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Evaluation of Preoperative Screening Tests for Predicting Difficult Airway in Surgical Patients

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ABSTRACT

Difficult airway management is a critical challenge in anesthesiology. Accurate preoperative assessment is essential to predict and manage difficult intubations. This study evaluates the validity of widely accepted clinical and radiological screening tests to predict difficult airway in surgical patients. To compare the sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV) of clinical and radiological parameters in predicting difficult intubation. A prospective observational study was conducted on 300 patients aged 15-75 years undergoing surgery under general anesthesia with endotracheal intubation. Clinical predictors included the modified Mallampati classification, inter-incisor gap, thyromental distance, sternomental distance and Wilson risk sum score. Radiological parameters included atlanto-occipital distance, effective mandibular length, anterior and posterior mandibular depths and C2 spine depth. Difficult intubation was defined as Cormack-Lehane grades III or IV during laryngoscope. Sensitivity, specificity, PPV and NPV of each parameter were analyzed. Difficult intubation was observed in 38 patients (12.7%). Among clinical predictors, modified Mallampati classification had the highest sensitivity (100%) and NPV (100%), while thyromental distance demonstrated the highest specificity (99.4%) and PPV (97.43%). Radiological predictors showed limited sensitivity, with atlanto-occipital distance achieving the highest sensitivity (97.43%) and NPV (99.37%). Effective and posterior mandibular depths, as well as C2 spine depth, exhibited lower predictive values. Clinical parameters, particularly modified Mallampati classification, thyro mental distance and sterno mental distance, are more reliable than radiological measurements in predicting difficult airway. Preoperative airway assessment should prioritize clinical screening tools for effective airway management.

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Key Words
Difficult airway, preoperative assessment, modified mallampati classification, thyromental distance, cormack-lehane grades, radiological predictors, sensitivity, specificity

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INTRODUCTION

Airway management is a critical component of anesthetic practice, with a difficult airway posing a significant challenge to anesthesiologists[1]. Failure to manage the airway effectively can lead to serious complications, including hypoxia, brain damage and even mortality[2]. The ability to predict a difficult airway preoperatively allows for better preparation and implementation of strategies to mitigate these risks[3]. Preoperative airway assessment involves evaluating clinical and anatomical parameters to anticipate potential challenges during intubation[4]. Various screening tests, including the modified Mallampati test, thyromental distance and interincisor gap measurements, have been widely used to predict difficult intubation. However, the predictive accuracy of these tests varies and no single test has proven universally reliable[5,6]. Combining clinical parameters with radiological measurements, such as atlanto-occipital distance and mandibular dimensions, may improve the sensitivity and specificity of difficult airway prediction[7]. Despite the availability of numerous predictive tools, the complexity of airway management lies in the multi factorial nature of difficult intubation. Factors such as obesity, head and neck pathologies and reduced mobility of the cervical spine can further complicate predictions[8]. Hence, a comprehensive evaluation incorporating both clinical and radiological predictors is essential. In this study, we aimed to evaluate the sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV) of multiple clinical and radiological parameters in predicting difficult intubation. By analyzing the performance of these predictors, we sought to identify the most reliable methods for preoperative airway assessment in patients undergoing elective surgeries under general anesthesia. This study provides insights into optimizing airway management strategies and improving patient safety during anesthesia.

MATERIALS AND METHODS

Study Design and Setting: This cross-sectional study was conducted at the Department of Anaesthesiology, Konaseema Institute of Medical Science and Research Foundation (KIMS) in Amalapuram, East Godavari, Andhra Pradesh, between December 2020 and October 2022. The study was approved by the Institutional Ethics Committee.

Study Population: The study included 300 patients undergoing elective surgeries under general anesthesia across various surgical specialties. Convenient sampling was used for patient selection.

Inclusion Criteria:

- Patients aged 18-50 years.
- Patients of both sexes.
- Patients scheduled for elective surgical procedures under general anesthesia.

Exclusion Criteria:

- Patients undergoing surgeries under regional anesthesia.
- Patients requiring emergency surgical procedures.
- Patients younger than 18 years or older than 50 years.

Data Collection: Each patient underwent a detailed preoperative evaluation that included a thorough history-taking and comprehensive general examination. Multiple screening tests were conducted to assess the potential for a difficult airway. These included measurements of height and weight, evaluation for airway pathologies such as symptoms of airway compression (dyspnea, dysphonia and dysphagia), facial malformations, cervical spondylosis, occipito-atlanto-axial disease, airway tumors and complications associated with long-term diabetes mellitus, such as stiff joint syndrome. The modified Mallampati test (as per Samsoon and Young's classification) was performed, along with interincisor gap (IIG) and thyromental distance (TMD) measurements. Additionally, Wilson's test was used to evaluate head and neck mobility. Key predictors of difficult intubation were identified, including gross weight exceeding 110 kg, pathologies of the airway, modified Mallampati grades III or IV, head and neck movement <80°, an interincisor gap of <3.5 cm and a thyromental distance of 6 cm or less.

Equipment Preparation: To ensure readiness for airway management, a laryngoscope with Macintosh blades (sizes 3 and 4), endotracheal tubes of various sizes and airways (nasopharyngeal, oropharyngeal and laryngeal mask airways) were prepared. Additional tools such as suction equipment and fiberoptic equipment were also made available. Emergency medications, including atropine, adrenaline, dopamine and lidocaine, were kept on hand, alongside essential monitors such as ECG, pulse oximetry and sphygmomanometers.

Procedure: All patients underwent preoxygenation with 100% oxygen for three minutes before induction. Thiopentone sodium (5 mg/kg) was administered, followed by succinylcholine (1 mg/kg) to facilitate intubation. Laryngoscopy was performed using a Macintosh medium-sized blade (size 3) and the view was classified using the Cormack and Lehane system: Grade I (entire vocal cords visible), Grade II (posterior commissar visible), Grade III (epiglottis visible) and Grade IV (no structures visible). In cases of difficulty, maneuvers such as backward, upward and rightward pressure (BURP) were employed and additional tools such as stylets or larger blades (size 4) were used. For severe predicted difficulties, awake fiberoptic intubation was performed.

Definition of Difficult Intubation: Endotracheal intubation was classified as difficult if any of the

following were observed: Cormack and Lehane grades III or IV, >three intubation attempts or a total time exceeding 10 minutes, or the necessity for alternative techniques such as fiberoptic or blind nasal intubation.

Data Recording: All measurements and observations were systematically recorded using a standardized form. Instances of easy and difficult intubations were documented separately for analysis.

Statistical Analysis: The collected data were analyzed to evaluate the sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV) of various clinical and radiological screening tests in predicting difficult intubation.

RESULTS AND DISCUSSIONS

The study evaluated 300 patients, aged between 15 and 75 years, undergoing surgery under general anesthesia with endotracheal intubation. The results are summarized below:

Age and Gender Distribution: The age distribution of patients is shown in **(Table No. 1)**. The majority of patients were between 18-30 years (27.7%) and 31-40 years (31.3%). The study included 141 females (47%) and 159 males (53%), as depicted in **(Table No. 2)**.

Table 1: Age Distribution

Age (yrs)	Number of Cases
18-30	83
31-40	94
41-50	66
51-75	56

Table 2: Gender Distribution

Gender	Number of Cases
Female	141
Male	159

Incidence of Difficult Intubation: Difficult intubation was observed in 38 patients (12.7%). The mean age of the difficult intubation group was significantly higher (43.7±13.1 years) compared to the easy intubation group (36.1±11.7 years., p<0.01). This data is presented in **(Table No. 3)**.

Table 3: Incidence of Difficult Intubation

Parameter	Value
Mean Age (Difficult)	43.7±13.1
Mean Age (Easy)	36.1±11.7
P Value	<0.01

Clinical Predictors of Difficult Intubation:

Among Clinical Parameters: Modified Mallampati Classification demonstrated the highest sensitivity (100%) and NPV (100%). Thyromental Distance had the highest specificity (99.4%) and PPV (97.43%). Sternomental Distance showed excellent sensitivity (97.29%) and NPV (99.37%). The Wilson Risk Sum Score was less sensitive (65.78%) but highly specific (100%) with a PPV of 100%. Detailed data is available in **(Table No. 4)**.

Table 4: Clinical Predictors of Difficult Intubation

Test	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)
Modified Mallampati Classification	100	95.9	90.24	100
Inter-incisor Gap	85	97.61	89.47	96.47
Thyromental Distance	95	99.4	97.43	95.97
Sternomental Distance	97.29	93.56	76.59	99.37
Wilson Risk Sum Score	65.78	100	100	94.53

Radiological Predictors of Difficult Intubation:

Radiological Parameters were Less Predictive Compared to Clinical Tests: Atlanto-Occipital Distance showed the highest sensitivity (97.43%) and NPV (99.37%). Other parameters, such as Effective Mandibular Length, Anterior Mandibular Depth, Posterior Mandibular Depth and C2 Spine Depth, exhibited lower sensitivities and specificities, with PPVs ranging from 16.32-30.48%. These findings are detailed in **(Table No. 5)**.

Table 5: Radiological Predictors of Difficult Intubation

Test	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)
Atlanto-Occipital Distance	97.43	94.11	78.72	99.37
Effective Mandibular Length	67.56	66.66	30.48	90.47
Anterior Mandibular Depth	77.77	51.16	25	91.66
Posterior Mandibular Depth	43.24	52.04	16.32	80.9
C2 Spine Depth	48.71	59.76	21.83	83.47

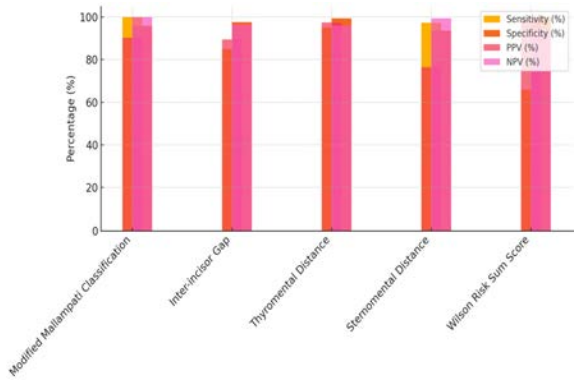

Fig 1: Clinical Predictors of Difficult Intubation

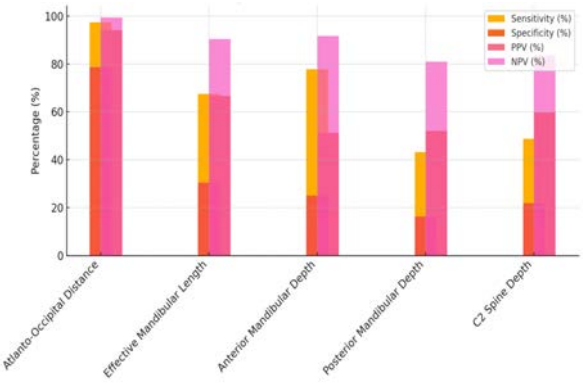

Fig. 2: Radiological Predictors of Difficult Intubation

Airway management is a cornerstone of anesthetic practice, with difficult intubation being one of the most critical challenges faced by anesthesiologists. Failure to predict and adequately prepare for a difficult airway can result in severe complications, including hypoxia,

aspiration, cardiac arrest and even mortality (Roth[9]). Therefore, a reliable preoperative evaluation is essential to enhance patient safety and optimize outcomes. This study systematically evaluated the predictive efficacy of multiple clinical and radiological screening tests for identifying difficult intubation, emphasizing the importance of a structured and multi modal assessment approach. The incidence of difficult intubation in this study was 12.7%, consistent with global incidence rates reported in previous literature (Arné[10] Trambadia[13]). This consistency underscores the robustness of the study's methodology and the representativeness of its patient population. The findings highlight the superior predictive value of clinical parameters compared to radiological assessments, reflecting their practicality and reliability in routine anesthetic practice. The Modified Mallampati Classification was the most sensitive clinical predictor, with a sensitivity and negative predictive value (NPV) of 100%. This confirms that a normal Mallampati classification reliably excludes the likelihood of a difficult airway, making it an indispensable first-line screening tool (Harjai[11] Marchis[12]). Similarly, thyromental distance exhibited exceptional specificity (99.4%) and positive predictive value (PPV) (97.43%), confirming its effectiveness in identifying high-risk patients (Trambadia[13] Wang[14]). The sternomental distance demonstrated high sensitivity (97.29%) and NPV (99.37%), making it particularly useful for assessing patients with anatomical or mobility limitations (Arne[10]). In contrast, the Wilson Risk Sum Score, though less sensitive (65.78%), exhibited perfect specificity (100%), suggesting its utility as an adjunctive tool for confirming suspected difficult airways (Trambadia[13]).

Radiological Predictors: Radiological assessments generally showed lower predictive accuracy compared to clinical parameters. Among the radiological measures, the atlanto-occipital distance had the highest sensitivity (97.43%) and NPV (99.37%), making it a potentially useful adjunct in certain cases (Fernandez-Vaquero[15]). However, other parameters, such as posterior mandibular depth and C2 spine depth, demonstrated limited sensitivity and specificity, reducing their utility as standalone predictors (Roth[9] Bhagavan and Nelamangala[16]). Radiological evaluations may be particularly valuable in complex cases, such as those involving cervical spine abnormalities or head and neck tumors, where clinical assessments may be inconclusive (Marchis[12] Wang[14]).

Clinical Implications: These findings emphasize the importance of integrating multiple clinical tests for a comprehensive airway evaluation. The high sensitivity and specificity of clinical predictors, such as the Modified Mallampati Classification, thyromental distance and sternomental distance, make them essential tools for preoperative planning. These tests enable anesthesiologists to anticipate potential difficulties, prepare appropriate equipment and adopt tailored strategies to mitigate airway-related risks (Harjai[11] Trambadia[13]). Radiological assessments, while less predictive overall, have a complementary role in cases where clinical findings are inconclusive or when patients present with anatomical abnormalities (Fernandez-Vaquero[15] Bhagavan and Nelamangala[16]). Their adjunctive use can be particularly beneficial in tertiary care centers equipped with advanced imaging facilities (Marchis[12] Wang[14]).

Limitations: This study is limited by its cross-sectional design and reliance on single-center data, which may not fully account for variability in patient populations and anesthetic practices. Additionally, while radiological assessments were included, their use in routine preoperative evaluation may be constrained by resource availability.

CONCLUSION

This study highlights the effectiveness of clinical predictors in preoperative airway assessment. The Modified Mallampati Classification, with 100% sensitivity and negative predictive value, emerged as the most reliable tool for ruling out difficult intubations. Thyromental distance and sternomental distance demonstrated high specificity (99.4% and 93.56%, respectively) and positive predictive values, further reinforcing their utility. Radiological parameters, such as atlanto-occipital distance, showed potential but were less reliable overall compared to clinical tests. The incidence of difficult intubation (12.7%) aligns with global trends, emphasizing the importance of structured evaluations. Combining multiple clinical predictors with radiological insights in complex cases ensures better preparedness, enhancing patient safety and outcomes in airway management.

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