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MODIFIED UNIVERSAL RAMP VERSUS INFLATABLE RAMP FOR CONVENTIONAL LARYNGOSCOPY IN OBESE PATIENTS: A RANDOMIZED COMPARATIVE STUDY

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ABSTRACT

Background: There are several alterations that exist within the structure of obese patients due to which the risk of difficult laryngoscopy becomes high. Although the use of ramp devices for better optimization of positioning is associated with improvement in conditions for intubation, there exists no comparison of Modified Universal Ramp versus Inflatable Ramp till date.

Objectives: A comparative study of the effectiveness of Modified Universal Ramp and Inflatable Ramp for improving glottic view (as determined by Cormack–Lehane grading) and ease of intubation on a 5-point Likert scale using conventional laryngoscopy technique in obese subjects.

Methods: One prospective randomized comparative study in a single-blind method was carried out at Saveetha Medical College and Hospital. Sixty obese patients (BMI> 30kg/ m2) undergoing elective surgeries under general anesthesia were randomly allocated into two groups (30 patients each). The first group (Group A) had patients with Modified Universal Ramp (MUR) while the second group had Inflatable Ramp. Assessment of CL grade and laryngoscopy (using 5-point Likert Scale) were the primary objectives. Statistical analysis of results involved Chi-Square Test (p-value <0.05)

Results: Both groups were comparable in age, BMI, gender, and ASA status. In the Modified Universal Ramp group, 56.7% of patients achieved CL Grade I and 43.3% Grade II, with no Grade III views. In the Inflatable Ramp group, no patients achieved Grade I, 50.0% were Grade II, and 50.0% were Grade III ($p = 0.01$). Ease of laryngoscopy was rated as 'easy' or 'very easy' in all Modified Universal Ramp patients, compared to 50.0% 'difficult' and 50.0% 'not difficult' in the Inflatable Ramp group ($p = 0.03$).

Conclusion: The Modified Universal Ramp demonstrates greater glottic visibility and easy laryngoscopy as opposed to the Inflatable Ramp, especially during laryngoscopy among obese patients. The Modified Universal Ramp is stable and enables airway alignment easily; therefore, it is more likely to be used among obese patients.

KEYWORDS: Airway management; Obesity; Ramp position; Cormack–Lehane grade; Laryngoscopy; Modified Universal Ramp; Inflatable Ramp; Endotracheal intubation

1. INTRODUCTION

Obesity is becoming one of the biggest problems in anesthetic care today due to its serious consequences for the safety of anesthesia1-2. In the last thirty years, there has been an explosion in obesity levels worldwide, in developed and developing countries alike, making it into an epidemic that shows no signs of dying down. It is also considered by the WHO as one of the biggest health concerns today, with effects far beyond the metabolic and cardiovascular problems caused by the condition and going into the realm of surgery and anesthesiology3. More and more patients coming for elective and emergency surgery are having a body mass index over 30 kg/m², leaving anesthesiologists with the difficult task of securing their airway4.

In comparison to people with normal body build, the management of airway in obese patients is inherently complicated because of a host of anatomic and physiologic changes that make such patients vulnerable to difficulty in intubation. Accumulation of fat deposits in the pharyngeal walls causes narrowing of the upper airway at several anatomical levels and makes it difficult for air to pass through, leading to partial or complete airway obstruction during the apneic period of general anesthesia induction.[1] Obese patients have limited flexibility in cervical spine due to the presence of excess soft tissues in the back of the neck and in the upper chest, thus making it difficult to achieve optimal head positioning during laryngoscopy and reducing the visibility of glottis.[2] In addition, the functional residual capacity in such patients is greatly decreased because of cephalad shifting of the diaphragm due to accumulation of fat mass in the abdomen, especially when

lying supine.[1,2] This results in faster development of apnea-induced hypoxemia during intubation attempts, with the functional residual capacity being lower than closing capacity even in resting conditions.[1,2]
Apart from the dangers associated with hypoxemia, difficult laryngoscopy in obese individuals also presents with other negative implications such as multiple attempts to intubate, injury to the airway, aspiration of stomach content, as well as cannot-intubate/cannot-oxygenate situation, which is among the most dreaded emergencies in anaesthesia care [4-5]. Obese patients have been observed to experience the problem of difficult laryngoscopy more than their non-obese patients, and the predictors of difficult intubation in this category of patients, which include greater neck circumference, high Mallampati classification, and small mouth opening, have been commonly observed in clinical settings[6]. Positioning of the patient represents one of the primary and easily modifiable factors affecting the success of the laryngoscopy. The standard sniffing position, attained through the flexion of the lower cervical spine and extension of the atlanto-occipital joint, is commonly used in non-obese patients for the alignment of the oral, pharynx, and laryngeal axis for optimal visualization[7]. Nevertheless, this position is not adequate in cases of morbid obesity, when due to large amount of fatty tissue located in the posterior region of the neck and upper part of the back the occiput cannot be elevated enough for proper axial alignment and visualization of the glottis. The ramped position characterized by horizontal alignment of the external auditory meatus with the sternal notch was proved to provide a solution to this problem by lifting the torso and head high enough to ensure the needed alignment.[5] It results in better visualization of the glottis, better chances of successful first-attempt intubation and longer safe apnea time because of more efficient preoxygenation in the head-elevated position.[5,6] The latter one also promotes recruitment of the dependent lung units, improves ventilation-perfusion matching and provides more oxygen in the reservoir during apnea period.

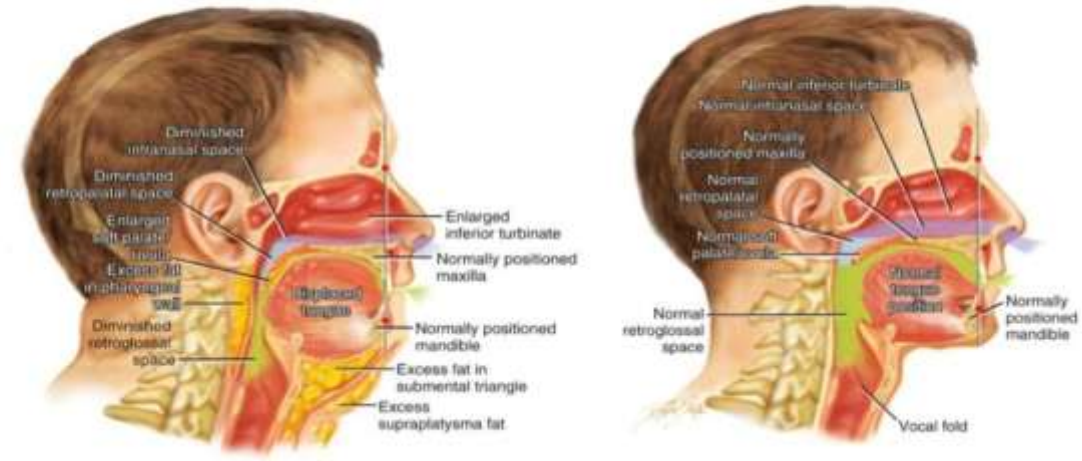

Figure 1: Sagittal shows comparing upper airway anatomy in obese (left) and non-obese (right) individuals, highlighting excess pharyngeal fat, diminished airway spaces, displaced tongue, enlarged soft palate — contributing to anticipated difficult airway management in obesity

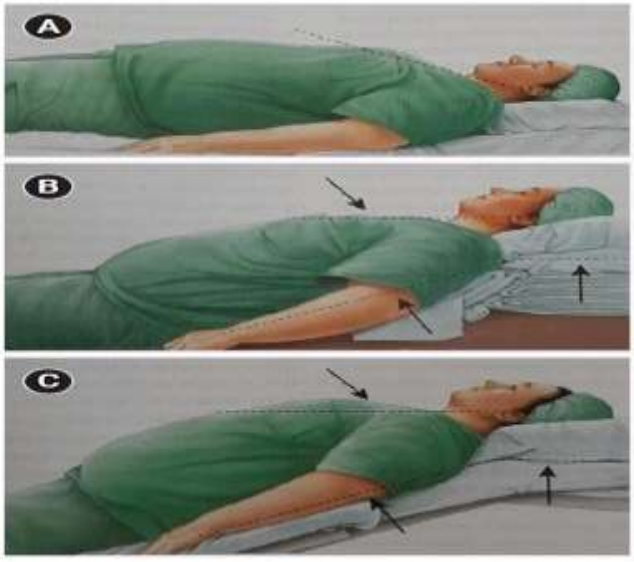

Figure 2: Sequential figures demonstrating standard supine (A), blanket-assisted ramp (B), and device-assisted ramp (C) positioning in obese patients, aimed at aligning airway axes by achieving the ear-to-sternal-notch horizontal plane for optimal laryngoscopy.

These flaws have led to the development of engineered positioning ramp devices meant to create consistency in the elevation of the upper body and head of obese patients. Two of the current positioning ramp devices available in the market are the Modified Universal Ramp and the Inflatable Ramp. The Modified Universal Ramp is a multi-level foam device with an integrated alignment scale and a head positioning system which allows for step-wise elevation of the upper body and head. The rigidity of the foam ensures that the ramp maintains its height regardless of the weight on it during the pre-oxygenation and intubation process [8]. The integrated alignment scale enables visualization and thus precise positioning of the ears and the sternal notch regardless of differences in body habitus between patients. The Inflatable Ramp is a pneumatic ramp, which can be adjusted individually via insufflation of air [9]. The ability to control the degree of inflation makes this ramp customizable based on patient body contours. Thus, it is capable of providing for a greater range of body types compared to the other devices. Comparative studies on the effectiveness of these two positioning ramps in improving laryngoscopic conditions are limited [10].

Accordingly, the present study was designed to compare the effectiveness of the Modified Universal Ramp and the Inflatable Ramp in facilitating glottic visualization during conventional laryngoscopy in obese patients, with laryngoscopic grade assessed using the Cormack–Lehane classification system [11-12]. The findings of this study are intended to provide evidence-based guidance for device selection in the perioperative airway management of the obese patient population, and to contribute to the growing body of literature aimed at enhancing intubation safety and success in this challenging clinical cohort [13].

Although the importance of appropriate positioning in obese patients is increasingly recognized, standardized guidelines for selecting positioning devices during routine anaesthesia are still lacking. In many healthcare settings, the choice of device is primarily influenced by clinician preference or local availability rather than robust comparative evidence, leading to substantial variation in practice among institutions [14]. This variability is clinically relevant because small differences in the height and stability of head elevation can significantly affect laryngoscopic view, intubation success, the number of attempts required, and overall patient safety [15-16]. In addition, most previous studies investigating ramp positioning devices have focused on comparing them with improvised ramps or the traditional sniffing position, while direct comparisons between commercially available devices remain limited.[7] Differences in patient populations, assessment methods, outcome variables, and laryngoscopy techniques across studies have further complicated the interpretation of available evidence and hindered definitive conclusions regarding the relative effectiveness of individual devices[17]. Consequently, there is a strong need for prospective, methodologically rigorous comparative research that directly evaluates these devices using standardized endpoints, thereby providing reliable evidence to guide perioperative airway management strategies in obese patients[3, 18].

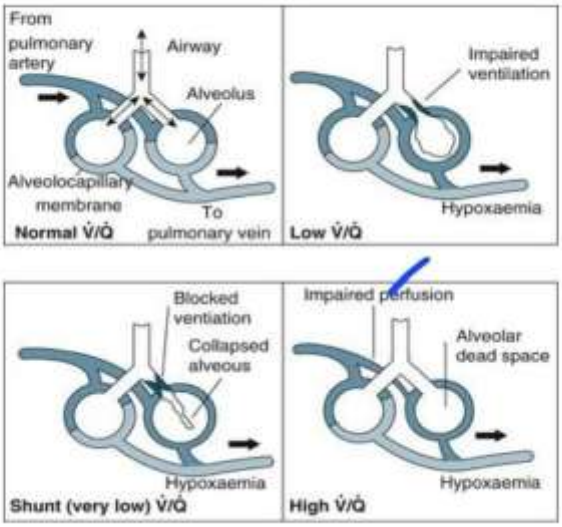

Figure 3: Schematic representation of four ventilation-perfusion (V̇/Q̇) states — normal, low, shunt, and high V̇/Q̇ — demonstrating their individual effects on alveolar gas exchange and the resulting hypoxaemia, particularly relevant in obese patients.

2. MATERIALS AND METHODS

Study Design And Setting

A single blinded, prospective randomized comparison study was done at the Department of Anaesthesia in Saveetha Medical College & Hospital, Chennai, India, between December 2024 and December 2025. This was approved by the Institutional Human Ethics Committee with approval number 017/01/2025/IEC/SMCH and registered with Clinical Trials Registry India, CTRI/2026/02/102764. Procedures were performed adhering to the Declaration of Helsinki. Consent was obtained from all subjects before inclusion in the study.

2.2 Participants

Patients of 18 to 60 years old who have BMI >30 kg/m², have physical condition status of ASA physical status class II or III, and who would undergo elective surgery under GA requiring intubation with conventional laryngoscopy are included

in this study. Patients with hemodynamic instability (systolic BP less than 90 mmHg on inotropes) with inability to perform oral manipulation and those with neck injury which needs immobilization and ASA physical status more than IV are excluded from this study.

2.3 Randomization And Allocation

A total of 60 patients were enrolled and randomized using simple randomization into two equal groups of 30 participants each: Group A (Modified Universal Ramp) and Group B (Inflatable Ramp). An experienced anaesthesiologist blinded to group allocation performed all laryngoscopies.

2.4 Intervention

After conventional patient monitoring (electrocardiogram, non-invasive blood pressure, pulse oximeter, and end-tidal CO_2) and measuring baseline vital signs, patients will then be placed based on their allocation. Patients in Group A will use the Modified Universal Ramp, consisting of step-wise foam wedge with angular adjustment of 10° and alignment guide, to position the body from head up to the chest such that the external auditory meatus is in line with the sternal notch level. In Group B, Inflatable Ramp, consisting of air-filled, multilayer, height-adjustable devices, was used to do the same thing. Patients in both groups will be intubated using Macintosh laryngoscope by a single anaesthesiologist.

2.5 Primary Outcome Measures Glottic visualization, using the Modified CL Classification system (Grade I: complete visibility of glottis; Grade II: partial visibility of glottis; Grade III: epiglottis visible only; Grade IV: none of glottis or epiglottis seen) and difficulty in laryngoscopy, using a 5-point Likert scale (−2: very difficult; −1: difficult; 0: not difficult; +1: easy; +2: very easy) will be determined as the primary outcome measures.

2.6 Statistical Analysis

Statistical analysis was carried out using IBM SPSS Statistics for Windows Version 26.0. Normality testing was performed by Kolmogorov-Smirnov test and Shapiro-Wilk test. Continuous data were expressed as means ± standard deviations and were compared using independent t-test. Categorical data were expressed as frequency (%) and compared using chi-square test.

3. RESULTS

3.1 Baseline Characteristics

The study population consisted of 60 patients (30 patients in each group). The two groups were comparable in terms of baseline demographic and clinical profiles (Table 1). Mean age for Group A was 45.67 ± 4.30 years and 46.87 ± 3.79 years for Group B (p = 0.464). Mean body mass index (BMI) was 36.27 ± 2.03 kg/m2 and 36.63 ± 1.92 kg/m2, respectively (p = 0.794). The gender profile was similar in both groups (male and female – 50% each). ASA classification was also similar (p = 0.060).

Table 1.Demographic and clinical profile of the study population at baseline.

Variable	Modified Universal RAMP(Group A, n=30)	Inflatable RAMP(Group B, n=30)	P Value
Age (years), Mean ± SD	45.67 ± 4.30	46.87 ± 3.79	0.464
BMI (kg/m²), Mean ± SD	36.27 ± 2.03	36.63 ± 1.92	0.794
Gender (Male/Female)	15/15 (50%/50%)	15/15 (50%/50%)	1.000
ASA II / ASA III	22 (73.3%) / 8 (26.7%)	20 (66.7%) / 10 (33.3%)	0.060

SD = standard deviation; ASA = American Society of Anesthesiologists physical status.

3.2 Primary Outcome 1: Cormack–Lehane Grading (Glottic Visualization)

The distribution of Cormack–Lehane grades was significantly different among the groups (Table 2). The Modified Universal Ramp group resulted in CL Grade I in 56.7% and CL Grade II in 43.3%; all cases with CL Grade I were not observed in this group. On the contrary, none of the subjects attained Grade I in the Inflatable Ramp group, with 50% in Grade II and the other 50% in Grade III. This difference was statistically significant (p = 0.01), suggesting better glottic exposure with Modified Universal Ramp.

Table 2.Cormack-Lehane Grade distribution according to positioning device used.

CL Grade	Modified Universal RAMPn (%)	Inflatable RAMPn (%)	Chi-Square	P Value
Grade I	17 (56.7%)	0 (0.0%)	8.94	0.01*
Grade II	13 (43.3%)	15 (50.0%)		
Grade III	0 (0.0%)	15 (50.0%)		

*CL = Cormack–Lehane; *p <0.05 statistically significant.*

3.3 Primary Outcome 2: Ease Of Laryngoscopy

Easiness of laryngoscopy was recorded as "easy" (+1) or "very easy" (+2) for all 30 participants who underwent Modified Universal Ramp positioning (easy: 46.7%; very easy: 53.3%). Meanwhile, none of the subjects from the other group gave a positive rating: 50.0% were marked as "difficult" (−1) while the remaining half was marked as "not difficult" (0). There was a statistically significant difference in this respect (p = 0.03) which proves that laryngoscopy was more easily conducted using Modified Universal Ramp (see Table 3).

Table 3. Easiness of laryngoscopy distribution according to positioning devices used..

Ease of Laryngoscopy	Modified Universal RAMPn (%)	Inflatable RAMPn (%)	Chi-Square	P Value
Very Easy	16 (53.3%)	0 (0.0%)	60.00	0.03*
Easy	14 (46.7%)	0 (0.0%)		
Not Difficult	0 (0.0%)	15 (50.0%)		
Difficult	0 (0.0%)	15 (50.0%)		

**p <0.05 statistically significant.*

4. DISCUSSION

The randomized study under consideration is one of the novel studies that have directly compared the Modified Universal Ramp to the Inflatable Ramp in relation to the outcomes of conventional laryngoscopy in obese patients [3, 13]. Despite the fact that both devices can be regarded as specifically designed means of overcoming the well-known difficulty of managing the airways in obese patients, the results of this study point to the clinically relevant differences in the performance of these devices[17]. It has become clear that there is a statistically significant advantage of the Modified Universal Ramp in two primary outcomes: Cormack-Lehane grade (visualization of glottis) and ease of laryngoscopy [15-16].

The present study evaluated the efficacy of the Modified Universal RAMP in comparison with the Inflatable RAMP for optimizing intubation conditions using conventional laryngoscopy in obese patients [13-14]. The findings of this study demonstrated that the Modified Universal RAMP significantly improved glottic visualization, ease of laryngoscopy, and ease of positioning when compared to the Inflatable RAMP, while baseline demographic variables remained comparable between the two groups.

In the current study, both groups were well matched with respect to age, gender, BMI, and ASA physical status, with no statistically significant differences observed. The mean age distribution (45.67 ± 4.30 vs. 46.87 ± 3.78 years) and BMI (36.27 ± 2.03 vs. 36.63 ± 1.92 kg/m²) were comparable (p > 0.05). This uniformity ensures that the observed differences in intubation conditions can be attributed primarily to the positioning techniques rather than confounding demographic variables. Similar baseline comparability has been reported in studies by Collins JS et al. and Gaszynski I, where demographic variables were evenly distributed between comparison groups, strengthening the validity of outcome assessment (3). In contrast, study by Li N et al. reported variations in baseline characteristics, including BMI and clinical status, between groups, which could potentially influence intubation outcomes and introduce bias (14). Such differences highlight the strength of the present study, where well-matched groups reduce confounding and allow for more accurate comparison of positioning techniques [18-19].

The most significant finding of the present study was the marked improvement in glottic visualization with the Modified Universal RAMP. A majority of patients (56.7%) in this group had Cormack–Lehane Grade I view, with no Grade III views, whereas the Inflatable RAMP group showed no Grade I views and 50% Grade III views (p = 0.01). This indicates superior alignment of airway axes with the Modified Universal RAMP. These findings are consistent with the study by Nandhakumar JS et al., (2021) who demonstrated that the “ramped position” significantly improves laryngoscopic view in obese patients by aligning the external auditory meatus with the sternal notch (15). Similarly, Dixon BJ et al. (2005) reported improved laryngeal visualization and oxygenation with head-elevated positioning in obese individuals (6). In contrast, study by Alimian et al., (2021) reported that the poorer glottic views observed with the Inflatable RAMP in the present study may be attributed to inconsistent or unstable elevation, leading to suboptimal airway alignment.

The ease of laryngoscopy was significantly better in the Modified Universal RAMP group, with all patients categorized as either “easy” or “very easy,” whereas the Inflatable RAMP group demonstrated 50% “difficult” cases (p = 0.03). This aligns with findings from Khandelwal N et al., who reported that proper ramp positioning reduces the difficulty of laryngoscopy in obese patients by improving line-of-sight visualization (16). The improved ergonomics and stable positioning provided by the Modified Universal RAMP likely contributed to this outcome. In contrast, a study by Pachisia et al., (2019) evaluating adjustable or inflatable positioning devices reported no significant difference in ease of laryngoscopy between groups, possibly due to variability in device stability and operator experience (16).

Similarly, ease of positioning was significantly better with the Modified Universal RAMP (p = 0.05), with the majority of cases rated as “easy” or “very easy.” These findings of the present study are consistent with those reported by Lee JS

et al., who demonstrated that structured ramp positioning significantly improved patient alignment and facilitated easier positioning for laryngoscopy in obese patients. In contrast, Lee et al., (2024) reported that inflatable positioning devices provided inconsistent support, resulting in variable ease of positioning and a higher proportion of "difficult" cases, highlighting the limitations of devices lacking rigid structural stability (17).

The superiority of the Modified Universal RAMP observed in this study can be attributed to its structured, multi-layered design, which provides consistent and reproducible elevation. The presence of a sliding scale for alignment and an integrated head support system likely contributed to better anatomical positioning (18). In contrast, the Inflatable RAMP, although adjustable, may lack precision and stability, leading to variability in positioning and suboptimal airway alignment.

Another important consideration is that obese patients present unique airway challenges due to increased soft tissue mass and reduced functional residual capacity. Previous studies, including those by Dixon BJ et al., (2005) have highlighted the importance of head-elevated positioning in improving airway patency and oxygenation (6). The findings of the present study further reinforce the importance of optimal ramp positioning in this population.

However, some studies have reported that inflatable or adjustable devices can be useful in achieving individualized positioning [16]. The contrast observed in the present study may be due to differences in device design, operator familiarity, and the degree of control over alignment achieved with each device.

Overall, the present study demonstrates that the Modified Universal RAMP provides superior intubating conditions compared to the Inflatable RAMP in obese patients [13, 15-17]. The significant improvement in glottic visualization, ease of laryngoscopy, and ease of positioning suggests that structured ramp devices may be more effective than inflatable systems in achieving optimal airway alignment.

5. CONCLUSION

The Modified Universal Ramp was found to be superior to Inflatable Ramp in achieving ease of laryngoscopy and glottic visualization among obese patients. Its standardized and predictable nature guarantees that the alignment of airways is achieved consistently, leading to a higher likelihood of better Cormack-Lehane scores and laryngoscopy that is easily done by all operators. The results suggest that Modified Universal Ramp can serve as a reliable tool for positioning before conventional laryngoscopy among obese surgery patients. Further clinical trials at multiple centers are needed to confirm the results.

Informed Consent: Written informed consent was obtained from all participants.

Conflicts of Interest: The authors declare no conflicts of interest.

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Author Contributions: Priyanka Reddybathula conceived the study, collected data, and drafted the manuscript; Dr. Rajkumaran K supervised the study design, interpreted the results, and critically reviewed the manuscript Dr. Harish Kumar. J edited the photos and corrected the full manuscripts, Dr.S.Alagendran – Conceptualization the written, editing and final manuscripts.

Data Availability: The datasets used and analyzed during the current study are available from the corresponding author on reasonable request.

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