External Predictors of Difficult Laryngoscopy and Airway. Are they Really Accurate? A Literature Review

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Received: July 18, 2019; **Published:** October 31, 2019

Abstract

Difficult airway is one of the most important adverse events in Anaesthesiology and Critical Care. Being able to anticipate its appearance is essential to improve results and reduce morbidity and mortality. A series of difficult airway predictors have been described, which are simple clinical tests performed during the physical examination of the patient. The results of these tests in the literature are very heterogeneous. Its low sensitivity stands out in the analysis of large series, which makes it worse screening tests than many anaesthesiologists believe. A complete physical examination, the combined use of several validated tests and the permanent preparation for the possible appearance of an unexpected difficult airway are recommended strategies.

Keywords: *Difficult Airway; External Predictor; Modified Mallampati Test; Thyromental Distance; Sternomental Distance; Mouth Opening; Upper Lip Bite Test; Wilson's Score; Sensitivity; Specificity*

Literature Review

The incidence of difficult airway has been, since the very beginning of Anaesthesiology, one of the complications related to the care of patients who have required anaesthesia, sedation, intensive care or resuscitation. It must be borne in mind that the difficult airway itself cannot be considered a disease, but it is rather the interaction between numerous factors of the environment among which stand out: the anatomical characteristics of the patient, the circumstances of the health care, the equipment available, and the doctor's experience [1]. It can be defined, therefore, as a clinical situation in which a trained anesthesiologist experiences difficulty in ventilating the patient with facial mask, in the visualization of the vocal cords (understood as a Cormack-Lehane score 3 or 4), in endotracheal intubation, in placing an effective supraglottic device, or for any of the listed ones [2].

There is a clear proof that the environment and the experience of health personnel greatly influence the prevalence of difficult airway: it has been shown that the prevalence of difficult airway is greater in prehospital environment than in hospital environment [3]. In the first situation, environment and pathologies are usually much more unforeseen and catastrophic when it is required to perform an advanced management of the airway, since it is not possible to guarantee standards such as the previous fasting period, a complete and calmed evaluation of the airway, a good positioning and preparation of the patient prior to intubation, or the availability of adequate material.

The maintenance of a safe and open airway is fundamental at all times, and when the patient loses consciousness, or is unable to perform effective ventilation on his own, the health care personnel should be in charge of achieving it. Only this way an adequate gas exchange can be ensured and unwanted substances (secretions, blood, gastric contents) can be prevented from reaching the bronchi and lungs. Without a patent airway, suffocation occurs in minutes, and death immediately after [2]. Therefore, the moment of anaesthetic induction is a critical step that must be prepared with the utmost meticulousness, and also the possible presence of difficult airway should be anticipated if it is feasible in order to choose the strategy to be followed and ensure the presence of necessary technical and human resources.

Today the Cormack-Lehane scale is accepted as standard of the difficulty of a direct laryngoscopy [4], which classifies the degree of visualization of the glottis in:

1. Full visualization of the vocal cords, including their anterior commissure.
2. Partial visualization of the vocal cords.
3. No visualization of the vocal cords, seeing only the epiglottis.
4. No visualization of glosso-epiglottic structures.

Due to the mechanics of tracheal intubation, the cases classified as Cormack 3 and 4 grades are considered as difficult laryngoscopy [2], since the introduction of the endotracheal tube under direct vision of its passage between the vocal chords cannot be seen. Other alternatives have been developed, such as the POGO scale (Percentage Of Glottic Opening) [5], but they have not reached pre-eminence in global clinical practice.

Since the definitions of difficult airway are not fully standardized and depend on the different authors, the prevalence depends on the definition chosen. Thus, the prevalence of difficult laryngoscopy (understood as a Cormack-Lehane score 3 or 4) can stay between 6 and 27% [6] or be 10.1% [7]. On the other hand, if the difficult airway is considered as three or more direct laryngoscopy attempts before inserting the endotracheal tube, the prevalence is 1.9%; or if it is considered as the inability to intubate under direct laryngoscopy, the prevalence is 0.1% [7].

Therefore, we can conclude that the advanced management of the airway includes a certain probability of facing the difficult airway (simplifying a lot, we could say that 1 in 10 endotracheal intubations could be presented as a difficult airway) [8] and that its early detection allows to prepare and diminish its potentially catastrophic consequences. To try to achieve this anticipation, a series of anatomical/corporal characteristics that can be identified with the naked eye in the patients before starting the anaesthetic induction have been described; a series of bedside tests have also been developed, so they can be performed easily, quickly, and without the need for additional specialized equipment, and usually known as external predictors of difficult airway.

The anatomical features that are considered most relevant are [2]:

1. Distance between the upper and lower incisors.
2. Length and position of the upper incisors.
3. Neck length.
4. Diameter of the neck.
5. Angle of flexion and extension of the neck.
6. Palate shape.
7. Flexibility of the tissue of the submandibular space.
8. Relationship between the upper and lower incisors during the bite (prognathism/retrognathism).

9. Relationship between superior and inferior initiates during voluntary protrusion of the jaw
10. Capacity of subluxation of the temporomandibular joint.
11. Visibility of the uvula.

Although it is not the subject of this review, we must remember that the concept of difficult ventilation with facial mask is also a difficult airway category. This concept is especially relevant because face mask ventilation is the rescue strategy in most of the difficult airway algorithms after an impossible or problematic airway instrumentation [9]. The risk factors for possible difficult ventilation with face mask are [10,11]:

1. Presence of beard (the only modifiable factor).
2. Body mass index > 26 kg/m^2.
3. Absence of teeth.
4. Age > 55 years.
5. History of snorer.
6. Mandibular protrusion capacity.

These anatomical characteristics have the disadvantage that they are evaluated in a relatively isolated way and, in many cases, subjectively. Seeking to unite the significance of several of these anatomical characteristics, as well as to standardize the results and allow their replication, the external predictors of difficult airway were born. The most commonly used are:

1. Modified Mallampati test.
2. Thyromental distance.
3. Sternomental distance.
4. Mouth opening.
5. Upper lip bite test.
6. Wilson's score.
7. Mandibulohyoid distance
8. Palm print test/prayer sign for diabetic patients
9. Adnet's Intubation difficulty scale
10. El-Ganzouri risk index
11. De Jong's MACOCHA score for ICU patients
12. LEMON airway assessment method
13. Biro's F.R.O.N.T. formula

The Mallampati test was published for the first time in 1985 [12]. This test classified the visibility of the oropharynx and the relationships of the different anatomical structures to each other when the patient performed the maximum voluntary opening of the mouth, together with the maximum protrusion of the tongue in the absence of phonation. The result is greatly influenced by the size of the tongue in relation to the oral cavity and can be used to estimate whether the tongue's displacement by the laryngoscope blade will be easy or difficult. This test does not take into account critical aspects when performing a laryngoscopy such as the mobility of the patient's neck, or the size of the mandibular space, and this may be the cause of its weaknesses as a predictive test. This classification was subsequently modified [13], adding the fourth class and giving rise to the modified Mallampati test, which is the one mostly used today. It is classified in the following grades:

1. Complete visualization of the uvula and tonsil pillars.
2. Partial visualization of the uvula (final part is covered behind the tongue) and the tonsil pillars, with complete visualization of the palate.
3. Complete visualization of the soft palate and nothing of the uvula or only of its base.
4. Visualization only of the hard palate (soft palate covered behind the tongue).

Thyromental distance (also known as the Patil test) is defined as the distance between the most anterior part of the jaw (the chin) and the most anterior and easily palpable area of the thyroid cartilage, measured in a straight line with the neck to the fullest extent. Therefore, it evaluates the width of the mandibular space and the facility to align the mouth-pharynx-glottis axis. In the original publication [14] it was reported that a thyromental distance of less than 6 cm indicated difficult laryngoscopy, while a distance greater than 6.5 cm predicted a good or acceptable laryngoscopic view of the glottis. However, many other authors [15,16] have chosen 6 cm or less to predict a bad laryngoscopy, and 7 cm or more to predict a good laryngoscopy. The exact point of cut in centimeters is not completely clear due to the different results of sensitivity and specificity that have been obtained in successive studies, but it is a very useful test to qualify patients in "probable poor laryngoscopy" (< 6 cm), "probable good laryngoscopy" (> 7 cm), and "gray area" (6 - 7 cm).

The sternomental distance is defined as the distance between the most anterior part of the jaw (the chin) and the most cranial part of the sternum (jugular notch or "jugulum sterni"), measured in a straight line with the neck in maximum extension. It shares a large part of the characteristics of the thyromental distance but gives more importance to the extension capacity of the neck and less to the mandibular space. In many cases, one or the other is chosen to be used, not both. A sternomental distance of less than 13 cm or 12.5 cm is considered as a predictor of difficult airway [17] or less than 12.5 cm [18]. The published results are variable, some giving better values of sensitivity and specificity to the thyromental distance, and others, on the contrary, to the sternomental distance [18].

Oral opening is defined as the maximum distance that can be achieved between the upper and lower incisors. This is a fundamental measure, since its magnitude will not only allow sufficient space to have a good view of the glottis, but also if it is too small it will prevent the use of difficult airway rescue devices, such as certain videolaryngoscopes or laryngeal masks, which can precipitate a catastrophic situation. There are authors who consider it a predictor of difficult airway when it is less than 2 cm [19], while others do it below 4 cm [20], being this classification more useful today in our opinion. In the absence of incisors, the distance is measured from the edge of the gum, and this may be why edentulous patients are known to be easier to intubate (despite being more difficult to ventilate).

The upper lip bite test [21] consists on asking the patient to bite with his lower incisors his upper lip, and three degrees are distinguished according to the result achieved:

1. The patient is capable of completely biting the upper lip, hiding the entire thickness of the labial mucosa behind the lower incisors.
2. The patient is capable of partially biting the upper lip, leaving part of the thickness of the labial mucosa visible above the upper edge of the lower incisors.
3. The patient is not capable of biting the upper lip.

It is a test that evaluates mainly the protrusion (or subluxation) capacity of the jaw, as well as the relation of space between the incisors; both are fundamental factors to achieve direct vision of the glottis during direct laryngoscopy.

Wilson score [22] is a classification system based on 5 factors considered predictors of difficult airway after the analysis of 1500 intubated patients. They are: weight, mobility of head and neck, mandibular movement, mandibular retraction, very large and extruded teeth. Each of these factors can be worth 0, 1 or 2 points depending on the severity of their alteration (maximum score of 10) and it is considered that a score of 3 or more predicts a 75% probability of difficulty in intubation.

The heterogeneity in published results is a constant when dealing with this topic. However, in 2018 the largest meta-analysis to date was published, under the seal of the Cochrane Library [8]. It analyzed 133 studies on external predictors of difficult airway (126 cohort studies and 6 case-control type studies), including a total of 844,206 patients. The predictors included in the meta-analysis were those previously mentioned, as well as any combination of them. After the corresponding evaluation of biases (which were considered scarce), the results that were obtained were the following:

- Prevalence of difficult laryngoscopy 11% (6 - 19%), difficult tracheal intubation 13% (5 - 16%), difficult ventilation with facial mask 6% (5 - 25%), and failed intubation 0.6% (0.3 - 0.9%).

  Predicting difficult laryngoscopy, the different tests obtained:

- For the modified Mallampati test (80 studies with 232,939 patients), a sensitivity of 0.53 (95% confidence interval 0.47 - 0.59) and a specificity of 0.80 (95% confidence interval 0.74 - 0.85).
- For the Wilson score (5 studies with 5862 patients), a sensitivity of 0.51 (95% confidence interval 0.40 - 0.61) and a specificity of 0.95 (95% confidence interval 0.88 - 0.98).
- For the thyromental distance (42 studies with 33,189 patients), a sensitivity of 0.37 (95% confidence interval 0.28 - 0.47), and a specificity of 0.89 (95% confidence interval 0.84 - 0.93).
- For the sternomental distance (16 studies with 12,211 patients), a sensitivity of 0.33 (95% confidence interval 0.16 - 0.56) and a specificity of 0.92 (95% confidence interval 0.86 - 0.96).
- For the mouth opening test (24 studies including 22,179 patients), a sensitivity of 0.22 (95% confidence interval 0.13 - 0.33) and a specificity of 0.94 (95% confidence interval 0.90 - 0.97).
- For the upper lip bite test (27 studies with 19,609 patients), a sensitivity of 0.67 (95% confidence interval 0.45 - 0.83), and a specificity of 0.92 (95% confidence interval 0.86 - 0.95).

These results can be summarized. The upper lip bite test has the highest sensitivity, the modified Mallampati test has greater sensitivity than the thyromental distance or the oral opening test and the mouth opening test has the highest specificity. However, the authors conclude that these predictors present, in general, very low sensitivity to be good screening tests (which is what they were designed for, that is, to detect difficult airways), along with a high variability in its results; interestingly, in general they possess a good specificity (they detect well the normal airways as such).

Conclusion

As we can see after a thorough literature review, there is no definitive consensus on what predictor or combination of them should be used in each situation, and it is likely that there will not be in the near future. This is due to the heterogeneity of the results obtained in the different studies. However, we can draw a series of clear conclusions:

1. A careful physical examination of the patient from the clinical experience in the management of the airway will always be necessary.
2. A combination of several validated difficult airway predictors will probably always be superior to the use of one of them separately, since each one affects different aspects of the airway.
3. The largest systematic review done to date shows that these predictors of difficult airway are not as sensitive as we would like, and we must always be prepared to handle an unexpected difficult airway.

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Volume 5 Issue 11 November 2019