

## Equipment

# Difficult airway management: comparison of the Bullard laryngoscope with the video-optical intubation stylet

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**Purpose:** To evaluate, whether the video-optical intubation stylet (VOIS) was more successful for difficult tracheal intubation than the Bullard laryngoscope (BL).

**Methods:** An intubation mannequin head was modified so that, using a Macintosh blade size 3, only the epiglottis was visible at direct laryngoscopy, representing a grade III laryngoscopic view. Forty anesthesiologists attempted tracheal intubation using each technique. Tracheal intubation with the Bullard laryngoscope was performed using the attached non-malleable intubating stylet preloaded with an endotracheal tube. The video-optical intubation stylet inserted into an endotracheal tube was used with direct laryngoscopy. During conventional laryngoscopy, the video-view from the stylet tip allowed the tracheal tube to be guided behind the epiglottis into the trachea.

Ten attempts with each technique were performed by each anesthesiologist in randomized order. Intubation time, and failed intubation ( $> 60$  sec / esophageal intubation) were recorded. The operators assessed the degree of difficulty of each method using a Likert-scale.

**Results:** Mean intubation time ( $19.2 \pm 4.5$  sec for the BL and  $18.8 \pm 4.6$  sec for the VOIS) was almost the identical. The video-optical intubation stylet was associated with fewer failed intubations (8 vs 41;  $P < 0.005$ ) and had a lower degree of difficulty ( $1.7 \pm 0.65$  for the VOIS and  $2.6 \pm 0.74$  for the BL;  $P < 0.0001$ ). No correlation was found between the anesthesiologist's experience and mean intubation time, estimated degree of difficulty or number of unsuccessful intubation.

**Conclusion:** The video-optical intubation stylet was a more effective and simpler intubation device to facilitate difficult tracheal intubation than the Bullard laryngoscope.

**Objectif :** Évaluer si le stylet d'intubation vidéo-optique (SIVO) est plus approprié que le laryngoscope de Bullard (LB) dans les cas d'intubation difficile.

**Méthode :** Une tête de mannequin d'intubation a été modifiée de sorte qu'en utilisant une lame Macintosh 3 seule l'épiglotte était visible à la laryngoscopie directe, représentant une vue laryngoscopique de grade III. Quarante anesthésiologistes ont utilisé deux dispositifs d'intubation. L'intubation avec le LB a été réalisée en utilisant le stylet d'intubation rigide qui y est attaché et déjà muni d'un tube endotrachéal. Le stylet d'intubation vidéo-optique inséré dans un tube endotrachéal a été utilisé pour la laryngoscopie directe. Pendant la laryngoscopie traditionnelle, la vidéo-transmission provenant de la pointe du stylet a permis de guider le tube trachéal dans la trachée derrière l'épiglotte. Dix essais selon chacune des techniques ont été réalisés par chacun des anesthésiologistes en ordre aléatoire. On a noté le temps nécessaire à l'intubation et les échecs ( $> 60$  s / intubation oesophagienne). Les opérateurs ont évalué le degré de difficulté de chaque méthode selon l'échelle Likert.

**Résultats :** Le temps moyen nécessaire à l'intubation ( $19,2 \pm 4,5$  s pour le LB et  $18,8 \pm 4,6$  s pour le SIVO) a été sensiblement le même avec les deux appareils. Le SIVO a été associé à moins d'échecs d'intubation (41 vs 8;  $P < 0,005$ ) et à un plus bas degré de difficulté ( $1,7 \pm 0,65$  pour le SIVO et  $2,6 \pm 0,74$  pour le LB;  $P < 0,0001$ ). Aucune corrélation n'a été établie entre l'expérience de l'anesthésiologiste et le temps moyen nécessaire à l'intubation, le degré de difficulté estimé ou le nombre d'essais infructueux.

**Conclusion :** Le stylet d'intubation vidéo-optique s'est révélé un instrument d'intubation plus efficace et plus simple à utiliser que le laryngoscope de Bullard dans les cas d'intubation difficile.

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**I**NABILITY to intubate the trachea successfully is a leading cause of anesthetic morbidity and mortality.<sup>1,2</sup> No single factor reliably predicts these difficulties.<sup>3</sup> Consequently, many difficult intubations will not be recognized until after induction of anesthesia. Immediate tracheal intubation is necessary especially in patients at risk for gastric regurgitation or with limited cardio-pulmonary reserve and rapid, simple fibreoptic assistance may be needed.

The Bullard laryngoscope (BL) (Circon ACMI, Stamford, CT), is a rigid, fibreoptic intubating laryngoscope for indirect oral laryngoscopy, transmitting the view from the tip of the L-shaped blade to a proximal view finder.<sup>4</sup> It has been reported to be a valuable aid for the management of the predicted as well the unanticipated difficult tracheal intubation.<sup>5,6</sup>

The video-optical intubation stylet (VOIS) (VOLPI AG, Schlieren, Switzerland) is a new intubation device, especially designed for rapid management of the unexpected difficult intubation.<sup>7</sup> Inserted into an endotracheal tube (ETT), the VOIS transmits the view from the stylet tip onto a bedside monitor. During difficult direct laryngoscopy, this allows the anesthesiologist to guide the endotracheal tube into the trachea using the video-view from the stylet tip.<sup>7,8</sup>

The purpose of this study was to compare the ease and success of tracheal intubation facilitated by the video-optical intubation stylet or the Bullard laryngoscope in a model of difficult intubation.

## Methods

An intubation mannequin head (Intubation Trainer, Laerdal, Stavanger, Norway) was adjusted in a neutral position by drapes so that head extension was impossible, the tongue base was lifted cranially and mouth opening was reduced 30%. Using a Macintosh blade size 3, only the tip of the epiglottis was visible even at forced direct laryngoscopy, corresponding to a grade III view classified by Cormack and Lehane.<sup>9</sup>

Forty anesthesiologists of different years of experience and without experience with the intubation device, were asked to attempt tracheal intubation using each method:

### *Bullard laryngoscope using the non-malleable intubating stylet*

Before starting intubation an ETT I.D. 7.0 mm with cuff (RUESCHELIT<sup>TM</sup>, Willy Ruesch AG, Kernen, Germany) was loaded on the non-malleable intubation stylet attached to the BL. Tracheal intubation with the Bullard laryngoscope was performed as described and evaluated by Cooper *et al.*<sup>10</sup>

### *Video-optical intubation stylet inserted into an endotracheal tube*

A malleable video-optical intubation stylet (Volpi AG, Schlieren, Switzerland) with O.D. 5 mm was used for tracheal intubation.<sup>7</sup> The malleable intubation stylet has integrated 10,000 image fibres and additional light transmitting fibres. They leave the stylet at its proximal end as a 1.7 metre long ultra-thin cable (O.D. 2.8 mm) which is attached to a video-monitor system. The VOIS was inserted into an ETT I.D. 7.0 mm with cuff (RUESCHELIT<sup>TM</sup>, Willy Ruesch AG, Kernen, Germany) slightly protruding the ETT tip.

Conventional laryngoscopy was performed by the operator as usual. While maintaining the best laryngoscopic view (grade III only possible) the distal end of the ETT, bent into an appropriate hockey stick curve, was placed by the operator behind the epiglottis under direct vision. Then, using the monitor view from the stylet tip, the ETT was directed through the glottic opening into the trachea. Final tracheal ETT position was confirmed respectively adjusted using the monitor view before removing the stylet from the ETT.

After one demonstration of each intubation technique by the supervisor, the operator was allowed to do one practice intubation attempt with each technique. Then, each anesthesiologist performed each technique 10 times in succession (order randomized). The time was recorded for each attempt from initial insertion of the blade into the oral cavity until complete removal of the intubation device from the ETT. Failed intubation was defined as requiring > 60 sec or which resulted in esophageal intubation. At the end of each sequence, the operators were asked to attach a degree of difficulty to the method using a Likert-scale from 1 (extremely simple technique) to 5 (impossible technique).

The results were statistically evaluated using Mann-Whitney-U-test for comparison of intubation times and Chi<sup>2</sup>-test for comparison of proportions of failure rates and degrees of difficulty. A *P* value of < 0.05 was considered statistically significant.

## Results

### *Failed intubation*

Seven hundred and fifty-one of the 800 tracheal intubation attempts were successful (93.9%). The video-optical intubation stylet was associated with fewer failed intubations than the Bullard laryngoscope (8 in the VOIS group and 41 in the BL group; *P* = < 0.01), particularly regarding esophageal intubation (1 vs 21; *P* < 0.01) (Figure 1). There was no difference in success rate if intubation was performed first with the Bullard laryngoscope or with the video-optical intubation stylet

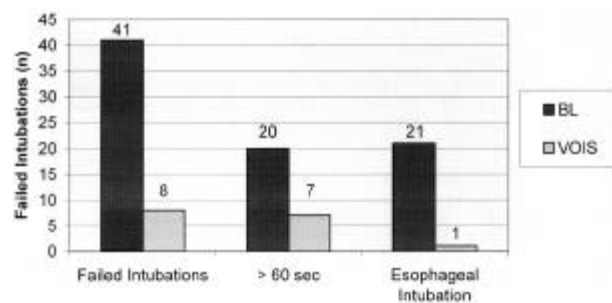


FIGURE 1 Comparison of failed intubation using the Bullard laryngoscope (BL: 400 intubation attempts) or the video-optical intubation stylet (VOIS: 400 intubation attempts).

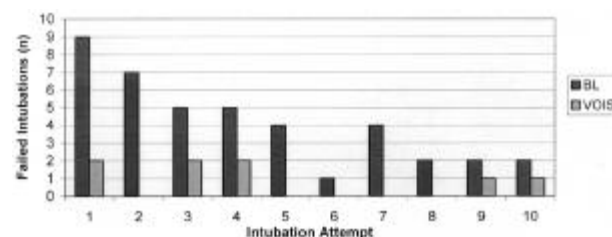


FIGURE 2 Changes in failed intubation (> 60 sec and esophageal intubation) with practice using the Bullard laryngoscope (BL) or the video-optical intubation stylet (VOIS) (n operator = 40 / n intubation attempts = 10).

( $P = 0.41$ ). No correlation between incidence of failed intubation and years of experience in anesthetic practice was found ( $P = 0.72$ ). In contrast to the VOIS group, failed intubations in the Bullard group between the first five and second five intubation attempts were decreased ( $P < 0.005$ ) (Table I/ Figure 2).

Comparison of failed intubation at different intubation time limits such as 30 sec, 45 sec and 60 sec did not show a difference between the two devices ( $P_{\text{Failed} > 30 \text{ sec}} = 0.178$  /  $P_{\text{Failed} > 45 \text{ sec}} = 0.256$  /  $P_{\text{Failed} > 60 \text{ sec}} = 0.32$ ). (Figure 3).

#### Mean intubation time

Mean intubation time was almost identical for both groups ( $19.2 \pm 4.5$  for the BL and  $18.8 \pm 4.6$  sec for the VOIS;  $P = 0.579$ ) and there was improvement with practice for both techniques (Table II). No correlation was found in mean intubation time, if the BL or the VOIS method was initially used ( $P = 0.86$ ).

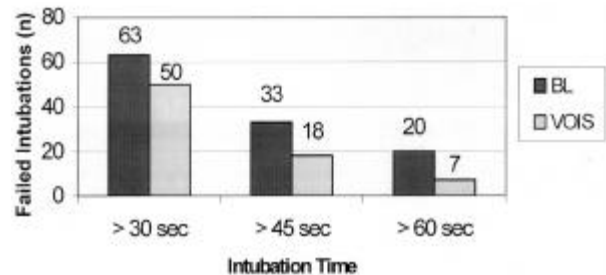


FIGURE 3 Comparison of failed intubation at different time limits using the Bullard laryngoscope (BL: 400 intubation attempts) or the video-optical intubation stylet (VOIS: 400 intubation attempts).

#### Degree of difficulty

Management of difficult laryngoscopy was judged to be easier using the VOIS (mean degree of difficulty:  $2.6 \pm 0.74$ ) than with the Bullard laryngoscope (mean degree of difficulty:  $1.7 \pm 0.65$ ) / ( $P = 0.0001$ ) (Table II). Overall, there was no correlation between estimated degree of difficulty and years of operator's experience ( $P = 0.33$ ). However, in contrast to the junior group (< 2 yr of experience) with no difference of difficulty between the BL ( $2.6 \pm 0.53$ ) and the VOIS ( $2.1 \pm 0.78$ ) / ( $P = 0.3$ ), the more experienced anesthesiologists judged the VOIS to be less difficult ( $1.6 \pm 0.57$ ) than for the BL ( $2.6 \pm 0.80$ ) / ( $P < 0.05$ ).

#### Discussion

Simulating difficult tracheal intubation in patients or in an intubation mannequin is a well-known approach to evaluate, compare and teach intubation techniques.<sup>9,11,12</sup> Although the use of a mannequin does not fully replicate intubating conditions in patients, a simulated grade III in an intubation mannequin allows training for and evaluation of intubation techniques in situations that frequently lead to intubation difficulties in humans.

In the present study, we compared the ease and success of tracheal intubation using the Bullard laryngoscope or the video-optical intubation stylet in a difficult intubation setting. The results showed the superiority of the VOIS to the BL regarding success rates and degree of estimated difficulty of intubation but not of mean intubation time.

Failed intubation was more common with the Bullard laryngoscope. The higher esophageal intubation rate in the Bullard group can be explained by the ETT obstructing the endoscopic view of the cords during intubation. During tracheal intubation with

TABLE I Failed intubation using the Bullard laryngoscope and the video-optical intubation stylet

	<i>Bullard</i>	<i>VOIS</i>	<i>P</i>
Failed intubations (Attempts 1-10)	41 / 400	8 / 400	< 0.01
Failed intubations (Attempts 1- 5)	30 / 200	6 / 200	< 0.01
Failed intubations (Attempts 6-10)	11 / 200	2 / 200	NS
Comparison of attempts 1-5 with 6-10	$P = 0.0001$	NS	
Esophageal intubations	21 / 200	1 / 200	< 0.01
Over time intubations (>60 sec)	20 / 200	7 / 200	NS

TABLE II Mean intubation time and estimated degree of difficulty using the Bullard laryngoscope and the video-optical intubation stylet

<i>Mean Intubation Time</i>	<i>Bullard</i> <i>mean ± SD sec</i>	<i>VOIS</i> <i>mean ± SD sec</i>	<i>P</i>
Mean intubation time (Attempts 1-10)	19.2 ± 4.5 (n = 359)	18.8 ± 4.6 (n = 392)	NS
Mean intubation time (Attempts 1-5)	21.4 ± 8.0 (n = 170)	21.7 ± 6.7 (n = 194)	NS
Mean intubation time (Attempts 6-10)	17.8 ± 5.8 (n = 189)	15.9 ± 4.5 (n = 198)	NS
Estimated degree of difficulty mean ± SD	mean ± SD	mean ± SD	
All operators (n = 40)	2.63 ± 0.74	1.68 ± 0.65	> 0.0001
< 2 yr experience (n = 9)	2.56 ± 0.53	2.11 ± 0.78	NS
2 – 5 yr experience (n = 14)	2.64 ± 0.74	1.43 ± 0.51	< 0.05
> 5 yr experience (n = 17)	2.61 ± 0.91	1.65 ± 0.57	< 0.05

the VOIS, the view of the cords is never obstructed and tracheal intubation is immediately confirmed by recognizing the tracheal rings. The only recorded esophageal intubation in the VOIS group was immediately recognized by the operator on the video-display but intubation time was already > 60 sec. The video-optical intubation stylet allows recognition and correction of esophageal intubation during tube insertion, before gastric air insufflation occurs. In addition, the view from the ETT tip helps in the avoidance of accidental endobronchial intubation.

Most of the intubations were performed within an acceptable time with either technique. Since the Bullard laryngoscope has been equipped with a non-malleable stylet, tracheal intubation with the BL has become simple and rapid.<sup>10</sup> Although the VOIS technique includes two maneuvers such as direct laryngoscopy and steering a tracheal tube according to the video-view, mean intubation times were similar in both groups. Comparison of failed intubation at 30 sec and 45 sec was not different between the two techniques (Table I), indicating that both techniques are suitable endoscopic aids in patients with limited cardio-respiratory reserves.

Using the video-optical intubation stylet in a patient with a grade III laryngoscopic view is similar to using a gum elastic bougie or stylet. However, instead of blind probing for the glottic opening, the

endotracheal tube is directed into the trachea using the video-view from the stylet tip. The familiar nature of the VOIS technique was reflected by the decreased estimate of difficulty particularly in the group of experienced anesthesiologists, the higher success rate in the first five intubation attempts compared with the BL and the lack of a learning curve in the VOIS (failed intubation).

The video-optical intubation stylet can be used with a standard intubation technique. There is no need to change the intubation procedure if an anticipated difficult laryngoscopy occurs. When the VOIS has been already inserted into the ETT before starting a rapid sequence induction, it does not interfere with conventional tracheal intubation, but can be used instantly when urgent endoscopic intubation assistance is required.

### Conclusion

There were fewer failed intubations and less difficulty when management of difficult tracheal intubation was facilitated with the video-optical intubation stylet than with the Bullard laryngoscope. Our results suggest that the video-optical intubation stylet could become a valuable aid in the unpredicted difficult intubation with very little training.

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