Difficult Intubation in the High-Risk Surgical Patient

12

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Key Points

- Airway control is at high priority in management of the surgical patient.
- Difficult or failed ventilation and intubation is a major contributor to perioperative morbidity and mortality. High-risk patients are susceptible to have a difficult airway event, also to experience serious morbidity and mortality as a result of such an event.
- Several professional societies published guidelines for the management of difficult airway, with some variance between them. They all agree that confronting difficulty in ventilating or intubating the patient is an emergency that requires skillful and timely approach.
- Airway assessment has an important role in predicting airway difficulties. However, problems may appear in time of ventilation or intubation without pre-operative indication for that occurrence.
- Preparing the patient to airway manipulation is important. Placing the patient in the 'sniffing position' improves direct laryngoscopic view. Effective de-nitrogenation and pre-oxygenation increases the 'safe apnea time' allows more time for laryngoscopy, tracheal intubation and for applying alternative airway techniques should intubation fail.
- When confronting difficulties in intubating the patient, one should ***call for help*** and consider alternative techniques and devices for airway management, such as video laryngoscopy or supra glottic airway device. In extreme cases, when all alternatives have failed, surgical airway is to be executed.

12.1 Introduction

Airway management is at high priority in management of the surgical patient.

Difficult or failed ventilation and intubation is a major contributor to patient morbidity and mortality [1–5]. Professional and quick management of the airway may be the difference between ability and disability, and sometimes between life and death. The difficulty of airway management is highly variable. It depends on several factors including the patient's anatomy and pathology, medical and surgical history, airway examination, the clinical context for which airway management is required, the experience of the physician in charge, the environment, and the available airway equipment. The outcomes of airway problems rely deeply on the patient's physical and medical status. While a young and healthy patient may undergo airway problem uneventfully, older and sicker one may suffer grave morbidity following the same airway event.

There are few definitions for difficult airway. The American Society of Anesthesiologists (ASA) defines a difficult airway as "a conventionally trained anesthesiologist experiences difficulty with facemask ventilation of the upper airway, difficulty with tracheal intubation, or both" [5]. Similar definitions were submitted by other national professional societies with some variations between them [6–9]. However, all agree that confronting difficulty in ventilating or intubating the patient is an emergency that requires skillful and timely approach.

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12.2 Airway Management

During the past three decades, airway management changed considerably. The publication of difficult airway guidelines [10–12] and updates [5–9] and its implementation in the clinical practice contributed to a widespread airway management improvement. In addition, multiple advanced airway devices, including newer video laryngoscopes and supraglottic airway devices, have been introduced and incorporated into clinical practice. However, since surgical volume is large and continues to grow, and there is a worldwide tendency to operate on older and sicker patients [13–15], and the morbidity and mortality due to complex airway situations are increasing [3].

Successful management of the patient's airway requires (a) meticulous airway evaluation, (b) theoretical and practical familiarity with various airway devices, and (c) knowledge of several strategies to the difficult airway. Here, we describe these aspects of airway management.

12.3 Airway Assessment

Thorough airway evaluation is important in order to detect the patients at risk of difficult mask ventilation or difficult intubation and prepare accordingly. The patient's history, physical examination, and radiologic tests are used to assess the airway (Table 12.1). Previous difficulty in intubation may be known to the patient or family [16, 17]. The condition of the face and neck, mouth, bony structure, and soft tissue is to be inspected. In addition, the physician should examine the inside view of the mouth, also known as Mallampati score (Fig. 12.1): poor vision of the hard and soft palate has a higher score and a higher risk for difficult intubation. Mallampati's oropharyngeal classification was first proposed as a hypothesis for prediction of difficult intubation [18]; its efficacy in the prediction of difficulty at direct laryngoscopy was demonstrated later in clinical trials [19–22]. Although several simple clinical findings are useful for predicting a higher likelihood of difficult endotracheal intubation, no clinical finding reliably excludes the possibility of difficult intubation [23, 24]. Some patients arrive with neck and chest X-ray or CT scan that are part of their surgical workout. These imaging tests may add detailed information about inner airway anatomy that is not evident by physical examination. Upper airway ultrasound is also used as pre-operative airway evaluation tool [25, 26]. Recently, the three-dimensional computed tomography imaging facilitated prediction of difficult intubation in pediatric patients [27–29].

While examining the patient's airway, the physician decides what is the type and size of airway device most suitable for the patient and situation.

Table 12.1 Airway assessment

• Medical history:
– History of difficult intubation, including syndromes, such as Dawn syndrome and Pierre–Rubin syndrome
– Pathology of the oropharynx area or neck (e.g., maxillofacial trauma, cervical spine injury)
– Previous treatment to the oropharynx or neck (e.g., radiation to the neck, cervical neck fixation)
– Obstructive sleep apnea
• Physical examination:
– Mouth opening (should be more than three fingerbreadths)
– Thyro-mental distance (should be more than three fingerbreadths)
– Condition of the mouth cavity and teeth (e.g., denture)
– Temporo-mandibular joint and neck mobility
– Size of tongue and mandible
– Mallampati score (ref)
– The upper lip bite test (lower incisors cannot extend to reach the upper lip)
– Facial hair
• Imaging
– Neck X-ray
– CT scan
– Ultra-sound

12.4 Techniques and Devices for Airway Management

There are many techniques and devices to manage the patient's airway; however, the basic and frequently practiced approaches are mask ventilation and endotracheal intubation. One should be familiar and experienced with these techniques before advancing to other airway techniques. The necessary equipment for mask ventilation and endotracheal intubation is to be prepared and checked: face mask, oral airway, reservoir bag, direct laryngoscope, endotracheal tube, oxygen supply, and suction catheter (Fig. 12.2).

In order to improve the conditions for both the patient and the operator, the patient should be preoxygenated and positioned in the "sniffing position". Preoxygenation increases the oxygen reserve, delays the onset of hypoxemia, and allows more time for laryngoscopy, tracheal intubation and for airway rescue should intubation fail [30–32]. Placing the patient in the "sniffing position", with neck flexion and upper cervical extension, is a traditionally recommended for intubation, since it improves laryngeal view [33, 34].

12.4.1 Mask Ventilation

Ventilating the patient with a face mask is the primary and easiest method of ventilation and oxygenation. The physician should select the proper mask size that fits the patient's

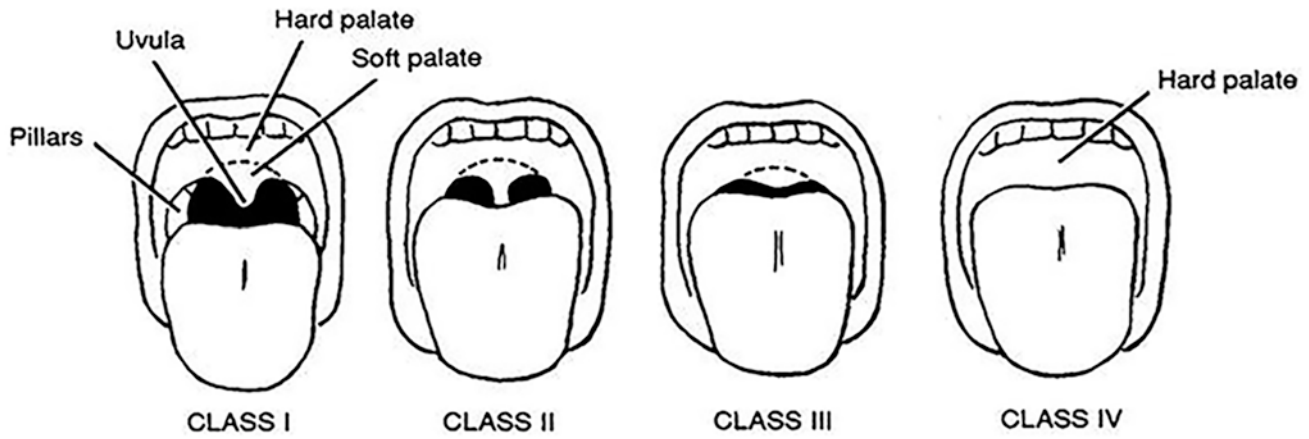

Fig. 12.1 Mallampati score

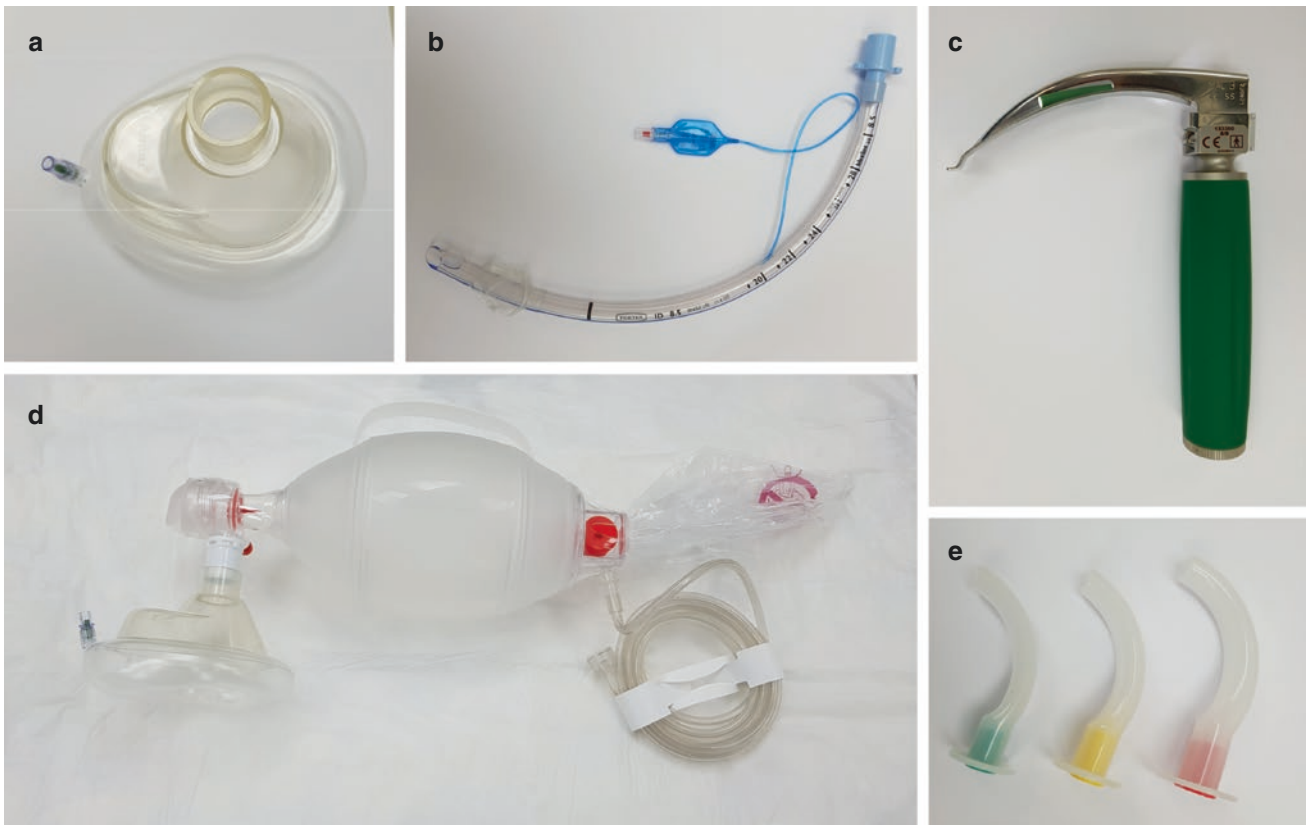

Fig. 12.2 Necessary equipment for basic airway management: (**a**) face mask, (**b**) endotrachel tube, (**c**) direct laryngoscope, (**d**) reservoir bag with oxygen supply, (**e**) oral airway

face in order to have effective ventilation. In some patients, an oral or nasal airway is required to ensure adequate air passage to the patient's larynx and lungs. In case of difficulty, two-person technique is necessary: one holds the mask with both hands and seals it to the patients face and the other ventilates with the reservoir bag.

The disadvantage of mask ventilation is that it is not a definitive airway, thus: (a) it is difficult to continue managing the patient for a long time with mask ventilation and (b) there is a chance of inflating the stomach and increasing the risk of gastric content regurgitation followed by its aspiration into the lungs.

12.4.2 Tracheal Intubation

Orotracheal intubation with direct laryngoscopy is a simple, straightforward and most common method for securing the airway. It is performed with a conventional laryngoscope, e.g., Macintosh blade. Sometimes, the application of a gum elastic bougie as an introducer for the endotracheal tube is useful [35–37]. Failure to achieve tracheal intubation to a maximum of three attempts is defined as failed tracheal intubation and indicates the need to change strategy and ***call for help*** [5–9]. Multiple failed attempts at tracheal intubation injure the patient' larynx and may be harmful [38–40]. Every additional laryngoscopy causes soft tissue edema, bleeding, and secretions, thus worsening the airways condition and decreasing the likelihood of successful tracheal intubation. It may also cause difficulties in mask ventilation due to vocal cords edema. Difficult intubation may occur in 1.5–8.5% and failed intubation occurs in 0.13–0.3% of general anesthesia cases [41]. Analysis of failed cases identified poor identification of at-risk patients, poor or incomplete strategy, inadequate provision of skilled staff and equipment to manage these events successfully, delayed recognition of problems, and failed rescue plan [1–4]. Therefore, airway management necessitates a firm concept of alternative techniques, whereby tracheal intubation is not feasible with standard direct laryngoscopy.

Fig. 12.3 Video-laryngoscope

12.4.3 Alternative Airway Techniques and Devices

The main obstacle in performing successful endotracheal intubation is not having a clear view of the vocal cords. Numerous airway devices have been developed to overcome this obstacle. Some devices, such as the video laryngoscope or flexible fiber-optic bronchoscope (FOB), enable an indirect view of the vocal cords. Other devices, such as the laryngeal mask airway (LMA) can be inserted blindly and do not require a view of the vocal cords by any means. Another option for endotracheal intubation of a patient with difficult intubation is to place an LMA and then pass an endotracheal tube through it. The final option is the surgical one: to establish direct access to the trachea by performing a cricothyrotomy or a tracheotomy.

12.4.3.1 Video Laryngoscopy

The video laryngoscope is a device that enables an indirect view of the epiglottis and the vocal cords, rather than a direct view as with conventional laryngoscopes. The images from the patient's larynx are displayed on a screen or a monitor in the operator's vicinity (Fig. 12.3). There are many types of video laryngoscopes, such as GlideScope®, C-CAM, Truview PCD™, King Vision™, and others that are commonly used in difficult airway situations [42–44].

Studies have shown that video laryngoscopy was associated with better vocal cord visualization and a higher rate of first attempt successful intubations compared with a conventional direct laryngoscopy [45, 46]. During the COVID-19 pandemia, video laryngoscopy was recommended as first-line for tracheal intubation, hence became commonly used [47–49]. Consequently, many physicians gained experience with that device and feel comfortable to use it as the first alternative to the standard direct laryngoscopy in case of difficult intubation.

12.4.3.2 Fiber-Optic Bronchoscopy

Performing awake fiber-optic intubation under local anaesthesia for achieving successful endotracheal intubation in the spontaneous breathing patient is one of the recommended methods in situations, where there is a risk for difficulties in airway management [5–9]. However, awake intubation with a FOB requires patient's full cooperation and an experienced physician. This option may not be beneficial to a case, where difficulties in airway management were not anticipated, since following several attempts to intubate the patient with

Fig. 12.4 Laryngeal Mask Airway (LMA)

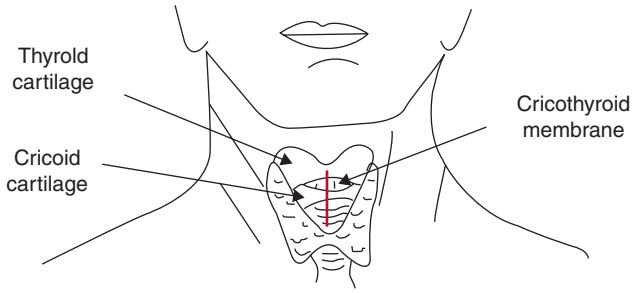

Fig. 12.5 Anatomical landmark for cricothyrotomy

direct or video laryngoscope, blood, and secretions may preclude FOB usage.

12.4.3.3 Supraglottic Airway Devices

Supraglottic airway devices (SAD), such as the LMA (Fig. 12.4) and its several diverse variations, are very important devices for managing the difficult airway [5–9]. The SAD is placed blindly in the oropharynx and its successful placement requires minimal experience [50–52]. The SAD is a rescue device for ventilating the patient until intubation is accomplished. In addition, specific types of SADs, such as I-Gel, are used as a conduit, through which the endotracheal tube is inserted [53–55]. However, SADs do not provide a definitive airway and it may be displaced when moving or positioning the patient for the surgical procedure.

12.4.3.4 Surgical Airway

Performing a cricothyrotomy is a lifesaving procedure in selected patients in the 'cannot intubate, cannot ventilate' (CICO) situation [5–9, 56–58]. Surgical establishment of an airway is a safe method for securing the airway when an experienced surgeon performs the procedure. Factors that can make the cricothryotomy particularly challenging are lack of familiarity with the procedure, poor anatomical landmark as in morbidly obese patient, previous radiation to the neck, hematoma, injury, or previous surgery to the laryngeal region. When a patient experiences acute respiratory distress and surgical airway access is performed under local anesthesia, the patient's movements may pose additional difficulty to the surgeon. Yet, patient's spontaneous breathing should be preserved until achieving secured airway. It is prudent to consider mild sedation (midazolam); however, it is better to have a restless alive patient with an open airway than a sedated or paralyzed patient with a complete airway obstruction.

Surgical Technique

The procedure is performed with the patient in a semi-recumbent position. Neck overextension should be avoided, since it further narrows the airway. Disinfection of the neck is important, although time is limited. They use a 2% lidocaine injection preferable with epinephrine; to facilitate local anesthesia and hemostasis in an awake, patient is preferable. After standard preparation of the skin, a 2 cm vertical incision of the skin of the neck just below the laryngeal prominence (thyroid cartilage) is performed (Fig. 12.5). The next step is to make a transverse incision in the cricothyroid membrane, which lies deep to this point. Then, a tracheostomy tube or endotracheal tube is inserted into the trachea, and its cuff inflated. Securing this precious airway is of utmost importance. The tube is to be fixated to the skin with a stich. Several commercial supplies are designed for this procedure and include all the equipment needed. It is recommended to have one of these in the Emergency Airway Cart.

Cricothyrotomy Vs. Tracheostomy

The advantage of performing cricothyrotomy rather than tracheostomy is that the cricothyroid membrane is superficial and minimal dissection is required. The disadvantage of this approach is that the cricothyroid membrane's area is small and several adjacent structures may be injured, such as the cricothyroid muscles and the central cricothyroid artery. In case of cricoid cartilage damage due to pressure necrosis or unintentional scalpel damage, perichondritis may follow, with subsequent stenosis.

Although the procedure of choice in emergent situations is cricothyrotomy, in practice, there seems to be a propensity for doing a tracheotomy rather than a cricothyrotomy [59]. This preference may be attributed to the higher failure risk of cricothyrotomy. The surgical airway procedure carries a 6% rate of complications, such as haemorrhage or pneumothorax, in an elective scenario, and higher complication rate when the procedure is performed in an urgent or emergent situation [60–62] and can, occasionally, be fatal [63].

When cricothyrotomy is carried out as a resuscitative effort during CICO, it may be extremely stressful for the operator, especially the less experienced one [64, 65]. It is very important that emergency department physicians are trained and practiced with this procedure [66, 67].

12.5 Approach to the Difficult Airway

Difficult intubation combined with difficult mask ventilation is an infrequent but not rare phenomenon, with an incidence of 0.4%, or approximately one of every 250 patients that undergo general anesthesia [68]. Difficulty in mask ventilation or tracheal intubation requires a quick response as to how to manage the patient's airway. Several professional societies, including the ASA and the Difficult Airway Society, have published guidelines to assist the physician in decision making at that crucial point [5, 7]. The main issues are similar in all guidelines, progressing from simple to more advanced airway devises while maintaining the patient's safety. Emphasis is placed on preserving oxygenation during the procedure and minimizing trauma from airway interventions. The number of airway interventions is to be limited. It is important to take into account the physician experience and familiarity with airway devices, since it may affect considerably the likelihood to succeed [69, 70]. In all the guidelines ***calling for help*** is the first step, as soon as a problem appears.

In each patient, the physician should try to maintain patient's vital signs stable and maximize oxygenation while following the guidelines. However, in case of high-risk patient, it may be more difficult, since the high-risk patient copes poorly with the stress of airway manipulation. This may prolong the procedure and turn it yet more challenging.

12.5.1 Anticipated Difficult Airway

In case that there is an anticipation for difficulty by airway assessment, the physician should plan the procedure and be prepared accordingly, with the suitable equipment and competent helpers. The safe approach is to achieve airway control, while the patient maintains spontaneous breathing. It is recommended to perform an awake fiberoptic or video laryngoscopic intubation, after applying local anesthesia to the airway. This is not technically easy, nor it free of complications [71–73]. Some recommend administering mild sedation in order to improve patient's cooperation and prolong the time for the procedure [74, 75]. If intubation fails, one may consider other options, including postponing the case [5–7].

12.5.2 Unanticipated Difficult Intubation with Easy Mask Ventilation

Although the importance of airway assessment is established, its sensitivity in predicting difficult intubation is not high, and problems may appear in time of ventilation or intubation without pre-operative indication for that occurrence [23, 24]. A suboptimal attempt to intubate the patient is a wasted attempt and having failed, the chance of success declines with each subsequent attempt [76–78]. Repeated attempts at tracheal intubation may reduce the likelihood of effective airway rescue with an SAD. Most guidelines recommend a maximum of three attempts at intubation; a fourth attempt by a more experienced colleague is permissible [5–7]. If unsuccessful, a failed intubation should be declared and the physician should try an alternative approach, such as video laryngoscopy or SAD, according to the physician's experience and the equipment available at that time and place. Using SAD following failed intubation is advantageous, since it provides a route for oxygenation while assessing how to proceed, thus enables the physician to have a calm consideration of the various options, plan a strategy and prepare to the following step. Another option at that time is to use video laryngoscope. Again, if video laryngoscopy failed, one may turn to SAD.

When tracheal intubation, video laryngoscopy and supraglottic airway device insertion have failed and the surgery is not urgent, then the safest option is to wake the patient up, and this should be considered first [5–7]. If waking the patent up is not an option (for example, where life-saving surgery must proceed immediately), the remaining options should be considered, such as surgical airway.

12.5.3 Unanticipated Difficult Intubation with Difficult Mask Ventilation

At each stage, as long as face mask ventilation is possible and the patient is well-oxygenated, it is safe to continue trying various airway techniques. However, as soon as it is difficult to ventilate the patient with face mask, it becomes unsafe and an emergency situation is declared. Difficult mask ventilation may be evident at the beginning of the procedure or appear after several attempts to intubate the patient, due to soft tissue edema, secretions, and bleeding. If intubation failed and ventilating with face mask is impossible in the presence of muscle relaxation, this is (CICO) situation and surgical airway should be done immediately [5–9]. In very extreme, rare cases extracorporeal membrane oxygenation device was used to oxygenate patient with complete airway obstruction [79].

12.5.4 Muscle Relaxation

The use of neuromuscular blocking agents is a *double-edged sword*: in many cases, it improves the airway conditions and allows easy mask ventilation and intubation [80, 81].

However, if intubation failed after administering muscle relaxants, there is no spontaneous breathing and the patient's safety relies solely on the physician ability to ventilate and oxygenate effectively. It is recommended to try ventilating the patient after inducing sedation and before administration of muscle relaxation, in order to conduct a safe practice [82].

12.5.5 Extubation of the Difficult Airway Patient

The patient with a difficult airway is also at high risk for post-extubation complications. Following airway manipulation, the mucous membranes are edematous, the soft tissues are swollen, and the airway may be compressed. Neck expandability is relatively low and even a small haemorrhage or subcutaneous emphysema in the region could result in airway compromise. Sometimes, the laryngeal reflexes are not functioning and gastric content might regurgitate [83, 84]. Airway complications during extubation account for 12% and during recovery 5% of all perioperative airway events [3]. The decision about the timing of extubation should rely on airways condition, the effectiveness of the patient's spontaneous breathing, and the capability to manage the airway in case of post-extubation ventilatory deterioration. Optimization of the patient's parameters should be done before proceeding, and awake extubation is the strategy of choice [84–86]. The use of airway exchange catheters is recommended during scheduled extubation in patients with difficult airway [86, 87]. During extubation, the patient should be monitored closely and the care providers should be prepared for the possibility of re-intubation.

Documentation of the difficulties in airway management and its solution is crucial. All caretakers of the patient should be notified about it. This information should be brought up before each and every anaesthesia, in order to avoid risking the patient in the future [88, 89].

12.6 Difficult Airway and the High-Risk Patient

The consequences of airway incident may range from minor and temporary complications, such as airway edema or soft tissue lacerations, to major permanent damage, such as neurologic insult or death [1–4]. Research regarding difficult airway studies both the risk of having difficult airway and who is the patient that will suffer more severe complications following airway manipulation. Data indicate that the high-risk patient is susceptible for both.

One of the scales to grade the patient's medical condition is the ASA physical status, ranges I–V, with VI for the organ donor patient (Table 12.2). Higher score represents worse health or severe co-morbidities. The correlation between high ASA physical status, meaning high-risk patient, and peri-operative morbidity and mortality is well-established [91, 92]. The ASA physical status correlates also with the patient's risk for difficult airway. A large-scale analysis of 4092 patients with difficult or failed intubation showed that the risk for difficult or failed intubations increased significantly for: increased ASA physical status, increased Charlson Comorbidity Index, patients aged 45–75, obese patients, and patients undergoing emergency surgery [93]. Similar results were found in the analysis of 102,306 patients who underwent general anesthesia with direct laryngoscopy, where male gender, Mallampati score III–IV, obesity with a BMI $\geq$35 kg/m^2, and physical status ASA III–IV were identified as risk factors for difficult laryngoscopy [94]. Thus, high ASA physical status, of any reason, is a risk factor for difficult airway situation.

Furthermore, when there is a difficult airway event, the high-risk patient is more susceptible to experience grave morbidity and mortality. Airway manipulation, especially when difficulties occur, imposes physiological stress on the patient. Occurrence of hypoxemia, hypercarbia, acidosis, hypotension, or hypertension may cause severe arrhythmia and cardiac arrest [68, 95–97]. Reduced physiological reserve of the high-risk patient contributes dramatically to increased possibility and severity of complications. A healthy young patient has larger oxygen reserve, has longer time to endure apnea before hypoxemia proceeds, good perfusion to vital organs, and, therefore, copes better with episode of hypoxemia than the old, obese, or high-risk patient. Therefore, the higher risk patient suffers severe complications, while the young healthy subject may experience trivial ones.

Most of the data regarding difficult airway events come from large litigation and critical incident databases, such as the ASA Closed Claims Project (ASACCP) in the USA or the NHS Litigation Authority in England. According to the

Table 12.2 American Society of Anesthesiologists (ASA) physical status (PS)

The ASA PS	Definition
ASA I	A normal health patient
ASA II	A patient with mild systemic disease
ASA III	A patient with severe systemic disease
ASA IV	A patient with severe systemic disease that is constant threat of life
ASA V	A moribund patient who is not expected to survive without the operation
ASA VI	A declared brain-dead patient whose organs are being removed for donor purposes

The addition of "**E**" denotes Emergency surgery: (An emergency is defined as existing when delay in treatment of the patient would lead to a significant increase in the threat to life or body part) [90]

British registry, airway and respiratory claims account for 12% of all anesthesia claims, but 53% of deaths, 27% of cost, and 10 of the 50 most expensive claims in the data set [98]. Data from Denmark are similar, with 21% of anesthesia claims described respiratory complications, with a mortality rate of 50% and substandard care identified in one-third of the cases [99]. According to the ASACCP, patients with ASA physical status III–V were 47% of the patients who suffered morbidity and mortality following a difficult airway event during 1993–99 [3]. This was changing during the years: 78% of the patients in 2000–2012 difficult intubation closed claims analysis had high ASA physical status [3]. In addition, a higher rate of death following difficult airway events was in 2000–2012 than in 1993–99 claims. Thus, the rate of high ASA physical status patient who suffer morbidity and mortality following difficult airway is high, and is increasing with time.

12.6.1 Critically Ill Patients

Critically ill patients are at the highest risk for complications in the hospital. As such, their management is especially challenging. In these patients, standard airway assessment may be precluded. Urgency and reduced physiological reserve contribute dramatically to increased risks of profound peri-intubation hypoxemia, hypotension, arrhythmia, and death [83].

Critical illness and its management can make previous anatomically 'normal' airways 'physiologically difficult'. Fluid resuscitation, capillary leak syndromes, prone position, and prolonged intubation all contribute to airway edema and distortion [100]. Additional significant challenges include the environment, experience of the operator or attending staff, and other human factors [101]. Failure of 'first pass' intubation occurs in up to 30% of ICU intubations, significantly higher than in the operating room. Severe hypoxemia (S_PO_2 < 80%) during ICU intubation is reported in up to 25% of patients. When major airway events occur in ICU, the incidence of death and brain damage is roughly 60-fold higher than during operative anesthesia [84, 99]. Another problem is the extubation of the critically ill patient with the difficult airway [83, 102]. Post-extubation deterioration is fairly frequent and so is re-intubation. Re-intubation is usually more difficult than the first one, due to secretions, edema, minor bleeding in the larynx and the 'physiologic difficult' mentioned above [103].

12.6.2 The Trauma Patient

Establishing a definitive airway in a trauma patient is a primary essential of early management according to the guidelines of the Advanced Trauma Life Support [104]. The definitive airway is orotracheal tube, nasotracheal tube, or surgical airway, meaning cricothyrotomy or tracheostomy. Difficulties in airway management may arise due to anatomical or technical reasons, especially if the trauma involves the face and neck regions.

Airway assessment is not always possible, depending the patient's condition and cooperation. In addition, trauma patient is generally regarded as having a "full stomach" and require rapid sequence induction to minimize the risk of gastric content aspiration during endotracheal intubation [105, 106]. Sometimes, the trauma patient has not been cleared of a C-spine injury; therefore, the "sniffing position" is not feasible. The time available to accomplish airway control is short and the patient's condition may deteriorate rapidly. Both decision-making and performance are impaired in such circumstances [107].

The use of the difficult airway guidelines is often not suitable in managing the trauma patient, because: (a) techniques of awake intubation are time consuming and not always possible for the trauma patient, (b) maintaining the patient's spontaneous breathing may be impracticable in trauma patient, and (c) the recommendations for either "cancel case" or "wake patient," neither of which is a realistic option with trauma patients. Consequently, the physician in charge has to be prepared earlier than usual to proceed to the option of surgical airway.

12.6.3 Morbid Obese Patients

Obesity is a risk factor for both mask ventilation and tracheal intubation [108–110]. Optimizing the patient condition before the beginning of airway manipulation is extremely important in the obese patient. Positioning the obese patient in a "rump position" improves direct laryngeal view [111, 112]. Pre-oxygenation is crucial in these patients; 'safe apnea time' relates to the volume of the patient's functional residual capacity (FRC), effective de-nitrogenation and oxygenation of the FRC, and oxygen consumption. The obese patient has low FRC, and normal to high oxygen consumption. Therefore, they tend to have very short time until hypoxemia pursues. FRC increases with the reverse Trendelenburg position. Hence, with persistent lengthy pre-oxygenation and the reverse Trendelenburg position, oxygen reserve increases and safe time prolongs [113–116].

12.7 Future Considerations

Considering the growing surgical volume and the global tendency to operate on older and sicker patients, difficult airway problems may be more and more prevalent. Worldwide,

avoidable events range from 25% to 50% of all airway complications [95]. In order to cope with that prospective, effort should be aimed on improving practice and reducing the preventable airway morbidity and mortality. This requires recruitment of all the elements in the health institution. The physician in charge of the patient is to be aware of the significance of airway problem and proceed thoroughly with all aspects of airway management: airway evaluation, planning strategy, preparing suitable equipment and assistance, optimization of the patient condition with pre-oxygenation and position, being familiar with alternative airway devices. Health organizations and professional societies are to ascertain dissemination and implementation of difficult airway guidelines with continuing everyday practice of the physicians. Education programs for teaching and practicing airway devices and techniques are crucial [117, 118]. In addition, hospital designated "airway team" that helps in case with airway problem may contribute to improve outcomes [119, 120]. The collaboration of nurses, physicians, and respiratory therapists is essential for optimal function during airway crisis and should be learned and exercised.

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