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Original Article

Nasogastric tube placement with video-guided laryngoscope: A manikin simulator study

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Abstract

Background: This study aimed to investigate video-guided laryngoscopy for nasogastric tube placement.
Methods: This was an observational comparative study performed in a hospital. The participants included volunteers from the medical staff (physicians and nurses) experienced with nasogastric intubation, and non-medical staff (medical students, pharmacists and emergent medical technicians) with knowledge of nasogastric intubation but lacking procedural experience. Medical and non-medical hospital staff performed manual, laryngoscope-assisted and video-guided laryngoscope nasogastric intubation both in the presence and in the absence of an endotracheal tube, using a manikin. Nasogastric intubation times were compared between groups and methods.
Results: Using the video-guided laryngoscope resulted in a significantly shorter intubation time compared to the other 2 methods, both with and without an endotracheal tube, for the medical and non-medical staff alike (all $p < 0.05$). For the medical staff, mean nasogastric intubation time was significantly shorter using video-guided laryngoscope without endotracheal intubation, direct laryngoscope with endotracheal intubation and video-guided laryngoscope with endotracheal intubation compared to manual intubation without endotracheal intubation (0.49, 0.63 and 0.72 vs. 5.63, respectively, $p \leq 0.008$). For non-medical staff, nasogastric intubation time was significantly shorter using video-guided laryngoscope without endotracheal intubation, direct laryngoscope with endotracheal intubation and video-guided laryngoscope with endotracheal intubation compared to manual intubation without endotracheal intubation (1.67, 1.58 and 0.95 vs. 6.9, respectively, $p \leq 0.002$). And mean nasogastric intubation time for video-guided laryngoscope endotracheal intubation was significantly shorter for medical staff than for non-medical staff (0.49 vs. 1.67 min, respectively, $p = 0.041$).
Conclusion: Video-guided laryngoscope reduces nasogastric intubation time compared to manual and direct laryngoscope intubation, which promotes a consistent technique when performed by experienced medical and previously untrained non-medical staff.

Keywords: Endotracheal tube; Laryngoscope; Laryngoscopy/methods; Nasogastric intubation; Video laryngoscope

1. Introduction

Insertion of a nasogastric tube is a common procedure in hospital departments, operating rooms, and critical care settings.[1−3] Such tubing is used for many purposes, for example to deliver nutrients or medication, to evacuate the stomach contents when there is danger of aspiration, or to

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remove air introduced into the stomach during positive pressure breathing. However, proper placement of a nasogastric tube can be difficult, particularly in situations where visualization of the glottis and vocal cords is limited due to conditions such as edema, local hematoma or mass, or scarring from previous surgery, or when the patient's head and neck cannot be positioned in a way that permits a direct view.[1–3] Errors during attempts at correct placement can cause complications, including significant soft tissue damage and pneumonia from aspiration of the stomach contents into the lungs.

Nasogastric tubes are commonly inserted blindly. Direct laryngoscopic guidance is also sometimes used to assist placement. What is needed is a means of visualization that can be used effectively in conditions in which insertion of the nasogastric tube is expected to be difficult and when routine methods have failed. Because hospitals sometimes have a shortage of medical personnel able and available to perform nasogastric intubation at the times when it is needed, it is important also to have procedures that can train non-medical personnel in intubation techniques quickly, simply, and reliably.

Video laryngoscopes were developed to assist endotracheal intubations and are reported to provide a better view of the glottis, require less movement and positioning of the head, and result in less trauma for the patient than other methods. They improve the rate of physician success with tracheal intubations in patients with predicted difficult airways. And novice physicians without significant intubation experience have been shown to have greater success with tracheal intubation and shorter intubation times when using a video laryngoscope than with other methods.[4,5] With video assistance, the medical staff providing intubation, regardless of level of experience, can place the tube correctly into the trachea even when the view is compromised.[6]

Although developed for use in endotracheal tube placement, video laryngoscopes have also been used to facilitate nasogastric tube placement, and the use of this type of visualization has been reported to result in a higher success rate than that seen with blind placement.[7–9] In this study, we wished to see whether manikin training in video laryngoscope-assisted nasogastric tube placement would be effective for both professional and non-professional staff. Also, we hypothesized that, in our institution, tube placement times achieved with video-guided laryngoscope assistance in manikins would be shorter than placement times using blind and direct laryngoscope methods. Therefore, we investigated the time taken for video-guided nasogastric tube placement when used by trained medical staff and by non-medical staff with limited or no experience, and also whether performing nasogastric intubation in the presence of an endotracheal tube was associated with longer tube placement times. This study was conducted to investigate the potential advantages of video-guided laryngoscopy compared to manual and direct laryngoscopy in performing nasogastric intubation, and the ultimate usefulness for non-medical staff of manikin training in this technique.

2. Methods

2.1. Ethical considerations

Participants were those who responded to a posted request for volunteers to perform nasogastric intubation on a manikin (not on patients) using different intubation methods. Volunteers were assured that they would remain anonymous and that only their intubation times would be included in the study report. The Internal Review Board of Show Chwan Memorial Hospital reviewed and approved the study protocol. The participants received a 20-minute explanatory briefing prior to intubation, and signed agreements stating that the experiment involved no medical or ethical issues.

2.2. Equipment

A manikin airway simulator was used to mimic the high-risk population that most often requires nasogastric intubation. The Laerdal Airway Management Trainer (Laerdal Medical, Wappingers Falls, NY, USA) has transparent anatomical structures that facilitate correct performance of nasogastric or nasotracheal tube placement. Standard Macintosh-type laryngoscopy was used for direct laryngoscope nasogastric tube placement. The Pentax Airway Scope AWS-5100 (Pentax Corporation, Tokyo, Japan) was used for video-guided laryngoscope nasogastric tube placement. Nasogastric tube placement was done using a polyethylene Levin tube (Symphon Chemical, Inc., Taipei, Taiwan).

2.3. Methods

This observational comparative study was conducted from September to December, 2012 at Show Chwan Memorial Hospital in Changhua, Taiwan. We enrolled volunteers from the medical staff (n = 14) experienced with nasogastric tube placement. We also enrolled volunteers from non-medical staff (n = 15) with knowledge of intubation but without prior training or experience. The medical staff included physicians and nurses, and non-medical staff included medical students, pharmacists and emergency medical technicians (EMTs).

All participants in this study were from the same hospital. We selected those who were willing to participate, and from this number excluded some who were unsuitable. Two thirds of the total medical and non-medical staff were chosen to participate, and their testing order was determined using a random sequence generator. Both the medical and non-medical staff had to receive information about the same procedure of comparative intubation tests, and all participants had to perform six timed intubations.

After receiving instructions about each method from experienced otolaryngologists or anesthesiologists, medical staff members and non-medical staff performed blind nasogastric tube insertion, direct laryngoscope nasogastric tube insertion, and finally nasogastric tube insertion with video-guided laryngoscope (Figure S1). When intubation was performed on the manikin, its transparent structures were covered (Figure S1).

This sequence of intubations was used by all participants, and a medical lubricant was used in every case. Tube placement times were recorded for each procedure completed by each participant. The staff members continued to try when their first intubation was a failure, and the time needed was recorded until they successfully completed intubation. When more than 10 min were needed, the time was recorded as 10 min. The test timekeeper was a male nurse with more than 10 years of ER experience; all tests were timed by the same person. After the procedures in the "normal" manikin were completed, an endotracheal tube was added to the manikin to simulate the clinical situation in which endotracheal intubation was present during the nasogastric tube placement procedure. All nasogastric tube placement procedures (manual, direct laryngoscope, video-guided laryngoscope) were then repeated and the times were recorded as nasogastric tube placement *with* endotracheal intubation in place. Nasogastric tube placement times were compared between medical and non-medical participants and between different tube placement methods. Successful tube placement was defined as completing a successful nasogastric tube placement that was confirmed by the supervising instructor/researcher within 120 s or less. However, although we considered nasogastric tube placement within 120 s as success, we used intubation time, rather than success rate as an end point, because we were comparing intubation methods using different types of tube insertion.

2.4. Nasogastric tube placement

In the video-guided laryngoscope procedure, after a Levin nasogastric tube was inserted nasally, the video laryngoscope (Pentax-AWS) was inserted orally in order to obtain a view of the glottis. The video laryngoscope's tubular guide slot can only facilitate tracheal intubation, so the Pentax could not be used directly to guide the tube into the esophagus, but was useful in the following manner. The Levin tube is advanced until its tip comes into view on the video screen. The tip of the tube is then directed toward the target symbol on the video screen (Figure S2). This view enables the operator to see if the tube has or has not entered the esophagus and to correct any mistaken, non-esophageal placement, and in this way helps to advance the tube correctly into the esophagus. The Levin nasogastric tube size was 16 Fr, and the laryngoscopy blade used was size #3, 130 mm.

The blind and direct laryngoscope procedures for tube placement were performed similarly. The Levin tube was introduced into the nasal passage and, after the larynx is visualized, is inserted through the vocal cords, but without video screen images for guidance. The timing commenced upon advancing the laryngoscope beyond the dentition, and ended with the participant asking for confirmation of tube placement by the instructor/researcher.

2.5. Statistical analysis

The times for performing nasogastric tube placement are presented as means and standard deviations (SDs). The independent *t*-test was performed to compare the differences between the times of medical versus non-medical participants for performing tube placement. Repeated measures ANOVA with Bonferroni post hoc test was used to compare the differences in the times for intubation between different nasogastric intubation methods. Statistical analyses used SPSS software version 17 (SPSS Inc, Chicago, IL, USA). A two-tailed p of <0.05 was considered significant.

Because the sample size was determined by the number of available participants, we could not perform initial power calculations to determine sample size. Therefore, we did the power calculation according to the results. For the difference in different intubation times in the medical and non-medical staff for different methods, the power ranged from 0.606 to 1.00; this was except for the direct laryngoscope without endotracheal tube and the video-guided laryngoscope with endotracheal tube, where the power was less than 0.5.

3. Results

Comparison of nasogastric medical and non-medical staff nasogastric tube placement times are shown in Table 1 tube placement times between medical and non-medical staff.

When an endotracheal tube was absent, the mean time for video laryngoscope-assisted completion of nasogastric intubation was significantly shorter for medical than non-medical staff (29.57 vs. 99.93 s, $p = 0.041$). But this was not the case for the blind or direct laryngoscopy techniques. Medical and non-medical staff nasogastric tube placement times are shown in Table 1. When an endotracheal tube was present, no significant differences in times were found between medical versus non-medical staff for any of the three techniques (all $p > 0.05$).

3.1. Comparisons of nasogastric tube placement times between different nasogastric tube placement methods

Video-guided and direct laryngoscope insertions took shorter times than blind insertions for both medical and non-medical staff and in both endotracheal tube presence and endotracheal tube absence. These differences were statistically significant in all cases except when direct laryngoscopy was compared to blind placement, and no endotracheal tube was

Table 1
Comparisons of intubation times between medical and non-medical staff.

Time (sec)	Medical staff (n = 14)	Non-medical staff (n = 15)	p
Without endotracheal tube			
Blind	337.71 ± 250.89	414.00 ± 215.75	0.387
Direct laryngoscope	153.00 ± 176.01	137.67 ± 189.07	0.823
Video-guided laryngoscope	29.57 ± 16.75	99.93 ± 120.14	0.041
With endotracheal tube			
Blind	246.50 ± 256.33	336.27 ± 269.11	0.367
Direct laryngoscope	37.57 ± 28.80	94.67 ± 129.42	0.116
Video-guided laryngoscope	43.14 ± 58.75	57.27 ± 56.65	0.515

Table 2
Comparisons of intubation times between different nasogastric intubation methods.

Time (sec)	Endotracheal tube absent			Endotracheal tube present			p
	Blind	Direct laryngoscope	Video-guided laryngoscope	Blind	Direct laryngoscope	Video-guided laryngoscope	
Medical staff	337.71 ± 250.89	153 ± 176.01	29.57 ± 16.75[abc]	246.5 ± 256.33	37.57 ± 28.8[ac]	43.14 ± 58.75[ac]	<0.001
Non-medical staff	414.00 ± 215.75	137.67 ± 189.07[a]	99.93 ± 120.14[ac]	336.27 ± 269.11[d]	94.67 ± 129.42[ace]	57.27 ± 56.65[ace]	<0.001

a. $p < 0.05$ significantly different than with blind method stratified by without and with endotracheal tube.
b. $p < 0.05$ significantly different than with direct laryngoscope in the group without endotracheal tube.
c. $p < 0.05$ significantly different than with blind method without endotracheal tube.
d. $p < 0.05$ significantly different than with video-guided laryngoscope without endotracheal tube.
e. $p < 0.05$ significantly different than with blind method with endotracheal tube.
p values in right hand column mean that intubation times were significantly different among different intubation methods for medical staff (top value) or non-medical staff (bottom value).

present. The time needed for successful placement using the three nasogastric tube placement methods are presented in Table 2. In addition, video-guided laryngoscope assisted placement took a shorter time than direct laryngoscope placement for both medical and non-medical staff, and for both endotracheal tube presence and endotracheal tube absence. But these differences only reached statistical significance when the direct and video-assisted times were compared for medical staff and no endotracheal tube was present.

4. Discussion

Video laryngoscope-assisted nasogastric tube placement time was significantly shorter than blind placement under all conditions, and had a trend to be shorter than direct laryngoscope placement that reached significance in one case, for the medical staff when no endotracheal tube was present. Video laryngoscope placement times were not lengthened when the esophagus was partially obstructed by the addition of an endotracheal tube. And manikin nasogastric tube placement times were similar for both medical staff and non-medical staff with all techniques and conditions except for the first use of video laryngoscope-assisted tube placement (that is, the placement when no endotracheal tube was present).

The insertion times for all three techniques were shorter when the endotracheal tube was present than when it was absent. This is because when there was already a tube in the trachea, there was no chance of the nasogastric tube being inserted mistakenly into the trachea and needing to be removed and re-inserted. For high risk patients who cannot open their mouth, such as those with head or neck cancer, using video-assisted placement and viewing the site directly can avoid misplacement of the tube for such high risk patients. A clinical study comparing nasogastric intubation performed before and after endotracheal intubation reported that nasogastric intubation took longer when performed after endotracheal intubation.[10] However, this was a study of anesthetized patients intubated with no laryngoscopic assistance and therefore was not comparable to our study. Use of a guide wire to assist intubation is another method of tube insertion, but this method easily leads to rupture of the esophagus and insertion of the nasogastric tube into the thoracic cavity,[11] and is seldom used. Additionally, use of a stronger nasogastric tube does not increase the probability that the nasogastric tube can be inserted into the proximal part of the pharyngeal cavity. Instead, it actually increases the risk of insertion into the brain or thoracic cavity.[12]

Patients do not require sedation before nasogastric tube insertion, so our study was performed on manikins instead of patients. However, in those who are sedated when tube insertion is performed, the swallowing function is lost and the proximal part of the pharyngeal cavity cannot be opened through swallowing. Consequently, when the proximal part of the pharyngeal cavity is not open, it may take an excessively long time to insert a nasogastric tube, which may put the patient at risk of suffocation. Propping open the pharyngeal space through use of a laryngoscope can reduce this problem.

Our results compare favorably with two other studies of the use of video laryngoscopy-assisted endotracheal and nasotracheal intubations.[4,13] For endotracheal intubations in manikins, Ambrozio et al.[4] reported that the mean intubation time for direct placement of the laryngoscope was 69.0 s compared to a mean placement time of 23.1 s using the video-assisted laryngoscope. For video laryngoscope-assisted nasotracheal intubations, Asai,[13] using the same Pentax-Airway Scope that was used in our study to assist nasogastric intubation in three awake patients, reported that this method could achieve nasogastric intubation in 15 s. The author concluded that video-guided laryngoscopy could be useful for nasotracheal intubations in awake patients with unstable necks, and in those awake patients where fiberoptic intubation had failed.[13]

Our results show clearly that both experienced and inexperienced providers of nasogastric intubation are able to achieve success using the video-guided Pentax-Airway Scope in manikins with both a ‘normal’ view of the esophagus and a view partially obstructed by the presence of an endotracheal tube. These video-guided instruments have a camera at the distal tip of the laryngoscope blade, providing images on an LCD display; visualization of the glottis does not require specific positioning of the head and neck. This easier operation offers inexperienced physicians, nurses, or other hospital personnel an important advantage when faced with a difficult airway situation.

Video laryngoscope-assisted tracheal intubation in manikins was reported to take longer than direct laryngoscopy when performed in helicopter air ambulances.[14] This was probably partly because of the difficult working environment in which the methods were tested. Other investigators reported endotracheal intubation success rates of 51% for direct laryngoscopy and 93% for intubation with the GlideScope when performed by untrained staff in patients with non-difficult airways.[6] These examples show that the setting, the patient's condition, and the operator's experience and confidence levels can make a difference in achieving successful tracheal intubation and imply that they will also make a difference in achieving successful nasogastric intubation.

In a report on nasogastric tube placement in a patient with cervical instability, Kinoshita et al.[15] stated that use of the video-guided AirwayScope™(IMI Co. Ltd., Japan) facilitated its placement and was effective in detecting points such as arytenoids, cartilages and pyriform sinuses that can interfere with nasogastric tube placement. A study comparing the Pentax-AWS videolaryngoscope with the Macintosh laryngoscope for tracheal intubation in 203 anesthetized patients with stabilized necks reported that the video-guided procedure provided a better view of the glottis and a higher success rate.[16] In that study, the time to visualize the glottis was shorter using video laryngoscopy, but total intubation times were similar. One consideration in deciding which method of nasogastric tube placement to use is that tube insertion is especially difficult for many patients even without endotracheal intubation obstructing the esophagus, including those in a vegetative state or with recurrent stroke. We suspect that difficulty or failure of nasogastric intubation in such situations is not only due to difficulty swallowing, but also partly due to the presence of a narrow prepharyngeal space. In this situation, the video laryngoscope can be used to gently lift retropharyngeal tissue so that it does not obstruct passage of the nasogastric tube.

One limitation of the current study is that the sequence in which the insertion methods were tested was always the same (blind, direct laryngoscopy, video-assisted laryngoscopy), and the effect of more practice in tube insertion that may be partially responsible for the shorter tube placement times seen in the laryngoscope-assisted procedures.

The results of this study are limited by the fact that it was a manikin-only use of video-guided laryngoscope, and therefore cannot be generalized to patient populations. However, the manikin's oral cavity and laryngopharyngeal space were modeled on a real person, and the manikin's inability to swallow simulates the condition of an unconscious person who has lost the swallowing reflex. Therefore, it is a good simulation model for teaching nasogastric tube insertion. Another limitation is that a manikin study cannot examine differences in insertion-related complications that might be seen with the different methods. Future study should be prospective and include live intubation by manikin-trained operators using standard procedures and video-guided laryngoscope. Our observations during the present study suggest that patient safety initiatives and checklists for monitoring patients with nasogastric tubes are essential, and that establishing hospital standards and training programs for consistent performance of nasogastric intubation may be a way to reduce failed nasogastric intubations and related complications in the hospital setting.

In conclusion, the Pentax-AWS video-guided laryngoscope reduces nasogastric intubation times compared to manual and direct laryngoscope intubation, promoting consistent handling and correct placement by experienced medical staff and previously untrained non-medical staff. Our results suggest that nasogastric intubation by video-guided laryngoscope may be safe and effective for use in nasogastric intubation of high-risk patients.

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Appendix A. Supplementary data

Supplementary data related to this article can be found at http://dx.doi.org/10.1016/j.jcma.2017.01.009.

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