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ARAŞTIRMA MAKALESİ / RESEARCH ARTICLE

Predictive Values of LEMON and LEON Scores in Elective Oral and Maxillofacial Surgery- Correlation with Intubation Difficulty Scale

LEMON ve LEON Skorlarının Elektif Ağız, Diş ve Çene Cerrahisinde Modifiye Entübasyon Zorluk Ölçeği ile Korelasyonu

Necmiye ŞENGEL[1], Gülsüm KARABULUT[1], M. Emin TOPRAK[1], Arzu Esen TEKELİ[2]

[1]Department of Oral, Maxillofacial Surgery, Faculty of Dentistry, Gazi University, Ankara, Turkey
[2]Department of Anesthesiology and Reanimation, Faculty of Medicine, Van Yüzüncü Yıl University, Van, Turkey

ABSTRACT

Introduction: Airway management can be a major concern, due to the possibility of encountering difficult ventilation and intubation. The Modified Intubation Difficulty Scale (MIDS) is a quantitative scale that can objectively compare nasotracheal intubation. LEMON method which consists of following assessments; Look-Evaluate-Mallampati-Obstruction-Neck mobility and modified LEMON scores (LEON) are popular scoring systems described for airway management due to their easy usability. We aimed to evaluate usability of the LEMON and LEON scores in patients who underwent oral and maxillofacial surgery by studying correlation between each score and the MIDS.

Materials and Methods: The records of 72 patients were reviewed retrospectively. At the pre-anesthetic evaluation; airway assessments were recorded according to LEMON, LEON scores; MIDS were recorded after intubation. Patients were allocated into two groups: Non-difficult (NonD; MIDS ≤5) and Difficult (D; MIDS >5). Correlations between scores were analyzed using Spearman's rank correlation. Receiver operating characteristic (ROC) curve plots were used to determine possible cut-off values; specificity, sensitivity, negative-predictive values for LEON and LEMON scores. In all analyses, $p<0.05$ were considered statistically significant.

Results: LEMON and LEON scores were correlated with the MIDS. Analysis of ROC curve plots revealed 2 cut-off values (≥4 and ≥5) for LEMON; 1 cut-off value (≥4) for LEON score. Among the scores, LEMON (≥4), LEON had the highest sensitivity and negative-predictive values (both 100%); LEON showed higher specificity than the LEMON (≥4) (96.7% vs 91.8%). LEMON (≥5) had the highest specificity (98.4%) but the lowest sensitivity (90.4%), negative-predictive value (90.9%) among the group.

Conclusion: LEON scores ≥4 can be effectively used with 100% sensitivity, 96.7% specificity and, 100% negative-predictive-value for predicting difficult airway and intubation in elective maxillofacial surgeries.

Keywords: Oral and maxillofacial surgery, airway assessment, LEON Score, LEMON Score, Modified Intubation Difficulty Scale

ÖZ

Giriş: Zor ventilasyon ve entübasyonla karşılaşma olasılığı nedeniyle hava yolu yönetimi dikkat edilmesi gereken önemli bir konudur. Modifiye Entübasyon Zorluk Ölçeği (MIDS), nazotrakeal entübasyonu objektif olarak karşılaştırabilen nicel bir skaladır. Bak-Değerlendir-Mallampati-Obstruksiyon-Boyun hareketliliğinin değerlendirildiği LEMON ve modifiye LEMON skoru (LEON), kolay kullanılabilirliği nedeniyle hava yolu yönetimi için tanımlanan popüler skorlama sistemleridir. Her bir skor ile MIDS arasındaki korelasyonu inceleyerek, oral ve maksillofasiyal cerrahi uygulanan hastalarda LEMON, LEON skorunun kullanılabilirliğini değerlendirmeyi amaçladık.

Gereç ve Yöntem: 72 hastanın kayıtları geriye dönük olarak incelenmiştir. Anestezi öncesi değerlendirmede; hava yolu değerlendirmeleri LEMON, LEON skorlarına göre kaydedilmiş; entübasyondan sonrası MIDS kaydedilmiştir. Hastalar, zor-olmayan (NonD; MIDS ≤5) ve zor entübasyon (D; MIDS >5) olarak iki gruba ayrılmıştır. Skorlar arasındaki korelasyonlar Spearman's korelasyonu kullanılarak analiz edilmiştir. LEON ve LEMON skorlarının cut-off değerleri, özgüllük, duyarlılık, negatif prediktif değerleri ROC eğrisi grafikleri kullanılarak belirlenmiştir. Tüm analizlerde 0,05'ten küçük p değerleri istatistiksel olarak anlamlı kabul edilmiştir.

Bulgular: LEMON ve LEON skorlarının MIDS ile korele olduğu görülmüştür. Alıcı İşletim Karakteristiği (ROC) eğrisi grafiklerinin analiziyle LEMON için 2 cut-off değeri (≥4 ve ≥5); LEON değerlendirmesi için 1 cut-off değeri (≥4) elde edilmiştir. Skorlar arasında LEMON (≥4) ve LEON en yüksek duyarlılık ve negatif tahmin değerlerine sahip olduğu (her ikisi de %100); LEON'un, LEMON'dan daha yüksek özgüllük gösterdiği (≥4) (%96,7'ye karşı %91,8) görülmüştür. LEMON (≥5) en yüksek özgüllüğe (%98,4) ancak grup içinde en düşük duyarlılık (%90,4), negatif tahmin değerine (%90,9) sahip olduğu görülmüştür.

Sonuç: Elektif maksillofasiyal cerrahilerde zor hava yolu ve entübasyonu öngörmede LEON skorları ≥4 olduğunda %100 duyarlılık, %96,7 özgüllük ve %100 negatif öngörü değeri ile etkin bir şekilde kullanılabilir.

Anahtar Sözcükler: Ağız ve çene cerrahisi, hava yolu değerlendirmesi, LEON Skoru, LEMON Skoru, Modifiye Entübasyon Zorluk Ölçeği

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Yazışma Adresi/Correspondence Address: Necmiye ŞENGEL, Department of Oral, Maxillofacial Surgery, Faculty of Dentistry, Gazi University, Ankara, Turkey
E-posta: necmiyesengel@hotmail.com ; **N.Ş.:** 0000-0001-8591-3658; **G.K.:** 0000-0001-5359-8905; **M.E.T:** 0000-0003-4281-5913; **A.E.T.:** 0000-0001-6468-8850

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Introduction

Airway management can be a major concern for the anesthesiologist, due to the possibility of encountering difficult intubation (1). In patients undergoing maxillofacial surgeries, securing the airway can be more challenging than other type of surgeries owing to the fact that in the maxillofacial surgeries the airway is involved in the surgical field. Moreover, difficult intubation is an important issue in anesthesia practice as it can lead to hypoxic brain injury, which is the most important cause of anesthesia-related morbidity and mortality (2,3).

Difficult airway was defined by the "American Society of Anesthesiologists Task Force on Management of The Difficult Airway" as the clinical scenario in which a conventionally trained anesthesiologist faces difficulty with facemask ventilation of the upper airway, tracheal intubation or both. The task force strongly recommends the availability of at least one additional anesthesia personnel and preoxygenation before initiating the airway management in case of a known or suspected difficult airway. There are several airway management strategies (e.g., awake fiberoptic intubation, Intubating Laryngeal mask airways) that can be discussed if difficult airway was anticipated beforehand (4). Therefore, it is imperative to predict the difficult airway and be prepared.

Various scoring systems can be used to evaluate the difficult intubation. The intubation difficulty scale is a quantitative scale that can objectively compare the complexity of orotracheal intubations (5). The scoring system was modified for nasotracheal intubations in a more recent study and has been named as modified intubation difficulty scale (MIDS) (6). The LEMON score is one of the most popular scoring systems described to evaluate difficult intubation due to its easy usability (7). The LEMON mnemonic includes Look–Evaluate–Mallampati–Obstruction–Neck mobility components.

In this study, MIDS was used as a measure of actual intubation difficulty and it was aimed to evaluate the usability of the traditional and a modified version of the LEMON score in predicting the difficulty of intubation in oral and maxillofacial surgery patients by studying the correlation between each score and the MIDS. Moreover, secondary outcome of this study is to determine the most relevant cut-off values by comparing the sensitivity, specificity and negative-predictive values.

Material and Methods

Patients

After the approval by the local ethics committee (protocol number 21071282/05099) in accordance with the Declaration of Helsinki, the records of 72 patients who had undergone oral and/or maxillofacial surgery under general anesthesia with nasotracheal intubation between September 2019 and March 2020 were reviewed retrospectively (Figure 1).

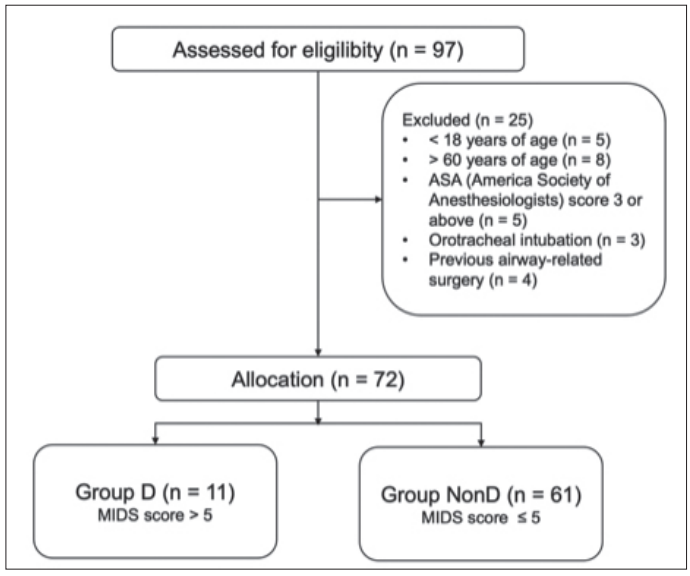

Figure 1. Flowchart of patients included in this study.

Data Collection

The same anesthesia protocol was used in all patients by the same anesthesiologist who was assigned to the general anesthesia department of the facility.

LEMON and LEON Scores

Airway assessments were recorded according to LEMON and LEON method (Figure 2). LEON scores were calculated from the LEMON scores by omitting the Mallampati component, therefore with a maximum of 9 points.

Anesthetic management

After routine monitoring in accordance with the ASA standards (Electrocardiography (ECG), non-invasive blood pressure and pulse oximetry), anesthesia was induced with propofol (1.5–2 mg/kg), lidocaine (1 mg/kg) and fentanyl (1 mcg/kg) intravenously (i.v.). Muscle relaxation was achieved with rocuronium bromide (0.6 mg/kg). After mask ventilation with 2.0% sevoflurane in 100% oxygen, nasotracheal intubation was performed with a spiral endotracheal tube which was softened in hot water (approximately 40°C) and lubricated with gel (Internal diameter 5.5–6.0 for women and 6.5–7.0 for men). Anesthesia then maintained with sevoflurane (2%) and remifentanil (0.2–0.5 mcg/kg/min i.v. infusion).

Modified Intubation Difficulty Scale (MIDS) recording

Seven evaluation criteria in the MIDS (Figure 2) that were defined in line with the previous literature on the nasotracheal intubation (5,6) were recorded by the anesthesiologist immediately after each intubation. Intubation difficulty is defined according to the sum of N1 to N7 (MIDS=0= >ideal; MIDS=1–5= >slight difficulty; MIDS >5= >major difficulty). Patients were allocated into two groups according to whether intubations were with ideal or slight difficulty (group non-difficult [NonD]); MIDS ≤5) or major difficulty (group Difficult [D]; MIDS >5).

LEMON Evaluation chart	Points
Look externally	
Facial trauma	1
Larger incisors	1
Beard or moustache	1
Large tongue	1
Evaluate	
Inter-incisors distance < 3 fingerbreaths	1
Hyoid-to-mental distance < 3 fingerbreaths	1
Tyroid-to-hyoid distance < 2	1
Mallampati score	
Score ≥ 3	1
Obstruction	
Obstruction signs include any condition causing airway obstruction such as peritonsillar abcess, upper airway trauma, epiglottitis, or sleep apnea	1
Neck mobility	
Limited neck mobility	1
Total Score	10

LEON scores are calculated from LEMON scores by omiting the points from Mallampati component

Modified Intubation Difficulty Scale (MIDS) recording		
Paramater	Score	Calculation
The number of endotracheal intubation attempts >1	N1	Every additional attemp add 1 point
The number of endotracheal intubation practitioners >1	N2	Each additional anesthesiologist add 1 point
If the first attempt failed, the number of alternative intubation techniques	N3	Each tecnique adds 1 point
Cormack-Lahane grade*	N4	grade 1 = score 0, grade 2 = score 1, grade 3 = score 2, and grade 4 = score 3.
The lifting force applied during laryngoscopy	N5	0 = if little effort is necessary, 1 = if there is a need for an increased lifting force
The need to apply external laryngeal pressure for optimized glottic appearance	N6	0 = not applied,1 = if external laryngeal pressure was applied
The techniques to aid intubation	N7	0 = none, 1 = cuff inflation or use of Magill forceps

*Cormack – Lehane grade of laryngoscopy view (grade 1, vocal cords are fully visible; grade 2, only arytenoids are visible; grade 3, only epiglottis is visible; and grade 4, epiglottis is not visible)

Figure 2. Evaluation charts.

Statistical Analysis

Data analyses were performed via SPSS software (IBM SPSS Statistics for Windows, Version 26.0. Armonk, NY: IBM Corp; 2016). Kolmogorov-Smirnov test was the preferred test for normality. Independent samples t-test and Mann Whitney U test were used for the analysis of continuous variables. On the other hand, for comparing categorical variables, Chi-square and Fisher's exact tests were performed. In this study we also tested a modified version of LEMON score in which "Mallampati" parameter was omitted (LEON). Correlations between scores (LEON vs. MIDS and LEMON vs. MIDS) were analyzed using Spearman's rank correlation. A receiver operating characteristic (ROC) curve plots were used to determine possible cut-off values and specificity, sensitivity and negative-predictive values for LEON and LEMON scoring systems. In all analyses, p values less than 0.05 were considered statistically significant.

Results

The data of 72 patients were analyzed in this study and 11 of them were fitted in the D group (MIDS >5), while 61 patients were allocated into the NonD (MIDS ≤5) group. Patients' characteristics including demographic information, body mass indexes (BMI) and ASA scores were demonstrated in Table 1. All parameters were comparable between the groups except for BMI. Patients in the group D had statistically higher BMI scores than the patients in the NonD group (27.5±6.0 vs 23.9±4.0; p=0.012).

Both LEMON and LEON scores were strongly correlated with the MIDS score (Spearman's correlation coefficients: 0.825, p<0.001; 0.815, p<0.001, respectively; Figure 3). After

Table 1. Patients' characteristics

	Group D (n=11)	Group nonD (n=61)	*P* value
Age (years)	27 (20–53)	28 (20–41)	0.991[α]
Gender (%)			
Male	5 (45.45)	31 (50.82)	Chi² test 1.00
Female	6 (54.55)	30 (49.18)	
Weight (kg)	76 (62–86)	65 (58–77)	0.159[α]
Height (cm)	164.5±9.8	168.8±9.2	0.159[β]
*BMI (kg/m²)	27.5±6.0	23.9±4.0	0.012[β]
ASA score (%)			
1	5 (45.45)	33 (54.10)	Chi² test 0.746
2	6 (33.33)	28 (45.90)	

*p<0.05 is considered statistically significant.
[α] Mann-Whitney U test; values are expressed as median (25th–75th interquartile range).
[β] Independent Samples t test; values are expressed as mean ± standard deviation.

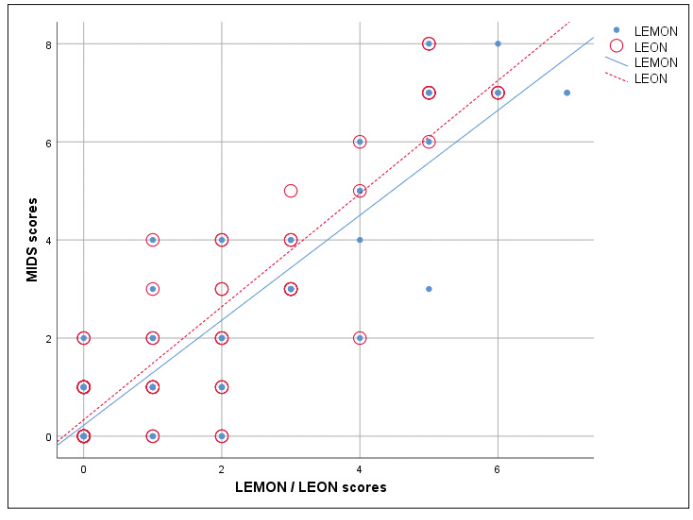

Figure 3. Correlations of LEMON and LEON scores with MIDS score.

the analysis of ROC curve plots, 2 cut-off values (≥4 and ≥5) for LEMON score and 1 cut-off value (≥4) for LEON score were selected for further calculations of sensitivity, specificity and negative-predictive values which were shown in Table 2. Among the scores, LEMON (≥4) and LEON tests had the highest sensitivity and negative-predictive values (both 100%), however LEON test showed slightly higher specificity than the LEMON (≥4) test (96.7% vs 91.8%, respectively). On the other hand, LEMON (≥5) test had the highest specificity (98.4%) but the lowest sensitivity (90.4%) and negative-predictive value (90.9%) among the group.

Table 3 demonstrates the percentages of each parameter of the LEMON score between the groups. All patients from the group D and only 4.9% of the patients from the group NonD had hyoid-to-mental distance <3 fingerbreadths (Fbs) and tyroid-to-hyoid distance <2 Fbs (p<0.001). 20 patients from the NonD group and 10 patients from the D group had Inter-incisor distance less than 3 Fbs, (32.8% vs 90.9%, respectively; p<0.001). Patients with large incisors and tongues were higher in number in the D group: 72.7% vs 13.1% ; 90.9% vs 29.5%, respectively (p<0.001). All patients with a facial trauma were allocated in the NonD group, the difference was not significant (p=0.342). 45.5% of the patients in the D group and 21.3% of the patients in the NonD group had a Mallampati score 3 or higher (p=0.128). The D group had 3 patients with obstruction signs and also the same number of patients with limited neck mobility. The NonD group had 2 patients who showed obstructions signs and 1 patient with limited neck mobility.

Table 2. Sensitivity, specificity, and negative predictive value of LEMON scores with different cut-off values and LEON score

Scores (cut-off value)	Sensitivity (%)	Specificity (%)	Negative predictive value (%)
LEMON (≥4 p*)	100	91.8	100
LEMON (≥5 p)	90.9	98.4	98.4
LEON (≥4 p)	100	96.7	100

* p, Points.

Table 3. Percentages of each parameter of LEMON score

Criteria, n (%)	Overall	Group D	Group NonD	P* value
L Facial trauma	10 (13.9%)	0	10 (16.4%)	0.342
Large incisors	16 (22.2%)	8 (72.7%)	8 (13.1%)	<0.001
Beard or moustache	0	0	0	
Large tongue	28 (38.9%)	10 (90.9%)	18 (29.5%)	<0.001
E Inter-incisor distance <3 Fbs	30 (41.7%)	10 (90.9%)	20 (32.8%)	<0.001
Hyoid-to-mental distance <3 Fbs	14 (19.4%)	11 (100%)	3 (4.9%)	<0.001
Thyroid-to-hyoid distance <2 Fbs	14 (19.4%)	11 (100%)	3 (4.9%)	<0.001
M Mallampati score ≥3	18 (25%)	5 (45.5%)	13 (21.3%)	0.128
O Obstruction signs	5 (6.9%)	3 (27.3%)	2 (3.3%)	0.023
N Limited neck mobility	4 (5.6%)	3 (27.3%)	1 (1.6%)	0.01

* p value for Fisher's exact test, p<0.05 is considered statistically significant.
Fbs: finger breadths.
Group NonD indicates patients with MIDS scores <5 and group D indicates patients with MIDS scores ≥5
Obstruction signs include any condition causing airway obstruction such as peritonsillar abcess, upper airway trauma, epiglottitis, or sleep apnea.

Discussion

In the present study, our aim was to determine the predictive values of LEMON and LEON scores by testing the correlations of each scoring system with the MIDS scores in patients undergoing elective maxillofacial surgeries. In most of the cases where difficult intubation was expected according to the MIDS score (MIDS >5), the values above 4 in the LEMON and LEON scores were observed.

Although the MIDS score is the gold standard in this evaluation, preoperative guidance remains weak as it also includes laryngoscopy findings. For this reason, there is a need for a test that will guide us before the operation, and it will be useful to know the cut-off values.

Various scoring systems were proposed to predict difficult airway and intubation throughout the years, the LEMON being one of them (7). In order to predict difficult intubation, its applicability is easier compared to the MIDS scoring system with criteria that can be determined according to the patient's appearance and the finger width of the observer.

Previous studies investigating the validity of LEMON and LEON scores were mainly conducted in the emergency departments and only one of them proposed a cut-off value. Ji and his colleagues investigated the relationship between LEON score and intubation difficulty score in adult trauma patients undergoing emergency surgery; they suggested that a patient with LEON score ≥3 may show intubation difficulty (8). When we look at the literature, we failed to find any studies evaluating the LEMON and LEON scoring system in nasotracheal intubation. Therefore, our study could be considered as a first study to evaluate these scoring systems in nasotracheal intubation in the maxillofacial surgery patient group.

Due to difficulties in assessment of Mallampati component in the LEMON score in trauma patients admitted to emergency departments, some authors described and studied the LEON (Look-Evaluate-Obstruction-Neck mobility) scoring system (8,9). On the other hand, Mallampati scores were found to have high predicting value for intubation difficulty in patients with orofacial tumours in a study conducted by Akadiri et al. (10). After consideration of these studies, we decided to look into both LEMON and LEON scores in our selected patient group. Moreover, in the study by Akadiri et al. (10) the actual difficulty of intubation was defined by using an algorithm based on the number of attempts and performer's experience in the field. In the present study we preferred using MIDS scores validated for

nasotracheal intubations by previous studies, this enabled us to conduct correlation analyses similarly as the study by Sung-Mi et al. (5,6,8).

In the analysis of patient characteristics, only BMI scores between the groups were found statistically different (Group D: 27.5±6.0 vs Group NonD: 23.9±4.0; p=0.012). Previous studies found that higher BMI scores were associated with intubation difficulty (11,12). Moreover, in the MOANS scoring system proposed for predicting airway and intubation difficulty, the "O" stands for "Obstruction or Obesity" suggesting the presence of redundant soft tissue could be a cause of obstruction (7). Therefore, our results support previous findings and high BMI scores in the maxillofacial surgery patient group should be considered as a risk factor for difficult intubation.

In the present study, patients with intubation difficulty were more likely to have "large incisors", "large tongue" and reduced "inter-incisor", "hyoid-to-mental" and "thyroid-to-hyoid" distances (Table 3). Similarly, Reed and colleagues demonstrated that patients who had "large incisors" or reduced "inter-incisor" and "thyroid-to-hyoid" distances were more likely to have poor laryngoscopic views (Cormack-Lehane grade 2, 3, 4) (13). On the contrary, Ji and colleagues found that thyroid-to-hyoid distance was not an independent predictor of intubation difficulty and attributed those findings to the usage of video laryngoscopes (8).

Although facial trauma is a component of LEMON scoring system, our study failed to support its contribution to the intubation difficulty as all patients with a facial trauma were fitted in the NonD group. In a study conducted in the emergency department by Soyuncu and colleagues, percentages of facial trauma in the groups were found similar (15.1% in the difficult group; 12.5% in the easy group) (14). Furthermore, in another study also conducted in the emergency department, 27.8% of patients in the not difficult group, and 28.1% of the patients in the difficult group had facial trauma (8). As these previous studies' findings support our study, we suggest that, facial trauma component in the LEMON scoring system needs more clear definition and should be further investigated. Moreover, the decrease in the sensitivity percentages when the cut-off value for LEMON score changed from 4 to 5 could be attributed to the facial trauma component of the scoring system.

In the present study, 45.5% of the patients in the D group had a Mallampati score 3 or higher, whereas the percentage was only 21.3% in the NonD group. However, the difference was not significant (p=0.128). Moreover, in our study, both LEMON and LEON scores were strongly correlated with the MIDS scores (Spearman's correlation coefficients: 0.825, p<0.001; 0.815, p<0.001, respectively). As unanticipated difficult airway could lead to life threatening complications like hypoxic brain injury even death, the suggested test predicting difficult airway should have zero false negative rate (100% negative predictive value) in order to not miss any difficult airways and be unprepared (2,3). In our study, we calculated the sensitivity, specificity and negative-predictive values of two predictive tests with three cut off values (LEMON ≥4, LEMON ≥5 and, LEON ≥4). Both LEMON ≥4 and LEON ≥4 had 100% sensitivity and negative-predictive-values. However, since LEON ≥4 showed slightly higher specificity than LEMON ≥4 (96.7% vs 91.8%, respectively), we suggest that LEON scoring system with cut off value ≥4 can be used effectively in elective maxillofacial surgery.

There are several limitations to this study. First, a retrospective study design and a relatively small sample size could have contributed the results. Although, LEMON, LEON and MIDS scores were self-reported and could be unreliable; having the same operator for all the process involved eliminated the performance bias. Moreover, for the recall bias, the scoring systems were already implemented in routine practice and also MIDS scores were recorded immediately after the intubation process. Second, the present study did not include emergent surgeries and acute trauma patients. Therefore, the results could not be attributed to all maxillofacial surgeries.

Conclusion

LEON scores ≥4 can be effectively used with a 100% sensitivity, 96.7% specificity and, 100% negative-predictive-value for predicting difficult airway and intubation in elective maxillofacial surgeries.

Ethics Committee Approval: The study was performed according to the Ethical Principles determined in the Helsinki Declaration. Approval was obtained by the local ethics committee (21071282/05099).

Peer-review: Externally peer-reviewed.

Author Contributions: Concept - NŞ; Design - NŞ; Supervision - AET, MET; Data Collection and/ or Processing - NŞ, GK; Analysis and/or Interpretation - AET, MET; Literature Search - NŞ, GK, AET, MET; Writing - NŞ, GK, AET, MET; Critical Reviews - AET, MET.

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