Comparison of Bougie-Assisted Intubation with Traditional Endotracheal Intubation in a Simulated Difficult Airway

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ABSTRACT

Objective. To compare the success and ease of bougie-assisted intubation (BAI) with those of traditional endotracheal intubation (ETI) in a simulated difficult airway (20.4 seconds for BAI vs. 16.7 seconds for ETI, p = 0.102). **Methods.** This was a prospective, randomized, crossover, single-blind study comparing BAI with ETI in a simulated difficult airway. The 35 participants included paramedics, flight nurses, and emergency medicine resident physicians. Participants were already experienced in ETI and received a brief demonstration of BAI. A simulated difficult airway was created using a Laerdal adult intubation manikin. Cervical motion was mechanically limited to provide a grade III Cormack and Lehane glottic view. Participants performed ETI and BAI in randomized order. Successful placement in the trachea and time to successful placement were recorded for both techniques by each participant. After intubating the manikin with both techniques, each participant was asked to complete a Likert-style survey assessing ease of each technique. **Results.** Of the 35 participants, 27 were successful with both techniques and two failed with both techniques. The remaining six participants all failed at ETI but were able to intubate using BAI. There was significantly greater success in intubating the simulated difficult airway with BAI than with ETI (94% vs. 77%, p = 0.0313). The order of techniques attempted did not influence this conclusion. There was no difference in average time to successful intubation (20.4 seconds for BAI vs. 16.7 seconds for ETI, p = 0.102). Thirty-two (91.4%) of the participants completed the survey regarding ease of performing each technique. Forty-one percent rated the ease of intubation as the same for the two methods, 50% rated BAI as easier, and 9% rated ETI as easier (p = 0.0006). **Conclusion.** In a simulated difficult airway, BAI has a higher success rate than traditional ETI without increasing the time to successful intubation. Intubators perceive BAI as being easier to perform than traditional ETI in this simulated difficult airway scenario. **Key words:** endotracheal intubation; bougie; intubation; emergency medical services; prehospital; airway management

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Introduction

Traditional endotracheal intubation (ETI) using direct laryngoscopy is a psychomotor skill that is within the scope of practice of many health care providers, including emergency medical services (EMS) personnel. The skill requires significant experience to master, but patient and situational characteristics may add further difficulties to achieving successful ETI. Patient factors often cited as causes for a difficult intubation include prominent overbite, limited mouth opening, restriction of neck motion, obesity, short neck, fluids or foreign material in the airway, and anterior position of the larynx, but occasionally patients lacking any of these criteria are still found to be difficult to intubate by ETI. In the out-of-hospital setting, the glottic view obtained by direct laryngoscopy may be further hindered by the need for cervical spine immobilization and patient positioning on the ground.[1]

The *bougie*, or endotracheal tube (ETT) introducer, is a simple flexible device that serves as an adjunct to placing an ETT into the trachea. The bougie has been reported to be a useful adjunct to direct laryngoscopy in the surgical suite, emergency department, and out-of-hospital EMS settings.[2–9] The bougie is similar to the malleable stylet used in traditional ETI, except that it is made of a plastic polymer that is more flexible and significantly longer than a malleable stylet. The bougie can be inserted into the glottic opening more easily than an ETT can, because it is smaller-caliber and more easily manipulated. Once it is in place in the trachea, it can be used as a Seldinger-type guide or track when the ETT is placed over a bougie and guided into the trachea.[4] When visualization of the glottis is difficult or incomplete, it is easier to insert the smaller-caliber bougie through the glottis than a larger and less maneuverable ETT; therefore, bougie-assisted intubation (BAI) is hypothesized to be easier to accomplish in a difficult airway scenario.

In one study by Nolan and Wilson in 1993, comparing BAI with ETI in patients in the operating room setting under conditions simulating cervical spine

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immobilization, the bougie was shown to be superior to traditional intubation. In fact, no failures were recorded in the bougie group.[10] The bougie has also been found to allow for less cervical spine motion when compared with other methods of intubating, as evaluated by fluoroscopy.[2] A study by Gataure et al. showed that BAI in an operating room setting was more successful than ETI using a traditional malleable stylet; however, this study using human subjects did not standardize the degree of difficulty for each intubation.[11]

Considerable data have already been collected on the use of the bougie in the anesthesia setting, and the device has been found in this setting to be an inexpensive adjunct capable of securing airways with an ETT even when the airway anatomy provides a less-than-optimal view with traditional direct laryngoscopy.[9] One study has shown that BAI is as effective as ETI in the prehospital setting, but this study did not address the specific utility in limited or difficult airway views or any potential time difference between the two techniques.[5] Other studies have compared BAI with the fiberoptic stylet and the Airway Scope (Pentax Corp., Tokyo, Japan), and in both studies the bougie was found to be as successful in intubating the trachea as both of these more expensive devices.[12,13]

For this study, we had three separate hypotheses: The first was that BAI would be more successful than ETI in a difficult airway scenario; the second was that BAI would take no more time to complete than ETI in a difficult airway scenario; and the third was that BAI would be perceived by providers to be as easy to perform as traditional intubation.

METHODS

This was a prospective, randomized, crossover, single-blind study comparing BAI with ETI in a simulated difficult airway scenario. Thirty-five prehospital EMS providers participated in the study, including ground and flight paramedics (19), flight nurses (5), and flight physicians (emergency medicine residents) (11). All subjects had prior experience in ETI, although the experience levels varied significantly.

The study was done in conjunction with an annual skills competency assessment session. Each participant was being assessed for competence in nine different out-of-hospital procedural skills, and the study involved only one of the skill stations. The participants gave written consent to participate, but they were blinded to which skill was being assessed and what data were being obtained during the study. At the ETI station, a brief explanation and demonstration of BAI was given to each participant.

A simulated difficult airway was created using a Laerdal adult intubation manikin (Laerdal Medical, Wappingers Falls, NY). A rigid cervical collar was placed on the manikin, and the neck of the manikin was fixed to the table using a 2-inch cinch strap to prevent extension of the manikin's neck. Before and during the study, three experienced emergency physicians verified that the best obtainable view by direct laryngoscopy was a partial glottis opening of approximately 20%—equivalent to a grade III Cormack and Lehane glottic view.

Participants were asked to perform both traditional ETI and BAI in randomized order. If the participant preferred to use a two-person BAI technique, with the second person advancing the ETT along the bougie while the participant maintained the laryngoscope position, a single observer served in the role of the second person for all participants. Equipment available to the participants was standardized, including a SunMed polyethylene ETT introducer (bougie) with coude tip (SunMed Healthcare, Largo, FL),[14] a 7.5-mm ETT with malleable stylet, Macintosh and Miller laryngoscope blades of various sizes, an end-tidal carbon dioxide device, and a bag–valve–mask (BVM). There was no attempt to control laryngoscope blade selection, because provider choice presumably gives the intubator the option to use the blade with which he or she is most comfortable and confident. The participants were not aware that they were being timed. Timing began when the laryngoscope blade entered the mouth and ended with ventilation through the ETT with the BVM (evidence of successful ventilation as determined by manikin lung inflation or evidence of failed placement as determined by manikin stomach inflation).

Overall success or failure was recorded for each of the two techniques. Participants could take more than one attempt to achieve successful placement of the ETT, but no further attempt was permitted after the participant attempted to ventilate the manikin. In other words, the participant could reinsert a laryngoscope blade or change blades to obtain a better view, but the overall attempt was terminated after the first ventilation through the ETT—whether or not the ETT was successfully located in the trachea. Time to complete each technique was measured for each successful placement. If the proctor deemed an attempt to be a failure, the time to completion was not recorded. Upon completion of the two techniques, each participant was asked to complete a five-point Likert-style survey to assess his or her overall ease of intubation with both techniques in this particular difficult airway model.

Statistical analyses were completed using SAS (version 9.2, SAS Institute Inc., Cary, NC). McNemar's test was used to determine whether the rates of successful intubation were different between the intubation methods. A paired t-test was used to determine whether times until completed successful intubation were different between the two intubation methods. This analysis was limited to the 27 participants who were successful for both methods. To determine

whether participants' ratings of the ease of intubation were different between the two groups, a Jonckheere-Terpstra test was used to test for trends in paired ordinal data. This analysis was limited to the 32 participants who completed this section of the survey. All tests were two-sided, and p-values <0.05 were considered significant.

This study was approved by the Geisinger Health System Institutional Review Board (IRB) with the specific determination that this study met the waived criteria for full IRB approval. Each participant gave written informed consent to participate, as required by the IRB.

RESULTS

The results are listed below for each of the three study hypotheses.

Objective 1: Success in Placing the Endotracheal Tube by Bougie-Assisted Intubation versus Traditional Endotracheal Intubation

Of the 35 participants, 27 were successful using both methods and two were unsuccessful using both methods. The remaining six participants were successful with the BAI method but unsuccessful with the traditional ETI method (of these, three had attempted ETI first and three had attempted BAI first) (Table 1). There was significantly greater success in intubating the simulated difficult airway with BAI than with ETI (94% vs. 77%, McNemar's exact p = 0.0313). The order of techniques attempted did not influence this conclusion.

Objective 2: Time to Successful Endotracheal Tube Placement by Bougie-Assisted Intubation versus Traditional Endotracheal Intubation

There was no significant difference in the average time to successful intubation (20.4 seconds for BAI [standard deviation (SD) = 9.1 seconds] versus 16.7 seconds for ETI [SD = 9.6 seconds], paired t-test p = 0.102). When controlling for order of techniques attempted, the difference between the groups remained nonsignificant (p = 0.0901). The analysis was limited to the 27 participants who were successful with both methods.

TABLE 1. Success of the Participants in Placing the Endotracheal Tube for Bougie-Assisted Intubation and Traditional Endotracheal Intubation

Traditional ETI Method	BAI Method		
	Success	Failure	Total
Success	27	0	27
Failure	6	2	8
Total	33	2	$N = 35$

McNemar's exact p = 0.0313.
BAI = bougie-assisted intubation; ETI = endotracheal intubation.

Objective 3: Perceived Ease of Bougie-Assisted Intubation versus Traditional Endotracheal Intubation

Participants were given the opportunity to complete the Likert ease-of-use survey at the end of the session, and 32 of 35 (91.4%) subjects completed the survey. Of these, 41% rated the ease of intubation the same for the two methods (asterisked values in Table 2), 50% rated the BAI to be easier than traditional ETI, and 9% rated traditional ETI to be easier than BAI. The participants perceived the BAI to be easier than traditional ETI in this difficult airway model (Jonckheere-Terpstra exact p = 0.0006).

DISCUSSION

All health care personnel who perform ETI encounter patients who are difficult to intubate, and out-of-hospital EMS personnel face some additional difficulties due to their patient population and environmental situations. Contingency or backup plans for difficult intubations are essential for all health care providers who do ETI, and these strategies may include secondary or rescue devices that temporarily establish the airway in lieu of an ETT or adjuncts to ETI that facilitate successful placement of an ETT. The advantage of adjuncts that facilitate successful ETI, such as the bougie tube introducer used in this study, is that the resulting airway is secured with an ETT—the ideal result for prolonged airway management for most patients.

TABLE 2. Ease of Endotracheal Tube Placement Using Bougie-Assisted Intubation and Traditional Endotracheal Intubation by Number of Participants within Each Rating Combination on a Likert Survey

BAI Rating	Traditional ETI Rating					
	1	2	3	4	5	Total
1	6*	3	2	0	0	11
2	1	6*	5	3	0	15
3	1	0	0*	1	0	2
4	0	1	0	0*	2	3
5	0	0	0	0	1*	1
Total	8	10	7	4	3	$N = 32$

Likert scale definitions: 1 = extremely easy; 2 = easy; 3 = somewhat easy; 4 = not very easy; 5 = most difficult.
Jonckheere-Terpstra exact p = 0.0006.
*Participants (41%) rating the ease of intubation the same for the two methods.
BAI = bougie-assisted intubation; ETI = endotracheal intubation.

The bougie, or ETT introducer, is a very practical, lightweight, and relatively inexpensive device that requires similar psychomotor skills to those previously attained by individuals trained in ETI with direct laryngoscopy. The use of BAI potentially increases the chance of successfully placing an ETT in a patient with a limited glottic view.

This study provides evidence that the bougie may assist in securing placement of an ETT in a difficult airway setting, and the successful use of BAI may secure the airway before the need arises to utilize a supraglottic or other device that does not ultimately end with the placement of an ETT. Certainly, if a provider encounters difficulty placing an ETT even with BAI, then the individual must still maintain the judgment to abort attempts at ETI in favor of alternative or rescue airway devices when appropriate.

LIMITATIONS

This study does have important limitations. First and foremost, although intubation manikins are designed to simulate airway anatomy and this difficult airway model has the advantage of providing each participant with the same degree of difficulty in visualizing the glottis, manikins do not precisely simulate the conditions of intubating a human subject.

Additionally, each EMS provider received a standardized education on the use of the bougie immediately prior to the study, but we did not attempt to quantify preexisting familiarity or experience of each provider with either BAI or ETI. Whereas the local EMS systems did not routinely use BAI at the time of the study, it is possible that some subjects had used a bougie in practice or in clinical care prior to the study. Although no data were collected regarding the previous experience with ETI for each provider, it was apparent to the proctors that those providers with more experience (for example, veteran flight crew members) did not seem to have trouble with the bougie or the traditional ETI technique, even when faced with this model of a limited glottic view.

It is worth noting that our method of simulating a "difficult airway" with limited glottic view—basic airway manikin with cervical collar and a cinch strap across the neck and anchoring the manikin to the table—provided a reproducible and standardized glottis exposure. We found this model to be an easy and inexpensive way to provide EMS personnel with a difficult airway experience without the use of a high-fidelity simulator, and this model may be useful for routine EMS procedural skill training and skill maintenance.

CONCLUSION

In this simulated difficult airway, BAI has a higher success rate than traditional ETI, and BAI does not significantly increase the time to successful intubation. Intubators perceive BAI as being easier to perform than traditional ETI in this simulated difficult airway scenario.

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