Original Article

Intubating conditions with articulating vs. intubating stylet during video laryngoscope intubation in anticipated difficult airway patients

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ABSTRACT

Objective: To evaluate the intubation conditions and length of intubation duration of a conventional stylet and an articulating stylet during video laryngoscopy in anticipated difficult intubations
Design: A prospective randomized comparative study
Setting: University of Health Sciences Diskapi Yildirim Beyazit Training and Research Hospital, Ankara, Turkey
Subjects: Forty-nine patients aged 18-65 years assigned for elective surgery with anticipated difficult intubation were randomized to intubation with either an articulating stylet (Group AS, n=25) or intubating stylet (Group IS, n=24) during videolaryngoscopy.
Interventions: Standard anesthesia induction was performed and muscle relaxation was facilitated with rocuronuim 0.6 mg/kg after assessment of mask ventilation. In all patients, the same video laryngoscope and angulated blade was used. Anticipated difficult airway scores, thyromental distances (cm), maximum mouth opening, existence of buckteeth, cervical spine range of motion, Mallampati scores, time to intubation (TTI) and number of attempts were recorded. Mean arterial pressure, heart rate and oxygen saturation were recorded before anesthesia induction (T0), one minute after induction (T1), before attempt of intubation (T2) and one minute after intubation (T3).
Main outcome measures: Success rate and duration of intubation during videolaryngoscopy
Results: The mean TTI was significantly shorter in the AS group than in the IS group (51.8±26.2 s vs 112.8±84.7 s) (*P*=.001). Successful intubation performance (percent) in the first attempt was 60% in AS group and 16% in IS group (*P*=.032).
Conclusion: During intubation with highly angulated videolaryngoscopes in patients with anticipated difficult intubation, the use of articulating stylets which provide this angulation simultaneously might facililate intubation.

KEY WORDS: articulating stylet, difficult airway, tracheal intubation, videolaryngoscope

INTRODUCTION

Video laryngoscopes (VLs) provide a better view of laryngeal structures when compared with conventional direct laryngoscopy. However, although they provide a better view, tracheal intubation can still be difficult because the pharyngo-laryngo-tracheal axis might not be in alignment.

The use of blades with a greater vertical angle might provide a better glottic view, but their use can also make intubation more difficult; having a good view of the glottis does not ensure an easy intubation[1,2]. To direct the endotracheal tube (ETT) to the target, many anesthesiologists prefer to use stylets. Without stylets, intubation often takes longer, requires repeated attempts, and in some cases, can be unsuccessful all together[3]. As such, the use of preformed vertically angled stylets with a suitable blade angle has been suggested[4].

Articulating stylets are loaded in the tracheal tube before intubation and enable angling during intubation. This study investigates the success rate and duration of intubation when using a conventional stylet versus that of an articulating stylet during videolaryngoscopy in anticipated difficult intubations.

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SUBJECTS AND METHODS

This prospective, randomized, single-blind study was conducted after ethics committee approval was obtained from the ethical committee of the Ministry of Health Diskapi Yildirim Beyazit Training and Research Hospital (Ethical Committee 27/28; approved on 22/03/2016) and written informed consent was obtained from patients. This trial was registered at www.clinicaltrials.gov (NCT02805569).

Included in this study were eligible patients between the ages of 18 and 65 who had American Society of Anesthesiologists scores of 1 or 2 and who were assigned for elective surgery with anticipated difficult intubation due to anticipated difficult airway scores greater than 6[5] (Table 1). Patients who had undergone oropharyngeal surgery before, had an immobilized cervical spine, required rapid sequence induction, required emergency surgery, had a tendency to bleed, required awake fiberoptic intubation or were pregnant were excluded from the study. Patients were randomly assigned to either the articulating stylet (AS) group or to the intubating stylet (IS) group using computer-generated random numbers.

Table 1: Anticipated Difficult Airway (ADA) Score*

Airway Factors	0	1	2
Mallampati classification	Class I	Class 2	Class III-IV
Tyromental distance (cm)	>6.5	6-6.5	<6
Head and neck movement (degrees)	>90	90	<90
Body mass index (kg/m^2)	<25	≥25	NA
Buck teeth	No	Mild	Severe
Inter-incisor gap(cm)	>5	4-5	<4

*Easy airway strata: ADA score ≤ 6; difficult airway strata >6; NA not applicable[5]

In the preoperative assessment, each patient's anticipated difficult airway score, thyromental distance (cm), maximum mouth opening (cm), existence of buckteeth, cervical spine range of motion and Mallampati score were recorded[6]. Patients did not receive any premedication and they were monitored using an electrocardiogram, pulse oximetry (SpO_2) and a non-invasive blood pressure monitor in the operating room. All patients received 100% oxygen at a rate of 5L/min with a closed breathing circuit until their end-tidal oxygen reached over 90.

Anesthesia induction was managed using 1 mcg/kg fentanyl and 2 mg/kg propofol, and muscle relaxation was facilitated using 0.6 mg/kg rocuronium after assessing mask ventilation. For all patients, the same type of VL and blade (C-Mac Storz D-Blade®, Karl Storz Endoscopy, Tuttlingen, Germany) were used. Male patients received 7.5 to 8 cuffed ETTs, while female patients received 6.5 to 7.

After lubrication, the stylet (Truphatec® International Ltd., Netanya, Israel) was loaded with the suitable ETT for the patients in the AS group (Figure 1). When glottis view was achieved, the ETT loaded with an AS shaped in the appropriate manner advanced through the glottis. While the AS was being removed after the intubation, the AS was returned to its neutral position in order to facilitate the withdrawal of the ETT. For the patients in the IS group, the stylet (Work® Lotus Global Co. Ltd., London, UK) was loaded with the adequate ETT and given the same angle as the blade (*i.e.*, the ETT was shaped according to the curvature of the VL blade).

The anesthesiologist performing the videolaryngoscopy advanced the stylet loaded with the ETT only if the laryngeal inlet view of glottic opening score percentage was above 40%. The intubations completed in this study were performed by three anesthesiologists, each of whom had more than 10 years of experience and completed at least 50 successful intubations using a VL.

Primary outcome monitored in this study was the time to intubation (TTI), which is defined as the time from inserting the blade between the patient's incisors to viewing the first end-tidal carbon dioxide tracing on the capnograph. The stopwatch was stopped if the intubation was unsuccessful during the first attempt. In other attempts, the stopwatch was started again from the same point. Only successful tracheal intubation times were counted in the analysis. An attempt was still counted if the VL or ETT needed to be removed for reoxygenation or for the reshaping of the stylet. During each intubation attempt, another experienced anesthesiologist, as well as difficult airway equipment, was kept at the ready in case of "can't intubate, can't oxygenate" situations, according to Difficult Airway Society guidelines[7].

When intubation duration exceeded 2 minutes or peripheral SpO_2 decreased below 95%, the attempt was accepted as a failed attempt and mask ventilation was used instead. A maximum of three attempts was allowed for intubation, with anesthesia being discontinued if a fourth attempt using a different intubation method also failed.

The intubation performance of the stylets was classified as "easy", "medium" or "difficult". Blood on the VL blade was reported as indicating oropharyngeal bleeding, and mucosal bleeding after intubation was recorded as "none", "trace", "moderate" or "severe".

Mean arterial pressure, heart rate and SpO_2 were recorded before anesthesia induction (T0), one minute after induction (T1), before intubation attempt (T2) and one minute after intubation (T3).

Patients were extubated after the reversal of the neuromuscular block and after having ensured

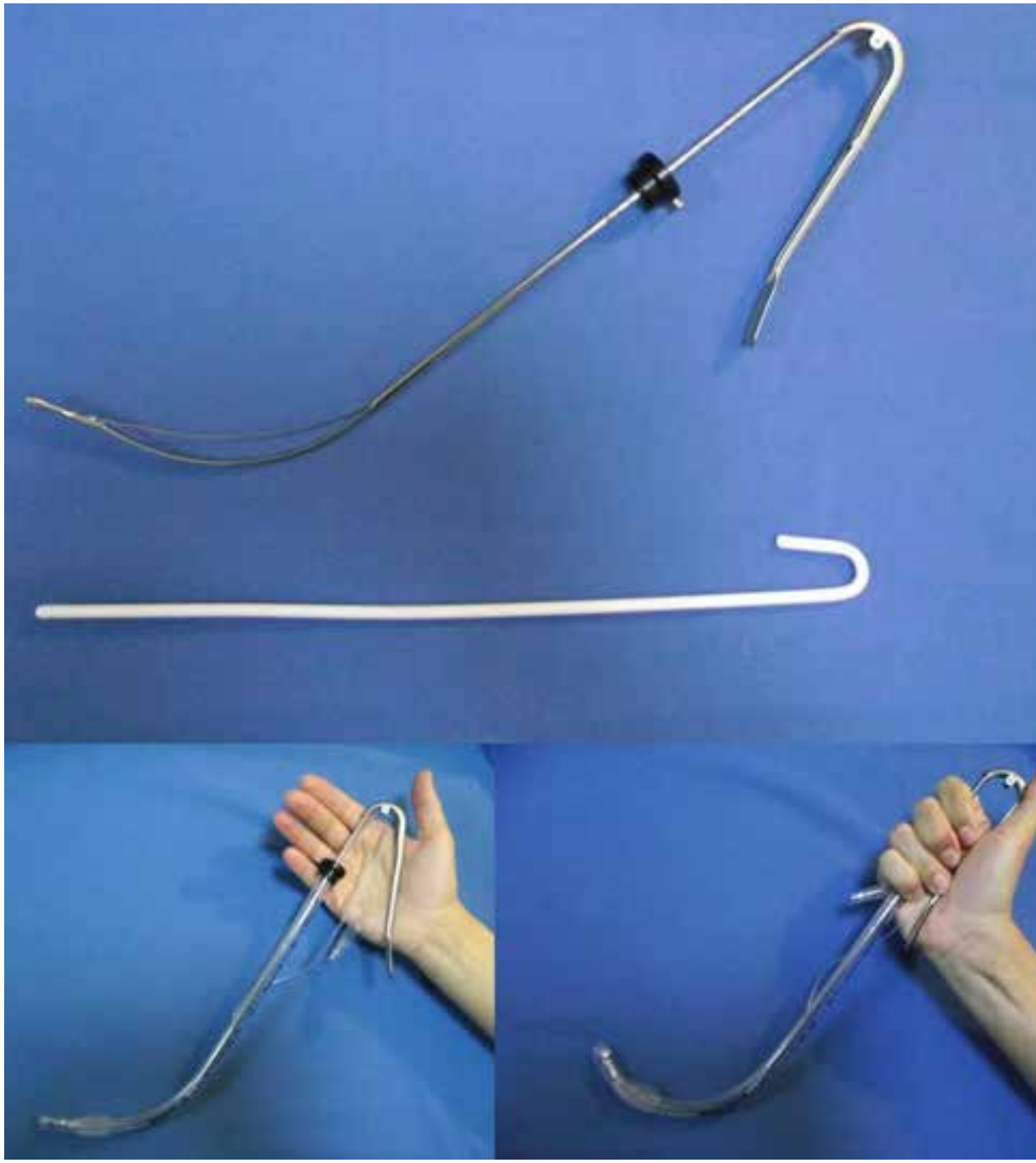

Fig 1: Truflex® articulating stylet and the Work® intubating stylet

a sufficient tidal volume and that the patient is responsive to verbal stimuli, by administering 4 mg/kg sugammadex intravenously, taking precautions for difficult reintubation (*e.g.*, changing catheters). Complications such as bleeding, laryngospasm, bronchospasm and desaturation were recorded.

Group size was calculated according to the results of a pilot study (AS group: n=4, 50.88±28 s; IS group: n=4, 105.27±85 s TTI), on the basis of detecting a 50% decrease in the TTI in the AS group when compared with the IS group. A minimum of 24 patients was required in each group (α=0.05, power 80%). In this study, 26 patients were included in each group because of dropout.

Statistical analysis was performed using SPSS 15.0 software (SPSS Inc., Chicago, Illinois, USA). Data

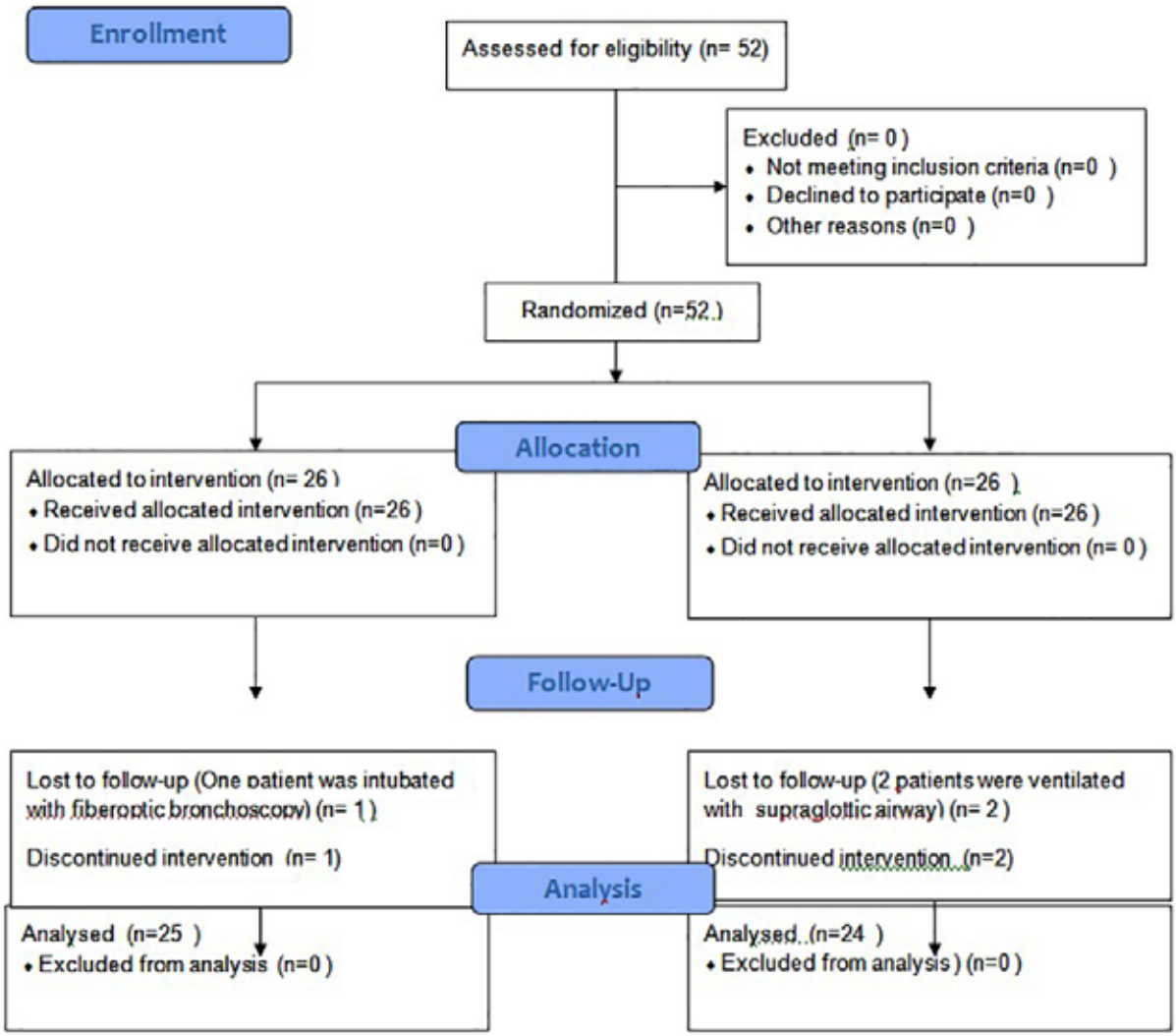

Fig 2: Consort diagram (AS, Articulating Stylet; IS, Intubation Stylet)

are presented as mean±SD, percentages, medians or ranges. All data were tested for normal distribution using the Kolmogorov–Smirnov test. Statistical analysis was performed using the t-test for continuous variables, the Mann–Whitney U test for nonparametric variables and the x^2 or Fisher's Exact test for categorical variables. A *P*-value <.05 was considered statistically significant. A repeated measure analysis of variance test was performed for the analyses of hemodynamic variables.

RESULTS

Of the 52 patients considered in this study, 49 patients participated (Figure 2). One patient from the AS group was intubated using fiberoptic bronchoscopy and two patients from the IS group were ventilated

Table 2: Demographic details of the patients

Demographic details	Group AS (n=25)	Group IS (n=24)	*P*
Age (years) (mean±SD)	46.8±10.3	49.0±13.1	.627
Sex (Female/Male)(n)	12/13	8/16	.296
BMI (kg/m^2)	26.5±4.5	28.4±4.45	.139
Mallampati score (1/2/3/4) (n)	0/3/17/5	0/0/19/5	.213
Head and neck movement degrees (>90/90/<90) (n)	17/6/2	9/10/5	.09
Tyromental distance (cm)	6.1±0.63	6.2±0.69	.551
Inter-incisor gap (cm)	4.7±0.6	4.9±0.7	.455
Buck teeth (No/Mild/Severe) (n)	19/6/0	19/5/0	.791
ADA score (7/8/9/10) (n)	4/10/10/1	4/9/10/1	.998

ADA: anticipated difficult airway
Data are presented as mean ± SD or number.*P <.05 significant differences between the groups.

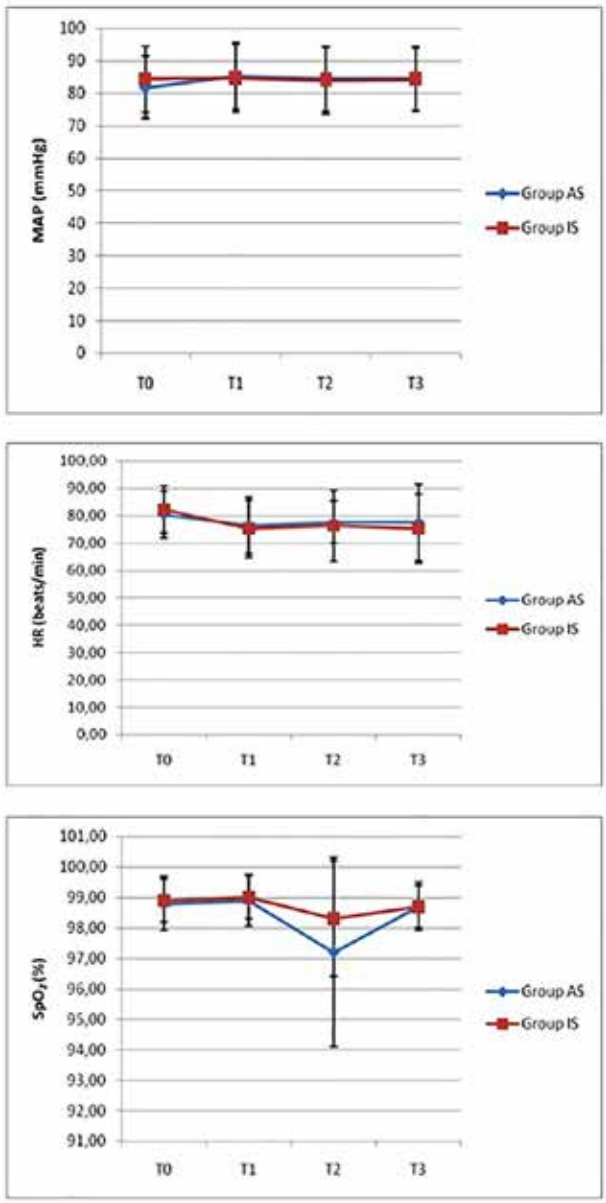

Fig 3: Hemodynamic and SpO_2 changes during anesthesia induction. **P* <.05 compared between the Group AS and Group IS. Data are expressed as mean±SD.

using supraglottic airway devices; as such, these three patients were excluded from the study.

The demographic details of the patients were similar (*P* >.05, Table 2). The two groups in the analysis were homogeneous, with no significant differences among the participants. The mean arterial pressure, heart rate and SpO_2 values of the patients were similar at all assessment periods (*P* >.05, Figure 3).

The mean TTI was significantly shorter in the AS group than it was in the IS group (51.8±26.2 s vs. 112.8±84.7 s, *P*=.001, Table 3). The number of attempts for successful intubation was also significantly lower in AS group than it was in the IS group, with the successful intubation rate upon first attempt in the AS group being 60% and in the IS group 16% (*P*=.032, Table 3). The percentage of glottic opening, bleeding and ease of intubation scores were similar in both groups (*P* >.05, Table 3).

Table 3: Intubation profiles

Intubation profiles	Group AS (n=25)	Group IS (n=24)	*P*
POGO (%)(mean±SD)	61.4±10.3	51.8±26.2	.185
TTI (s) (mean±SD)	51.8±26.2	112.8±84.7	.001*
Number of attempt (1/2/3)(n)	15/9/1	4/14/6	.032*
Bleeding (none/trace/moderate/severe)	16/9/0/0	17/7/0/0	.610
Ease of intubation (easy/moderate/difficult)	11/6/8	5/11/8	.224

POGO: percentage of glottic opening; TTI: time to intubation
Data are presented as mean ± SD or number.**P* <.05 significant differences between the groups.

There were no complications related to intubation or extubation such as laryngospasm or bronchospasm in the perioperative period.

DISCUSSION

The results of this study indicate the rates of intubation success of ASs and ISs are comparable; however, ASs lead to 50% faster intubation and fewer intubation attempts during intubation with VLs.

Guidelines have been created for performing difficult intubations and the use of VLs features in these guidelines[8]. The C-Mac D-Blade is a significantly angled blade that was specially designed for difficult laryngoscopy[9]. This blade, with its increased slope, was designed for performing difficult indirect laryngoscopy in patients with a Cormack–Lehane grade of 3 or 4. However, even with the aid of the C-Mac D-Blade and even when the glottis is clearly in view, it can still be difficult to direct the ETT to the trachea[10].

An AS is a stylet for which the 3 cm distal part can be curved to an angle of 30 to 60 degrees with the aid of an operator. In other words, the AS permits the dynamic shaping of the curvature of the distal end of the premounted ETT based on the angle required during videolaryngoscopy[5]. Hence, in addition to facilitating intubation, it can increase the operator's comfort, as this study determined that comfort of the anesthesiologist was better in the AS group than it was in the IS group.

In a mannequin study, Mc Elwain *et al* pointed out that it is not necessary to use a stylet in cases of easy laryngoscopy but that, in cases of difficult laryngoscopy, the angulation of the distal part of the ETT can optimize intubation[11]. It was also reported

that, in a study that used five different stylets—including the C-Mac D-Blade—on mannequins simulating difficult laryngoscopy, stylet use was necessary, but there was a little difference among the stylets in terms of intubation duration.

Some previous studies have recommended using ASs with specially angled blades before intubation, such as C-Mac D-Blades[12]. However, anterior commissure produces resistance, which impedes the advance of the ETT to the trachea[13]. Therefore, shaping the stylet according to the blade during the intubation attempt and reshaping it during the advance to the trachea may facilitate intubation.

The intubation time was found to be shorter in the AS group in this study (51.8±26.2 s vs. 112.8±84.7 s). This result may be due to angulation of the preloaded ETT as well as the anesthesiologist's ability to manipulate this angle when needed. In a mannequin study conducted by Batuwitage, which compared TTI in difficult settings using a tube that was distally loaded at the tip and a proximally loaded bougie tube with intubating stylets, the TTIs were 16.5 seconds (14-21 seconds) and 16.5 seconds (15-20.5 seconds), respectively[14]. In a study by Lee, however, routine videolaryngoscopy was used for intubation and TTI was 29.3±6.4 s versus 32.5±9.4 s, with a 60°-angled IS versus a 90°-angled IS, respectively[13]. In the latter study, the mean TTI was longer than it was in the current study, which might be because all patients in the current study were candidates for difficult intubation.

The primary finding of this study is that the number of intubation attempts was lower in the AS group than it was in the IS group. This might be due to the need to withdraw the ETT to reshape the style in the IS group.

There are a few limitations in this study. First, as the patients were assessed as candidates for difficult intubation and videolaryngoscopic intubations are handled by a senior anesthesiologist, the intubation attempts might have been fewer and the intubation duration might have been shorter because of the high level of experience of those performing the intubation. Hence, another study could be conducted to examine the performance of these stylets in less experienced hands. Second, there may be reporting bias in this study, as it was not a double-blind study.

CONCLUSION

This study demonstrated that during intubation with highly angulated VLs in patients with anticipated difficult intubation, stylets must be set to an angle that is similar to that of the blade used. The use of ASs, which allow for this angulation to be performed, can therefore facilitate intubation.

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Author contribution

Derya Ozkan: design analysis and/or interpretation, manuscript writing; Burak Nalbant: data collection and/or processing; Ilkay Baran: data collection and/or processing, supervision; Murat Sayin: materials and literature search; Julide Ergil: resources; Asli Donmez: resources.

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