VIDEOLARYNGOSCOPIC ENDOTRACHEAL INTUBATION (GLIDESCOPE®) OF MORBIDLY OBESE PATIENTS IN SEMI-ERECT POSITION: A COMPARISON WITH RAPID SEQUENCE INDUCTION IN SUPINE POSITION*

Deepak Gupta, Konstantin Rusin

Abstract

Background: In regards to peri-anesthetic morbidity considerations, morbidly obese patients often have full stomach for extended periods secondary to delayed gastric emptying. Additionally, they may have difficulty lying supine because of multiple reasons.

Study Objectives: The purpose of the study was to compare endotracheal intubation of morbidly obese patients placed in semi-erect position with the rapid sequence induction in the supine position using GlideScope® video laryngoscopy.

Methods: A prospective randomized study was conducted in ASA I-III patients aged 18-65 years who were scheduled for bariatric surgery. Group A (Study Group): General anesthesia was induced in the semi-erect position, and endotracheal intubation was performed by the investigator positioned in front of the patient. The GlideScope® blade was held in the right hand of the investigator during intubation and endotracheal tube with rigid stylet was inserted using the left hand. Group B (Control Group): General anesthesia was induced and patient's trachea intubated in the standard supine position.

Results: 39 patients underwent endotracheal intubation in semi-erect position (Study Group) and 37 patients underwent endotracheal intubation in supine position (Control Group). No differences were observed in the intubation parameters or patient safety. Intubation times required to secure patients' airways were not significantly insignificant ($p = 0.42$) between the two groups; desaturation episodes occurred 50% less frequently (though insignificant $p = 0.42$) in the semi-erect group.

Conclusion: This is the first prospective study demonstrating endotracheal intubation with GlideScope® in the semi-erect position as comparable to standard supine position intubation. Moreover, gravity-directed and aligned biomechanics in the semi-erect position may be ergonomically more efficient for intubating morbidly obese patients.

* Department of Anesthesiology, Wayne State University/Detroit Medical Center, Detroit, MI 48201, United States.
Corresponding Author: Konstantin Rusin, M.D., Ph.D. Associate Medical Director, Anesthesiology, Wayne State University, Box No 162, 3990 John R, Detroit, Michigan 48201, United States, Tel: 1-313-745-7233, Fax: 1-313-993-3889. E-mail: krusin@med.wayne.edu

Introduction

The rising incidence of morbid obesity necessitates that anesthesia care providers search for safer and optimal techniques to secure these patients' airways. In regards to peri-anesthetic morbidity considerations, morbidly obese patients often have full stomach for extended periods secondary to delayed gastric emptying. Additionally, they may have difficulty lying supine because of multiple reasons. Therefore, to perform surgery in this patient population, anesthetic induction and intubation in a semi-erect position may be required. Postural change from supine to sitting position significantly reduces collapsibility of pharyngeal airway in anesthetized and paralyzed patients with obstructive sleep apnea[1]. However, intubation in the semi-erect position may be difficult, if not impossible, with a conventional direct laryngoscope. In such difficult cases, flexible fiberoptic bronchoscope intubation has been the standard technique, with the practitioner positioned at the patient's right side facing the patient. Recently cases studies have reported awake intubation performed with video laryngoscopy by Airtraq (Prodol, Vizcaya, Spain)[2] and Pentax-AWS airway Scope systems (AWS; Hoya, Tokyo, Japan)[3] in patients placed in the semi-erect position. Thus far there have been no prospective human studies with GlideScope® (Verathon Inc., Bothell, WA, United States) aided endotracheal intubation in obese semi-erect patients.

The purpose of the study was to assess the feasibility in regards to patient safety considerations and ease for operator's use in general anesthesia induction and endotracheal intubation of morbidly obese patients placed in semi-erect position and to compare this technique with the rapid sequence induction in the supine position using GlideScope® video laryngoscopy.

Methods

After institutional review board approval for the study protocol and written informed consent, a prospective randomized study was conducted in 85 ASA I-III patients aged 18-65 years who were scheduled for bariatric surgery under general anesthesia using standard general anesthetic techniques.

The laryngoscopy and intubation procedure was performed as follows:

- Group A (Study Group): The patient was seated on the operating room table adjusted to the semi-erect angle in which the patient felt most comfortable. After standard ASA monitors application, patient was pre-oxygenated in the semi-erect position. General anesthesia was induced in the semi-erect position, and endotracheal intubation was performed by the investigator positioned in front of the patient. The GlideScope® blade was held in the right hand of the investigator during intubation and endotracheal tube with rigid stylet was inserted using the left hand.
- Group B (Control Group): The patient was pre-oxygenated and general anesthesia was induced in the standard supine position. Subsequently, patient's trachea was intubated with GlideScope® in the standard supine position.

The following observations were recorded pre-operatively: body mass index (BMI), past medical history of gastro-esophageal reflux disease, obstructive sleep apnea and continuous positive airway pressure (CPAP) use, and pre-existing intolerances to lay supine with corresponding causes for these intolerances**.** Intra-operatively, following parameters were recorded: the total time for video laryngoscopy and intubation, incidence of failure to intubate in the first attempt, incidence of desaturation episodes (pulse oximetry readings decreasing below 90%), incidence of the need for bag-mask ventilation interrupting laryngoscopy and intubation, and incidence of gross visible regurgitation of gastric contents into the oropharynx during video-laryngoscopy.

For statistical analysis, an ANOVA single factor test was applied to compare the means and variance of the continuous data. A Fisher exact probability test (two tailed) was utilized to compare all categorical data. Normality/distribution of data was evaluated by histogram and probability plots. For non-parametric data Mann Whitney tests was used. A p-value of <0.05 was considered significant.

Results

A total of 85 patients were recruited for inclusion in the study protocol. However, after written informed consent and completed recruitment, nine patients were excluded from the study because tracheal intubation was performed with Mac-Miller laryngoscopes instead of GlideScope® due to unforeseen unavailability of the GlideScope®. Among the remaining 76 eligible patients, 39 patients underwent endotracheal intubation in semi-erect position (Study Group) and 37 patients underwent endotracheal intubation in supine position (Control Group). In comparing the two groups the intubation times (control group 51.8 ± 17.8s; study group 54.6 ± 13.2 s) were not significantly different (P = 0.42). In comparing the two groups there were no significant differences in the intubation parameters (Table 1). There were also no significant differences in regards to preoperative characteristics except a higher BMI in supine controls (51.6 ± 10.5 kg/m^2 control group; 46.8 ± 8.9 kg/m^2 study group), which was statistically significant (P = 0.04).

Discussion

In this first prospective study to compare anesthesia induction and endotracheal intubation with GlideScope® in semi-erect position versus supine position, no differences were observed in the intubation parameters or patient safety. Intubation times required to secure patients' airways were not significantly between the two groups; desaturation episodes occurred 50% less frequently (though insignificant p = 0.42) in the semi-erect group.

Table 1
Pre-Operative Demographics and Intra-Operative Intubation Characteristics

Characteristic	Semi-Erect Intubation Group (n = 39)	Supine Intubation Group(n = 37)	P value (***significant if <0.05**)
Body Mass Index (kg/m^2)	46.8 ± 8.9	51.6 ± 10.5	**0.04***
Pre-Existing Co-Morbidities			
Diagnosed Gastro-esophageal Reflux Disease (n)	38% (15/39)	54% (20/37)	0.25
Diagnosed Obstructive Sleep Apnea (n)	36% (14/39)	41% (15/37)	0.81
CPAP Treatment for Sleep Apnea at Home (n)	28% (11/39)	35% (13/37)	0.62
Symptomatic Intolerance to Supine Position (n)	77% (30/39)	76% (28/37)	>0.99
Underlying Reason for Intolerance to Supine Position			
Dyspnea	53% (16/30)	50% (14/28)	>0.99
Heartburn	23% (7/30)	32% (9/28)	0.56
Gastropharyngeal Reflux	13% (4/30)	21% (6/28)	0.50
Backache	60% (18/30)	79% (22/28)	0.16
Others	23% (7/30)	7% (2/28)	0.15
Multiple	47% (14/30)	50% (14/28)	>0.99
Tolerance to Supine Position Despite Symptoms	11% (1/9) (Despite Dyspnea and Heartburn)	56% (5/9) (Despite Heartburn or Pharyngeal Reflux)	0.13
Intubation Parameters			
Intraoperative Time Taken to Intubate (s)	54.6 ± 13.2	51.8 ± 17.8	0.42
Intraoperative Failure to Intubate in First Attempt (n)	8% (3/39)	5% (2/37)	>0.99
Intraoperative Desaturation Episodes (n)	5% (2/39)	11% (4/37)	0.42
Intraoperative Bag-Mask Ventilation before Second Intubation Attempt (n)	3% (1/39)	0% (0/37)	>0.99
Visible Gross Regurgitation during Intubation (n)	5% (2/39)	3% (1/37)	>0.99

Induction and intubation in morbidly obese patients can be challenging. While performing endotracheal intubation in morbidly obese patients, the anesthesia care providers may encounter; (a) large redundant oropharyngeal tissues compressing on the lax glottic opening (b) low functional residual capacity that markedly reduces allowable apneic time (c) large breasts (male or female) and (d) less cervical spine mobility with potentially increased risk of dental or oropharyngeal injuries during laryngoscopy. Pre-anesthetic sleep patterns may predict patients' physiological responses at the time of induction of anesthesia before the cellular and molecular effects of inhalational anesthesia, mechanics of positive pressure ventilation and technicalities of the operative procedures charter patients' pathophysiology into domains unpredictable from their pre-anesthetic sleep patterns. It is reasonable to hypothesize that the cardiorespiratory variables of morbidly obese patients are more favorable when they are lying in their comfortable sleeping positions. Majority of these patients have intolerance to supine position and are either using ergonomically incorrect multitude of pillows or biomechanically correct reclining beds. These intolerances arise from a variety of reasons that are similar to as observed in our study (Table 1) and may caution the anesthesia care provider to anticipate difficult airway secondary to failure to ventilate/intubate, gross pulmonary aspirations, rapid desaturation episodes, and severely labile hemodynamics.

The next step for designing the present study was to utilize an ergonomically correct method that would be less strenuous on the patients' airways that are being intubated as well as on the operators performing the intubation. Presently, unless an extraordinarily difficult airway is predicted, most practitioners prefer sleep induction and endotracheal intubation as compared to an awake state endotracheal intubation. Therefore, to compare the endotracheal intubation with GlideScope® in morbidly obese patients in two different positions, sleep induction protocol was chosen for the present study. The additional reasons for sleep induction as the choice was that the videolaryngoscopy method used in this study (GlideScope®) requires rigid stylet (GlideRite®), which may not be safe to manipulate within the un-relaxed airways of awake patients. Other case reports observed that different models of video-laryngoscopes (Airtraq[2] and Pentax-AWS airway Scope systems[3]) might have been equivalently useful to accomplish sleep endotracheal intubation in semi-erect position (this can be a domain for future endeavors by the airway researchers).

One of the major alternative positions for endotracheal intubation in morbidly obese patients is the 'Ramped' position[4-7]. The 'ramped' position is achieved by arranging blankets, pillows, solution bags or the Rapid Airway Management Positioner (RAMP, Airpal Inc., Center Valley, PA)[6] beneath the patient's shoulders and head before anesthesia induction. Some RAMP devices are placed beneath the patient's shoulders after anesthetic induction[7] and then inflated to elevate patient's shoulders and upper thorax. Disadvantage with 'ramped' position is the need for patient re-positioning after endotracheal intubation to remove blankets, pillows, or RAMPs beneath the patient. This maneuvering can risk injury to patients as well as operating room personnel. Semi-erect positioning of patient nullifies the need for 'ramped' positioners and video laryngoscopy nullifies the need for the operator to be at patient's head end for intubation. This technique is similar to flexible fiberoptic bronchoscope guided awake intubation performed in semi-erect position.

To demonstrate anatomical maneuverability advantages, the positions used in our study have been described as schematic diagrams with manikins in Figs. 1 and 2 for control group (supine position intubation) and study group (semi-erect position intubation) respectively. Positioning shown in Fig. 3 (a schematic diagram of the conventional method for semi-erect position intubation with operator's position at the patient's head-end) was not used in our study, and is only shown as a comparative method for endotracheal intubation. From an operator's perspective, potentially favorable biomechanics (Table 2) for performing intubation in the semi-erect position (Fig. 2) are evident with (a) maintained neutral cervical Spine position for operator (b) patient's mouth and video display aligned in one line of sight for operator (c) forces required for laryngoscopy primarily directed towards gravity and (d) minimal force requirement for lower jaw depression to achieve an optimal video-laryngoscopic view. The favorable biomechanics for patients in the studied semi-

Fig. 1
Schematic Diagrams with Manikin demonstrating GlideScope® Aided Endotracheal Intubation in Supine Position (THIS POSITION WAS USED IN CONTROL GROUP)

Fig. 2
Schematic Diagrams with Manikin demonstrating GlideScope® Aided Endotracheal Intubation in Semi-Erect Position with Operator on the Right Side of the Manikin facing the Manikin (THIS POSITION WAS USED IN STUDY GROUP)

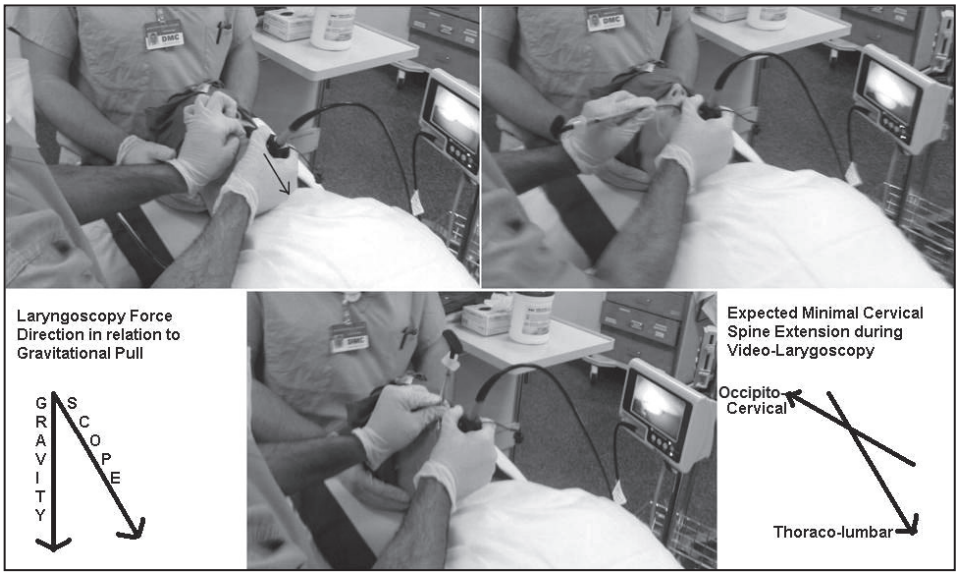
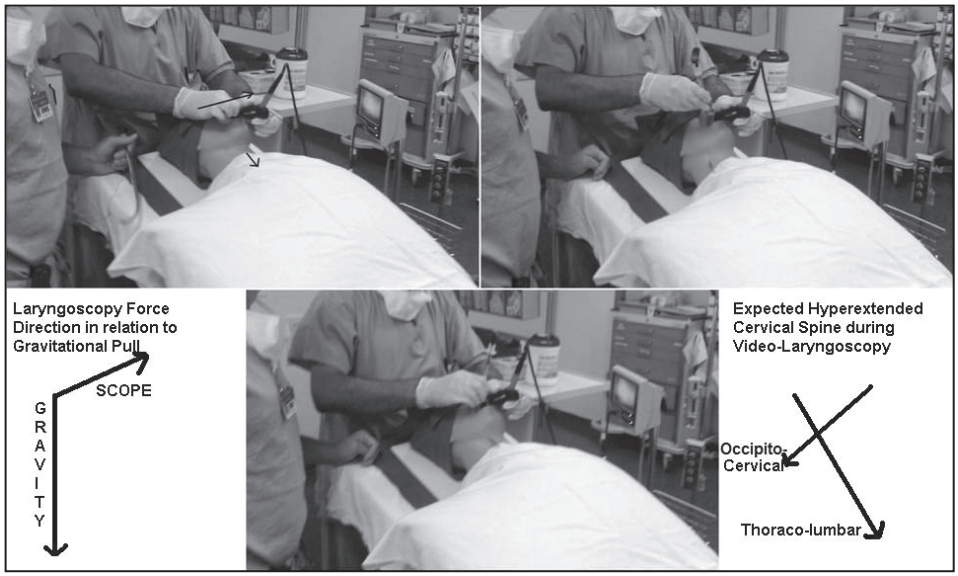


Fig. 3
Schematic Diagrams with Manikin demonstrating GlideScope® Aided Endotracheal Intubation in Semi-Erect Position with Operator on the Head End of the Manikin (THIS POSITION WAS NOT USED DURING THIS STUDY)



erect position (Fig. 2) are evident with (a) operators' hands staying away from their eyes and (b) avoidance of laryngoscopic forces on the patients' maxillary teeth and upper lips. However while intubating from the patient's right side, caution is required to avoid un-warranted forceful lower jaw depression that may cause injuries to mandibular teeth, lower lips and tongue. Even though GlideScope® is known to cause moderate cervical spine extension in classical supine position[8], the semi-erect position (Fig. 2) may achieve video-laryngoscopic view for intubation with minimal neck extension.

The limitations of the semi-erect position (Fig. 2) are (a) operator's side position while intubation (instead of head-end position) (b) exchange of hands for using GlideScope® blade and holding the endotracheal tube (c) difficult ergonomics while performing the jaw-pull maneuver for face-mask seal and bag-mask ventilation from the right side of the patient (sometimes may require the assistance of secondary operators at the head end). Secondary anesthesia operators will have

Table 2

Biomechanical Comparisons between the Various Positions for GlideScope® Aided Endotracheal Intubatio.

Characteristic	Supine Position as in Control Group *See Fig. 1*	Semi-Erect Position as in Study Group *See Fig. 2*	Alternative Semi-Erect Position (NOT USED in this study) *See Fig. 3*
Patient Position	Laying Flat on Surgical Table	Table Back End Up to Patient Comfort Level	Table Back End Up to Patient Comfort Level
Primary Operator Position	Head End of Patient	Right Side of Patient	Head End of Patient
Face-Mask Seal	Using Jaw Thrust Away from Operator 180º to Gravity	Using Jaw Pull Towards Operator 90º to Gravity	Using Jaw Thrust Away from Operator 120º-150º to Gravity
GlideScope® Blade	In Left Hand	In Right Hand	In Left Hand
Endotracheal Tube	In Right Hand	In Left Hand	In Right Hand
Video Display on Left Side of Patient	Operator's Eyes, Patient's Opened Mouth and Video Display: NOT ALIGNED in one line of sight	Operator's Eyes, Patient's Opened Mouth and Video Display: all ALIGNED in one line of sight	Operator's Eyes, Patient's Opened Mouth and Video Display: NOT ALIGNED in one line of sight
Neutral Cervical Spine Motion of Operator	Not Maintained as NOT ALIGNED line of sight	Maintained as ALIGNED line of sight	Not Maintained as NOT ALIGNED line of sight
Upper Extremity Movements of Operator	Left Arm Flexion; Pronation of Supinated Right Arm	Right Arm Abduction and External Rotation; Supination of Pronated Left Arm	Left Forearm Extension with Left Arm Flexion; Pronation of Supinated Right Arm
Direction for Laryngocopy Movement	180º to Gravity (Against Gravity)	30-60º to Gravity (Towards Gravity)	120-150º to Gravity (Away from Gravity)
Primary Force for Laryngoscopy	Strong Force for Lower Jaw Lifting	Minimal Force for Lower Jaw Depression	Moderate Force for Lower Jaw Thrusting and then Lifting
Oral Injury Cautions	For Maxillary Teeth For Upper Lip	For Mandibular Teeth For Lower Lip	For Both Teeth For Both Lips
Patient's Cervical Spine Motion	Moderate Extension	Minimal Extension Primarily Neutral	Hyperextension Likely
Secondary Operator	Right Side of Patient For Cricoid Pressure; Second Pairs of Hand	Head End of Patient For Stabilizing Head; Second Pairs of Hand	Right Side of Patient For Cricoid Pressure; Second Pairs of Hand

to perform additional tasks including (a) stabilization of relaxed patient's head (b) assisting with jaw-thrust maneuver if jaw-pull maneuver fails, and (c) bag-mask ventilation in case of unanticipated difficult airway or prolonged anesthesia induction period. This may appear to increase the anesthesia personnel requirements in the operating rooms. However, this is not a major concern as there is always a certified registered nurse anesthetist or a resident anesthesiologist as the primary operator at the time of anesthesia induction under the direct supervision of attending anesthesiologist as the secondary operator in most of the hospitals in the United States. A potential future study will be to quantify whether this more optimal ergonomic intubation positioning leads to its generalized acceptance for semi-erect position endotracheal intubation.

There were some limitations to the present study. Based on the intubation times as the primary outcome, the power of the study was 0.29. To adequately power this study ($1-\beta = 0.8$), the total patients required would have been approximately 800. However, even this large number of patients will only give a statistical advantage to the classical supine position intubation (51.8 sec) as compared to studied semi-erect position intubation (54.6 sec). This 3-second gain may be statistically significant but in our opinion will not be clinically significant. Despite randomization of the patients' allocation between the two groups, lower BMI in semi-erect position ($P = 0.04$) may have a role to play in equivalent results between the two groups; however both study group patients as well as controls were morbidly obese with mean BMI above 45 kg/m2. Additionally, though 50% decrease in the oxygen desaturation episodes among the semi-erect group patients may require validation in larger adequately powered studies, the prevention of oxygen desaturation elicited in our study may still be clinically significant.

Conclusion

This is the first prospective study demonstrating endotracheal intubation with GlideScope® in the semi-erect position. There were no statistical differences in any intubating parameters in the semi-erect position as compared to the standard supine intubation. Moreover, gravity-directed and aligned biomechanics in the semi-erect position may be ergonomically more efficient for intubating morbidly obese patients.

Acknowledgement

The authors are thankful to Dr George Mckelvey, Research Associate, Department of Anesthesiology, Wayne State University for completing the statistics and copyediting the final manuscript.

References

1. Tagaito Y, Isono S, Tanaka A, Ishikawa T, Nishino T: Sitting posture decreases collapsibility of the passive pharynx in anesthetized paralyzed patients with obstructive sleep apnea. *Anesthesiology*; 2010, 113:812-8.
2. Uakritdathikarn T, Asampinawat T, Wanasuwannakul T, Yoosamran B: Awake intubation with Airtraq laryngoscope in a morbidly obese patient. *J Med Assoc Thai*; 2008, 91:564-7.
3. Suzuki A, Terao M, Aizawa K, Sasakawa T, Henderson JJ, Iwasaki H: Pentax-AWS airway Scope as an alternative for awake flexible fiberoptic intubation of a morbidly obese patient in the semi-sitting position. *J Anesth*; 2009, 23:162-3.
4. Collins JS, Lemmens HJ, Brodsky JB, Brock-Utne JG, Levitan RM: Laryngoscopy and morbid obesity: a comparison of the "sniff" and "ramped" positions. *Obes Surg*; 2004, 14:1171-5.
5. Neligan PJ, Porter S, Max B, Malhotra G, Greenblatt EP, Ochroch EA: Obstructive sleep apnea is not a risk factor for difficult intubation in morbidly obese patients. *Anesth Analg*; 2009, 109:1182-6.
6. Cattano D, Melnikov V, Khalil Y, Sridhar S, Hagberg CA: An evaluation of the rapid airway management positioner in obese patients undergoing gastric bypass or laparoscopic gastric banding surgery. *Obes Surg*; 2010, 20:1436-41.
7. Brzezinski M, Lee A, Holak EJ, Pagel PS: A simple method for obtaining a "ramped" laryngoscopy position after anesthetic induction. *J Cardiothorac Vasc Anesth*; 2010, 24:537-9.
8. Turkstra TP, Craen RA, Pelz DM, Gelb AW: Cervical spine motion: a fluoroscopic comparison during intubation with lighted stylet, GlideScope®, and Macintosh laryngoscope. *Anesth Analg*; 2005, 101:910-5.