

Trachway video intubating stylet allows for optimization of electromyographic endotracheal tube placement for monitored thyroidectomy

Pi-Ying Chang¹, Pin-Yang Hu², Yi-Chu Lin^{3,4}, Hsiu-Ya Chen^{2,5}, Feng-Yu Chiang^{3,4}, Che-Wei Wu^{3,4}, Gianlorenzo Dionigi⁶, I-Cheng Lu^{2,7}

¹Department of Anesthesiology, Kaohsiung Municipal Ta-Tung Hospital, Kaohsiung, Taiwan; ²Department of Anesthesiology, Kaohsiung Medical University Hospital, Kaohsiung, Taiwan; ³Department of Otorhinolaryngology—Head and Neck Surgery, Kaohsiung Medical University Hospital, Kaohsiung, Taiwan; ⁴Department of Otorhinolaryngology—Head and Neck Surgery, Faculty of Medicine, College of Medicine, Kaohsiung Medical University, Kaohsiung, Taiwan; ⁵Department of Nursing, Kaohsiung Medical University Hospital, Kaohsiung, Taiwan; ⁶Division for Endocrine Surgery, Department of Human Pathology in Adulthood and Childhood “G. Barresi”, University Hospital—Policlinico “G. Martino”, University of Messina, Messina, Italy; ⁷Department of Anesthesiology, Faculty of Medicine, Kaohsiung Medical University, Kaohsiung, Taiwan

Contributions: (I) Conception and design: PY Chang, CW Wu, G Dionigi; (II) Administrative support: FY Chiang, IC Lu; (III) Provision of study materials or patients: PY Hu, YC Lin; (IV) Collection and assembly of data: HY Chen; (V) Data analysis and interpretation: PY Chang, IC Lu; (VI) Manuscript writing: All authors; (VII) Final approval of manuscript: All authors.

Correspondence to: I-Cheng Lu, MD. Department of Anesthesiology, Kaohsiung Medical University Hospital, No.100, Tzyou 1st Road, Kaohsiung City 807, Taiwan. Email: u9251112@gmail.com.

Background: Endotracheal tube-based surface electrodes are now commonly applied to measure evoked electromyographic (EMG) response of the vocal cord during monitored thyroidectomy. The aim of the study was to determine the incidence of difficult intubation and to assess the effectiveness of using video-assisted intubating stylet (Trachway) for EMG tube placement in patients undergoing monitored thyroidectomy.

Methods: Medical records were collected from consecutive patients undergoing thyroid surgery before and after implementation of the protocol. A total of 748 patients intubated with EMG tube for monitored thyroidectomy by the same team were enrolled in this study. Patient allocation was based on intubation technique either conventional direct laryngoscopy (n=336) or Trachway (n=412). The intubation difficulty was assessed and analyzed.

Results: The overall incidence of difficult intubation was 4.4%. Incidence of difficult intubation was significantly lower in patients with the Trachway procedure (2.7%) than direct laryngoscopy (6.5%, $P=0.01$). The incidence of “unable to intubate” (>3 attempts, or change airway device or anesthesiologist) also significantly reduced from 2.3% to 0.5% after introduction of the Trachway intubating stylet ($P=0.02$).

Conclusions: We conclude that the incidence of difficult intubation was significantly lower with Trachway than direct laryngoscopy. The Trachway video-intubating stylet is useful and helpful to reduce EMG tube intubation difficulty for monitored thyroidectomy.

Keywords: Difficult intubation; thyroid surgery; neuromonitoring; Trachway video intubating stylet; tracheal intubation

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Introduction

Intraoperative neuromonitoring of the recurrent laryngeal nerves has obtained growing popularity during thyroid surgery (1-4). The proper placement of the electromyographic (EMG) endotracheal tube is the key point for successful recurrent laryngeal nerve monitoring (5-7). Thyroid surgery may be considered as a risk factor for difficult intubation due to large goiter or cancer. The reported incidence of difficult intubation in thyroid ranges from 5.3% to 24.6% higher than in the general population (8-10). If difficult intubation occurs while neuromonitoring is planned for thyroid surgery, an alternative intubation technique might be chosen at the expense of neuromonitoring. For example, airway management without EMG endotracheal tube (such as laryngeal mask airway or nasal intubation) could not be feasible for neuromonitoring. In recent decades, some novel airway management devices such as video-assisted laryngoscope or intubating stylet have been developed to improve the success rate of tracheal intubation and reduce intubation difficulty (11-13).

The Trachway video intubating stylet (Biotronic Instrument Enterprise Ltd., Tai Chung, Taiwan) is a recently developed video-assisted rigid intubating stylet with a distal camera screen. Another proximal light source is mounted on the distal end of the stylet, which has an upward curvature. The Trachway has been reported to be effective in both easy and difficult intubation conditions in both oral and nasal routes (14-16). It was introduced into our neuromonitoring anesthesia protocol to facilitate EMG endotracheal tube placement from 2011. The purpose of this study was to determine the incidence of difficult intubation in patients undergoing thyroid surgery with a neuromonitoring system. Furthermore, we aimed to evaluate the effectiveness of a novel intubation tool (Trachway) in EMG endotracheal tube placement.

Methods

The study was approved by the Institutional Review Board of Kaohsiung Medical University Hospital (KMUH-IRB-E-20150023). Medical records were collected from 748 patients undergoing thyroid surgery with neuromonitoring system between April 2006 and October 2015 in a tertiary medical center. All of them were informed of the protocol to use the neuromonitoring system to aid in the identification and assessment of the recurrent laryngeal nerves function during surgical procedure. All patients were treated by the same surgeon (F.-Y.C) and an anesthesia team that included two experienced anesthesiologists and one nurse anesthetist

experienced in anesthetic care.

From the anesthesia and neuromonitoring records, an experienced nurse anesthetist gathered the data as follows: demographics, ASA physical status, intubation device (laryngoscope, Trachway or fiberoptic bronchoscope), surgical procedure and pathologic reports. Patient allocation was based on intubation technique either direct laryngoscopy (n=336) or Trachway (n=412). The standard anesthesia induction protocol included intravenous anesthetics and a single bolus of neuromuscular blocking agent (NMBA). From April 2006 to December 2010, the placement of EMG endotracheal tube (NIM® Standard EMG Tube, Medtronic, Jacksonville, FL, USA) was routinely done by direct laryngoscopy. The tube was placed with the middle of the exposed electrodes in contact with the true vocal cords under direct visualization. From January 2011 to October 2015, the Trachway video intubating stylet (Trachway) was routinely applied to perform tracheal intubation (*Figure 1*). All EMG tube positions were further rechecked by fiberscope after successful tracheal intubation.

In the laryngoscope group, difficult intubation was defined as poor glottic view under direct laryngoscopy namely Cormark grade III/IV (17,18). In the Trachway group, difficult intubation was defined when Trachway required extensive manipulated in all directions to identify the vocal cords. Among difficult intubation patients, unable to intubate (extreme difficulty) was defined if there was more than three intubation attempts, or a change in airway device used or a change in person to perform intubation. The classification of tracheal intubation difficulty was assessed by anesthesiologists who performed the anesthesia induction and tracheal intubation. The main outcome was assessed by incidence of difficult intubation. The first attempt success rate and further analysis of difficult intubation were also reported.

All data were expressed as mean (SD). Statistical analysis of continuous variables between groups was compared using the 2-samplet *t*-test. Categorical nominal variables were analyzed with the chi-square test or the Fisher exact test. All statistical tests were 2-tailed, and a probability of $P < 0.05$ was considered statistically significant.

Results

Patient characteristics of both groups are compared in *Table 1*. Physical status, types of surgery and disease did not differ significantly between the two groups. The overall incidence of difficult intubation was 4.4% in patients undergoing EMG tube placement for thyroid surgery. The Trachway group showed lower incidence of difficult



Figure 1 The Trachway intubating stylet loaded with an EMG endotracheal tube. The rigid stylet was lengthened up to a 34-cm fit for the EMG tube.

Table 1 Patient characteristics between groups

Characteristics	Laryngoscope (N=336)	Trachway (N=412)	P
Age (y/o)	50.4±14.5	50.8±13.2	0.69
Gender (n)	54/282	74/338	0.49
Male/female			
BMI (kg/m ²)	24.4±3.5	25.1±4.1	0.23
Surgery (n)			0.93
Total	238 (70.8%)	293	
Thyroidectomy		(71.1%)	
Total	98 (29.2%)	119	
Lobectomy		(28.9%)	
Disease			0.12
Benign goiter	242 (72%)	275	
		(66.7%)	
Cancer	94 (28%)	137	
		(33.3%)	

intubation (2.7% *vs.* 6.5%, $P=0.014$) and higher success rate of first intubation attempt (99.0% *vs.* 96.4%, $P=0.01$) when compared to the Laryngoscope group (*Table 2*).

The tracheal intubation was extremely difficult (unable to intubate) in 36% (8/22) and 18% (2/11) of patients within difficult intubation population in the Laryngoscope and the Trachway group respectively ($P=0.02$). Overall, the incidence of unable to intubate was significantly reduced from 2.3% to 0.5% after introduction of the Trachway intubating stylet ($P=0.02$). All 10 patients underwent successful tracheal intubation with an EMG endotracheal tube by alternative methods. Two of them in the Laryngoscope group were

Table 2 Analysis of difficult intubation outcome between groups

Intubation conditions	Laryngoscope (N=336)	Trachway (N=412)	P
First attempt success	324 (96.4%)	408 (99.0%)	0.01
Airway classification			0.01
Non-difficult intubation	314 (93.5%)	401 (97.3%)	
Difficult intubation	22 (6.5%)	11 (2.7%)	
Unable to intubate (CI)	8 (2.3%)	2 (0.5%)	0.02
Alternative method for CI	Fiberoptic bronchoscopy (n=3); lightwand (n=1); trachway (n=2); change person (n=2)	Laryngoscope (n=2)	

intubated via the nasal route with fiberoptic bronchoscopy due to failed attempts via the oral route.

Discussions

Failure of tracheal intubation is related to catastrophic complications followed by hypoxia and hypoventilation. In operation rooms, the difficulty to intubate occurs in 1.15–3.8% of population (19). The enlargement of the thyroid gland or cancerous goiter might be associated with tracheal deviation or compression and result in higher incidence of difficult intubation. This study demonstrated that overall incidence of difficult EMG endotracheal tube placement for thyroid surgery was 4.4%, similar to 5.3–5.5% reported by Bouaggad *et al.* and Kalezić *et al.* respectively (8,10) and lower than most reports, that ranged from 8.5–11.1% (9,20). According to the literature, the reported difficult intubation was the outcome of direct laryngoscopy with Macintosh blade. In this study, difficult intubation occurred in 6.5% of patients when direct laryngoscopy was used as the routine technique.

The results of this study depicted the significantly reduced difficult intubation incidence from 6.5% to 2.7% after the introduction of the Trachway as first-line airway device. Since the clinical application of intubating stylet and video laryngoscopy, these airway devices have improved the success rate, and reduced the difficulty and time of tracheal intubation than conventional direct laryngoscopy technique

(13-15,21). In a prospective manikin study of new users, where the Trachway was used in both normal and difficult intubation scenarios (11), the intubation success rates for normal and difficult airways were as high as 97.2% and 95.4% respectively. The times for successful orotracheal intubation were 11.2 ± 6.5 vs. 17.1 ± 11.1 , which is acceptable in clinical settings. Another case series by anesthesiology expertise showed the video laryngoscope (i.e., Glidescope) facilitated optimal position of the EMG endotracheal tube between the vocal cords by visualization on the video screen (22). Other video laryngoscopy such as the McGrath scope or the Pentax airway scope might also allow EMG endotracheal tube placement under real-time video screen confirmation and are deserving of further clinical trials.

The Trachway intubating stylet was chosen as the standard device to place the EMG endotracheal tube for several reasons. Firstly, the Trachway provided better visualization of vocal cords on the video screen compared to other video-assisted airway devices. Then the optimal tube position could be confirmed by fiberoptic examination routinely in our setting. Secondly, the technique without a blade could reduce noxious stimulation during tracheal intubation. Moreover, its rigid stylet within a 7.0 EMG endotracheal tube (outer diameter less than 1 cm) allowed airway manipulation even in limited mouth opening scenarios. Finally, the EMG endotracheal tube was about 2 cm longer than a regular endotracheal tube. The manufactured designed lengthened stylet fit through this specific tube. A drawback of the Trachway was its limited visualization field, which is easily affected by secretion or blood during intubation (11). We found that routinely performed suction before insertion of the Trachway could solve this problem in most situations.

Difficult tracheal intubation is less frequent after the introduction of novel airway devices such as the video-laryngoscope (Glidescope, McGrath, Pentax Airway Scope) and video intubating stylet (Trachway). Limited literature exists concerning airway management when an EMG endotracheal tube failed to intubate. According to difficult airway algorithms, keeping oxygenation and ventilation is the first priority. There are two potential challenges of tracheal intubation for patients undergoing thyroid surgery with neuromonitoring. Firstly, enlargement of the thyroid gland or cancerous goiter might be associated with tracheal deviation or compression and result in difficult intubation. Secondly, both successful intubation and proper EMG endotracheal tube should be achieved for a successful neuromonitoring system.

In two cases with large thyroid cancer in the Laryngoscope group, oral tracheal intubation was impossible by laryngoscopy

at initial attempts. A classic laryngeal mask airway could provide adequate oxygenation and ventilation but not is suitable for surgery. Since an EMG endotracheal tube was wider in diameter than a standard endotracheal tube, oral tracheal intubation was chosen to avoid potential nasal trauma. Unfortunately, an EMG endotracheal tube placement via the oral route under fiberoptic bronchoscopic guidance failed again due to oral secretion and poor scope orientation. Fiberoptic nasal intubation could be done successfully with a regular nasal tracheal tube, but could not meet the demand of neuromonitoring. Therefore, these two cases underwent fiberoptic nasal intubation with EMG endotracheal tube after sufficient nasal packing with vasoconstrictor.

One limitation of this study is the retrospective design. Therefore, the comparison of two devices was not blinded and randomized. The degree of neuromuscular blockade at tracheal intubation was not identical for each group. Our clinical practice is to use a single bolus of NMBA and avoid its maintenance dose. The NMBA might be rocuronium or atracurium and dosage ranged from 1 to 2 effective doses. Definition of difficult intubation differs between studies (9,10,13) and some bias of difficult intubation incidence might exist. The intubation difficulty based on evaluation of intubating condition was documented routinely in our practice (23).

Conclusions

In conclusion, the introduction of the Trachway intubating stylet could reduce the incidence of difficult intubation in patients undergoing thyroid surgery with neuromonitoring. The routine use of a video-assisted airway device is highly suggested for EMG endotracheal intubation. An alternative device should be available for difficult intubation, even though it is rare.

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Footnote

Conflicts of Interest: The authors have no conflicts of interest to declare.

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