

# Chapter 2

## Evaluation of the Airway

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## Introduction

The safety of anesthesia is predicated on anticipating difficulties in advance instead of reacting to them when they occur. Of course, we do not always have the luxury of time when dealing with unconscious patients. The manner in which we handle the airway is central to the safety of anesthesia because most of the serious problems we encounter in anesthesia usually have an airway component.

What exactly is a “difficult airway”? To many of us a “difficult airway” is one that we cannot tracheally intubate. In reality, a truly difficult airway is one that prevents us from delivering that vital gas, oxygen, to the lungs. So before we even think about difficulties placing an endotracheal tube in the airway, we must ask a more fundamental question. “Will I be able to maintain this patient’s airway when he is unconscious and if not can I at least maintain oxygenation?” A thorough evaluation of the airway allows us to estimate that risk in the vast majority of patients, but not all. For example, a patient may have a perfectly normal anatomical airway by assessment and still be very difficult to oxygenate and ventilate because of severe bronchospasm or an undetected foreign body in the airway. Fortunately, these situations are rare, but if they do occur we should be able to make the diagnosis promptly and institute therapy immediately. Therefore, our whole philosophy about airway assessment must change. Before we even render a patient unconscious, we must ask ourselves the following four questions:

1. Will I be able to oxygenate/ventilate this patient using a mask?
2. Will I be able to place a supraglottic device in this patient if required?
3. Will I be able to tracheally intubate this patient should the need arise?
4. Do I have access to this patient’s trachea if a surgical airway is required?

The only way we can accurately answer these questions is if we do a thorough assessment of the airway. Even in a dire emergency, we should be able to answer these questions. Fortunately, we will have time to do a proper assessment in most of the cases. Despite the importance of this task, we do not do this very well in many cases and in this text we are appealing to those responsible for airway management to spend more time, not just evaluating the airway, but also recording the findings because quite often in modern practice the person performing the evaluation is not the person assigned to perform the procedure. This unavoidable arrangement results in less careful scrutiny of the airway during the initial evaluation because there is less accountability. We also appreciate that not all airway emergencies involve anesthesia.

Three mechanisms of injury account for most serious airway complications: esophageal intubation, failure to ventilate, and difficult intubation – with difficult intubation playing a role in all three.<sup>1</sup> The vast majority of difficult intubations (98% or more) may be anticipated by performing a thorough evaluation of the airway in advance.<sup>2,3</sup> Nevertheless, many clinicians pay little attention to this important task and confine their examination of the airway to a cursory examination of the mouth and teeth. The information in this chapter will allow you to anticipate with a reasonable degree of accuracy when airway management may be difficult.

## The Normal/Abnormal Airway

There are a number of wide-ranging characteristics and measurements in adults that constitute a “normal airway” (Box 2.1). When patients with these features present for airway management, problems do not usually occur. There are also a number of features that make up the “difficult airway” (Box 2.2), and when patients with these characteristics present for airway management, problems frequently occur.

## Predictive Tests for Difficult Intubation

Anesthesiologists are constantly seeking ways to develop a foolproof system for predicting difficult intubation. The Mallampati test has undeserved status as a reliable predictor of difficult intubation. In reality, a Mallampati class III airway only has a positive predictive value of 21% for laryngoscopy grades 3 and 4 combined, and only 4.7% for laryngoscopy grade 4 alone. Therefore, if we relied solely on this test to predict difficult intubation, we would be performing a considerable number of unnecessary

### **Box 2.1** Factors Characterizing the Normal Airway in Adolescents and Adults

1. History of one or more easy intubations without sequelae
2. Normal appearing face with “regular” features
3. Normal clear voice
4. Absence of scars, burns, swelling, infection, tumor, or hematoma; no history of radiation therapy to head or neck
5. Ability to lie supine asymptotically; no history of snoring or sleep apnea
6. Patent nares
7. Ability to open the mouth widely (minimum of 4 cm or three fingers held vertically in the mouth) with good TMJ function
8. Mallampati/Samsoon class I (i.e., with patient sitting up straight, opening mouth as wide as possible, with protruding tongue; the uvula, posterior pharyngeal wall, entire tonsillar pillars, and fauces can be seen)
9. At least 6.5 cm (three finger-breadths) from tip of mandible to thyroid notch with neck extended
10. At least 9 cm from symphysis of mandible to mandibular angle
11. Slender supple neck without masses; full range of neck motion
12. Larynx movable with swallowing and manually movable laterally (about 1.5 cm on each side)
13. Slender to moderate body build
14. Ability to maximally extend the atlantooccipital joint (normal extension is 35°)
15. Airway appears normal in profile

**Box 2.2** Signs Indicative of an Abnormal Airway

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1. Trauma, deformity; burns, radiation therapy, infection, swelling; hematoma of the face, mouth, pharynx, larynx, and/or neck
2. Stridor or “air hunger”
3. Hoarseness or “underwater” voice
4. Intolerance of the supine position
5. Mandibular abnormality:
  - (a) Decreased mobility or inability to open the mouth at least three finger-breadths
  - (b) Micrognathia, receding chin:
    - (i) Treacher Collins, Pierre Robin, other syndromes
    - (ii) Less than 6 cm (three finger-breadths) from tip of the mandible to thyroid notch with neck in full extension (adolescents and adults)
  - (c) Less than 9 cm from angle of the jaw to symphysis
  - (d) Increased anterior or posterior mandibular depth
6. Laryngeal abnormalities: fixation of the larynx to other structures of neck, hyoid, or floor of mouth
7. Macroglossia
8. Deep, narrow, high-arched oropharynx
9. Protruding teeth
10. Mallampati/Samsoon classes III and IV (see Figs. 5.6 and 5.7); inability to visualize the posterior oropharyngeal structures (tonsillar fossae, pillars, uvula) on voluntary protrusion of the tongue with mouth wide open and the patient seated
11. Neck abnormalities:
  - (a) Short and thick
  - (b) Decreased range of motion (arthritis, spondylitis, disk disease)
  - (c) Fracture (possibility of subluxation)
  - (d) Obvious trauma
12. Thoracoabdominal abnormalities:
  - (a) Kyphoscoliosis
  - (b) Prominent chest or large breasts
  - (c) Morbid obesity
  - (d) Term or near-term pregnancy
13. Age between 40 and 59 years
14. Gender (male)
15. Snoring and sleep apnea syndrome

awake intubations. It may seem unreasonable to single out this one test; however, in reality anesthesiologists have given enormous credence to this test. The truth, of course, is that most of the other tests we use for this purpose are equally disappointing when positive predictive value is measured, with the exception of a history of difficult intubation.

How reliable is our predictability if we use a combination of tests? Common sense tells us that if we use more than one test to predict difficult intubation, our chances of predicting difficulty increase. However, one of the problems noted is that there is very poor interobservational reliability for many of the tests that we commonly use to predict difficult intubation. A paper by El-Ganzouri et al.<sup>4</sup> demonstrated increased accuracy predicting difficult intubation when one used objective airway risk criteria. They prospectively studied 10,507 patients presenting for intubation under general anesthesia.

Risk factors for difficult intubation include the following:

- Mouth opening less than 4 cm
- Thyromental distance less than 6 cm
- Mallampati Class III or higher
- Neck movement less than 80%
- Inability to advance the mandible (prognathism)
- Body weight greater than 110 kg
- Positive history of difficult intubation

Following induction of anesthesia, the laryngeal view at laryngoscopy was graded. Poor intubating conditions were noted in 107 cases (1%). Logistic regression identified all seven criteria as *independent* predictors of difficulty. A composite airway risk index, as well as a simplified risk weighting system, revealed a higher predictive value for grade 4 laryngoscopy (Table 2.1). While it may be impractical to perform these calculations on all cases, they certainly have potential for the future. The real message here is that multiple abnormal tests predicting difficult intubation are better than any single test.

**Table 2.1** Reliability of risk factors in predicting difficult intubation

Risk factor	LG	Sensitivity (%)	Specificity (%)
Mouth opening <4 cm	≥III	26.3	94.8
	IV	46.7	93.9
Thyromental distance <6.0 cm	≥III	7.0	99.2
	IV	16.8	99.0
Mallampati class III	≥III	44.7	89.0
	IV	59.8	87.4
Neck movement <80°	≥III	10.4	98.4
	IV	16.8	97.9
Inability to prognath	≥III	16.5	95.8
	IV	26.2	95.3
Body weight >110 kg	≥III	11.1	94.6
	IV	13.1	94.3
Positive history of difficult intubation	≥III	4.5	99.8
	IV	9.3	99.7

Source: Data from El-Ganzouri<sup>4</sup> LG = Laryngoscopy grade (see figures 2.2 and 2.8)

## Elective Intubation

Most elective intubations are performed by anesthesiologists or anesthesiologists on patients presenting for elective surgery. Occasionally, patients will be tracheally intubated on an elective basis on the ward. In all elective intubations, an assessment of the patient's overall medical status is advised.

The technique of endotracheal intubation depends heavily on the ability to manipulate the cervical spine, the atlantooccipital joint, the mandible, oral soft tissues, neck, and hyoid bone. Therefore, any disease, congenital or acquired, that interferes with the mobility of these structures can create difficulties that prevent one from seeing the larynx during direct laryngoscopy. The same factors apply to successful nasal intubation, but in addition, patency of the nasal passages is required. It should also be remembered that the ability to see the larynx does not always ensure a successful intubation. Occasionally, abnormal dentition or obstruction by other, more proximal, structures may impair one's ability to place an endotracheal tube between the vocal cords. Unrecognized pathology in the vicinity of the larynx may impede the passage of an endotracheal tube large enough to allow adequate ventilation. This background information should be kept in mind when evaluating patients for tracheal intubation.

### *History Pertinent to Elective Airway Management*

Patients should be specifically questioned about:

- Previous airway interventions (review old records whenever possible)
- Dental problems (bridges, caps, fillings, appliances, loose teeth)
- Respiratory disease (snoring, sleep apnea syndrome, smoking, coughing, sputum production, and wheezing)
- Arthritis (temporomandibular joint [TMJ] disease, ankylosing spondylitis, osteoarthritis, and rheumatoid arthritis)
- Clotting abnormalities (especially before nasal intubation)
- A history of gastroesophageal reflux disease (GERD)
- Congenital abnormalities and syndromes (especially those involving the head, face, and neck)
- Type I diabetes mellitus

### *Diabetes Mellitus*

It has been estimated<sup>5</sup> that the incidence of difficult intubation is about ten times higher in patients suffering from long-term diabetes mellitus than in normal healthy patients. The limited joint mobility syndrome occurs in 30–40% of insulin-dependent diabetics and is thought to be due to glycosylation of tissue proteins that occurs in patients with chronic hyperglycemia.<sup>6</sup>



**Fig. 2.1** Hands of a young diabetic woman in the “prayer sign” position

Limited joint mobility is best seen when a diabetic patient’s hands assume the “prayer sign” position (Fig. 2.1). The patient typically is unable to straighten the interphalangeal joints of the fourth and fifth fingers. Another way of demonstrating this deficiency is to obtain palm print scores on patients with diabetes. To do this, the palm of the hand is stained with black ink and an imprint is made on white paper. Patients with the abnormality have deficient palm prints. It has been postulated that the same process affects the cervical spine, TMJ, and larynx. Nadal et al.<sup>7</sup> recently tested the validity of the palm print test in 83 adult diabetics scheduled for surgery under general anesthesia. They evaluated the airway using the Mallampati test, the thyromental distance, head extension, and the palm print. The sensitivity, specificity, and the positive predictive value were calculated for each test. The palm print test had the highest sensitivity (100%). The other three tests failed to detect 9 out of 13 difficult airways.

### ***NPO Status***

Elective intubation of the trachea frequently involves the administration of potent intravenous anesthetic agents and neuromuscular blocking drugs. For this reason, patients who have recently ingested solid food and liquids are at considerable risk when airway intervention is performed in the presence of a full stomach.

Therefore, it is incumbent upon you to ascertain the NPO status of the patient in advance. Elective intubation should not be performed if an *adult* patient has ingested a full meal within an 8 h period or a light meal within a 6 h period.<sup>8</sup> Patients with GERD have an additional risk factor when airway intervention is required.

## ***Physical Examination***

### **General**

On first approaching patients presenting for elective intubation, it is advisable to make a general assessment – i.e., the level of consciousness, the facies and body habitus, the presence or absence of cyanosis, the posture, and pregnancy. Rose and Cohen<sup>4</sup> have shown that the incidence of difficult intubation increases: in males, in persons aged 40–59, and in the obese. A recent study from Denmark suggests that a high body mass index (BMI) may be a more appropriate predictor of difficult tracheal intubation than body weight alone.<sup>9</sup>

### **Facies**

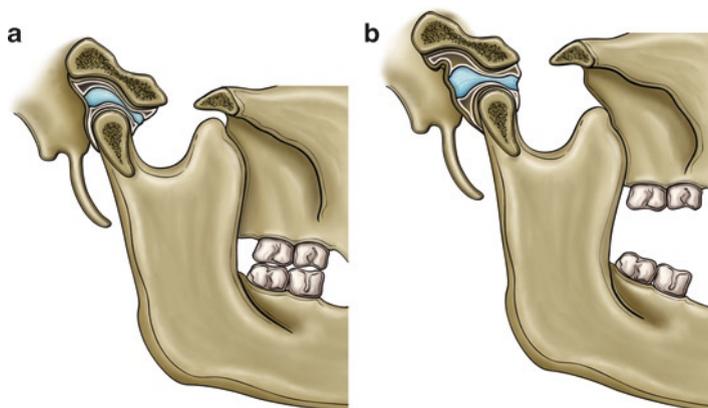
Particular attention should be paid to the facial appearance of the patient. A number of syndromes and disease states can make intubation difficult, many of which are associated with abnormal facial features, (e.g., Pierre–Robin, Treacher–Collins, Klippel–Feil, Apert’s, Fetal Alcohol syndromes). A comprehensive list of these syndromes can be found in Stewart and Lerman’s *Manual of Pediatric Anesthesia*.<sup>10</sup> Thus, when one encounters a patient with abnormal facial features, one should inquire about specific syndromes or consult a pediatrician. Schmitt et al. recently described a high incidence of difficult intubation in acromegalic patients. They studied 128 patients and reported difficulty in 26% of cases.<sup>11</sup>

### **Nose**

The nose should be carefully examined when nasotracheal intubation is planned, observing the position of the nasal septum and whether or not polyps are present. Nasal intubation should be avoided, if possible, in the presence of a clotting abnormality, CSF leakage, nasal polyps, a history of epistaxis, or a basal skull fracture. The patency of each nostril can be tested by having the patient breathe forcefully through the unoccluded nostril. In many cases, one nostril will be more patent than the other.

### **Temporomandibular Joint**

The ability to open the mouth may be limited by disease of the TMJ or by masseter spasm, or a combination of both. The function of the TMJ is complex, involving



**Fig. 2.2** Temporomandibular joint in closed (a) and open (b) positions. Note the rotation and translation of the condyle

articulation and movement between the mandible and cranium. The mandible may be depressed, elevated, or manipulated anteriorly, posteriorly, or laterally. There are two distinct components to this action, each contributing about 50% to the total. The first is a hinge-like movement of the condyle through the synovial cavity, accounting for the first 20 mm or so of opening, and the second is the forward displacement of the disk and condyle, accounting for an additional 25 mm or so<sup>12</sup> (Fig. 2.2a, b).

A number of conditions can affect TMJ function. Prominent among these are the arthritides (including rheumatoid arthritis, ankylosing spondylitis, psoriatic arthritis) and, most commonly, degenerative joint disease or osteoarthritis. TMJ function should be assessed in all patients presenting for endotracheal intubation. With the middle finger of each hand posterior and inferior to the patient's earlobes, place your index fingers just anterior to the tragus (Fig. 2.3) and instruct the patient to open widely. Two distinct movements should be felt<sup>13</sup>: the first is rotational, and the second involves advancement of the condylar head (Fig. 2.4). Listen and palpate for clicks and crepitus, both of which indicate joint dysfunction.

TMJ function may also be assessed by asking the patient to insert two or three fingers (of their own hand) held vertically, into the oral cavity in the midline (Fig. 2.5). Normal adults are capable of inserting at least three fingers, which corresponds to a range of mandibular opening between 40 and 60 mm.<sup>14</sup> Patients capable of inserting only two or fewer fingers are considered to have major limitations. If the maximal mandibular opening is less than 30 mm in the adult, oral surgeons suggest that significant TMJ dysfunction is present. If less than 25 mm, it is unlikely that the larynx will be visible using conventional laryngoscopy, since exposure of the larynx depends to a great extent upon the ability to move the mandible and soft tissues forward. If mouth opening is 20 mm or less, a Macintosh 3 or 4 blade will not fit in the mouth and therefore alternative methods of intubation are required (e.g., light wand, trach light, or fiberoptic-assisted intubation).

It is important to be able to distinguish between limited mouth opening due to muscle spasm and restriction due to joint disease. The former will respond to



**Fig. 2.3** Assessment of temporomandibular joint function



**Fig. 2.4** Palpating an advanced condylar head



**Fig. 2.5** Estimating interdental distance (normally three fingers or about 50 mm)

muscle relaxation, the latter will not. Patients with mandibular fractures have severely limited mouth opening because of trismus. If the fracture does not involve the TMJ, it is safe to induce general anesthesia with muscle relaxation in these patients in preparation for intubation. If there is some doubt, an intravenous or inhalational anesthetic should be administered first without a muscle relaxant, and the ability to open the mouth tested before committing to the use of neuromuscular blocking drugs. Caution should also be exercised when performing laryngoscopy in patients with TMJ disease. Vigorous mouth opening in the presence of profound muscle relaxation may add to existing damage to the TMJ. Avoid direct laryngoscopy in these cases whenever possible.

The *mandibular protrusion test* (Figs. 2.6a–c) can be performed when assessing temporomandibular function. This test is performed by asking the patient to advance the mandible as far as possible and the classification is as follows:

Class A: the lower incisors can be protruded beyond the upper incisors (Fig. 2.6a).

Class B: the lower incisors can be advanced only to the level of the upper incisors (Fig. 2.6b).

Class C: the lower incisors cannot reach the level of the upper incisors (Fig. 2.6c).



**Fig. 2.6** Mandibular protrusion test. (a) Shows mandibular advancement beyond the upper teeth. (b) Shows that the mandible cannot be advanced beyond the upper teeth. (c) Shows that the lower incisors cannot reach the upper teeth

Impaired mandibular protrusion is associated with difficult laryngoscopy and difficult mask ventilation (DMV)<sup>15, 16</sup> Another variation of the *mandibular protrusion test* is the *upper lip bite test* recently mentioned by Khan et al.<sup>17</sup> This test measures the ability to bite (gently) the upper lip with the lower teeth and is another measure of difficult intubation.

Calder et al. stressed the importance of head and neck position when measuring mouth opening. They demonstrated that maximal mouth opening was achieved when craniocervical extension was  $26^\circ$  from the neutral position. This is an important observation because the Mallampati test requires the head to be in the neutral position.<sup>18</sup>

## Lips

A cleft lip deformity can present problems during instrumentation of the airway, in that the laryngoscope blade tends to enter the cleft. Absence of the philtrum is a diagnostic feature of Fetal Alcohol syndrome,<sup>19</sup> which is associated with difficult intubation.

## Oral Cavity

Before tracheal intubation, the state of oral hygiene should be assessed. Occasionally, foreign bodies, such as candy or chewing gum, may be hidden in the recesses of the oral cavity, especially in children.

## Teeth

Upon examining the oral cavity, inspect the teeth. Long, protruding teeth (buck teeth) can restrict visualization of the airway. During direct laryngoscopy, damage

is usually caused by excessive pressure on teeth that are already loose or repaired (e.g., fillings, caps, bridges, or other attachments). The incisors and canines are usually at greater risk, because the laryngoscope is generally inserted in close proximity to these teeth.

Experience is a major factor determining the frequency of damage to the teeth. A number of dental accidents occur when teaching novices airway management. Experienced laryngoscopists exert little if any pressure on the upper teeth, unless they are protruding. Teeth can be injured by vigorous manipulation of oral airways. Dental damage occurring in association with anesthesiology procedures accounted for 24.8% of all litigations against St. Paul Fire and Marine Insurance Company between the years 1973 and 1978.<sup>20</sup> More recent data from a New Zealand study<sup>21</sup> confirm earlier observations that dental damage is still one of the most common reasons for complaints against anesthesiologists. A review of files from the Accident Compensation Corporation in New Zealand covering a 2-year period revealed 76 claims. The number of claims made by women was twice that by men. Most injuries occurred to teeth that had already been restored (60%) and, as expected, the upper central incisors were most commonly involved. The most common injury was fracture or displacement of a filling or crown during intubation. However, a significant number of incidents occurred during emergence from anesthesia, and many of these involved biting down on oral airways. A separate survey of dental damage associated with anesthesia in New Zealand revealed an incidence of 10.4 injuries per 1,000 cases, which was much greater than that reported to the Accident Compensation Corporation.

If patients are properly informed of potential dental problems, and reasonable care is taken during the procedure, the clinician is not considered liable if damage occurs. Davies<sup>22</sup> emphasized the importance of careful scrutiny of the dentition and recommended including a schematic diagram of the teeth on the evaluation sheet (Table 2.2). Careful documentation of the intervention is also important not just for medical–legal purposes, but also for subsequent interventions.

Patients presenting with loose or exfoliating teeth are at increased risk for aspiration or ingestion of teeth. Consequently, it is advisable to discuss the potential risks with the patient and seek permission to remove the tooth or teeth prior to intubation. Most patients are agreeable to this approach. Children frequently present for surgery with loose deciduous teeth, and the parents are usually quite willing to consent to a minor dental procedure while the child is anesthetized; also, an

**Table 2.2** Dental chart

Right	Left
7,6,5,4,3,2,1	1,2,3,4,5,6,7
7,6,5,4,3,2,1	1,2,3,4,5,6,7

Schematic representation of anterior view of dentition with teeth numbered sequentially from midline. Indicate abnormalities as: *A* appliance; *B* bridge; *C* caps; *L* loose; *M* missing

*Source:* Modified with permission from Davies.<sup>22</sup>

unheralded visit from the “tooth fairy” tends to lessen the tension surrounding a hospital visit.

Having discussed the implications of the teeth with reference to intubation, it is appropriate to mention that the edentulous state is rarely associated with difficulty visualizing the airway. On the other hand, airway management using bag/valve/mask ventilation is usually more difficult under these circumstances because the normal contour of the face is distorted and collapsed and it is difficult to maintain a mask seal. The insertion of an oral airway usually allows more effective ventilation in the edentulous state.

There is a suggestion that bag/valve/mask ventilation may be facilitated in the presence of dentures. There now are some data supporting the idea that bag/valve/mask airway management is easier when dentures remain in place. Conlon et al.<sup>23</sup> convincingly demonstrated this observation in a clinical trial involving 165 patients. However, most patients are still required to remove dentures before entering the operating suite. Clearly, anything we can do to avoid respiratory embarrassment in our patients is strongly recommended. The removal of dentures preoperatively is the source of significant general embarrassment to most patients and is one of the most disturbing minor concerns patients face when coming to the operating room. We now have some data to support changing this convention, but like many issues in medicine, we are very slow to change our routines.

## Tongue

Two features of the tongue may interfere with one's ability to visualize the larynx. One is its size in relation to the oral cavity, and the other is mobility. The tongue may be abnormally large and therefore occupy a greater proportion of the oropharynx or, conversely, be of normal size in an unusually small oropharynx. Mallampati<sup>24</sup> and Mallampati et al.<sup>25</sup> have studied the correlation between the ability to observe intraoral structures and the incidence of subsequent difficult intubation. The patient is instructed to sit erect with the head in neutral position, to open the mouth as widely as possible, and to protrude the tongue maximally. Samssoon and Young<sup>26</sup> modified the Mallampati classification as follows: the examiner sits opposite the patient at eye level and observes various intraoral structures using a flashlight:

Class I: soft palate, tonsillar fauces, tonsillar pillars, and uvula visualized

Class II: soft palate, tonsillar fauces, and uvula visualized

Class III: soft palate and base of uvula visualized

Class IV: soft palate not visualized (Fig. 2.7)

The results of the Mallampati test vary depending on whether the patient is asked to phonate during the examination or not. The specificity of the test increases with phonation, but the number of false negatives also increases.<sup>27</sup> The view of the oropharyngeal structures improves significantly with phonation.<sup>28</sup> The results of the Mallampati test also vary depending on the position of the patient during the examination, but not consistently. Lewis et al.<sup>29</sup> recommend that the Mallampati test be performed in the sitting position, with the head and neck in full extension and with the tongue

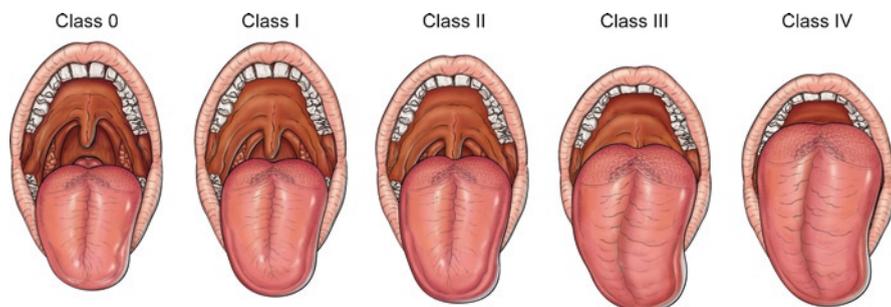


Fig. 2.7 Classification of pharyngeal structures from 0 to IV



Fig. 2.8 Grading of laryngoscopy view based on Cormack and Lehane's classification<sup>28</sup>

protruded with the patient phonating. A recent publication by Ezri et al. refers to a Class 0 airway.<sup>30</sup> While performing the Mallampati test, it is possible to see the epiglottis in a small percentage of patients. This is not necessarily a predictor of easy laryngoscopy. In some of these cases, the epiglottis is elongated and floppy which may create difficulty when attempting to expose the larynx,<sup>31</sup> especially with the Macintosh blade. In general, exposure of the airway with a Macintosh blade is easy in Class I and II airways, but often difficult in Class III or IV airways. It should be remembered, however, that this classification is only a guideline and cannot be relied upon to be the sole predictor of difficult intubations. Cohen et al.,<sup>32</sup> using Cormack and Lehane's<sup>33</sup> grading system for ease or difficulty of intubation (Fig. 2.8), compared the Mallampati classification with the actual grade observed during attempted laryngoscopy and found a high correlation at the extremes. Pilkington et al. showed that the Mallampati grade increased during pregnancy. They studied 242 pregnant patients. They performed the Mallampati test at 12 and 38 weeks gestation and showed that the number of grade 4 cases had increased by 34%. They speculated that the reason for the change in Mallampati grade was most likely fluid retention.<sup>34</sup> The incidence of failed intubation is reported to be three to ten times greater<sup>24, 35</sup> in obstetric patients compared with the general surgical population and the changing Mallampati score during pregnancy may partially explain this phenomenon.

The diseased tongue may also prevent one from visualizing the larynx – e.g., tumors tend to limit lingular mobility and thus one's ability to expose the larynx. The presence of lingual tonsillar tissue can also create unexpected difficulty with intubation, resulting in catastrophic airway obstruction.<sup>36</sup> Ectopic thyroid tissue can be found at the base of the tongue and may bleed following laryngoscopy, leading to difficulties with the airway. This anomaly is rare, occurring in 1:100,000 cases.<sup>37</sup>

Tongue piercing has become popular among the younger generation. This now established trend may pose problems for those performing any form of airway management. Metal or plastic objects in the tongue may become detached and aspirated or ingested or plainly lost in the course of airway management or anesthesia. Pressure of the laryngoscope or oropharyngeal airway, placement of supraglottic devices, or endotracheal tubes may cause pressure necrosis and there is also a risk of electrocautery burns when metal rings or studs are used. For all of these reasons, it is advisable to remove *all* lingual hardware before any type of airway management. Patients should be informed of the risks and strongly encouraged to remove these objects before arrival in the operating room. Patients express concerns that the opening in the tongue closes in quickly when the tongue ring is removed. It is our understanding that a pierced tongue remains patent for several hours following removal. Epidural catheters have been threaded through the opening in the tongue to maintain patency in some cases. In summary, patients should be encouraged to remove tongue rings or studs before arrival in the operating room.<sup>38, 39</sup>

### Mandible and Floor of Mouth

The optimal position for exposure of the larynx when using a Macintosh laryngoscope is attained by flexing the neck and extending the atlantooccipital joint.<sup>40</sup> In individuals with normal anatomy, this aligns the axes of the larynx, pharynx, and mouth so that they are almost parallel (Fig. 2.9). A number of factors may interfere

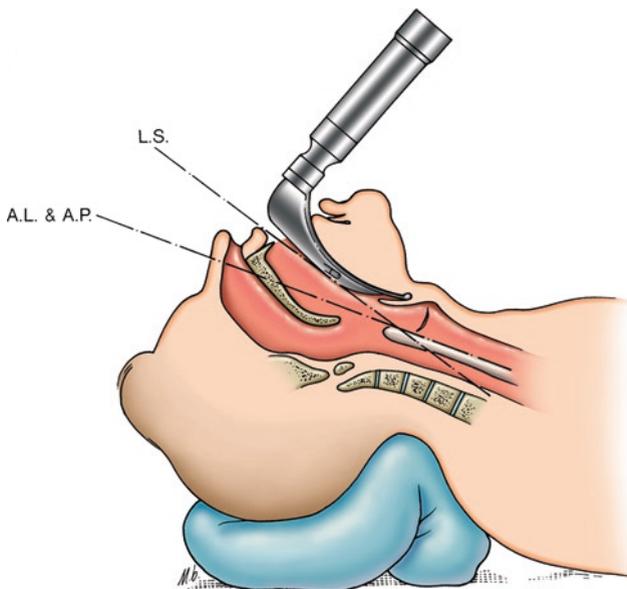


Fig. 2.9 Final exposure



**Fig. 2.10** Thyromental distance

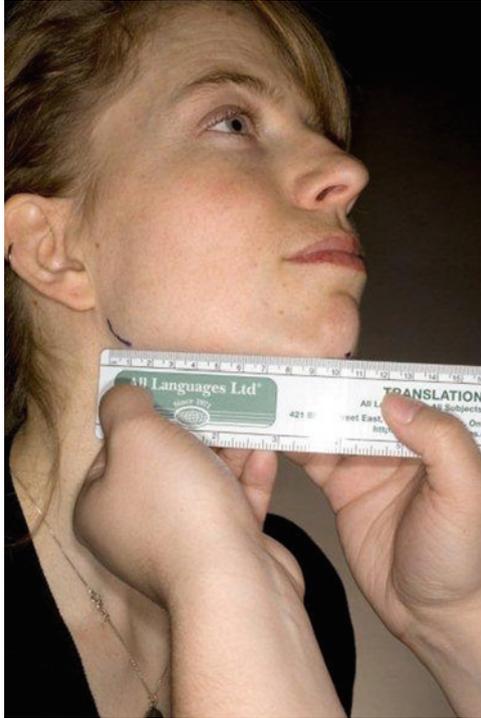
with the ability to align these axes, such as a large or tethered tongue, a short mandible, protruding upper incisors, pathology in the floor of the mouth or neck, or reduced size of intra and submandibular space.

Two well-known congenital anomalies associated with mandibular shortening are the Treacher Collins and Pierre Robin syndromes. In these conditions, mandibular shortening is obvious and extreme. A number of individuals, however, will present with less obvious shortening of the mandible. Two very simple measurements that can be made at the bedside are the *thyromental distance*, which should exceed 6.5 cm in adults when the atlantooccipital is fully extended<sup>41</sup> (Fig. 2.10), and the *mandibular angle-mental symphysis distances*, which should be at least 9 cm in adults (Fig. 2.11). Al Ramadhani et al.<sup>42</sup> recently published a report suggesting that the *sternomental distance* was a useful, sole predictor of difficult intubation in obstetric patients. A *sternomental distance* of less than 13.5 cm was a predictor of difficult laryngoscopy in obstetric patients. To our knowledge, this claim has never been validated.

When the above measurements are reduced, one can expect difficulty exposing the larynx with a Macintosh laryngoscope. Few clinicians use a ruler; rather, they estimate the anterior mandibular space by placing their fingers horizontally beneath the patient's chin. In normal adults, the distance from the hyoid bone to the mandibular symphysis is at least three finger-breadths (Fig. 2.12). If it is two finger-breadths or less, the mandible is considered hypoplastic. A number of other measurements may be used, but they are of little practical value.

### Neck, Cervical Spine, and Hyoid Bone

The neck and cervical spine should be carefully examined before intubation; the general neck contour should be inspected first. Obese patients with short, muscular, thick necks (which have a limited range of motion) are more difficult to intubate than



**Fig. 2.11** Mandibular length

patients with normal, supple, or elongated necks. Some recent data suggest that neck circumference measurement may be a useful method of predicting difficult tracheal intubation in obese patients. However, on reading these papers the authors of this publication were not convinced that neck circumference measurement by itself was a useful indicator of difficult intubation in morbidly obese patients and so far has not been shown to be an independent risk factor in this group.<sup>43,44</sup> Patients with Klippel–Feil syndrome (characterized by a reduced number of cervical vertebrae) present problems at intubation, since the neck is shorter and thus has impaired mobility.

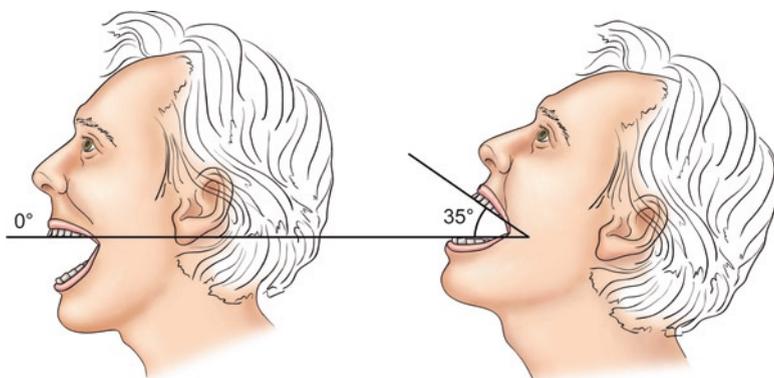
During examination of the neck, the skin color should be noted. Pigmentation changes may indicate that a patient has had previous radiotherapy, which could have caused acute inflammatory changes with later scarring and fibrosis in the neck region. Particular attention should be paid to scars or masses in the neck and the overall texture of the neck tissues. Though almost all of these warrant some concern, any due to vascular injuries is particularly ominous because the airway could become occluded without warning when bleeding occurs. Previous tracheostomy scars should lead one to suspect tracheal stenosis and one should then consider selecting a smaller endotracheal tube. Always check for deviation of the trachea and evaluate the degree of tracheal mobility.



**Fig. 2.12** Assessing the mandibular space

What role does the hyoid bone play in facilitating laryngoscopy? Chou et al.<sup>45</sup> radiographically studied the mandibulothyoid distance (MHD) in eleven patients with known difficult airways and compared measurements in 100 patients in the general population (control). They measured the vertical distance between the mandible and hyoid bone and showed that there was considerable variation among the general population, but MHD was significantly longer in those with problem airways compared to the control group and this difference was statistically significant. Mean values in males with difficult airways (rounded) were 34 mm compared to 21 mm in controls. The same was true in the female cohort. Females with difficult airways had a mean MHL of 26 vs. 15 mm in the control group. There was a very large variation in the MHD in both abnormal and control groups. The MHD is another measurement that can be added to an already lengthy list of measurements for predicting difficult laryngoscopy.

A significant number of patients in the general population develop calcification of the stylohyoid ligament, which may interfere with the ability to elevate the epiglottis during laryngoscopy using a Macintosh laryngoscope. There are a limited number of case reports in the literature on this topic.<sup>46–48</sup> The clinical sign that should lead one to suspect this problem is relative immobility of the hyoid bone or larynx. Laryngeal mobility should be routinely checked in all patients presenting for tracheal intubation.



**Fig. 2.13** An assessment of atlantooccipital translation can be made by estimating the angle traversed by the maxillary teeth when the neck is extended

Upon palpating the neck, one should assess the degree of mobility of the cervical spine and note any limitation in flexion or extension. The optimal position for endotracheal intubation is flexion of the cervical spine and extension of the head at the atlantooccipital joint. Consequently, flexion or extension deformities of the cervical spine associated with the arthritides may make direct laryngoscopy difficult or impossible. Keenan et al.<sup>49</sup> have reported that problems intubating patients with flexion and extension deformities of the cervical spine are not entirely due to failure to align the axes of the larynx, pharynx, and oral cavity. Rather, an additional factor is present, shortening of the cervical spine, which can cause laryngeal and tracheal deviation or forward buckling of the trachea, and this tends to force the larynx into an anterior position.

Under normal circumstances, 35° of cervical extension is possible at the atlantooccipital joint<sup>50</sup> (Fig. 2.13). This angle can be readily estimated at the bedside by asking the patient to sit straight up, with the head erect and the line of sight parallel to the ground. Then ask the patient to open wide. In this position, the occlusal surfaces of the upper teeth are horizontal to the ground. On extending the atlantooccipital joint, the angle created by moving the occlusal surfaces is estimated. Goniometry may be used to estimate the angle more accurately, but in practice the angle is estimated visually.

### Vocal Quality

In listening for vocal quality, try to assess whether stridor is present and, if so, in which phase(s) of respiration it occurs. Stridor at rest in adults indicates that the airway diameter is reduced by about fifty percent. Lesions that are predominantly supraglottic are usually associated with inspiratory stridor, whereas subglottic lesions tend to cause both inspiratory and expiratory stridor.

## **Cardiorespiratory System**

An examination of the airway is incomplete without a review of the cardiac and respiratory systems. This will give some measure of the patient's cardiorespiratory reserve. The minimum information required, even in emergencies, is the vital signs. Time permitting, all patients undergoing endotracheal intubation should have a thorough cardiorespiratory examination that includes a history and physical examination.

### **Patient History**

Every patient should be questioned about coughs and colds and whether they are acute or chronic. A patient presenting with recent cold symptoms is not a good candidate for general anesthesia because inhalation agents tend to irritate the already inflamed mucosa of the larynx, trachea, and bronchi, and this can lead to laryngospasm, bronchospasm, and hypoxemia both intraoperatively and postoperatively.

If sputum is produced, its color and amount should be estimated. Green or yellow sputum or an increased production of sputum suggests acute infection, and elective procedures should be delayed until it has cleared. Each patient should be questioned about smoking and the number of pack-years recorded (the number of packs of cigarettes smoked times the number of years smoking). Smokers are more likely to develop laryngeal spasm during airway interventions. Patients should be questioned about dyspnea, orthopnea, or paroxysmal nocturnal dyspnea and an effort should be made to determine if it is of cardiac or respiratory origin.

Obesity has become a major problem in modern life and is often associated with Sleep Apnea Syndrome. Therefore, it is very important to inquire about snoring and signs of airway obstruction and apneic periods when sleeping. Clearly, this information cannot be gleaned without evidence from a relative or partner, therefore it is very important to include these individuals in the interview.

The patient should also be questioned about asthma; the severity of asthma can be estimated by the number of hospital admissions and the medications required. An asthmatic individual presenting for surgery and requiring steroid therapy has advanced disease and will need supplementation. Patients can usually apprise you of the current status of their asthma and can subjectively rate their chest tightness. Endotracheal intubation in the presence of wheezing often aggravates the situation and elective surgery should be delayed whenever possible. On the other hand, emergency intubation may be required for a patient suffering an acute asthmatic episode. In this case, if the patient presents with a clear history of asthma, they should be pretreated with aerosolized bronchodilators and beta-2 agonists whenever possible.

Information needs to be obtained about the patient's past medical and surgical history pertaining to the respiratory system (e.g., previous thoracotomy, pulmonary aspiration, pneumothorax).

## Physical Examination

It is necessary to determine if the patient is cyanotic and, if so, whether the cyanosis is central or peripheral. The degree of cyanosis can be determined by performing pulse oximetry. Does the patient appear dyspneic? Record the respiratory rate and whether retractions are present. The normal adult will breathe 16–20 times per minute. Does the chest expand symmetrically? Is the patient wheezing? Look for scars indicating previous surgery or chest tubes. A patient with a history of chronic bronchitis and emphysema will often have an increased anterior–posterior (AP) diameter (barrel chest).

When palpating the chest, feel the larynx and trachea and determine if they are in the midline, deviated, or mobile. Check for lymph nodes in the supraclavicular fossae and axillae. Feel the apical beat and determine its position. Does the chest expand symmetrically? Percussion may help determine if atelectasis, pneumothorax, consolidation, or pleural effusion is present.

Listen carefully to the breath sounds over both lung fields. Are they normal? Are they equal on both sides? Are there any additional sounds? If rhonchi are present, are they coarse or high pitched, occasional or diffuse, unilateral or bilateral? Crepitations or rales are moist sounds that usually indicate pulmonary edema. They are often present in older patients, but usually clear on coughing. Tubular sounds or bronchial breathing may indicate pulmonary consolidation. Diminished or absent breath sounds may indicate pneumothorax, atelectasis, or pleural effusion, but are frequently due to obesity and emphysema.

## Cardiovascular System

Endotracheal intubation may have a profound effect on the cardiovascular system, so a thorough history and physical examination is necessary in elective situations.

### Patient History

Ask the patient about chest pain. If present, determine its exact site and radiation. Also try to determine its quality. You may suggest adjectives that assist the patient in identifying the pain (e.g., gripping, stabbing, burning, dull ache, or heartburn). Is it continuous or intermittent? Is it associated with respiration? What relieves the pain? Does it radiate? If so where? Is it associated with exercise? If so, what is the exercise tolerance? What brings it on and what relieves it? Are any medications being taken? Time spent eliciting details about chest pain is most important and should never be rushed.

If dyspnea is present, try to evaluate if it is of cardiac or respiratory origin. Does the patient have orthopnea or paroxysmal nocturnal dyspnea? Does he suffer from palpitations, fainting spells, or ankle edema? Patients with cardiac failure often complain of tiredness and weakness. Pertinent history includes questions about hypertension, previous myocardial infarction (MI), and rheumatic fever. Find out what cardiac medications the patient is taking. Record details about smoking and alcohol intake, both of which can cause serious cardiac disease.

Physical Examination

The physical examination will entail inspection, palpation auscultation, and electrocardiography.

Observe the patient for cyanosis. Look at the neck veins. Jugular venous distention may be an indication of cardiac dysfunction.

Palpate the apical beat and determine its exact location. In normal adults, it is in the fifth left intercostal space 3½ in. from the midline. Determine blood pressure and pulse rate.

Listen for heart sounds. The first heart sound is best heard at the apex, and the second at the base in the aortic area. Also listen for additional sounds. An S<sub>3</sub> gallop indicates left ventricular dysfunction, and an S<sub>4</sub> may be indicative of an atrial abnormality. Mitral murmurs are best heard at the apex, and aortic at the base. If murmurs are present, where are they best heard and do they radiate? Listen for carotid bruits.

A cardiac examination is incomplete unless the ECG is evaluated. Routine ECG is required in all patients with a history of cardiac disease or in patients who are 50 years of age or older.

Structured Approach

In 1991, Davies designed a systematic approach to airway evaluation using the acronym MOUTHS (Table 2.3). It is a quite useful approach and may encourage clinicians to pay more attention to this component of patient evaluation.

**Table 2.3** MOUTHS

Components	Descriptors	Assessment activities
Mandible	Length and subluxation	Measure hyomental distance and anterior displacement of mandible
Opening	Base, symmetry, range	Assess and measure mouth opening in centimeters
Uvula	Visibility	Assess pharyngeal structures and classify
Teeth	Dentition	Assess for presence of loose or malpositioned teeth and dental appliances
Head	Flexion, extension, rotation of head/neck, and cervical spine	Assess all ranges of movement
Silhouette	Upper body abnormalities, both anterior and posterior	Identify potential impact on control of airway of large breasts, buffalo hump, kyphosis, etc.

Source: Modified from Davies,<sup>22</sup> with permission

## Bag/Valve/Mask Ventilation

In the process of evaluating the airway, we focus perhaps too much on anticipating difficult intubation and not enough on anticipating DMV. When confronted with difficult intubation, we rely heavily on the ability to perform effective mask ventilation. We must always keep this issue in mind when evaluating the airway. Bag/valve/mask ventilation can be difficult under certain circumstances – for instance, in bearded individuals, the edentulous, and very obese. However, finding a suitable mask fit may be difficult but, more important, the force required to ventilate the lungs may necessitate using two hands and sometimes requires an assistant. It may be difficult to maintain an effective seal in patients with nasogastric tubes. The mouth and nose may be distorted following trauma, preventing maintenance of an adequate seal. Bag/valve/mask ventilation may be impossible when penetrating objects are lodged in the vicinity of the mouth and nose. Patients with mandibular deformities are sometimes more difficult to manage using bag/valve/mask ventilation. Similarly, patients with serious flexion deformities of the cervical spine may not only be impossible to intubate, but also difficult to ventilate using bag/valve/mask ventilation. Tracheostomy may also be very difficult under these circumstances.

Langeron et al.<sup>16</sup> published a study on the topic of DMV. They studied 1,502 patients and reported a 5% incidence of DMV. Using a univariate analysis, risk factors for DMV included: increased BMI, age, macroglossia, the presence of a beard, the edentulous state, a history of snoring, increased Mallampati grade, and a short thyromental distance. They identified five independent factors for DMV in a multivariate analysis and they are listed in order of importance, the odds ratio being greater for the presence of a beard and least for a history of snoring (Table 2.4). The presence of two of these criteria was an accurate predictor of DMV (sensitivity and specificity greater than 70%). The authors also showed that DMV was the harbinger of difficult intubation in up to 30% of cases.

Langeron et al.’s paper sparked further interest in this topic. Kheterpal et al.<sup>51</sup> recently published an additional study involving 22,660 patients. They used a grading system for DMV established by Han et al.<sup>52</sup> Using this system, DMV was graded in the following manner:

**Table 2.4** Difficult mask ventilation

Variable
Beard
BMI > 26
Edentulous
Age > 55 years
History of snoring
Parameter listed in order of importance

Source: Data from Langeron et al.<sup>16</sup>

- Grade 1 Mask ventilation was readily achieved
- Grade 2 Mask ventilation was achieved but required either an airway or muscle relaxant (NMB)
- Grade 3 Mask ventilation was difficult requiring additional manual assistance± NMB
- Grade 4 Mask ventilation was impossible

Using this grading system, Kheterpal et al.<sup>51</sup> observed a 1.4% incidence of grade 3 DMV and a 0.16% incidence of grade 4 DMV and a 0.37% incidence of grade 3 or 4 DMV and difficult intubation. The disparity between the two studies on the incidence of DMV can be explained on the basis of the different measuring tools used by the researchers. The risk factors for DMV were comparable in both studies but Kheterpal et al. added an additional factor and modified some of the existing factors reported by Langeron et al.<sup>16</sup> (Table 2.5).The ability to advance the mandible is an important addition to the existing list of independent risk factors for DMV.

Is there any link between DMV and difficult intubation (DI)? Langeron suggested that DMV was linked with DI in 30% of the cases. Kheterpal et al. provided a list of independent risk factors for grade 3 or 4 DMV and difficult intubation which they gleaned from their study (Table 2.6). There were 37 cases of grade 4 DMV in Kheterpal et al.’s original study, one patient required a cricothyrotomy, 10 experienced difficult intubation, and 26 were easily intubated. In Kheterpal’s most recent study in which there were 77 cases of IMV, 19 of these cases proved to be difficult intubations (25%).

**Table 2.5** Risk factors for DMV

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Independent risk factors for grade 3 DMV
BMI ≥ 30 kg/m <sup>2</sup>
Beard
Mallampati Class III or IV
Age ≥ 57
Snoring
Jaw protrusion – very restricted
Independent risk factors for grade 4 DMV
Snoring
Thyromental distance < 6 cm

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*Source:* Data from Langeron et al.<sup>16</sup>

**Table 2.6** Independent risk factors for grade 3 or 4 mask ventilation and difficult intubation

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Jaw protrusion – very restricted
Thick/obese neck
Sleep apnea
Snoring
BMI ≥ 30

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*Source:* Data from Kheterpal et al.<sup>51</sup>

**Table 2.7** Independent risk factors for impossible mask ventilation include

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Previous neck radiation
Male gender
Sleep apnea syndrome
Mallampati Class III or IV
Beard

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Source: Kheterpal et al.<sup>53</sup>

Kheterpal et al.<sup>53</sup> have completed yet another study on the topic of DMV recently. This time they included more than 50,000 patients in their study. They reported a 1.5% incidence of grade 3 DMV, which is very similar to that observed in their earlier report. In this most recent study, they accumulated 77 cases of impossible mask ventilation (0.15%) and again the incidence of grade 4 DMV was very similar to that observed in the previous report (0.16%) (Table 2.7).

The most important factor associated with IMV was *previous neck radiation*, which had an odds ratio of greater than 7.

In summary, a considerable amount has been written about DMV in the past 10 years or so, which certainly makes up for the paucity of information on this topic before then. It may be difficult to remember the details of all of these studies. Most of the factors linked with DMV are also associated with DI. Therefore, a complete and thorough examination of the airway will reveal either of these problems or both as they are often linked. In addition to all the usual warning signs of difficult intubation and DMV, we must now add *previous neck radiation* and remember that it is the harbinger of impossible mask ventilation in a significant percentage of cases.

The introduction of the laryngeal mask airway (LMA) has lessened our anxiety about DMV. In a “cannot intubate, cannot ventilate” situation, one should not hesitate to insert an LMA or an alternative supraglottic device. DMV will also be discussed in some detail in Chap. 9.

## Additional Information

### *Arterial Blood Gases*

The decision to perform endotracheal intubation in nonoperating room situations often depends upon arterial blood gas results, and so in a hospital setting, this information is usually readily available. Arterial blood gas specimens are not required in healthy patients undergoing intubation for elective surgery. However, if these data are available, record them and use them to assess the success or failure of your subsequent intervention.

## ***ENT Consultation***

An ENT consultation is warranted if you suspect pathology in the vicinity of the airway. Indirect laryngoscopy, which is usually performed by an ENT surgeon, involves examination of the larynx by observing its reflection via a laryngeal mirror or fiberoptic laryngoscope. Thus, the airway can be visualized and the nature and extent of any disease assessed before the patient is anesthetized for direct laryngoscopy and intubation. Yamamoto et al.<sup>54</sup> evaluated indirect laryngoscopy as a predictor of difficult intubation in more than 6,000 patients. This test had a specificity of 98.4%, a sensitivity of 69.2%, and a positive predictive value of 31%. The test could not be performed in 15% of patients because of an excessively active gag reflex.

## ***Radiologic Studies***

Most patients presenting for emergency intubation will probably have had a recent chest X-ray examination. The chest X-ray is worth reviewing because, in addition to being a useful screening test, it can reveal pathology not evident clinically – pathology that could later be attributed to your intervention. AP and lateral neck films should always be obtained whenever there is encroachment on the airway, regardless of the etiology. Norton et al.<sup>55</sup> recommend dynamic fluoroscopy primarily to assess soft tissue position and motion. If these initial radiologic studies yield insufficient information, it is worthwhile to request a radiology consultation for recommendations on which additional studies will be performed. Appropriate selection is important, since unnecessary studies are time-consuming, costly, and needlessly expose patients to radiation. Modern technological advances in radiology (e.g., computed tomography [CT] and magnetic resonance imaging [MRI]) have greatly improved our ability to diagnose complex airway disorders.

## ***Pulmonary Function Studies***

Pulmonary function studies provide additional information about lung function and help distinguish between obstructive and restrictive lung disease. They also allow one to determine the reversibility of airway disease by performing tests before and after various treatments (bronchodilators, steroids, and anticholinergics). Spirometry is the basis of pulmonary function studies and the equipment used for these measurements is called a spirometer, which is a very simple device that measures forced vital capacity (FVC) during exhalation. One of the disadvantages of spirometry is that patient effort is required and repetitive tests are needed (usually three) in order to validate the results. Graphical depiction of a typical

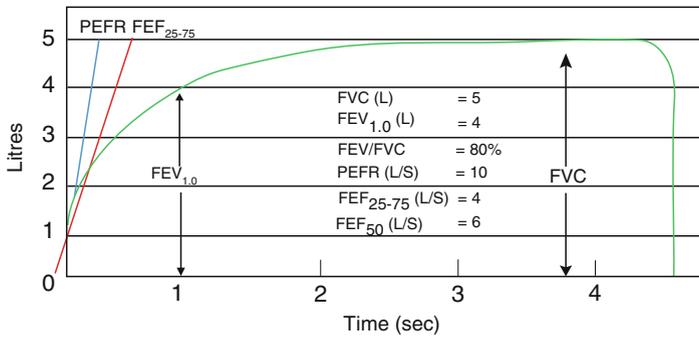


Fig. 2.14 Spirometry

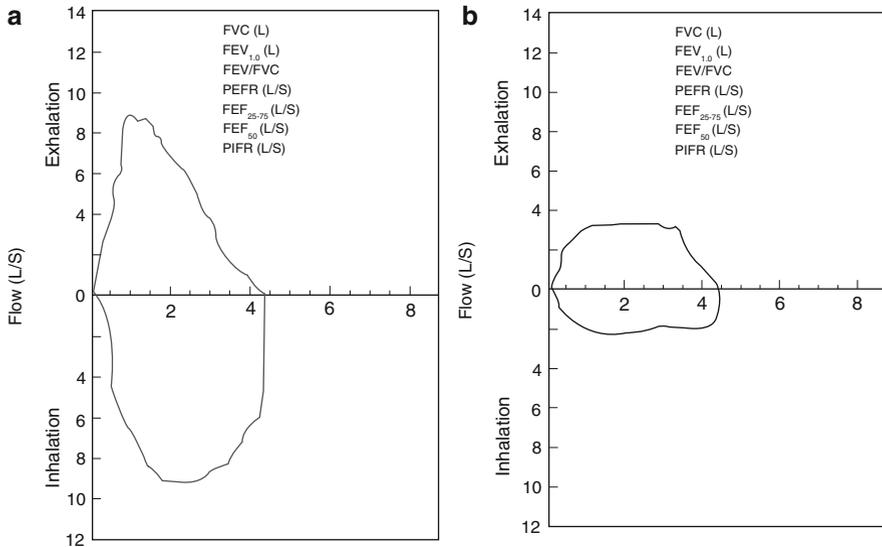
spirogram can be seen in Fig. 2.14. Several useful measurements of lung function can be obtained in this way.<sup>56</sup>

### *Flow-Volume Loops*

Another way of studying pulmonary function is to measure flow and volume in both phases of respiration. The graph generated by this biphasic measurement is called a flow-volume loop. To be more specific, this is a pulmonary function study in which the forced expiratory volume (FEV) and forced inspiratory volume (FIV) are recorded in succession on a spirogram. Flow is plotted on the vertical axis, and volume on the horizontal. Flow-volume loops help distinguish between small and large airway obstructions. They also may help pinpoint the site of a large airway obstruction and whether the obstruction is fixed or variable and whether the obstruction is intrathoracic or extrathoracic.<sup>57</sup> An example of a normal flow-volume loop is depicted in Fig. 2.15a and an abnormal flow-volume loop is depicted in Fig. 2.15b. One of the advantages of flow-volume loops over basic spirometry is that they can distinguish between intrathoracic and extrathoracic obstruction because measurements are made in both phases of respiration. In extrathoracic obstructions, the changes are most noteworthy during the inspiratory phase. Conversely, intrathoracic obstruction is reflected in the expiratory phase of the flow-volume loop.

### *Difficult Airway Clinic*

In 1987, Norton et al.<sup>55</sup> established a “difficult airway” clinic at the University of Michigan. Patients with potential airway difficulties are referred to that clinic by anesthesiologists and surgeons. In that setting, a formal evaluation of the airway is carried out and a plan of action is formulated. One of the important functions of modern preadmission clinics (PAC) is to preemptively detect problem airways



**Fig. 2.15** (a, b) Showing flow-volume loops. (a) Is normal (b) is showing airway obstruction

before the scheduled day of surgery. Unfortunately, not all patients are seen in the PAC. Consequently, a number of healthy patients with problem airways present on the day of surgery and, in that setting, the urgency of maintaining “throughput” sometimes takes priority over careful preoperative assessment of patients.

### *The “Awake Look”*

The “awake look” is a procedure used by some anesthesiologists as a final assessment of the airway before making a decision about the safety of inducing anesthesia. We have already discussed in detail the various tests available to determine the status of the airway and the limitations thereof. In a way, the “awake look” is the final test available to us before we make that definitive decision about how to proceed. The procedure is as follows: the patient is prepared as they would be for general anesthesia including preoperative assessment and monitoring. Then the patient is sedated usually using a combination of opiate and benzodiazepine and, when the patient is adequately sedated, topical anesthesia is applied to the supraglottic structures, and direct laryngoscopy is attempted. If the epiglottis can be readily elevated and some part of vocal apparatus seen, we can then assume that it is safe to proceed with general anesthesia. If we cannot see the epiglottis or if the epiglottis is fixed in place, we must then perform an “awake” intubation. This should always be considered before attempting intubation in a patient with suspected airway difficulty if the problem has not been well defined. The “awake look” test has not yet been validated as a useful tool to predict difficult intubation.

## Summary

The one very clear message that we have been trying to convey in this chapter is the importance of taking the time to conduct a thorough evaluation of the airway. If you abide by that rule, you will uncover the vast majority of problem airways. We have done a thorough search of the literature to help guide you when performing this task. We have conveyed that there is no single guaranteed test available to predict the problem airway. However, there are now a number of tests that we can perform during our evaluation that will allow us to detect the problem airway in the vast majority of cases. Traditionally, we have focused most of our attention on the task of endotracheal intubation and possible problems with that procedure. We need to ask ourselves a more fundamental question when dealing with airway issues. “Will I be able to oxygenate and ventilate this patient if or when he/she becomes unconscious?” We should be able to answer that question affirmatively in all cases, and if not, we need contingency plans.

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