Investigation of the availability of tongue movements in Mallampati classification

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ABSTRACT

الأهداف: العثور على طريقة جديدة مرادفة لتصنيف مالامباتي بواسطة تحديد حركات عضلة اللسان، وبإمكان هذه الطريقة توقع مدى سهولة إدخال الأنبوب.

الطريقة: أُجريت هذه الدراسة في قسم التخدير بكلية الطب التابعة لجامعة تراكيا، إدرين، تركيا، واستمرت خلال الفترة من أبريل إلى أكتوبر 2009م. لقد قسم تصنيف مالامباتي الذي تم تعديله إلى أربع أصناف وذلك اعتماداً على إمكانية رؤية بعض الأعضاء داخل تجويف الفم وهذه الأصناف هي: MMS1، و MMS2، وMMS3، وMMS4، وعلى هذا الأساس جرى تقسيم المشاركين والذين بلغ عددهم 230 مشاركاً إلى مجموعتين وهما: مجموعة MMS1 وMMS2، ومجموعة MMS3، وMMS4. واُستخدمت الخطوط العمودية والأفقية من أجل تحديد حركات اللسان، حيث كانت الخطوط العمودية تمر خلال النقاط الوسطى للشفة العليا والفك السفلي، فيما تمر الخطوط العمودية خلال النقاط اليمنى واليسرى للعضلة الرافعة. لقد طُلب من المشاركين في الدراسة أن يقوموا برفع، وضغط، ومحاذاة (تحريك إلى اليمين واليسار) قمة ألسنتهم، وفيما بعد تم تحديد الدرجات التي حصل عليها المشاركين والتي كانت موافقة لحركات اللسان.

النتائج: أسفرت النتائج عن ظهور فروق واضحة بين مجموعة MMS1 وMMS2 والمجموعة MMS3، وMMS4 وذلك عند ضغط قمة اللسان ومحاذاتها لليمين واليسار (p=0.001). ويزيد التصنيف MMS3، وMMS4 بين المجموعات التي لا تستطيع ضغط قمة اللسان بمعدل 5.5 مرة، وبين المجموعات التي لا تستطيع محاذاة قمة اللسان بمعدل 5.4 مرة وذلك عند المقارنة مع المجموعات التي تستطيع فعل ذلك.

خاتمة: أثبتت هذه الدراسة أنه بالإمكان الجمع بين هذه الطريقة التي تعتمد على تحديد حركات اللسان وتصنيف مالامباتي، وتتطلب هذه الطريقة الخبرة الكافية في توقع ومواجهة صعوبات إدخال الأنبوب.

Objectives: To investigate the relation of Mallampati classification with a new alternative method suggested for use in the estimation of tongue movements.

Method: This study was conducted in the Department of Anesthesiology, Faculty of Medicine, Trakya University, Edirne, Turkey from April to October 2009. Two hundred and thirty patients were enrolled in this study. The modified Mallampati score (MMS) was devised by an anesthetist. To define tongue movements, horizontal and vertical lines were utilized. Horizontal lines passing through the mid points of the upper lip and mandible, and vertical lines passing through the right and left infraorbitale points were constituted on each subject. Subjects were asked to elevate, depress, and abduct (right-left) the tip of the tongue. The scores corresponding with the movements of the tongue were determined.

Results: Depression of the tip of the tongue (DTT) and elevation of the tip of the tongue (ETT) levels were significantly different between MMS 1, MMS 2, and MMS 3, MMS 4 groups (p=0.001). The risk of being MMS 3 or MMS 4 for the groups that cannot reach the borderline for the DTT or ETT are 5.5 times and 5.4 times higher consequently than the groups that can reach the borderline.

Conclusion: This new method can be combined with MMS classification, which requires clinical experience and knowledge in predicting difficult intubation.

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The tongue forms a major part of the upper airway and is comprised of both extrinsic and intrinsic muscles.[1] During respiration, its position relative to the posterior pharyngeal wall is very important. Its form and position in the oral cavity also influence the shape and dimensions of the airway between the palate and the tongue surface.[2] The part in the oral cavity, which can be seen in the mouth is the mobile part of the tongue. The pharyngeal part is situated behind, and is fixed. The fixed pharyngeal part anchors the tongue, and the mobile anterior part in the oral cavity can change shape, and be manipulated for the tongue to execute its various actions. Tongue movements are produced by extrinsic (hyoglossus, genioglossus, styloglossus, palatoglossus muscles) and intrinsic muscles.[1] The Mallampati classification is a rough estimate of the tongue size relative to the oral cavity.[2] It is a standard method of assessing the airway in potentially difficult intubation. In other words, the Mallampati classification is meant to identify a relatively large tongue that obscure the oropharyngeal structure.[2,3] The patient is more likely to be difficult to be intubated using direct laryngoscopy, if the tongue is relatively large.[3] The Samsoon modification of the Mallampati airway classification is based on the visibility of the soft palate, faucial pillars, and uvula.[4,5] The visibility of the structures depend on the relative capacity of the oropharyngeal cavity and the volume of the root of the tongue. If the root of the tongue is disproportionately large, and/or the movements of the tongue are limited, it can mask the visibility of faucial pillars and the uvula (increasing airway class), by encroaching into the oropharyngeal cavity.[4] This leads to a relative decrease in the oropharyngeal volumes. The accuracy of the Mallampati test may vary according to gender, tongue volume, and whether the patient is pregnant.[6] The tongue is one of the most important structures in the classification of Mallampati.[6,7] In this context, it was presumed that there is a possible relation between Mallampati and tongue movements[7] There are various discrepancies in the estimation of Mallampati classification, and this is probably due to the different levels of clinical experience and clinical skills between physicians.[8] In order to reduce these discrepancies and acquire objective and accurate results, alternative new methods should be improved that can be used together with the Mallampati classification. The purpose of this study is to find a new and an alternative method instead of the Mallampati classification by defining tongue movements.

Methods. This study was conducted in the Department of Anesthesiology, Faculty of Medicine, Trakya University, Edirne, Turkey from April to October 2009. After obtaining institutional ethics committee approval and written informed consent, 230 patients were enrolled in this study. The following general exclusion criteria were applied: refusal or inability to give informed consent, inability to sit, macroglossia, short frenulum, recent surgery of the head and neck, patients with severe cardiorespiratory disorders, patients with dental prosthesis, and patients <20 years of age and >70 years of age. The modified Mallampati score (MMS)[5] was made by a single anesthetist with 5 years clinical experience, and the measurements of the tongue movements were made by an anatomist who has no experience in performing the MMS.

The MMS.[5] Oropharyngeal view was assessed with the patient in sitting position, with the neck in neutral position, and with the tongue fully protruded but without phonation. It was rated: class 1 - if the soft palate, fauces, uvula, and pillars were visible; class 2 - if the soft palate, fauces, and uvula were visible; class 3 - if only the soft palate and base of the uvula were visible; and class 4 - if the soft palate was not visible. The patients may be intubated easily if their MMS classes are 1 or 2, however, difficult intubation may be experienced if the patients' MMS classes are 3 or 4.[3,5,6,8] Therefore, the patients were grouped in 2; one group for MMS class 1 and 2, and another group for MMS class 3 and 4. To define tongue movements, horizontal and vertical lines are used. Horizontal lines passing through the mid points of the upper lip and mandible, and vertical lines passing through the right and left infraorbitale points were constituted on each subject (**Figure 1**). Subjects were asked to elevate, depress, and abduct (right-left) the tip of the tongue in sitting position with the neck and head in neutral position (**Figure 2**). The scores corresponding with the movements of the tongue are shown in **Table 1**.

Results are expressed as mean ± standard deviation or number (percentage). The Chi-square test was used for comparison of the movements of tongue variables between the 2 MMS groups. Then odds ratios (OR) and 95% confidence intervals (95% CI) were calculated. $P<0.05$ was considered statistically significant.

Results. Demographic data of patient's includes age, gender, weight, height, and body mass index (BMI) (**Table 2**). Of the 230 patients, 60 (26%) had MMS 3 or 4 score. The comparisons of the movements of tongue between MMS groups are shown in **Table 3**. The MMS score and number of patients for each group are: class 1 - 84; class 2 - 86; class 3 - 34; and class 4 - 26. The DTT (depression of the tip of tongue) and ETT (elevation of the tip of tongue) levels were significantly different ($p<0.001$) between MMS 1, 2 and MMS 3, 4 group. The patients who cannot be reached border line in DTT, the possibility of being MMS 3 or MMS 4 class is 5.5 times higher than the other group (OR=5.5; 95% CI: 4.1-7.3). Similarly, the patients who cannot be reached border line in ETT, the possibility of being

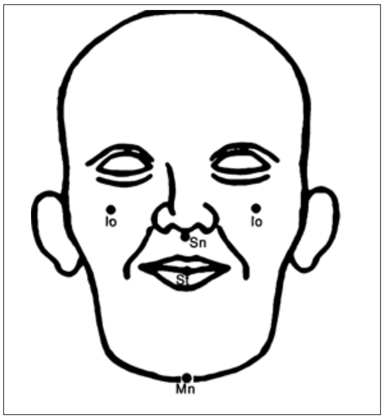

Figure 1 - Anatomic landmarks used to define tongue movements. Sn - subnasale, St - stomion, Mn - Mentum, Io - Infraorbitale

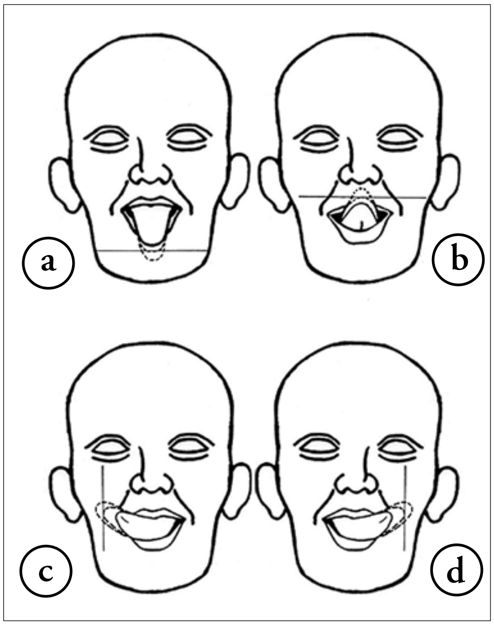

Figure 2 - Tongue movements showing: **a**) DTT - depression of the tip of the tongue; **b**) ETT - elevation of the tip of the tongue; **c**) RATT - right abduction of the tip of the tongue; and **d**) LATT - left abduction of the tip of the tongue.

Table 2 - Demographic data of patients (n=230).

Demographics	Mean ± standard deviation
Age, years	45.81 ± 16.42
Gender	
Male	112
Female	118
Height, cm	168.46 ± 7.03
Weight, kg	77.61 ± 8.59
Body mass index, (kg/m^2)	27.39 ± 2.95

Table 3 - Comparison of tongue movements between modified Mallampati score (MMS) in groups 1 & 2 versus 3 & 4.

Variables	MMS 1 or 2 (n=170)	MMS 3 or 4 (n=60)	OR	95% CI for OR	*P*-value
DTT					
cannot be reached border line	0	22	5.5	4.1-7.3	<0.001
can be reached and pass border line	170	38			
ETT					
cannot be reached border line	0	21	5.4	4.0-7.1	<0.001
can be reached and pass border line	170	39			
RATT					
cannot be reached border line	34	16	0.7	0.4-1.4	0.371
can be reached and pass border line	136	44			
LATT					
cannot be reached border line	45	12	1.4	0.7-3.0	0.410
can be reached and pass border line	125	48			

95% CI - 95% confidence intervals, OR - odds ratio, ETT - elevation of the tip of tongue, DTT - depression of the tip of tongue, RATT - right abduction of the tip of tongue, LATT - left abduction of the tip of tongue

Table 1 - The scores corresponding with the movements of the tongue.

Tests	Score 1	Score 2
ETT	The tip of the tongue cannot be reached to the horizontal line passing through the midpoint of upper lip height	The tip of the tongue can be reached beyond the horizontal line passing through the midpoint of upper lip height
DTT	The tip of the tongue cannot be reached to the horizontal line passing through the midpoint of mandible height	The tip of the tongue can be reached beyond the horizontal line constituted through the midpoint of mandible height
LATT and RATT	The tip of the tongue cannot be reached to the vertical line passing through the right and left infraorbitale	The tip of the tongue can be reached beyond the vertical line passing through the right and left infraorbitale

ETT - elevation of the tip of tongue, DTT - depression of the tip of tongue, RATT - right abduction of the tip of tongue, LATT - left abduction of the tip of tongue

MMS 3 or MMS 4 class is 5.4 times higher than the other group (OR=5.4; 95% CI: 4.0-7.1). However, right abduction of the tip of tongue (RATT) (p=0.371), and left abduction of the tip of tongue (LATT)(p=0.410) levels were not significantly different between MMS 1, MMS 2 and MMS 3, MMS 4 groups (**Table 3**).

Discussion. Although the tongue is not the strongest muscle in the body, it is a fully functioning muscle that is vital to human growth, as well as human enjoyment.[1,2] The tongue is responsible for many different functions in the human body. The tongue provides a path for food to travel through the digestive system, it has taste buds so that we can enjoy the flavor of that food, and the tongue is largely responsible for speech, among other things.[2]

Hiiemae and Palmer,[2] and Abd-el-Malek[9] provided the first description of tongue movements. With the recent technologic developments, tongue movements were investigated more comprehensively. The tongue movements during mastication and swallowing were investigated by various methods like electropalatography, electromagnetic articulometer, cineradiography and videoflourography.[10-17] All of these methods are used to evaluate the tongue movements functionally. However, none of these methods can be used practically in clinical investigation.

In this study, the evaluation of the movements of the tongue is made by investigating ETT, DTT, RATT and LATT. The increase in these movements facilitates the view of oropharyngeal structures by increasing the tongue part that stick out the mouth. Due to limited mobility of soft palate and uvula, their effect in the estimation of Mallampati classification is poor.[4,5] The movements of the tongue affect the estimation of Mallampati classification directly. The genioglossus, styloglossus, hyoglossus and intrinsic muscles are responsible of the tongue movements. The genioglossus muscle protrudes the tongue.[18,19] With respect to the study of electromyographic (EMG) activity of the airway muscles, genioglossus is the primary upper airway dilator muscle.[1] In EMG studies of the genioglossus, it has been reported that this muscle dilates the upper airway during inspiration as the onset of the activity is just before airflow.[20] Negative pressure in the upper airway appears to activate this muscle reflexly as there is a powerful correlation between negative epiglottic pressure and the level of genioglossus EMG.[1,21] While genioglossus muscle protrudes the tongue, the intrinsic muscles of the tongue decrease vertical diameter. By protruding the tongue and depressing the root of the tongue, genioglossus contributes to an increase in the distance between the root of tongue and uvula, and may lead to a decrease in Mallampati score.

The styloglossus muscle retracts and elevates the tongue.[18,19] Through the action of styloglossus and palatoglossal arch the distance between the root of tongue and soft palate reduces. In this circumstance, a high Mallampati class may be determined. The hyoglossus muscle depresses and retracts the tongue.[18,19] The over-development of this muscle contributes to the increase in the distance between the root of the tongue and uvula, and may lead to a decrease in Mallampati class. The genioglossus muscle works against the hyoglossus and styloglossus muscles, therefore increases the portion of the tongue out of the mouth. If the tip of tongue passes through the horizontal lines, this movement decreases the portion of the tongue in the mouth. Moreover, the Mallampati classification may decrease. The styloglossus and hyoglossus muscles, which are responsible for the up and down retraction of the tongue increase the portion of the tongue in the mouth, and this increase may lead to an increase in the Mallampati score due to the obstruction of the oropharyngeal visibility.[19]

Since most of the patients could not perform the lateral tongue movements properly, a long period of exercise of these movements may be essential. Specific neuromuscular strategies are required in these movements. The minority of the muscles functioning in lateral movements of the tongue may affect the results. During the lateral movements, the muscles of the tongue are flexed unilaterally and the muscles on the opposite of the flexed side should be extended. During the vertical movements, the muscles of the tongue are flexed bilaterally, so the vertical movements are more prominent. It was observed that it could not be standardized like the other movements. Also, the correlation coefficient was not statistically significant. In this study, we found that ETT and DTT movements significantly differs from the Mallampati classification, furthermore, these movements may be used instead of the Mallampati classification.[4,5]

There are several limitations of this study. First, the anatomic presentation of frenulum may affect the movements of the tongue. For instance, a long frenulum enables a wider range of motion for extrinsic and intrinsic muscles of the tongue, which in turn may facilitate monitorization of oropharyngeal structures. Second, evaluation of the size and contour of the tongue base would be beneficial.

In conclusion, a new alternative method to the Mallampati classification was presented by describing the movements of tongue. This new method can be combined with the Mallampati classification, which requests clinical experience and knowledge in predicting difficult intubation. In this preliminary study, we focused on the relation between the tongue movements and Mallampati score. Hence, more advanced studies correlated with tracheal intubation should be carried out.

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