"A COMPARATIVE STUDY OF EASE OF INTUBATION BETWEEN SNIFFING AND RAMP POSITION IN ELECTIVE INTUBATIONS: A RANDOMISED CONTROL TRIAL"

By

Dr. M. SAI SHARATH MEGHANA

DISSERTATION SUBMITTED TO SRI DEVARAJ URS ACADEMY OF HIGHER EDUCATION AND RESEARCH, KOLAR, KARNATAKA

In partial fulfillment of the requirements for the degree of

DOCTOR OF MEDICINE

IN

ANAESTHESIOLOGY

Under the Guidance of

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ABSTRACT

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Date: **Dr M SAI SHARATH MEGHANA**

Place: Kolar

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ABBREVIATIONS

ASA	American Society of Anaesthesiologists
BMI	Body Mass Index
BP	Blood Pressure
CL	Cormack-Lehane
Cm	centimeter
DBP	Diastolic Blood Pressure
ECG	Electrocardiogram
EAMS	External Auditory Meatus to Sternal notch
ELM	External Laryngeal Manipulation
ET	Endotracheal
ETT	Endotracheal Tube
FRC	Functional Residual Capacity
HR	Heart Rate
ID	Internal Diameter
IV	Intravenous
Kg	Kilogram
MAP	Mean Arterial Pressure

Mg	Milligram
Min	Minute
Ml	Milliliter
Mm	Millimeter
mmHg	Millimeter of Mercury
OA	Oral Axis
OELM	Optimal External Laryngeal Manipulation
OT	Operation Theatre
PA	Pharyngeal Axis
POGO	Percentage of Glottic Opening
RAMP	Rapid Airway Management Position
RCT	Randomized Controlled Trial
SBP	Systolic Blood Pressure
SD	Standard Deviation
Sec	Second
SpO_2	Oxygen Saturation measured by Pulse Oximetry
TMLD	Thyromental Length Distance

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ABSTRACT

Background: Endotracheal intubation is a critical procedure performed during general anesthesia that requires optimal positioning to facilitate visualization of the glottis and successful tube placement. “Traditionally, the Sniffing position has been considered the gold standard for direct laryngoscopy. However, recent studies suggest that the Ramped position (RAMP) may offer advantages in certain patient populations. This randomized controlled trial aimed to compare the ease of intubation between the Sniffing and RAMP positions in patients undergoing elective surgeries requiring general anesthesia with endotracheal intubation.”

Materials and Methods: One hundred and eight adult patients (ASA I-II) scheduled for elective surgeries under general anesthesia were randomly allocated to either the RAMP position (n=54) or the Sniffing position (n=54). The primary outcomes measured were laryngoscopic view (Cormack-Lehane grade), time to successful intubation, and number of intubation attempts. Secondary outcomes included hemodynamic responses (heart rate, blood pressure) to laryngoscopy and intubation, oxygen saturation, and complications. Data were analyzed using appropriate statistical tests with $p<0.05$ considered significant.

Results: Demographic characteristics were comparable between the two groups. While there was no significant difference in Cormack-Lehane grading between the groups (p=0.692), the time to successful intubation was significantly shorter in the RAMP position (28.88 ± 8.36 seconds versus 32.22 ± 8.70 seconds, p=0.04). The first-attempt success rate was significantly higher in the RAMP position (92.6% versus 74.1%, p=0.02). Hemodynamic responses were significantly attenuated in the RAMP position, with lower post-laryngoscopy heart rate (p=0.009), systolic blood pressure (p=0.002), diastolic blood pressure (p=0.018), and mean arterial pressure (p=0.001) compared to the Sniffing position. These differences persisted until 5 minutes post-intubation. Fewer complications were observed in the RAMP position group (3.7% versus 22.2%, p=0.01), particularly sore throat (1.8% versus 16.7%). Oxygen saturation remained comparable between the groups throughout the study period

Conclusion: The RAMP position is associated with shorter intubation time, higher first-attempt success rate, attenuated hemodynamic responses to laryngoscopy and intubation, and fewer complications compared to the traditional Sniffing position in patients undergoing elective surgeries. These findings suggest that the RAMP position may be considered as a preferred positioning technique for routine endotracheal intubation in the elective setting.

Keywords: Endotracheal intubation; RAMP position; Sniffing position; Laryngoscopy; Intubation time; Hemodynamic response; Airway management; First-attempt success; Cormack-Lehane grade; General anesthesia

INTRODUCTION

INTRODUCTION

Respiratory passage control constitutes an essential competency within anesthesiology practice, with tracheal cannulation remaining the preeminent approach for establishing respiratory security during general anesthetic administration. Procedural success fundamentally depends upon achieving optimal cephalic and cervical positioning to create alignment between oral, pharyngeal, and laryngeal anatomical trajectories, thereby facilitating optimal visualization of the glottic aperture during conventional laryngoscopic examination. Throughout anesthetic clinical evolution, numerous cephalic positioning methodologies have been proposed and investigated to enhance cannulation procedural success rates.[1]

The conventional "olfactory position," initially characterized by Sir Ivan Magill in 1936, has historically been regarded as the preferred orientation for conventional laryngoscopic visualization and tracheal cannulation procedures. This positioning technique involves cervical flexion of 35 degrees relative to thoracic alignment coupled with cephalic extension approximating 15 degrees relative to cervical orientation. The olfactory position has been extensively integrated into educational curricula and accepted as procedural standard for endotracheal instrumentation based on morphological investigations and empirical clinical observations.[2] Anatomical evaluations have established that this orientation facilitates alignment between three trajectories - oral, pharyngeal, and laryngeal - theoretically optimizing direct visualization pathway to the glottic aperture during laryngoscopic examination. A comprehensive analytical review conducted by El-Orbany and colleagues demonstrated that olfactory positioning substantially enhanced laryngeal visualization compared with isolated cephalic extension among normative adult populations undergoing elective surgical interventions[3]

Nevertheless, contemporary investigations have questioned universal implementation of the olfactory positioning approach, particularly among individuals with variant body morphology or anatomical differences. Collins and colleagues conducted magnetic resonance imaging evaluation that challenged the triple-trajectory alignment hypothesis, suggesting complete alignment may neither be essential nor physiologically achievable across all patient demographics[4] .This has generated increased investigational interest regarding alternative positioning methodologies potentially offering advantages among specific patient populations or clinical circumstances.

The Elevated positioning technique, alternatively designated Head-Elevated Laryngoscopic Positioning (HELP), has emerged as a promising procedural alternative, particularly during recent clinical practice evolution. This positioning methodology involves upper torso and cephalic elevation utilizing textile supports, folded linens, or purpose-designed positioning apparatus "until horizontal alignment is achieved between the external auditory canal and sternal notch". Initially developed for enhancing laryngoscopic visualization among individuals with elevated body mass indices, the Elevated positioning technique has demonstrated potential benefits within general patient populations.[5] A prospective randomized investigation by Semler and associates demonstrated improved initial-attempt success rates and enhanced glottic visualization when implementing elevated positioning compared with conventional olfactory positioning among critically ill individuals requiring endotracheal cannulation.[6]

The physiological advantages of the RAMP position extend beyond simply improving the laryngeal view. Studies have shown that this position can enhance pre-oxygenation efficiency and increase functional residual capacity, potentially providing a longer safe apnea time during intubation attempts. Research by Lane et al. demonstrated that the ramped position significantly improved respiratory mechanics and oxygen saturation during the pre-oxygenation period compared to the supine position.[7] These physiological benefits could be particularly valuable in patients with reduced respiratory reserve or those at higher risk of rapid desaturation. The choice between sniffing and RAMP positions may also have implications for hemodynamic stability during intubation. A prospective observational study by Martinez et al. found that patients positioned in the RAMP position experienced fewer episodes of significant blood pressure fluctuations during laryngoscopy compared to those in the sniffing position.[8] This could be attributed to reduced cervical spine movement and less sympathetic stimulation during the intubation process, although more research is needed to fully understand these mechanisms.

The impact of patient positioning on intubation success becomes even more critical when considering the potential complications of failed or difficult intubation attempts. Multiple attempts at laryngoscopy can lead to airway trauma, dental injury, hypoxemia, and in severe cases, cannot-intubate-cannot-ventilate scenarios. “A meta-analysis by Cook et al. revealed that the risk of adverse events increases significantly with each subsequent intubation attempt”.[9] Therefore, optimizing the first attempt through proper positioning is crucial for patient safety and successful airway management.

Despite the growing body of research comparing these positions, there remains considerable debate about which approach should be considered standard practice for elective intubations in the general population. While some studies have shown clear advantages for specific patient groups, the results have not been consistently reproducible across all clinical settings and patient populations. Additionally, many existing studies have focused on emergency intubations or specific patient subgroups, leaving a gap in our understanding of the optimal position for routine elective cases in the general surgical population.[10]

This controversy is further complicated by variations in technique and definition of both positions across different studies and clinical settings. The exact degree of elevation, use of supporting devices, and methods of confirming proper positioning can vary significantly between practitioners and institutions. This variability makes it challenging to draw definitive conclusions from existing research and highlights the need for well-designed, standardized studies comparing these positions in controlled settings.

AIMS & OBJECTIVES

AIMS & OBJECTIVES

1. To compare Cormack Lehane grades in sniffing and RAMP positions.
2. To estimate the time taken for successful intubation in both Sniffing and RAMP position.
3. To measure the stress response to laryngoscopy.
4. To compare the attempts required for successful intubation in Sniffing and RAMP position.
5. To compare oxygen saturation levels and complications occurring during intubation in Sniffing and RAMP position.

REVIEW OF LITERATURE

REVIEW OF LITERATURE

ANATOMY OF UPPER AIRWAY

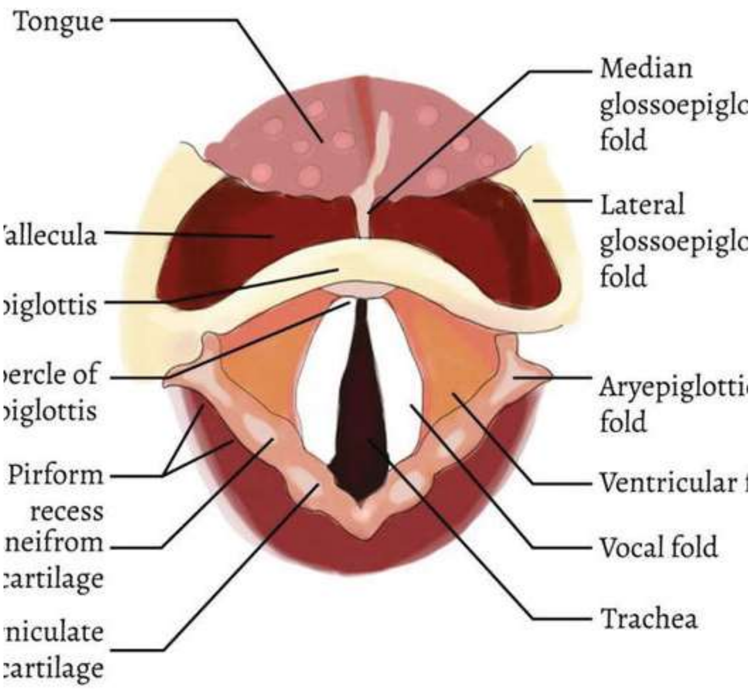
The respiratory conduit system encompasses anatomical structures facilitating gaseous exchange during pulmonary ventilation. This system extends from the nasal apertures and oral entrance to the terminal alveolar compartments. These structures are organized into distinct anatomical zones containing specialized tissues serving particular physiological functions. The respiratory pathway can be categorized into superior and inferior segments, each comprising multiple anatomical subdivisions as detailed subsequently.[11 12]

Upper Airway

- The pharynx functions as a conduit in the respiratory tract, situated between the cranial base and the esophagus, featuring mucous membrane lining and comprising three distinct regions:
- Nasopharynx, alternatively referred to as the "rhino-pharynx or post-nasal space, consists of a muscular passage extending from the nares, encompassing the posterior nasal chamber, separated from the oropharynx by the palatal structure, and adjoining the base of the skull at its superior boundary"
- The oro-pharynx serves as the intermediate connection between the naso and hypopharynx. "This segment extends from the palate to the hyoid bone, with its anterior aspect differentiated from the oral cavity by the tonsillar pillars
- The hypopharynx establishes continuity between the oropharynx and both the esophagus and larynx, constituting the pharyngeal portion inferior" to the hyoid bone.

- "The larynx is the portion of the airway between the pharynx and the trachea, contains the organs for the production of speech. Formed of a cartilaginous skeleton of nine cartilages, it includes the important organs of the epiglottis and the vocal folds (vocal cords) which are the opening to the glottis."

Figure 1: Anatomy of Upper Airway



Structure and Function

Respiratory conduits enable atmospheric gas movement during respiratory cycles from environmental surroundings to pulmonary exchange surfaces where gaseous transfer supporting metabolic processes occurs[13, 14]

To facilitate optimal function while maintaining physiological homeostasis and providing environmental protection, these anatomical structures perform multiple protective barrier functions:

- Hydration preservation mechanism comprising mucosal epithelial lining functioning as moisture conservation barrier preventing excessive water loss during respiratory cycles by enhancing atmospheric moisture content within superior respiratory passages
- Thermoregulatory mechanism functioning relative to core physiological temperature, as environmental conditions typically present reduced thermal values, with specialized vascular networks and anatomical

formations including nasal conchae warming inspired gases during transit through respiratory channels

- Antimicrobial defensive system as respiratory passages incorporate extensive lymphatic networks including mucosa-associated lymphoid aggregations (MALA) preventing pathogenic organism penetration. Complementary to this, mobile phagocytic cells continuously survey respiratory exchange surfaces providing fundamental components of the "pulmonary-circulatory interface"

Embryology

Superior respiratory passages develop embryologically from pharyngeal arch structures during cephalic and cervical formation processes.

At approximately four gestational weeks, laryngeal and inferior respiratory structures originate “from the longitudinal laryngotracheal sulcus forming a medial, groove-like” formation progressively developing into a tubular, terminal structure termed the laryngotracheal evagination. This structure subsequently separates from developing foregut through tracheo-esophageal fold formation.

Laryngeal cartilaginous and muscular components derive from fourth and sixth pharyngeal arch tissues, with glottic aperture formation establishing communication between this anatomical region and tracheal structure.[15]

Blood Supply and Lymphatics

Superior respiratory conduits supplied by diverse branches of “external carotid” arterial system with venous drainage into internal jugular vascular channels. The nasopharyngeal and oropharyngeal regions additionally receive arterial perfusion via facial arterial branch of external carotid system through tonsillar arterial distribution. Venous circulation from these anatomical structures proceeds through pharyngeal venous network ultimately entering “internal jugular” venous system. “Lymphatic drainage proceeds through various cervical lymphatic networks surrounding internal jugular vascular structures”[15]

Muscles

Pharyngeal and laryngeal musculature provides structural framework for superior respiratory passages and consists of striated muscular elements under combined visceral and somatic neurological regulation. These muscular components demonstrate functional association with deglutition processes.[15]

Indications

The primary objective of emergency tracheal cannulation is respiratory passage security with initial-attempt procedural success. Multiple clinical indications exist for tracheal cannulation procedures, including inadequate respiratory drive, questionable respiratory passage patency, oxygen deficiency states, and carbon dioxide retention. These parameters are evaluated through assessment of patient's cognitive status, conditions potentially compromising respiratory passage, consciousness level, respiratory frequency, ventilatory acidosis, and oxygenation parameters. Within trauma scenarios, "Glasgow Coma Scale measurement of 8 or below generally constitutes an indication for cannulation intervention"[16]

Contraindications

Risk-benefit analysis should precede tracheal cannulation procedures similar to all interventional procedures. Patients potentially benefiting from less invasive interventions should initially receive alternative modalities including non-invasive positive pressure ventilatory support or supplemental oxygenation techniques. Severe maxillofacial traumatic injury may impede conventional oropharyngeal cannulation due to significant hemorrhage or anatomical disruption affecting facial and superior respiratory structures. Cervical vertebral manipulation during cannulation procedures may potentially exacerbate injury among patients with vertebral compromise and immobilization requirements. Within these clinical scenarios, alternative ventilatory and oxygenation methodologies should be implemented when clinical circumstances permit. Should definitive respiratory passage establishment become necessary, practitioners should maintain preparedness for potential surgical respiratory passage intervention. No absolute contraindications exist regarding tracheal cannulation, with decisions regarding definitive respiratory passage establishment requiring individualized consideration of unique clinical presentations.

Personnel

The healthcare provider responsible for patient care who determines tracheal cannulation necessity typically represents the individual with appropriate procedural expertise to coordinate the intervention team. This provider assumes responsibility for task delegation among team members. The procedural operator maintains position at cranial aspect of the treatment surface. The nursing professional responsible for pharmacological administration should position at “patient's left lateral aspect or in proximity to medication administration site. The respiratory assistant”, responsible for ventilatory support, airway manipulation when indicated, and delivery of tracheal cannulation apparatus to the operator, should maintain position at patient's right lateral aspect. When cervical vertebral immobilization becomes necessary, an additional assistant should position at operator's left lateral aspect, prepared to maintain cervical positioning throughout the procedure.[17]

Preparation

Airway Evaluation

When circumstances permit, initial preparatory measures include conducting respiratory passage assessment, encompassing historical documentation of previous cannulation procedures and complications. External anatomical evaluation may predict potential procedural difficulties. Individuals with limited cervical mobility, elevated body mass indices, and facial or cervical traumatic injury potentially present procedural challenges, necessitating practitioner anticipation of alternative cannulation methodologies.

A commonly implemented assessment framework utilizes the "LEMON" mnemonic. "Visual inspection" for external indicators including traumatic injury, facial hair presence, cervical masses, macroglossia, or dental prostheses. "Assessment of the 3-3-2 parameters: Less than three-finger width between dental elements, three-finger measurement between hyoid structure and mental prominence, and two-finger interval between hyoid structure and thyroid” cartilaginous prominence potentially indicate procedural challenges.

"Oropharyngeal classification" exceeding or equivalent to classification 3 predicts cannulation difficulty. "Airway narrowing" or adiposity may restrict vocal fold visualization. "Cervical" mobility limitations potentially contribute to tracheal tube placement difficulties.[18]

Positioning

Following completion of patient external evaluation, cephalic positioning requires optimization to achieve maximal vocal fold visualization. The "olfactory positioning" has traditionally been considered optimal for conventional laryngoscopic examination through “alignment of oral, pharyngeal, and laryngeal” anatomical trajectories. This positioning is achieved through cephalic elevation, cervical extension at the craniovertebral junction, and horizontal alignment between auricular structures and sternal notch. Among individuals with significant adiposity, supportive positioning devices “may be utilized to elevate the cranium until external auditory” canal achieves horizontal alignment with sternal notch.

Endotracheal Tube

Conventionally, tracheal cannulation apparatus dimensions utilize 7.0 measurement for female subjects, while 8.0 measurement is implemented for male subjects. Dimensional variations correlate with subject height characteristics and potential requirement for bronchoscopic procedures. Bronchoscopic evaluation necessitates minimum 7.5 or 8.0 cannulation apparatus dimensions. For pediatric populations, cannulation apparatus dimensional selection employs mathematical formulations: dimension = [(Chronological age/4) + 4] for non-inflatable devices and dimension = [(Chronological age/4) +3.5] for inflatable devices. Inflatable tracheal cannulation apparatus has gained increasing preference among pediatric populations during recent clinical practice evolution.[19] Cannulation apparatus preparation involves internal stylet placement, proximal straightening of the apparatus, and creation of 35-degree angulation proximal to the inflatable component. The inflatable component receives atmospheric air through syringe delivery via auxiliary port connection and requires leak assessment during preparatory procedures.[20]

Medications

Expedited sequence cannulation (ESC) frequently represents the methodology employed by healthcare providers in emergent scenarios as evidence demonstrates improved initial-attempt success probability and aspiration risk reduction. ESC utilizes pharmacological agents characterized by rapid onset and abbreviated duration profiles. Administration of these agents within condensed timeframes (e.g., <30 seconds) minimizes respiratory cessation duration[21] ESC protocol components include hypnotic agent administration concurrent with neuromuscular blockade. Staged sequence cannulation (SSC) provides alternative methodology for individuals where adequate pre-procedural oxygenation proves unachievable due to agitation and/or cognitive impairment.

A dissociative pharmacological agent, exemplified by ketamine, facilitates "patient compliance and adequate pre-oxygenation duration. Dissociative agents lacking respiratory" suppressant properties enable positive pressure ventilatory support implementation during pre-cannulation phase to optimize oxygenation status[22] For individuals with anticipated procedural difficulties not requiring immediate definitive respiratory passage establishment, conscious cannulation represents the preferred methodology. Conscious cannulation necessitates sufficient preparation time for anticholinergic agent administration to reduce secretory production, topical anesthetic application, non-respiratory suppressant anxiolytic administration, and respiratory equipment preparation.[23] The nursing professional responsible for pharmacological management should prepare these medications in appropriate delivery devices with clear identification and availability for immediate administration with adequate saline irrigation solutions.

Pre-Oxygenation

Following preparation of all cannulation instrumentation, "the patient requires preliminary oxygenation to enhance alveolar oxygen concentrations and reduce alveolar nitrogen levels". Preliminary oxygenation achieves implementation through elevated inspired oxygen fraction (FiO2) administration prior to hypnotic and neuromuscular blocking pharmacological delivery. The fundamental objective of preliminary oxygenation involves decelerating oxyhemoglobin saturation decline during respiratory cessation periods. The optimal preliminary oxygenation delivery system comprises a non-rebreather facial interface incorporating unidirectional valvular mechanisms permitting approximately 90% FiO2 delivery while preventing re-inspiration of exhaled respiratory gases.

Alternative oxygen delivery interfaces lacking unidirectional valvular mechanisms can provide approximately 70% FiO2 when properly sealed against facial contours, while manual resuscitation devices frequently deliver oxygen concentrations exceeding atmospheric levels. “Terminal expiratory pressure enhancement (TEPE) utilizing continuous positive pressure ventilation (CPPV) or non-invasive dual-level positive pressure ventilation (DLPPV)” may be implemented for individuals with pulmonary shunting pathophysiology as preliminary oxygenation methodologies. “Patients with underlying conditions causing perfused but non-ventilated alveolar units potentially benefit from” elevated terminal expiratory pressure through these mechanisms. Preliminary oxygenation should continue for 3-minute duration and achieve terminal expiratory oxygen measurement (TEO2) exceeding 90%.[22]

In emergent clinical scenarios where TEO2 monitoring equipment remains unavailable, peripheral oxygen saturation monitoring may function as surrogate indicator of arterial oxygen content. These preliminary oxygenation approaches apply to individuals maintaining adequate respiratory drive. For individuals with respiratory cessation or inadequate respiratory drive, manual resuscitation device ventilation delivering maximal available oxygen concentration represents the most appropriate preliminary oxygenation methodology.

Apneic Oxygenation

Passive oxygenation during respiratory cessation operates through gaseous diffusion mechanisms and assists in extending safe apneic duration during cannulation procedures. Effective passive oxygenation efficacy depends upon respiratory passage patency and individual pulmonary residual volume capacity. Implementation occurs through oxygen administration via nasopharyngeal or oropharyngeal routes. Commonly, this involves nasal oxygen delivery apparatus “with flow rates approaching 15 L/min or high-velocity nasal oxygen” delivery systems providing 100% FiO2 during oropharyngeal cannulation procedures.

These methodologies can maintain adequate oxygenation for approximately 10-minute duration during cannulation attempts among individuals “without underlying pulmonary pathology”.[24]

Technique

“Appropriate patient preparation and positioning are” fundamental for cannulation success. The procedural operator should verify illumination source functionality and secure blade attachment on the laryngoscopic device. The operator maintains laryngoscope in left-handed grip. Subsequently, the operator introduces laryngoscope into right oral commissure “and advances medially while applying upward force at 45-degree angulation against” lingual surface. As laryngoscope progresses toward posterior oropharyngeal structures, the operator may displace lingual tissue leftward creating space for tracheal cannulation apparatus advancement. While maintaining firm upward pressure through laryngoscope with left-handed grip avoiding wrist flexion, oropharyngeal structures undergo progressive visualization until vocal fold exposure occurs.

When implementing curved laryngoscopic technique, the operator identifies epiglottic structure and positions blade tip within vallecula. Applying consistent upward force at 45-degree angulation, the curved laryngoscope elevates epiglottic tissue revealing vocal fold structures. Upon glottic visualization, the operator requests respiratory assistant placement of tracheal cannulation apparatus with flexible stylet into operator's right hand. The operator then introduces cannulation apparatus rightward of laryngoscopic blade and observes passage through vocal fold structures. Certain manufacturers incorporate markings proximal to inflatable components indicating appropriate insertion depth through vocal fold structures.

If epiglottic elevation fails to reveal vocal fold structures, the operator may employ right-handed external laryngeal manipulation. This maneuver frequently improves glottic visualization. Following optimal tracheal positioning, the operator requests respiratory assistant hand replacement maintaining established position while operator advances cannulation apparatus to appropriate position.

During straight blade technique implementation, the operator introduces blade midline accessing epiglottic structure. Straight blade technique elevates mandibular, lingual, and epiglottic structures as unified component. Straight blade tip positions beneath epiglottic structure elevating it to reveal vocal fold structures. This contrasts with curved blade methodology where placement occurs within vallecula.[4]

For anticipated procedural complications, operators should consider initial attempt with video-assisted laryngoscopy. Most video-assisted devices incorporate curved blade design, some requiring rigid rather than flexible stylet. Video-assisted technique resembles conventional laryngoscopy with consideration that certain video blade configurations may obstruct cannulation apparatus passage during Cormack Lehane classification 1 visualization (complete glottic exposure). In such circumstances, Cormack Lehane classification 2 visualization (partial glottic exposure) facilitates cannulation apparatus passage.

Following unsuccessful initial attempt, operators must modify approach and methodology for subsequent attempts. Tracheal introducer apparatus, alternatively termed bougie, represents secondary option following initial failure. This flexible device with anteriorly angled tip introduces into respiratory passage during suboptimal vocal fold visualization. Introducer placement allows indirect identification of cartilaginous structures within anterior airway. Cannulation apparatus advances over introducer through vocal fold structures. Tracheal introducers warrant consideration during initial attempt when anticipating procedural difficulties[21]

Following cannulation apparatus passage through vocal fold structures, the inflatable component receives air delivery via “5 cc or 10 cc syringe. The internal stylet undergoes removal, and proximal” cannulation apparatus terminus connects to carbon dioxide monitoring device and ventilatory apparatus. Conventionally, desired positioning depth from dental structures to distal cannulation apparatus terminus approximates 21 and 23 cm for female and male subjects, respectively. However, evidence suggests optimal positioning depth demonstrates stronger correlation with vertical height parameters rather than gender characteristics.[25]

Confirmation of Endotracheal Tube Position

Following successful cannulation apparatus placement, critical verification of tracheal positioning and location proximal to carinal bifurcation becomes essential. Terminal expiratory carbon dioxide monitoring represents the definitive standard for confirming tracheal positioning. To exclude esophageal or hypopharyngeal malpositioning, terminal expiratory carbon dioxide apparatus measures exhaled carbon dioxide during respiratory cycles. Extratracheal carbon dioxide waveform displays 0 mmHg measurement, while appropriate tracheal positioning demonstrates reliable correlation with arterial carbon dioxide partial pressure. The procedural operator should additionally perform auscultation verifying symmetrical bilateral respiratory sounds and confirming absence of gastric respiratory sounds. Post-procedural radiographic imaging confirms distal cannulation apparatus terminus positioning 2-4 cm proximal to carinal bifurcation and excludes primary bronchial malpositioning.[26]

AIRWAY ASSESSMENT

Comprehensive yet concise respiratory passage assessment remains fundamental for individuals requiring advanced respiratory management. Respiratory intervention indications include oxygenation failure, ventilation inadequacy, or respiratory passage patency compromise. Intervention methodology “primarily depends on etiology and severity of patient's condition” while considering environmental factors and practitioner expertise.

Respiratory management incorporates both non-invasive and invasive methodologies. Non-invasive respiratory management encompasses passive oxygenation techniques, manual resuscitation device ventilation, supraglottic apparatus placement, “and non-invasive positive pressure ventilatory support. Invasive respiratory management includes advanced procedural skills including tracheal cannulation,” cricothyroid membrane access, and permanent tracheal access creation[27]

Individuals requiring respiratory management necessitate evaluation for potential procedural difficulties. Challenging respiratory anatomy may prevent effective mask ventilation or increase procedural failure probability. Failed respiratory intervention defines as three unsuccessful cannulation attempts by experienced practitioners.

Systematic pre-procedural assessment achieves implementation through several efficient evaluation methodologies.

Oral aperture assessment utilizes digital width measurement. With maximal oral opening, mandibular separation in adults should minimally reach 4 centimeters or approximately three to four digital widths. Mental-hyoid interval measurement should demonstrate three to four digital widths. Reduced mandibular dimensions increase lingual obstruction probability impairing anatomical structure visualization during cannulation procedures. Similarly, increased mandibular dimensions potentially elongate oral anatomical trajectory impairing vocal fold visualization.

Subject evaluation includes upright positioning with maximal oral aperture to assess lingual interference with posterior pharyngeal visualization. The oropharyngeal classification system facilitates identification of anatomical structures potentially complicating cannulation procedures. Higher oropharyngeal classification correlates with increased procedural failure rates due to suboptimal glottic visualization.[28]

Mallampati Classification

The oropharyngeal visualization classification correlates lingual dimensions with oral cavity visualization capabilities. Increased lingual obstruction of pharyngeal structural visualization potentially indicates increased procedural complexity.[29] This classification system encompasses four distinct visualization categories:

- Classification I: complete visualization of palatal arch structure, including bilateral faucial columns visible to their inferior attachment
- Classification II: superior portion of faucial columns and majority of uvular structure remain visible
- Classification III: visualization limited to hard and soft palatal structures

- Classification IV: visualization restricted exclusively to hard palatal structure

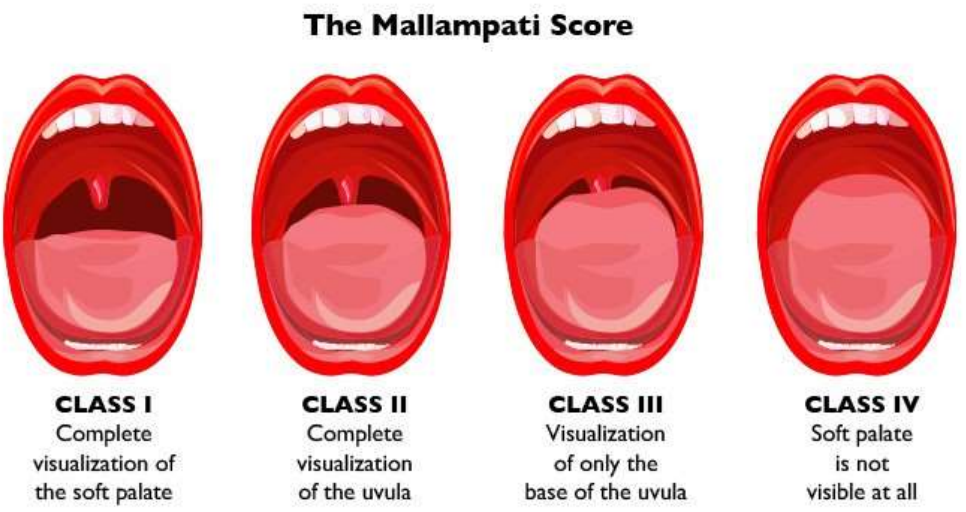


Figure 2: Mallampati score

Neck Mobility

Cervical mobility represents a significant factor in respiratory passage assessment. Optimal positioning for cannulation procedures involves the "olfactory position." This positioning technique requires cervical "flexion to 35 degrees combined with cephalic extension to 15 degrees. Cervical immobility interferes with alignment between pharyngeal, oral, and laryngeal anatomical trajectorie". Cervical "mobility" limitations may result from protective collars or structural abnormalities including osseous fracture, articular displacement, or degenerative joint disease. In absence of cervical spine injury concerns, craniovertebral extension may undergo assessment. When cervical spine injury remains suspected, cervical alignment requires continuous maintenance during cannulation procedures, potentially increasing procedural complexity.[28]

Upper Lip Bite Test

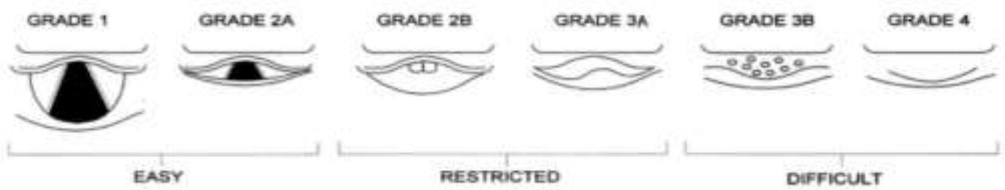
Subjects may undergo assessment requesting mandibular protrusion or vermilion border manipulation. The vermilion border manipulation evaluation assesses capacity to position inferior dental elements over superior labial structure. This evaluation predicts mandibular subluxation capability during laryngoscopic examination. The assessment categorization system includes the following classifications:[28]

- Classification 1: subject demonstrates complete superior labial structure coverage with inferior dental elements
- Classification 2: subject demonstrates partial superior labial structure coverage with inferior dental elements
- Classification 3: subject cannot position inferior dental elements in contact with superior labial structures

Cormack–Lehane (CL) Grading

- One tool commonly used for laryngoscopic view description during standard laryngoscopic evaluation is the Cormack–Lehane (CL) grading(Fig. 1). This approach was first published in 1984 and has since become the most widely used standard for classifying respiratory passages in clinical practice and research pertaining to respiratory passages. However, the CL visualization classification has not been thoroughly validated, even though it has been widely used[30]

Figure 3: Cormack–Lehane (CL) Grading



AIRWAY POSITIONING

Evolution of airway positioning for intubation

The evolution of airway positioning for intubation represents a fascinating journey in the history of anesthesiology, dating back to the early 20th century. Before the 1940s, there was no standardized approach to patient positioning for intubation. The breakthrough came in 1944 when Sir Ivan Magill first described the importance of head positioning for successful intubation. This was followed by Bannister and MacBeth's seminal work in 1944, “which formally introduced the 'sniffing position' as the optimal head position for direct laryngoscopy. They described it as extension of the head on the neck combined with anterior flexion of the neck on the chest, likening it to the position of sniffing the morning air. This position was believed to achieve the best alignment of the oral, pharyngeal, and laryngeal axes.” The concept remained largely unchanged until the late 20th century when the increasing prevalence of obesity led to modifications in positioning techniques. The RAMP position emerged as an alternative, initially described for obese patients, “where the external auditory meatus is horizontally aligned with the sternal notch”. This evolution continued with the advent of video laryngoscopy in the 1990s, which challenged some traditional concepts about optimal positioning. Recent years have seen a more evidence-based approach to airway positioning, with numerous studies comparing different positions and their impact on intubation success rates across various patient populations. The field continues to evolve with ongoing research and technological advancements, leading to more individualized approaches to airway positioning based on patient characteristics and available equipment.[2]

Sniffing Position

In 1936, Sir Ivan Magill advocated positioning supportive cushioning beneath occipital region to elevate cephalic structures followed by extension maneuvers to achieve optimal laryngeal exposure. He provided initial characterization of optimal cephalic positioning for conventional laryngoscopy as reproducing the natural cephalic orientation observed during environmental olfactory sampling.[7] Bannister and Macbeth[2] subsequently introduced the Triple Axis Alignment Theory in 1944 to provide anatomical foundation supporting the superiority of this positioning methodology.

The olfactory positioning technique, a fundamental approach in respiratory passage management, receives technical definition as inferior cervical spine flexion (cervical flexion) combined with superior cervical spine extension (cephalic extension) at the craniovertebral articulation. This positioning creates approximately 35° cervical flexion with 15° cephalic extension, achieved through occipital elevation measuring 7-10 cm utilizing cushioning or supportive structures while extending cephalic orientation at the craniovertebral junction. This positioning technique derives nomenclature from its resemblance to olfactory sampling positioning.[37,31]

The physiological foundation for olfactory positioning methodology centers upon achieving optimal alignment between three anatomical trajectories: oral, pharyngeal, and laryngeal. This alignment theoretically establishes optimal visualization pathway for conventional laryngoscopy through reduction of anatomical impediments obstructing glottic aperture visualization. This positioning additionally facilitates anterior lingual displacement and enhances submandibular spatial dimensions, improving laryngoscopic blade insertion and manipulation capabilities.

Regarding advantages and limitations, olfactory positioning demonstrates several documented benefits including enhanced laryngeal visualization during conventional laryngoscopy, minimized cervical vertebral movement during cannulation procedures, and optimized preliminary oxygenation efficiency. However, limitations include potential complications among individuals with cervical pathology, elevated body mass indices, or restricted cervical mobility. Certain investigations have questioned traditional "triple-trajectory alignment theory," suggesting complete anatomical alignment may not represent absolute requirement for successful cannulation procedures.

Current evidence and recommendations support olfactory positioning implementation as initial positioning for conventional laryngoscopy among most adult populations. A systematic analytical review by Akihisa and colleagues (2017) demonstrated olfactory positioning significantly enhances glottic visualization compared with isolated cephalic extension, particularly among individuals with elevated body mass indices. However, contemporary guidelines emphasize individualization necessity based on patient characteristics and suggest potential modifications for specific populations, such as individuals with obesity potentially benefiting from elevated positioning techniques.[32 33]

Figure 4: Sniffing Position

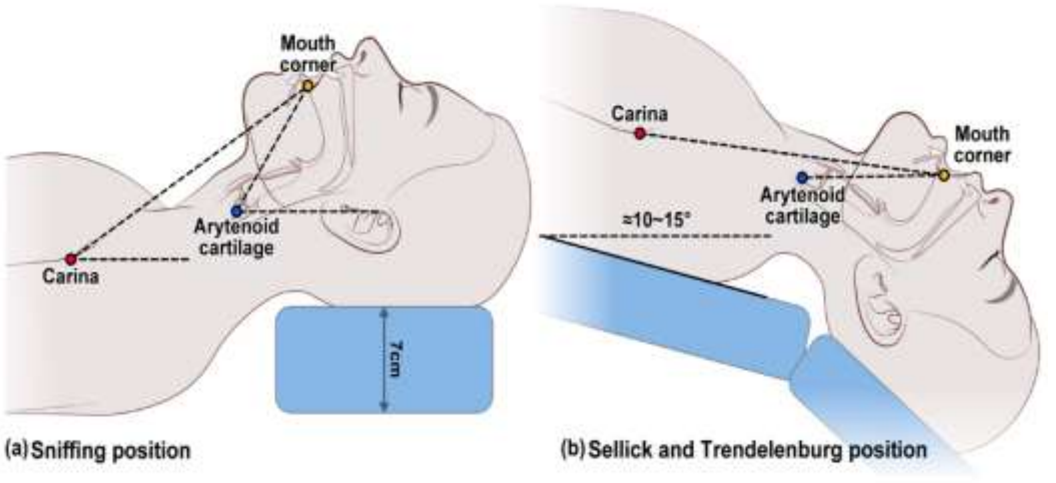
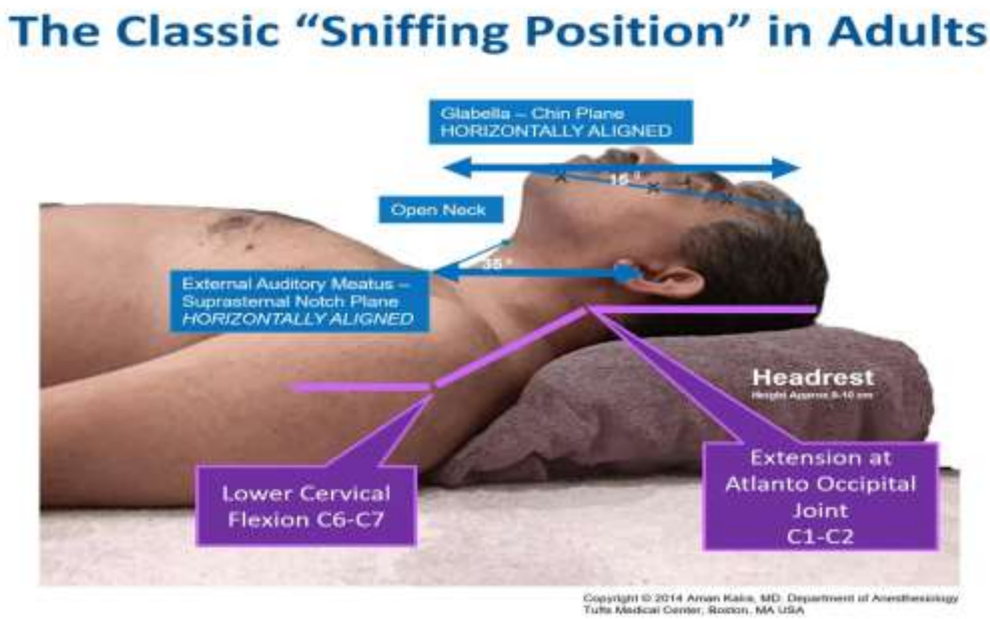


Figure 5: Physiological Aspects of Sniffing Position



RAMP position:[34]

The RAMP position, initially described for obese patients, is "defined as the horizontal alignment of the external auditory meatus with the sternal notch. This" can be achieved through two primary methods: either using specialized positioning equipment like the RAMP device. In the properly achieved RAMP position, an imaginary horizontal line should connect "the external auditory meatus and the sternal notch, while another horizontal line" should run from sternal notch to the xiphoid process, creating a ramped appearance of the upper body.

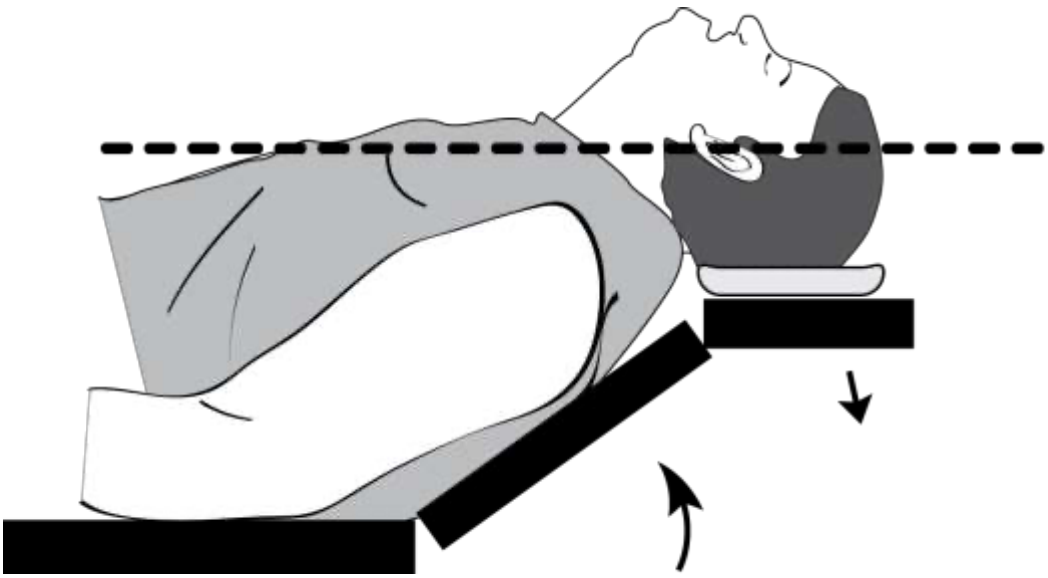
In elevated positioning methodology, the treatment surface maintains semi-horizontal orientation with cephalic elevation approaching 25°. The subject's facial plane maintains parallel alignment with ceiling structures, while cervical and truncal components position at 25° angulations, with lower extremities maintaining parallel ceiling alignment. Supportive cushioning or folded linens undergo addition or removal beneath cephalic structures to establish alignment between external auditory canal and sternal notch. Following achievement of optimal subject positioning, the entire treatment surface undergoes vertical adjustment positioning the subject's oral aperture at appropriate procedural height.[9] This positioning technique potentially enhances glottic visualization while facilitating cannulation and ventilatory procedures. Achieving this positioning represents critical importance, however establishing elevated positioning utilizing supportive cushioning creates procedural complexity and temporal inefficiency. Furthermore, this technique demonstrates significant dependence upon practitioner experience, potentially creating complications for subjects during surgical intervention or post-procedural recovery periods.

The physiological rationale behind the RAMP position centers on optimizing pre-oxygenation and creating ideal intubating conditions by maximizing the functional residual capacity and reducing the work of breathing. This position helps overcome the anatomical challenges posed by excess tissue and gravity effects on upper airway structures. By elevating the upper body, it reduces the compression of the diaphragm by abdominal contents and decreases posterior displacement of the tongue and soft tissues, thereby improving the laryngeal view during laryngoscopy. Additionally, this position enhances the effectiveness of pre-oxygenation by optimizing ventilation-perfusion matching.

The benefits of the RAMP position include improved laryngeal visualization, increased safe apnea time due to better pre-oxygenation, reduced work of breathing, and potentially easier bag-mask ventilation. The position also helps prevent early oxygen desaturation during intubation attempts by maintaining better functional residual capacity. However, potential drawbacks include the time and resources required for proper positioning, the need for specific equipment or multiple pillows/blankets, potential instability if not properly implemented, and the possibility of patient discomfort. There's also a learning curve for practitioners in achieving the correct position consistently.

Current evidence base, particularly from studies by Collins et al. and Lebowitz et al., demonstrates superior laryngeal views and improved intubation conditions with “the RAMP position compared to the standard sniffing position”, especially in obese patients. Research has shown increased first-attempt success rates and reduced intubation-related complications when using the RAMP position in appropriate patient populations. However, while the evidence strongly supports its use in obese patients, the benefits in non-obese populations are still being evaluated through ongoing research.

Figure 6: RAMP Position



Modified RAMP Position

A triangular supportive positioning device measuring 15 cm height, 30° angulation, 80 cm length, and incorporating 20-cm cylindrical support component, designated modified Elevated apparatus, underwent development through collaborative efforts between emergency medicine specialists, anesthesiology practitioners, and investigational personnel to position subjects according to oral, laryngeal, and pharyngeal anatomical trajectory measurements. Placement of this modified Elevated apparatus beneath subject's cephalic region, compared with conventional Elevated positioning methodology, establishes enhanced cephalic extension, potentially facilitating optimal cannulation conditions, particularly among individuals with elevated body mass indices demonstrating adipose accumulation in posterior cervical and shoulder regions, subjects with abbreviated cervical length, and challenging cannulation scenarios. Furthermore, this methodology demonstrates significantly reduced temporal requirements compared with conventional Elevated positioning techniques[35]

Factors Affecting Ease of Intubation[36]

The ease of intubation is influenced by multiple interrelated factors that can be broadly categorized into patient-related, technical, and operator-dependent variables. Patient-related factors include anatomical characteristics such as Mallampati classification, thyromental distance, neck circumference, neck mobility, and mouth opening. Other significant patient factors include body mass index, dentition, tongue size, and the presence of any pathological conditions affecting the airway such as tumors, infections, or congenital abnormalities. Age and gender can also influence intubation difficulty, with advanced age often associated with changes in airway anatomy and tissue elasticity.

Technical factors encompass the choice of equipment and positioning techniques. The selection of appropriate laryngoscope type and size, endotracheal tube dimensions, use of stylets or bougies, and the quality of illumination all play crucial roles. The positioning technique chosen (sniffing vs. RAMP) must be appropriate for the patient's specific characteristics. Environmental factors such as adequate lighting, appropriate bed height, and availability of necessary equipment can significantly impact the procedure's success.

Operator-dependent variables significantly influence intubation success rates. These include the practitioner's experience level, familiarity with different techniques and equipment, ability to assess airways accurately, and skill in handling unexpected difficulties. The operator's physical attributes, such as height and hand dominance, can affect their ability to achieve optimal laryngeal views. Additionally, the presence of trained assistants and their coordination with the primary operator can impact the procedure's smoothness.

Clinical factors like the urgency of the situation (emergency vs. elective), presence of active bleeding or secretions, full stomach status, and hemodynamic stability of the patient can substantially affect intubation difficulty. The effectiveness of pre-oxygenation and the patient's oxygen reserve play crucial roles in determining the time available for intubation attempts. Assessment tools such as the “LEMON (Look-Evaluate-Mallampati-Obstruction-Neck mobility) score and El-Ganzouri Risk Index” help in predicting potential difficulties, enabling better preparation and selection of appropriate techniques.

REVIEW OF RELATED ARTICLES

A study[45] conducted in 2024, in which a prospective randomized investigation including 150 adult subjects with elevated body mass indices (BMI >30 kg/m2) requiring cannulation utilizing video-assisted laryngoscopy. Subjects underwent randomization into three distinct positioning groups: olfactory positioning, elevated positioning, and 25° inclined positioning. Research findings demonstrated 25° inclined positioning reduced successful cannulation duration to 161.80 seconds compared with elevated positioning (“172.56 seconds) and olfactory positioning (171.84 seconds) with statistical significance ($p<0.0001$). Mean duration for optimal glottic visualization measured 18.82 seconds in group C, compared with 38.24 seconds for group B, and 39.66 seconds for group A ($p<0.0001$). Procedural ease assessment demonstrated very easy/easy classifications in 9/28 subjects in group C compared with 3/16 and 3/17 subjects respectively in groups A and B ($p=0.007$). Initial cannulation attempt success occurred in 47 subjects in group C compared with 32 and 40 subjects in groups A and B respectively ($p=0.001$). No significant differences appeared in Cormack and Lehane” visualization classification across different positioning techniques. The investigators concluded that 25° inclined positioning represents a simplified and beneficial technique improving glottic visualization and cannulation success rates while reducing procedural duration compared with elevated and olfactory positioning methodologies.

A 2023 study[46] conducted a comparative analysis evaluating tracheal cannulation timing utilizing video-enhanced laryngoscopic technology among individuals with significant adiposity comparing elevated versus traditional positioning methodologies. Challenging face-mask ventilation frequency (Warters assessment ≥ 4) demonstrated statistically significant reduction within elevated positioning cohort ($n = 40$) compared with traditional positioning cohort ($n = 41$) (2.5% compared with 34.1%, $P < 0.001$). Uncomplicated cannulation procedure frequency (IDS = 0) showed statistically significant improvement within elevated positioning cohort compared with traditional positioning cohort (70.0% compared with 7.3%, $P < 0.001$). Comprehensive procedural duration measurements demonstrated statistically significant reduction within elevated positioning cohort compared with traditional positioning cohort (22.5 ± 6.2 compared with 40.9 ± 9.0, $P < 0.001$). Investigators concluded that compared with traditional positioning methodology, elevated positioning technique reduced procedural duration among individuals with significant adiposity while demonstrating improved efficacy regarding both mask-assisted ventilation and tracheal cannulation utilizing video-enhanced laryngoscopic technology.

A study[37] about intubating conditions with sniffing and ramp position in non-obese patients have shown that ramp position is better in terms of laryngeal view and faster intubation time and lesser need for external maneuvers.

An investigation conducted[38] for examining tracheal cannulation procedures in elevated versus horizontal positioning within emergency clinical environments concluded that elevated positioning methodology enhances glottic aperture visualization and improves operator procedural comfort when performing cannulation procedures on simulated challenging respiratory passages.

Another study[39] conducted an investigation "to determine efficacy and safety parameters comparing tracheal cannulation in elevated versus traditional positioning" methodologies. From 2631 titles/abstracts evaluated, three investigations (encompassing 513 subjects) met inclusion criteria for meta-analytical processing. The combined risk ratio with 95% confidence interval (CI) comparing traditional versus elevated positioning demonstrated: initial successful attempt, 0.97; laryngoscopic attempts ≤ 2, 1.08; and satisfactory glottic visualization with Cormack-Lehane classification ≤ 2, 0.86. They concluded that no advantageous characteristics of elevated positioning compared with traditional positioning. Consequently, additional investigational studies remain necessary to determine optimal positioning methodology for tracheal cannulation procedures.

A comprehensive analytical review and meta-analysis implemented by a study[40] examining comparative outcomes between elevated positioning methodology and traditional positioning technique during tracheal cannulation procedures demonstrated that elevated positioning potentially provides clinical advantages for surgical candidates undergoing tracheal cannulation procedures through enhancement of laryngeal structure visualization.

A 2020 study[41] implemented meta-analytical methodology combining effect estimates across 4 included randomized controlled trials (n = 632). No significant differences emerged between elevated and traditional positioning regarding initial attempt cannulation success, procedural duration, auxiliary airway manipulation requirement, and airway adjunct utilization, with evidence demonstrating substantial heterogeneity across investigations. However, elevated positioning among surgical populations demonstrated association with increased probability of CLG 1/2 and reduced probability of CLG 3/4, representing moderate evidence quality.

An investigation performed in a study[42] evaluating individuals with significant adiposity, comparing elevated versus traditional positioning methodologies during video-assisted laryngoscopic tracheal cannulation demonstrated that relative to traditional positioning techniques, elevated positioning methodology reduced procedural duration among individuals with significant adiposity while concurrently demonstrating improved efficacy regarding both mask-assisted ventilation and tracheal cannulation implementation utilizing video-assisted laryngoscopic technology.

A multi-center, randomized investigation comparing elevated versus traditional positioning methodologies during tracheal cannulation among critically ill adult populations, conducted by 2017 study[6] determined that elevated positioning failed to demonstrate oxygenation improvement during tracheal cannulation procedures among critically ill adult subjects compared with traditional positioning techniques. Elevated positioning methodology potentially compromises glottic aperture visualization and potentially increases required procedural attempts for successful cannulation.

Research conducted in a 2015 study[34] investigated successful tracheal cannulation rates comparing traditional versus elevated positioning methodologies among subjects with anticipated procedural difficulties. Subjects underwent randomization into distinct groups: group S received traditional positioning while group R received elevated positioning during conventional laryngoscopy. Group R demonstrated superior successful tracheal cannulation rates and enhanced laryngeal visualization compared with group S ($P < 0.05$). Successful tracheal cannulation rates showed elevation in group R compared with group S at both operational surface height configurations; however, no significant differences appeared within individual groups. Laryngeal visualization demonstrated no significant differences between groups or within individual groups when comparing operational surface height configurations. Comprehensively trained and experienced specialist practitioners achieved superior successful tracheal cannulation rates compared with less experienced training practitioners in group R ($P < 0.05$) but demonstrated no significant differences in group S. The investigators concluded that elevated positioning methodology and clinical experience represent significant contributing factors influencing laryngeal visualization and successful tracheal cannulation rates among subjects with anticipated procedural difficulties.

METHODOLOGY

MATERIAL & METHOD

- **Study design:** An observational double group randomized control trial
- **Study area:** Department of Anaesthesiology, Sri Devaraj Urs Medical College, A Constituent of SDUAHER, Tamaka, Kolar.
- **Study period:** Research study was conducted from December 2022 to July 2024. Below is the work plan.

  Table 1: Work plan of the study with percentage of allocation of study time and duration in months

Work plan	**% of allocation of study time**	**Duration in months**
Understanding the problem, preparation of questionnaire.	5-10%	December 2022 to February 2023
Pilot study, Validation of questionnaire, data collection and manipulation	Upto 80%	March 2023 to January 2024
Analysis and interpretation	5-10%	February 2024 to April 2024
Dissertation write-up and submission	5-10%	May 2024 to July 2024

- **Sample size**: Sample size was calculated by using the formula As per Das et al., the sample size formula is given below.

  Where,

  n =minimum required sample size

  = The critical value (Table value) "from a standard normal distribution that the test statistic must exceed in order to show a statistically significant result at 'α' level of significance.

= Standard normal table value for the power of the test

= Standard deviation of the response variable (obtained from previous study

d =the effect size

= the minimum clinically important difference that the investigator wishes to detect."

In the present case, at 5 %level of significance = 1.28 at 90% power

As per the study by Mathew et al., (2017), a minimum difference of 5% in lowest arterial oxygen saturation would be clinically important from previous study. So, d =5 Assuming a SD in lowest arterial oxygen saturation as 8%. ie. σ = 8. Then the minimum required sample size computed is 53.75 ≅ 54

Patients were divided into two groups according to computer generated random table.

1. **Group A: RAMP position**: pillows and folded blankets were kept under the shoulder and head, to align the external auditory meatus and sternal notch in the same horizontal axis
2. **Group B: Sniffing position**: which is achieved by neck flexion and head extension at atlanto-occipital joint by using a 10 cms thickness pillow under the head

- **Sampling technique:** Computer generated Random sampling

INCLUSION CRITERIA

1. Patients aged 18 to 60 years
2. American Society of Anesthesiologists (ASA) physical status grades I– II
3. Patients scheduled for non-cardiovascular, non-obstetric surgery under general anaesthesia

EXCLUSION CRITERIA

1. Severe cardiovascular disease [unstable angina or ejection fraction < 40%]
2. Obstetric surgeries
3. Emergency surgeries
4. Patient unwilling to participate in study
5. Patients with BMI >25
6. Mallampati Class 3and 4.
7. Anticipated difficult airway.

SAMPLING PROCEDURE:

The study was initiated following "approval from the Institutional Ethics Committee (IEC) and registration with the Clinical Trials Registry of India (CTRI). Adult patients aged 18 years and above, scheduled for elective procedures under general anesthesia, were enrolled after obtaining written informed consent.

A comprehensive clinical history was documented for each participant. Preoperative investigations including complete blood count (CBC), serum electrolytes, urea, and creatinine were performed. Additional investigations such as electrocardiogram (ECG) and chest X-ray (CXR)" were conducted as clinically indicated.

All patients were maintained on a standard preoperative fasting protocol of 8 hours for solids and 2 hours for clear fluids. Intravenous crystalloids were administered based on individual body weight calculations for maintenance requirements.

Patient allocation was performed using a computer-generated randomization table, dividing participants into two groups. Group A received the RAMP position, achieved by placing pillows and folded blankets beneath the shoulder and head to align the external auditory meatus with the sternal notch in a horizontal plane. Group B utilized the Sniffing position, accomplished through neck flexion and head extension at the atlanto-occipital joint using a 10 cm thick pillow under the head.

Pre-oxygenation was conducted with high-flow oxygen for three minutes. Premedication consisted of intravenous ondansetron (0.1 mg/kg), glycopyrrolate (0.01 mg/kg), and fentanyl (2 mcg/kg). Anesthesia was induced with propofol (2 mg/kg), and after confirming adequate mask ventilation, succinylcholine (2 mg/kg) was administered for muscle relaxation.

Following complete muscle relaxation, laryngoscopy was performed using a Macintosh laryngoscope. The glottic view was assessed and documented according to the Cormack Lehane grading system:

- Grade 1: Full exposure of vocal cords
- Grade 2a: Partial cord visibility
- Grade 2b: Only arytenoids or posterior cords visible
- Grade 3: Only epiglottis visible
- Grade 4: No glottic structures visible

Throughout the procedure, the duration of laryngoscopy and associated stress responses were recorded. Vital parameters including heart rate (HR), peripheral oxygen saturation (SpO_2), systolic blood pressure(SBP), diastolic blood pressure(DBP), mean arterial pressure (MAP), end-tidal carbon dioxide ($EtCO_2$) were continuously monitored during the procedure and throughout the intraoperative period.

STATISTICAL ANALYSIS

The statistical analysis involved compilation of information in an excel spreadsheet followed by processing through SPSS software version 21. Findings were exhibited in tables and graphics for clarity. For quantitative measurements, calculations included mean, median, standard deviation, and range parameters. Frequency counts and percentage distributions were utilized to represent qualitative observations. Statistical significance was evaluated using the Two-Tailed Student t test methodology, with statistical significance threshold established at P value <0.05. This analytical framework enabled comprehensive interpretation of the research outcomes.

RESULTS

RESULTS

This is a comparative study of ease of intubation between sniffing and RAMP position in elective intubations conducted in patients requiring elective intubations undergoing general anaesthesia for elective surgeries at R. L. Jalappa Hospital, Tamaka, Kolar

Table 2: Age distribution

Age (years)	RAMP Position (n=54)	Sniffing Position (n=54)	P-value
Mean ± SD	37.89 ± 15.25	37.63 ± 12.54	0.921

This table compares the mean age of patients in the RAMP position group (37.89 ± 15.25 years) and the Sniffing position group (37.63 ± 12.54 years). With a “p-value of 0.921, there is no statistically significant difference in age between the two groups”. This indicates that the groups were well-matched for age, which is important for ensuring that any differences in outcomes are not due to age differences.

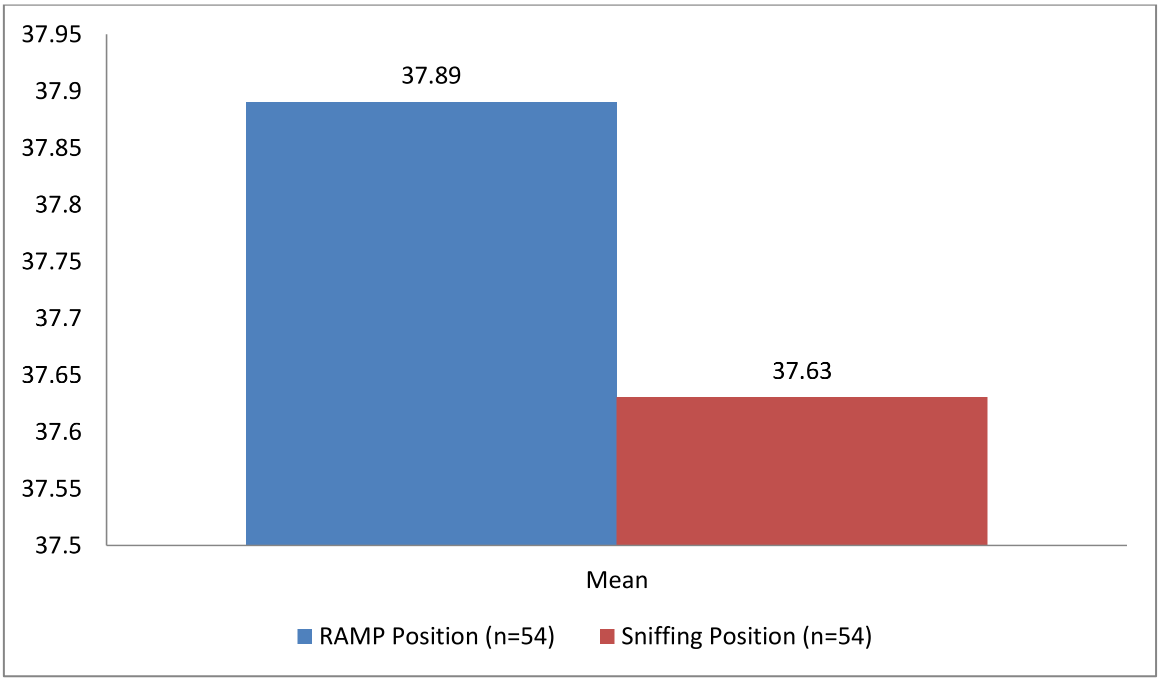


Figure 7: Age distribution

Table 3: Age Groups

This table breaks down the age distribution into three categories: 18-20 years, 21-40 years, and 41-60 years. In the RAMP position group, 14.8% were 18-20 years, 37.0% were 21-40 years, and 48.1% were 41-60 years. In the Sniffing position group, 7.4% were 18-20 years, 44.4% were 21-40 years, and 48.1% were 41-60 years. The “p-value of 0.498 indicates no statistically significant difference in age group distribution between the two positions”, confirming that the groups were comparable in terms of age categories.

Figure 8: Age Groups

Age Category	RAMP Position (n=54)	Sniffing Position (n=54)	P-value
18-20 years	8 (14.8%)	4 (7.4%)	0.498
21-40 years	20 (37.0%)	24 (44.4%)	
41-60 years	26 (48.1%)	26 (48.1%)	

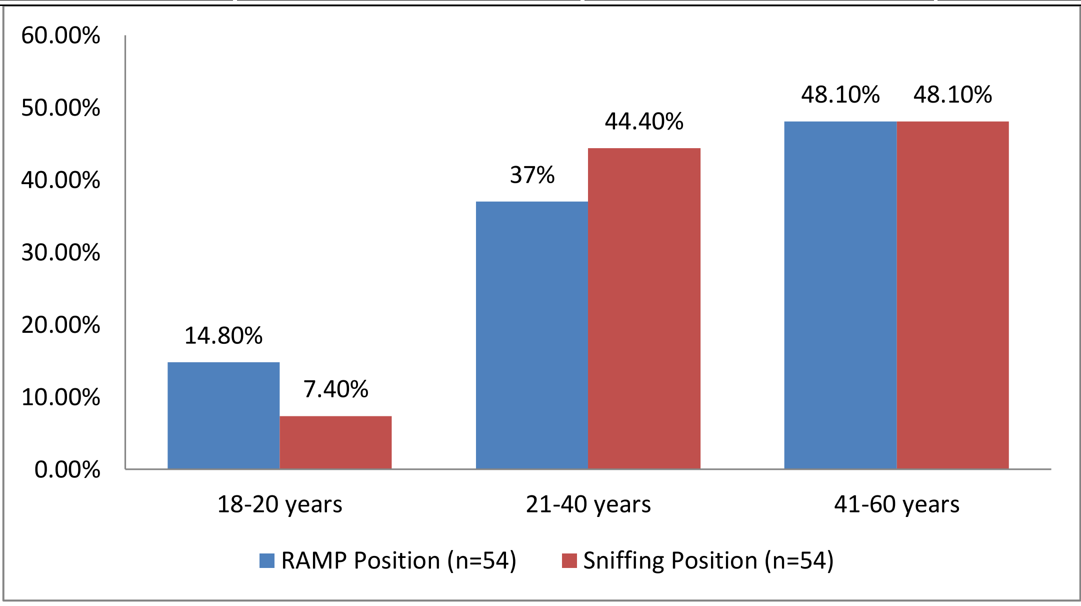


Table 4: Gender distribution

Gender	RAMP Position (n=54)	Sniffing Position (n=54)	P-value
Male	32 (59.3%)	30 (55.6%)	0.699
Female	22 (40.7%)	24 (44.4%)	

This table shows that in the RAMP position group, 59.3% were male and 40.7% were female, while in the Sniffing position group, 55.6% were male and 44.4% were female. With a "p-value of 0.699, there was no statistically significant difference in gender distribution between the two groups, demonstrating that the groups were comparable in terms of gender composition".

Figure 9: Gender distribution

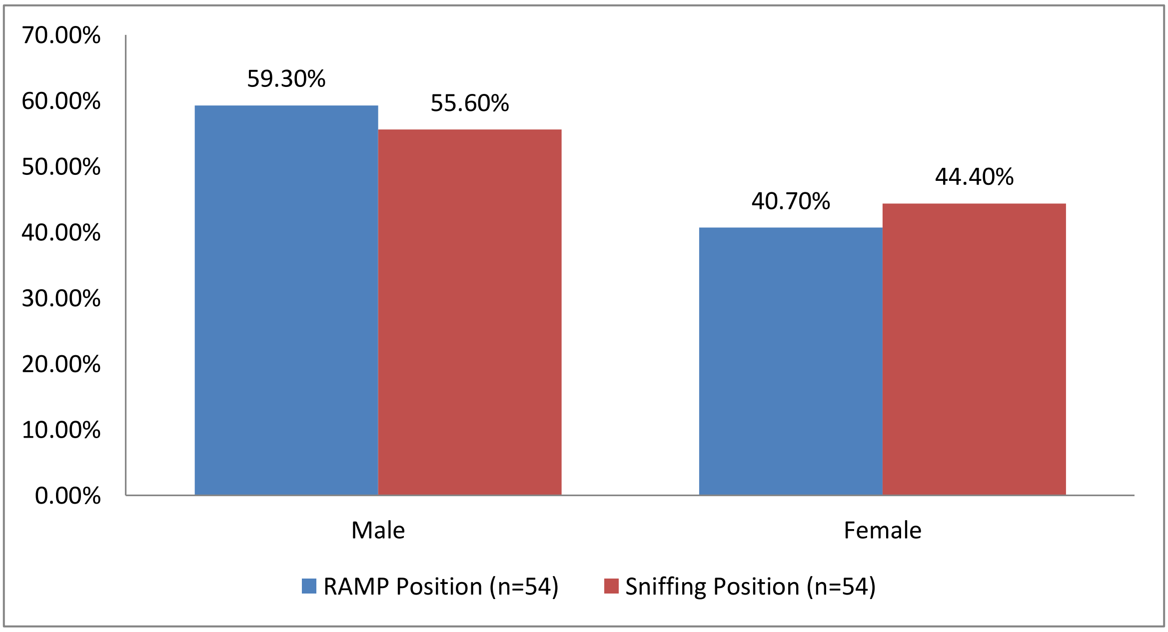


Table 5: Weight distribution

Weight (kg)	RAMP Position (n=54)	Sniffing Position (n=54)	P-value
Mean ± SD	72.01 ± 11.99	72.37 ± 11.51	0.873

This table compares the mean weight of patients in the RAMP position group (72.01 ± 11.99 kg) and the Sniffing position group (72.37 ± 11.51 kg). Statistical analysis yielded a p-value of 0.873 regarding weight distribution comparisons, demonstrating absence of significant statistical variance between the examined cohorts, thus confirming appropriate weight parameter equivalence across the studied populations.

Figure 10: Weight distribution

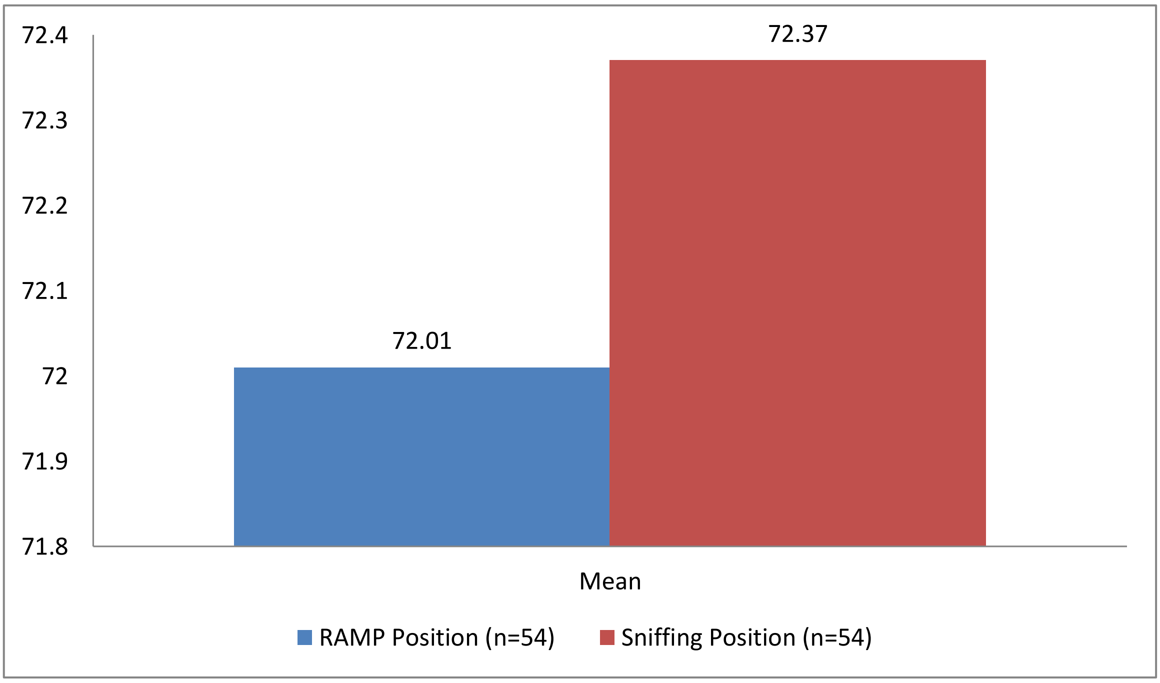


Table 6: ASA Physical Status

ASA Physical Status	RAMP Position (n=54)	Sniffing Position (n=54)	P-value
ASA I	34 (63.0%)	32 (59.3%)	0.695
ASA II	20 (37.0%)	22 (40.7%)	

This table presents the “American Society of Anesthesiologists (ASA) physical status classification” of patients. In the RAMP position group, 63.0% were ASA I (healthy patients) and 37.0% were ASA II (mild systemic disease). Among subjects positioned in the Sniffing configuration, ASA classification revealed 59.3% categorized as ASA I while 40.7% met ASA II criteria. Statistical evaluation produced a p-value of 0.695 regarding ASA physical status distribution, establishing absence of meaningful statistical variance between comparative cohorts, thereby confirming equivalent baseline health conditions across the investigated groups.

Figure 6: ASA Physical Status

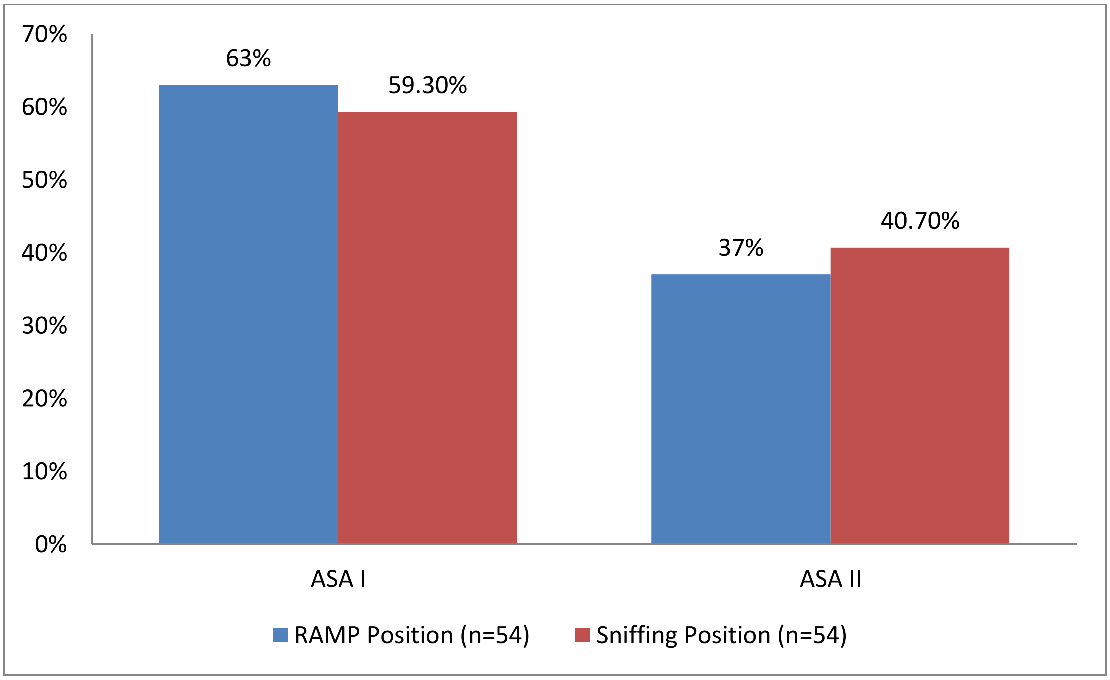


Table 7: Mallampati Classification

Mallampati Class	RAMP Position (n=54)	Sniffing Position (n=54)	P-value
Class 1	38 (70.4%)	34 (63.0%)	0.408
Class 2	16 (29.6%)	20 (37.0%)	

This table shows the Mallampati classification, which predicts the ease of intubation based on the visibility of oropharyngeal structures. In the RAMP position group, 70.4% were Class 1 and 29.6% were Class 2. In the Sniffing position group, 63.0% were Class 1 and 37.0% were Class 2. "The p-value of 0.408 indicates no statistically significant difference in Mallampati classification between the groups", suggesting comparable predicted ease of intubation between groups.

Figure 7: Mallampati Classification

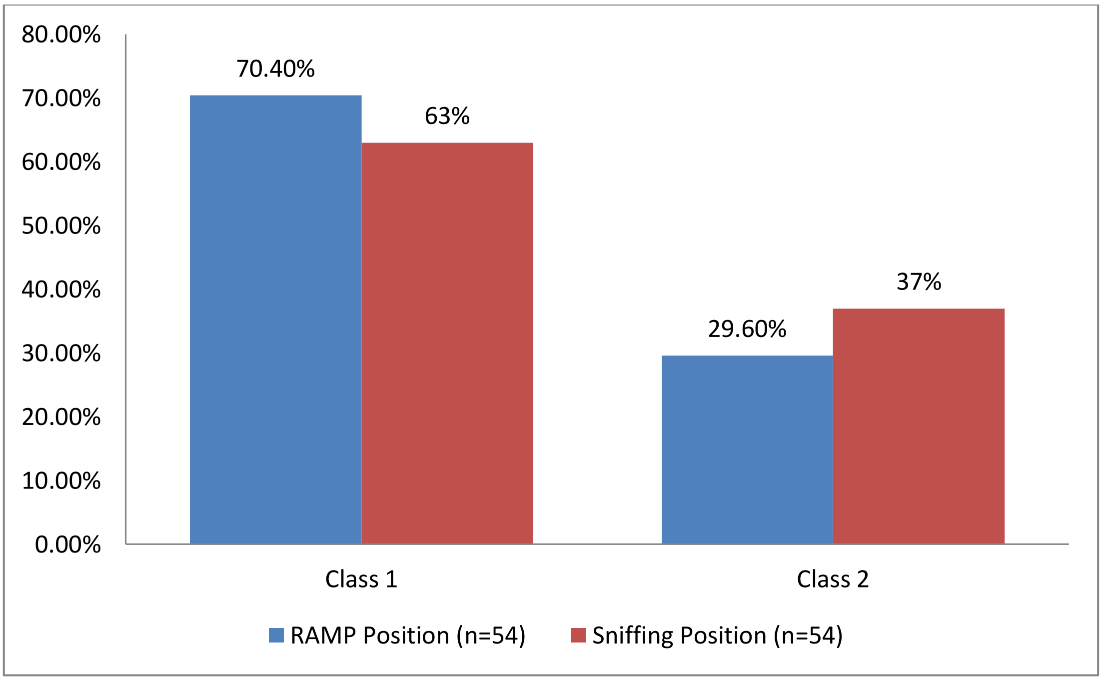


Table 8: Cormack Lehane Grade

Cormack Lehane Grade	RAMP Position (n=54)	Sniffing Position (n=54)	P-value
Grade 1	36 (66.7%)	32 (59.3%)	0.692
Grade 2	12 (22.2%)	16 (29.6%)	
Grade 3	6 (11.1%)	6 (11.1%)	

This table presents the “Cormack Lehane grading system”, which classifies the view of the glottis during laryngoscopy. In the RAMP position group, 66.7% were Grade 1 (full view of glottis), 22.2% were Grade 2 (partial view), and 11.1% were Grade 3 (only epiglottis visible). In the Sniffing position group, 59.3% were Grade 1, 29.6% were Grade 2, and 11.1% were Grade 3. “With a p-value of 0.692, there was no statistically significant difference in Cormack Lehane grades between the groups”.

Figure 8: Cormack Lehane Grade

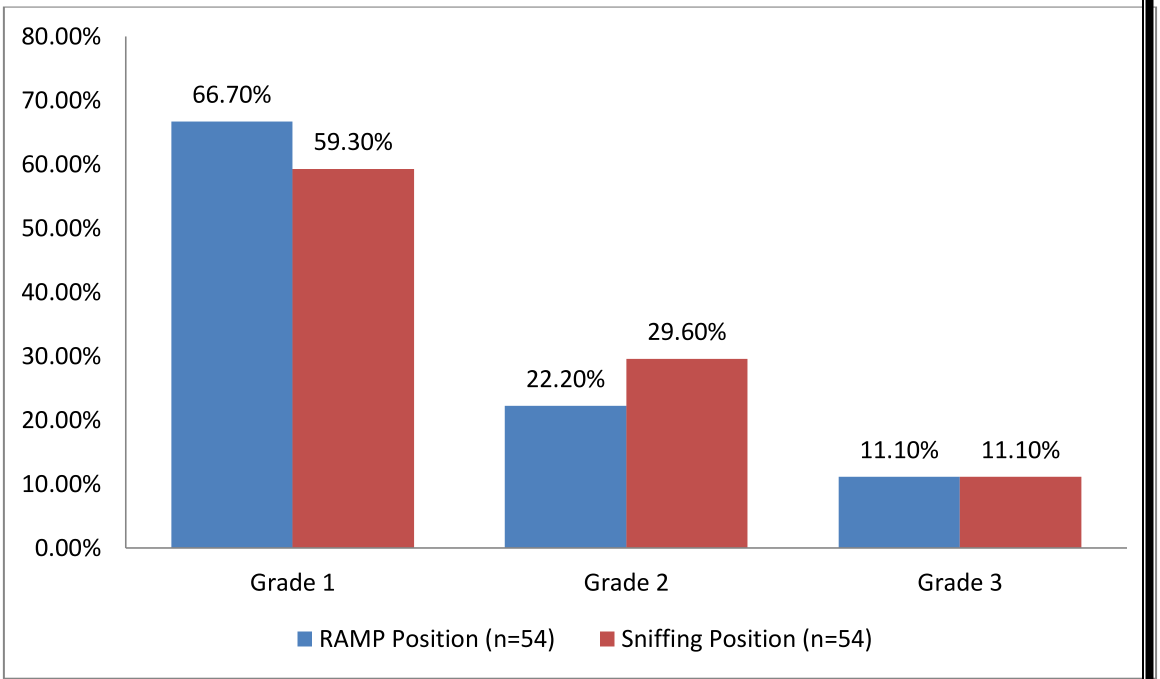


Table 9: Time to successful intubation

Time to intubation (seconds)	RAMP Position (n=54)	Sniffing Position (n=54)	P-value
Mean ± SD	28.88 ± 8.36	32.22 ± 8.70	**0.04**

This table compares the mean time to successful intubation in seconds. The RAMP position group had a mean time of 28.88 ± 8.36 seconds, while the Sniffing position group had a mean time of 32.22 ± 8.70 seconds. "With a p-value of 0.04, this difference is statistically significant, indicating that intubation was faster in the RAMP position compared to the Sniffing position".

Figure 9: Time to successful intubation

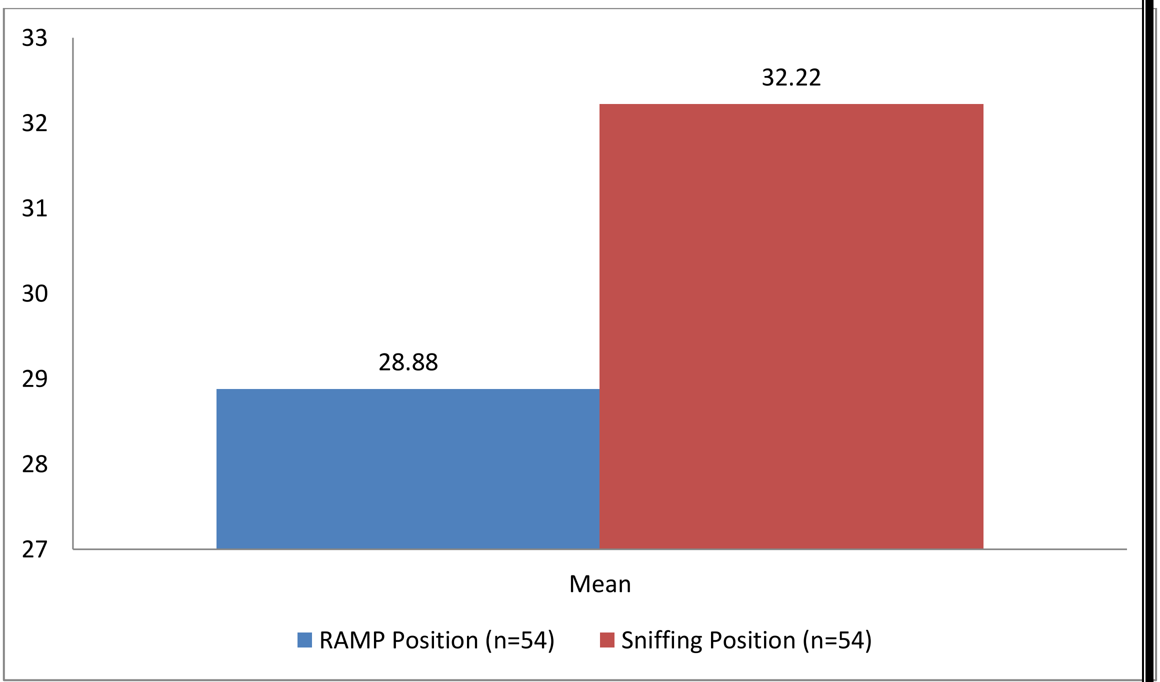


Table 10: Number of intubation attempts

Intubation attempts	RAMP Position (n=54)	Sniffing Position (n=54)	P-value
1	50 (92.6%)	40 (74.1%)	**0.02**
2	4 (7.4%)	10 (18.5%)	
3	0	4 (7.4%)	

This table shows the number of attempts required for successful intubation. In the RAMP position group, 92.6% of patients required only 1 attempt, 7.4% required 2 attempts, and none required 3 attempts. In the Sniffing position group, 74.1% required 1 attempt, 18.5% required 2 attempts, and 7.4% required 3 attempts. With a "p-value of 0.02, this difference is statistically significant, demonstrating that the RAMP position was associated with fewer intubation attempts compared to the Sniffing position".

Figure 10: Number of intubation attempts

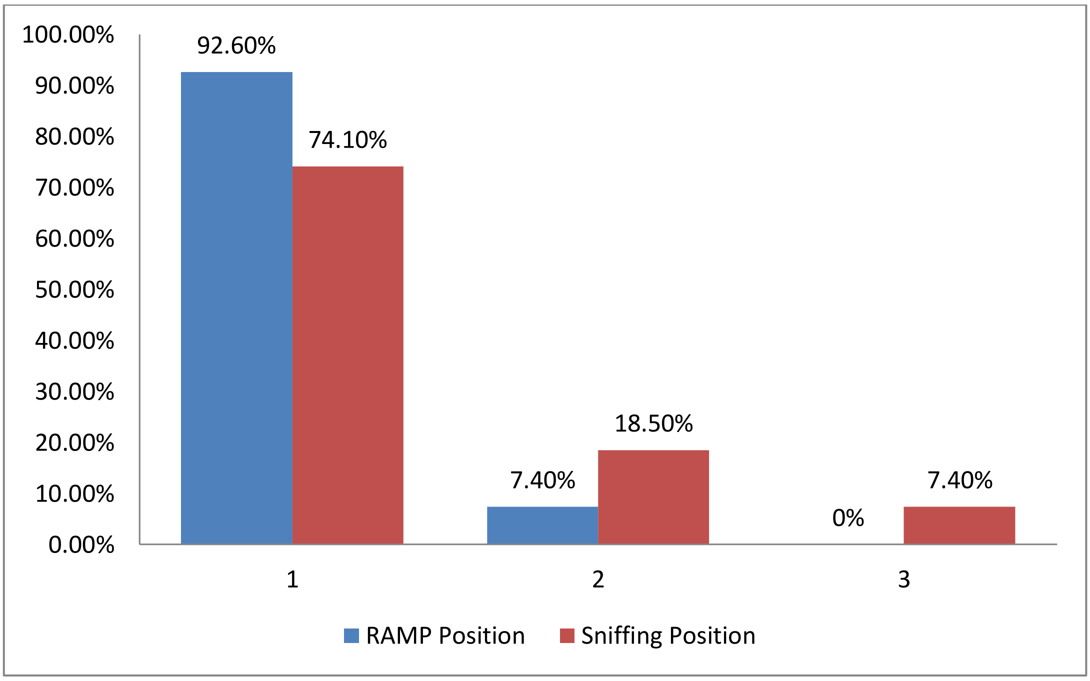


Table 11: Complications

Complications	**RAMP Position (n=54)**	**Sniffing Position (n=54)**	**P-value**
None	52 (96.3%)	42 (77.8%)	**0.01**
Dental trauma	1 (1.8%)	3 (5.6%)	
Sore throat	1 (1.8%)	9 (16.7%)	

This table presents complications associated with intubation. In the RAMP position group, 96.3% had no complications, 1.8% experienced dental trauma, and 1.8% had a sore throat. In the Sniffing position group, 77.8% had no complications, 5.6% experienced dental trauma, and 16.7% had a sore throat. With a p-value of 0.01, this difference is statistically significant, indicating that the RAMP position was associated with fewer complications compared to the Sniffing position.

Figure 11: Complications

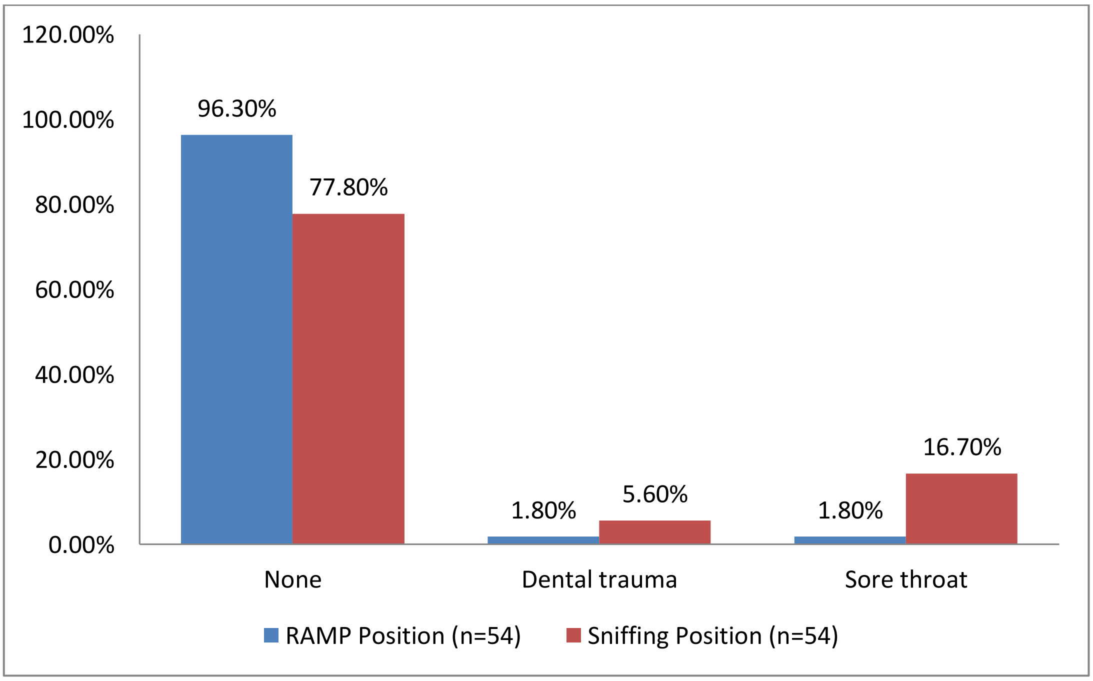


Table 12: Heart Rate changes(beats/min)

Time Point	RAMP Position (n=54)	Sniffing Position (n=54)	P-value
Baseline	83.11 ± 7.20	83.89 ± 8.00	0.592
Post laryngoscopy	89.30 ± 9.58	94.15 ± 8.09	**0.009**
1 min	87.1 ± 12.5	93.9 ± 12.4	**0.007**
2 min	84.07 ± 15.20	90.85 ± 12.47	**0.018**
5 min	82.48 ± 14.17	88.81 ± 17.52	**0.042**
10 min	80.00 ± 13.09	86.81 ± 16.39	0.318
15 min	83.48 ± 10.8	85.59 ± 10.78	0.135

This table tracks heart rate changes at different time points. At baseline, there was no significant difference between groups (p=0.592). However, after laryngoscopy and at 1, 2, and 5 minutes post-intubation, heart rates "were significantly higher in Sniffing position group compared to the RAMP position group (p=0.009, p=0.007, p=0.018, and p=0.042, respectively"). This suggests that the RAMP position was associated with a more stable hemodynamic response during and immediately after intubation. By 10 and 15 minutes, heart rates were comparable between the two groups (p=0.318 and p=0.135).

Figure 12: Heart Rate changes

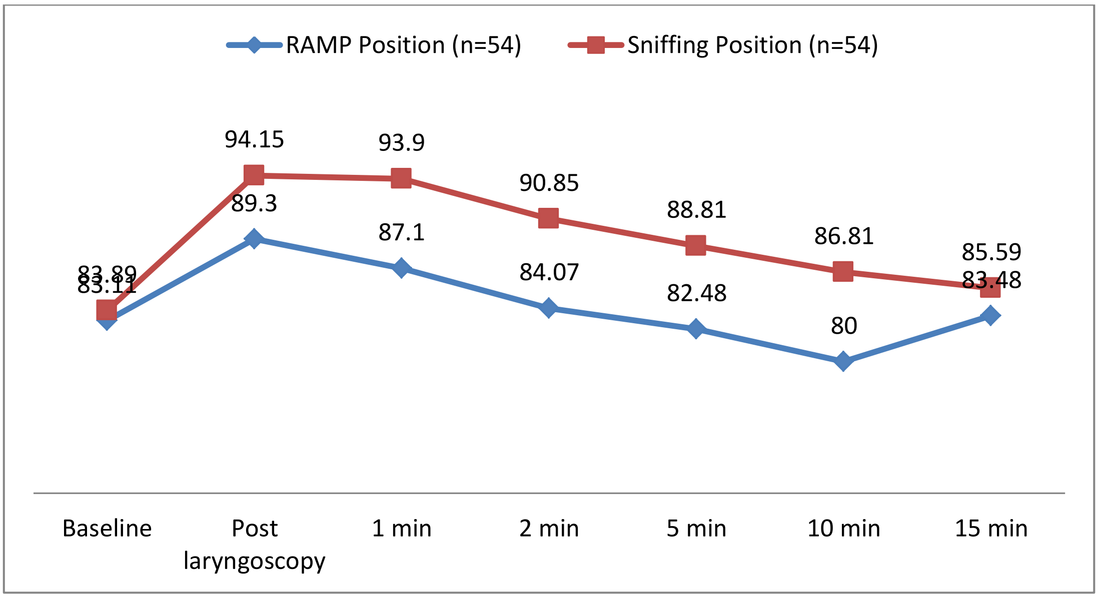


Table 13: Systolic Blood Pressure changes

Time Point	RAMP Position (n=54)	Sniffing Position (n=54)	P-value
Baseline	130.00 ± 9.31	129.19 ± 8.51	0.637
Post laryngoscopy	138.00 ± 10.31	144.78 ± 11.16	**0.002**
1 min	133.15 ± 10.8	140.81 ± 8.4	**0.001**
2 min	128.07 ± 10.20	136.4 ± 10.1	**0.004**
5 min	124.00 ± 13.28	132.74 ± 10.79	**0.021**
10 min	120.11 ± 13.82	127.96 ± 7.70	0.121
15 min	127.07 ± 13.28	130.07 ± 7.91	0.625

This table shows changes in "systolic blood pressure. At baseline, there was no significant difference between groups (p=0.637"). However, post-laryngoscopy and at 1, 2, and 5 minutes, systolic blood pressure was significantly lower in the RAMP position group compared to the Sniffing position group (p=0.002, p=0.001, p=0.004, and p=0.021, respectively). By 10 and 15 minutes, systolic blood pressure values were comparable between groups (p=0.121 and p=0.625). This indicates that the RAMP position resulted in less systolic blood pressure elevation during and after intubation.

Figure 13: Systolic Blood Pressure changes (mmHg)

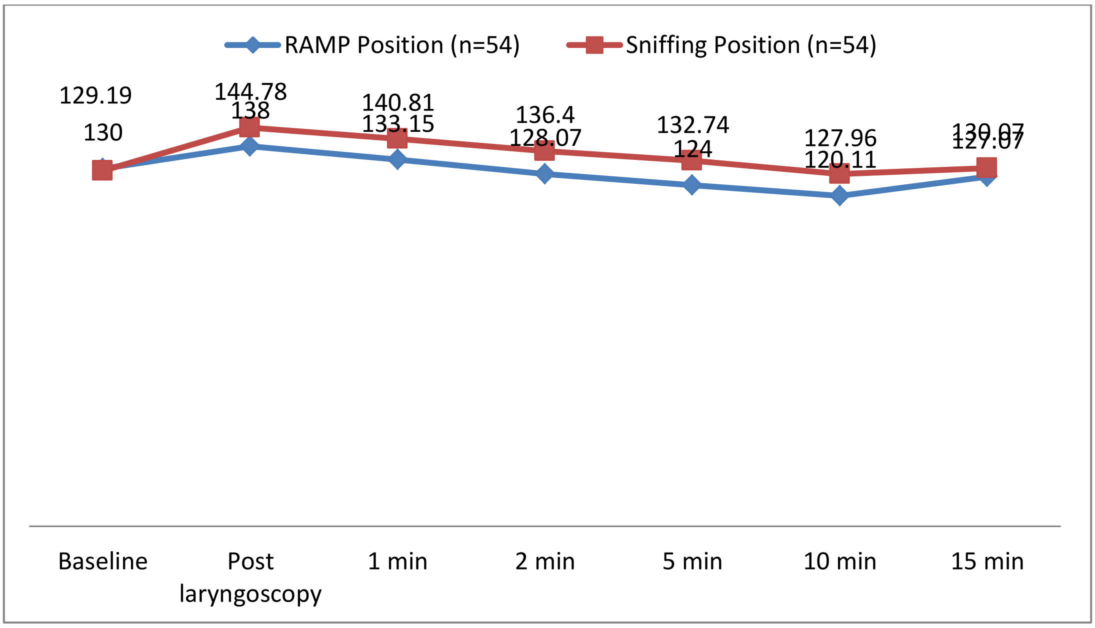


Table 14: Diastolic Blood Pressure changes (mmHg)

Time Point	RAMP Position (n=54)	Sniffing Position (n=54)	P-value
Baseline	79.63 ± 11.11	79.89 ± 9.78	0.897
Post laryngoscopy	85.26 ± 12.18	90.52 ± 9.94	**0.018**
1 min	80.15 ± 9.43	86.8 ± 14.80	**0.006**
2 min	78.70 ± 8.98	83.30 ± 8.15	**0.009**
5 min	76.22 ± 9.15	81.67 ± 8.61	**0.031**
10 min	74.59 ± 8.87	79.5 ± 9.94	0.063
15 min	77.33 ± 7.55	80.63 ± 10.10	0.162

This table presents changes in "diastolic blood pressure. At baseline, there was no significant difference between groups (p=0.89"). However, post-laryngoscopy and at 1, 2, and 5 minutes, diastolic blood pressure was significantly lower in the RAMP position group compared to the Sniffing position group (p=0.018, p=0.006, p=0.009, and p=0.031, respectively). By 10 and 15 minutes, diastolic blood pressure values were comparable between groups (p=0.063 and p=0.162). This shows that the RAMP position caused less diastolic blood pressure elevation during and after intubation.

Figure 14: Diastolic Blood Pressure changes (mmHg)

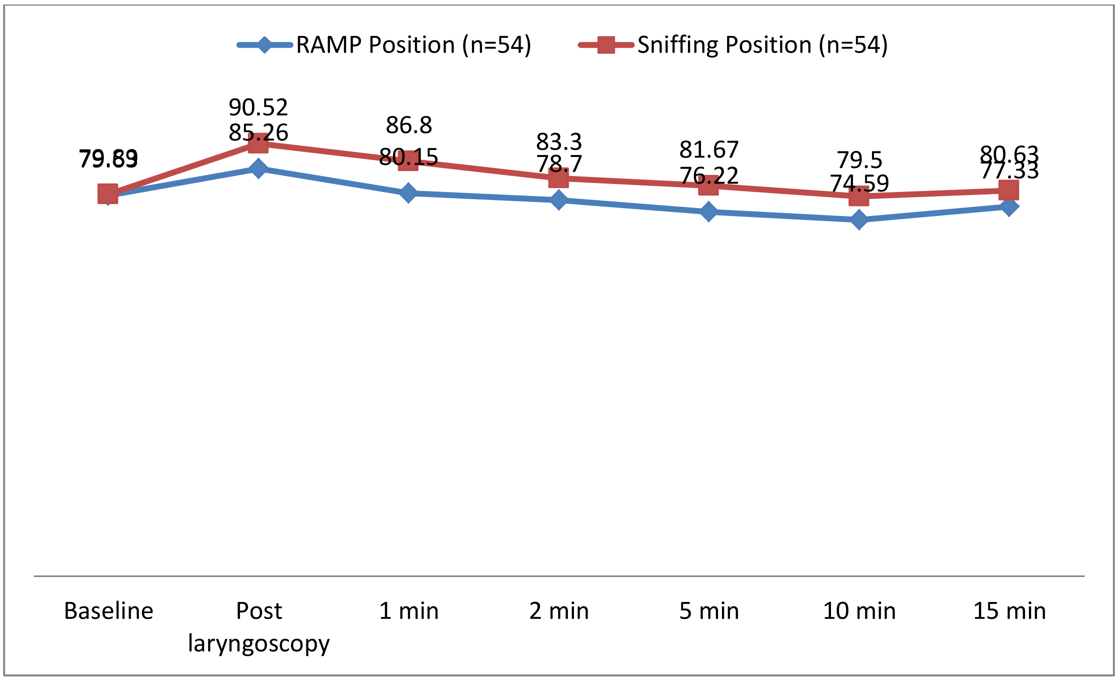


Table 15: Mean Arterial Pressure changes (mmHg)

Time Point	RAMP Position (n=54)	Sniffing Position (n=54)	P-value
Baseline	96.33 ± 7.74	96.33 ± 6.74	1.000
Post laryngoscopy	102.85 ± 8.78	108.96 ± 6.85	**0.001**
1 min	97.78 ± 9.30	104.70 ± 16.38	**0.005**
2 min	94.37 ± 9.17	101.41 ± 11.21	**0.003**
5 min	90.33 ± 10.46	98.52 ± 10.74	**0.012**
10 min	89.89 ± 10.51	95.96 ± 9.65	0.083
15 min	93.41 ± 10.05	96.67 ± 9.25	0.178

This table shows changes in mean arterial pressure. At baseline, there was no significant difference between groups (p=1.000). However, post-laryngoscopy and at 1, 2, and 5 minutes, mean arterial pressure was significantly lower in the RAMP position "group compared to the Sniffing position group (p=0.001, p=0.005, p=0.003, and p=0.012, respectively"). By 10 and 15 minutes, mean arterial pressure values were comparable between groups (p=0.083 and p=0.178). This indicates that the RAMP position resulted in lower mean arterial pressure increases during and after intubation.

Figure 15: Mean Arterial Pressure changes (mmHg)

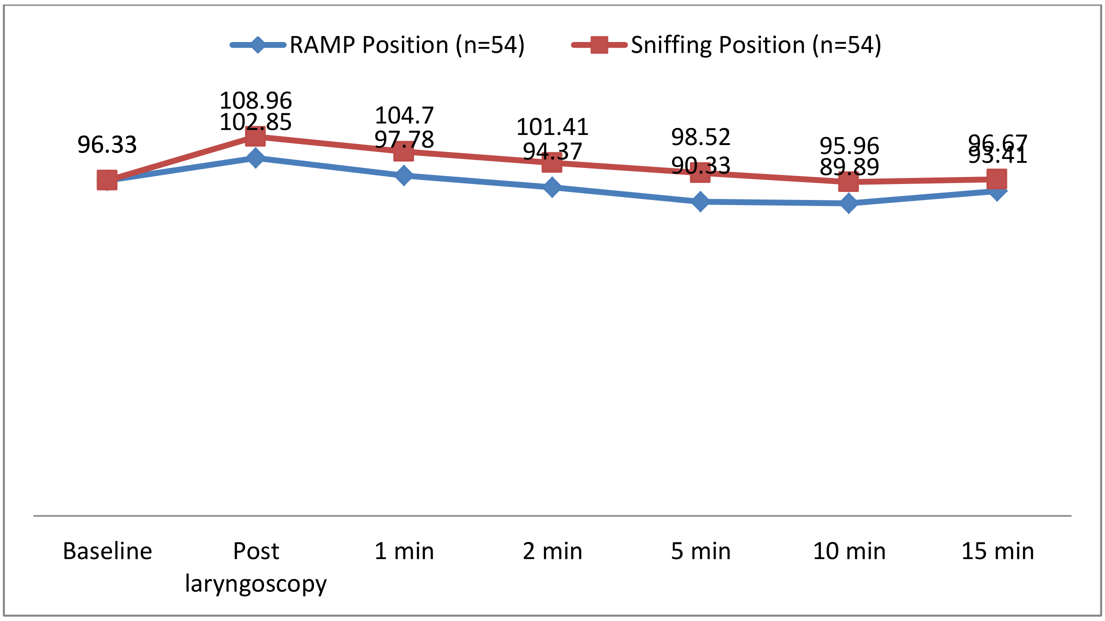
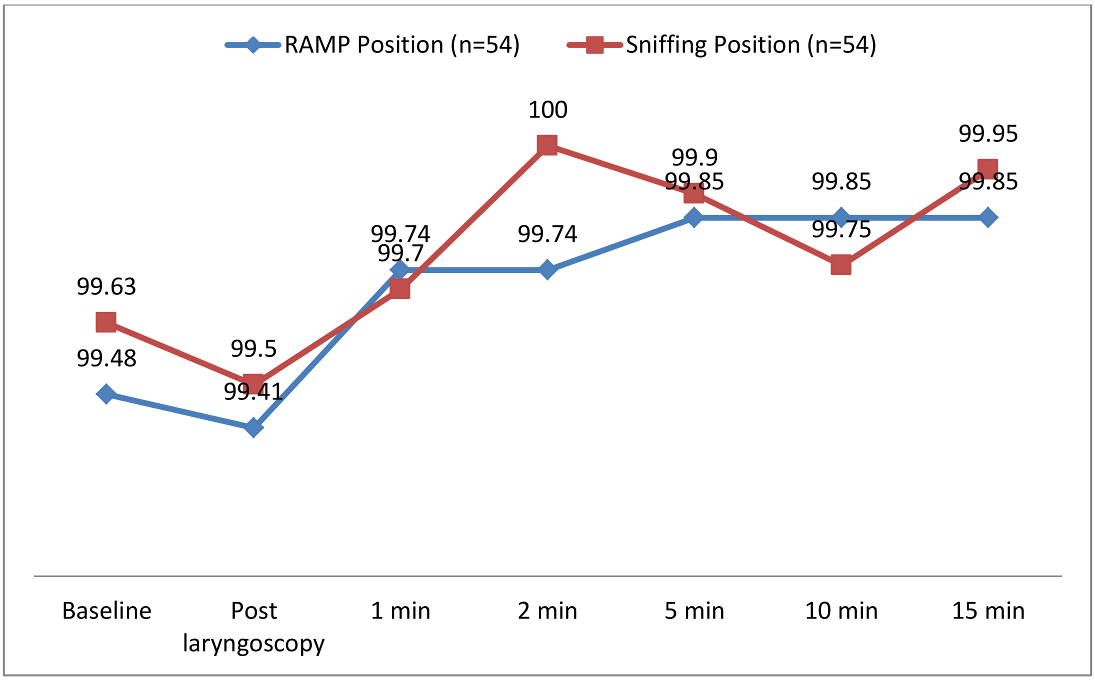


Table 16: Oxygen Saturation (SpO2 %) changes

Time Point	RAMP Position (n=54)	Sniffing Position (n=54)	P-value
Baseline	99.48 ± 0.51	99.63 ± 0.63	0.174
Post laryngoscopy	99.41 ± 0.50	99.50 ± 0.50	0.352
1 min	99.74 ± 0.45	99.70 ± 0.50	0.232
2 min	99.74 ± 0.45	100.00 ± 0.00	0.168
5 min	99.85 ± 0.36	99.9 ± 0.45	0.525
10 min	99.85 ± 0.36	99.75 ± 0.55	0.266
15 min	99.85 ± 0.36	99.95 ± 0.45	0.205

This table presents changes in oxygen saturation levels. There were no statistically significant differences in oxygen saturation levels between the RAMP and Sniffing position groups at any time point (all p-values > 0.05). This suggests that both positions maintained adequate oxygenation throughout the intubation procedure and post-intubation period.

Figure 21: Oxygen Saturation (SpO2 %) changes



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DISCUSSION

DISCUSSION

Endotracheal intubation is a critical procedure performed during general anesthesia to secure the airway and ensure adequate oxygenation and ventilation. The ideal patient positioning for optimal intubation conditions has been a subject of ongoing research and debate in anesthesiology. Traditionally, the sniffing position—characterized by flexion of the neck and extension of the head at the atlanto-occipital joint—has been considered the gold standard for direct laryngoscopy. However, in recent years, the Ramped position (RAMP), which involves elevation of the patient's upper body and head until the external auditory meatus and sternal notch are horizontally aligned, has gained attention as a potentially superior alternative, particularly in certain patient populations.

This randomized controlled trial was designed to compare the ease of intubation between the Sniffing and RAMP positions in elective surgeries requiring general anesthesia with endotracheal intubation. The study evaluated several key parameters including laryngoscopic view (as assessed by Cormack-Lehane grading), time to successful intubation, number of intubation attempts, hemodynamic responses to laryngoscopy and intubation, and associated complications. The findings of this study have important implications for clinical practice and contribute to the growing body of evidence regarding optimal positioning for endotracheal intubation.

Demographic and Baseline Characteristics

Our study included a total of 108 patients, with 54 patients randomized to each of the two positioning techniques. The demographic characteristics of patients in both groups were comparable, with no statistically significant differences in age, gender distribution, weight, ASA physical status, or Mallampati classification. This homogeneity between the groups strengthens the validity of our findings by minimizing potential confounding variables.

The mean age of patients in the RAMP and Sniffing position groups was 37.89 ± 15.25 years and 37.63 ± 12.54 years, respectively (p=0.921). Both groups had a predominance of male patients (59.3% - RAMP group and 55.6% - Sniffing group, p=0.699). The mean weight was also similar between the two groups (72.01 ± 11.99 kg - RAMP group and 72.37 ± 11.51 kg in the Sniffing group, p=0.873). Most patients in both groups were classified as ASA I (63.0% in the RAMP group and 59.3% in the

Sniffing group, p=0.695). Similarly, the majority of patients in both groups had Mallampati Class 1 (70.4% - RAMP group and 63.0% - Sniffing group, p=0.408).

These findings are consistent with other comparative studies in the literature. Xavier N et al. conducted a similar study comparing the two positions and reported comparable baseline characteristics between their study groups, which strengthens the external validity of our findings.[43] Semler et al. also found no significant differences in demographic characteristics in their multicenter trial comparing the effectiveness of the RAMP versus Sniffing position.[6]

Laryngoscopic View

The Cormack-Lehane (CL) grading system is widely used to assess the view of the glottis during direct laryngoscopy, with Grade 1 representing the best view and Grade 4 the worst. In our study, "there was no statistically significant difference in the distribution of CL grades between the two groups (p=0.692"). However, a higher percentage of patients in the RAMP group had Grade 1 views (66.7%) compared to the Sniffing position group (59.3%), although this difference did not reach statistical significance.

Contrary to our findings, several previous studies have reported significantly improved glottic visualization with the RAMP position. Reddy et al. found that the RAMP position significantly improved the laryngoscopic view compared to the sniffing position, with 72% of patients in the RAMP group having CL Grade 1 views compared to 52% in the sniffing position group (p<0.01).[44] Similarly, Lee S et al. demonstrated that the RAMP position improved the laryngoscopic view by at least one CL grade in 18% of patients compared to the sniffing position.[34]

The discrepancy between our findings and these studies may be attributed to several factors. First, our study population consisted predominantly of patients with normal body mass index and without anticipated difficult airways, as evidenced by the majority having Mallampati Class 1. The advantages of the RAMP position in improving laryngoscopic view may be more pronounced in patients with obesity or predicted difficult airways. Indeed, Lebowitz and associates demonstrated that elevated positioning methodology demonstrated significant enhancement of laryngoscopic visualization specifically among individuals with elevated body mass indices (BMI ≥ 30 kg/m[45]

Additionally, the experience and technique of the laryngoscopist can influence the assessment of laryngoscopic views. In our study, all intubations were performed by experienced anesthesiologists familiar with both positioning techniques, which may have minimized differences in laryngoscopic views between the two positions.

Time to Successful Intubation

A key observation of our research was the significantly shorter time to successful intubation "in the RAMP position group compared to the Sniffing position" group (28.88 ± 8.36 seconds versus 32.22 ± 8.70 seconds, p=0.04). This finding suggests that despite similar laryngoscopic views, the RAMP position facilitated more efficient intubation.

Our results align with those reported by Hasanin et al., who found that the mean time to successful intubation was significantly shorter in the RAMP position compared to the sniffing position (37.5 ± 9.8 seconds versus 44.3 ± 8.6 seconds, p<0.001) in their study of non-obese patients undergoing elective surgeries.[46] Similarly, Cattano et al. reported "that the RAMP position was associated with" a 5.2-second reduction in mean intubation time compared to the sniffing position (p=0.02).[47]

The shorter intubation time in the RAMP position may be attributed to several physiological advantages. The RAMP position creates better alignment of the oral, pharyngeal, and laryngeal axes, which facilitates easier passage of the endotracheal tube. Additionally, the head-elevated position enhances the displacement of the tongue and epiglottis, providing a clearer path for intubation. These advantages may explain why intubation was accomplished more quickly in the RAMP position despite similar laryngoscopic views.

Number of Intubation Attempts

Another significant finding of our study was the difference in the number of intubation attempts between the two groups. In the RAMP position group, 92.6% of patients were successfully intubated on the first attempt, compared to 74.1% in the "Sniffing position group". Furthermore, no patients in the RAMP group required three attempts, whereas 7.4% of patients in the Sniffing group needed three attempts for successful intubation. This difference was statistically significant (p=0.02).

These findings corroborate those reported by Khandelwal et al., who found that the first-attempt success rate was significantly higher with the RAMP position compared to the sniffing position (88% versus 71%, p=0.01) in their randomized trial of 200 patients undergoing general anesthesia[48] Similarly, Park et al. demonstrated a "significantly higher first-attempt success rate in the RAMP position (90.2%) compared to the sniffing position" (75.5%) in their study of obese patients ($p<0.01$).[49]

The higher first-attempt success rate in the RAMP position has important clinical implications. Multiple intubation attempts are associated with increased risk of airway trauma, hypoxemia, and cardiac arrhythmias. Therefore, positioning techniques that enhance first-attempt success are highly desirable for patient safety. Our findings suggest that the RAMP position offers advantages in this regard, particularly for routine elective intubations.

Hemodynamic Responses

Our study demonstrated significant differences in hemodynamic responses to laryngoscopy and intubation between the two positioning techniques. Patients in the RAMP position group showed significantly lower increases in heart rate, systolic blood pressure, diastolic blood pressure, and mean arterial pressure compared to those in the Sniffing position group.

Specifically, post-laryngoscopy heart rate was significantly lower in the RAMP group compared to the Sniffing group (89.30 ± 9.58 versus 94.15 ± 8.09 beats/min, $p=0.009$), and this difference persisted at 1 minute, 2 minutes, and 5 minutes post-intubation. Similarly, post-laryngoscopy systolic blood pressure (138.00 ± 10.31 versus 144.78 ± 11.16 mmHg, $p=0.002$), diastolic blood pressure (85.26 ± 12.18 versus 90.52 ± 9.94 mmHg, $p=0.018$), and mean arterial pressure (102.85 ± 8.78 versus 108.96 ± 6.85 mmHg, $p=0.001$) were all significantly lower in the RAMP group compared to the Sniffing group. These differences persisted until 5 minutes post-intubation for all parameters.

These findings are consistent with those reported by Collins JS et al., who found that the pressor response to laryngoscopy and intubation was significantly attenuated in "the RAMP position compared to the sniffing position"[50]. Their study showed that the mean increase in heart rate (15.2% versus 23.5%, $p<0.01$) and mean arterial pressure (10.8% versus 18.6%, $p<0.01$) from baseline was significantly lower in the RAMP position.

The attenuated hemodynamic response associated with the RAMP position may be explained by several mechanisms. First, the RAMP position may reduce the force required for laryngoscopy due to better alignment of the airway axes, resulting in less stimulation of the oropharyngeal structures and consequently less sympathetic activation. Second, the head-elevated position in the RAMP technique may result in reduced venous return and cardiac preload, contributing to lower hemodynamic responses. Lastly, the RAMP position may be associated with less cervical spine movement during laryngoscopy, resulting in less nociceptive stimulation.

The clinical significance of these hemodynamic differences is particularly relevant for patients with cardiovascular comorbidities, such as coronary artery disease, hypertension, or cerebrovascular disease, in whom exaggerated "hemodynamic responses to laryngoscopy and intubation can precipitate adverse events such as myocardial ischemia, arrhythmias, or cerebrovascular accidents". Our findings suggest that the RAMP position may be preferable in such patients to mitigate these risks.

Complications

Our study revealed a significant difference in the incidence of complications between the two positioning techniques. In the RAMP position group, 96.3% of patients experienced no complications, compared to 77.8% in the Sniffing position group (p=0.01). Specific complications such as dental trauma (1.8% versus 5.6%) and sore throat (1.8% versus 16.7%) were less frequent in the RAMP position group.

These findings are consistent with those reported by Yeom et al., who found that the incidence of postoperative sore throat was significantly lower in patients intubated in the RAMP position compared to the sniffing position (14% versus 28%, p=0.02).[51]

The lower complication rate associated with the RAMP position may be attributed to several factors. First, the improved laryngeal exposure and shorter intubation time in the RAMP position may reduce the need for excessive manipulation during laryngoscopy, thereby minimizing trauma to the oropharyngeal structures. Second, the higher first-attempt success rate in the RAMP position reduces the number of laryngoscopy attempts, which is a known risk factor for airway complications. Lastly, the RAMP position may provide a more stable platform for intubation, reducing the likelihood of accidental trauma to the teeth and soft tissues.

The reduction in complications has important implications for patient comfort and satisfaction. Postoperative sore throat, while minor, is a common complaint that can significantly affect the patient's perception of perioperative care. Similarly, dental trauma, although rare, can lead to significant patient dissatisfaction and potential medico-legal implications. Our findings suggest that adopting the RAMP position as a standard for elective intubations may improve overall patient experience by reducing these complications.

Oxygen Saturation

Our study found no significant differences in oxygen saturation (SpO_2) between the two positioning techniques at any time point during the study period. Both groups maintained excellent oxygenation throughout, with SpO_2 values consistently above 99%.

This finding contrasts with some previous studies that have reported improved oxygenation with the RAMP position. For instance, Ramkumar et al. found that patients in the RAMP position maintained higher SpO_2 levels during the apneic period of intubation compared to those in the sniffing position.[66] Similarly, Lane et al. demonstrated that the time to desaturation (SpO_2 < 90%) was significantly longer in “the RAMP position compared to the sniffing position” during simulated difficult airway scenarios.[7]

The discrepancy between our findings and these studies may be explained by several factors. First, our study involved elective surgeries in relatively healthy patients (predominantly ASA I and II) without significant cardiopulmonary disease or morbid obesity. In such patients, the baseline functional residual capacity and oxygen reserves are likely to be adequate, regardless of positioning. Second, all patients in our study received “pre-oxygenation with 100% oxygen” for 3 minutes before induction, which would have maximized oxygen reserves in both groups. Lastly, the relatively short duration of apnea during intubation (mean time to successful intubation less than 35 seconds in both groups) may not have been sufficient to reveal potential differences in oxygenation between the two positions.

It is worth noting that the potential advantages of the RAMP position in maintaining oxygenation may be more pronounced in high-risk scenarios, such as in obese patients, emergency intubations, or in patients with reduced cardiopulmonary reserve. Future studies focusing on these high-risk populations may better elucidate the impact of positioning on oxygenation during intubation.

Subgroup Analysis and Special Populations

While our study did not specifically focus on subpopulations, it is important to consider how our findings may apply to specific patient groups. Several studies in the literature have examined the effects of positioning in particular patient populations, which may complement our findings.

Obesity is one such population where positioning techniques have been extensively studied. Greenland et al. “demonstrated that the RAMP position significantly” improved pre-oxygenation and prolonged the safe apnea time in morbidly obese patients compared to the sniffing position.[52] Similarly, Dixon et al. found that the RAMP position improved laryngoscopic views and first-attempt success rates in obese patients undergoing bariatric surgery.[5] These findings suggest that the advantages of the RAMP position observed in our study may be even more pronounced in obese patients.

Age is another factor that may influence the optimal positioning for intubation. Elderly patients often have reduced neck mobility and anatomical changes that can make intubation more challenging. Semler MW et al. “found that the RAMP position was associated with improved” laryngoscopic views and higher first-attempt success rates in patients older than 65 years compared to the sniffing position.[56]This suggests that the RAMP position may offer particular advantages in the geriatric population.

Pregnant women represent another important subpopulation. The physiological changes of pregnancy, including weight gain, breast enlargement, and increased oxygen consumption, can complicate airway management. Mushambi et al. recommended the RAMP position for obstetric intubations, based on their finding that it improved laryngoscopic views and reduced intubation difficulty in pregnant patients at term.[53]

These studies highlight the importance of considering patient-specific factors when choosing the optimal positioning for intubation. While our findings suggest overall advantages of the RAMP position in a general elective surgery population, the benefits may vary based on individual patient characteristics and comorbidities.

Implications for Clinical Practice

The findings of our study have several important implications for clinical practice. First, our results suggest that the RAMP position offers advantages over the traditional sniffing position for routine elective intubations, particularly in terms of shorter intubation time, higher first-attempt success rate, attenuated hemodynamic responses, and fewer complications. Given these advantages, anesthesiologists may consider adopting the RAMP position as the standard positioning technique for elective intubations, especially in patients where these benefits are most relevant (e.g., those with cardiovascular comorbidities).

Second, our findings suggest that the RAMP position is at least as effective as the sniffing position in terms of laryngoscopic view in patients without anticipated difficult airways. This challenges the traditional teaching that the sniffing position is the optimal position for routine direct laryngoscopy and suggests that the RAMP position may be a viable alternative even in straightforward cases.

Third, the significant reduction in complications associated with the RAMP position highlights its potential to improve patient comfort and satisfaction. Incorporating the RAMP position into routine practice may therefore enhance the overall quality of perioperative care.

Fourth, the attenuated hemodynamic response to laryngoscopy and intubation observed with the RAMP position suggests that this technique may be particularly beneficial in patients at risk for adverse events from hemodynamic fluctuations, such as those with coronary artery disease, hypertension, or cerebrovascular disease.

Lastly, it is important to note that the RAMP position is relatively simple to implement and requires no specialized equipment beyond what is routinely available in operating rooms. This makes it a cost-effective intervention that can be readily incorporated into clinical practice across a variety of healthcare settings.

Limitations and Future Research

Our study has several limitations that should be acknowledged. First, blinding of the laryngoscopist to the positioning technique was not feasible due to the nature of the intervention. This could potentially introduce bias in the assessment of laryngoscopic views and intubation difficulty. However, objective measures such as time to successful intubation and number of attempts were used to minimize this bias.

Second, our study population consisted predominantly of ASA I and II patients without anticipated difficult airways. The findings may not be generalizable to patients with predicted difficult airways or higher ASA status. Future studies should specifically target these high-risk populations to determine if the benefits of the RAMP position are more pronounced in such cases.

Third, all intubations in our study were performed by experienced anesthesiologists familiar with both positioning techniques. The results may differ for novice laryngoscopists or those with limited experience with the RAMP position. Studies comparing the learning curve and ease of use of the two positions for trainees would be valuable additions to the literature.

Fourth, our study did not assess the impact of body mass index (BMI) on the efficacy of the two positioning techniques. Previous research suggests that the advantages of the RAMP position may be more pronounced in patients with higher BMI. Future studies should stratify patients by BMI to determine if the effect of positioning varies with body habitus.

Fifth, our study focused on direct laryngoscopy using a Macintosh blade. The findings may not apply to other laryngoscopy techniques, such as videolaryngoscopy or the use of alternative blade designs. Comparative studies using different laryngoscopy equipment would provide a more comprehensive understanding of the advantages and limitations of the RAMP position.

Lastly, long-term outcomes such as postoperative respiratory complications, length of hospital stay, and patient satisfaction were not assessed in our study. Future research should incorporate these outcome measures to better understand the overall impact of positioning techniques on patient care.

Conclusion

In conclusion, our randomized controlled trial comparing the RAMP and Sniffing positions for elective intubations demonstrated several significant advantages of the RAMP position, including shorter time to successful intubation, higher first-attempt success rate, attenuated hemodynamic responses to laryngoscopy and intubation, and fewer complications. While laryngoscopic views and oxygen saturation were similar between the two techniques, the overall findings suggest that the RAMP position may be a superior alternative to the traditional sniffing position for routine elective intubations.

These findings contribute to the growing body of evidence supporting the use of the RAMP position in airway management and challenge the longstanding tradition of using the sniffing position as the standard for direct laryngoscopy. Further research is needed to determine if these advantages extend to specific patient populations and alternative laryngoscopy techniques. Nevertheless, our study provides compelling evidence for anesthesiologists to consider adopting the RAMP position as a standard practice for elective intubations, particularly in patients where the observed benefits are most relevant.

LIMITATIONS OF THE STUDY

- The study excluded patients with BMI >25, which limits the generalizability of results to overweight or obese populations where airway management is often more challenging.
- Only ASA I-II patients were included, leaving uncertainty about the benefits in higher-risk patients (ASA III-IV).
- The sample size (n=108) was calculated based on oxygen saturation differences, but this parameter "showed no significant differences between groups", suggesting possible inadequate power for this specific outcome.
- The study was limited to elective, non-cardiovascular, non-obstetric surgeries, restricting applicability to emergency or specialized surgical settings.
- Only patients with Mallampati Class 1-2 were included, excluding those with anticipated difficult airways (Class 3-4) who might benefit most from positioning optimization.
- The study did not include long-term follow-up to assess potential delayed complications beyond the immediate post-intubation period.
- The observational nature of the study, despite randomization, may introduce some observer bias, especially in subjective assessments like Cormack-Lehane grading.
- The study did not account for the variability in clinician experience levels, which could influence intubation success rates independent of positioning technique.
- No blinding was mentioned in the methodology, which could introduce performance and detection bias.
- The study did not include patient-reported outcomes such as post-operative discomfort or satisfaction with the procedure.

CONCLUSION

CONCLUSION

This randomized controlled trial compared the ease of intubation between the RAMP and Sniffing positions in 108 patients (54 in each group) undergoing elective surgeries requiring general anesthesia with endotracheal intubation. The demographic characteristics of both groups were comparable, with no significant differences in age, gender distribution, weight, ASA physical status, or Mallampati classification.

The Cormack-Lehane grading for laryngoscopic view showed no statistically significant difference between the two groups (p=0.692), although a higher percentage of patients in the RAMP group had Grade 1 views (66.7%) compared to the Sniffing position group (59.3%).

The time to successful intubation was significantly shorter in the RAMP position group compared to the Sniffing position group (28.88 ± 8.36 seconds versus 32.22 ± 8.70 seconds, p=0.04). Similarly, the RAMP position was associated with a significantly higher first-attempt success rate (92.6% versus 74.1%, p=0.02), with "no patients in the RAMP group requiring three attempts, whereas 7.4% of patients in the Sniffing group needed three attempts".

Hemodynamic responses to laryngoscopy and intubation were significantly attenuated in the RAMP position group. Post-laryngoscopy heart rate (89.30 ± 9.58 versus 94.15 ± 8.09 beats/min, p=0.009), systolic blood pressure (138.00 ± 10.31 versus 144.78 ± 11.16 mmHg, p=0.002), diastolic blood pressure (85.26 ± 12.18 versus 90.52 ± 9.94 mmHg, p=0.018), and mean arterial pressure (102.85 ± 8.78 versus 108.96 ± 6.85 mmHg, p=0.001) were all significantly lower in the RAMP group compared to the Sniffing group. These differences persisted until 5 minutes post-intubation for all parameters.

The incidence of complications was significantly lower in the RAMP position group, with 96.3% of patients experiencing no complications, compared to 77.8% in the Sniffing position group (p=0.01). Specific complications such as dental trauma (1.8% versus 5.6%) and sore throat (1.8% versus 16.7%) were less frequent in the RAMP position group. Oxygen saturation remained comparable between the two groups throughout the study period.

Overall, the study demonstrates that the RAMP position offers several advantages over the Sniffing position for elective intubations, including shorter intubation time, higher first-attempt success rate, attenuated hemodynamic responses, and fewer complications.

SUMMARY

SUMMARY

This study compared two different positioning techniques for endotracheal intubation: the RAMP (Ramped position) versus the Sniffing position. The study involved 108 patients equally divided between the two groups (54 in each**).**

Demographic Characteristics

- Both groups were comparable in terms of age (mean age around 37 years), gender distribution, weight, ASA physical status, and Mallampati classification, with no statistically significant differences between groups.

Intubation Performance Metrics

- **Time to successful intubation**: The RAMP position required significantly less time (28.88 ± 8.36 seconds) compared to the Sniffing position (32.22 ± 8.70 seconds), p=0.04.
- **Number of intubation attempts**: The RAMP position showed significantly better first-attempt success rates (92.6% vs 74.1% in Sniffing position), with fewer patients requiring multiple attempts (p=0.02).
- **Laryngeal view**: While the RAMP position showed slightly better Cormack Lehane Grade 1 views (66.7% vs 59.3%), this difference was not statistically significant (p=0.692).

Complications

- The RAMP position was associated with significantly fewer complications (p=0.01):
    - Only 3.6% of patients in the RAMP group experienced complications (1.8% dental trauma, 1.8% sore throat)
    - 22.2% of patients in the Sniffing position group experienced complications (5.6% dental trauma, 16.7% sore throat)

Hemodynamic Responses

- **Heart Rate:** The RAMP position showed significantly lower heart rates at post-laryngoscopy, 1 min, 2 min, and 5 min time points compared to the Sniffing position.

- **Blood Pressure:**
  - Systolic, diastolic, and mean arterial pressure were all significantly lower in the RAMP position at post-laryngoscopy, 1 min, 2 min, and 5 min time points.
  - By 10 and 15 minutes, the differences between groups were no longer statistically significant.
- Oxygen Saturation: No significant differences were observed between the groups at any time point.

Conclusion

The RAMP position demonstrated superior performance compared to the Sniffing position for endotracheal intubation, with faster intubation times, higher first-attempt success rates, fewer complications, and a more stable hemodynamic response during and after the procedure. These findings suggest that the RAMP position may be the preferred patient positioning technique for endotracheal intubation, particularly when considering patient safety and procedural efficiency.

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ANNEXURES

ANNEXURE

PROFORMA

<u>A Comparative Study of Ease of Intubation between RAMP position and Sniffing position.</u>

<u>Investigators: Dr. M.Sai Sharath Meghana/ Dr. Vishnuvardhan.V.</u>

Name of the patient: **Age/Sex:**

IP No. : **ASA grade:**

<u>Diagnosis:</u>

<u>Surgery:</u>

<u>General physical examination:</u>

Height:	**Weight:**	**BMI:**
Pulse rate:		**Blood pressure:**

Pallor/icterus/cyanosis/clubbing/lymphadenopathy/edema

Systemic examination:

RS -

CVS –

CNS -

P/A -

Baseline vitals:

TIME	**HR:**	**SBP:**	**DBP:**	**MAP:**	**SpO2:**
Before intubation					
After					

intubation					
1 min					
2 min					
5 mins					
10 mins					
15 mins					

Cormack Lehane grade:

Grade 1: Full exposure of epiglottis (anterior + posterior commissure)

Grade 2: 2a: Partial view of the glottis

2b: Only the arytenoids or very posterior origin of cords are visible.

Grade 3: Epiglottis only

Grade 4: No glottic structure visible.[3]

Intubation position:

Time taken for intubation:

Number of attempts:

Complications:

INFORMATION SHEET

Study: A Comparative study of Ease of Intubation between RAMP position and sniffing position in elective intubations: A randomised control trial

Investigators: Dr. Sai Sharath Meghana / Dr. Vishnuvardhan V

Study location: R L Jalappa Hospital and Research Centre attached to Sri Devaraj Urs Medical College, Tamaka, Kolar.

Details: Non-obstetric patients without cardiac abnormalities/diseases/complication undergoing general anaesthesia for elective surgeries at R. L. Jalappa Hospital, Tamaka, Kolar are included in the study. Patients who meet exclusion criteria will be excluded from the study.

This study aims to assess the better position for intubation by comparing Cormack Lehane grading between ramped and sniffing positions . Patient and the attenders will be completely explained about the procedure. Throughout the study if any form of payment/purchase is necessary, it will be completely borne by the investigator. No extra cost will charged for patient throughout the study.

Please read the above mentioned information and discuss with your family members. You can ask any question regarding the study. If you agree to participate in the study we will collect required information and relevant history will be taken. The collected information will be used only for dissertation and publication.

All information collected from you will be kept confidential and will not be disclosed to any outsider. Your identity will not be revealed. There is no compulsion to agree to this study. The care you will get will not change if you do not wish to participate.

You are required to sign/ provide thumb impression only if you voluntarily agree to participate in this study.

For further information contact:

Dr. M.Sai Sharath Meghana

(Principal investigator)

Contact number:9791859349

Witness 1 (Signature/Thumb impression): ________________________

Name of witness 1: ____________________________________

Relationship to patient: ____________________________________

Research/Study conducting Doctor's signature: ________________________

Name of Doctor : Dr. M. Sai Sharath Meghana (Principal investigator)

KEY TO MASTER CHART

SBP	Systolic Blood Pressure
DBP	Diastolic Blood Pressure
HR	Heart Rate
ASA	American Society of Anesthesiologists
MIN	Minutes

MASTERCHART

A COMPARATIVE STUDY OF EASE OF INTUBATION BETWEEN SNIFFING AND RAMP POSITION IN ELECTIVE INTUBATIONS: A RANDOMISED CONTROL TRIAL

sl.no	age (years)	gender	weight (kg)	height (cm)	BMI	ASA	Mallampatti class	groups	groupsnos	cormack lehane grade	time to successful intubation (seconds)	number of intubation attempts	HR Baseline	HR post laryngoscopy	HR 1 min	HR 2min	HR 5 min	HR 10 MIN	HR 15 Min	SBP baseline	SBP post laryngoscopy	SBP 1 min	SBP 2min	SBP 5 min	SBP 10 MIN	SBP 15 Min
1	24	M	60.1	154.8	25.1	I	1	RAMP	1	1	42.4	1	78	80	6264	62	58	56	55	132	151	98	100	98	99	100
2	49	M	76.2	162	29	I	1	RAMP	1	1	37.7	1	90	104	74	76	74	80	78	121	123	110	130	128	130	136
3	24	M	72	172.8	24.1	I	2	RAMP	1	1	18.7	1	89	97	70	72	68	66	70	117	123	131	128	130	136	128
4	46	F	63.8	158.9	25.3	I	1	RAMP	1	1	23.2	1	80	82	114	116	110	107	103	138	140	110	116	103	105	108
5	57	F	64.6	175.8	20.9	I	1	RAMP	1	3	28.9	1	79	85	78	76	74	70	74	123	139	140	135	130	120	110
6	22	M	90.8	167.9	32.2	I	2	RAMP	1	1	40.6	1	69	82	74	72	70	72	68	144	146	116	120	118	126	140
7	20	M	75.8	176	24.5	II	1	RAMP	1	1	34.2	2	85	100	91	87	88	83	78	138	152	123	124	114	110	108
8	23	M	78.8	152.8	33.8	II	2	RAMP	1	1	21.7	2	93	108	82	72	74	70	88	127	135	110	100	90	90	100
9	28	F	76.1	184.3	22.4	II	1	RAMP	1	1	**40.6**	1	89	95	74	72	70	68	65	117	128	128	128	125	120	119
10	27	M	85.2	186.7	24.4	I	1	RAMP	1	1	39.9	1	88	103	72	74	74	73	72	132	143	140	132	132	134	134
11	37	F	80.1	157.2	32.4	I	2	RAMP	1	1	37.5	1	90	95	96	100	98	90	90	130	134	130	130	124	120	114
12	55	M	55.1	184.1	16.3	I	2	RAMP	1	1	28.3	1	79	80	114	116	110	107	103	138	141	131	128	130	136	128
13	44	F	72	183.7	21.3	I	1	RAMP	1	1	25.7	1	72	74	78	76	74	70	74	135	143	110	116	103	105	108
14	52	M	85	183.6	25.2	I	1	RAMP	1	3	31.6	1	75	83	74	72	70	72	68	126	129	140	135	130	120	110
15	56	M	87.1	168.4	30.7	I	1	RAMP	1	1	24.8	1	81	91	91	87	88	83	78	122	137	116	120	118	126	140
16	33	M	62.3	185.2	18.2	II	2	RAMP	1	2	24.8	1	92	95	82	72	74	70	88	123	125	123	124	114	110	108
17	22	M	71.4	172.9	23.9	II	1	RAMP	1	1	38	1	73	84	74	72	70	68	65	118	124	116	120	118	126	140
18	19	M	58.2	160	22.7	II	1	RAMP	1	2	18.3	1	88	105	82	72	74	70	88	125	138	123	124	114	110	108
19	25	M	51.1	187	14.6	I	1	RAMP	1	2	28.2	1	81	94	74	72	70	68	65	144	158	110	100	90	90	100
20	54	F	68.7	181.1	20.9	II	1	RAMP	1	1	21.5	2	88	98	72	74	74	73	72	118	129	128	128	125	120	119
21	19	M	83.6	158.4	33.3	I	1	RAMP	1	2	38.2	1	71	76	96	100	98	90	90	122	140	140	132	132	134	134
22	54	F	66.6	163.6	24.9	II	1	RAMP	1	1	28.3	3	88	99	114	116	110	107	103	140	145	130	130	124	120	114
23	58	F	81.7	166.6	29.4	II	1	RAMP	1	2	28.9	1	74	78	78	76	74	70	74	142	142	131	128	130	136	128
24	59	M	80.2	158.8	31.8	II	1	RAMP	1	1	43.8	1	89	91	74	72	70	72	68	137	148	110	116	103	105	108
25	18	F	51.4	173	17.2	I	2	RAMP	1	1	39.6	1	88	93	91	87	88	83	78	145	163	131	128	130	136	128
26	55	F	90.7	190.1	25.1	I	1	RAMP	1	2	34.3	1	85	96	74	72	70	68	65	120	138	110	116	103	105	108
27	43	F	55.6	159.6	21.8	I	2	RAMP	1	3	14	1	90	97	72	74	74	73	72	136	139	140	135	130	120	110
28	22	M	90.8	167.9	32.2	I	2	RAMP	1	1	40.6	1	69	82	74	72	70	72	68	144	146	116	120	118	126	140
29	20	M	75.8	176	24.5	II	1	RAMP	1	1	34.2	2	85	100	91	87	88	83	78	138	152	123	124	114	110	108
30	23	M	78.8	152.8	33.8	II	2	RAMP	1	1	21.7	2	93	108	82	72	74	70	88	127	135	110	100	90	90	100
31	28	F	76.1	184.3	22.4	II	1	RAMP	1	1	40.6	1	89	95	74	72	70	68	65	117	128	128	128	125	120	119
32	27	M	85.2	186.7	24.4	I	1	RAMP	1	1	39.9	1	88	103	72	74	74	73	72	132	143	140	132	132	134	134
33	37	F	80.1	157.2	32.4	I	2	RAMP	1	1	37.5	1	90	95	96	100	98	90	90	130	134	130	130	124	120	114
34	55	M	55.1	184.1	16.3	I	2	RAMP	1	1	28.3	1	79	80	114	116	110	107	103	138	141	131	128	130	136	128
35	44	F	72	183.7	21.3	I	1	RAMP	1	1	25.7	1	72	74	78	76	74	70	74	135	143	110	116	103	105	108
36	52	M	85	183.6	25.2	I	1	RAMP	1	3	31.6	1	75	83	74	72	70	72	68	126	129	140	135	130	120	110
37	56	M	87.1	168.4	30.7	I	1	RAMP	1	1	24.8	1	81	91	91	87	88	83	78	122	137	116	120	118	126	140
38	33	M	62.3	185.2	18.2	II	2	RAMP	1	2	24.8	1	92	95	82	72	74	70	88	123	125	123	124	114	110	108
39	22	M	71.4	172.9	23.9	II	1	RAMP	1	1	38	1	73	84	74	72	70	68	65	118	124	116	120	118	126	140
40	19	M	58.2	160	22.7	II	1	RAMP	1	2	18.3	1	88	105	82	72	74	70	88	125	138	123	124	114	110	108
41	25	M	51.1	187	14.6	I	1	RAMP	1	2	28.2	1	81	94	74	72	70	68	65	144	158	110	100	90	90	100
42	54	F	68.7	181.1	20.9	II	1	RAMP	1	1	21.5	2	88	98	72	74	74	73	72	118	129	128	128	125	120	119
43	19	M	83.6	158.4	33.3	I	1	RAMP	1	2	38.2	1	71	76	96	100	98	90	90	122	140	140	132	132	134	134
44	54	F	66.6	163.6	24.9	II	1	RAMP	1	1	28.3	3	88	99	114	116	110	107	103	140	145	130	130	124	120	114
45	54	F	68.7	181.1	20.9	II	1	RAMP	1	1	21.5	2	88	98	72	74	74	73	72	118	129	128	128	125	120	119
46	19	M	83.6	158.4	33.3	I	1	RAMP	1	2	38.2	1	71	76	96	100	98	90	90	122	140	140	132	132	134	134
47	54	F	66.6	163.6	24.9	II	1	RAMP	1	1	28.3	3	88	99	114	116	110	107	103	140	145	130	130	124	120	114
48	58	F	81.7	166.6	29.4	II	1	RAMP	1	2	28.9	1	74	78	78	76	74	70	74	142	142	131	128	130	136	128
49	59	M	80.2	158.8	31.8	II	1	RAMP	1	1	43.8	1	89	91	74	72	70	72	68	137	148	110	116	103	105	108
50	18	F	51.4	173	17.2	I	2	RAMP	1	1	39.6	1	88	93	91	87	88	83	78	145	163	131	128	130	136	128
51	55	F	90.7	190.1	25.1	I	1	RAMP	1	2	34.3	1	85	96	74	72	70	68	65	120	138	110	116	103	105	108
52	43	F	55.6	159.6	21.8	I	2	RAMP	1	3	14	1	90	97	72	74	74	73	72	136	139	140	135	130	120	110
53	22	M	90.8	167.9	32.2	I	2	RAMP	1	1	40.6	1	69	82	74	72	70	72	68	144	146	116	120	118	126	140
54	59	M	80.2	158.8	31.8	II	1	RAMP	1	1	43.8	1	89	91	74	72	70	72	68	137	148	110	116	103	105	108

sl.no	DBP baseline	DBP post laryngoscopy	DBP 1 min	DBP 2min	DBP 5 min	DBP 10 MIN	DBP 15 Min	MAP baseline	MAP post laryngoscopy	MAP 1 min	MAP 2min	MAP 5 min	MAP 10 MIN	MAP 15 Min	Complications	SPO2 baseline	SPO2 post laryngoscopy	SPO2 1 min	SPO2 2min	SPO2 5 min	SPO2 10 MIN	SPO2 15 Min
1	92	92	52	58	54	58	64	105	112	62	64	62	69	72	None	99	99	100	100	100	100	100
2	76	80	70	70	80	90	80	91	94	83	90	96	103	98	Sore throat	99	100	100	100	100	100	100
3	83	92	82	80	80	83	82	94	102	91	90	96	94	95	None	99	99	100	100	100	100	100
4	73	82	70	70	80	70	70	95	101	73	75	71	70	70	None	99	99	99	99	99	99	99
5	75	77	80	82	80	70	80	91	98	76	76	78	74	72	None	99	99	100	100	100	100	100
6	94	103	80	78	76	82	86	111	117	74	74	72	72	71	None	100	100	100	100	100	100	100
7	63	66	78	77	68	67	66	88	95	89	89	81	79	78	None	100	99	99	99	100	100	100
8	90	96	70	60	60	70	70	102	109	74	72	70	72	74	None	100	100	100	100	100	100	100
9	68	77	84	82	80	75	70	84	94	84	82	79	75	72	None	100	100	100	100	100	100	100
10	75	77	92	88	84	86	84	94	99	88	88	89	90	90	None	100	100	100	100	100	100	100
11	79	80	80	80	76	70	76	96	98	97	97	92	87	89	None	99	99	100	100	100	100	100
12	91	103	78	77	68	67	66	107	116	73	75	71	70	70	None	99	99	99	99	99	99	99
13	71	78	70	60	60	70	70	92	100	76	76	78	74	72	None	99	99	100	100	100	100	100
14	83	94	84	82	80	75	70	97	106	74	74	72	72	71	Sore throat	100	100	100	100	100	100	100
15	100	109	92	88	84	86	84	107	118	76	76	78	74	72	None	100	99	99	99	100	100	100
16	72	81	82	80	80	83	82	89	96	74	74	72	72	71	None	100	100	100	100	100	100	100
17	67	74	70	70	80	70	70	84	91	89	89	81	79	78	None	99	99	100	100	100	100	100
18	94	106	80	82	80	70	80	104	117	74	72	70	72	74	None	99	99	99	99	99	99	99
19	64	67	80	78	76	82	86	91	97	84	82	79	75	72	None	99	99	100	100	100	100	100
20	90	92	78	77	68	67	66	99	104	88	88	89	90	90	None	100	100	100	100	100	100	100
21	82	85	70	60	60	70	70	95	103	97	97	92	87	89	None	100	99	99	99	100	100	100
22	73	84	52	58	54	58	64	95	104	73	75	71	70	70	None	100	100	100	100	100	100	100
23	69	77	70	70	80	90	80	93	99	62	64	62	69	72	None	100	100	100	100	100	100	100
24	94	103	82	80	80	83	82	108	118	83	90	96	103	98	None	100	100	100	100	100	100	100
25	89	94	70	70	80	70	70	108	117	91	90	96	94	95	None	99	99	100	100	100	100	100
26	82	91	80	82	80	70	80	95	107	73	75	71	70	70	Dental trauma	99	99	99	99	99	99	99
27	61	69	80	78	76	82	86	86	92	76	76	78	74	72	None	99	99	100	100	100	100	100
28	94	103	80	78	76	82	86	111	117	74	74	72	72	71	None	100	100	100	100	100	100	100
29	63	66	78	77	68	67	66	88	95	89	89	81	79	78	None	100	99	99	99	100	100	100
30	90	96	70	60	60	70	70	102	109	74	72	70	72	74	None	100	100	100	100	100	100	100
31	68	77	84	82	80	75	70	84	94	84	82	79	75	72	None	100	100	100	100	100	100	100
32	75	77	92	88	84	86	84	94	99	88	88	89	90	90	None	100	100	100	100	100	100	100
33	79	80	80	80	76	70	76	96	98	97	97	92	87	89	None	99	99	100	100	100	100	100
34	91	103	78	77	68	67	66	107	116	73	75	71	70	70	None	99	99	99	99	99	99	99
35	71	78	70	60	60	70	70	92	100	76	76	78	74	72	None	99	99	100	100	100	100	100
36	83	94	84	82	80	75	70	97	106	74	74	72	72	71	Sore throat	100	100	100	100	100	100	100
37	100	109	92	88	84	86	84	107	118	76	76	78	74	72	None	100	99	99	99	100	100	100
38	72	81	82	80	80	83	82	89	96	74	74	72	72	71	None	100	100	100	100	100	100	100
39	67	74	70	70	80	70	70	84	91	89	89	81	79	78	None	99	99	100	100	100	100	100
40	94	106	80	82	80	70	80	104	117	74	72	70	72	74	None	99	99	99	99	99	99	99
41	64	67	80	78	76	82	86	91	97	84	82	79	75	72	None	99	99	100	100	100	100	100
42	90	92	78	77	68	67	66	99	104	88	88	89	90	90	None	100	100	100	100	100	100	100
43	82	85	70	60	60	70	70	95	103	97	97	92	87	89	None	100	99	99	99	100	100	100
44	73	84	52	58	54	58	64	95	104	73	75	71	70	70	None	100	100	100	100	100	100	100
45	90	92	78	77	68	67	66	99	104	88	88	89	90	90	None	100	100	100	100	100	100	100
46	82	85	70	60	60	70	70	95	103	97	97	92	87	89	None	100	99	99	99	100	100	100
47	73	84	52	58	54	58	64	95	104	73	75	71	70	70	None	100	100	100	100	100	100	100
48	69	77	70	70	80	90	80	93	99	62	64	62	69	72	None	100	100	100	100	100	100	100
49	94	103	82	80	80	83	82	108	118	83	90	96	103	98	None	100	100	100	100	100	100	100
50	89	94	70	70	80	70	70	108	117	91	90	96	94	95	None	99	99	100	100	100	100	100
51	82	91	80	82	80	70	80	95	107	73	75	71	70	70	Dental trauma	99	99	99	99	99	99	99
52	61	69	80	78	76	82	86	86	92	76	76	78	74	72	None	99	99	100	100	100	100	100
53	94	103	80	78	76	82	86	111	117	74	74	72	72	71	None	100	100	100	100	100	100	100
54	94	103	82	80	80	83	82	108	118	83	90	96	103	98	None	100	100	100	100	100	100	100

sl.no	age (years)	gender	weight (kg)	height (cm)	BMI	ASA	Mallampati class	groups	groupsnos	cormack lehane grade	time to successful intubation (seconds)	number of intubation attempts	HR Baseline	HR post laryngoscopy	HR 1 min	HR 2min	HR 5 min	HR 10 MIN	HR 15 Min	SBP baseline	SBP post laryngoscopy	SBP 1 min	SBP 2min	SBP 5 min	SBP 10 MIN	SBP 15 Min
55	31	M	78.2	155.4	32.4	II	1	Sniffing	2	1	38.4	1	77	88	83	77	85	77	72	135	152	120	108	129	125	119
56	20	F	54.9	182	16.6	I	1	Sniffing	2	1	15.7	2	81	88	71	74	72	70	70	123	126	116	138	121	109	127
57	25	M	74.7	159.1	29.5	I	2	Sniffing	2	2	21	3	77	92	81	80	77	74	72	142	154	100	90	100	110	130
58	53	F	80.8	153.1	34.5	II	1	Sniffing	2	2	27.2	1	81	82	88	84	86	78	70	118	128	120	120	130	132	128
59	30	M	87.3	156.7	35.6	I	1	Sniffing	2	1	29.4	1	96	100	80	80	72	70	66	130	135	124	120	120	110	110
60	22	F	54.7	164	20.3	I	1	Sniffing	2	1	37.3	1	73	85	115	120	90	90	84	121	121	140	140	130	127	128
61	39	M	69.2	165.2	25.4	I	2	Sniffing	2	1	29.4	2	88	96	50	50	50	51	50	131	137	105	104	108	115	116
62	43	M	76.6	164.9	28.2	I	1	Sniffing	2	1	44.3	1	97	97	104	93	95	94	88	125	127	159	135	123	120	122
63	58	F	52.8	179.7	16.4	II	1	Sniffing	2	3	41.4	1	77	81	104	96	94	86	86	137	150	120	114	110	118	121
64	22	M	80.6	185.1	23.5	I	1	Sniffing	2	1	26.6	1	96	102	124	128	115	110	108	129	131	112	123	96	103	104
65	43	M	88	185.4	25.6	I	2	Sniffing	2	1	21.1	1	83	96	94	90	86	82	78	132	141	138	132	126	122	120
66	58	M	69.4	168	24.6	I	1	Sniffing	2	2	29.5	1	79	87	60	62	61	62	62	131	137	116	112	109	114	111
67	32	M	85.1	168.9	29.8	I	2	Sniffing	2	2	36.8	1	83	86	108	103	102	100	102	129	144	130	140	120	110	120
68	42	F	74	179.4	23	II	1	Sniffing	2	2	31.5	1	74	82	92	92	95	94	108	146	161	106	108	110	111	110
69	47	F	85.3	156.8	34.7	II	1	Sniffing	2	1	42.1	2	77	91	72	73	77	70	70	140	146	101	102	108	107	108
70	46	F	63.7	158.9	25.2	II	1	Sniffing	2	1	35.3	1	91	92	115	120	90	90	84	114	121	124	120	120	110	110
71	58	M	60.7	163.6	22.7	I	2	Sniffing	2	1	20.5	1	92	96	50	50	50	51	50	135	155	140	140	130	127	128
72	33	F	82	178.7	25.7	I	1	Sniffing	2	2	37.2	1	92	109	104	93	95	94	88	142	154	105	104	108	115	116
73	37	M	84.8	189.9	23.5	I	2	Sniffing	2	1	44	1	96	100	104	96	94	86	86	139	141	159	135	123	120	122
74	21	M	53	179.8	16.4	I	1	Sniffing	2	1	24.5	1	72	82	124	128	115	110	108	121	125	120	114	110	118	121
75	44	F	75.4	170.9	25.8	I	2	Sniffing	2	3	36.2	1	72	75	104	96	94	86	86	122	132	112	123	96	103	104
76	19	M	82.4	161.9	31.4	I	1	Sniffing	2	1	45.5	2	82	86	124	128	115	110	108	135	148	120	114	110	118	121
77	43	F	55	172.2	18.5	II	1	Sniffing	2	1	20.2	1	91	106	94	90	86	82	78	121	136	112	123	96	103	104
78	43	M	70.8	162.1	26.9	II	2	Sniffing	2	1	38.6	1	85	89	60	62	61	62	62	119	134	138	132	126	122	120
79	33	F	82.5	175.7	26.7	II	1	Sniffing	2	2	43.6	1	86	95	108	103	102	100	102	126	144	116	112	109	114	111
80	53	F	70.8	157.7	28.5	II	2	Sniffing	2	2	26.1	1	78	87	92	92	95	94	108	120	128	130	140	120	110	120
81	21	M	60.9	179.9	18.8	II	2	Sniffing	2	3	27.7	1	89	91	115	120	90	90	84	125	139	106	108	110	111	110
82	58	F	52.8	179.7	16.4	II	1	Sniffing	2	3	41.4	1	77	81	104	96	94	86	86	137	150	120	114	110	118	121
83	22	M	80.6	185.1	23.5	I	1	Sniffing	2	1	26.6	1	96	102	124	128	115	110	108	129	131	112	123	96	103	104
84	43	M	88	185.4	25.6	I	2	Sniffing	2	1	21.1	1	83	96	94	90	86	82	78	132	141	138	132	126	122	120
85	58	M	69.4	168	24.6	I	1	Sniffing	2	2	29.5	1	79	87	60	62	61	62	62	131	137	116	112	109	114	111
86	32	M	85.1	168.9	29.8	I	2	Sniffing	2	2	36.8	1	83	86	108	103	102	100	102	129	144	130	140	120	110	120
87	42	F	74	179.4	23	II	1	Sniffing	2	2	31.5	1	74	82	92	92	95	94	108	146	161	106	108	110	111	110
88	47	F	85.3	156.8	34.7	II	1	Sniffing	2	1	42.1	2	77	91	72	73	77	70	70	140	146	101	102	108	107	108
89	46	F	63.7	158.9	25.2	II	1	Sniffing	2	1	35.3	1	91	92	115	120	90	90	84	114	121	124	120	120	110	110
90	58	M	60.7	163.6	22.7	I	2	Sniffing	2	1	20.5	1	92	96	50	50	50	51	50	135	155	140	140	130	127	128
91	33	F	82	178.7	25.7	I	1	Sniffing	2	2	37.2	1	92	109	104	93	95	94	88	142	154	105	104	108	115	116
92	37	M	84.8	189.9	23.5	I	2	Sniffing	2	1	44	1	96	100	104	96	94	86	86	139	141	159	135	123	120	122
93	21	M	53	179.8	16.4	I	1	Sniffing	2	1	24.5	1	72	82	124	128	115	110	108	121	125	120	114	110	118	121
94	44	F	75.4	170.9	25.8	I	2	Sniffing	2	3	36.2	1	72	75	104	96	94	86	86	122	132	112	123	96	103	104
95	19	M	82.4	161.9	31.4	I	1	Sniffing	2	1	45.5	2	82	86	124	128	115	110	108	135	148	120	114	110	118	121
96	43	M	88	185.4	25.6	I	2	Sniffing	2	1	21.1	1	83	96	94	90	86	82	78	132	141	138	132	126	122	120
97	58	M	69.4	168	24.6	I	1	Sniffing	2	2	29.5	1	79	87	60	62	61	62	62	131	137	116	112	109	114	111
98	32	M	85.1	168.9	29.8	I	2	Sniffing	2	2	36.8	1	83	86	108	103	102	100	102	129	144	130	140	120	110	120
99	42	F	74	179.4	23	II	1	Sniffing	2	2	31.5	1	74	82	92	92	95	94	108	146	161	106	108	110	111	110
100	47	F	85.3	156.8	34.7	II	1	Sniffing	2	1	42.1	2	77	91	72	73	77	70	70	140	146	101	102	108	107	108
101	46	F	63.7	158.9	25.2	II	1	Sniffing	2	1	35.3	1	91	92	115	120	90	90	84	114	121	124	120	120	110	110
102	58	M	60.7	163.6	22.7	I	2	Sniffing	2	1	20.5	1	92	96	50	50	50	51	50	135	155	140	140	130	127	128
103	33	F	82	178.7	25.7	I	1	Sniffing	2	2	37.2	1	92	109	104	93	95	94	88	142	154	105	104	108	115	116
104	37	M	84.8	189.9	23.5	I	2	Sniffing	2	1	44	1	96	100	104	96	94	86	86	139	141	159	135	123	120	122
105	21	M	53	179.8	16.4	I	1	Sniffing	2	1	24.5	1	72	82	124	128	115	110	108	121	125	120	114	110	118	121
106	44	F	75.4	170.9	25.8	I	2	Sniffing	2	3	36.2	1	72	75	104	96	94	86	86	122	132	112	123	96	103	104
107	19	M	82.4	161.9	31.4	I	1	Sniffing	2	1	45.5	2	82	86	124	128	115	110	108	135	148	120	114	110	118	121
108	43	M	88	185.4	25.6	I	2	Sniffing	2	1	21.1	1	83	96	94	90	86	82	78	132	141	138	132	126	122	120

sl.no	DBP baseline	DBP post laryngoscopy	DBP 1 min	DBP 2min	DBP 5 min	DBP 10 MIN	DBP 15 Min	MAP baseline	MAP post laryngoscopy	MAP 1 min	MAP 2min	MAP 5 min	MAP 10 MIN	MAP 15 Min	Complications	SPO2 baseline	SPO2 post laryngoscopy	SPO2 1 min	SPO2 2min	SPO2 5 min	SPO2 10 MIN	SPO2 15 Min
55	67	71	90	70	90	85	80	90	98	105	103	103	90	85	None	100	100	100	100	100	100	100
56	98	99	96	75	75	65	92	106	108	84	74	80	77	79	Dental trauma	100	100	100	100	100	100	100
57	72	77	70	60	70	70	80	95	103	71	70	74	72	90	None	99	100	100	100	100	100	100
58	85	94	80	76	70	101	98	96	105	84	82	111	111	108	None	99	100	100	100	100	100	100
59	88	98	80	80	80	70	70	102	110	95	93	93	83	83	None	98	100	100	100	100	100	100
60	68	77	90	90	90	80	80	86	92	106	106	103	95	96	None	100	100	100	100	100	100	100
61	83	86	65	65	65	79	70	99	103	76	79	77	77	82	None	100	100	100	100	100	100	100
62	90	103	107	80	72	74	76	102	111	123	90	85	83	89	None	99	100	100	100	100	100	100
63	89	93	82	80	70	72	70	105	112	84	79	75	72	72	None	100	100	100	100	100	100	100
64	88	96	55	81	64	71	63	102	108	73	99	83	77	79	None	100	100	100	100	100	100	100
65	70	76	84	82	78	76	68	91	98	92	90	88	84	80	None	100	100	100	100	100	100	100
66	85	95	70	74	72	78	74	100	109	71	69	70	68	67	Sore throat	100	100	100	100	100	100	100
67	93	103	70	70	70	70	80	105	117	88	86	82	70	72	None	100	100	100	100	100	100	100
68	78	89	62	64	51	50	58	101	113	74	74	74	74	78	None	100	100	100	100	100	100	100
69	70	77	78	72	74	77	70	93	100	77	76	79	71	77	None	100	100	100	100	100	100	100
70	70	76	96	75	75	65	92	85	91	95	93	93	83	83	None	99	100	100	100	100	100	100
71	80	92	70	60	70	70	80	98	113	106	106	103	95	96	None	98	100	100	100	100	100	100
72	82	84	80	76	70	101	98	102	107	76	79	77	77	82	None	100	100	100	100	100	100	100
73	86	89	80	80	80	70	70	104	106	123	90	85	83	89	None	100	100	100	100	100	100	100
74	85	86	90	90	90	80	80	97	99	84	79	75	72	72	None	99	100	100	100	100	100	100
75	71	78	65	65	65	79	70	88	96	73	99	83	77	79	None	100	100	100	100	100	100	100
76	63	70	107	80	72	74	76	87	96	92	90	88	84	80	Sore throat	99	100	100	100	100	100	100
77	90	95	65	65	65	79	70	100	109	123	90	85	83	89	Sore throat	100	100	100	100	100	100	100
78	79	90	107	80	72	74	76	92	105	84	79	75	72	72	None	100	100	100	100	100	100	100
79	69	75	82	80	70	72	70	88	98	73	99	83	77	79	None	100	100	100	100	100	100	100
80	91	91	55	81	64	71	63	101	103	92	90	88	84	80	None	100	100	100	100	100	100	100
81	67	76	84	82	78	76	68	86	97	71	69	70	68	67	None	100	100	100	100	100	100	100
82	89	93	82	80	70	72	70	105	112	84	79	75	72	72	None	100	100	100	100	100	100	100
83	88	96	55	81	64	71	63	102	108	73	99	83	77	79	None	100	100	100	100	100	100	100
84	70	76	84	82	78	76	68	91	98	92	90	88	84	80	None	100	100	100	100	100	100	100
85	85	95	70	74	72	78	74	100	109	71	69	70	68	67	Sore throat	100	100	100	100	100	100	100
86	93	103	70	70	70	70	80	105	117	88	86	82	70	72	None	100	100	100	100	100	100	100
87	78	89	62	64	51	50	58	101	113	74	74	74	74	78	None	100	100	100	100	100	100	100
88	70	77	78	72	74	77	70	93	100	77	76	79	71	77	None	100	100	100	100	100	100	100
89	70	76	96	75	75	65	92	85	91	95	93	93	83	83	None	99	100	100	100	100	100	100
90	80	92	70	60	70	70	80	98	113	106	106	103	95	96	None	98	100	100	100	100	100	100
91	82	84	80	76	70	101	98	102	107	76	79	77	77	82	None	100	100	100	100	100	100	100
92	86	89	80	80	80	70	70	104	106	123	90	85	83	89	None	100	100	100	100	100	100	100
93	85	86	90	90	90	80	80	97	99	84	79	75	72	72	None	99	100	100	100	100	100	100
94	71	78	65	65	65	79	70	88	96	73	99	83	77	79	None	100	100	100	100	100	100	100
95	63	70	107	80	72	74	76	87	96	92	90	88	84	80	Sore throat	99	100	100	100	100	100	100
96	70	76	84	82	78	76	68	91	98	92	90	88	84	80	None	100	100	100	100	100	100	100
97	85	95	70	74	72	78	74	100	109	71	69	70	68	67	Sore throat	100	100	100	100	100	100	100
98	93	103	70	70	70	70	80	105	117	88	86	82	70	72	None	100	100	100	100	100	100	100
99	78	89	62	64	51	50	58	101	113	74	74	74	74	78	None	100	100	100	100	100	100	100
100	70	77	78	72	74	77	70	93	100	77	76	79	71	77	None	100	100	100	100	100	100	100
101	70	76	96	75	75	65	92	85	91	95	93	93	83	83	None	99	100	100	100	100	100	100
102	80	92	70	60	70	70	80	98	113	106	106	103	95	96	None	98	100	100	100	100	100	100
103	82	84	80	76	70	101	98	102	107	76	79	77	77	82	None	100	100	100	100	100	100	100
104	86	89	80	80	80	70	70	104	106	123	90	85	83	89	None	100	100	100	100	100	100	100
105	85	86	90	90	90	80	80	97	99	84	79	75	72	72	None	99	100	100	100	100	100	100
106	71	78	65	65	65	79	70	88	96	73	99	83	77	79	None	100	100	100	100	100	100	100
107	63	70	107	80	72	74	76	87	96	92	90	88	84	80	Sore throat	99	100	100	100	100	100	100
108	70	76	84	82	78	76	68	91	98	92	90	88	84	80	None	100	100	100	100	100	100	100