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CASE REPORT

An Evaluation of the Rapid Airway Management Positioner in Obese Patients Undergoing Gastric Bypass or Laparoscopic Gastric Banding Surgery

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Abstract A new positioning device, the Rapid Airway Management Positioner (RAMP, Airpal Inc., Center Valley, PA) was evaluated to determine if there was an improvement in either mask ventilation, direct laryngoscopy, or both with the use of the RAMP in this patient population. Fifty-one morbidly obese patients (BMI>35 kg/m^2) undergoing elective bariatric surgery were enrolled. Ventilation and laryngoscopy was performed in the neutral and head-elevated laryngoscopy position (HELP). Direct laryngoscopy was performed noting the glottic view according to the Cormack–Lehane classification (Samsoon and Young, Anesthesiology 42:487, 1987). Mask ventilation was then recommenced. The HELP, or "ramped," position was achieved by inflating the RAMP, which was placed underneath the patient prior to entering the OR. Once proper HELP position was achieved, a second laryngoscopy was performed followed by endotracheal intubation. Two main outcomes were noted in the neutral and HELP positions: (1) laryngoscopic view and (2) ease of ventilation. The inflated ramped position provided greater ease of ventilation as compared to the neutral position (p=0.0003). There was also a significant improvement in the glottic view in the ramped position (p=0.04). Ease of intubation was perceived to be severely difficult among two, and overall use of the positioning device was found to be difficult among seven of the residents. The RAMP effectively positions morbidly obese patients in the HELP position. Ease of ventilation and laryngoscopic view were both improved with its use in this patient population.

Keywords Morbid obesity · Anesthesia · Airway · Positioning · Laryngoscopy · Intubation · RAMP · HELP · Ventilation

Introduction

Airway management of the obese patient requires special consideration. Since the prevalence of obesity has increased (16% in 1995 to 20% in 2000 to 26% in 2007 (Behavioral Risk Factor Surveillance System, www.cdc.gov/brfss/index.htm), and an estimated 220,000 bariatric cases performed in the USA in 2008 (American Society for Metabolic and Bariatric Surgery, www.asbs.org)), anesthesiologists have been facing the challenges of airway management with this population more frequently.

Difficult mask ventilation is predicted by a number of factors, including obesity. The incidence of difficult mask ventilation is 1.4–1.6% in the general population and possibly higher in the obese population. In fact, a high BMI has been found to be an independent risk factor in predicting difficulty with mask ventilation [1, 2]. An increased BMI is associated with reduced posterior airway space behind the tongue′s base as well as a more rapid development of hypoxemia when improper mask ventilation occurs [3]. Since appropriate bag-and-mask ventilation necessitates a patent airway, proper head and neck positioning to establish the patent airway becomes especially important.

It is estimated that endotracheal intubation is performed in approximately eight million patients per year in the USA.

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Approximately 80% of these intubations are performed by direct laryngoscopy with transoral placement of the endotracheal tube (ET) into the trachea. There is fairly uniform reporting of the incidence of failed intubation in the literature: approximately 0.05% or 1:2,230 in surgical patients and approximately 0.13% to 0.35%, or 1:750 to 1:280, in the obstetric patients [2, 4]. The incidence of unsuspected difficult intubation is higher and is estimated to be 3%. One factor that contributes to difficult intubation is poor visualization, and difficult laryngoscopy is highly correlated with poor laryngeal exposure [5]. There is a three-fold increased risk of difficult laryngoscopy among obese patients compared with individuals with normal body mass index [6–9]. Additionally, there are increased difficulties and risks for tracheal intubation in obese patients versus normal-weight patients. The chances for a successful first attempt at oral intubation decrease as patient weight increases [1, 8].

Optimal laryngeal view during laryngoscopy can be facilitated with proper head and neck positioning, including slight elevation of the head, neck flexion relative to the chest, and extreme atlanto-occipital extension [10]. Improving visualization of laryngeal structures will increase the likelihood of successful tracheal intubation, as increasing the percentage of glottic opening is negatively correlated with the number of intubation attempts, as well as the need for rescue intubation devices [11]. Fewer attempts at tracheal intubation should result in less trauma and a reduced number of complications. The "ramped" or head-elevated laryngoscopy position (HELP), where the patient′s external auditory meatus is horizontally aligned with their sternal notch, is superior to the standard "sniffing" position (defined as 7-cm occiput elevation) during direct laryngoscopy in morbidly obese patients [10]. This position has previously been achieved by layering blankets [10] or using predesigned foam elevation pillows [12]. The use of blankets can produce inconsistent positioning, and both of these may be inconvenient in terms of removal and further changes in positioning.

The Rapid Airway Management Positioner (RAMP, Airpal Inc., Center Valley, PA) is designed to optimize visualization during direct laryngoscopy by placing the patient into the proper HELP position. It is a variation of the standard air mattress system used for transferring obese patients and patients with mobility issues from bed to bed. It has an additional wedge-shaped chamber at the head of the bed which can be inflated independently via an air pump to simulate the HELP position. In morbidly obese patients, achieving this position is important [12] and requires a great deal of support under the head and shoulders that is difficult to perform singlehandedly [13]. The RAMP is an easy-to-use device that takes an average of 56 s to place and inflate [14].

The superiority of the HELP position has been established in several previous studies [5, 10, 12, 15]. The purpose of this study was to determine if the RAMP quickly and effectively achieves this position and thereby improves ease of ventilation, direct laryngoscopy, and tracheal intubation in obese patients undergoing gastric bypass or laparoscopic gastric banding surgery.

Methods

Following institutional review board approval and written informed consent, 51 adult surgical patients 18–80 years of age, ASA I–III, BMI≥35 kg/m^2 presenting for gastric bypass or laparoscopic gastric banding surgery who required general anesthesia were enrolled in this study. Patients who exhibited a Mallampati class IV, were ASA physical status IV–V, exhibited any spinal instability, or who required an awake intubation were excluded. Each of the 51 patients served as their own control. The RAMP was placed underneath each patient prior to entering the OR. All laryngoscopic procedures were performed by CA 1–3 residents.

In the operating room, standard ASA monitoring devices were applied, and general anesthesia was induced by bolus administration of propofol (2 mg/kg) and fentanyl (1 mcg/kg), and anesthesia was maintained with the use of inhalational agents. Rocuronium (0.6 mg/kg) was administered to provide muscle relaxation, and sevoflurane was utilized for maintenance of anesthesia once the ability to mask ventilate was confirmed. The lungs were mechanically ventilated in the neutral position with a semiclosed circle system to maintain an end-tidal CO_2 near 35 mmHg. Patients′ lungs were ventilated via an anesthesia mask for 5 min with 100% oxygen until the patient was completely relaxed (0 on train of 4).

The anesthesia resident then performed laryngoscopy utilizing a traditional Macintosh 4 laryngoscope. The prepositioned RAMP was then inflated underneath the patient until the HELP position was achieved. The resident again performed laryngoscopy utilizing the same technique, and the laryngeal view, as assessed by the Cormack–Lehane scale, was recorded (Table 1). The intubation was

Table 1 Definition of Cormack–Lehane classification for laryngoscopy [2]

Grade	Description
I	Full view of glottis
IIa	Partial view of glottis
IIb	Arytenoids or posterior portion of glottis just visible
III	Only epiglottis visible
IV	Neither epiglottis nor glottis visible

then performed. The number of intubation attempts (maximum 3) was also assessed. Additionally, the level of difficulty (none/mild/moderate/difficult) in the performance of laryngoscopy and intubation was recorded. Ease of ventilation in both positions was also determined according to the Han classification (Table 2). The quality of the airway was evaluated using the Mallampati classification system [16].

Finally, the number of attempts required for successful endotracheal intubation was recorded. An attempt was defined as an attempt at placement of an endotracheal tube through the glottic opening and into the trachea. Once an optimal position was obtained, position of the ET tube was not further altered.

Results

Patient demographics are listed in Table 3 and were utilized for the purpose of testing for confounders. Ordinal logistic regressions were calculated to evaluate possible demographic and clinical variable confounders. The majority of patients included in the study were female (41/51), which is representative of the patient population that undergoes bariatric surgery at our institution and in the USA in general.

In the inflated position, 52% of the patients could be ventilated by mask either without any assistance or with an oral airway device, as compared to only 33% of patients when deflated (Tables 4, 5). Ventilation was difficult (Han Grade 3) in 28% of patients in the neutral position and 15% when inflated (p=0.0003). Additionally, 35% of the cases showed improvement in mask ventilation with the RAMP (p=0.01). The Han classification improved by one grade in all of these cases, as determined by Pearson's Chi square test. There was one isolated case in which ventilation became more difficult with the RAMP (grades 2 to 3), but this was not significant. Of note, the provider used a donut pillow underneath the head while the RAMP was deflated; thus, the completely neutral position was not achieved in this case.

Full view of the glottis was achieved in 56% of the patients in the inflated position compared to 34% of patients when deflated, whereas no portion of the glottis was visible in 6% of the patients when inflated compared to 20% of the patients when deflated. With implementation of the RAMP, a total of 23 (45%) cases demonstrated improvement (p=0.04), as determined by the Pearson's Chi square test. Twelve (24%) Cormack–Lehane scores improved by one grade and eight (16%) of the scores improved by two grades. Two of the cases showed full vocal cord visibility following grades 3 and 4 view. There were also two cases where the view was worsened in the inflated position. Both of these were one grade worse (from 1 to 2a and 2a to 2b), and the view was acceptable for intubation in both cases; the resident noted only mild or no difficulty with intubation.

By logistical regression analysis, the only variable that produced significant differences in laryngoscopic view was the subjective assessment of neck thickness (as assessed by the resident).

Almost 32% (7/22) of patients with a subjective rating of a *medium-sized* neck exhibited an improved view of the glottis with the inflated RAMP, with an improvement of >1 grade in four of seven (57.1%) of those patients. None (0/22) exhibited a worse view. Sixty-nine percent (9/13) of patients with a *thick* neck exhibited an improved view of the glottis, while none (0/13) exhibited a worse view. Of the nine patients with an improved view, the view in six (66.7%) patients improved by more than one grade.

Ninety-four percent (47) of the cases required only one intubation attempt. The resident anesthesiologist rated the overall intubation difficulty to be none or mild in 82%,

Table 2 Definition of Han ventilation classification [24]

Grade	Description
I	Ventilated by mask
II	Ventilated by mask with oral airway/adjunct ± muscle relaxant
III	Difficult ventilation (inadequate, unstable, or requiring two providers) ± muscle relaxant
IV	Unable to mask ventilate ± muscle relaxant

Table 3 Patient demographics

Number of Patients	51
Sex (Male/Female)	10/41
Age (years)	42.76±10.9 (21–65)
Mallampati Class (1/2/3/4)	25/15/10/1
BMI (kg/m^2)	47.87±7.6 (32.7–63.1)
Neck Size (Small/Medium/Thick)	12/22/14

Table 4 Change in ventilability in neutral vs. inflated position

Ventilability by Han class (improved/no change/worse)					
		16/29/1 (35%/63%/2%)			
		Han Class in neutral position			
		I	*II*	*III*	*IV*
Han class in ramped position	*I*	15	9		
	II		8	7	
	III		1	6	
	IV				

Table 5 Change in glottic view in neutral vs. inflated position

Glottic view by Cormack–Lehane class (improved/no change/worse)						
		22/25/2 (45%/51%/4%)				
		Cormack–Lehane class in neutral position				
		I	*IIa*	*IIb*	*III*	*IV*
Cormack–Lehane class in ramped position	*I*	16	6	4	1	1
	IIa	1	4	4	4	
	IIb		1	4	1	
	III				1	1
	IV					1

moderately difficult in 14%, and difficult in 4% of the cases. There was only one case of failed intubation in which traditional fiberoptic intubation was also unsuccessful but was subsequently successful with an LMA used as a conduit for fiberoptic intubation. The subjective assessment performed by the resident of the use of the RAMP was noted to be very easy or easy by 86% of the residents, while 14% noted it was difficult to use overall.

Discussion

Obesity is a source of significant morbidity and mortality and continues to be a major health concern, especially in the USA. As the obesity epidemic continues to grow, it becomes ever important to understand the impact obesity has in the airway management of these patients.

Studies have demonstrated that obese patients present with unique problems in regards to the airway, including difficult mask ventilation, direct laryngoscopy, and endotracheal intubation [3, 6, 7]. Previous studies have also demonstrated that proper positioning of a patient in the HELP [12, 17] or the "ramped" [15] position results in a better laryngoscopic view, thus, facilitating intubation.

We found that by creating a better alignment between the oral, pharyngeal, and laryngeal axes, the RAMP effectively positions the obese patient in the HELP position (Fig. 1a) and results in an improved laryngoscopic view (Fig. 1b). Ninety-four percent of the cases required only one intubation attempt. It is possible that this percentage may be related to the improved view although no attempt at intubation was made in the neutral position. The RAMP was also more efficacious for those patients with larger necks. A larger neck circumference has been associated with greater difficulty in intubation. [7, 18] Thus, we can speculate that the HELP position is even more effective among those with a greater neck circumference who are more difficult to intubate than an obese individual whose fat distribution is not very prominent in the neck area.

In two (4%) of the cases, subjective assessment of severe difficulty in intubation occurred. Although no objective criterion was used to assess difficulty, this value is less than the 11.5–14% rate of difficult intubation found in other studies [8, 9]. Furthermore, in several of the cases where no difference in the laryngoscopic view was demonstrated, the subjective assessment of intubation was noted to be easier.

Fig. 1 **a** Patient profile in the neutral position; **b** patient profile in the head elevated laryngoscopy position with the RAMP

This may be due to a subjective finding that less force is needed for laryngoscopy in the altered or ramped position. These findings are especially significant since the laryngoscopist′s first attempt is the best opportunity to achieve successful intubation, as complications increase with increased number of laryngoscopic attempts [19], especially in a population which is more prone to hypoxemia [20].

Mask ventilation may also be more difficult to perform in the obese population [3, 21]. It has been shown that preoxygenation with the head elevated is more effective than the neutral position [6, 22]. Our findings suggest that adequate ventilation is easier to achieve in the HELP position, as opposed to the supine position. Once again, this is an important factor in the population currently under consideration since desaturation is known to occur earlier, and this situation may be exacerbated by a difficult intubation. By providing greater ease of ventilation, the HELP position may allow the anesthesiologist more time between ventilation and intubation and decrease the incidence of critical desaturation.

One of the challenges that remains, however, is how easily, quickly, and consistently this position can be achieved as well as to return the patient to a neutral position for surgery. The neutral position is usually desirable for the surgeon to operate as well as to reduce the possibility of brachial plexus injury. The RAMP is different in this respect from most other positioning devices. Prepositioning helps increase the desaturation safety period for morbidly obese patients [22]. Currently, placing a patient on top of stacked blankets is common and can create the HELP or “ramped” position [15]. Nonetheless, in addition to the lack of uniformity in achieving the desired position, there are several other disadvantages. The use of specifically manufactured elevation foam pillows has largely resolved the issue of consistency and speed [12]. Nonetheless, if the initial position is not adequate, the patient must sit up again. Furthermore, the wedge or blanket may be difficult to remove, especially from under the obese patient. Additionally, an elevated position may also be desirable during extubation and subsequent ventilation [17]. The RAMP is designed to eliminate these problems with easy and rapid inflation as well as deflation capabilities. Patient position and the amount of inflation can also be varied in order to achieve the HELP position in obese patients that differ in anatomical fat distribution.

As for overall ease of use, our study demonstrated a subjective assessment of difficulty in 14% of the cases. Although the device may be somewhat difficult to use by an inexperienced practitioner, it has certain features that are designed to aid the anesthesiologist in its use. The RAMP is currently designed to be used by a single practitioner using the foot pump mechanism. Also, the OR staff can attach or detach the pump to the positioning device itself. In addition to facilitating patient positioning, it is possible that by providing a better laryngeal view, the incidence of morbidity associated with intubation may decrease. Use of the RAMP may allow faster, easier, and less traumatic intubation in a population that is known to be difficult. The advantages should, therefore, far outweigh the disadvantages for a novice to learn how to properly use the device.

One of the major limitations of this study was the lack of a blinded observer for the purpose of rating the laryngoscopic view. In previous studies, this view was obtained by utilizing a video Macintosh laryngoscope or a rigid endoscope where the video lens is in relative proximity to the glottic structures. The authors felt that this would not be an adequate representation of what is actually visualized by the laryngoscopist. For this reason, it was our intention to utilize the Airway Cam laryngocopy video system (Airway Cam Technologies, Inc., Wayne, PA) [23], where the lens of the camera is essentially directly in front of the anesthesiologist and thereby better represents their view. Unfortunately, due to technical difficulties, most recordings were lost, and this view could not be replayed for a blinded viewer. Nonetheless, the rating of the view by the anesthesiologist performing the laryngoscopy has practical significance.

The inflatable RAMP serves as an effective way to efficiently and consistently achieve the HELP position, thus, making ventilation, laryngocopy, and intubation easier. As it is currently designed, the device may play a role in the positioning of obese patients, especially those patients whose airways are predicted to be more difficult.

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