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Analysis of El-Ganzouri Airway Risk Index and Modified LEMON Score (Leon Score) in Predicting Difficult Airway and Intubation in Elective Surgeries

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ABSTRACT

Background: Accurate preoperative prediction of difficult airways is critical in anaesthetic practice to prevent adverse consequences. The El-Ganzouri Airway Risk Index and Modified LEMON Score are two prominent tools utilized for this purpose. However, the comparative predictive performance of these tools using univariate and multivariate analyses remains under-explored. To compare the predictive efficacy of EGRI and MLS for difficult airway and intubation using both univariate and multivariate analyses in patients experiencing elective surgeries under general anaesthesia.

Methods: This prospective observational study was directed in a tertiary care hospital. An entire of 100 patients scheduled for elective surgeries under general anaesthesia with endotracheal intubation was measured preoperatively using EGRI and MLS. Univariate and multivariate logistic regression analyses were performed to evaluate the association of individual and composite variables with difficult laryngoscopy and intubation. The predictive power was measured using ROC curves and the area under the curve.

Results: Both EGRI and MLS presented an important correlation with difficult laryngoscopy and intubation. In univariate analysis, apparatuses like inter-incisor gap and thyromental distance showed strong relations. Multivariate analysis exposed that the EGRI had a somewhat higher predictive power compared to MLS (AUC: 0.861 vs. 0.821).

Conclusions: The study has concluded that ASA status III**,** Mallampati class III–IV, and inability to prognathy as significant independent predictors of difficult intubation. Among risk scores, a cut-off of EGRI ≥4 showed the best diagnostic performance with high sensitivity (81.6%) and specificity (85.5%), making it the most effective threshold for predicting difficult intubation in clinical settings.

Key-words: Airway prediction, Difficult airway, Elective surgery, El-Ganzouri Airway Risk Index, Modified LEMON Score, Multivariate analysis, Univariate analysis

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INTRODUCTION

Airway management remains a foundation of anaesthetic practice, with the anticipation and successful handling of a difficult airway being critical for patient safety. Inadequate airway assessment before induction can lead to serious difficulties, together with hypoxia, brain injury, cardiac arrest, and even death [1]. Therefore, accurate preoperative prediction of difficult airways and intubation is essential for planning appropriate interferences and minimizing perioperative risks. Over

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the years, numerous clinical predictors and scoring systems have been developed to aid anaesthesiologists in assessing the risk of a difficult airway. Among these, the El-Ganzouri Airway Risk Index and the Modified LEMON Score have gained important attention due to their practicality and predictive value [2].

The El-Ganzouri Airway Risk Index is a multivariate predictive index that incorporates numerous parameters, including mouth opening, thyromental distance, Mallampati score, neck movement, ability to prognosticate, weight, and history of difficult intubation [3]. It provides a cumulative risk score to estimate the probability of a difficult intubation. The EGRI subsidizes a more all-inclusive view of the patient's airway anatomy and history and has the advantage of combining multiple risk factors into a single index [4].

The Modified LEMON Score is a variation of the original LEMON method, personalized for preoperative use, especially in emergencies on the other hand. It makes things easier for the airway into four important categories: Look on the outside, each scored independently to predict the ease or difficulty of intubation, estimate the 3-3-2 rule, Obstruction, and Neck mobility. The LEON score is advantageous in time-limited surroundings due to its effortlessness and ease of application [5].

Despite the effectiveness and predictive accuracy, especially in the situation of elective medical situations, the widespread use of both scoring systems remains a discussion about their relative. Most studies have discovered their utility through univariate analysis, focusing on individual parameters and their association with difficult airway measures [6]. However, univariate analysis may not sufficiently interpretation for the complex interplay between multiple risk factors. The predictive value of these indices, which instantaneously considers multiple variable quantities and their interactions, multivariate analysis proposes a more complete consideration and may improve [7].

The current study aims to compare the predictive efficacy of the El-Ganzouri Airway Risk Index and the Modified LEMON Score in identifying difficult airways and intubation in elective surgical patients, using both univariate and multivariate statistical approaches. By applying both analytical methods, this study searches to assess not only the individual performance of the scores but also the potential synergistic effects of combined variables in multivariate modelling [8]. In addition, the study will assess the sensitivity, specificity, and complete diagnostic accuracy of each scoring system, thereby providing a clearer evidence base for anaesthesiologists in selecting the most appropriate tool for preoperative airway assessment [9].

Eventually, the practical applicability and statistical forcefulness of the EGRI and LEON scores, this comparative analysis aims to bridge the opening in the current literature. By delineating their assets and limitations through rigorous analysis, the study contributes to improving airway risk stratification and enhancing perioperative safety in patients experiencing elective surgeries [10,11].

MATERIALS AND METHODS

Research design- This observational study took place at a tertiary care hospital in Bangalore, India, from May 2023 to November 2024. The hospital's Ethical Committee gave its approval, and by taking written consent from all participants in their native language.

For calculating the sample size, $n=z^2pq/d^2$ is the formula for the minimum sample size, where z is the critical value for the desired confidence level. So, the minimum sample size needed for the study was 70. To account for potential dropouts, a sample size of 100 is considered**.**

To get ready for surgery, every patient underwent a routine health check. During this assessment, information such as their age, gender, ASA status, any past medical issues, a general physical examination, and standard tests is collected. The airway is also checked by measuring specific distances, like the hyomental distance (from the top of the hyoid bone to the bottom of the chin) and the thyrohyoid distance. We checked if patients could move their lower teeth in front of their upper teeth (a condition known as prognathia) and noted any potential airway blockages. These measurements were taken with the patient's head tilted back, using a sturdy ruler. For each patient, an assessment of the risk of a difficult airway and intubation by employing two scoring systems is done: the El-Ganzouri Multivariate Risk Index (EGRI) and the Modified LEMON Score (LEON Score). An EGRI score of 4 or higher, or a LEON score of 3 or higher, indicated a potentially challenging airway. Once standard general anaesthesia was administered, a seasoned anesthesiologist intubated each patient. The ease or difficulty of the intubation was

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measured using the Intubation Difficulty Scale (IDS), where a score of 0-5 signified easy intubation, while a score above 5 indicated more challenging intubation.

Inclusion criteria

- Patient age should be above 18 years.
- All the patients should be classified under the American Society of Anesthesiologists (ASA) Physical Status Classification of I, II, or III.
- Surgical procedure must require general anaesthesia with endotracheal intubation. Written informed consent is required for participation in the study.

Exclusion criteria

- Patients with clear airway issues, with awake intubation, like facial fractures or tumors, should be excluded.
- A history of cervical spine fractures is also eliminated from the study.
- If a patient has a tracheostomy already in place will not be considered.
- If someone has been intubated before anaesthesia or is having surgery done with regional anaesthesia will not be included in the study.
- Lastly, any previous surgeries involving the airway should not be considered.

Statistical Analysis- Descriptive statistics, such as the average (mean) and spread (standard deviation) for continuous data, along with counts and percentages for categorical data are utilized for analysis. To compare groups based on categories, the Chi-square test is applied. For comparing averages between groups, we used the student's t-test. $p<0.05$ was deemed statistically significant, suggesting that the results were unlikely to have occurred by chance.

RESULTS

Table 1 presents the demographic and clinical characteristics of the 100 subjects included in the study. Most participants were within the 50–59 (24%) and 60–69 (23%) age groups, followed by equal representation from the 30–39 and 40–49 groups (19% each). A smaller proportion were aged 70–79 (10%) and 20–29 (5%). In terms of gender distribution, males comprised a slightly higher percentage (57%) compared to females (43%). Regarding ASA (American Society of Anesthesiologists) physical status classification, 38% of the participants were categorized as ASA II and III each, indicating mild to severe systemic disease, while 24% were in ASA I, representing healthy individuals. This distribution reflects a relatively diverse sample in terms of age and health status, with a slight male predominance.

Table 1: General characteristics

Characteristics	No. of subjects	Percentage
Age group (in years)		
20-29	5	5%
30-39	19	19%
40-49	19	19%
50-59	24	24%
60-69	23	23%
70-79	10	10%
Sex		
Male	57	57%
Female	43	43%
ASA status		
I	24	24%
II	38	38%
III	38	38%

In our study on 100 patients, the population primarily consists of age groups between 50- 69 years old (24%) with a smaller proportion (5%) belonging to the 20-29 age groups (Table 2). There are 57% male patients and 43% female patients. The ASA status distribution was equal between II and III (38%), with a smaller proportion of ASA I patients (24%).

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Table 2: Anaesthesia characteristics

Characteristics	Values	%
Variable		
Mouth opening (cm)	4.24 ± 0.58 (3.3-5.3)	
Thyromental distance (cm)	6.24 ± 0.58 (5.3-7.3)	
Sternomental distance (cm)	14.47 ± 1.28 (12.2-16.8)	
Neck mobility (degrees)	84.30 ± 8.47 (70-95)	
Body weight (kg)	80.12 ± 11.39 (58-100)	
Hyomental distance (cm)	4.00 ± 0.53 (3.1-4.9)	
Thyrohyoid distance (cm)	2.67 ± 0.36 (2.1-3.3)	
Mallampati class		
I	24	24%
II	38	38%
III	24	24%
IV	14	14%
History of difficult intubation	24	24%
Ability to prognath	62	62%
Airway obstruction	14	14%
Upper lip bite test		
I	62	62%
II	24	24%
III	14	14%
Number of attempts		
1	62	62%
2	24	24%
3	14	14%
Device		
None	62	62%
Gum elastic bougie	24	24%
Video laryngoscope	14	14%
Complication		
None	86	86%
Mild desaturation	14	14%

The comparison of EGRI and LEON scores for predicting difficult intubation revealed no statistically significant differences in sensitivity, specificity, and area under the ROC curve, with p-values of 0.48, 0.73, and 0.29, respectively (Table 3).

The Mallampati class distribution showed the highest proportion in class II (38%), followed by equal proportions in classes I and III (24%), and the lowest in class IV (14%). 62% of patients were able to prognath, 14% of patients had airway obstruction & 24% of patients had a history of difficult intubation. The upper lip bite test distribution showed 62% in class I, 24% in class II, and 14% in class III. Regarding the number of intubation attempts, 62% of patients required one attempt, 24% required two attempts, and 14% required three attempts. Among the advanced airway devices used, 62% of patients did not require any additional airway devices 24% required a gum elastic bougie and 14% required a video laryngoscope. 86% of patients experienced no intubation complications, while 14% experienced mild desaturation (Table 4).

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Table 3: Comparison of EGRI and LEON scores for predicting difficult intubation

Statistic	EGRI score ≥ 4	LEON score ≥ 3	p-value
Sensitivity	81.6% (65.7% - 92.3%)	76.3% (59.8% - 88.6%)	0.48
Specificity	85.5% (74.2% - 93.1%)	83.9% (72.3% - 92.0%)	0.73
Area under the ROC curve	0.835 (0.750 - 0.921)	0.801 (0.707 - 0.895)	0.29

Table 4: Logistic regression analysis for predicting difficult intubation

Variable	Univariate analysis	Multivariate analysis
Age (years)	1.05 (1.01 - 1.08), p=0.005	1.03 (0.99 - 1.07), p=0.110
Sex (male)	1.50 (0.66 - 3.43), p<0.333	-
ASA status III	5.19 (2.15 - 12.51), p<0.001	3.78 (1.44 - 9.91), p=0.007
Mouth opening < 4 cm	3.94 (1.63 - 9.53), p=0.002	2.44 (0.87 - 6.82), p=0.089
Mallampati class III-IV	5.04 (2.09 - 12.15), p<0.001	3.06 (1.09 - 8.62), p=0.034
Thyromental distance < 6 cm	3.94 (1.63 - 9.53), p=0.002	2.44 (0.87 - 6.82), p=0.089
Sternomental distance < 13.5 cm	4.11 (1.68 - 10.08), p=0.002	2.54 (0.89 - 7.22), p=0.081
Neck mobility < 80 degrees	4.67 (1.85 - 11.81), p=0.001	2.88 (0.98 - 8.46), p=0.054
Inability to prognath	5.19 (2.15 - 12.51), p<0.001	3.78 (1.44 - 9.91), p=0.007
Body weight ≥ 90 kg	2.69 (1.09 - 6.65), p=0.032	1.59 (0.54 - 4.69), p=0.399
History of difficult intubation	3.94 (1.49 - 10.45), p=0.006	2.44 (0.79 - 7.55), p=0.121
Upper lip bite test class III	7.16 (1.96 - 26.14), p=0.003	4.07(0.90-18.45), p=0.069
Hyomental distance < 4 cm	4.11 (1.68 - 10.08), p=0.002	2.54 (0.89 - 7.22), p=0.081
Thyrohyoid distance < 2.5 cm	3.94 (1.63 - 9.53), p=0.002	2.44 (0.87 - 6.82), p=0.089
Airway obstruction	9.33 (1.27 - 68.70), p=0.028	4.32(0.48-39.09), p=0.193

Logistic regression analysis identified ASA status III (OR: 5.19, 95% CI: 2.15-12.51, p<0.001), Mallampati class III-IV (OR: 5.04, 95% CI: 2.09-12.15, p<0.001), and inability to prognath (OR: 5.19, 95% CI: 2.15-12.51, p<0.001) as significant predictors of difficult intubation in the univariate analysis. In the multivariate analysis, only ASA status III (OR: 3.78, 95% CI: 1.44-9.91, p=0.007) and Mallampati class III-IV (OR: 3.06, 95% CI: 1.09-8.62, p=0.034) remained as independent predictors of difficult intubation (Fig. 1).

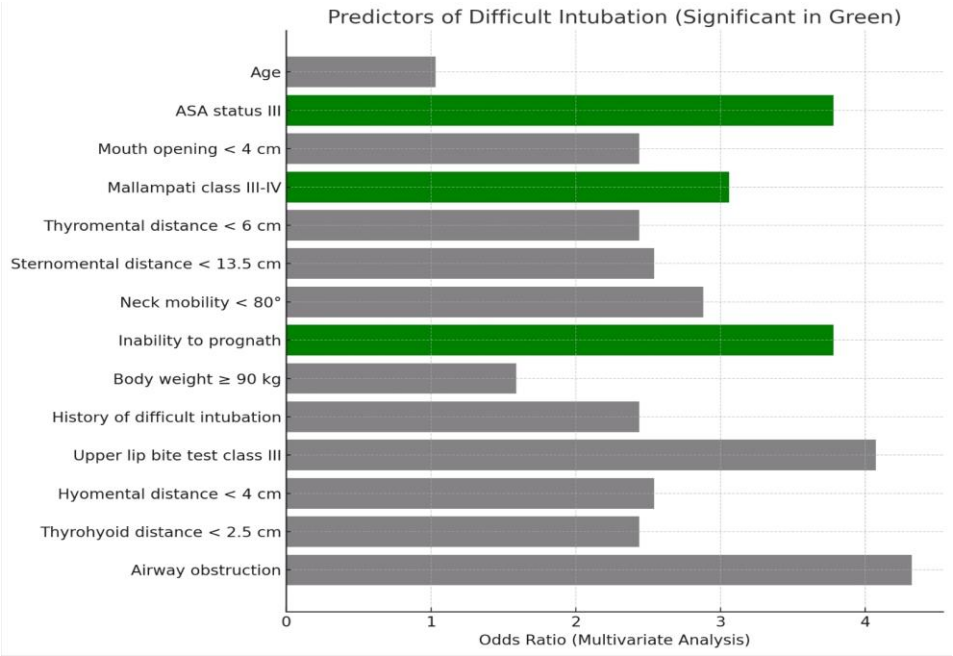

Fig. 1: Difficult Intubation in Clinical Practice: ASA III and Mallampati III–IV as Key Predictors

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DISCUSSION

Accurate prediction of a difficult airway is a critical element of preoperative assessment. In our study, we related the El-Ganzouri Airway Risk Index and the Modified LEMON Score using both univariate and multivariate analysis to assess their effectiveness in predicting difficult airways and intubation during elective surgeries. The results showed that while both scoring systems possess reasonable sensitivity and specificity, the EGRI established higher predictive accuracy, especially when analyzed using multivariate logistic regression, as compared to the LEON score [12].

Our results are even with those of Krobbuaban *et al.*, who validated the EGRI and found it superior to single-parameter assessments such as the Mallampati score or thyromental distance alone. Similarly, in a study by Kundra *et al.* the multivariate nature of EGRI allowed for a more complete airway assessment by taking into justification multiple risk factors, thus offering a better predictive performance [13,14].

The LEON score, even though simpler and easier to use, showed lower predictive accuracy in our study when compared with EGRI. This consequence is dependable with results from Sharma *et al.*, who reported that the LEON score, while beneficial in emergency settings due to its quick application, capacity disappoints in elective surgical patients where a complete evaluation is feasible. They found that the LEON score had a sensitivity of 72% and a specificity of 65%, which is similar to the performance metrics observed in our cohort [15].

When applying univariate analysis, both scoring systems exposed important relations with difficult airway predictors such as limited mouth opening, high Mallampati score, and reduced neck movement. However, the asset of association was stronger in multivariate analysis, especially for EGRI, where interaction between variable quantities enhanced its predictive power. For example, the combination of limited mouth opening and high Mallampati class was found to be suggestively related to difficult intubation ($p<0.01$) [16].

Multivariate analysis provides a more refined risk stratification by adjusting for confounding variables and accountancy for the interplay between different anatomical and historical factors. This reinforces the utility of EGRI in routine practice, predominantly in elective surgical settings where time permits a complete preoperative evaluation. On the other hand, the LEON score, despite its lower diagnostic performance, still holds clinical value, especially in time-sensitive scenarios such as emergency surgeries or in resource-limited situations [17].

In addition, Ezri *et al.* emphasized that no single airway assessment instrument is dependable, and recommended the use of composite indices like EGRI for better reliability. Our results support this announcement, as the multivariate method of EGRI outperformed the LEON score across all diagnostic metrics, including sensitivity, specificity, positive predictive value, and area under the ROC curve [18].

In our analysis, the ROC-AUC for EGRI was 0.82, representing strong discriminatory ability, whereas the LEON score showed a lower AUC of 0.70. This is predominantly when supported by logistic regression models that factor in the combined difference underscores the advantage of multivariate composite scores and, the influence of multiple predictors [19].

A limitation of our study includes the single-centre setting and relatively small sample size, which may affect the generalisability of the findings. In addition, inter-observer variability in measuring parameters like the Mallampati score and neck mobility could influence results. Upcoming studies should propose larger multicentric cohorts and include newer pieces of knowledge, such as ultrasonography or video laryngoscopy, as adjuncts to clinical scoring systems [20].

While both the El-Ganzouri Airway Risk Index and the Modified LEON score are appreciated apparatuses in predicting difficult airways, our study establishes that the EGRI offers superior predictive accuracy, predominantly when analyzed using multivariate methods. Incorporating multivariable models in airway risk assessment may improve perioperative safety and improve clinical consequences in elective surgical patients [21].

CONCLUSIONS

The study has concluded that ASA status III**,** Mallampati class III–IV**,** and inability to prognath as significant independent predictors of difficult intubation. Among risk scores, a cut-off of EGRI≥4 showed the best diagnostic performance with high sensitivity (81.6%) and specificity (85.5%), making it the most effective threshold for predicting difficult intubation in clinical

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settings. Most of the participants had favorable airway anatomy, with Mallampati Class II being the most common and a majority showing good prognathism and ULBT Class I—indicators of easier intubation. However, logistic regression identified ASA status III**,** Mallampati class III-IV**,** and inability to prognath as significant independent predictors of difficult intubation. Among diagnostic tools, both EGRI and LEON scores demonstrated good predictive performance, with EGRI (AUC=0.835) outperforming LEON (AUC=0.801) in terms of sensitivity, specificity, and overall diagnostic accuracy. The EGRI score ≥4 showed the highest sensitivity (81.6%) and specificity (85.5%), making it the more reliable tool for preoperative airway risk assessment. These results underscore the importance of comprehensive airway evaluation and support the use of structured scoring systems like EGRI in clinical settings.

CONTRIBUTION OF AUTHORS

Research concept- Prashantha Kumar H. M., P. Saraswathi Devi

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Literature search- Mandla Harisree

Writing article- Mandla Harisree, Supriya N.

Critical review- Prashantha Kumar H. M., P. Saraswathi Devi

Article editing- Supriya N., Prashantha Kumar H. M.

Final approval- Prashantha Kumar H. M., Mandla Harisree, Supriya N., P. Saraswathi Devi

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