A manikin study to compare video-optical intubation stylet versus Macintosh laryngoscope used by novice in normal and simulated difficult airway intubation

一個比較新手使用錄像視覺插喉管心探子對麥金托什喉鏡作正常及模擬困難氣道插喉的人體模型研究

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Objective: To compare Macintosh laryngoscope with video-optical intubation stylet on rates and time durations of successful tracheal intubation in normal and simulated difficult airway. *Design:* Crossover experimental study. *Setting:* Intubation training laboratory. *Methods:* A group of novices (58 medical students) attempted intubation on manikin under normal and simulated difficult airway (grade 3 larygnoscopic view) settings using both Macintosh laryngoscope and video-optical intubation stylet. The success rate, duration to intubate and occurrence of complications (oesophageal intubation and incisor breakage) when using the two different devices were measured and compared. The time results were analysed by paired t-test and categorical results by chi square test or Fisher's exact test. *Results:* The success rate to intubate difficult airway using video-optical intubation stylet (0.92) was significantly higher than using Macintosh laryngoscope (0.59) (p=0.002). The mean time taken to intubate difficult airway using video-optical intubation stylet was significantly shorter than using Macintosh laryngoscope by 10.90 seconds (p=0.004). Oesophageal intubation rate was significantly higher when using Macintosh laryngoscope to intubate difficult airway compared to video-optical intubation stylet (p=0.002). There was no significant difference on the rate of incisor breakage between the two instruments. *Conclusions:* Novice can learn to use both Macintosh laryngoscope and video-optical intubation stylet to intubate successfully after a short training. Video-optical intubation stylet is an effective "Plan B" instrument because it shortens the duration and increases the rate of successful intubation in difficult airway situations. (*Hong Kong j.emerg.med.* 2008;15:133-138)

目的：在正常及模擬困難氣道下，比較麥金托什喉鏡及錄像視覺插喉管心探子的氣管插喉成功率及所需時間。**設計：**交換型的實驗研究。**環境：**插喉訓練實驗室。**方法：**一組新手（58 名醫科學生）嘗試在人體模型正常及模擬困難氣道（喉鏡視域第 3 級）的環境下插喉，使用麥金托什喉鏡及錄像視覺插喉管心探子。量度及比較使用這兩種不同器材的成功率，插喉所需時間，及出現的併發症（導管誤入食道及門牙破損）。時間的結果以配對 t 檢驗法分析而分類的結果以卡方檢驗法或費希爾氏精確檢驗法分析。**結果：**困難氣道插喉的成功率，使用錄像視覺插喉管心探子（0.92）比使用麥金托什喉鏡（0.59）顯著地較高（p=0.002）。使用錄像視覺插喉管心探子在困難氣道插喉的平均時間比使用麥金托什喉鏡顯著地較短（10.90 秒）（p=0.004）。使用麥金托什喉鏡在困難氣道插喉的導管誤入食道率比錄

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像視覺插喉管心探子顯著地高（p=0.002）。兩種器材間的門牙破損率沒有顯著的分別。**結論：**新手可在短暫訓練後學會使用麥金托什喉鏡及錄像視覺插喉管心探子成功地插喉。錄像視覺插喉管心探子是有效的「B 計劃」器材，因為它在困難氣道的情況下，縮短所需時間及增加插喉的成功率。

Keywords: Intratracheal intubation, laryngoscopes, laryngoscopy

關鍵詞：氣管內插喉、喉鏡、喉鏡檢查

Introduction

Inability to intubate the trachea successfully is a major cause of morbidity and mortality during resuscitation[1] and has always been a 'nightmare' to emergency physicians. Emergency departments in Hong Kong, like many other developed countries, have developed alternative airway plans for difficult airway management – "Plan B, C, D, etc". The availability of difficult airway devices has become a core standard in emergency medicine. However, the use of video-optical intubation stylet (VOIS) which is a rigid fibroscope and their extended concept of video assisted airway management (VAAM) remain relatively new to many emergency physicians.[2-4]

The use of VOIS or other rigid fibroscopes and the concept of VAAM have been more popular in the anaesthesia medicine field. A high reluctance to employ this new method of intubation by emergency physicians especially trainees has been noted locally and may be explained by their lack of knowledge on the merits of the device as well as hands-on opportunity to learn the necessary skills. Common queries from the non-supporters included whether VAAM could be learnt easily, whether the device could really shorten the duration of time to intubate and whether the device could reduce complication rate in comparison to the standard intubating device of Macintosh laryngoscope (ML).

In order to answer the queries, we conducted a manikin study to compare VOIS with ML in normal and simulated difficult airways by novice. We aimed to compare the success rates, time durations of successful intubation and complication rates between these two different devices. In order to have a fair comparison, we preferred to use novice (medical students) rather than physicians or trainees in order to minimise confounding effects of preformed bias or prior experience with the devices. The type of VOIS used in this study was the Seeing Optical Stylet (SOS).[5]

Subjects and methods

We contacted the Cluster Ethics Committee of the Hospital Authority, Hong Kong with details of the study. They replied that formal ethical approval was not required for volunteer subjects because this manikin study did not involve patients.

We performed an experimental crossover study on 58 volunteer participants. They were all year-one medical students studying in the Medical Faculty of the Chinese University of Hong Kong. They had attended anatomy class but received no bedside experience or training in tracheal intubation before the experiment. Verbal consent for voluntary participation was obtained and they were free to withdraw from the study at any time. Two identical experimental sessions were arranged. The first involved 28 participants and the second 30 participants. Each session began with a 4-hour pre-experiment training session. During the training session, the participants received lecture and video demonstration to explain on the anatomy of airway, equipment and intubation procedure. Real-time demonstration, ample opportunities of hands-on practice in intubation using VOIS and ML on manikins were provided. All 58 participants finished both the training and experiment sessions and no one withdrew from the study.

We set up intubation manikin heads of an identical model (Laerdal Airway Management Trainer) into two types. The first type was manikins without modification and acted as the normal airway. They were the same as the one used by the participants to practice intubation during the pre-experiment training session. The other type was manikins with modification made for simulating a Cormack and Lehane[6] Grade 3 laryngoscopic view difficult airway, namely, (1) neck adjusted in neutral position by attaching neck collar so that head extension was impossible and mouth opening was reduced, and (2) tongue base lifted by embedding gauze.

In the first part of the experiment, all participants would be asked to intubate the normal airway using a size 3 ML and VOIS for one time only. The time used to complete the procedure would be recorded and round up to whole second before documentation. Successful intubation would be checked and defined as placement of a size 7.5 tracheal tube into the trachea within 60 seconds. Both oesophageal intubation and time taken longer than 60 seconds would be considered as failed procedure. Trauma to the manikin's teeth resulting in a "click" sound would be recorded as complication of incisor injury but not considered as criteria of failed procedure.

Only participants who succeeded in intubating using both VOIS and ML would enter into the second part of the experiment, i.e. to intubate the modified manikins simulating difficult airway. Again, they would be asked to intubate using VOIS and ML in turn and timed on the procedures.

Participants who failed the first part of the experiment were also allowed to intubate on the difficult airway as a trial of experience but they were not timed. All participants would be requested to fill up a questionnaire to survey on their opinion on the ease to learn intubation with the two devices and their preference in different airway settings.

All time results were analysed using 2-tailed paired t-test as the data nearly fitted a normal distribution in the initial data examination. The rate of successful intubation and occurrence of complications in different devices were analysed using 2-tailed chi-square test or Fisher's exact test. We used SPSS 12 as the statistical program.

Results

There were 58 subjects entered into the first part of normal airway experiment and 37 subjects had successful intubation using both devices. When these 37 subjects entered into the second part of difficult airway experiment, only 21 of them had successful intubation with both devices (Figure 1).

The intubation success rates in normal airway using ML and VOIS were 0.76 and 0.86 respectively, but the difference was not statistically significant (p=0.335) (Table 1). We performed paired comparison on the 37 subjects who had successful intubation in normal airway using both devices. The mean time taken to intubate was 15.05 s (SD=8.94) using ML and 23.08 s (SD=10.36) using VOIS. The mean time difference was 8.03 s and statistically significant (p=0.001).

The intubation success rates in difficult airway with ML and VOIS were 0.59 and 0.92 respectively and the difference was statistically significant (p=0.002) (Table 2). We performed paired comparison on the 21 subjects who had successful intubation with both devices in difficult airway. The mean time taken to intubate was 26.90 s (SD=13.59) using ML and 16.00 s (SD=6.82) using VOIS. The mean time difference was 10.90 s and statistically significant (p=0.004).

For normal airway setting, the occurrence of oesophageal intubation using ML was 3 times of those using VOIS, but the difference was not statistically significant (p=0.123) (Table 1). For difficult airway setting, the occurrence of oesophageal intubation using ML was 6 times of those using VOIS, and the difference was statistically significant (p=0.002) (Table 2).

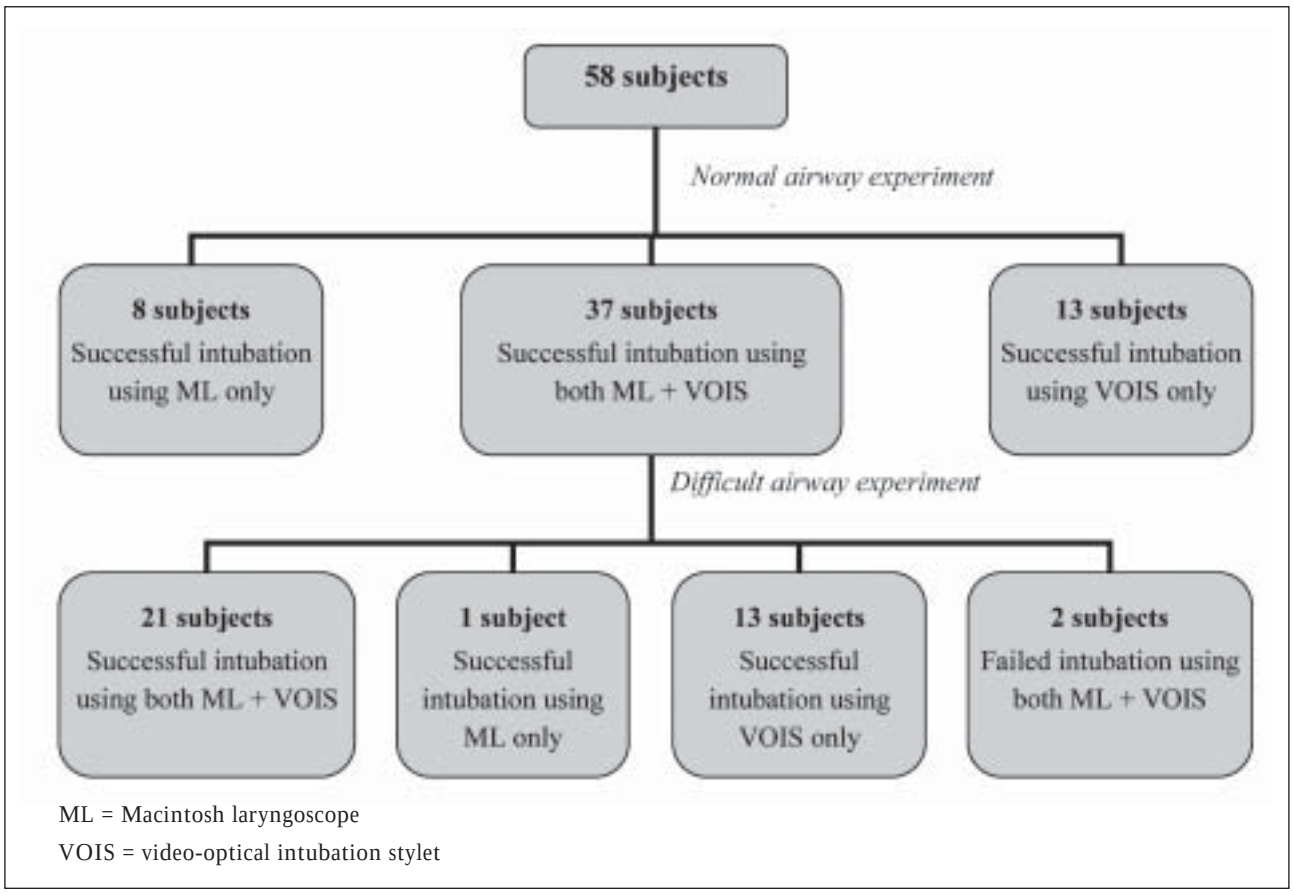

Figure 1. The experimental flow and outcome of study subjects.

Table 1. Outcome of normal airway experiment

Normal airway	ML (N=58)	VOIS (N=58)	p value
Successful intubation	45	50	0.335
Failed intubation	13	8	–
Oesophageal intubation	9	3	0.123
Incisor breakage	17	11	0.278
Mean time to intubate (s)*	15.05	23.08	0.001

ML=Macintosh laryngoscope; VOIS=video-optical intubation stylet

*Based on the 37 participants who were successful in intubating by both ML and VOIS

For normal airway setting, the occurrence of incisor breakage complication using ML was 1.5 times of VOIS, but the difference was not statistically significant (p=0.278) (Table 1). For difficult airway setting, the occurrence of incisor breakage complication using ML was 3.5 times of VOIS, but the difference was again not statistically significant (p=0.152) (Table 2).

Concerning opinion about ease of learning, 55% subjects considered VOIS easier to learn, 14% considered ML easier to learn and 31% considered the

Table 2. Outcome of difficult airway experiment

Difficult airway	ML (N=37)	VOIS (N=37)	p value
Successful intubation	22	34	0.002
Failed intubation	15	3	–
Oesophageal intubation	12	2	0.002
Incisor breakage	7	2	0.152
Mean time to intubate (s)*	26.90	16.00	0.004

ML=Macintosh laryngoscope; VOIS=video-optical intubation stylet

*Based on the 21 participants who were successful in intubation by both ML and VOIS

same. Concerning opinion about preference of use in normal airway setting, 43% of the subjects preferred to use ML, while 57% preferred to use VOIS. Concerning opinion about preference of use in difficult airway setting, most of the subjects (93%) preferred to use VOIS.

Discussion

We set out to compare ML with VOIS on different parameters including success rate, intubation duration and complication rate under normal and difficult airway settings. We also performed an opinion survey on the ease and preference to use the devices in a group of novices that could be our potential trainees in the future. We recruited novice (medical student) rather than physician or trainee as studying subject in order to minimise confounding effects of preformed bias and prior experience with the devices. Since the intubation was performed by novices, it was impossible to allow them to intubate on human subjects. We chose to intubate manikin because it was the safest approach. In addition to that, it allowed us to standardise the normal and difficult airway settings easily and to overcome the difficulty in recruiting Grade 3 difficult airway cases. This study showed that the medical students as novices could learn the technique of intubation using both devices quickly. This could be reflected from the high successful intubation rate in the normal airway setting. This agreed with the opinions of other researchers. Weiss et al reported that VOIS was easy to learn and had a very short learning curve among anaesthetists.[7]

For difficult airway setting, our results showed that the novices performed significantly better when using VOIS than ML. Using VOIS had a significantly higher success rate and shorter intubation duration compared to using ML. Of course, one could argue that VOIS had a slight advantage in that the tracheal tube was already preloaded on to the VOIS before the stopwatch started. However, one should bear in mind that in this experiment, we also allowed the malleable stylet to be preloaded into the tracheal tube in the case of using ML. Therefore, the advantages in the opposite sides might offset each other. Our results showed that VOIS could be an effective "Plan B" instrument and they agreed with other researcher's findings that VOIS was better than other "Plan B" instruments like gum elastic bougie or the Bullard laryngoscope.[7,8]

This study also showed that oesophageal intubation occurred significantly more often when using ML than VOIS especially in the difficult airway setting. It agreed with the findings of other investigators.[8] In difficult airway setting, using ML might fail to lift up the jaw and tongue together with the epiglottis to an extent to expose the glottic opening clearly because neck extension was limited and the glottic opening was not in alignment with the mouth opening. Furthermore, the view could also be obscured by the raised tongue. However, when using VOIS, the operator could simply slide the J-shaped blade along the tongue surface till the tip of the endoscope was placed beneath the epiglottis so that the glottic opening would be shown clearly on the monitor.

Theoretically, using a VOIS requires minimal lifting force to obtain a view of the glottic opening and therefore has a lesser chance to break the incisor than ML. However, our results did not support any significant difference between the two devices.

One interesting finding was that using ML in normal airway intubation had significantly shorter intubation duration than using VOIS. It suggested that ML might still be the instrument of choice in airway management without any anticipated difficulty. The superiority of using VOIS over ML might only be apparent in difficult airway settings.

This study has several limitations. Although other researches have shown that manikin study could allow a promising evaluation of equipment and techniques in situations that lead to intubation difficulties in humans, manikin itself cannot reproduce laryngoscopic conditions of real patients.[1,8] Obviously, manikin is made of plastic which is more rigid than flesh. Besides, the presence of secretion in real patients and its effect in obscuring the view can hardly be reproduced on manikins. All these should affect the possibility to translate results generating from manikin study to human practice. Besides, we have studied one particular type of difficult airway only. Other difficult airway situations like limited jaw movement in rheumatoid arthritis patients or severe maxillofacial injury patients with craniofacial disruption etc. were not tested. This might further put a limit to generalise the results to other airway situations.

Conclusion

VOIS can be an effective "Plan B" instrument because it can shorten the time duration as well as increase the success rate of difficult airway intubation. We believe that novice or trainee can learn to use VOIS in the same way as ML. Teaching on VOIS should be included into the curriculum of an airway management training program and is advisable to deliver to young doctors or trainees in their early career.

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