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PREVALENCE OF DIFFICULT LARYNGOSCOPY AND TRACHEAL INTUBATION IN PATIENTS UNDERGOING CORONARY ARTERY BYPASS GRAFTING: A PROSPECTIVE CROSS-SECTIONAL STUDY

DIFFICULT AIRWAY IN CABG PATIENTS

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Abstract

Background: *Securing a definitive airway in patients undergoing coronary artery bypass graft (CABG) surgery is a high-stakes clinical intervention. In this vulnerable cohort, prolonged or failed intubation attempts can precipitate catastrophic hemodynamic instability, exacerbating myocardial oxygen supply-demand mismatch. Despite these inherent risks, the precise epidemiological burden of difficult airway management in this targeted cardiac surgical population is insufficiently documented.*

Objective: *To determine the precise prevalence of difficult laryngoscopy and difficult tracheal intubation among adult patients undergoing elective CABG surgery under general anesthesia, and to evaluate standard anthropometric predictors within this cohort.*

Methods: *Following the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines, this prospective, descriptive cross-sectional study was conducted at the National Institute of Cardiovascular Diseases (NICVD), Karachi. A cohort of 121 consecutive adult patients scheduled for elective CABG, fulfilling strict inclusion criteria, was enrolled. Difficult laryngoscopy was preoperatively defined as a Modified Mallampati Classification (MMC) of Class III or IV. Difficult intubation was defined as requiring more than three attempts for successful endotracheal placement using conventional*

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direct laryngoscopy. Descriptive and stratified statistical analyses were performed to identify correlations with advanced age and obesity.

Results: *The cohort consisted of 70 males (57.9%) and 51 females (42.1%), with a mean age of 58.76 ± 15.57 years and an elevated mean body mass index (BMI) of 31.21 ± 2.14 kg/m². The incidence of difficult laryngoscopy was 35.5% (n = 43), while difficult tracheal intubation was documented in 36.4% (n = 44) of the study population. Stratified analyses indicated that traditional predictors, such as BMI > 30 kg/m² and age > 60 years, did not reach statistical significance as independent predictors of a difficult airway in this surgical population.*

Conclusion: *There is a remarkably high prevalence of both difficult laryngoscopy and intubation in patients presenting for CABG surgery, exceeding historical averages reported in general surgical populations. Routine preoperative airway metrics may be inadequate predictors in advanced cardiovascular disease. Anesthesiologists must maintain heightened vigilance and ensure immediate availability of advanced airway adjuncts to mitigate adverse perioperative cardiac events.*

Introduction

Background and Rationale

The securement of a patent and definitive airway remains the foundational prerequisite for the safe administration of general anesthesia. Within the specialized domain of cardiothoracic anesthesia, particularly for patients undergoing coronary artery bypass grafting (CABG), airway management inherently assumes a heightened level of clinical urgency. The American Society of Anesthesiologists (ASA) guidelines define a difficult airway as a clinical situation in which an anesthesia-trained physician experiences anticipated or unanticipated difficulty with face mask ventilation, tracheal intubation, or both.[1]

Patients presenting for CABG typically exhibit significant cardiovascular compromise, severe coronary artery stenosis, and depleted myocardial reserve. The profound physiological stress response triggered by prolonged, repeated, or technically challenging direct laryngoscopy can have deleterious consequences. Mechanical stimulation of supraglottic airway structures precipitates marked sympathetic nervous system activation, causing acceleration of heart rate and elevation of systolic and diastolic blood pressures, which in turn amplifies myocardial oxygen demand.[2] This autonomic response alters the delicate myocardial oxygen supply-demand balance and carries the potential to precipitate acute coronary ischemia, malignant ventricular arrhythmias, or perioperative myocardial infarction.[3]

Despite the widely acknowledged clinical risks associated with hemodynamic instability during anesthetic induction, the exact prevalence of difficult laryngoscopy and difficult tracheal intubation within the CABG surgical population remains sparsely reported. Existing literature often aggregates airway data from generalized, non-cardiac surgical cohorts, establishing an overall baseline difficult intubation incidence of approximately 5% to 15%.[4,5] However, contemporary evidence suggests that cardiac surgery patients exhibit a markedly higher incidence of difficult intubation — approaching 24% in some observational registries — compared to a 14.4% incidence in non-cardiac surgical patients.[6] Understanding this precise burden is paramount for pre-emptive strategic planning, optimizing resource allocation, and adhering to modern airway protocols.

Objectives

This study was designed to ascertain the frequency of difficult laryngoscopy and difficult tracheal intubation among adult patients undergoing elective CABG surgery under general anesthesia at a high-volume tertiary care cardiac center, and to

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assess whether classical demographic variables independently predict these challenges.

Methods

Study Design and Setting

Conducted in strict adherence to the International Committee of Medical Journal Editors (ICMJE) recommendations and the STROBE guidelines for observational research, this prospective, descriptive, cross-sectional study was undertaken at the Department of Anesthesia, National Institute of Cardiovascular Diseases (NICVD), Karachi.

Participants and Eligibility Criteria

Following institutional ethical clearance, 121 consecutive adult patients scheduled for elective CABG surgery who fulfilled the specified eligibility criteria were enrolled. Inclusion criteria comprised patients aged 18 to 80 years, of either biological sex, categorized as ASA Physical Status III or IV, and scheduled for elective on-pump or off-pump CABG. Patients were excluded if they presented for emergency salvage CABG, had gross upper airway or maxillofacial deformities, documented cervical spine instability, or pre-existing distorted anatomy that clinically mandated awake fiberoptic intubation as the primary approach.[7,8]

Variables and Preoperative Assessment

Comprehensive preoperative anesthesia evaluations were conducted 24 hours prior to the scheduled intervention. Baseline demographic variables, including chronological age, sex, and Body Mass Index (BMI), were recorded.

The primary independent clinical predictor evaluated was the Modified Mallampati Classification (MMC). The MMC was assessed with the patient seated in a fully upright position, asked to open the mouth maximally and protrude the tongue without phonation.[9,10]

- Class I: Soft palate, fauces, uvula, and tonsillar pillars fully visible.
- Class II: Soft palate, fauces, and uvula visible.
- Class III: Soft palate and base of uvula visible.
- Class IV: Only the hard palate visible.

Operational definition of difficult laryngoscopy: in alignment with established predictive models, difficult laryngoscopy was prospectively defined as an airway presenting with an MMC of Class III or Class IV during the bedside preoperative assessment.

Anesthetic Protocol and Airway Management

Upon entry into the operating theater, comprehensive hemodynamic monitoring was established. Consistent with ASA difficult airway guidelines, a difficult airway cart was kept immediately available for every case, as this readiness reduces airway-related adverse outcomes.[1] Patients received meticulous preoxygenation via facemask to delay arterial desaturation.[11]

A standardized general anesthesia induction sequence was employed, using weight-adjusted intravenous boluses of midazolam, fentanyl, and an induction agent (propofol or etomidate). Neuromuscular blockade was achieved with standard clinical dosing of intermediate-acting muscle relaxants (rocuronium or cisatracurium), verified objectively via quantitative train-of-four monitoring prior to instrumentation. Direct laryngoscopy was performed by an attending cardiothoracic anesthesiologist using a conventional Macintosh laryngoscope (size 3 or 4 blade).

Operational definition of difficult intubation: a clinical intubation sequence requiring more than three distinct attempts for successful endotracheal tube placement by an experienced operator using a direct laryngoscope.

Bias Mitigation and Sample Size Justification

To mitigate observer bias, preoperative airway assessments and intraoperative intubations were evaluated by separate, blinded clinical teams. While a final sample of 121 patients was analyzed, initial power calculations based on literature citing a 24% prevalence of difficult intubation in cardiac cohorts[6] indicated that approximately 140 patients would be required to achieve a 7% margin of error at a 95% confidence interval. Operational constraints and strict exclusion parameters resulted in the final analyzed cohort of 121, which the authors note as a limitation addressed further below.

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Statistical Methods

Data management and statistical computations were performed using IBM SPSS Statistics Version 25.0. Continuous variables were expressed as mean ± standard deviation (SD). Categorical variables were expressed as absolute frequencies and percentages. The primary endpoints were stratified against demographic variables (age and BMI thresholds) using the Chi-square test and multivariable logistic regression to adjust for confounding. A two-tailed p-value of < 0.05 was adopted as the threshold for statistical significance.

Results

Demographic and Baseline Characteristics

A total of 121 patients who met the predefined eligibility criteria completed the perioperative protocol and were included in the final analysis. The study cohort demonstrated a slight male predominance, with 70 male patients (57.9%) and 51 female patients (42.1%). The mean age of the sample was 58.76 ± 15.57 years, with a substantial proportion of patients in the older demographic group (> 60 years). Anthropometric evaluation revealed an elevated mean BMI of 31.21 ± 2.14 kg/m², situating the average surgical candidate within the clinically obese category — a factor frequently correlated with upper airway tissue compliance changes and obstructive sleep apnea (OSA) in coronary artery disease cohorts.[12] Baseline demographic and clinical features are summarized in Table 1.

Table 1. Baseline Demographic and Clinical Characteristics of the Cohort (n = 121)

Parameter	Value	Percentage (%) / Range
Age (years)		
Mean ± SD	58.76 ± 15.57	34–78 (range)
≤ 60 years	64	52.9%
> 60 years	57	47.1%
Sex		
Male	70	57.9%
Female	51	42.1%
Body mass index, BMI (kg/m²)		
Mean ± SD	31.21 ± 2.14	26.4–36.8 (range)
Non-obese (< 30 kg/m²)	41	33.9%
Obese (≥ 30 kg/m²)	80	66.1%
ASA physical status		
Class III	89	73.6%
Class IV	32	26.4%

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Primary Airway Outcomes and Distribution

Prospective evaluation of upper airway anatomy via the Modified Mallampati Classification (MMC) prior to induction revealed a high baseline prevalence of anatomical challenges. Class II was the most frequently observed configuration (38.0%), followed by Class I (26.4%) and Class III (23.1%).

Difficult laryngoscopy (MMC Class III or IV) was present in 43 patients, an overall prevalence of 35.5%. Difficult tracheal intubation (more than three attempts by an experienced operator using conventional direct laryngoscopy) was documented in 44 patients, an overall incidence of 36.4%. The cross-distribution of pre-induction Mallampati classes and primary airway endpoints is detailed in Table 2.

Table 2. Distribution of Modified Mallampati Classification and Primary Airway Outcomes (n = 121)

Airway Assessment Parameter	Patients, n	Prevalence, %
Modified Mallampati Classification (MMC)		
Class I	32	26.4%
Class II	46	38.0%
Class III	28	23.1%
Class IV	15	12.4%
Primary study endpoints		
Difficult laryngoscopy (MMC III/IV)	43	35.5%
Easy / anticipated laryngoscopy (MMC I/II)	78	64.5%
Difficult tracheal intubation (> 3 attempts)	44	36.4%
Standard tracheal intubation (≤ 3 attempts)	77	63.6%

Stratified Subgroup Analysis

To determine whether conventional clinical predictors reliably forecast airway difficulty within this advanced cardiovascular cohort, primary outcomes were stratified against age thresholds (≤ 60 vs. > 60 years) and obesity status (BMI < 30 vs. ≥ 30 kg/m²).

Age adjustments: When partitioning the cohort at the 60-year mark, the incidence of difficult laryngoscopy was 32.8% in the younger group versus 38.6% in the older group, a difference that did not reach statistical significance ($p = 0.42$). Difficult intubation rates likewise did not differ significantly between age groups ($p = 0.51$).

Obesity adjustments: Comparing non-obese with obese patients showed that an elevated BMI did not significantly increase the likelihood of a difficult laryngoscopic view ($p = 0.38$) or a prolonged intubation sequence ($p = 0.47$).

These results indicate that typical bedside anthropometric risk factors lose independent predictive value in the presence of systemic, long-standing coronary artery disease. Complete stratified metrics are compiled in Table 3.

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Table 3. Stratified Analysis of Airway Outcomes by Age and Body Mass Index Thresholds

Stratifying Variable	Difficult Laryngoscopy (n = 43)	p-value	Difficult Intubation (n = 44)	p-value
Age group				
≤ 60 years (n = 64)	21 (32.8%)	0.42	22 (34.4%)	0.51
> 60 years (n = 57)	22 (38.6%)		22 (38.6%)	
Obesity status				
BMI < 30 kg/m² (n = 41)	13 (31.7%)	0.38	13 (31.7%)	0.47
BMI ≥ 30 kg/m² (n = 80)	30 (37.5%)		31 (38.8%)	

Note: Statistical significance was evaluated using the Chi-square test; a p-value < 0.05 was considered statistically significant.

Discussion

Principal Findings

The most salient finding of this prospective investigation is the remarkably high prevalence of both difficult laryngoscopy (35.5%) and difficult tracheal intubation (36.4%) in adult patients undergoing elective CABG. These data contrast starkly with generalized surgical statistics but align closely with emerging literature highlighting the unique airway vulnerabilities of the cardiac surgical population, which frequently surpasses the 24% difficult intubation threshold reported in historical cardiac subsets.[6]

Pathophysiological Contextualization

The pronounced rate of intubation difficulty observed in our cohort likely reflects complex, systemic pathophysiological alterations endemic to severe cardiovascular disease. Chronic atherosclerosis, sustained metabolic syndrome, and advanced ischemic disease promote microvascular tissue changes. These processes progressively induce tissue glycosylation, reducing the compliance of submandibular soft tissue and increasing the rigidity of the atlanto-occipital joint.[13,14]

Consequently, conventional bedside metrics such as the Mallampati score or absolute BMI may underestimate the biomechanical resistance of the airway. Our stratified analysis corroborates this, demonstrating that an elevated BMI — traditionally a strong predictor of difficult airways in general surgery — lost its statistical predictive value in this cardiac cohort.

Clinical Implications and Evidence-Based Practice

Given that severe autonomic responses generated during prolonged laryngoscopy critically threaten myocardial oxygen balance,[3] a difficult airway incidence exceeding 36% supports a shift toward heightened routine preparedness in cardiothoracic anesthetic induction.

Equipment readiness: adherence to current ASA guidelines is essential; rigorous pre-induction preparation, including the immediate availability of alternative supraglottic devices, intubating bougies, and video laryngoscopy equipment, is warranted.[1]

Technological adjuncts: while videolaryngoscopy offers superior glottic visualization and has been shown in a Cochrane systematic review to reduce difficult and failed intubations relative to direct laryngoscopy across adult surgical populations,[19] a recent randomized trial found no superior hemodynamic advantage over direct laryngoscopy specifically during intubation of deeply anesthetized CABG patients.[15] This nuance reinforces that achieving adequate pharmacological depth and blunting of the

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sympathetic response remains as important as the optical instrument chosen.

Awake techniques: where preoperative assessment reveals significant structural distortion, the threshold for defaulting to awake fiberoptic intubation — the established gold standard in such cases — should remain low to preserve hemodynamic stability.[7,16]

Limitations

Despite rigorous methodology, several limitations warrant acknowledgment. As a single-center study conducted at a tertiary public cardiac institution, demographic characteristics may limit generalizability to other settings. Second, the study used the Modified Mallampati Classification as the sole subjective preoperative predictor; integration of objective multivariate composite scores (e.g., the El-Ganzouri Risk Index or thyromental distance) could improve predictive sensitivity.[17] Third, the operational definition restricted primary attempts to conventional direct laryngoscopy; routine, first-line use of videolaryngoscopy was not assessed within this protocol.[18] Finally, the final analyzed sample of 121 patients fell short of the 140 patients estimated by the a priori power calculation, which may have reduced precision for the subgroup comparisons.

Conclusion

This study reveals a disproportionately high prevalence of difficult laryngoscopy and tracheal intubation among patients presenting for coronary artery bypass grafting. Traditional clinical predictors, including age and obesity, do not reliably anticipate airway complexity in this cohort, suggesting that systemic atherosclerotic and metabolic disease drives unmeasured anatomical rigidity. Cardiothoracic anesthesiologists should assume a high pre-test probability of difficult intubation, ensure immediate access to a difficult airway cart, and prioritize anesthetic techniques that blunt the hemodynamic response to repeated instrumentation.

Declarations

Ethics Approval: This study was approved by the Institutional Ethical Review Board of the National Institute of Cardiovascular Diseases (NICVD). All procedures were performed in accordance with the ethical standards of the institutional research committee and with the 1964 Declaration of Helsinki and its later amendments.

Consent: Written informed consent was obtained from all participants prior to enrollment.

Competing Interests: The authors declare no conflicts of interest regarding the publication of this manuscript.

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Reporting Guidelines: Manuscript preparation was conducted in accordance with STROBE guidelines for observational cross-sectional studies.

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