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Airway Management Abstracts

Contents

AI-guided motorized videolaryngoscope: a cadaver study

Submission ID

66

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INTRODUCTION

Videolaryngoscopy improves laryngeal visualization, yet tube advancement can still fail or be prolonged despite an adequate view. In non-operating room settings, first-attempt success with videolaryngoscopy has been reported to plateau around 85% in intensive care units and to fall as low as 22% in difficult emergency department airways.[1,2] This “can see but can’t intubate” problem accounts for a substantial proportion of videolaryngoscope failures and reflects persistent ergonomic and cognitive demands during endotracheal intubation, including hand-eye coordination, bimanual workflow, and reliance on stylets.[1] These challenges may widen performance gaps between expert and infrequent intubators, particularly in high-stress environments. We evaluated a novel AI-guided, motorized videolaryngoscope (AI-VL) designed to support glottic targeting and enable motorized tube advancement with the goal of reducing manual dexterity demands and operator workload.

METHODS

A preclinical study was performed using five Thiel-embalmed human cadavers following local research ethics review. Three operators with differing airway experience completed 30 oral tracheal intubations using the AI-VL incorporating joystick-controlled tube advancement and real-time visual glottic targeting. Primary outcomes were first-attempt success, intubation time, and visible airway trauma. Intubation time was measured from device insertion past the teeth to confirmed tracheal tube placement. Secondary outcomes included perceived workload using the weighted NASA Task Load (NASA-TLX) and usability using a post-procedure 10-item Likert questionnaire assessing ergonomics, intuitiveness, precision, training suitability, and likelihood of future clinical use. Analyses were descriptive.

RESULTS

Across 30 intubations, first-attempt success was 100%. Median intubation time was 14.3 seconds (IQR 11.0 to 22.8), which is shorter than published benchmarks for conventional videolaryngoscopy, typically reported between 26 and 60 seconds.[1] No visible airway trauma or tissue injury was observed following any procedure. Mean weighted NASA-TLX global workload was 29.1 ± 6.7 (0-100 scale), below the 25th percentile of published medical task norms, consistent with low to moderate perceived demand.[3] Workload remained lowest across physical demand, effort, and frustration subscales. Mean overall usability rating was 4.3 ± 0.6 out of 5. The highest rated items were training suitability (5.0 ± 0.0) and likelihood of clinical use or recommendation (4.7 ± 0.6).

DISCUSSION

In this cadaver study, use of the AI-VL achieved consistent first-pass intubation, short procedure times, low perceived workload, and favorable usability scores. The combined design is intended to reduce the technical demands for succesful intubation by pairing joystick-controlled tube advancement with real-time glottic targetting. Motorized tube advancement may reduce bimanual coordination demands and could free the other hand for adjunct maneuvers such as external laryngeal manipulation, repositioning, suction, or bougie use.[4] AI based targeting may further provide intuitive cognitive support and training value. Limitations include cadaver conditions, small sample size, and no comparator device. Future prospective clinical comparative studies are needed.

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Airway management in post-tonsillectomy bleeding

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107

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INTRODUCTION

Oropharyngeal airway bleeding is associated with increased risk of failed intubation (1). Management for post-tonsillectomy hemorrhage has classically favoured direct laryngoscopy due to concerns for bleeding to obscure video cameras, which has limited video laryngoscopy use in this group of patients, who present with factors that may contribute to an anatomically or physiologically "difficult airway", such as recent airway instrumentation, aspiration risk, and emergent status (2). In recent years, and particularly since the COVID-19 pandemic, consensus has shifted to a more widespread adoption of video laryngoscopy. Despite this, it remains unclear if one approach to airway management is associated with higher rates of failed first attempt. Our aim for the current study was to determine the first attempt failure rate associated with each method in patients presenting with post-tonsillectomy. Our secondary aim was to characterize failed first attempt events to help inform future practice.

METHODS

Electronic medical records on all local post-tonsillectomy bleeding cases from November 2019 – March 2025 were reviewed. The list of relevant medical records was generated by an information technologies analyst according to operating room procedure bookings. An overview of all post-tonsillectomy bleeding cases (both pediatric and adult populations) in the province was then obtained from anonymized data on the Electronic Health Record (Epic Systems Corporation) to correlate zone data to provincial trends. Inclusion criteria were recent tonsillectomy surgery, postoperative bleed requiring both intubation and surgery, and documentation of intubation procedure. Exclusion criteria hemorrhage not requiring intubation or surgery, incomplete documentation, and intubation by a non-anesthesia healthcare provider. Cases of repeat post-tonsillectomy bleeding was reviewed as individual cases.

The primary outcome was the frequency of failed first attempt to capture airway using either DL or VL as the primary method. Secondary outcomes assessed include methods of successful subsequent attempts and frequencies of aspiration events, desaturation events,

and peri-operative mortality rate. Comments from procedure notes were also extracted to provide additional insight into failed intubation attempts.

Ethics was approved by the institutional research ethics board prior to accessing patient medical records.

RESULTS

Within the local zone, VL uptake was 28.1% and was not statistically different from provincial data for post-tonsillectomy hemorrhage cases (24.6%, p=0.774) or the broad surgical population (29.7%, p=0.5229). There was no statistically significant difference in the rates of failed first intubation attempts between DL and VL (0/40 with DL vs 1/17 with VL, p=0.298). Correspondingly, there were no differences in the rates of complications associated with airway capture. These data were consistent at the provincial level.

Among post-tonsillectomy bleeding cases in the zone, there were two documented failed first intubation attempts. In one case, oral cavity bleeding obstructed the VL view resulting in failed initial airway capture. Intubation via DL was successful thereafter. In the other case, a second attempt at intubation was required due to the initial endotracheal tube being too large. The latter case was excluded from the study as the intubator was not an anesthesia provider.

DISCUSSION

The overall results of this study suggest VL may provide utility for post-tonsillectomy hemorrhage cases in the setting of appropriate provider experience and careful clinical assessment. Even in our small sample size we did encounter one instance of blood obscuring the VL camera - resulting in a failed attempt at intubation. Caution should be utilized in all patients with post-tonsillectomy bleed and skill of the anesthesia provider with DL remains crucial as an airway management technique.

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Alpha-power preservation and neuroinjury biomarkers as determinants of postoperative recovery quality: a randomized trial of qEEG-guided anesthesia

Submission ID

29

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INTRODUCTION

To assess the feasibility, safety, and efficacy of qEEG-guided anesthetic titration that preserves frontal alpha power compared with conventional depth-index guidance.

METHODS

This single-center, double-blind, randomized trial enrolled adults aged 50 years or older undergoing elective noncardiac surgery between June 2023 and September 2025. Participants were randomized 1:1 to qEEG-guided care, targeting individualized frontal alpha power with defined responses to alpha decline, or to standard care with a BIS target of 40–60. Allocation was concealed, and assessors of QoR-15 and CAM/CAM-ICU were blinded. The primary endpoint was QoR-15 at 24 hours. Secondary endpoints included time to PACU readiness (Aldrete ≥9), changes in neurofilament light (NfL) and glial fibrillary acidic protein (GFAP) from baseline to 24–48 hours, postoperative nausea and vomiting, pain, and delirium. Analyses were intention-to-treat and adjusted for age, ASA class, surgery type, and opioid dose.

RESULTS

Of 210 randomized patients, 198 completed the study (99 per group). QoR-15 at 24 hours was higher with qEEG guidance (118 ± 14) than with standard care (112 ± 15; $p<0.01$). A clinically important improvement (≥8 points) occurred in 46% versus 31% ($p<0.05$). PACU readiness was faster with qEEG guidance (median 45 vs 53 minutes; $p<0.05$). Increases in NfL and GFAP were smaller with qEEG guidance (both $p<0.05$). Rates of nausea, pain, delirium, and adverse events were similar.

DISCUSSION

qEEG-guided anesthesia that preserves alpha activity improved early recovery and reduced neuroinjury biomarker release without compromising safety.

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Bench comparison of suction performance of three flexible video endoscopes using simulated airway contaminants

Submission ID

60

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INTRODUCTION

Flexible endoscopes are employed in the intensive care unit, emergency department, and operating room to facilitate airway examination, secretion clearance, and endotracheal intubation. The integrated suction capability enables the decontamination of contaminated airways during airway management. However, data on the efficacy of various endoscopes with built-in suction channels for this purpose are lacking. The relationship between endoscopes' external diameters and internal designs may influence their efficacy in secretory clearance. This study aims to quantify the time required to clear a pre-defined volume of high or low viscosity solution to guide clinical decision-making surrounding endoscopes with varying diameters.

METHODS

Ethics approval was waived as this equipment study did not involve patients or patient data. Two solutions were prepared to simulate commonly encountered airway contaminants. Xanthan gum solutions were mixed at concentrations of 5 g/L (low viscosity) and 10 g/L (high viscosity), as previously described[1]. Volumes of 5, 10, and 20 mL were prepared in 20-mL syringes for testing. Single-use flexible video endoscopes (Storz FIVE S®) with outer diameters of 3.5 mm (working channel 1.2 mm), 5.3 mm (2.2 mm), and 6.5 mm (3.0 mm) were evaluated. A suction pressure of −350 mmHg was generated using a Datex-Ohmeda Aisys CS2 anesthesia machine and verified with a manometer. Each endoscope was tested six times for each volume and solution within a 60-second timeframe. The order of testing by endoscope type, solution viscosity, and volume was randomized using an online randomization tool (GraphPad.com). The primary outcome was the time (seconds) required to clear the syringe contents completely. Successful clearance was defined as complete evacuation within 60 seconds; failure was defined as incomplete clearance within this time. Data are presented as mean with 95% confidence intervals. Between-group comparisons were performed using one-way ANOVA with Bonferroni post-hoc correction or Welch’s t-test, as appropriate.

RESULTS

A total of 108 measurements were performed (n=6 per condition). Using 5.3 mm and 6.5 mm endoscopes allowed to clear all studied solutions, both high- and low-viscosity, without channel blockage. The 3.5 mm endoscope provided only 5- and 10-ml clearance for low-viscosity fluid and was unsuccessful in clearing 20 ml of low-viscosity fluid or any volume of high-viscosity fluid. The time difference between a 6.5 mm and a 3.5 mm endoscope during suctioning of low-viscosity solution for 5 ml was 29.5s, and for 10 ml, 53.5s. The difference between the 5.3 mm and the 3.5 mm endoscopes for 5 ml was 28.9s, and for 10 ml was 52.9s, for low-viscosity solutions. The 6.5 mm endoscope demonstrated consistently faster clearance times than the 5.3 mm device across all volumes and viscosities. A maximum time difference of 26.7s was observed in the 20ml high-viscosity group (Table 1).

DISCUSSION

The study's findings demonstrate that flexible endoscopes can successfully clear viscous fluids resembling airway contaminants; however, the size of the scope and corresponding suction channel yield significantly different clearance times. The 3.5 mm endoscope demonstrated limited efficacy in clearing experimental secretions. For adults, we suggest using 5.3 or 6.5mm scopes for low-viscosity secretions. However, a 6.5 mm scope performs substantially better when high-viscosity fluids, such as gastric contents, need to be cleared. These findings suggest that the availability of larger-diameter endoscopes is advantageous in environments where airway decontamination is anticipated.

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Table 1

Mean time (in seconds, 95% Confidence Intervals) for Complete Clearance of Low and High Viscosity Fluids

Type of Solution	**Outer Diameter (OD) of Flexible Endoscope**				
	3.5 mm	**5.3 mm**	**6.5 mm**	**P**	**Post-hoc test significance**
Low Viscosity (Mucus-like consistency)					
5 ml	30.29s (26.88-33.51)	1.37s (1.18-1.56)	0.77s (0.49-1.06)	<0.001	6.5mm vs 5.3mm: p<0.001 5.3mm vs 3.5mm: p<0.001
10 ml	55.93s (52.43-59.43)	3.06s (2.80-3.31)	1.16s (0.84-1.48)	<0.001	6.5mm vs 5.3mm: p<0.001 5.3mm vs 3.5mm: p<0.001
20 ml	Failed (> 60s)	5.77s (5.34-6.20)	2.41s (2.11-2.72)	<0.001	
High Viscosity (Gastric contents-like consistency)					
5 ml	Failed (> 60s)	4.02s (2.96-5.05)	0.86s (0.70-1.02)	<0.001	
10 ml	Failed (> 60s)	12.54s (9.42-15.66)	2.15s (1.59-2.72)	<0.001	
20 ml	Failed (> 60s)	33.6s (28.5-38.71)	6.95s (5.80-8.10)	<0.001	

Effects of tracheal tube size and airway adjunct use on the magnitude of forces incident upon the glottis during tracheal intubation

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99

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INTRODUCTION

Excessive force during tracheal intubation may be associated with complications such as dysphonia, soft tissue trauma, post-operative sore throat (POST), dental injury, and glottic or tracheal injuries[1]. In clinical studies, the use of airway stylets during tracheal intubation[2] and stylet extraction forces exceeding 10.3 N have been associated with POST[3]. The mechanical forces applied during rigid bronchoscopy[4] and laryngoscopy[5] have previously been reported in the literature. However, these are gross measurements of the summative forces applied to all upper airway structures, not the forces acting directly upon the peri-glottic structures during tracheal tube passage. The purpose of this study was to measure the tracheal tube passage forces incident upon the glottis during intubation with commonly used adult tracheal tubes and airway adjunct devices.

METHODS

This bench top equipment study was exempt from ethics review. A custom-built test fixture which included a plastic larynx model (Laerdal Airway Model) mounted on a low friction roller bed and in-line load cell (BTE 50N digital force gauge) was used for testing. The effect of tracheal tube (TT) size on intubation force was assessed using four sizes of Shiley Hi-Lo tracheal tubes (6.0, 7.0, 7.5, and 8.0 mm ID, Covidien). Prior to each intubation, the cuff of each TT was lubricated with 0.5 ml of water-soluble lubricant. The TT was inserted under direct vision at a clinically relevant rate by an experienced staff anesthesiologist and the peak insertion force was recorded from the load cell. Ten intubation trials were repeated for each experimental variable. The intubation forces for the passage of a 7.5 mm TT into the glottis over three different stylet configurations and a bougie (15 Fr coude tip, SunMed) were also tested. The three stylet configurations included a “Satin Slip” stylet (Covidien) with a “standard” moderate curvature versus a “hockey stick” shape, and a “CMAC Guide”

preformed stylet (Storz). The peak intubation forces were analysed using linear regression and ANOVA with the Holm-Sidak correction for multiple comparisons.

RESULTS

Increasing tracheal tube size correlated with significantly higher glottic insertion forces (Figure 1A, regression slope +1.7 N per mm increase in diameter, $P<0.001$). We were unable to detect a statistical difference between the insertion forces for the 7.0 and 7.5 mm tracheal tube groups (ANOVA $p=0.07$). Insertion of a 7.5 mm tracheal tube alone resulted in the least glottic insertion forces in comparison to the advancement of a 7.5 mm TT over a stylet or bougie (Figure 1B, ANOVA $p<0.001$). The passage of a TT over the bougie resulted in significantly higher forces than the "standard" arcuate curved stylet or "CMAC guide" stylet ($p < 0.001$). Overall, the use of an introducer (bougie or stylet) as an airway adjunct resulted in median glottic insertion force increases of 1.9 to 2.8 times higher than use of a tracheal tube alone.

DISCUSSION

In this study, the use of an isolated larynx model (without laryngoscopy) eliminated confounding upper airway forces, allowing for measurement of glottic forces arising specifically from tracheal tube passage. Our study is the first to provide comparative data on the magnitude of glottic forces when using different size tracheal tubes and introducer adjuncts for intubation. The limitations of this study include the use of a manikin model and a single operator. Our results suggest that the use of a stylet instead of a bougie may reduce the magnitude of intubation forces on the glottic structures and the risk of POST.

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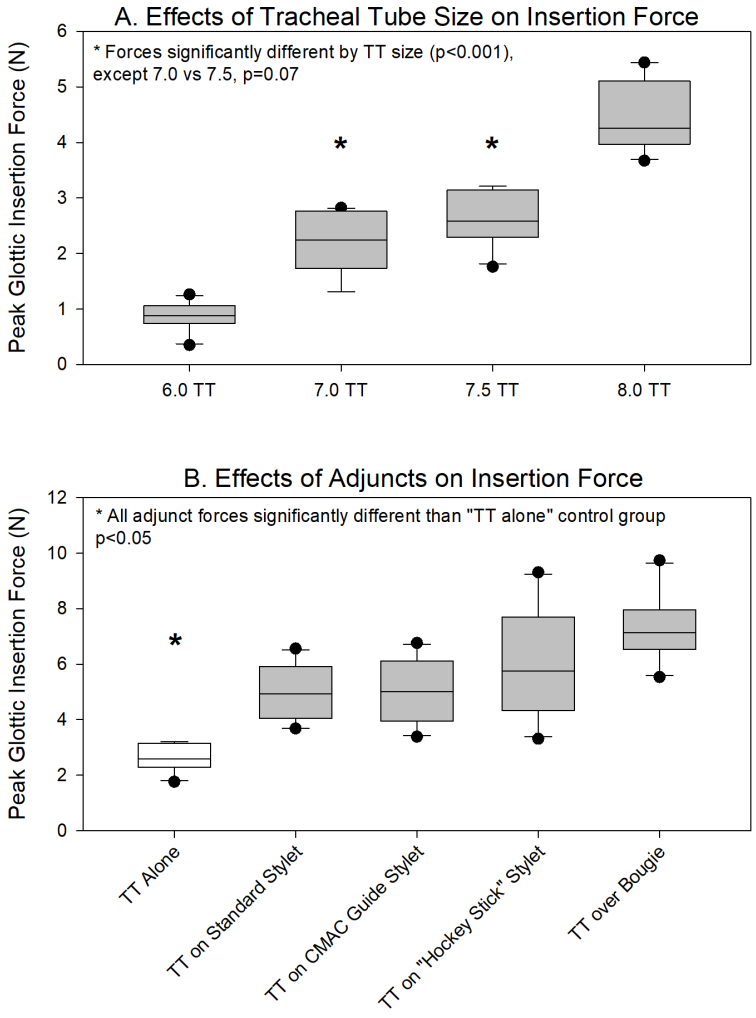

Figure 1

Severe oropharyngeal pain due to uvular necrosis following elective surgery: a patient–medical trainee case report highlighting the role of topical lidocaine

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197

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INTRODUCTION

Uvular necrosis is a rare and underreported post-operative complication, estimated to have an incidence of 0.3% and mostly being reported in young male patients undergoing endotracheal tube (ETT) intubation.1 The ischemic uvular injury results in severe pain 2-3 days post-insult. Cases reported in the literature include injuries to the uvula due to oropharyngeal manipulation, including ETT intubation, laryngeal mask placement, oral-pharyngeal suction, or the insertion of other medical devices (e.g., bronchoscopy, transesophageal echocardiography probe). Uvular necrosis presents with diagnostic and management challenges.

This case presents the unique dual perspective of both patient and medical trainee, which provides a detailed description of the clinical course, management challenges, and recovery following uvular necrosis after an elective septo-turbinoplasty. Patient consent was obtained, and Institutional Research Ethic Board approval was waived.

CASE PRESENTATION

A 24-year-old male (75 kg) underwent septoplasty and bilateral inferior turbinoplasty for allergic chronic rhinosinusitis. Past medical history included dust mite allergies treated with daily cetirizine, intranasal ciclesonide, and saline irrigation, as well as inhaled budesonide/formoterol and gastroesophageal reflux disease. General anesthesia was administered with uncomplicated orotracheal intubation (7.5 ETT, Macintosh 3 blade). The procedure was uneventful with minimal blood loss.

Immediately postoperatively (POD 0), the patient reported mild throat discomfort (VAS 2/10), managed conservatively with acetaminophen, saltwater rinses, cold fluids, and use of a face mask to reduce oropharyngeal dryness. By POD 1, throat pain worsened to 6/10,

exacerbated by mouth breathing and sleep disruption. Self-examination revealed a swollen, discolored uvula with necrotic changes involving the inferior third.

On POD 2, pain escalated to severe intensity (8/10), described as constant, dull, and burning, diffusely involving the throat and worse than a prior Colles fracture. Pain was aggravated by swallowing, eating, and oral dryness, with minimal relief from acetaminophen q6h. By POD 3, necrotic uvular tissue had spontaneously sloughed, and the patient was assessed in otolaryngology clinic, where uvular necrosis was confirmed. Oral 1% lidocaine suspension was prescribed, providing significant but short-lived relief (60–90 minutes), necessitating frequent use. Between PODs 4–5, severe pain recurred when lidocaine effects wore off. From POD 6 onward, symptoms gradually improved, with decreasing lidocaine requirements. By PODs 9–10, analgesic needs were minimal, and recovery was otherwise uncomplicated.

This case illustrates delayed-onset uvular necrosis following airway instrumentation, associated with severe, disproportionate postoperative pain and a prolonged but self-limited recovery.

CONCLUSION

Uvular necrosis is a rare but clinically significant anesthetic-related complication characterized by delayed onset, severe disproportionate oropharyngeal pain, and prolonged recovery. Atypical post-operative throat pain with referred otalgia should prompt consideration of uvular necrosis, which is readily diagnosed by oropharyngeal inspection. In this case, topical oral lidocaine 1% provided the most effective symptomatic relief when systemic analgesics were ineffective, highlighting its central role in management, with counseling regarding safe dosing. The likely iatrogenic etiology implicates modifiable factors such as ETT positioning and suction technique. Improved awareness, documentation, preventive strategies, early recognition and targeted topical therapy, may reduce morbidity and improve patient experience.

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Trachlight 2 prototype vs. CMAC-Macintosh laryngoscope for the tracheal intubation of cadavers with a simulated upper gastrointestinal bleed model

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143

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INTRODUCTION

Despite routine use, tracheal intubation under direct laryngoscopy can be difficult or impossible in 1–3% of general surgical patients and in 0.05–3.5% of those undergoing obstetric anesthesia[1]. Video-assisted laryngoscopy provides an indirect video view of the glottis, reducing the need for direct line-of-sight laryngoscopic intubation. However, the effectiveness of video-laryngoscopy in contaminated airways has long been a concern, as blood and secretions can obscure the camera lens and impair glottic visualization.[2] According to the ASA Difficult Airway Guidelines,[3] lightwand remains to play an important role as an alternative intubation technique when visualization of the glottis becomes difficult. In this study, we evaluated the performance of a novel lightwand prototype Trachlight™ 2 (LW) with the C-MAC® Macintosh video-laryngoscope (CM) using a cadaveric model simulating active upper gastrointestinal (GI) bleed.

METHODS

Following REB approval, 8 staff anesthesiologists were recruited and consented to perform 4 intubations with each device (LW and CM) on 4 embalmed 'clinical grade' human cadavers with a simulated upper GI bleed model with a blood flow rate of more than 420 $mL \cdot min^{-1}$. All participants were experienced users of the CM, but not the LW. Participants were randomly assigned to a starting device and cadaver. Each intubation was recorded, and tube placement was confirmed. Recordings were sent to an independent investigator, who determined time to intubation (TTI), number of attempts, success rate of each device, participants' comments, and optimization maneuvers used. Following each intubation, participants rated the intubation experience based on the degree of difficulty using a Visual

Analogue Scale (VAS). After all intubation attempts were complete, participants were asked to choose their preferred device for this simulated bloody airway. The Wilcoxon Signed-Rank test and McNemar's test were used for analysis where appropriate.

RESULTS

Sixty-four intubations (32 per device) were performed by 8 experienced anesthesiologists (*Mean* = 22.5 years of experience; *SD* = 11.2 years). Primary outcome analysis revealed significantly shorter TTIs for LW (*Median* = 21.45s for LW vs *Median* = 39.15s for CM [p = .0015]). Secondary outcomes showed significantly lower ratings of difficulty when using the LW (*Median* = 2.95 for LW vs *Median* = 7.30 for CM [p = .00027]). No significant differences were observed in the number of intubation attempts between devices (p = .33) or the success rate of either device (p = .56). Exploratory findings further revealed that majority of participants (62.5%) would prefer to use the LW over the CM for this upper GI bleed model.

DISCUSSION

Preliminary data analysis showed that the LW had significantly shorter intubation time and lower ratings of perceived difficulty by experienced anesthesiologists. Moreover, there were no significant differences in success rate or intubation attempts between the two devices. While further evidence is needed to confirm the clinical utility of this device, our findings suggest that the LW has potential in the management of difficult soiled airways. In addition, the LW's reusable and low-cost design can provide alternative methods of intubation in resource-limited settings.

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