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Airway Trauma: Assessment and Management

Yasser Mahmoud Hammad Ali Hammad and Nabil A. Shallik

Abstract

Recognizing airway trauma and safety management is challenging for any anaesthesiologist. Many types of airway injuries require identifying airway anatomy correctly; early assessment and proper management are crucial for saving many lives. Proper management involves the classification of those patients into three categories. Each one has a unique and different control. Knowing your capabilities and skills are very important for safe airway management. It does not matter where you are but skills, knowledge of airway management algorithms and tools you have. After reading this book chapter, the participant will be able to define airway trauma, proper airway risk assessment and safety management.

Keywords: airway obstruction, facial injuries, intubation, mandibular fractures, maxillary fractures, maxillofacial injuries, surgical airway

1. Introduction

Many head and neck procedures have special and challenging requirements for anaesthesia care beyond airway management; however, securing the airway in patients with maxillofacial and neck trauma is crucial and lifesaving. Direct traumatic airway injury is rare (incidence <1%); hence, the airway assessment and management are not well structured because physicians rarely treat such cases [1, 2].

Trauma to the airway carries a life threatening situation because it can cause by itself airway obstruction or obstruction by blood, secretions, tissue oedema, debris and vomitus. It may be associated with cervical spine injury which will worsen intubating conditions. Finally, the risk of airway obstruction continues to postoperative period and the decision to extubate in part is based on the prevention of reintubation and/or to prevent postoperative airway obstruction by tissue oedema in certain types of trauma and facial bone fixation.

There are specific situations in patients with facial and neck trauma, as described by Hutchison et al. [3] to adversely affect the airway:

1. The displacement of posterior-inferior-fractured maxilla parallel to the inclined plane of the base of the skull can block the nasopharyngeal airway.
2. In the supine patient, a bilateral fracture of the anterior mandible may cause the tongue and the fractured symphysis to slide posteriorly and block the oropharynx.
3. Exfoliated and/or fractured teeth, bone fragments, vomitus, blood and secretions as well as foreign bodies, such as dentures, debris and shrapnel, may block the airway anywhere along the oropharynx and larynx.

4. Haemorrhage from open wounds or severe nasal bleeding may contribute to airway obstruction.
5. Trauma-induced soft tissue oedema and swelling can cause delayed airway compromise.
6. Trauma to the larynx and the trachea can cause displacement of the epiglottis, arytenoid cartilages and vocal cords, thereby increasing the risk of cervical airway obstruction.

2. Airway trauma and findings, modified from Jain et al. and De Angelis studies

2.1 Maxillofacial trauma

- Dento-alveolar: Exfoliated and/or fractured teeth, soft tissue lacerations, swelling and oropharyngeal bleeding [4, 5]. Gastric distension from swallowing of the blood can cause regurgitation and aspiration while securing the airway.
- Bilateral or comminuted parasymphiseal mandibular fractures: It can lead to posterior tongue displacement in supine position and airway obstruction. Movement to sitting position can relieve the obstruction, however those injuries may be associated with cervical spine injury.
- Temporo-mandibular fractures: A condylar fracture and displacement can prevent mouth opening. The mouth may be locked open or closed. Trismus which is secondary to the spasm of the masseter muscle due to irritation may be the cause of mouth lock.
- Mid-face fractures: Unilateral or bilateral Le Fort fractures (I-II&III) may cause airway compromise via maxillary prolapse, oedema or hemorrhage. Le Fort fractures II&III may be associated with fracture base of the skull with CSF leakage from the nose, epistaxis and oedema. Ng and colleagues reported establishing an emergency airway in 22 (34%) of 64 patients presenting with Le Fort fractures; the severity of the Le Fort fracture also correlated with an increased need for intubation [6].
- Zygomatic and orbital fractures: It can cause retro-bulbar hemorrhage and vision loss, traumatic mydriasis and increased intraocular pressure.
- Fracture base of the skull (temporal, occipital, sphenoid and ethmoid bones): It can cause peri-orbital ecchymosis (Raccoon eyes), Battle's sign, CSF rhinorrhea and cranial nerves palsy.

2.2 Neck and laryngeal trauma

- Penetrating trauma to the neck can cause arterial injury in 12–13% of the cases, and venous injury in 18–20% of the patients as reported by Britt et al. [7].
- Blunt trauma can cause airway obstruction by tissue disruption, oedema and hematoma. It can be associated with cervical spine (C-spine) injury. C-spine injury at or above C4 and C5 can cause airway obstruction by laryngeal oedema and apnea by diaphragmatic paralysis and neurogenic shock [8].

- Laryngeal trauma: The clinical presentation may not reflect the severity of the injury; some patients may present with delayed airway obstruction after blunt trauma to the neck. Others are associated with fracture base of the skull, C-spine injury, pharyngeal, oesophageal and vascular injury [9].

Patients with neck trauma including the trachea can be presented with one or combination of the following symptoms and signs: subcutaneous emphysema, crepitus, external bleeding, ecchymosis, hematoma, dyspnea, hypopnea, stridor, wheezing, cough, dysphonia, hoarseness, pain with phonation, dysphagia, drooling, haemoptysis, tracheal deviation and nerve injury [4].

3. Airway assessment and management

Despite the incidence of airway traumatic injury being low, it is associated to injuries, or to the airway obstruction and severe hypoxemia [1, 2].

According to a retrospective review of 12,187 civilian patients treated at a regional trauma Canadian centre, mortality was 36% in blunt airway trauma and 16% in penetrating airway trauma [1].

The definitive airway assessment and instantaneous management may be performed as soon as indicated, whether outside the hospital in case of profuse bleeding with airway compromise or inside the hospital, as it may cause early death in trauma. Securing the airway should be done with cervical spine stabilization to avoid spinal cord injury and based on the advanced trauma life support (ATLS) concept for managing patients who have sustained life-threatening injuries [3, 10].

The airway should be reevaluated frequently at least for several hours. The symptoms and signs of airway obstruction described before should be carefully examined, for example, inspiratory stridor suggests impending loss of airway. Ability to speak and answer simple questions indicates a patent airway, enough respiratory effort to generate voice and enough blood pressure to perfuse the brain [11].

A thorough history and physical examination should be made for every patient before the initiation of anaesthetic care and airway management. However, this should not delay the immediate securing of the airway in case of its compromise; as indicated in the Advanced Trauma Life Support Manual, there are three underlying concepts:

1. Treat the greatest threat to life first.
2. The lack of a definitive diagnosis should never impede the application of an indicated treatment.
3. A detailed history is not essential to begin the evaluation of a patient with acute injuries [12].

Gruen et al. found 16% of inpatients' deaths among 2594 trauma patients due to failure to establish and/or secure the airway and oxygenation [13].

This is followed by the standard preoperative airway assessment, which attempts to identify risk factors for difficult bag mask ventilation combined with difficult direct laryngoscopy [14].

The next step is to evaluate the traumatized airway and the adjoining structures using direct or video laryngoscopy, fiberoptic bronchoscopy (FOB) or ultrasonic imaging, with or without sedation and topical anaesthesia.

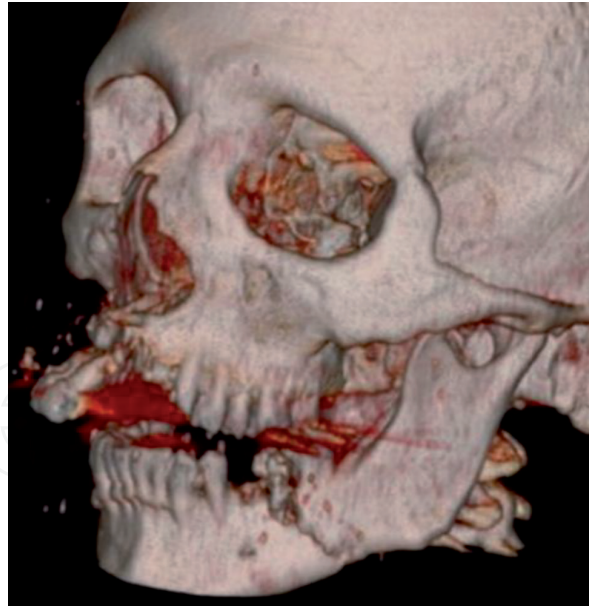


Figure 1.
3-D CT reconstruction showing loose teeth and bone that can cause airway obstruction.

If airway is maintained and there is no need for intubation, then computerized Tomography (CT) and Magnetic Resonance Imaging (MRI) can be performed. Imaging provides comprehensive information about airway and surrounding.

Virtual endoscopy and 3-D reconstruction of upper airway could be done, and all the injuries are identified, and the risk of airway compression is evaluated (**Figure 1**).

Once the airway risk assessment is done, the choice of airway management and possible interventions should be planned before the induction of anaesthesia.

4. Preintubation check list

1. Oxygen mask and nasal cannula oxygen running
2. Suction working
3. Bag Mask Value (BMV) ready
4. Different sizes of Guedel's oral airway
5. Laryngoscope functioning
6. Endotracheal tube (ETT)
7. Supraglottis airway (SGA) device ready
8. Intravenous line functioning (and blood pressure cuff on opposite arm)
9. Assistant designated to provide manual in-line stabilization (MILS)
10. Medications drawn up (including paralytic, even if not planning to use it)
11. Patient position optimized (if possible)
12. Airway plan verbalized with all personnel involved

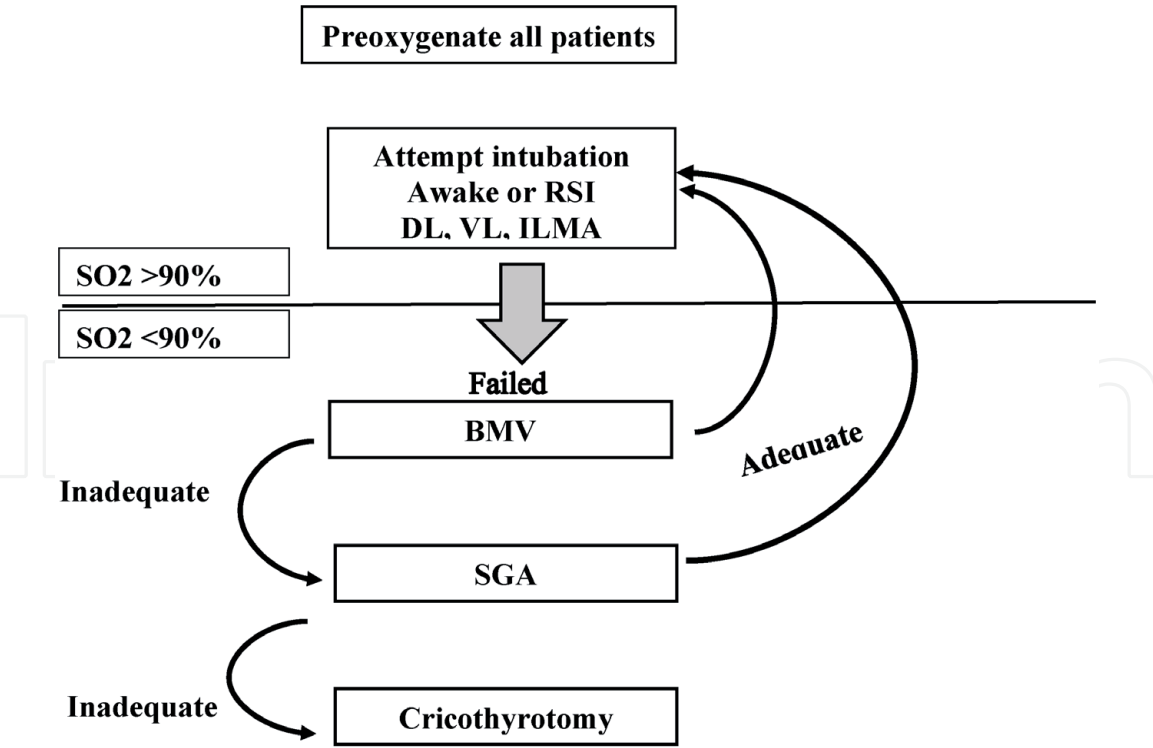


Figure 2.
Airway management algorithm (SO₂ = oxygen saturation, RSI = rapid sequence induction, DL = direct laryngoscopy, VL = video laryngoscopy, ILMA = intubating laryngeal mask airway, BMV=bag mask ventilation, SGA = Supraglottis airway).

The optimal airway management depends on the availability of expertise and equipment, not the location of the care. Communication should be clear between team members, concerning the airway plan and the role of each of them. Regardless of who oversees airway management, it should be clear who will make the decision to proceed and who will perform the procedure if a cricothyrotomy or surgical airway is required. Reardon et al. suggested airway management algorithm (Figure 2) [15].

5. Suggested airway management technique

5.1 Preoxygenation

Preoxygenation is critical to success and safety of emergency intubation, especially when rapid sequence induction and intubation (RSI) is used. The best way to provide high fraction of inspired oxygen (FiO₂; 100) for preoxygenation is by using a standard reservoir facemask with the oxygen flow rate set as high as possible. Patients should be preoxygenated for 3 min or 8 maximal capacity breaths if time is short. It is best to preoxygenate patients in a head-elevated position or in reverse Trendelenburg, especially if the patient is obese. Apneic oxygenation is a relatively new concept that can help prevent oxygen desaturation during RSI. This is best accomplished by placing a nasal cannula (with an oxygen flow rate more than 15 L/min) under the facemask during preoxygenation and leaving it in place during intubation [16].

Patients may be classified into the following three groups when deciding how to intubate:

- Group 1 (G1): Those at low risk of difficulty.

- Group 2 (G2): Those at higher risk of difficulty (as the real difficulty is uncertain).
- Group 3 (G3): Those with known airway difficulty or are highly likely to be difficult.

Patients with low risk of difficulty G1: Needs direct laryngoscopy and standard equipment with usual backup.

Patients with a higher risk of difficulty and uncertainty G2: Different plans should be ready, including video laryngoscopy (VL), suitable laryngeal masks (LMA) and emergent surgical airway.

Patients who are known difficult G3: Awake technique and spontaneous ventilation are maintained; fiberoptic intubation or elective surgical airway (tracheostomy).

5.2 Awake fiberoptic intubation

The technique has the advantage that patient is breathing throughout, however it has many disadvantages and limitations when used for management of patients with airway trauma.

The airway visualization is challenging with ongoing haemorrhage, the use of local anaesthetic is difficult due to trauma and hemorrhage and the procedure itself needs cooperative patient and expert anaesthesiologist.

When airway management is beyond emergency situations, the patient is stable with SpO₂ > 90% and in operating theater, the following situations should be considered:

5.3 Patients with full stomach

In general, all patients with trauma should be managed as with full stomach until proved otherwise. The risk of regurgitation and aspiration of food or swallowed and ingested blood is high.

Evacuating the contents of the stomach may be tried by the insertion of nasogastric tube before starting airway management in cooperative patients and in the absence of contraindications as mid face fractures. Applying cricoid pressure is not indicated any more with induction of anaesthesia in patients with trauma [17, 18] as it may itself hamper endotracheal tube insertion, may cause rupture oesophagus and its efficiency is suspected [19, 20].

5.4 Patients with C-spine injury

Any patient with trauma to the head and neck is considered to have C-spine injury till proved otherwise [21, 22].

Those patients are kept in neck collar and cervical spine inline stabilization during insertion of endotracheal tube to prevent neck movement, which may worsen intubating conditions [8].

Indirect video laryngoscopy (**Figure 3**) is proved to be useful compared to conventional direct laryngoscopy in some studies, when used for patients who need to be immobilized during intubation [23–25].

5.5 Nature of injury and decision making

According to the nature of maxillofacial trauma and the previous classification to six criteria either single or mixed, the decision of endotracheal intubation and



Figure 3.
Indirect videolaryngoscopy with permission from Verathon, Inc., Bothell, WA.

whether oral or nasal and the possibility to do surgical airway should be discussed before starting the procedure between the attending anaesthesiologist and surgeon. The level of experience with airway management should be the highest in the hospital especially with G2 and G3 patients. Nasal intubation is preferred by most of maxillofacial surgeons especially when the mouth is closed at the end of surgery by maxilla-mandibular fixation (MMF) [26]; however it is contraindicated in patients with mid-face and base of the skull fractures [27]. Decongestant nasal drops have to be used to reduce nasal vascularity before insertion of nasotracheal tube, secure the tube position by a loose stitch to the columella of the nose [28], oral insertion of the tube is fixed strongly by tape with tincture benzoin or by submental insertion as both anaesthesia and surgery teams share the same work space (**Figure 4**).

5.6 Submental orotracheal tube intubation

The technique was described to give the surgeon full access to the oral cavity and is indicated in patients with mid-face comminuted fracture, when nasal intubation is contraindicated, or in those patients who require restoration of the occlusion and their condition permits extubating patients at the end of surgery [29].

The technique is contraindicated in inpatients with comminuted mandibular fractures [29].



Figure 4.
Submental intubation.

A reinforced, armored, endotracheal tube is used in this technique, in order to prevent the tube from kinking during its usage. After a regular orotracheal intubation, the tube is passed by blunt dissection through the floor of the mouth at halfway between the chin and the angle of the mandible, and then sutured to the skin to secure position (**Figure 4**).

Complications from submental endotracheal intubation include bleeding, damage to the lingual and mandibular branch of the facial nerve and damage to the submandibular gland and/or its duct [30, 31].

6. Airway control in emergency situations

The securing of a patent airway for maxillofacial trauma patients in emergency situations whether inside or outside the hospital carries a considerable risk of failure and death due to airway obstruction. An additional risk is added when most of those patients are managed by inexperienced medical staff. This was shown in a study where there was 97% of trauma patients who were managed by inexperienced physicians in airway management. Most maxillofacial trauma patients who are acutely desaturating are intubated via orotracheal route by direct laryngoscopy [32].

1. Additional choices for managing the emergent airway include the Fastrach intubating laryngeal mask airway (ILMA Fastrach) (**Figure 5**), placed blindly through the mouth to seals off the hypopharynx via a circumferential inflatable cuff; this may prevent aspiration of blood [32, 33].
2. Intubation through LMA using Aintree exchange catheter (**Figure 6**).

Aintree intubation catheter (Cook Medical, Bloomington, IN, USA) permits intubating patients via any LMA (sizes 3,4,5) with ETT 6–8 mm ID without interruption of oxygenation [34].

Despite weak reports, blind endotracheal intubation (ETI) with blind use of either gum elastic bougie or tube exchange catheter is not advisable in critically ill patients as it's associated with tracheal injury and has been the cause for positive pressure ventilation-related pneumomediastinum.

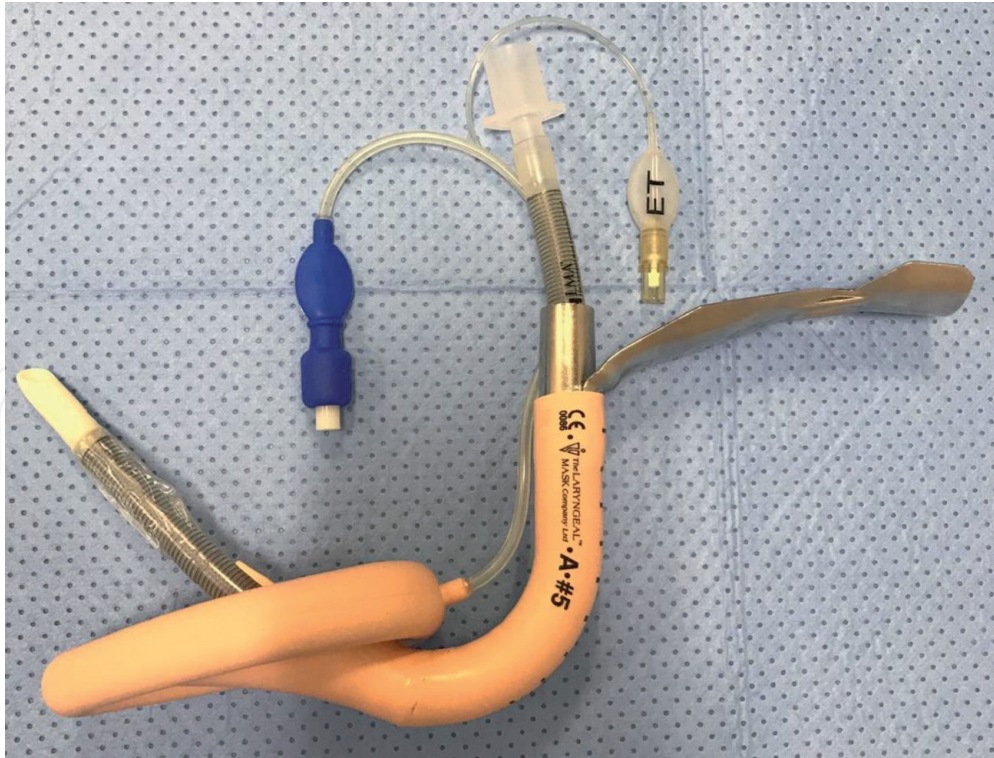


Figure 5.
The intubating laryngeal mask airway.

3. The double lumen airway (Combitube, Tyco Healthcare Group LP, Pleasanton, CA or the laryngeal tube and also known as the King LT (VBM Medizintechnik, Sulz, Germany)), is a dual lumen tube, with dual cuff that is blindly inserted into the oesophagus (**Figure 7**). The distal balloon is smaller and inflated within the oesophagus to prevent gastric reflux. The proximal one is a larger balloon which seals off the oropharynx and allows ventilation via perforations between the two cuffs [35, 36].

This tube is always inserted by paramedics at the scene due to ease of insertion in comparison of endotracheal intubation [37].


4. Finally, the cricothyroidotomy is indicated in failed attempts at intubation or ventilation [32].

Other reported indications include airway obstruction by excessive emesis or haemorrhage, known cervical spine fracture, and inability to visualize the vocal cords [38].

Cricothyroidotomy was reported in 0.4% of emergent airway control patients in total of 8320 trauma admissions [39], and in 0.1–3.3% of patients with maxillofacial trauma [40]. Other studies showed that 15–23% of emergent cricothyroidotomies was used as the first and only means of airway control [41, 42].


6.1 Scalpel cricothyroidotomy

Scalpel cricothyroidotomy is the rapid and most suitable method of securing the airway in the emergency situation. A cuffed endotracheal tube in the trachea prevents the airway from aspiration, provides a secure route for expiration, permits low-pressure ventilation using traditional breathing systems and allows end-tidal CO₂ monitoring. A number of surgical techniques have been described, but there is a lack of evidence of the superiority of one over another. The techniques all have common steps in general: neck extension, identification of the cricothyroid membrane, cutting through the skin and



FIBREOPTIC GUIDED TRACHEAL INTUBATION THROUGH SUPRAGLOTTIC AIRWAY DEVICE (SAD) USING AINTREE INTUBATION CATHETER


Please ensure the SAD is in place; give 100% oxygen;
confirm adequate sedation/anaesthesia, ventilation & paralysis



Aintree catheter


- ◆ 56cm long hollow catheter
- ◆ 6.5mm outer diameter; 4.7mm inner diameter
- ◆ Easily preloaded onto an appropriately sized intubating fibroscope (maximum insertion cord diameter - 4.2mm)
- ◆ Flexible enough for loading over fibroscope
- ◆ Stiff enough to facilitate railroad of tracheal tube
- ◆ Comes with 2 rapidit adaptors (please refer to manufacturer's guidelines)
- ◆ Used for SAD assisted orotracheal fibreoptic intubation

4




Note depth of AIC. With assistant immobilising SAD and the operator maintaining the position of AIC, the FS alone is withdrawn after removal of securing tape.

1




Having prepared the fibroscope (FS) and camera system, lubricate the outer surfaces of both the Aintree Intubation Catheter (AIC) and FS. Preload AIC onto FS and secure with tape. Attach a 15mm bronchoscopic swivel connector (with port) to SAD and attach the anaesthetic circuit to the swivel connector. Confirm adequate anaesthesia, muscle relaxation and assisted ventilation.

5




Briefly disconnect SAD (along with swivel connector) from anaesthetic circuit, deflate cuff (if present) and start withdrawing SAD (along with swivel connector), applying counter pressure on AIC to prevent movement. Once the SAD cuff becomes visible, grasp AIC in the mouth and fully remove SAD with the swivel connector. The process should be done with care. Again note the depth of AIC at the lips, ensuring that it never exceeds 26cm.

2



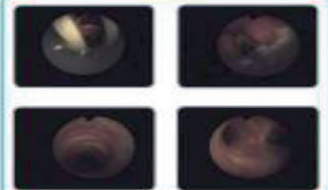
The SAD should be immobilised by an assistant. Introduce FS with loaded AIC through top port of swivel connector into the SAD lumen.

6




Using a laryngoscope, railroad the tracheal tube (ETT) over AIC ensuring a 'tip anterior' orientation. Use a conventional ETT - minimum size is 7.0 and pre-cut to appropriate length.

3



Sequentially visualise SAD aperture bars (if present), glottis, tracheal rings and finally carina as the FS passes caudally. Never advance beyond carina.

7



Reconnect circuit and re-establish anaesthesia and ventilation. Confirm end-tidal CO₂. Consider FS confirmation of ETT position.

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Dr. Barry McCusker, Consultant Anaesthetist, NHS Tayside
Illustrations produced by Andy Morris, Medical Illustration Department, NHS Lanarkshire, 24/07/2020

The AIC was invented in Liverpool, UK.
Reference: Anaesthesia, 1996, volume 51, pages 112-112A.

This is not an airway rescue technique
It should be performed in a controlled setting for practice
The process is designed to provide controlled ventilation/regeneration via the SAD and swivel connector until the SAD is removed and tracheal tube is railroaded in place
Oxygen can be delivered via the AIC in situations where railroad of tracheal tube is impossible, allowing ventilation via this route to allow subsequent oxygenation (lack of cuff)
Refer to manufacturer's guidelines for methods of oxygen delivery

Recommendations:

1. Consider a second assistant in addition to a trained assistant.
2. Use a camera system for fibroscopy.

Caution

The Aintree catheter is not recommended with the DAS laryngoscope.

Figure 6.

Fibreoptic guided tracheal intubation through supra-glottic airway device (SAD) using Aintree intubation catheter (DAS guideline with written permission).

cricothyroid membrane and insertion of a cuffed endotracheal tube. In some instances, the skin and cricothyroid membrane are cut sequentially; in others, a single incision is recommended. Many include a placeholder to keep the wound open until the endotracheal tube is in place. Some use special equipment like cricoid hook, tracheal dilators, etc. A single stab incision through the cricothyroid membrane is appealing in terms of its simplicity, but this approach may fail in the thick neck patient or if the anatomy is difficult, and a vertical skin incision is recommended in this situation [43].

6.2 Narrow cannula technique

Narrow-bore cannula techniques are effective in the elective setting; however, their limitations have been well known. Ventilation can be achieved only by using a high-pressure machine, and this is associated with a high risk of barotrauma. Failure because of kinking, obstruction, malposition, or displacement of the cannula can occur even with predesigned cannulae, such as the Ravussin™ (VBM, Sulz, Germany). High-pressure ventilation equipment may not be available in all facilities, and most anaesthesiologists do not use them on a regular basis. Their use in these situations should be restricted to experienced clinicians who use them in routine clinical practice [43].



Figure 7.
Oesophageal/tracheal Combitude.

6.3 Wide-bore cannula

Wide-bore cannula over the guidewire: some wide-bore cannula kits, such as the Cook Melker® emergency cricothyrotomy set, use a wire-guided (Seldinger) technique. This approach is less invasive than a surgical cricothyroidotomy and decrease the need for special machine for ventilation. The skills required are familiar to anaesthesiologists and intensivists because they are common to central line insertion and per-cutaneous tracheostomy method; however, these techniques require fine and smooth motor control, making them less suited to stressful situations. However, a wire-guided technique may be a reasonable alternative for anaesthetists who are experienced with this method, the evidence suggests that a surgical cricothyroidotomy is both faster and more reliable.

Non-Seldinger wide-bore cannula: A number of non-Seldinger wide-bore cannula-over-trochar devices are available for airway rescue. Although successful use has been reported in Cannot intubate, cannot oxygenate (CICO), there have been no large studies of these devices in clinical practice [43].

7. Postoperative management

7.1 Extubation

Extubating patients at the end of surgery should be discussed between anaesthesia and surgery teams. Patients with severe trauma to the airway, those with

pan facial fracture fixation, prolonged surgery and airway oedema should be kept ventilated in intensive care unit. Extubating patients should be done carefully with all equipment for reintubation ready. Some patients may be extubated in operating theater over airway exchange catheters (AEC) (**Figure 8**).

AEC is a long hollow bougie that comes in several sizes and can be placed into the trachea through the tracheal tube. The tracheal tube is then removed, and the AEC left in the airway with the tip at the level of the mid trachea. It is important that the catheter remains above the carina, and it should not be inserted beyond 25 cm in an adult patient. The AEC can then be used in the same way as a bougie to help reintubate the trachea in case of deterioration. It has been used in the recovery unit and on critical care unit after head and neck surgery. Usually, the AEC can be left in for few hours after extubation but is can be tolerated for up to 72 h [44].

While transferring the patient to intensive therapy unit (ITU), it is safer to keep the patient asleep with tracheal tube in place, but extra care to be taken to avoid tube dislodgment.

7.2 Prepare for unplanned extubation

Notify the team providing ongoing care if the patient had a difficult airway, and have advanced airway equipment and a surgical airway tray at the patient's bedside in case of an unplanned extubation.

7.3 Bailey manoeuvre for extubation

This manoeuvre can be performed by several ways, but it must be done with an adequate depth of anaesthesia (and muscle relaxation) to minimize the risk of laryngospasm. The patient should be properly positioned and preoxygenated, and the oropharynx should be gently suctioned. A deflated SGA is introduced behind the endotracheal tube, its position is confirmed and its cuff is inflated.

The cuff of the endotracheal tube is deflated and the tube is removed, taking care not to remove the SGA with the tube (**Figure 9**).

7.4 Staged extubation set with wire

Staged extubation uses a staged extubation wire (**Figure 10**) to maintain continuous airway access and a staged reintubation catheter to facilitate a successful reintubation if required. Soft, tapered and kink-resistant wire is coated in a polymeric jacket to assure minimal irritation while in position [45].

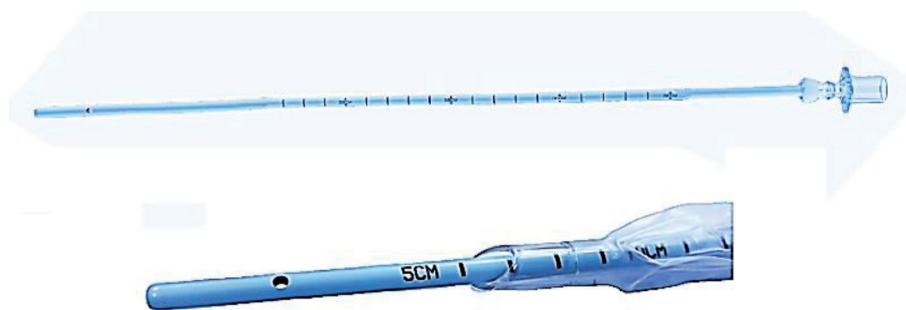


Figure 8.
Airway exchange catheter.



Figure 9.
Bailey manoeuvre.

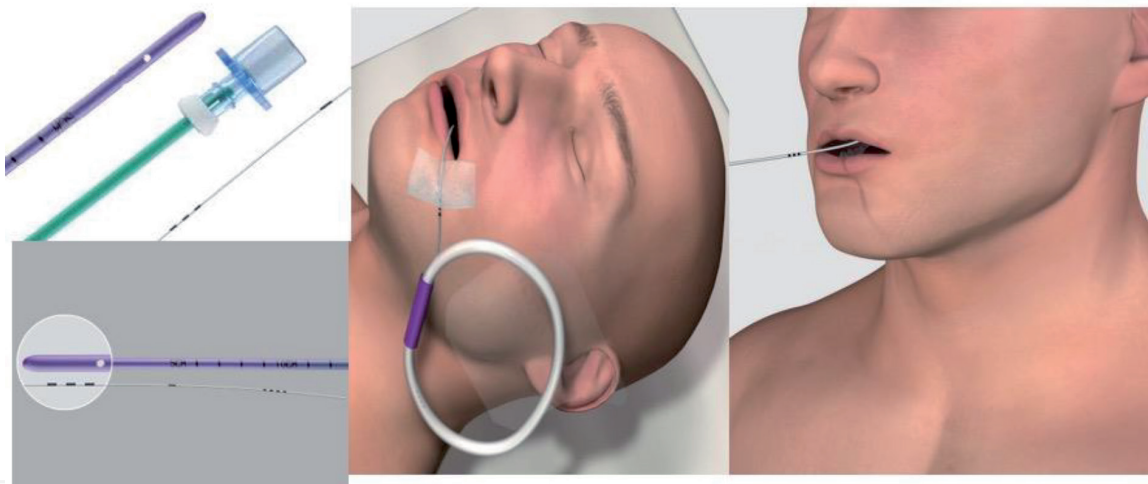


Figure 10.
Staged extubation set with wire.

8. Conclusion

Establishing a secure airway in a trauma patient is one of the primary essentials of treatment. Maxillofacial trauma directly impacts on the airway resulting in compromise and hindering attempts to secure the airway and any delays in securing the airway may lead to morbidity and mortality. So, multiple approaches to securing the airway are possible; each has advantages and disadvantages. Every airway manager has a different set of skills, experience and availability of airway equipment, so management details will vary based on these factors. It is useful to understand common facial injury patterns that affect airway management and then consider how each injury pattern will interfere with common emergency airway manoeuvres. The time available to accomplish the task is short and the patient's condition may deteriorate rapidly. Both decision-making and performance are impaired in such circumstances. In this chapter, we discussed the complexity of the situation and presented a treatment approach.

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