Maxillofacial Trauma and Airway Management

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1.1 Introduction

Maxillofacial trauma represents a challenge for the anesthesiologist in the emergency airway management. This kind of injuries can often compromise the patient's airways and become potentially life threatening.

Maxillofacial injuries may occur as an isolated damage or as a part of traumatic injuries [1].

The American College of Surgeons in Advanced Trauma Life Support (ATLS®) system represents the "gold standard" for the polytrauma patient management.

Within the ATLS® protocols, the first priority is always represented by the maintenance and the protection of the respiratory tract together with the cervical spine protection.

In-hospital mortality and morbidity of trauma patients often result from pitfall related to airway management.

In a large study population (2594 patients), Gruen et al. found the errors in the airway management are the most common factors related to mortality (2594 patients were analyzed) [2].

Current literature points out the complexity of this clinical scenario characterized by potentially life-threatening injuries [3–5].

Together with the assessment of maxillofacial trauma patients applying ATLS® protocols, it is necessary to understand specific features of this scenario: priority can conflict or suddenly change and hidden pitfalls can arise [3, 6, 7].

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D. Chiumello (ed.), *Practical Trends in Anesthesia and Intensive Care 2017*,
http://doi.org/10.1007/978-3-319-61325-3_1

This chapter aims to provide an overview of the maxillofacial airway management for anesthesiologists and intensive care physicians on the basis of recent literature.

1.2 A Complex Scenario

Beside the anticipated difficult airway, other factors can complicate this clinical setting. C-spine injury, unexpected vomiting, facial bleeding, and facial fractures pose additional problems both for the decision-making and for the practical approach. Identifying major difficulties and pitfalls may help the clinician to choose the best strategy for the airway management.

1.2.1 Cervical Spine Injuries

Cervical spine injuries are reported in 1–10% of patients presenting with facial fractures [7]. Cervical injuries should always be suspected in patients with lower- and midface trauma until it can be clinically or radiologically excluded. However, frequently clinical exclusion is not possible in a patient with altered Glasgow Coma Scale (GCS) and alcohol or drug intoxication [4]. In these cases a computed tomography (CT) scan evaluation is needed [8].

In general, based on the reported maxillofacial trauma, it is possible to hypothesize the most frequent associated C-spine injuries [9]:

- Midface injuries are associated with C5-7 trauma.
- Lower-face injuries are commonly associated with C1-4 trauma.

Complete C-spine diagnosis can take hours, and in the meanwhile the patient's C-spine has to be protected by a semirigid collar and spinal immobilization in the supine position, avoiding neck movements. If endotracheal intubation is needed, in-line stabilization has to be maintained during the procedure. Unfortunately, manual in-line stabilization has demonstrated to reduce the laryngoscopic view. It has been suggested the use of videolaryngoscopy rather than the direct laryngoscopy to minimize neck movements [10].

1.2.2 Unexpected Vomiting

The maxillofacial trauma patient should always be considered to have a "full stomach": he often bleeds from the facial injuries and fractures and swallows blood, with a high risk of vomiting. Furthermore, the patient may have recently eaten or taken alcohol or drugs. At the same time, opioids for pain relief and brain injury can trigger nausea and vomiting [1, 4]. However we don't suggest the insertion of a nasogastric tube to decompress the stomach in maxillofacial patients who are confused and not cooperative, because the maneuver itself could represent a trigger for vomiting [11].

Vomiting that occurs in the presence of facial injuries represents a threat to airway protection, especially when C-spine lesions coexist. Vomiting may occur suddenly so that it is mandatory to identify patients, which are at highest risk of pulmonary aspiration and require intubation to secure the airway. Conversely, patients with minor facial injuries and preserved state of consciousness could not vomit, and the indication to protect the airway is not impelling.

Moving from these considerations, it is important to remember that the decision to intubate the patient may be influenced by the need for an intra- or extra-hospital transport. The goal is to minimize risks and maximize safety for patients during transport.

However, anesthesia and intubation are at high risk of pulmonary aspiration; in fact, the assessment of risks and benefits of an early intubation requires the judgment of an expert help [11].

- In case of early episodes of vomiting in the emergency department, when the patient is still on a spinal board, the inclination of the board will be useful to lower the head together with a high flow suction of the airway. Trendelenburg position allows the vomit following into the oropharynx, thus reducing the aspiration risk.
- If repeated episodes of vomiting occur in patients with moderate brain injury, drug intoxication and/or full stomach together with maxillofacial trauma, and a high risk of lung aspiration, airway protection should be ensured.
- After an accurate airway evaluation, the anesthetist decides whether to proceed with tracheal intubation with spontaneous breathing patient or with a rapid sequence induction. Preoxygenation will always be provided and in-line spine stabilization maintained during these maneuvers.
- Sellick's maneuver (cricoid pressure) is suggested during rapid sequence induction; however it is contraindicated in a patient who is vomiting because of the esophageal rupture risk. Furthermore this maneuver can worse the laryngeal view, making endotracheal tube placement more difficult [12, 13]. Definitely, cricoid pressure is part of an overall approach of rapid-sequence induction to minimize the risk of aspiration, but it can be reduced when the laryngeal view is impeded.

1.2.3 Bleeding

Blood loss from maxillofacial bleeding is rarely life threatening and at the same time only in few cases induces hemodynamic instability or hypotension. Nevertheless, it can represent a pitfall in airway management. Then, clinicians should always consider that:

(a) Small bleedings, in supine awake patients who swallows, can trigger vomiting.
(b) Profuse bleeding (from extensive tissue disruption or from distinct vessels) may contribute to acute airway obstruction.

Prompt hemostasis and tracheal intubation, when feasible, should be considered according to ATLS® guidelines [6].

Hemostasis can be achieved externally or internally by:

- Direct pressure
- Sutures
- Packing in the oral cavities
- Balloon tamponade
- Reduction of facial fractures

When conservative treatment fails, arterial embolization or surgical approach of the bleeding vessels may be considered [14]. After hemostasis is achieved, maxillofacial injuries do not require immediate repair [15].

1.2.4 Facial Fractures and Timing of Surgery

Surgical maxillofacial treatment can often be deferred until life-threatening injuries have been managed, except for upper airway obstruction and profuse hemorrhage [16].

Most patients with maxillofacial trauma present a stable airway, but there are specific situations associated with this kind of trauma that require emergency airway. Conditions at higher risk for airway obstruction are presented in Table 1.1 [17].

Moreover, C-spine injury, severe neurological impairment, soft tissue neck injury and smoke aspiration are considered conditions at high risk for airway obstruction and require endotracheal intubation in the emergency room [18, 19].

Apart from mentioned specific clinical conditions that need early and emergent airway control, optimal time for repairing maxillofacial fractures is still debated.

Conditions that need immediate treatment:

- Control of profuse hemorrhage
- Stabilization of bleeding fractures

Conditions needing urgent treatments within few hours:

- Reduction of open fractures.
- Surgical repair of contaminated wounds.
- All injuries that could lead to severe infections or lasting functional impairment should be treated within 24 h [20–22].

Table 1.1 Conditions at higher risk for airway obstruction

Injuries	Nature of airway obstruction
1. Posteroinferior displacement of a fractured maxilla	Nasopharyngeal obstruction
2. Bilateral fractures of the anterior mandible	Loss of tongue support in supine patient
3. Fractured teeth or bone fragments	Obstruction or the airway anywhere
4. Profuse oronasal hemorrhage	Airway bleeding
5. Soft tissue swelling and edema	Upper airway obstruction
6. Fractures of the larynx and hyoid	Swelling of the glottis

Conditions in which surgical treatment can be safely deferred (within days):

- Patients with associated clinical life-threatening injuries require urgent tracheostomy for the risk of increasing facial edema.

In this setting the maxillofacial surgeon should be early involved in the trauma team's decision-making process [3].

1.3 Airway Management

Maxillofacial trauma often presents a problem of difficult mask ventilation and a predicted difficult intubation, because of:

- Suspected C-spine injury
- High risk of vomiting and aspiration of gastric content
- Oronasal bleeding
- Soft tissue disruption
- Rapidly evolving clinical picture

The fourth National Audit Project of the Royal College of Anesthetists (NAP4—Major complication of airway management) recommends that senior staff should be available in the emergency department, because the complication rate of intubation in this clinical scenario can exceed 20% [23–25].

The anesthetist will choose the best approach, balancing the risks and benefits in relation to the patient's characteristics, airway, signs of impending obstruction, and staff experience (Fig. 1.1):

- Monitoring in awake, spontaneously breathing patient
- Early tracheal intubation [11]

When the airway is patent and no emergency intubation is needed, anesthetists can assess the airway to identify patients who may have difficult anatomy.

Airway difficulty can depend on several factors [26]:

- Poor patient's cooperation
- Difficult mask ventilation
- Difficult supraglottic device placement
- Predicted difficult laryngoscopy
- Difficult endotracheal intubation
- Difficult surgical airway access

When the anesthetist decides on early intubation approach with a predicted difficulty, different options exist. It is important to consider consultation with surgeon and a review of recent imaging studies before proceeding with the airway management [27]:

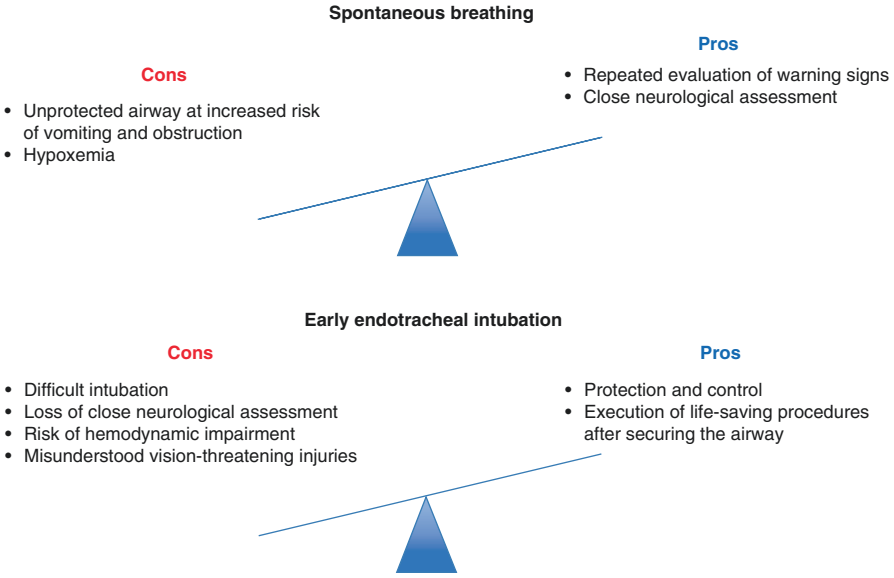

Fig. 1.1 Risks and benefits of the spontaneous breathing approach compared to early tracheal intubation

- Endotracheal intubation in awake spontaneous breathing patient versus intubation after general anesthesia induction
- Noninvasive versus surgical techniques

When difficult intubation is anticipated, guidelines strongly recommend [27, 28]:

1. Adequate patient's position, equipment for primary intubation including capnography in the emergency department and other alternative devices, adequate size of supraglottic device, and additional skilled help and "exit strategy" in case of failed intubation after three attempts
2. Preoxygenation with 100% of inspired oxygen for 3 min of tidal volume breathing

Intubation failure should be declared after three attempts, according to the Difficult Airway Society and the Canadian recommendations on management of the unanticipated difficulty airway.

In this clinical setting when general anesthesia is induced and patients are adequately oxygenated, exit strategies include:

1. Wake the patient
2. Supraglottic device positioning
3. Additional equipment and expert help for further controlled tracheal intubation attempt
4. Surgical access

If oxygenation fails after failed intubation, it is strongly recommended to make one attempt at placing a supraglottic device. Then, if oxygenation is still not adequate with this device, immediate cricothyrotomy should be done.

When tracheal intubation is achieved, periodical reassessment of the stability of the tube should be performed. In fact, patient transport (radiological department, operating room, evolving edema) can result in tube displacement.

1.3.1 Noninvasive Techniques

1.3.1.1 Orotracheal Intubation: Direct Laryngoscopy

Direct laryngoscopy with orotracheal intubation is not the method of choice in maxillofacial surgery because the presence of an oral tube can interfere with surgical maneuvers.

Lee et al. considered direct laryngoscopy as the fastest technique in the emergent airway management of patient with facial fractures in the operating room setting; however it is mandatory to approach this technique with the appropriate expertise [28]. In fact, direct laryngoscopy is indicated in case of emergency airway in a "can't intubate can't oxygenate scenario" with nasal pyramid fractures and skull base fractures or when maxillo-mandibular fixation is not required [16].

On the other end, direct laryngoscopy is contraindicated in case of trauma that can limit mouth opening after general anesthesia induction, of laryngeal trauma, or when maxilla-mandibular fixation is required [15].

1.3.1.2 Nasotracheal Intubation

Nasotracheal intubation often represents the option of choice for elective airway management of patients scheduled for maxillofacial surgery. This technique offers the surgeon better visibility and the possibility of maxilla-mandibular fixation, and it is in patients with reduction of mouth opening. Nasotracheal intubation can be also done in awake patients (fiber-optic intubation under local anesthesia and spontaneously breathing patients) or after general anesthesia induction (direct laryngoscopy) or by a "blind" approach [15].

In the end, it is important to remember that it is contraindicated in case of basal skull fractures with nasal fractures for the risk of intracranial placement during blind insertion. No cases of intracranial placement of tube are reported when fiber-optic intubation is performed [29].

1.3.1.3 Restricted Visual Intubation Techniques

Anatomic abnormalities and the presence of foreign materials decrease the success rate of tracheal intubation to 80% especially when severe oronasal hemorrhage coexists [14].

In case of tracheal intubation with a restricted view (direct laryngoscopy Cormack-Lehane 2b–3) despite continuous suctioning of the oral cavity, the tracheal tube introducer should be considered (recommendation for the airway management—Canadian Airway Focus Group).

Gum elastic bougies and lighted stylet have been proposed as support devices to facilitate tracheal intubation. The gum elastic bougie is considered more effective when the best view is Cormack-Lehane 3 [30, 31]. However, when a rigid device is inserted, great care must be taken to not apply excessive force [23].

The lighted stylet technique is based on the principle of the transillumination of anterior neck soft tissue to guide endotracheal tube. This device can be used during direct laryngoscopy or combined with the intubation through a laryngeal mask (*aintree* catheter). Lighted stylet is considered an option for difficult intubations in maxillofacial trauma [32–34].

As pointed out before, this technique should be only performed by an expert anesthetist; obviously when neck or laryngeal abnormalities preclude transillumination, the lighted stylet is not appropriate [35].

1.3.1.4 Visual Intubation Techniques

Difficult airway algorithms describe visual intubation techniques for the management of anticipated difficult airway [27, 36].

Rigid fiber-optic laryngoscopes can facilitate intubation in patients with suspected or known unstable C-spine injuries: they do not require head or neck movements to obtain a clear view (Wuscopes, Bullard laryngoscopes) [37, 38]. The American Society of Anesthesiologists (ASA) and the Italian Society of Anesthesia and Intensive Care Unit (SIAARTI) include videolaryngoscopes among the alternative intubation devices when a failed intubation is declared and oxygenation is adequate [27, 36, 39].

A recent systematic review underlined that the use of videolaryngoscopy is strongly recommended in patients at higher risk of difficult laryngoscopy, but it is cautiously recommended in patients with known difficult direct laryngoscopy [40]. In trauma setting videolaryngoscope provides a better laryngeal view maintaining cervical in-line stabilization [41], but it is well known that a clear visibility is essential for a correct use of these devices (fogging, secretions, blood, and vomit in maxillofacial trauma can impair the vision).

In patient with anticipated difficult intubation and difficult mask ventilation, fiber-optic intubation under local anesthesia in spontaneously breathing patients is the first choice [27, 36]. Unfortunately, it is challenging and sometimes not practical in maxillofacial trauma because of oral bleeding, vomit, or secretions that can occlude supraglottic structures. Nevertheless, although time-consuming, fiber-optic intubation has been used by skilled clinicians in patients with penetrating neck trauma, oronasal bleeding, and unstable fractures [15].

1.3.2 Alternatives to Tracheal Intubation

Supraglottic devices (SGD) have a limited role in this kind of trauma patients because they have to be placed blindly and do not provide an airway protection, with the risk of displacement and aspiration of gastric content [23]. However, SGD are recommended as “exit strategy” when intubation is failed after induction of

anesthesia in adequately oxygenated patient or when oxygenation fails after failed intubation attempt [36].

Of note, SGD allow the passage of a tracheal tube with a blind technique or under fiber-optic guidance. Fiber-optic assisted intubation via a place classic laryngeal mask should be considered only when dedicated laryngeal masks are not available [31].

Similarly, the Combitube can be inserted quickly and may also protect against the aspiration of gastric content or blood. It is important to keep in mind that its insertion may cause complications in the upper esophageal tract, particularly when disruption of the anatomy and tissue damage are present [42].

1.3.3 Surgical Techniques

A surgical airway is mandatory in emergency [43]. Cricothyrotomy is recommended over tracheostomy by the Canadian and Italian guidelines and ATLS® because it is less time-consuming, easier, and causes fewer complications. The cricothyroid membrane is less vascular and more palpable. Canadian guidelines recommend that cricothyrotomy should be done with a percutaneous needle-guided wide bore cannula or surgical technique, because the percutaneous insertion of an intravenous type cannula is associated with the highest complications and failure rates and does not allow the placement of a cuffed tracheal tube to ventilate, although it is advocated by ATLS® to buy time while preparing for a definitive airway [36].

Tracheostomy can be considered in a patient with a previously secured airway when the severity of maxillofacial trauma or the associated multi-organ injuries require prolonged mechanical ventilation. In some cases, after expert evaluation of the patient's clinical conditions and local anatomic abnormalities, tracheostomy under local anesthesia could be performed. Progressive soft tissue swelling can often require an elective tracheostomy at the end of other surgical procedures. To avoid tracheostomy, which is associated with higher morbidity, maxillofacial surgeons have described submental and retromolar intubation in selected patients with maxillofacial trauma [15]. In fact, several maxillo-surgical procedures preclude the conventional oral intubation route. The submental surgical route described by Hernandez-Altemir, performed after orotracheal intubation, might offer an effective option for the surgeon and the anesthetist to obtain an unobstructed surgical field and ensure the maintenance of a secure airway [44].

1.4 Vision-Threatening Injuries

Maxillofacial trauma can also result in various degrees of orbital floor fractures, so that a compartmental syndrome can develop. A reduction in perfusion pressure and ischemia of the optic nerve can occur within 2 h [21, 45]. Moving from these considerations, an urgent ophthalmic assessment is needed in all patients with periorbital lesions (Fig. 1.2).

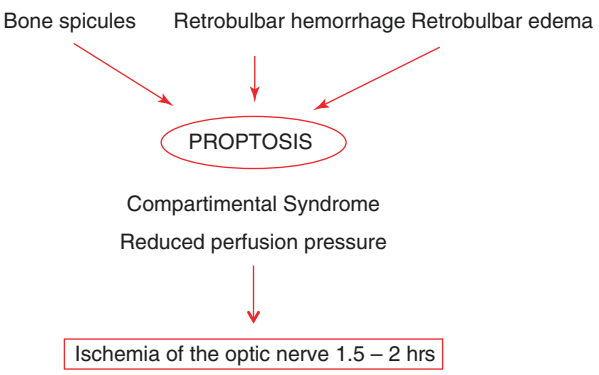

Fig. 1.2 Vision-threatening injuries

Recognition and appropriate treatment of vision lesions should be performed at the end of the "A, B, C, D, E" evaluation and should not delay life-saving interventions. The management of vision-threatening injuries consists in globe protection: high-dose steroids and surgical decompression (under local or general anesthesia). Before surgical treatment, a computed tomography scan will be helpful to clarify and identify anatomical structures. However, proptosis per se is rarely an indication for urgent surgery [21, 45, 46].

Conclusions

In conclusion, maxillofacial trauma may be challenging for the decision-making process and clinical management. Knowledge of the priorities and of specific potential complications together with the cooperation among different professional figures in a multidisciplinary team is crucial for the successful management of patient with maxillofacial trauma.

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