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REVIEW

Preoperative assessment of the airway

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SUMMARY

Failure to secure a patient's airway can cause severe and long-lasting consequences, including death. Indeed, failed airway management is a leading cause of legal claims in the field of anesthesiology. Anticipating and preparing for difficulty in airway management is crucial to avoiding airway catastrophes. Many of the traditional methods for predicting a difficult airway have low sensitivity and specificity, but prediction models and adjuncts to traditional methods of airway evaluation are being researched extensively. This article reviews airway assessment approaches, including the use of newer airway assessment models and imaging, and emphasizes the need for involvement of multiple disciplines to improve airway safety.

1. Introduction

The definition of a difficult airway varies greatly in the literature. The American Society of Anesthesiology's (ASA) Difficult Airway Guidelines define a difficult airway as one in which "a conventionally trained anesthesiologist experiences difficulty with facemask ventilation of the upper airway, difficulty with tracheal intubation, or both".[1] Failed airway management can lead to rapid deterioration of oxygenation and ventilation and devastating consequences such as brain injury and death. The ASA Closed Claims database revealed that airway events account for 34% of all claims and that difficult intubation has been the most common damaging event in anesthesia claims since the 1990s.[2,3] Adequate preoperative airway planning, including specific techniques and equipment tailored to each specific patient, can play an important role in decreasing the risks associated with difficult airway management. A thorough review of the patient's medical history, comorbid conditions, and prior anesthetics is imperative for creating an airway-management plan. Specific airway assessment tools, especially when used in combination, can help in predicting difficult airway anatomy. In addition, especially in non-emergent situations, the use of imaging studies such as endoscopy and bedside ultrasound may improve the efficacy of existing prediction tools.

2. Predictors of difficult airway

2.1. Bedside airway assessment

When possible, anesthesia providers should perform a targeted history and physical examination of patients preoperatively. Anesthesia records should be reviewed, prior difficult airway should be noted as a risk factor,[4] and, if available, techniques used for previous airway management should be reviewed. Close attention should be paid to medical diagnoses, including laryngeal and mediastinal pathologies, as well as other diagnoses that have been associated with the difficult airway (Table 1).[5] In addition, several specific tests have been recommended to help predict difficult intubation (Table 2).

2.1.1. Overall appearance

The patient should then be assessed for physical signs of difficult mask ventilation and intubation. The assessment should begin with a look at the patient's general appearance. Any abnormal head and neck appearance, including masses, evidence of trauma such as lacerations, fractures and bleeding, or presence of a cervical collar should be noted and may alert the provider to possible difficulty.

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Table 1
Disease states associated with difficult airway management.

Congenital	Acquired
Pierre–Robin syndrome	Morbid obesity
Treacher–Collins syndrome	Acromegaly
Goldenhar's syndrome	Infections involving the airway (Ludwig's Angina)
Mucopolysaccharidoses	Rheumatoid arthritis
Achondroplasia	Ankylosing spondylitis
Micrognathia	Tumors involving the airway
Down's syndrome	Trauma (airway, cervical spine)

Table 2
Predictors of difficult intubation.

Risk factor	References
Mallampati class	Tse,[16] Arne,[4] Naguib,[8] Iohom,[17] El-Ganzouri,[12] Langeron[15]
Head and neck movement	Tse,[16] Wilson,[7] Arne[4]
Mouth opening	Wilson,[7] Karkouti,[18] Langeron[15]
Thyromental distance	Tse,[16] Arne,[4] Naguib,[8] Iohom,[17] Langeron[15]
Sternomental distance	Iohom[17]
Upper lip bite test	Khan[19]
Prominent "buck" teeth	Wilson,[7] Naguib[8]
Inter-incisor distance	Arne[4]
Mandible luxation	Arne[4]

2.1.2. Mouth opening

The extent of mouth opening can be used to estimate ease of access to the larynx as well as mobility of the temporomandibular joint. A mouth opening of ≤4 cm has been identified as a risk factor for difficult intubation.[6] Examination of the mouth also allows for assessment of dentition. Dentures or loose teeth may be at risk for dislodgement during intubation. Prominent teeth may make placement of laryngoscope blades for direct laryngoscopy more challenging.[7,8]

2.1.3. Mallampati class

Subsequently, the size of the tongue relative to the pharyngeal space should be examined. This exam focuses on both mouth opening and the visibility of the pharyngeal space.[9] In his first description of the exam, Dr. Mallampati designated three classes for visualization of the uvula, tonsillar pillars, and palate. Samsoon and Young added a fourth class and linked higher Mallampati scores (III and IV) to higher (more difficult) Cormack–Lehane grades of laryngoscopy and difficult intubation (Fig. 1).[9,10] The four classes as they are now used are as follows:

Class I: Soft palate, uvula, fauces, and tonsillar pillars are visible.
Class II: Soft palate, uvula, and fauces are visible.
Class III: Soft palate and base of uvula are visible.
Class IV: Hard palate is visible.

A meta-analysis of the predictability of the Mallampati tests shows a good discriminatory power of the modified Mallampati score for difficult direct laryngoscopy (ROC 0.89 ± 0.05) and intubation (0.83 ± 0.03) but poor power for predicting difficult ventilation.[11]

2.1.4. Thyromental distance

Thyromental distance is the distance between the chin and the thyroid cartilage (measured in finger breadths or cm). This exam can be used to assess mandibular space and compliance and to predict the ease of tongue displacement during direct laryngoscopy. Patients with micrognathia (abnormally small mandible) or retrognathia (abnormally posterior mandible relative to other facial structures) will be expected to have short thyromental distances. Measurements less than 6 cm, especially coupled with higher Mallampati classes, have been associated with higher odds of difficult intubation.[12]

2.1.5. Neck range of motion

Good neck mobility with normal flexion and extension allows the anesthesia provider to manipulate the neck and enhance view on direct laryngoscopy. The extent of neck mobility, evidence of prior neck surgery, and pain and/or neurologic symptoms upon movement should be assessed. A retrospective review of >14,000 patients identified decreased cervical spine motion as an independent risk factor for difficult mask ventilation, direct laryngoscopy, and intubation.[13]

2.1.6. Combining prediction assessments

These physical exam findings and a myriad of others have poor predictive values when used alone. A meta-analysis published by Shiga et al.[14] confirmed that individual findings lack good discriminatory power but suggested that prediction is improved when findings are used in combination. Efforts have been made to develop prediction tools that use different combinations of the airway exam. Wilson et al.[7] developed a risk score using five risk factors (weight, head and neck movement, jaw movement, receding mandible, buck teeth) that had reasonable sensitivity but also high false-positive values. El-Ganzouri et al.[12] studied over 10,000 patients and identified seven risk factors for difficult intubation (mouth opening, thyromental distance, Mallampati class, neck movement, inability to extend the lower jaw, body weight,

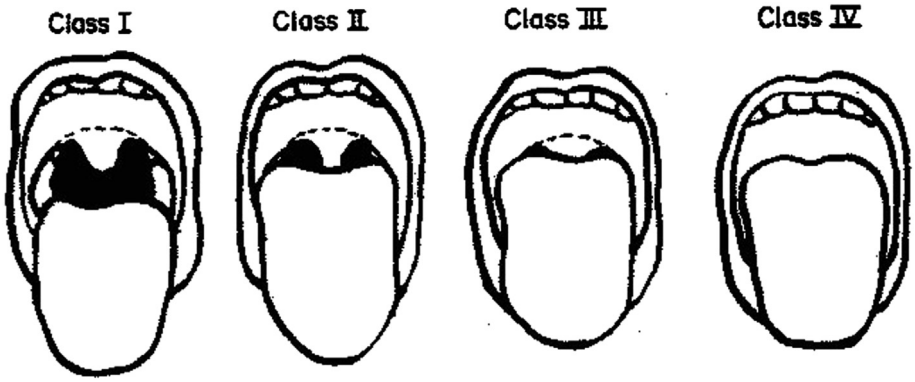

Fig. 1. Mallampati classes.