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Review Article

Airway Trauma and Management

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Abstract

Numeurous studies have pointed out that the timely airway securing is essential for the survival of polytraumatised patients. However, sometimes intubation is hard to perform due to the presence of a direct airway trauma. Direct airway trauma includes: maxillofacial trauma, mandibular trauma, laryngotracheal injuries, injuries of the distal airway, penetrating neck injuries and damage of the soft structures and bleeding. Depending on the injury type different intubation techniques can be used. The most usual intubation technique is direct laryngoscopy or blinded intubation. Intubation with the help of fiberoptic flexible bronchoscope gave the best results, but in the case of the impossible intubation techniques like urgent cricothyrotomy and tracheotomy can be used.

Keywords: *Intubation; Airway Control; Multiple Injuries; Injuries, Neck; Chest Injuries*

Introduction

The inability of airway securing has major influence on the increase of mortality in polytraumatized patients [1]. Studies which have examined the trauma mortality show that the fatal outcome could be avoided by adequate airway management in more than 85% of patients who suffered non-lethal injuries [2,3]. The fact is that the airway securing by endotracheal intubation improves the survival of traumatized patients [4]. However, although essential, sometimes it is difficult to provide intubation since the airway management in polytraumatized patients could be aggravated by the presence of direct airway trauma. Direct airway trauma includes: maxillofacial trauma, mandibular trauma, laryngotracheal injuries, distal airway injuries, penetrating neck injuries and damage of the soft structures and bleeding. This category also includes the cases which represent a real challenge even for the experts in this field. Autopsy material indicates that about 70-80% of patients with the immediate airway trauma die before even receiving medical aid.

Maxillofacial Injuries and Airway Management

Maxillofacial injuries are predominantly associated with traffic accidents. They occur in 22% of patients who are polytraumatised in traffic. Patients with this type of injury are usually stable after hospital admission but as much as 35% of them will require airway securing during the next hours. Midface injuries/Le Fort III and mutual fractures of the mandible could lead to the obstruction of the upper airway. Airway securing in the midface injuries and especially in panfacial trauma, which includes mandible in the fracture line, require special attention. Different techniques of intubation as well as the modalities of surgical airway securing are described in the literature. Large studies have shown that in most cases of maxillofacial trauma airway is initially secured by (oro/naso) tracheal intubation (80%), while urgent cricothyrotomy (8%) or tracheotomy (6%) are considerably less provided [5]. On the other hand, oral route for tracheal intubation could be inconvenient in some maxillofacial injuries primarily due to interference with the surgical field and occlusion with teeth which is sometimes necessary for the fixation stabilization of maxillary and mandibular fractures [6].

The nasal intubation route could be used as an alternative. However, in some panfacial fractures, deformities and fractures of the nasal bone could make this route impassable. Nasotracheal intubation is also contraindicated in patients with the fracture of cribriform plate of ethmoid bone, which is often associated with maxillar fractures of Le Fort II and III type. This is because of the potential danger of infection entry into the central nervous system as well as because of the possibility of fatal cranial intubation occurrence [7,8]. Surgical airway securing by performing preoperative tracheotomy could represent a valid alternative when orotracheal and nasotracheal route are contraindicated or unavailable. However, the performance of this method carries a high risk of dangerous complications, especially in children, in obese patients and in patients with an enlarged thyroid gland [9]. Modern anesthetic practice points out that the useful method for airway securing and maintenance in maxillofacial surgery could be the technique of submental or submandibular endotracheal tube placing. Submental intubation was introduced into anesthesia practice in 1986 by Hernandez Altemir [10] as an alternative to short-term tracheotomy in the case when both orotracheal and nasotracheal intubation techniques are contraindicated or impossible to perform. Original Altemir technique carried risks of serious complications like: sublingual salivary gland and its ductal damage, submandibular gland ductal damage and lingual nerve lesion. Regardless of the relative low incidence of these complications, the original technique of submental intubation experienced certain modification in the following years [11,12]. However, in 1994 Stol *et al*. [13] recommended a new modification with the place of incision shifted more backwards, in submandibular region, reducing the risks of salivatory structures injuries to a minimum. Recent studies prove that submandibular intubation is easily feasible and highly effective procedure of airway security in panfacial trauma when the oral and nasal routes of intubation are inadequate [14-16].

Laryngotracheal Injuries and Airway Management

Direct laryngotracheal trauma is uncommon and quite rare (it occurs in only 0.1% of traumatized patients) but it can represent a very serious challenge in the terms of airway securing. Over 75% of patients with a trauma like this die on the accident site or after admission to the emergency department. Between 14 and 25% of patients who survive the initial laryngotracheal trauma die due to associated injuries [17]. A special difficulty in management represents the fact that these injuries frequently remain unrecognized in initial assessment of polytraumatized patients. Only direct laryngoscopy during endotracheal intubation in the patients with threatening respiratory arrest or head injuries that require immediate surgery, make these injuries visible. Isolated laryngeal injuries are extremely rare primarily due to the fact that larynx is relatively well protected by osteomuscular armor (mandible, sternum and sternocleidomastoid muscle) during the blunt trauma. Individually, over 50% of laryngeal injuries are cricoid injuries [18]. Apart from blunt trauma, an isolated cricoids injury can be seen in the specific circumstances of violent injury such as strangulation [19]. The most important factor which determines the timely diagnosis of laryngeal trauma is the high level of expressed doubt that there exists the injury of the laryngeal structures as part of the polytrauma with the blunt injury of the neck. According to the American College of Surgeons' Advanced Trauma Life Support protocol there are three clinical indicators which directly point to the laryngeal injury: hoarseness, subcutaneous emphysema and palpable fractures of laryngeal cartilage [20]. Traditionally, tracheotomy and cricothyrotomy are recommended as urgent, life-saving procedures since the orotracheal intubation by direct laryngoscopy could cause additional, iatrogenic complications in patients with laryngeal trauma [21]. In the recent years, the technique of flexible fiberoptic laryngoscopy is imposed as the gold standard in the diagnosis of laryngeal injuries and in the airway management. But in spite of that, the early surgical intervention is favored in massive laryngeal edema, in cartilage fracture with dislocation and in the need for immobilization of the cervical spine [22].

Signs and symptoms could be nonspecific and barely noticeable, especially in isolated tracheal trauma, when they do not specifically differ from pneumothorax caused by serial rib fractures. About 80% of these fractures are located on the 2.5 cm of carina. This trauma is about 5 times more common in men. Anyway, an isolated tracheal separation is clinically characterized by: airway distress, hoarseness, traces of laceration and skin contusion above the tracheal projection as well as subcutaneous emphysema [23]. In the case of incomplete tracheal transaction, mediosternal tissue around the injury could sometimes form the so-called "neo-trachea" and maintain the patency of airway until the pressure in the trachea isn't too high. Tracheal intubation is in this case extremely dangerous because the distal end of the tube obstruct the airway on the transaction site by entering the false lumen of tissue neo-tracheal.

This is how the gas leaks in the mediastinum and pleura, which is particularly obvious when the tube is connected to the positive pressure ventilation. Air leakage in the space between the damaged part of trachea and pretracheal fascia in the terms of positive pressure ventilation could lead to a significant air accumulation in the pericardial sac and dramatic image of cardiac tamponade [24]. However, even in the case of a complete tracheal disruption with tearing off the distal part of trachea and its migration in the mediastinum, endotracheal intubation is possible to perform using a flexible bronchoscope as a guide for endotracheal tube's introduction into the disrupted distal part of trachea. In this way it is possible to establish an airway in such a dramatic and hazardous situation. Tracheotomy should be performed only in the case of a failed bronchoscope guided intubation [25].

Distal Airway Injuries and Airway Management

It seems that the distal airway injuries are a product of the modern society, although the first written data about tracheobronchial injuries date from the year 1792 [26]. Tracheobronchial injuries are very rare but although essential, prompt diagnosis can be very difficult and delayed. Symptoms of direct tracheobronchial trauma are uncharacteristic and hard to notice, so their importance could be neglected when compared to other injuries. There is a real variety of symptoms, which range from death due to the airway obstruction even before hospital admission to silent and less obvious signs of distal airway injuries. Overall, tracheobronchial injuries are divided into: extrathoracic tracheal injuries and intrathoracic tracheobroncial injuries. Tracheobronchial clefts deserve a particularly great attention, primarily because of the high mortality rate which varies between 20 and 50% [27,28]. Fortunately, only 1% of all the patients with a closed blunt trauma have this character and type of injuries [29]. Subcutaneous emphysema is a common finding in these injuries. Studies show that subcutaneous emphysema is verified in 64% of patients with tracheobronchial cleft [29,30]. Mediastinal emphysema, especially in the absence of pneumothorax, strongly argues in favor of esophageal or tracheobronchial rupture. Fibroptic bronchoscopy is a mandatory method of airway security when there exists a doubt for this type of injury. A direct visualization of tracheobronchial tree allows the proper position of the tube cuff which was placed distal from the cleft site during the surgical management of trauma. In contrast, at the end of the procedure fiberoptic bronchoscopy makes the withdrawal of the tube backwards easy with the aim to place the tube end proximal of the place of lesion suture. Bronchoscopy is on the other side necessary to exclude the doubt that tracheobronchial disruption exists in the polytraumatised patients with: dyspnea, hemoptysis and medistainal emphysema [31,32].

Penetrating Neck Injuries and Airway Management

Penetrating neck injuries (PNI) represent a real nightmare for every medical doctor who works in the emergency department. In the USA, only 1% of trauma patients are patients with PNI. As much as one third of these patients also have other life threatening injuries. In 45% of cases these injuries are the consequence of the firearm influence, in 40% those are stabbing injuries, while other 5% are the buckshot wounds. The mortality of PNI is between 3 and 6%, with the injuries of big neck blood vessels as the leading direct cause of death [33]. PNI is according to the anatomic localization of injury divided into the injury located on the front and back side, or three zones. Zone I extends from the clavicle to cricoids. Zone II extends between the lower edge of the cricoids cartilage and horizontal line which connects both angles of the mandible. Zone III represents the space between the angle of mandible and the skull base (Figure 1) [34].

The neck is a body part with a complex anatomy, with a lot of vital structures which are a couple of millimeters away from each other. From that point of view, procedures of initial assessment and stabilization of vital functions of the patients with PNI represents a top priority. Airway securing certainly represents that kind of measure. Airway management in patients with PNI is controversial. In the two year study of 107 patients with a penetrating neck injury, Shearer and Giescke have investigated: the choice of (intubation) technique, mechanism of injury, zone and type of affected neck structures. Direct laryngoscopy with pharmacological support (Rapid Sequence Induction-RSI technique) has been applied in 89 cases (83%), in 6 patients (6%) airway was secured surgically, in 7 patients (8%) awake fiberoptic bronchoscopy was performed, while a blinded nasotracheal intubation has been attampted in 4 patients (4%). The success rate was not significantly different when we compare the applied strategies, although two patients have died after an unsuccessful attempt of blinded nasotracheal intubation.

Having those devastating complications in mind, and on the other hand, the limitating factor of time and training in fiberoptic intubation performance, these authors recommend the RSI technique with direct laryngoscopy and surgical airway management as the techniques of choice in patients with PNI and a threatening airway failure [35]. Other studies which have dealt with this problem also had a retrospective character but they also included significantly lower number of patients. These studies also point out the direct laryngoscopy including RSI protocol as the most frequently used technique with a high percent of success in airway management (95-100%) [36-38].

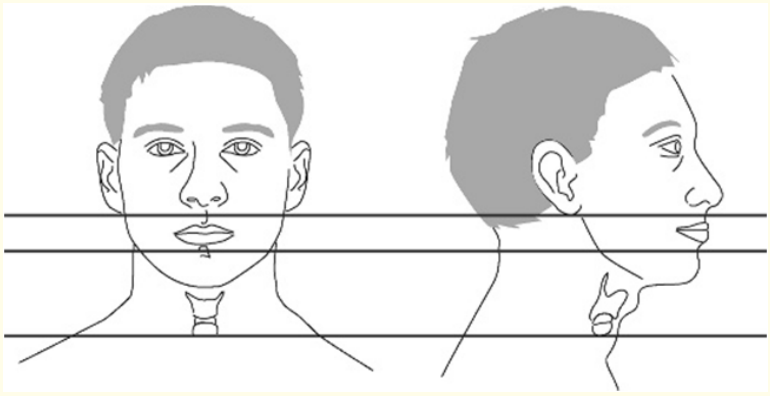

Figure 1: *Areas of penetrating neck injuries in relation to the anatomical classification.*

Damage of the Soft Structures of the Neck and Airway Management

Injuries of the upper airway often lead to a dramatic image of acute airway obstruction. Fortunately, incidence of these injuries is very low (< 1%). Pharyngeal injuries are a relatively common cause of upper airway obstruction. Trauma usually occurs by a coarse instrumentation on vulnerable pharyngeal mucosa in the cases of: nasopharyngeal airway placing, nasogastric tube placing, difficult nasotracheal and orotracheal intubation and using of supraglottic devices [39]. Less commonly, pharyngeal trauma can occur from the rescucitators fingers in the case of removing the foreign bodies from the airway [40]. Pharyngeal trauma followed by perforation in retropharyngeal and parapharyngeal space is further complicated by the development of mediastinitis and frequently ends in death. Other, much rarer, circumstances which indirectly lead to airway obstruction include: edema of soft tissues of the oral cavity (lips and tongue) [41], edema of supraglottic region or the presence of large neck hematoma cause by ruptured pseudoanerysm of carotid artery or by the artificial puncture of carotid artery during the central venous cannulation [42].

Conclusion

We can point out in the conclusion that the airway securing in polytraumatized patient represents a real challenge. Craniofacial injuries, penetrating neck and thoracic injuries, as well as closed, blunt trauma of thorax and neck often lead to insufficient airway. Depending on the type of injury and airway management we can use intubation techniques with the help of direct laryngoscopy or blinded techniques, intubation with the help of fiberoptic flexible bronchoscope and also the technique of the urgent cricothyrotomy and tracheotomy.

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