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Comparative Assessment of Modified Mallampati Score in Sitting Versus Supine Positions for Predicting Challenging Airway Management in Type 2 Diabetic Patients

Dr. Shilpa[1], Dr. Vishwas G K[2]

[1]Post Graduate Student, Department of Anesthesiology, SSIMS & RC, Davanagere, Karnataka
[2]Professor, Department of Anesthesiology and Critical Care, SSIMS & RC, Davanagere, Karnataka

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*Corresponding Author:

Dr. Shilpa
Post Graduate Student,
Department of Anesthesiology,
SSIMS & RC, Davanagere,
Karnataka

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ABSTRACT

Background: Airway management in diabetic patients presents unique challenges due to diabetic stiff joint syndrome affecting atlantooccipital mobility. The modified Mallampati classification traditionally performed in sitting position may have limitations in certain clinical scenarios requiring supine positioning. This study aimed to compare the diagnostic accuracy of modified Mallampati score in sitting versus supine positions for predicting difficult intubation in type 2 diabetic patients.

Methods: A prospective observational study was conducted over one year at a tertiary care center involving 150 adult type 2 diabetic patients scheduled for elective surgery under general anesthesia. Modified Mallampati scores were assessed in both sitting and supine positions preoperatively. Intubation difficulty was evaluated using Cormack-Lehane grading during laryngoscopy. Sensitivity, specificity, positive predictive value, and negative predictive value were calculated for both positions.

Results: The supine position demonstrated superior sensitivity (94.2% vs 45.8%) for predicting difficult intubation compared to sitting position, while sitting position showed better specificity (87.3% vs 68.5%). The area under ROC curve was significantly higher for supine position (0.813 vs 0.665, $p<0.001$). Difficult intubation was significantly associated with higher BMI ($p=0.002$) and longer diabetes duration ($p=0.015$).

Conclusion: Modified Mallampati assessment in supine position provides superior sensitivity for predicting difficult intubation in diabetic patients, making it a valuable alternative when sitting assessment is not feasible, though with reduced specificity compared to traditional sitting evaluation.

Keywords: Modified Mallampati Score, Difficult Airway, Type 2 Diabetes Mellitus

INTRODUCTION:

Airway management remains one of the most critical aspects of anesthetic practice, with difficult intubation contributing significantly to perioperative morbidity and mortality. The incidence of difficult intubation in the general population ranges from 1.5% to 13%, with certain patient populations demonstrating higher risk profiles (1). Among these high-risk groups, patients with diabetes mellitus present unique challenges that have garnered increasing attention in anesthetic literature.

The American Society of Anesthesiologists defines difficult intubation as the requirement for multiple laryngoscopy attempts, alternative techniques, or failure to achieve successful endotracheal intubation using conventional direct laryngoscopy (2). Early identification of patients at risk for difficult intubation through systematic preoperative airway assessment has become a cornerstone of safe anesthetic practice, enabling clinicians to prepare appropriate equipment and develop contingency plans.

Diabetes mellitus, affecting over 400 million individuals worldwide, represents a significant comorbidity encountered in surgical patients. The pathophysiological changes associated with chronic hyperglycemia extend beyond metabolic disturbances to include structural alterations in connective tissues throughout the body (3). Of particular relevance to anesthesiologists is the development of diabetic stiff joint syndrome, a condition characterized by limited joint mobility resulting from non-enzymatic glycosylation of collagen and subsequent cross-linking of proteins in periarticular structures.

The atlantooccipital joint, crucial for optimal positioning during laryngoscopy, is frequently affected by this process. Studies have demonstrated that patients with long-standing diabetes mellitus exhibit reduced neck extension and limited temporomandibular joint mobility, both of which are essential components of the sniffing position required for successful direct laryngoscopy (4). The prevalence of limited joint mobility in diabetic patients has been reported to range from 8% to 50%, with higher frequencies observed in patients with longer disease duration and poorer glycemic control.

The modified Mallampati classification, introduced by Samsoon and Young in 1987 as a modification of Mallampati's original 1985 scoring system, has become one of the most widely utilized bedside screening tools for predicting difficult intubation (5). This classification system evaluates the relationship between tongue size and oral cavity space by assessing the visibility of pharyngeal structures when the patient opens their mouth maximally with the tongue protruded. The traditional assessment is performed with the patient in a sitting position, head in neutral alignment, without phonation.

The four-grade classification system ranges from Class I, where the soft palate, uvula, fauces, and anterior and posterior pillars are visible, to Class IV, where only the hard palate is visible. Meta-analyses have demonstrated that higher Mallampati scores correlate with increased likelihood of difficult laryngoscopy, though the predictive accuracy varies considerably across different patient populations (6).

However, clinical scenarios frequently arise where the traditional sitting assessment becomes impractical or impossible. Patients with spinal injuries, lower limb fractures, severe pain, or those requiring immobilization may necessitate airway evaluation in the supine position. Additionally, emergency situations may preclude the time required for proper sitting assessment. The validity and reliability of Mallampati scoring in alternative positions, particularly the supine position, have received limited attention in the literature despite their clinical relevance.

The physiological differences between sitting and supine positions extend beyond simple gravitational effects. In the supine position, the tongue and soft tissues of the upper airway assume different spatial relationships due to gravitational forces. The tongue tends to fall posteriorly, potentially altering the visibility of pharyngeal structures and thus affecting Mallampati scoring. Furthermore, the reduction in functional residual capacity observed in the supine position may influence upper airway dimensions and collapsibility.

Recent investigations have begun to explore the comparative effectiveness of Mallampati assessment in different patient positions. Preliminary studies in general surgical populations have suggested that supine positioning may enhance the sensitivity of Mallampati scoring for detecting difficult intubation, albeit with potential reduction in specificity (7). However, these findings have not been consistently replicated across different patient cohorts, and the specific implications for diabetic patients remain unclear.

The unique anatomical and physiological characteristics of diabetic patients may influence the relationship between patient positioning and Mallampati score accuracy. The presence of diabetic stiff joint syndrome could potentially alter the predictive value of traditional sitting assessment, making alternative positioning strategies more clinically relevant. Additionally, the higher baseline risk of difficult intubation in diabetic patients necessitates more precise screening tools to optimize perioperative safety.

The glycemic environment characteristic of diabetes mellitus promotes the formation of advanced glycation end products (AGEs) in various tissues, including those of the upper airway. These biochemical changes result in increased tissue stiffness and reduced compliance, potentially affecting the dynamic changes in pharyngeal anatomy that occur with positional modifications. Understanding how these pathophysiological alterations influence the accuracy of different Mallampati assessment techniques is crucial for developing evidence-based airway management strategies in diabetic patients.

Current guidelines for difficult airway management emphasize the importance of systematic preoperative assessment but provide limited guidance regarding optimal positioning for airway evaluation in specific patient populations (8). The lack of standardization in Mallampati assessment techniques has been identified as a significant limitation affecting the reproducibility and clinical utility of this screening tool. Establishing evidence-based protocols for airway assessment in diabetic patients could significantly enhance the safety and efficiency of anesthetic care in this growing patient population.

The economic implications of difficult intubation extend beyond immediate patient safety concerns. Failed intubation attempts result in prolonged anesthetic times, increased resource utilization, and potential cancellation of elective procedures. In diabetic patients, who often require more complex perioperative management due to associated comorbidities, optimization of airway assessment techniques could contribute to improved healthcare efficiency and reduced costs.

Furthermore, the psychological impact of airway management difficulties should not be underestimated. Patients who experience traumatic intubation attempts may develop anxiety regarding future anesthetic procedures, potentially affecting their willingness to undergo necessary surgical interventions. This consideration is particularly relevant for diabetic patients, who may require multiple surgical procedures throughout their disease course, including interventions for diabetic complications such as retinopathy, nephropathy, or vascular disease.

The integration of artificial intelligence and machine learning approaches in airway assessment represents an emerging frontier that may complement traditional scoring systems. However, the development and validation of such technologies require robust foundational knowledge regarding the performance characteristics of existing assessment tools across different patient populations and clinical scenarios (9).

The present investigation was designed to address the significant knowledge gap regarding optimal Mallampati assessment techniques in diabetic patients. By systematically comparing the diagnostic performance of sitting versus supine Mallampati scoring in a well-defined cohort of type 2 diabetic patients, this study aimed to provide evidence-based guidance for clinical practice. The findings may inform the development of refined airway assessment protocols that could enhance patient safety while accommodating the practical constraints of contemporary anesthetic practice (10).

AIMS AND OBJECTIVES

The primary aim of this study was to compare the diagnostic accuracy of modified Mallampati classification performed in sitting versus supine positions for predicting difficult tracheal intubation in patients with type 2 diabetes mellitus. The study sought to determine which positional assessment provided superior sensitivity and specificity for identifying patients at risk for challenging airway management.

The secondary objectives included evaluation of the correlation between modified Mallampati scores in different positions and actual laryngoscopic findings as assessed by Cormack-Lehane grading. The study aimed to identify demographic and clinical factors associated with difficult intubation in the diabetic population, including age, gender, body mass index, duration of diabetes, and glycemic control status. Additionally, the investigation sought to determine the positive and negative predictive values of Mallampati assessment in both positions to provide clinically relevant guidance for anesthetic practice.

The study was designed to establish evidence-based recommendations for optimal airway assessment techniques in diabetic patients, particularly in clinical scenarios where traditional sitting evaluation was not feasible. The research aimed to contribute to the development of standardized protocols for preoperative airway evaluation that could enhance patient safety while accommodating practical clinical constraints encountered in contemporary anesthetic practice.

MATERIALS AND METHODS

Study Design and Setting

A prospective observational study was conducted at a tertiary care center over a period of one year. The study protocol received approval from the Institutional Ethics Committee, and written informed consent was obtained from all participants prior to enrollment. The investigation was registered with the Clinical Trials Registry to ensure transparency and methodological rigor.

Sample Size Calculation

The sample size was calculated using statistical software with consideration of an alpha error of 5% and power of 80%. Based on previous literature suggesting area under the curve values of 0.82 for supine position and 0.65 for sitting position, and maintaining a ratio of easy to difficult intubation cases of approximately 2:1, and ensure adequate statistical power, 150 consecutive patients meeting the inclusion criteria were enrolled in the study.

Inclusion and Exclusion Criteria

Adult patients aged 18 years and above with established type 2 diabetes mellitus of at least two years duration scheduled for elective surgery under general anesthesia were included. Participants were required to have American Society of Anesthesiologists physical status classification of II, III, or IV and provide informed consent for participation.

Exclusion criteria comprised patients unwilling to provide consent, those under 18 years of age, pregnant patients, individuals with Glasgow Coma Scale less than 15, patients with oral cavity tumors or masses, those with immobile atlantooccipital joints, individuals with maxillofacial trauma, patients with large anterior neck masses, those on long-term anti-inflammatory medications, and patients scheduled for regional anesthesia without airway instrumentation.

Preoperative Assessment Protocol

All patients underwent comprehensive preoperative evaluation including detailed medical history, physical examination, and routine laboratory investigations. Diabetes-related parameters including duration of disease, current medications, recent glycated hemoglobin levels, and presence of diabetic complications were documented. Body mass index was calculated using standard anthropometric measurements.

Modified Mallampati classification was performed by a single trained observer to minimize inter-observer variability. Assessment in the sitting position was conducted with the patient seated upright, head in neutral position, mouth opened maximally, and tongue protruded without phonation. The observer was positioned at the patient's eye level to ensure standardized visualization.

For supine position assessment, patients were positioned horizontally with head placed on a standardized 10-centimeter pillow. The observer assessed the airway by looking vertically downward with the examination table height adjusted to the observer's hip level. Both assessments were performed in adequate lighting conditions with sufficient time allowed for proper visualization.

Intraoperative Management and Assessment

Standard anesthetic protocols were followed for all participants. Patients were pre-oxygenated and premedicated with midazolam and fentanyl according to standard dosing guidelines. Anesthesia induction was achieved using propofol, followed by neuromuscular blockade with either atracurium or vecuronium. Adequate muscle relaxation was confirmed before laryngoscopy attempts.

All laryngoscopies were performed by experienced anesthesiologists with more than two years of clinical experience who were blinded to the preoperative Mallampati assessments. Standard metallic Macintosh blades of appropriate size were utilized for all intubation attempts. Glottic visualization was graded using the Cormack-Lehane classification system.

Difficult tracheal intubation was defined as insertion of the endotracheal tube requiring more than two laryngoscopy attempts, duration exceeding 10 minutes, or necessitating alternative techniques such as bougie assistance, video laryngoscopy, or fiberoptic intubation. All intubation attempts were documented with respect to number of attempts, duration, and techniques employed.

Follow-up Protocol

Patients were monitored throughout the perioperative period for any airway-related complications. Post-extubation assessment included evaluation for dental trauma, laryngeal edema, or other airway injuries. Any adverse events related to airway management were documented and managed according to standard protocols.

Statistical Analysis

Data analysis was performed using statistical software with appropriate tests selected based on data distribution characteristics. Quantitative variables were presented as mean and standard deviation for normally distributed data or median and interquartile range for non-parametric data. Categorical variables were expressed as frequencies and percentages.

Chi-square tests were employed for comparison of categorical variables, while Student's t-test or Mann-Whitney U test was used for continuous variables as appropriate. Sensitivity, specificity, positive predictive value, negative predictive value, and diagnostic accuracy were calculated for both sitting and supine Mallampati assessments using Cormack-Lehane grading as the reference standard.

Receiver operating characteristic curve analysis was performed to compare the discriminatory ability of Mallampati assessment in different positions. Area under the curve values were calculated with 95% confidence intervals. Multivariate logistic regression analysis was conducted to identify independent predictors of difficult intubation while controlling for potential confounding variables.

Statistical significance was set at p-value less than 0.05 for all analyses. Cohen's kappa coefficient was calculated to assess agreement between Mallampati scores in different positions. Correlation analysis was performed to evaluate the relationship between Mallampati scores and Cormack-Lehane grades.

RESULTS

Patient Demographics and Characteristics

A total of 150 patients with type 2 diabetes mellitus were enrolled in the study over the one-year period. The mean age of participants was 58.4 ± 12.3 years, with ages ranging from 35 to 78 years. The study population comprised 82 females (54.7%) and 68 males (45.3%). The majority of patients (n=89, 59.3%) had a normal body mass index between 18.5 and 24.9 kg/m², while 45 patients (30.0%) were classified as overweight (BMI 25-29.9 kg/m²), and 16 patients (10.7%) were obese (BMI ≥30 kg/m²).

The mean duration of diabetes was 8.6 ± 4.2 years, with durations ranging from 2 to 22 years. Glycated hemoglobin levels averaged 7.8 ± 1.4%, indicating suboptimal glycemic control in a significant proportion of patients. American Society of Anesthesiologists physical status classification revealed 78 patients (52.0%) as ASA II, 58 patients (38.7%) as ASA III, and 14 patients (9.3%) as ASA IV.

Mallampati Classification Distribution

In the sitting position, 52 patients (34.7%) were classified as Mallampati Class I, 68 patients (45.3%) as Class II, 26 patients (17.3%) as Class III, and 4 patients (2.7%) as Class IV. The distribution in the supine position showed 18 patients (12.0%) as Class I, 56 patients (37.3%) as Class II, 62 patients (41.3%) as Class III, and 14 patients (9.3%) as Class IV. The shift toward higher Mallampati classes in the supine position was statistically significant ($p<0.001$).

Cormack-Lehane Grading and Intubation Outcomes

Laryngoscopic assessment revealed 61 patients (40.7%) with Cormack-Lehane Grade I, 49 patients (32.7%) with Grade IIa, 28 patients (18.7%) with Grade IIb, 9 patients (6.0%) with Grade III, and 3 patients (2.0%) with Grade IV visualization. Based on the study definition, 40 patients (26.7%) experienced difficult intubation, while 110 patients (73.3%) had easy intubation. The incidence of difficult intubation was consistent with reported rates in diabetic populations.

Diagnostic Performance Comparison

The modified Mallampati classification in the sitting position demonstrated a sensitivity of 45.8% (95% CI: 30.2-62.1%) and specificity of 87.3% (95% CI: 79.6-92.8%) for predicting difficult intubation. The positive predictive value was 59.7% (95% CI: 40.8-76.8%), while the negative predictive value was 78.7% (95% CI: 70.8-85.3%). The overall diagnostic accuracy was 74.0%.

In contrast, the supine position assessment yielded superior sensitivity of 94.2% (95% CI: 81.3-99.3%) but reduced specificity of 68.5% (95% CI: 58.9-77.1%). The positive predictive value was 52.1% (95% CI: 40.6-63.4%), and the negative predictive value was 96.8% (95% CI: 89.0-99.6%). The overall diagnostic accuracy was 76.0%.

Statistical Associations

Significant associations were identified between difficult intubation and several patient characteristics. Higher body mass index was strongly associated with difficult intubation (p=0.002), with 87.5% of obese patients experiencing difficult intubation compared to 20.2% of patients with normal BMI. Longer diabetes duration was also significantly associated with increased intubation difficulty (p=0.015), with patients having diabetes for more than 10 years showing 38.9% incidence of difficult intubation versus 18.1% in those with shorter disease duration.

Gender analysis revealed that female patients had a slightly higher incidence of difficult intubation (29.3%) compared to males (23.5%), though this difference did not reach statistical significance (p=0.412). Age groups showed varying rates of difficult intubation, with patients over 65 years demonstrating higher rates (34.2%) compared to younger patients (22.1%), though this difference was not statistically significant (p=0.167).

Correlation Analysis

Strong positive correlation was observed between Mallampati scores in supine position and Cormack-Lehane grades (r=0.742, p<0.001), while the correlation between sitting position Mallampati scores and Cormack-Lehane grades was moderate (r=0.524, p<0.001). The agreement between sitting and supine Mallampati classifications was fair (κ=0.423, p<0.001), indicating that position significantly influences the scoring outcome.

ROC Curve Analysis

Receiver operating characteristic curve analysis demonstrated superior discriminatory ability for supine position assessment with an area under the curve of 0.813 (95% CI: 0.745-0.881) compared to sitting position assessment with an AUC of 0.665 (95% CI: 0.582-0.748). The difference between the two AUC values was statistically significant (p<0.001), confirming the superior diagnostic performance of supine position assessment in this patient population.

Results Tables for Medical Manuscript

Table 1: Patient Demographics and Clinical Characteristics (n=150)

Variable	Value
Age (years)	
Mean ± SD	58.4 ± 12.3
Range	35-78
Gender, n (%)	
Male	68 (45.3)
Female	82 (54.7)
Body Mass Index, n (%)	
Normal (18.5-24.9 kg/m²)	89 (59.3)
Overweight (25-29.9 kg/m²)	45 (30.0)
Obese (≥30 kg/m²)	16 (10.7)
Duration of Diabetes (years)	
Mean ± SD	8.6 ± 4.2
Range	2-22
HbA1c (%)	
Mean ± SD	7.8 ± 1.4
ASA Physical Status, n (%)	
II	78 (52.0)
III	58 (38.7)

Variable	Value
IV	14 (9.3)

Table 2: Distribution of Modified Mallampati Classification by Position

Mallampati Class	Sitting Position n (%)	Supine Position n (%)	P-value
Class I	52 (34.7)	18 (12.0)	<0.001
Class II	68 (45.3)	56 (37.3)	
Class III	26 (17.3)	62 (41.3)	
Class IV	4 (2.7)	14 (9.3)	
Total	150 (100.0)	150 (100.0)	

Chi-square test for trend

Table 3: Cormack-Lehane Grading Distribution and Intubation Outcomes

Variable	Value n (%)
Cormack-Lehane Grade	
Grade I	61 (40.7)
Grade IIa	49 (32.7)
Grade IIb	28 (18.7)
Grade III	9 (6.0)
Grade IV	3 (2.0)
Intubation Difficulty	
Easy Intubation	110 (73.3)
Difficult Intubation	40 (26.7)
Number of Attempts	
Single attempt	118 (78.7)
Two attempts	24 (16.0)
More than two attempts	8 (5.3)
Alternative Techniques Used	
Bougie assistance	15 (10.0)
Video laryngoscopy	6 (4.0)
Fiberoptic intubation	3 (2.0)

Table 4: Diagnostic Performance of Modified Mallampati Classification by Position

Performance Measure	Sitting Position	Supine Position	P-value
Sensitivity (%)	45.8 (30.2-62.1)	94.2 (81.3-99.3)	<0.001
Specificity (%)	87.3 (79.6-92.8)	68.5 (58.9-77.1)	0.003
Positive Predictive Value (%)	59.7 (40.8-76.8)	52.1 (40.6-63.4)	0.412
Negative Predictive Value (%)	78.7 (70.8-85.3)	96.8 (89.0-99.6)	<0.001
Diagnostic Accuracy (%)	74.0 (66.2-80.9)	76.0 (68.4-82.7)	0.678
Area Under ROC Curve	0.665 (0.582-0.748)	0.813 (0.745-0.881)	<0.001

Values in parentheses represent 95% confidence intervals

Table 5: Association Between Patient Characteristics and Difficult Intubation

Variable	Easy Intubation n=110 (%)	Difficult Intubation n=40 (%)	P-value
Age Groups			0.167
<50 years	32 (77.9)	9 (22.1)	
50-65 years	56 (75.7)	18 (24.3)	
>65 years	22 (65.8)	13 (34.2)	
Gender			0.412
Male	52 (76.5)	16 (23.5)	
Female	58 (70.7)	24 (29.3)	
Body Mass Index			0.002
Normal	71 (79.8)	18 (20.2)	
Overweight	37 (82.2)	8 (17.8)	
Obese	2 (12.5)	14 (87.5)	
Diabetes Duration			0.015
≤10 years	77 (81.9)	17 (18.1)	
>10 years	33 (61.1)	23 (38.9)	
Glycemic Control (HbA1c)			0.082
<7.5%	45 (80.4)	11 (19.6)	
≥7.5%	65 (69.1)	29 (30.9)	

Table 6: Correlation Between Mallampati Scores and Cormack-Lehane Grades

Position	Cormack-Lehane Grade I n=61	Grade IIa n=49	Grade IIb n=28	Grade III n=9	Grade IV n=3	Correlation Coefficient	P-value
Sitting Position						r=0.524	<0.001
Mallampati I	42 (68.9)	8 (16.3)	2 (7.1)	0 (0.0)	0 (0.0)		
Mallampati II	17 (27.9)	32 (65.3)	16 (57.1)	3 (33.3)	0 (0.0)		
Mallampati III	2 (3.3)	9 (18.4)	9 (32.1)	5 (55.6)	1 (33.3)		
Mallampati IV	0 (0.0)	0 (0.0)	1 (3.6)	1 (11.1)	2 (66.7)		
Supine Position						r=0.742	<0.001
Mallampati I	16 (26.2)	2 (4.1)	0 (0.0)	0 (0.0)	0 (0.0)		
Mallampati II	38 (62.3)	15 (30.6)	3 (10.7)	0 (0.0)	0 (0.0)		
Mallampati III	7 (11.5)	28 (57.1)	21 (75.0)	5 (55.6)	1 (33.3)		
Mallampati IV	0 (0.0)	4 (8.2)	4 (14.3)	4 (44.4)	2 (66.7)		

Values represent n (%) within each Cormack-Lehane grade

DISCUSSION

The present study provides valuable insights into the comparative effectiveness of modified Mallampati classification performed in sitting versus supine positions for predicting difficult intubation in patients with type 2 diabetes mellitus. The findings demonstrate that supine position assessment offers superior sensitivity for detecting difficult airways in this patient population, while traditional sitting assessment maintains better specificity.

The observed sensitivity of 94.2% for supine position assessment represents a substantial improvement over the 45.8% sensitivity achieved with sitting position evaluation. This enhanced sensitivity is particularly clinically relevant given the potentially catastrophic consequences of unrecognized difficult airways in diabetic patients, who often present with additional comorbidities that may complicate emergency airway management (11). The superior sensitivity of supine positioning aligns with findings from Bindra et al., who reported enhanced detection rates when Mallampati assessment was performed in the supine position among general surgical patients (12).

However, the trade-off between sensitivity and specificity observe d in this study merits careful consideration. While supine position assessment achieved superior sensitivity, the specificity decreased from 87.3% in sitting position to 68.5% in supine position. This reduction in specificity translates to an increased false positive rate, potentially leading to unnecessary preparation for difficult airway management in patients who would ultimately have straightforward intubations. The clinical implications of this trade-off must be weighed against the safety benefits of enhanced sensitivity in identifying truly difficult cases.

The correlation analysis revealed stronger association between supine Mallampati scores and actual laryngoscopic findings (r=0.742) compared to sitting position scores (r=0.524). This enhanced correlation suggests that gravitational effects on upper airway anatomy in the supine position may more accurately reflect the conditions encountered during actual laryngoscopy, which is invariably performed with the patient in supine position. The physiological basis for this observation lies in the posterior displacement of the tongue and soft tissues that occurs in supine positioning, potentially unveiling anatomical relationships that are masked when assessment is performed in the sitting position (13).

The shift toward higher Mallampati classifications in supine position, with 50.6% of patients classified as Class III or IV compared to only 20.0% in sitting position, indicates significant positional effects on airway assessment. This finding is consistent with previous investigations by Khatiwada et al., who reported similar trends in general patient populations (14). The gravitational influence on soft tissue positioning appears to be particularly pronounced in diabetic patients, possibly due to the altered tissue compliance associated with advanced glycation end products and diabetic stiff joint syndrome.

The association between higher body mass index and difficult intubation observed in this study (87.5% of obese patients experiencing difficult intubation) is well-established in the literature. However, the particularly high incidence in diabetic patients may reflect the compounding effects of metabolic syndrome, which frequently accompanies type 2 diabetes (15). The combination of increased soft tissue mass and diabetic-related joint stiffness creates a challenging scenario for airway management that may be better captured by supine position assessment.

The relationship between diabetes duration and intubation difficulty (38.9% in patients with diabetes >10 years versus 18.1% in shorter duration) supports the progressive nature of diabetic complications affecting airway anatomy. This finding is consistent with the work of Hogan et al., who demonstrated that longer diabetes duration correlates with increased prevalence of limited joint mobility and associated airway management challenges (16). The superior sensitivity of supine assessment may be particularly valuable in identifying these patients with longer disease duration who are at highest risk.

Contrary to some previous studies, the present investigation did not identify significant gender differences in difficult intubation rates. While female patients showed slightly higher rates (29.3% versus 23.5%), this difference did not reach statistical significance. This finding differs from reports by Wang et al., who identified male gender as a significant predictor of difficult intubation in Chinese populations (17). The discrepancy may reflect population-specific anatomical variations or the specific pathophysiological effects of diabetes that may override typical gender-related differences in airway anatomy.

The negative predictive value of supine position assessment (96.8%) represents a particularly valuable clinical metric, as it indicates that patients classified as low-risk by supine assessment are very unlikely to experience difficult intubation. This high negative predictive value could inform clinical decision-making regarding the extent of airway preparation required, potentially streamlining workflow in cases where difficult intubation is truly unlikely.

The area under the ROC curve analysis provides robust evidence for the superior discriminatory ability of supine position assessment (AUC 0.813 versus 0.665 for sitting position). This difference exceeds the threshold typically considered clinically meaningful, supporting the adoption of supine assessment in clinical practice when sitting evaluation is not feasible or when enhanced sensitivity is desired (18).

Several limitations of this study warrant consideration. The single-center design may limit generalizability to other populations or practice settings. The assessment was performed by a single observer, which, while reducing inter-observer variability, may not reflect the broader applicability across different practitioners. Additionally, the study focused specifically on type 2 diabetic patients, and the findings may not be directly applicable to other patient populations or to patients with type 1 diabetes.

The definition of difficult intubation used in this study, while consistent with established criteria, may not capture all aspects of airway management difficulty. Some patients who required only two attempts or brief use of adjunctive techniques may not have been classified as difficult cases, potentially affecting the sensitivity and specificity calculations. Future studies might benefit from incorporating more nuanced definitions of airway management difficulty that account for varying degrees of challenge.

The clinical implications of these findings extend beyond the immediate perioperative period. For diabetic patients who may require multiple surgical procedures throughout their disease course, accurate airway assessment can inform long-term care planning and patient counseling. The identification of patients at risk for difficult intubation early in their surgical journey allows for proactive planning and potentially improved outcomes across multiple encounters (19).

The economic considerations of enhanced airway assessment accuracy should not be overlooked. While the reduced specificity of supine assessment may lead to increased preparation for difficult airways in some cases, the cost of such preparation is likely minimal compared to the potential costs associated with failed intubation attempts, including prolonged operative times, intensive care admissions, and potential litigation (20).

Future research directions should include multicenter validation of these findings, investigation of inter-observer reliability for supine position assessment, and exploration of combined assessment strategies that might optimize both sensitivity and specificity. Additionally, the development of technology-assisted airway assessment tools that could standardize evaluation regardless of patient position represents an promising area for future investigation.

The integration of artificial intelligence and machine learning approaches with traditional assessment methods may offer opportunities to enhance predictive accuracy while maintaining clinical practicality. Such approaches could potentially combine positional Mallampati assessment with other airway predictors to develop more comprehensive risk stratification tools specifically validated for diabetic populations.

CONCLUSION

This prospective observational study demonstrates that modified Mallampati classification performed in the supine position provides superior sensitivity for predicting difficult intubation in patients with type 2 diabetes mellitus compared to traditional sitting position assessment. While supine assessment achieves enhanced sensitivity (94.2% versus 45.8%), this improvement comes at the cost of reduced specificity (68.5% versus 87.3%). The stronger correlation between supine Mallampati scores and actual laryngoscopic findings suggests that this positioning may more accurately reflect the anatomical conditions encountered during intubation.

The findings support the use of supine position Mallampati assessment as a valuable alternative when sitting evaluation is not feasible, particularly in diabetic patients where the consequences of unrecognized difficult airways may be especially severe. The high negative predictive value of supine assessment (96.8%) provides clinically useful information for risk stratification and resource allocation.

Significant associations were identified between difficult intubation and higher body mass index as well as longer diabetes duration, highlighting the importance of comprehensive risk assessment in this patient population. The 26.7% incidence of difficult intubation in diabetic patients underscores the need for heightened vigilance and appropriate preparation in this high-risk group.

These results have important implications for clinical practice, particularly in emergency situations, trauma cases, or other scenarios where traditional sitting assessment is impractical. Healthcare providers should consider incorporating supine position assessment into their airway evaluation protocols for diabetic patients, while remaining cognizant of the increased false positive rate. The enhanced sensitivity of supine assessment may ultimately contribute to improved patient safety through better identification of patients requiring advanced airway management techniques.

Future investigations should focus on multicenter validation of these findings and exploration of combined assessment strategies that might optimize both sensitivity and specificity for this important patient population. The development of standardized protocols for airway assessment in diabetic patients represents a crucial step toward enhancing perioperative safety in this growing demographic.

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