and the impact of these techniques on the unstable cervical spine.

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Bleeding, Dysphagia, Dysphonia, Dysarthria, Severe Sore Throat, and Possible Recurrent Laryngeal, Hypoglossal, and Lingual Nerve Injury Associated with Routine Laryngeal Mask Airway Management: Where Is the Vigilance?

To the Editor:—In the study entitled "Gum Elastic Bougie–guided Insertion of the *ProSeal™* Laryngeal Mask Airway is Superior to the Digital and Introducer Tool Techniques," Brimacombe *et al.*[1] reported an overall airway morbidity consisting of sore throat (14.6%), dysphagia (10.4%), and dysphonia (7.1%). The authors classified two sore throats, three dysphagias, and two dysphonias as severe at 18–24 h postoperatively. Any sore throat that did not produce "constant pain, independent of swallowing" was excluded from their data. The unusual nature of the reported morbidity associated with the *ProSeal™* laryngeal mask airway (PLMA; Laryngeal Mask Company North America, San Diego, CA) deserves attention for a multitude of reasons.

Practice Guidelines for Management of the Difficult Airway[2] established by a Task Force of the American Society of Anesthesiologists state that the anesthesiologist should follow and evaluate patients with signs and symptoms such as sore throat and difficulty swallowing because these symptoms could indicate bleeding, edema, or more serious complications such as perforation of the esophagus or trachea. The report also instructs the anesthesiologist to enter a written report in the medical chart and appropriately advise the patient. Dysphonia, which occurred in 17 of 240 patients in the study of Brimacombe *et al.*, is not listed as a complication of any of the other methods for managing a difficult airway,[2] nor is it listed as a complication of airway management in standard texts of anesthesiology.[3,4] Regarding the sign of dysphonia, is this the same form of morbidity that Howarth *et al.*[5] referred to as *dysarthria* (1%) in a previous PLMA report? *Dysarthria* describes imperfect articulation, whereas *dysphonia* is any impairment of voice. Clarification of this point is essential so that PLMA providers and patients will know what to expect postoperatively. Did any of the patients have a perforation, permanent dysphonia, or dysphagia? The reported morbidity associated with the PLMA becomes less acceptable when one considers that patients known or predicted to have a difficult airway, a mouth opening less than 2.5 cm, or a body mass index greater than 35 kg/m^2 or those at risk for aspiration were excluded from the study. Normally, a group of patients selected by these criteria would have minimal if any morbidity regardless of the method of airway management, *i.e.*, facial mask and airway or even orotracheal intubation. Complications of the frequency and magnitude reported require elucidation and moreover a solution if the technique is to achieve maximum utility in anesthesia practice. There are at least three factors to be considered. Mucosal abrasion as manifested by both visual and occult blood is an obvious factor that could be worsened by pressure ischemia resulting from cuff inflation to 60 cm H_2O. Silent regurgitation of gastric acid either during the procedure or in the perioperative period either alone or in conjunction with mucosal abrasions and impaired tissue perfusion could further complicate the

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A Modified Rapid Sequence Induction Using the *ProSeal*™ Laryngeal Mask Airway and an Eschmann Tracheal Tube Introducer or Gum Elastic Bougie

To the Editor:—One of the most problematic difficult airway management situations is the patient with a known difficult airway who is at risk of aspiration but who is unsuitable for awake tracheal intubation. We describe a new approach to this situation that involves the use of the *ProSeal™* laryngeal mask airway (PLMA; Laryngeal Mask Company North America, San Diego, CA) and a reusable Eschmann endotracheal tube introducer or gum elastic bougie (GEB).

A 62-yr-old, 94-kg man with chronic obstructive pulmonary disease presented for an urgent laparotomy for a suspected perforated appendix. He had a well-documented history of failed laryngoscope-guided tracheal intubation (on two occasions due to poor laryngeal view) but successful facemask ventilation and laryngeal mask airway insertion. The patient insisted on airway management only after induction of anesthesia due to a previous bad experience with awake tracheal intubation. A decision was made to place a GEB using laryngoscope guidance either in the trachea using the bent end first (if any glottic structures could be seen) or in the esophagus using the straight end first (if no glottic structures could be seen) to facilitate insertion of an endotracheal tube or PLMA,[1] respectively. After 10 min of preoxygenation (time taken for end-tidal oxygen to be greater than 90%), the patient was induced with 0.5 mg alfentanil and 180 mg propofol, cricoid pressure was applied by a trained assistant, and 100 mg suxamethonium was administered. As predicted, neither the glottis nor the epiglottis could be seen, despite optimal laryngoscopic conditions. The GEB was therefore advanced with its straight end first along the right posterior pharyngeal wall toward the pyriform fossa. Cricoid pressure was released briefly (< 5 s) so that the GEB could be advanced through the hypopharynx into the proximal 10 cm of the esophagus.[2] The lack of the characteristic tactile sensation from the tracheal rings and the lack of resistance when inserted to length confirmed esophageal placement. A size 5 PLMA was then railroaded along its drain tube into the pharynx, and cricoid pressure was rereleased to allow the distal cuff to enter the hypopharynx. The cuff was immediately inflated with 20 ml air. The PLMA was fixed into position, the GEB was removed, and a gastric tube was inserted *via* the drain tube of the PLMA. Six hundred milliliters of bile-stained fluid was suctioned from the stomach. Ventilation was easy with tidal volumes greater than 1,000 ml without an oropharyngeal or esophageal leak and peak airway pressures of 25–30 cm H_2O. Oropharyngeal leak pressure was greater than 40 cm H_2O. Anesthesia management was otherwise uneventful, and there were no postoperative pulmonary complications.

In principle, this novel approach to difficult airway management should have a very high success rate because the failure rate for passage of a GEB into either the trachea or the esophagus should be very low, and the success rate for railroading an endotracheal tube or PLMA along it should be very high. If there is doubt about whether the GEB is in the trachea or esophagus, the PLMA should be railroaded first because esophageal placement is much more likely. If this does not provide an effective airway, it is likely that the GEB is in the trachea, and the PLMA should be removed and the endotracheal tube should be railroaded into position. In the unlikely event that both of these options fail, an alternative airway management strategy is required.

Although fiberoptic-guided intubation using a guide wire and airway exchange catheter is feasible using the PLMA,[3] we elected to complete the case with the PLMA. There is a moderate body of evidence (a cadaver study[4] and several anecdotal reports[5–13]) suggesting that a correctly placed PLMA provides protection against regurgitation. One group reported no episodes of regurgitation in 300 patients, as determined by litmus testing of the bowl after removal.[14] The efficacy of seal of the distal cuff against the hypopharynx, as determined in fresh cadavers,[4] is 40–80 cm H_2O—more than enough to protect against passive regurgitation.[15] In addition, the process of exchanging the PLMA for a endotracheal tube may put the patient at risk of aspiration, and success is not guaranteed.

The safety of placing a GEB into the esophagus has not been established; however, there is some evidence that it is probably safe when conducted under direct vision and force is avoided, and there can be little doubt that it is justified in the failed intubation scenario. A recent study reported no occult blood on the GEB in 80 of 80 patients,[16] and we have used the technique on more than 6,000 occasions without any evidence of minor or major esophageal injury. Furthermore, GEBs are frequently misplaced into the esophagus with the bent end first (probably more likely to cause injury than with the straight end first) during failed intubation, but esophageal injury is rarely reported.[17] It is worth noting that the American Society of Anesthesiologists already recommends the use of the esophageal tracheal Combitube (Kendall Sheridan Catheter Corporation, Argyl, New York),[18] which is known to cause esophageal injury,[19–21] as an option in failed tracheal intubation. The development of an atraumatic esophageal guide for use with the PLMA and other extraglottic airway devices is currently under way and should make this approach even safer.

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GlideScope®-assisted Fiberoptic Intubation: A New Airway Teaching Method

To the Editor:—It is well known that "practice makes perfect" when learning fiberoptic intubation (FOI). Although subjecting patients with normal airways to awake FOI for mere teaching purposes is usually inappropriate, it is common to have residents obtain FOI experience in patients with normal airways during general anesthesia. However, conducting FOI in this setting has time pressures that are not present with awake intubation, because special concerns of oxygenation, ventilation, and awakening exist. Complicating this situation is the fact that frequently only the operator can see what is happening, such that the supervisor can only offer limited assistance.

The purpose of this letter is to describe a new technique for FOI using the GlideScope® video laryngoscope (Vitaid Airway Management*, Williamsville, NY). After anesthetic induction, a GlideScope® is introduced in the usual manner,[1,2] followed by introduction of the fiberoptic bronchoscope (FOB). While the resident manipulates the FOB into position, the supervisor monitors the GlideScope® display to see where the tip of the FOB is located. (The resident looks only through the FOB and does not look at the GlideScope® display.) The supervisor then provides verbal feedback to the resident as to the location of the tip of the FOB. When the FOB has entered well into the trachea, the endotracheal tube is passed over the FOB into the glottis.

Additional material related to this article can be found on the ANESTHESIOLOGY Web site. Go to http://www.anesthesiology.org, click on Enhancements Index, and then scroll down to find the appropriate article and link. Supplementary material can also be accessed on the Web by clicking on the "ArticlePlus" link either in the Table of Contents or at the HTML version of the article.

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* Vitaid Airway Management. Available at: www.vitaid.com. Accessed June 10, 2004.

Here, use of the GlideScope® can again be helpful because, should the endotracheal tube get caught on the arytenoids[3] or other laryngeal structures, it becomes evident on the GlideScope® display, and appropriate corrective action (such as twisting the endotracheal tube) can easily be taken.

It should also be pointed out that during general anesthesia, the lumen of the pharynx and the larynx usually becomes smaller as a result of reduced muscle tone. Insertion of the GlideScope® lifts the tongue and the jaw to open up these structures and facilitates the identification of anatomical landmarks by the user of the FOB.

Finally, it should be emphasized that this technique would be expected to be useful for other purposes, as in situations where FOI is difficult even for experienced operators, as may occur, for example, in the case of an airway soiled by blood.

Based on using this technique in eight anesthetized patients to date, I have found it to be particularly valuable, especially in averting lengthy detours to peripheral structures such as the piriform fossae. It was also my experience that this technique offers a "macro view" that is helpful even when a video bronchoscope is available. Although it is my clinical impression that FOI using this technique can be accomplished in a shorter period and accelerates resident learning, formal studies are needed to test these impressions.

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Gum Elastic Bougie-Guided Insertion of the ProSeal Laryngeal Mask Airway Is Superior to the Digital and Introducer Tool Techniques in Patients with Simulated Difficult Laryngoscopy Using a Rigid Neck Collar

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BACKGROUND: We compared three techniques for insertion of the laryngeal mask airway ProSeal™ (PLMA) in patients with simulated difficult laryngoscopy using a rigid neck collar.

METHODS: Ninety-nine anesthetized healthy female patients aged 19–68 yr were randomly allocated for PLMA insertion using the digital, introducer tool (IT) or guided techniques. Difficult laryngoscopy was simulated using a rigid neck collar. The laryngoscopic view was graded before PLMA insertion. The digital and IT techniques were performed according to the manufacturer's instructions. The guided technique involved priming the drain tube with an Eschmann tracheal tube introducer, placing the introducer in the esophagus under direct vision and railroading the PLMA into position. Failed insertion was defined by any of the following criteria: 1) failed pharyngeal placement, 2) malposition, and 3) ineffective ventilation.

RESULTS: The median laryngoscopic view was 3 and the mean interincisor distance was 3.3 cm. Insertion was more frequently successful with the guided technique at the first attempt (guided 100%, digital 64%, IT 61%; $P < 0.0001$), but success after three attempts was similar (guided 100%, digital 94%, IT 91%). The time taken for successful placement was similar among groups at the first attempt, but was shorter for the guided technique after three attempts (guided 31 ± 8 s, digital 49 ± 28 s, IT 54 ± 37 s; $P < 0.02$).

CONCLUSION: The guided insertion technique is more frequently successful than the digital or IT techniques in patients with simulated difficult laryngoscopy using a rigid neck collar.

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The laryngeal mask airway ProSeal™ (PLMA) is a relatively new laryngeal mask airway (LMA) device with a large wedge-shaped double-cuff to improve the seal and a drain tube to prevent aspiration and gastric insufflation.[1] The manufacturer recommends inserting the PLMA using digital manipulation, like the LMA Classic™, or with an introducer tool (IT), like the LMA Fastrach™[2]; however, the first attempt success rate with these techniques averages about 90% because of impaction at the back of the mouth, folding over of the cuff, and failure of the distal cuff to reach its correct position in the hypopharynx.[3–7] In 2002, Howarth et al.[8] reported a 100% (100/100) first attempt success rate for a new technique which involved placing an Eschmann tracheal tube introducer (or "gum elastic bougie" [GEB]) in the esophagus and railroading the PLMA into position along its drain tube. Subsequent studies showed that this technique was superior to digital manipulation or the IT[7] and that it was the best backup technique if either recommended technique failed.[9] LMA devices have an established role in difficult laryngoscopy[10] and the PLMA is particularly suited for airway rescue as it can protect the airway and facilitate high airway pressure ventilation.[11] In the following study, we tested the hypothesis that guided insertion is more frequently successful than the digital and IT techniques in patients with simulated difficult laryngoscopy using a rigid neck collar.

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METHODS

Ninety-nine female patients (ASA physical status grade 1–2, aged 19–68 yr) undergoing elective gynecological surgery in the supine position were randomly allocated (by opening a sealed opaque envelope) into three equal-sized groups for PLMA insertion using the digital, IT, or guided techniques. Ethical committee approval and written informed consent were obtained. Patients were excluded if they were <19 yr, had a known or predicted difficult airway, a body mass index >35 kg/m^2, or were at risk of aspiration. All cases were conducted by three anesthesiologists with 3–5 yr training (>75 uses each technique). Each anesthesiologist conducted 11 insertions with each technique.

All patients were premedicated with midazolam 0.05–0.1 mg/kg orally 1 h preoperatively. Anesthesia was in the supine position with the patient's head in the neutral position on the operating table. A standard anesthesia protocol was followed and routine monitoring applied. Patients were administered oxygen for 3 min. Induction of anesthesia was with fentanyl 2–4 μg/kg and propofol 2.5–3.0 mg/kg given over 30 s. Neuromuscular blockade was with rocuronium 0.4 mg/kg. Maintenance of anesthesia was with remifentanil 0.25–0.5 $\mu g \cdot kg^{-1} \cdot min^{-1}$ and propofol 75–125 $\mu g \cdot kg^{-1} \cdot min^{-1}$ in O_2 33% and air. Patients were ventilated via a facemask for 3 min and then a stiff neck (Stifneck® Select Collar™, Laerdal Medical Corp., Wappingers Falls, NY), which has been used by other groups to simulate the difficult airway,[12,13] was applied according to the manufacturer's instructions.[14] Direct laryngoscopy was performed by one of the authors (C.K.) using a Macintosh blade size 3 to grade the laryngoscopic view (Cormack and Lehane). No laryngeal manipulation was done during grading. Afterwards the PLMA (all size 4) was inserted.

The digital and IT insertion techniques were performed according to the manufacturer's instructions.[2] The digital technique involved the use of the index finger to press the PLMA into, and advance it around, the palatopharyngeal curve. The IT technique involved attaching the IT, using a single-handed rotational technique to press the PLMA into, and advance it around, the palatopharyngeal curve, and removing the IT. For the guided technique, the drain tube of the PLMA was primed with a lubricated Eschmann tracheal tube introducer with its straight end first, leaving the 5-cm bent portion protruding from the proximal end (for the assistant to grip), and the maximum length protruding from the distal end (for the anesthesiologist to manipulate). The guided technique involved the following steps: 1) under gentle laryngoscope guidance, the distal portion of the guide was placed 5–10 cm into the esophagus while the assistant held the PLMA and proximal portion; 2) the laryngoscope was removed; 3) the PLMA was inserted using the digital insertion technique while the assistant stabilized the proximal end of the guide so it did not penetrate further into the esophagus; and 4) the guide was removed while the PLMA was held in position.[8] All techniques were performed with the cuff fully deflated and using a midline approach. Once the PLMA was inserted into the pharynx, the cuff was inflated with air until effective ventilation was established or the maximum recommended inflation volume reached. Fixation was according to the manufacturer's instructions.[2]

Patients' lungs were ventilated at an inspired tidal volume of 10 mL/kg, a respiratory rate of 12/min and an inspiratory:expiratory ratio of 1:2. The presence/absence of oropharyngeal air leaks (detected by listening over the mouth[15]), gastric air leaks (detected by listening with a stethoscope over the epigastrium[16]), drain tube air leaks (detected by placing lubricant over the proximal end of the drain tube), or an end-tidal CO_2 >45 mm Hg was noted. A well-lubricated 60-cm long, 14-Fr gastric tube was inserted through the drain if there was no air leak up the drain tube. Correct gastric tube placement was assessed by suction of fluid or detection of injected air by epigastric stethoscopy.

Three attempts were allowed before insertion was considered a failure. Failed insertion was defined by any of the following criteria: 1) failed passage into the pharynx; 2) malposition (air leaks or failed gastric tube insertion if pharyngeal placement successful); and 3) ineffective ventilation (maximum expired tidal volume <8 mL/kg or end-tidal CO_2 >45 mm Hg if correctly positioned). The time between picking up the laryngoscope or prepared PLMA (cuff deflated, lubricated, IT and guide attached) and successful placement was recorded. The etiology of failed insertion was documented. If insertion failed after three attempts, a single attempt was permitted with the guided technique. Once insertion was successful, the intracuff pressure was set at 60 cm H_2O using a digital manometer (Mallinckrodt Medical, Athlone, Ireland).

Cardiorespiratory data were collected every minute before and after PLMA insertion. Any episodes of bradycardia (<40/min), tachycardia >100/min, or systolic hypotension (<80 mm Hg) were documented, as were any episodes of hypoxia (Spo_2 < 90%) or other adverse events. Visible blood staining on the guide, laryngoscope, IT, or PLMA was noted at removal.

Data about failed passage into the pharynx, insertion time, and the etiology of failure were collected by an unblinded observer. Data about malposition, effective ventilation, hypoxic episodes, and blood staining were collected by an observer blinded to the insertion technique. Sample size was based on a projected difference of 25% among the groups for first attempt success rate, a Type I error of 0.05 and a power of 0.8, and was based on studies [3–5,8,17–23] reporting first attempt success rates. If the randomized device failed, all variables were assigned to the initial randomized device (intention-to-treat). The distribution of data was determined using Kolmogorov-Smirnov analysis.[24]

Table 1. Insertion Success, Insertion Time, Etiology of Failed Insertion and Visible Blood Among Techniques. Data are Mean ± SD or Numbers (%)

	Digital	Introducer tool	Guide
N	33	33	33
Insertion success (*n*)			
First attempt	21 (64)	20 (61)	33 (100)
Second attempt	8 (24)	5 (15)	0 (0)
Third attempt	2 (6)	5 (15)	0 (0)
Overall	31 (94)	30 (91)	33 (100)
Insertion time (S)			
First attempt	35 ± 10	35 ± 7	31 ± 8
Overall[a]	49 ± 28	54 ± 37	31 ± 8
Etiology of failure (*n*)			
Failed passage into pharynx	12 (36)	13 (39)	0 (0)
Malposition[b]	8 (27)	13 (33)	0 (0)
Failed ventilation[c]	2 (6)	1 (3)	0 (0)
Visible blood (*n*)			
ProSeal LMA	2 (6)	2 (6)	1 (3)
Introducer tool		1 (3)	
Guide			0 (0)
Laryngoscope			0 (0)
Overall	2	3	1

[a] Data from the five failed insertions not included.

[b] Drain tube air leaks and failed gastric tube insertion if pharyngeal placement successful.

[c] Maximum expired tidal volume <8 mL/kg or end-tidal CO_2 >45 mm Hg if correctly positioned.

Statistical analysis was with paired *t*-test, one-way analysis of variance with *post hoc* Benferroni-Holm corrections for multiple comparisons and χ^2 test. Data are mean ± SD unless otherwise stated. Significance was taken as $P < 0.05$.

RESULTS

The mean (range) age, height, and weight were 41 (19–68) yr, 165 (147–180) cm, and 64 (43–105) kg, respectively. There were no differences in demographic data. There were no differences in Cormack and Lehane score (score 1, 2, 3, 4: $n = 0, 10, 74, 15$) or mean interincisor distance (3.3 ± 0.3 cm). Insertion was more frequently successful with the guided technique at the first attempt than the digital or IT techniques ($P < 0.0001$), but overall success was similar (Table 1). The time taken for successful placement was similar among groups at the first attempt, but was shorter for the guided technique after three attempts ($P < 0.02$). There were no failed uses of the guided technique.

The digital technique failed in two patients: a single attempt with the guided technique was successful in both cases. The IT technique failed in three patients: a single attempt with the guided technique was successful in all three cases. The etiology and frequency of failed insertion was similar for the digital and IT techniques (Table 1). There were no episodes of hypoxia. There were no differences in the frequency of visible blood among groups.

DISCUSSION

Guided insertion is more frequently successful than the digital and IT techniques in patients with simulated difficult laryngoscopy. The rigid neck collar simulates difficult laryngoscopy by reducing both head/neck movement (necessary to align the oropharyngeal axes) and mouth opening (necessary to insert and maneuver the laryngoscope). In our study, the application of the rigid neck collar resulted in a median laryngoscopic score of 3 and a mean mouth opening of 3.3 cm and was thus successful in simulating difficult laryngoscopy. An earlier study by our group found a similar result for patients with normal airways.[7] The guided technique is more successful because it reduces impaction at the back of the mouth, prevents folding over of the distal cuff, and guides the distal cuff directly into its correct position in the hypopharynx. Interestingly, we found that all failed insertions with the digital and IT techniques were subsequently successful with the guided technique. This supports the findings of another study by our group which showed that the guided technique is the best backup technique if either the digital or IT techniques fail.[9] Other advantages of the guided technique for airway rescue are that 1) oropharyngeal pathology can be identified as a laryngoscope is used; 2) gastric tube insertion is easy as the drain tube and esophagus are prealigned; and 3) the time-consuming tests for malposition are not required as malposition is rare.

Potential disadvantages over the manufacturer's recommended techniques are 1) stimulation from laryngoscopy and 2) esophageal trauma from the GEB. We found no differences in the hemodynamic response to insertion. This is not surprising as little force is required to view the hypopharynx. Esophageal trauma from passage of a gastric tube is extremely rare and is usually associated with anatomic abnormalities such as an esophageal pouch.[25] Avoiding force during passage of the guide into the esophagus should eliminate the risk of esophageal trauma. The GEB is not ideal for use with the PLMA, as the distal portion does not have an atraumatic tip. The development of an atraumatic esophageal guide is currently underway. We have used the guided technique as the primary technique on over 17,000 occasions without any evidence of minor or major esophageal injury, including an absence of occult blood on the GEB in 1096/1096 tested. We do not recommend blind placement of an Eschmann tracheal tube introducer, as there is a higher risk of trauma and misplacement.

Our study has four limitations. First, all insertions were by experienced users and our results may not necessarily apply to less experienced personnel. However, we consider that the digital and IT techniques probably require more skill than the guided technique. Second, we did not include a fourth group where the PLMA was inserted using laryngoscope

guidance, but without the guide. In principle, laryngoscopy might have improved insertion conditions by widening the pharynx even after removal; however, we consider this unlikely. Third, we used a rigid neck collar to simulate the difficult laryngoscopy scenario and our results may not apply to other difficult airway scenerios. Interestingly, Asai et al.[26] found that the ProSeal LMA was more successful than the LMA Classic™ with manual-in-line stabilization applied. Finally, intraoperative data were collected by unblinded observers, a possible source of bias.

We conclude that the guided insertion technique is more frequently successful than the digital or IT techniques in patients with a simulated difficult laryngoscopy using a rigid neck collar.

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