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Original contribution

Shoulder and head elevation improves laryngoscopic view for tracheal intubation in nonobese as well as obese individuals☆

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Abstract

Study Objective: To determine whether shoulder and head elevation, such that the patient's ear lies at or higher than the sternum ("ramp"), improves laryngoscopic grade in adult patients of various body mass index (BMI) values.

Design: Prospective, unblinded study, with patients and laryngoscopists acting as their own controls.

Setting: Operating room of a university-affiliated hospital.

Patients: 189 adult ASA physical status 1, 2, and 3 patients.

Interventions: After performing a standard preoperative airway evaluation and inducing general anesthesia, the anesthetist performed and graded two laryngoscopies: one in the "ramp" position and one in the "sniff" position.

Measurements: Patient BMI, Mallampati airway class, thyromental distance, neck circumference, cervical extension ability, Cormack and Lehane laryngoscopic grade for each laryngoscopy, subjective lifting force required, and need for external laryngeal pressure were recorded.

Main Results: Use of the "ramp" provided significantly better or equal laryngoscopic views, relative to those with the "sniff" position, in the entire study population.

Conclusions: Shoulder and head elevation by any means that brings the patient's sternum onto the horizontal plane of the external auditory meatus maintains or improves laryngoscopic view significantly.
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1. Introduction

The sniff position, by providing lower cervical flexion and atlanto-occipital extension, promotes laryngeal visualization for tracheal intubation by aligning the oral, pharyngeal, and laryngeal anatomical axes. As a protuberant abdomen pushes

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the thorax upward and outward, the sniff position often fails to provide good laryngeal visualization in obese individuals, even when Mallampati class, thyromental distance, neck circumference, and cervical extension suggest the absence of difficulty.

Collins et al [1] have promulgated the idea that raising an obese patient's shoulders and increasing lower neck flexion beyond the sniff position so that the patient's ear lies at or higher than the sternum, improves laryngoscopic grade. Brodsky et al [2] also found that in morbidly obese patients [body mass index (BMI) > 40 kg/m^2] who were positioned with pillows under their shoulders and their head elevated and neck extended, large neck circumference and high Mallampati score were the only predictors of potential intubation difficulty.

In this study we evaluated both obese and nonobese adult patients presenting for general endotracheal anesthesia to determine whether combined shoulder-head elevation, so that the sternum aligned with the external auditory meatus, resulted in improved laryngoscopic view compared with a sniff position alone. We considered the usual preoperative modes of airway evaluation as confounders but primarily sought to distinguish "ramp" versus "sniff" over a range of patient BMIs.

2. Materials and methods

After obtaining approval from the Montefiore Medical Center Institutional Review Board, we enrolled consecutive adult patients (age 18 yrs or greater) presenting to the operating room (OR) for surgery during general endotracheal anesthesia. We excluded from the study patients who required rapid-sequence induction or awake fiberoptic intubation.

We recorded each study patient's BMI, dentition, Mallampati classification, thyromental distance, neck circumference, and atlanto-occipital extension ability. In the OR we positioned each patient on a single-unit foam rubber shoulder and head elevator (Troop Elevation Pillow; Mercury Medical, Clearwater, FL, USA) as well as on a 9-inch (23 cm) diameter, 7 cm-high foam rubber head cushion (Kendall #30009 Head Positioner Bagel; Covidien, Plymouth, MN, USA). After adminstration of the induction agent and muscle relaxant (choice of drugs left to the anesthesiologist's preference), the anesthetist, using a Macintosh 3 or 4 blade (again, according to the anesthetist's preference) assessed the laryngoscopic grade according to the Cormack and Lehane scale [3]. This constituted the "ramp" score. The anesthetist then sprayed 4% lidocaine between the vocal cords into the trachea. We then removed the ramp but left the foam head cushion in place, following which the anesthetist used the same laryngoscope and reassessed laryngoscopic grade. This constituted the "sniff" score. The anesthetist then intubated the patient's trachea.

We compared laryngoscopic grade, lifting force needed (subjectively estimated by the anesthetist), and external laryngeal pressure required (as subjectively estimated by the anesthetist) during each of the two laryngoscopies, with each patient serving as his or her own control. Each anesthetist was asked immediately after each laryngoscopy, taking lifting force and the perceived need for external laryngeal pressure by an assistant into consideration, if the "ramp" view was better, if the "sniff" view was better, or if both views were the same.

We performed chi-squared Fisher's exact test analyses to compare anesthetists' assessments of "ramp better", "sniff better", or "the same." We further applied the same analyses to groups of patients categorized by BMI, comparing high and low BMI patients with regard to laryngoscopic view during "ramp" or "sniff" use.

We also performed regression analyses of the preoperative airway evaluative data to establish correlations that related to improvement or worsening of laryngoscopic view in our study population. P-values < 0.05 were considered statistically significant for the chi-square analyses, and R-values > 0.9 were considered to be highly correlated.

3. Results

For the patients in our study, multivariate regression analysis showed no meaningful correlations between laryngoscopic grade change and Mallampati classification, thyromental distance, neck circumference, ability to extend the neck, and dentition, respectively.

The mean BMI of our 189 patients was 30±7 kg/m^2. When we compared the laryngoscopic view in patients in the "ramp" position relative to the view in the same patients in the "sniff" position, we found that the ramp led to improved or unchanged laryngoscopic grading in 89% of all patients, 88% of patients with BMI < 25 kg/m^2, 91% of patients with BMI > 30 kg/m^2, 96% of patients with BMI > 35 kg/m^2, 95% of patients with BMI > 40 kg/m^2, and 100% of patients with BMI > 45 kg/m^2.

Table 1 Number of study patients in whom ramp provided better, equal, or worse laryngoscopic view (P-value for ramp better or equal to sniff vs sniff better)

BMI (kg/m^2)	Ramp better	Ramp equal to sniff	Ramp better or equal to sniff	Sniff better	P-value
ALL	87	81	168	21	<0.0001
< 25	17	25	42	6	<0.0001
> 25	70	56	126	15	<0.0001
> 30	50	30	80	8	<0.0001
> 35	26	22	48	2	<0.0001
> 40	11	9	20	1	0.0003
> 45	4	5	9	0	0.0116

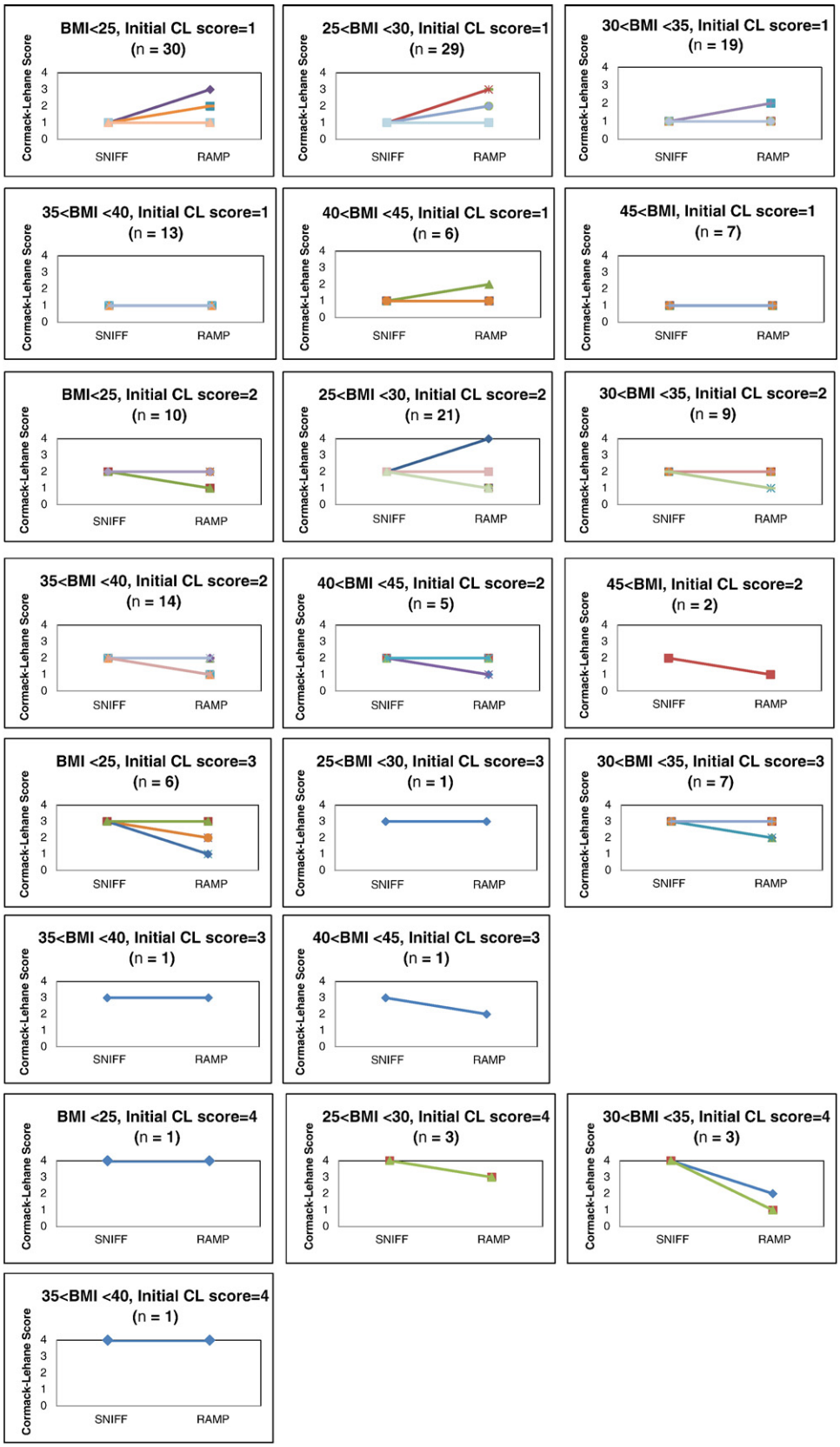

Fig. 1 Line plots of laryngeal views comparing "sniff" and "ramp" Cormack-Lehane (CL) scores for "sniff" CL grading of 1 in relation to body mass index (BMI) status.

Our study results (Table 1) show that the "ramp" provided significantly better or equal laryngoscopic views compared with those seen with the "sniff" position in the entire study population as well as in each BMI category. Fig. 1 shows the line plots for the study population, grouped by BMI and Cormack-Lehane score as viewed in the "sniff" position and "ramp"position. However, comparisons of improvement between the low-BMI group and successive strata of higher than normal BMI patients did not show statistically significant differences (Table 2). In addition, comparisons between operators, grouped by level of experience (CA-1 and rotating surgery residents), CA-2, CA-3, attending anesthesiologists, and CRNAs, did not show statistically significant differences in laryngoscopic view between "ramp" and "sniff" positions (Table 3).

4. Discussion

Morbidly obese patients undergoing general anesthesia present numerous challenges to the anesthesiologist, not the least of which is airway management. In 2004, Collins et al [1] showed that arranging blankets underneath a morbidly obese (BMI > 40 kg/m^2) patient's upper body and head until horizontal alignment was achieved between the external auditory meatus and the sternal notch ("ramp"), significantly improved laryngoscopic view in comparison to a separate, similar group of morbidly obese patients whose head was supported only by a 7 cm cushion ("sniff"). In 2008, Rao et al [4] showed that flexing the OR table at the trunk-thigh hinge and raising the trunk portion of the table yielded similar results to the folded blanket technique in ease of intubation in patients with BMI > 30 kg/m^2. Troop also described a precut foam cushion [5] designed to achieve the HELP (head elevated laryngoscopy position) position, coined by Levitan et al [6], to improve laryngeal exposure during laryngoscopy in morbidly obese patients. Rich [7] also described a premanufactured elevation pillow and claimed that it, when used in conjunction with a standard intubation pillow, provided better positioning than use of a standard intubation alone in morbidly obese individuals. Other methods, including the use of an inflatable head and shoulder elevator [8] or multiple irrigation bags and pillows [9], also have been described. The objective in all of these approaches is to align the oral, pharyngeal, and laryngeal axes so as to afford the laryngoscopist optimal visualization of the larynx.

Working from the findings of Collins et al., we sought to evaluate direct laryngeal visualization in anesthetized adult patients in the HELP or "ramp" position and, using each patient as his/her own control, compare it with laryngeal visualization in the "sniff" position. In addition to verifying the conclusions of the Collins et al study, we sought to determine whether the "ramp" position was valuable in laryngeal visualization of all patients.

One of the difficulties of this study was creating a protocol that did not give an advantage to either of the two positions. The ideal study design would have had patients selected at random to receive either the "ramp" or the "sniff" position first and the other second. The logic behind this approach is that an anesthetist who performs a laryngoscopy on a given patient gets to know the landmarks and the feel for that patient's airway, and will have an easier time attempting a second laryngoscopy on that patient. This logic would seem then to favor the "sniff" position in our study since it was always performed after the "ramp" position. We accepted this limitation because moving an anesthetized patient, particularly a morbidly obese one, onto the "ramp" would have required several assistants and added a hazard to the patient that was not encountered simply by removing the "ramp."

Since attending anesthesiologists, residents, and CRNAs served as laryngoscopists, the variability in laryngoscopic skill and interpretation of the resultant laryngeal views among the participants provided another limiting variable in assessing our results. To standardize a common reference point for all of the anesthetists participating in the study, each anesthetist was shown pictures of the different grades of the Cormack and Lehane scale before each laryngoscopy. Furthermore, the study required that the anesthetist perform both laryngoscopies on each study patient so as to standardize the grading. Hence, while there was variability among the laryngoscopists, each anesthetist served as his/her own control.

In trying to understand why the "ramp" versus the "sniff" position led to worsened laryngoscopic view in some patients, we observed that anesthetists of short stature reported this finding more often than taller ones. Because

Table 2 Comparison of "Ramp"- improved laryngoscopic view in low-BMI patients relative to that in high-BMI patients

BMI (kg/m^2) group	BMI (kg/m^2) group	*P*-value
<25	>25	0.7910
<25	>30	0.5632
<25	>35	0.1552
<25	>40	0.4268
<25	>45	0.5753

BMI=body mass index.

Table 3 Results of laryngoscopic views categorized by experience of the operators

	Ramp better or equal to sniff	Sniff better
CA-1 + other	115	14
CA-2	16	4
CA-3	19	2
CRNA	8	0
Attendings	10	1

Other=rotating surgery residents (n=3); two-tailed *P*=0.9609.
CA-1, CA-2, CA-3=anesthesiology residents; CRNA=certified registered nurse-anesthetisst; Attendings=attending anesthesiologists.

the "ramp" elevates the patient's shoulders and head, using the "ramp" requires the anesthetist to raise his/her orientation at the head of the table. Lowering the OR table to its base may not be sufficient to orient the patient's head at the level of a short anesthetist's sternum; standing on a stepstool may be required.

We did not measure the laryngoscopist's position relative to that of the patient's head but rather left it to each laryngoscopist to position himself/herself as he/she saw fit. Even so, the fact that our laryngoscopists evaluated nearly as many patient views as equal to that of the "sniff" as they evaluated the "ramp" superior to the "sniff" raises questions about the "ramp's" universal value. Clearly, anesthesiologists have intubated morbidly obese patients without benefit of a "ramp." In fact, our data showed that some patients in all BMI groups demonstrated better laryngoscopic views in the "sniff" position. The data do, however, support the idea that the "ramp" either maintains or improves the laryngoscopic view relative to that of the "sniff" in all BMI groups.

Another factor to consider is whether the patient is positioned properly on the "ramp." For the "ramp" to function to best advantage, patients must move themselves onto the "ramp" such that the head rests on its flat, upper elevated surface. If a patient's head is allowed to rest on the inclined portion of the "ramp," the patient's sternum will not be horizontal to the external auditory meatus and the patient's neck will not extend sufficiently to align the axes for optimal laryngoscopic view.

We conclude that shoulder and head elevation by any means that brings the patient's sternum onto the horizontal plane of the external auditory meatus maintains or improves laryngoscopic view significantly more often than it hinders it. This relationship becomes clinically important in morbidly obese patients and produces progressively more and consistently better laryngeal visualization, relative to the conventional "sniff" position, as BMI increases. Optimal laryngeal visualization also depends on proper positioning of the patient on the elevating device as well as on the laryngoscopist's appropriate positioning relative to the elevated patient.

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