The Impact of Patient Positioning on Video Laryngoscopy-Guided Tracheal Intubation in Obese Patients: A Prospective Observational Study Comparing Ramped versus Sniffing Position

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Abstract

Background: A successful tracheal intubation depends on the patient being positioned optimally, especially in obese patients who frequently have difficult airway anatomy. Hence, to identify the most practical and efficient method for managing airways, this study aimed to compare the ramped and sniffing postures during video laryngoscopy (VL)-guided tracheal intubation in obese individuals. **Materials and Methods:** A prospective observational study was conducted on 80 obese patients (body mass index > 30 kg/m^2) who were allocated to either the sniffing or ramped positions according to routine clinical practice. Total intubation time was the primary outcome, while endotracheal tube (ETT) insertion time, laryngoscopy time, and laryngoscopy view quality were secondary outcomes, along with intubation success rate. To identify significant differences between groups, statistical analysis was performed using data collected during intubation. **Results:** A fair comparison was ensured by a similar demographic profile of both groups. In comparison with the sniffing position, the ramped position significantly decreased total intubation time (25.74 ± 13.79 s vs. 42.51 ± 17.95 s; mean difference: −16.77 s, 95% confidence interval: −23.14 to −10.40 s, $P = 0.001$), as well as endotracheal tube insertion time ($P < 0.001$). In the sniffing position, laryngoscopy time was slightly shorter ($P = 0.035$). The improved Cormack–Lehane grade distribution in the ramped position was statistically significant ($P = 0.040$). **Conclusion:** In obese patients at higher risk of rapid desaturation, the ramped position significantly shortens intubation time, which is clinically relevant, without sacrificing laryngeal visualization or success rates, thereby enhancing safety and efficiency during VL-guided tracheal intubation.

Keywords: Endotracheal intubation, laryngoscopy, obesity, patient positioning, video-assisted technique

Introduction

Securing the airway through tracheal intubation requires optimal patient positioning, particularly in obese individuals, who often present anatomical and physiological challenges such as reduced functional residual capacity, rapid oxygen desaturation, and limited alignment of airway axes.[1,2] Video laryngoscopy (VL) has enhanced glottic visualization, intubation success rate, and favorable safety profile compared with direct laryngoscopy (DL) and has become an essential tool in the management of difficult airways.[3] However, the ideal patient position for VL-guided intubation in obese patients still eludes us.

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Two positions that are commonly used during airway management are the traditional sniffing position and the ramped position, in which the head and torso are elevated to align the external auditory meatus with the sternal notch.[4] Evidence from DL-based research generally supports the ramped position, largely due to improved airway alignment and prolonged apnea tolerance.[5-7] However, these findings cannot be directly extrapolated to VL, where indirect glottic visualization changes the mechanics of laryngoscopy. Comparative data under VL conditions are limited and inconsistent. Existing literature suggests that VL may offer enhanced intubation conditions in the ramped position for morbidly obese patients.[3] However, results across studies remain variable, and most have focused on DL[5-8] rather than VL techniques.

Furthermore, although obesity is recognized as a risk factor for difficult airway management, prior research has predominantly examined morbidly obese or critically ill populations.[9-12] There is a lack of prospective observational data evaluating how sniffing versus ramped positioning influences VL-guided intubation performance among non-morbidly obese surgical patients. Clarifying this is clinically relevant, as even modest delays in intubation may increase the risk of desaturation in this population.[1,2]

This study aimed to evaluate associations between patient positioning (ramped vs. sniffing) and key intubation metrics during VL-guided tracheal intubation in obese adults. The primary objective was to compare total intubation time between the two positions. Secondary objectives included comparing laryngoscopy time, endotracheal tube insertion time, glottic visualization, and intubation success.

Materials and Methods

Study design

This was a prospective, comparative, non-randomized observational study conducted at a tertiary care center over 12 months. Two patient positioning strategies for orotracheal intubation—the ramped and sniffing positions—were compared. Allocation to either position was not randomized and was determined by routine clinical practice and individual anesthesiologist preference. As allocation was neither random nor concealed, the study has quasi-experimental characteristics, and the potential for selection bias was recognized *a priori*.

The Institutional Ethics Committee approved the study protocol and was prospectively registered in the Clinical Trials Registry of India (CTRI/2024/01/061638). Written informed consent was obtained from all participants before enrollment.

Setting and participants

Adult patients with obesity scheduled for elective surgery requiring orotracheal intubation under general anesthesia were screened consecutively during the study period. Eligible participants were aged 18–80 years, had a body mass index (BMI) greater than 30 kg/m^2, and were classified as American Society of Anesthesiologists (ASA) physical status I–III. The upper age limit was retained to enhance external validity, provided that patients did not exhibit frailty or clinically significant airway limitations.

Patients were excluded if they had a known history of difficult intubation, cervical spine pathology, previous head or neck surgery, an increased risk of aspiration, a requirement for rapid sequence induction, or an anticipated difficult airway based on standardized criteria aligned with the ASA Difficult Airway Algorithm. These criteria included Mallampati class III–IV in combination with limited mouth opening, a thyromental distance of less than 6 cm, or restricted cervical spine mobility.

Variables

The primary exposure variable was patient positioning during intubation (ramped vs. sniffing). The primary outcome was total intubation time, defined as the sum of laryngoscopy time and endotracheal tube insertion time. Secondary outcomes included Cormack–Lehane glottic grade, number of intubation attempts, overall intubation success, and predefined airway-related adverse events. Operator experience was recorded as a potential confounder.

Data sources and measurements

All enrolled patients underwent a structured preoperative airway assessment, including Mallampati classification, thyromental distance, inter-incisor gap, cervical spine mobility, and a focused history of previous airway difficulties.

After induction of anesthesia, patients were positioned either in the sniffing position—achieved using an approximately 7 cm pillow placed under the occiput to facilitate neck flexion and head extension—or in the ramped position, created by elevating the head and upper torso with blankets or cushions until the external auditory meatus was horizontally aligned with the sternal notch. Positioning was verified visually; no spirit level or alignment device was used.

A standardized anesthetic induction protocol was applied in all cases to minimize variability. This included preoxygenation with 100% oxygen for 2–3 min, induction with propofol (1.5–2.5 mg/kg) and an opioid bolus such as fentanyl (1–2 μg/kg), followed by neuromuscular blockade with rocuronium (0.9–1.2 mg/kg) or vecuronium, as clinically appropriate. Orotracheal intubation was performed using a RESDATA BD-DF video laryngoscope fitted with a D blade. A Portex endotracheal tube (internal diameter: 7.0–8.0 mm) was selected according to the patient's sex and height.

All intubations were performed by consultant anesthesiologists with a minimum of 5 years of experience in VL. Although multiple consultants participated, operator experience was documented to allow exploratory assessment of its influence on outcomes. Blinding of the intubating anesthesiologist was not feasible. However, all timing variables were recorded by a second observer who was not involved in airway management. Pre-study calibration was conducted to standardize the definition of the time point at which the best glottic view was achieved.

Outcome

Laryngoscopy time was defined as the interval between insertion of the laryngoscope blade between the lips and attainment of the best glottic view. Endotracheal tube insertion time was defined as the interval from introduction of the tube into the oral cavity until its passage through the vocal cords. Total intubation time was calculated as the sum of these two intervals.

Successful intubation was predefined as completion within 90 s, maintenance of oxygen saturation (≥92%), and achievement within no more than two attempts. These thresholds were selected based on criteria commonly used in difficult airway research to balance procedural efficiency with patient safety in populations at risk of rapid desaturation. Adverse events—including oxygen desaturation below 92%, mucosal trauma, esophageal intubation, and dental injury—were prospectively defined and systematically recorded. The percentage of glottic opening (POGO) score was not used because consistent application across operators could not be ensured.

Bias

Selection bias was mitigated through consecutive patient recruitment. Measurement bias was reduced by applying a standardized induction protocol, using objective time-based endpoints, and employing a second observer to record timing variables. Although group allocation was visible, the observer's nonparticipation in airway management was intended to limit measurement bias.

Study size

Sample size estimation was based on previously published proportions of Cormack–Lehane grade I views during video-laryngoscope-guided intubation in obese patients positioned in the ramped versus sniffing positions.[3] Because robust data on differences in intubation time were unavailable, the Cormack–Lehane grade I view was used as a surrogate outcome. Assuming proportions of 95% and 63.4% for the ramped and sniffing positions, respectively, a power of 90%, and a two-sided alpha of 0.05, a minimum of 33 patients per group was required. To account for potential attrition, 40 patients were enrolled in each group. No interim analyses or sample size re-estimation were planned.

Statistical analysis

Statistical analysis was performed using Statistical Package for the Social Sciences version 21 (IBM Corp., Armonk, NY, USA). Data normality was assessed using the Shapiro–Wilk test, and homogeneity of variances was assessed using Levene's test. Continuous variables were compared using the Student's *t*-test, while categorical variables were analyzed using the chi-square test. Effect sizes with 95% confidence intervals (CIs) were reported for primary outcomes. Multiple-comparison adjustment was not performed, as only a limited number of predefined secondary outcomes were analyzed; this decision was acknowledged as a methodological consideration. All enrolled participants completed the study protocol, and analyses were conducted on a per-protocol basis. Exploratory assessment of potential confounding by BMI category and ASA III status was considered during interpretation, although the study was not powered for formal stratified analyses.

Results

A total of 96 patients were screened during the study period, and 80 met the eligibility criteria and were included in the analysis, with 40 patients each in the sniffing and ramped groups [Figure 1]. No patient who consented was excluded after enrollment. Since allocation was non-randomized, baseline comparability was assessed both statistically and clinically. Absolute differences between groups in age, BMI, ASA status, airway characteristics, and demographic variables were small, and corresponding standardized mean differences fell within ranges generally interpreted as indicating negligible imbalance. Thus, no clinically meaningful baseline differences were identified that could plausibly explain the outcome variation observed between groups [Table 1].

The primary outcome, total intubation time, was significantly shorter in patients placed in the ramped position than in those placed in the sniffing position [Table 2]. Mean total intubation time was 25.74 ± 13.79 s in the ramped group and 42.51 ± 17.95 s in the sniffing group, yielding a mean difference of −16.77 s (95% CI: −23.14 to −10.40; $P = 0.001$). This represents an approximate relative reduction of 40%, which exceeds what is typically considered clinically meaningful in obese patients who are vulnerable to rapid desaturation.

When the components of this interval were examined, laryngoscopy time was slightly shorter in the sniffing position (9.88 ± 2.76 s vs. 11.13 ± 4.50 s; mean difference: −1.25, 95% CI: −2.46 to −0.04; $P = 0.035$). Although laryngoscopy time was slightly shorter in the sniffing

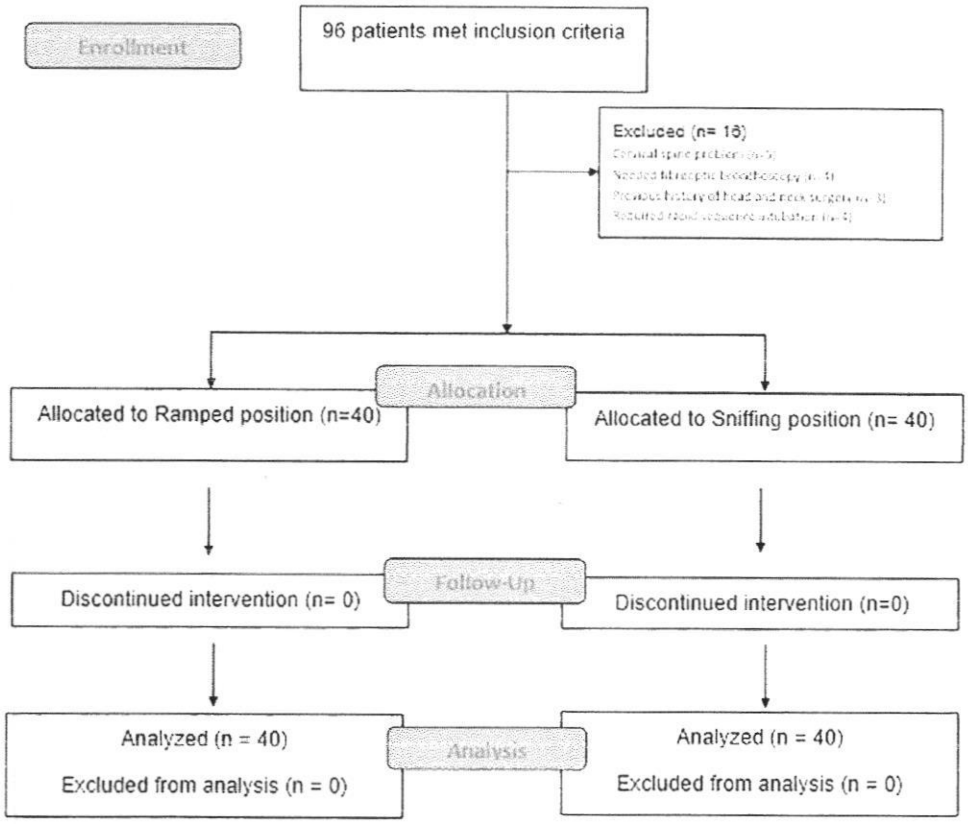

Figure 1: Flow diagram summarizing inclusion, allocation, and analysis

Table 1: Demographic profile

Variables	Group S ($n = 40$)	Group R ($n = 40$)	P
Age (years), mean ± SD	50.40 ± 12.46	46.43 ± 13.37	0.173
Sex, n (%)			1.000
Male	14 (35)	15 (37.5)	
Female	26 (65)	25 (62.5)	
BMI (kg/m^2), mean ± SD	32.96 ± 3.06	32.68 ± 3.33	0.694
ASA physical status, n (%)			0.658
I	10 (25)	13 (32.5)	
II	26 (65)	22 (55)	
III	4 (10)	5 (12.5)	
Mouth opening, n (%)			0.494
Two fingerbreadths	0 (0)	4 (10)	
Three fingerbreadths	40 (100)	36 (90)	
Mallampati class, n (%)			0.222
1	17 (42.5)	10 (25)	
2	21 (52.5)	26 (65)	
3	2 (5)	4 (10)	
Difficult airway, n (%)			0.359
Anticipated	27 (67.5)	22 (55)	
Not anticipated	13 (32.5)	18 (45)	

ASA: American Society of Anesthesiologists, BMI: body mass index, SD: standard deviation

position, this likely reflects the familiar ergonomics and ease of initial blade insertion in a horizontally aligned head posture. However, this advantage did not translate into faster overall intubation because the subsequent passage of the endotracheal tube was substantially more efficient in the ramped position. The head-elevated ramped position appeared to provide a more favorable laryngeal approach angle and pharyngeal space, facilitating smoother endotracheal tube advancement and ultimately resulting in a shorter total intubation time. Endotracheal

Table 2: Comparison of Cormack-Lehane grading, laryngoscopy time, endotracheal tube insertion time, and the total intubation time during video laryngoscopy

Variables	Group S (*n* = 40)	Group R (*n* = 40)	MD (95% CI)	*P*
Cormack–Lehane grade, *n* (%)			–	0.040
1	12 (30)	23 (57.5)		
2a	21 (52.5)	14 (35)		
2b	7 (17.5)	3 (7.5)		
Laryngoscopy time (s), mean ± SD	9.88 ± 2.76	11.13 ± 4.5	−1.25 (−2.46 to −0.04)	0.035
ETT insertion time (s), mean ± SD	32.84 ± 17.5	16.49 ± 12.48	−16.35 (−22.17 to −10.52)	<0.001
Total intubation time (s), mean ± SD	42.51 ± 17.95	25.74 ± 13.79	−16.77 (−23.14 to −10.40)	0.001

CI: confidence interval, MD: mean difference, SD: standard deviation, ETT: endotracheal tube

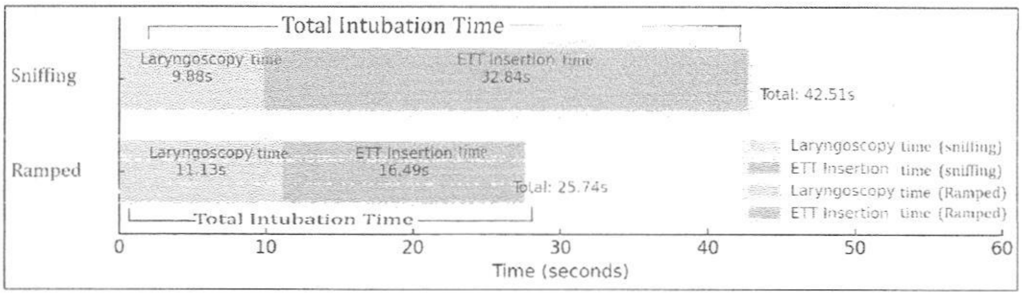

Figure 2: Schematic timeline diagram

Table 3: Number of attempts, intubation success, desaturation events, and esophageal intubation

Variables	Group S (*n* = 40)	Group R (*n* = 40)	*P*
Number of attempts, *n* (%)			0.091
1	32 (80)	38 (95)	
2	8 (20)	2 (5)	
Successful intubation, *n* (%)			0.608
Yes	37 (92.5)	39 (97.5)	
No	3 (7.5)	1 (2.5)	
Desaturation events, *n* (%)			0.608
Yes	3 (7.5)	1 (2.5)	
No	37 (92.5)	39 (97.5)	
Esophageal intubation, *n* (%)			0.356
Yes	4 (10)	1 (2.5)	
No	36 (90)	39 (97.5)	

tube insertion time was markedly shorter in the ramped group (16.49 ± 12.48 s vs. 32.84 ± 17.50 s in the sniffing group; mean difference: −16.35, 95% CI: −22.17 to −10.52; $P < 0.001$), indicating smoother advancement of the tube once the glottis was visualized [Table 2]. Glottic visualization also favored the ramped position. Cormack–Lehane grade I view was achieved in 57.5% of patients in the ramped group compared with 30% in the sniffing group ($P = 0.040$). No patient in either group had Cormack-Lehane (CL) grade III–IV views during VL. Figure 2 represents a schematic timeline diagram of these time variables.

Procedural success rates were high in both groups. First-attempt success was noticed in 95% of patients in the ramped group and 80% in the sniffing group. Overall, successful intubation, defined as completion within 90 s, maintenance of SpO_2 ≥92%, and not more than two attempts, was achieved in 97.5% of patients in the ramped group and 92.5% in the sniffing group [$P = 0.608$, Table 3].

No major complications occurred in either group. Minor adverse events were infrequent. Desaturation events (SpO_2 < 92%) occurred in three patients in the sniffing group and one patient in the ramped group. Esophageal intubation was recorded in four patients in the sniffing group and one in the ramped group. No dental injuries or clinically significant mucosal trauma were reported [Table 3]. As multiple secondary outcomes were evaluated without formal statistical adjustment, the possibility of inflated type I error exists; however, all outcomes were predefined, limited in number, and clinically independent, reducing this risk.

Discussion

In this prospective, non-randomized observational cohort, the ramped position was associated with a shorter total intubation time and a higher proportion of favorable glottic views during VL in obese surgical patients, similar to previously done studies, which highlight the physiological and anatomical benefits of ramped positioning.[3,4,7,13,14] Although numerical differences were substantial, the purpose of this discussion is to interpret their clinical meaning rather than repeat detailed statistics. A key observation is that the reduction in overall intubation time in the ramped position was not driven by faster initial laryngoscopy, but by a smoother, quicker passage of the endotracheal tube. This aligns with the concept that head-elevated positioning facilitates alignment of the external auditory meatus with the sternal notch, a configuration known to optimize upper airway geometry and improve operator ergonomics.[15,16] Even though VL does not require strict alignment of airway axes in the same way as DL, improved anatomical orientation and increased pharyngeal space may still contribute to more efficient intubation.[3,17,18]

The finding that laryngoscopy time alone was slightly shorter in the sniffing group warrants consideration. This could reflect the familiarity of clinicians with the sniffing posture and the ease of introducing the blade in a horizontally aligned head position. However, this initial advantage did not translate into faster intubation overall, likely because advancing the endotracheal tube may be less straightforward when head elevation is insufficient, and the glottic inlet appears acutely angled.[19,20] These interpretations remain tentative, as operator experience, table height, and ergonomic adjustments were not strictly standardized, and the study design does not allow firm mechanistic conclusions.

The improvement in Cormack–Lehane grade with ramped positioning is consistent with the principles of ear-to-sternal notch alignment. It has been described in both the direct and VL literature.[3,21] Nonetheless, the CL grading system was originally developed for DL and may not fully reflect the nature of the image produced by a video laryngoscope.[22] Although the POGO score might provide a more granular assessment, uniform application across observers was not feasible in this study. The results should therefore be interpreted with recognition that CL grading in the context of VL has inherent limitations.

The clinical relevance of the reduced intubation time should be considered in the context of obesity, where diminished functional residual capacity predisposes patients to rapid desaturation.[23,24] While this study did not measure oxygenation dynamics or quantify the relationship between intubation duration and desaturation events, even modest delays in securing the airway may have meaningful consequences in this population. Thus, the observed time difference, which represents a considerable relative improvement, suggests that ramped positioning may offer practical advantages during VL-guided intubation of obese patients,[3] though future studies with continuous oxygenation metrics are needed to confirm this hypothesis.

Although the findings align with the general recommendation for elevating the head and torso in obese patients, caution is warranted in interpreting these results as definitive evidence of superiority. The non-randomized design raises the possibility of unmeasured confounding, as anesthesiologists may have preferentially chosen positioning based on patient habitus, perceived difficulty, or operative context. Despite the apparent similarity in baseline characteristics, the potential for underlying bias still persists. Operator variability also represents a potential influence, despite attempts to standardize practice among experienced consultants. The inclusion of ASA III patients may also introduce unmeasured confounding, as physiological variability within this subgroup could influence intubation performance. Moreover, the sample size was calculated using Cormack–Lehane grade 1 as a surrogate outcome rather than the primary time-based endpoint, which could limit the power to detect smaller but clinically relevant effects on intubation duration. The study was conducted at a single center, which may limit generalizability to other settings with different equipment, staff expertise, or patient demographics. Another limitation is the absence of multivariable adjustment, which restricts the ability to account for covariates such as BMI range, ASA classification, or subtle variations in airway anatomy. The lack of detailed assessment of oxygenation profiles, hemodynamic changes, airway trauma, or patient comfort reduces insight into the broader safety and physiological implications of the two positions. While adverse events were few and comparable, this study cannot determine whether ramped positioning meaningfully improves peri-intubation safety beyond procedural efficiency.

Despite these limitations, this study contributes to the growing body of evidence suggesting potential advantages of head-elevated positioning for VL-guided intubation in obese patients. The associations observed here indicate that the ramped position may facilitate more efficient intubation and provide better glottic visualization than the traditional sniffing posture in this population. These findings warrant further evaluation in larger randomized and multicenter studies that incorporate detailed physiological endpoints, standardized ergonomic controls, and multivariable adjustment to better clarify the extent and mechanism of benefit. Until such data are available, these results offer support for considering ramped positioning as a practical approach in airway management strategies for obese individuals undergoing VL-assisted tracheal intubation.

In this observational cohort, the ramped position was associated with shorter total intubation time and more favorable laryngeal views during video-laryngoscope-guided intubation in obese patients. Although causality cannot be inferred, these findings suggest a potential advantage of head-elevated positioning in this population. The results may have practical relevance for perioperative airway management, particularly given the rapid desaturation risk in obese individuals. These findings support the potential incorporation of ramped positioning into airway management strategies for obese patients, while emphasizing the need for confirmation through larger, randomized multicenter studies.

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Authors contributions

Conceptualization: ST, DT, JPB, and SP. Methodology: ST, DT, JPB, and SP. Investigation: ST, DT, and JPB. Data curation: ST, DT, and JPB. Formal analysis: STand DT. Writing—original draft: ST, DT, JPB, and SP. Writing—review and editing: ST, DT, JPB, and SP. All authors approved the final manuscript.

Data availability statement

Deidentified individual participant data will be made available upon reasonable request to the corresponding author following publication, subject to institutional data-sharing policies and ethics approval.

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Conflicts of interest

There are no conflicts of interest.

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