Airway Assessment

This handout contains a written transcription of the narration in the online presentation (video). Please review the online presentation for additional material including interactive multimedia content, audio, and practice quizzes.

Case Study

Today, you're precepting Morgan, a junior student on her first day in the operating room. She shadows you as you conduct a thorough airway assessment on your next patient. Based on the findings of the exam, you ask the student to make sure there's a video laryngoscope in the room and that the difficult airway cart is nearby. The student is awestruck by your ability to predict a potential catastrophe before it arises, and she has many questions for you.

Why do we measure what we measure? What does an abnormal finding tell us? How will we modify the anesthetic plan based on the findings we obtain? In this objective, we're going to review the how's and why's of a thorough airway assessment and then follow with 5 questions that we must ask ourselves before anesthetizing any patient.

Preoperative Airway Assessment

Arguably, maintenance of oxygenation and ventilation is the most essential task in the provision of anesthetic services. Complications of airway management remain a common cause (in some studies, the most common cause) of morbidity and mortality attributable to anesthesia. Successful management requires planning, and a well-constructed plan is predicated on a thorough and systematic airway assessment. This assessment should be performed on all patients regardless of whether they're scheduled for general anesthesia, regional anesthesia, or even sedation.

Taking A History Of The Airway

Patients should be questioned about previous anesthetics and surgical procedures. Although it may not be possible in all cases, reviewing the previous anesthetic record (if one exists) will provide valuable information. This step is critical in the patient who discloses a history of difficult airway management.

Performing a full review of systems is also an essential part of the preoperative assessment, as some co-morbidities will greatly influence the airway plan. For example, a patient with COPD, asthma, or pneumonia may likely have baseline issues with oxygenation and ventilation. Similarly, cardiovascular disease, diabetes, certain medications, or a history of anaphylaxis necessitate consideration, as they may directly or indirectly influence airway management. Finally, asking the patient when he last ate or drank will help you determine if an elective case should be delayed or if aspiration prophylaxis is indicated for an emergent procedure.

Components Of Airway Examination

Before we discuss the components of airway assessment, we'd like to point out that many of these tests are classically used to predict the difficulty of direct vision laryngoscopy. Some authors suggest that the widespread adoption of video laryngoscopy and other indirect methods reduce the clinical value of some of these exams. Nevertheless, a thorough airway examination is the standard of care and must be performed on all our patients.

A complete airway assessment begins by looking at the patient's facial and body architecture. Body habitus (such as obesity, frailty, neck, and jaw structure), facial hair, sores, swelling, or tumor is likely to impact the planned approach to airway management. Other components of a thorough airway exam include assessment of mouth opening, dentition, oropharyngeal space, mandibular protrusion, neck mobility, and submandibular space. Click each test to learn more.

Mallampati Classification

The Mallampati test assesses the volume of the tongue relative to the volume of the oropharynx, where most sources list a class 3 or 4 as an independent predictor of difficult mask ventilation, difficult laryngoscopy, as well as the presence of sleep apnea.

Given the volume of studies, reviews, case reports, published technical reports, and books devoted to airway management, it should come as little surprise that the 1985 publication by Mallampati *et al*. (which included 7 authors, one of which was a CRNA) is perhaps the most cited paper in the entire body of the anesthesia literature. While this falls outside of the "latest evidence," there continue to be misconceptions about the Mallampati classification, and so we're going to take a critical look at this paper as well as subsequent investigations that provide additional context to Mallampati's work.

Difficulties in airway management have long plagued anesthesia providers, and Mallampati proposed the need for a simple sign that might predict difficulty in achieving tracheal intubation. He hypothesized that a disproportionately large tongue would block the view of the larynx obtained by direct laryngoscopy. He devised a standardized airway exam that included asking the patient to assume the seated position with his head in the neutral position, to open his mouth as wide as possible, and to protrude his tongue maximally. Notably, the patient was not asked to phonate, and the exam was performed before sedative premedications were administered. Each patient received a score (from 1 to 3) based on the structures observed.

- Class 1: Faucial pillars, soft palate & uvula visualized
- Class 2: Faucial pillars & soft palate visualized, uvula not seen
- Class 3: Only soft palate visualized

The researchers concluded that (in most cases) laryngeal visualization would not be difficult if the faucial pillars and uvula could be visualized during airway assessment. They went on to say that, if these structures are obscured by the base of the tongue and only the soft palate is visible, one should anticipate difficult endotracheal intubation. Today, most clinicians use the Samsoon and Young modification of the Mallampati scoring system, which includes a 4th classification as well as slightly different definitions for each class.

- Class 1: Soft palate, fauces, uvula, and pillars
- Class 2: Soft palate, fauces, and uvula
- Class 3: Soft palate and base of uvula
- Class 4: Soft palate not visible

It should come as no surprise that these differences have been a source of confusion in the anesthesia literature and textbooks, and so we highlight these minor differences in the spirit of maintaining historical accuracy.

How have Mallampati's findings held up over time? In 2006, a systematic review involving over 34,000 patients using either the original or modified Mallampati score found that, when used alone, these tests had limited accuracy for predicting the difficult airway and went so far as to say that these tests "are not useful screening tests". The authors also noted a poor predictive value for identifying difficult mask ventilation.

In 2011, a carefully performed meta-analysis involving over 177,000 patients revealed that the modified Mallampati score was inadequate as a stand-alone test of difficult laryngoscopy or tracheal intubation. The authors did advocate that the Mallampati score should be included as part of a multidimensional approach for predicting difficult tracheal intubation.

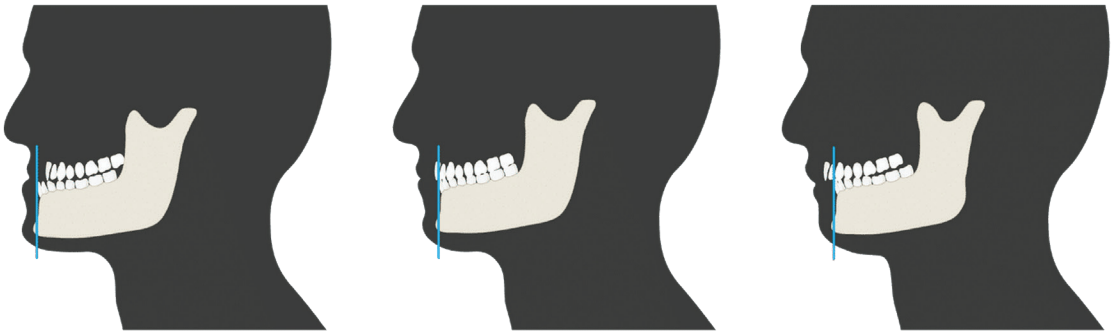
Given the complexity of the human airway, its multiple variants, and factors that may influence successful intubation, it should not be of great surprise that a single test, such as the Mallampati classification, lacks predictability. There may be further deterioration of its value when it's performed in a manner not adhering precisely to that described in Mallampati's paper. Common errors include asking the patient to phonate, performing the exam after the patient is

sedated, or examining the airway when the patient is supine or in the semi-sitting position. Having said this, there's literature that challenges these so-called "errors," thus highlighting the need for consensus on how to best perform the Mallampati exam.

Mandibular Protrusion Test

The mandibular protrusion test assesses the function of the temporomandibular joint, where poor function may reflect a reduction in submandibular volume and/or compliance thereby limiting tongue displacement during laryngoscopy. The patient is asked to sublux the jaw, and the position of the lower incisors (LI) is compared to the position of the upper incisors (UI).

- Class 1: Patient can move LI past UI
- Class 2: Patient can move LI in line with UI
- Class 3: Patient cannot move LI past UI (this suggests and increased risk of difficult intubation)



Class 1 Class 2 Class 3

Inter-Incisor Gap

"Open wide..." Having a look into the oral cavity allows us to gauge the extent to which the patient can open his mouth, as this affects your ability to align the oral, pharyngeal, and laryngeal axes. Additionally, placing a device in the mouth requires a minimum mouth opening. The mouth opening should minimally measure 3 – 4.5 cm (about 2 – 3 fingerbreadths). Conditions such as arthritis, scar tissue, temporomandibular joint disease, prior surgery, etc. may restrict mouth opening and should be identified early in the process of rendering patient care.

Dentition

The patient with poor or unusual dentition can pose significant challenges. Prominent incisors or a high, arched palate are associated with difficult laryngoscopy. Assessment of dental status includes identifying the presence of crowns, caps, implants, cosmetic alterations, braces, and loose or missing teeth. In addition to the medicolegal implications of dental damage, anything dislodged during airway management could be aspirated into the patient's lower airway.

Dentures may be left in place or removed at the provider's discretion. Although they're commonly removed, dentures provide structural support to the face during mask ventilation. Some providers will use this to their advantage and remove the dentures just before intubation. When performing MAC anesthesia, the presence of dentures can help maintain a patent airway.

Thyromental Distance

To expose the glottic opening during laryngoscopy, you must displace the tongue into the submandibular space. If this space is small or poorly compliant (due to tumor, radiation, or Ludwig's angina), then you may not be able to move the tongue enough to expose the glottis.

The thyromental distance helps us estimate the size of the submandibular space. With the neck extended and mouth closed, you can measure the distance from the tip of the thyroid cartilage to the tip of the mentum. Laryngoscopy may be more difficult if the TMD is less than 6 cm (or 3 fingerbreadths) or if it is greater than 9 cm. A short thyromental

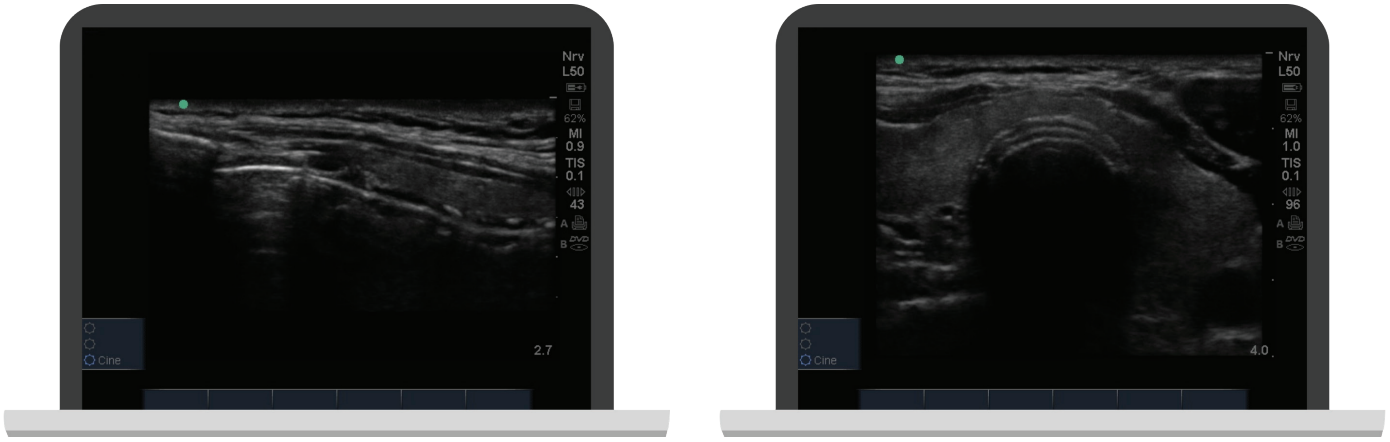
distance might indicate mandibular hypoplasia and a small submandibular space. A large distance can also be problematic. In this situation, the larynx assumes a more caudal position. Because the tongue is fixed at the hyoid bone, the tongue moves caudally as well. These changes shift the glottic opening beyond the line of site, increasing the difficulty of laryngoscopy.

Cervical Spine

The "sniffing position" consisting of cervical flexion and atlanto-occipital extension is generally regarded as the best position for direct laryngoscopy. Assessing the sternomental distance helps us assess head and neck mobility at the bedside, where a distance less than 12 cm suggests greater difficulty with tracheal intubation. Co-morbidities that impair cervical spine integrity include degenerative joint disease, rheumatoid arthritis, ankylosing spondylitis, trauma, surgical fixation, Klippel-Feil syndrome, and Down syndrome.

Ultrasound

Point of care ultrasound is now widely available, and in select cases, ultrasound imaging of the airway may reveal vital information that uniquely informs airway management. This technology has been used to identify the cricothyroid membrane, rule out esophageal intubation, and verify tracheal placement of the endotracheal tube when carbon dioxide detection fails. Additionally, ultrasound provides useful information in the patient with a tumor, mass, swelling, or unusual or distorted anatomy that might impact airway management.



Cormack and Lehane Glottic Assessment

While not a component of the preoperative airway assessment, we want to briefly discuss the Cormack and Lehane glottic assessment. This helps us communicate the view we obtain during direct vision laryngoscopy. Take a moment to review the definition of each classification and note that we've included the modified version of this assessment.

Class 1	Class 2A	Class 2B	Class 3	Class 4
Complete view of glottic opening	Posterior view of glottic opening	Corniculate cartilages and posterior vocal cords	Epiglottis only	Soft palate only

Questions To Ask When Developing The Airway Plan

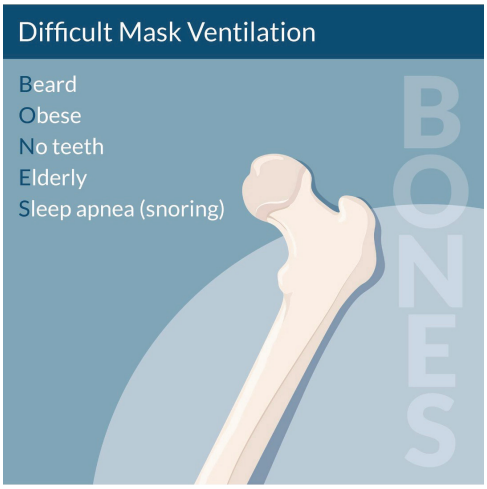
Let's apply what we've learned to clinical practice with five questions we should ask before anesthetizing any patient.

1. Will it be difficult to mask ventilate?
2. Will it be difficult to intubate?
3. Will it be difficult to place a supraglottic airway device?
4. Will it be difficult to perform a surgical airway?
5. How fast must I secure the airway?

Will It Be Difficult To Mask Ventilate?

A large number of case reports, retrospective studies, prospective studies, and closed claims analysis demonstrate the following commonly encountered risk factors for difficult mask ventilation:

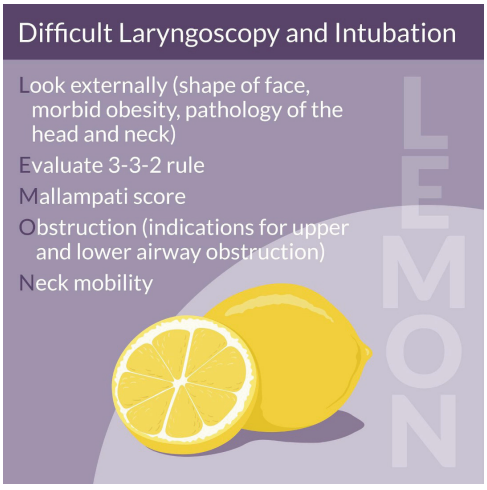
- Age > 55 years
- BMI >26
- Presence of a beard
- Edentulousness
- History of sleep apnea
- Male gender
- Short thyromental distance
- Very limited mandibular protrusion
- Mallampati class 3 or 4



Will It Be Difficult To Intubate?

A large number of case reports, retrospective studies, prospective studies, and closed claims analysis demonstrate the following commonly encountered risk factors for intubation:

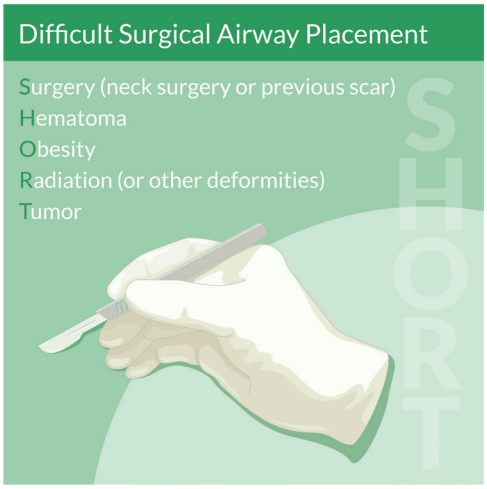
- History of previous difficult intubation
- Small or limited mouth opening (< 3 – 4.5 cm)
- Mallampati class 3 or 4
- Short thyromental distance (< 6 cm)
- Short sternomental distance < 12 cm)
- Limited atlanto-occipital extension (< 35°)
- Limited mandibular protrusion (class 3)
- Thick neck



Will It Be Difficult To Place A Supraglottic Airway?

Insertion of a supraglottic airway (SGA) is a blind procedure and success is highly dependent on selecting the correct size for the patient as well as practitioner experience and skill. A variety of supraglottic airways are available, where each has its own profile that can uniquely contribute to difficult or failed placement. As you can imagine, this makes it difficult to generalize across supraglottic airway devices. Having said this, there is a large body of literature that reveals the following factors that may be predictive of difficult supraglottic airway device placement:

- Small or limited mouth opening
- Neck radiation or scar tissue
- Tonsillar hypertrophy
- Cervical spine flexion deformity
- Concurrent use of cricoid pressure
- Obesity
- Poor dentition/large incisors
- Male gender

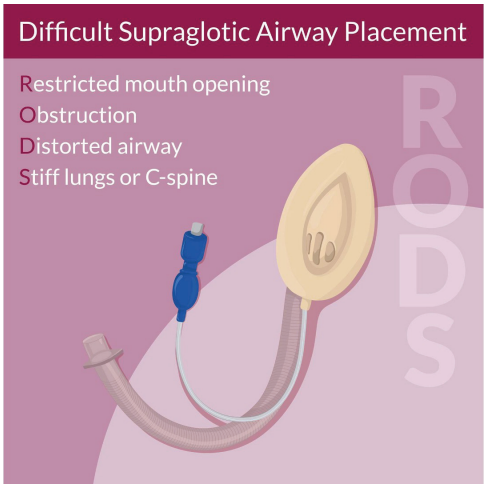


Additionally, other factors that can complicate ventilation after placement include poor lung compliance, increased airway resistance, or lower airway obstruction.

Will It Be Difficult To Perform A Surgical Airway?

Risk factors for difficult surgical airway placement include:

- Abnormal neck anatomy (tumor, hematoma, abscess, history of radiation)
- Obesity (difficult to identify the cricothyroid membrane)
- Short neck (difficult to identify the cricothyroid membrane)
- Laryngeal trauma
- Limited access to cricothyroid membrane (halo, neck flexion deformity)



How Fast Must We Secure The Airway?

The last question we must consider is how fast must I secure the airway? Said another way, does the patient require rapid sequence intubation? The current Practice Guidelines for Preoperative Fasting and Use of Pharmacologic Agents to Reduce the Risk of Pulmonary Aspiration recommendations are as follows:

- 2 hours = Clear liquids
- 4 hours = Breast milk
- 6 hours = Nonhuman milk, infant formula, solid food
- 8 hours = Fried or fatty foods

Are clear liquids before surgery beneficial? Yes- ingestion of clear liquids 2 hours before surgery reduces gastric volume and increases gastric pH.

How does chewing gum fit in? A recent meta-analysis found that chewing gum increased gastric volume without a change in gastric pH. The authors suggest that elective surgery should not be delayed or canceled in the patient who chews gum preoperatively. If the patient swallowed gum, many providers elect to treat it as solid food intake and delay surgery for 6 hours.

Rapid Sequence Intubation

If the patient has a full stomach or other risk factors for aspiration, then a rapid sequence induction is indicated. The patient is not ventilated, and the esophagus is compressed by applying pressure to the cricoid ring. Pressure is applied before the patient loses consciousness and maintained until tracheal intubation is confirmed.

- Pressure before LOC = 20 Newtons or ~ 2 kg
- Pressure after LOC = 40 Newtons or ~ 4 kg

We'd like to point out that the merits of cricoid pressure continue to be debated, and we'll explore this controversy in greater detail later in this module.

Key Points for Your Practice

Here are some key points for your practice:

- The preoperative airway assessment is vital to informing and determining the best approach to the airway management of a given patient.
- Combining tests of airway assessment is more likely to accurately predict difficult intubation. Even so, there is no 100% reliable airway assessment tool (or group of tools), and we will encounter unrecognized difficult airways despite our best efforts.
- Before anesthetizing any patient, we must consider the findings of the airway assessment and use them to anticipate the level of difficulty with mask ventilation, intubation, supraglottic airway placement, and creation of a surgical airway.
- As the tools of airway management evolve, new techniques of airway assessment will emerge to better inform all practitioners of airway management.