EXTUBATION STRATEGY FOLLOWING DIFFICULT INTUBATION

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SUMMARY – Airway management relates to the period of tracheal intubation, maintenance of endotracheal tube *in situ*, and finally extubation. Problems related to difficult extubation still pose significant challenge for both anesthesiologists and intensivists. This article reviews current approach to extubation strategy following difficult intubation. Guidelines and algorithm may be helpful in order to ensure safe management of the patient during this delicate period of airway management.

Key words: *Airway management; Difficult intubation; Extubation*

Introduction

Airway management focuses on the period of tracheal intubation, maintenance of the endotracheal tube *in situ*, and extubation including continuous control of the airway in the post-extubation period[1]. A large number of published papers and current guidelines on airway management focus on the period of induction of anesthesia and difficult tracheal intubation[2]. By following these guidelines, we nowadays witness their positive results. An analysis of the proportion of closed malpractice claims for death or brain damage performed by the American Society of Anesthesiologists has shown a significant decrease in death or brain damage with induction of anesthesia from 62% in the period between 1985 and 1992 to 35% between 1993 and 1999[3].

On the contrary, the number of published articles and guidelines focusing on the period of extubation following difficult intubation is much lower, although the risk of complications in this period seems to be relevant. Respiratory complications following tracheal extubation are three times more often compared to those during induction of anesthesia (12.6% *vs.* 4.6%)[3]. Accordingly, the proportion of malpractice claims for death or brain damage related to maintenance of anesthesia, extubation and post-anesthesia recovery did not change during the last ten years[2]. Therefore, problems related to difficult extubation still pose a significant challenge for both anesthesiologists and intensivists.

Extubation Strategy

The American Society of Anesthesiologists Task Force on Management of the Difficult Airway states that the use of an extubation strategy is a logical extension of the intubation process[4]. As it is often stressed in the literature, in a patient at a high risk of difficult airway it is essential to reformulate the extubation strategy. Since there is no single strategy for difficult intubation and the practitioner chooses between different options according to the clinical situation, there is also the need for specific extubation strategies, depending on the medical and surgical conditions of the patient, previous procedures on the airway, current airway status, as well as the skills and preferences of the anesthesiologist.

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Before choosing a specific strategy, it is assumed that the routine procedures of an extubation plan have been performed, including:

- deciding when, where and in which position to extubate the patient;
- recognizing and managing problems related to extubation; and
- recognizing patients at a high risk of difficult extubation and reintubation.

As a general rule, patients should be extubated awake[3]. Extubation in the state of deep anesthesia reduces cardiovascular stimulation and the incidence of coughing and straining, while increasing the incidence of respiratory complications regardless of the type of surgical procedure[3]. Traditional extubation practice in the left lateral recumbent position with a lowered head keeps the airway open, detaches the tongue from the posterior pharyngeal wall, and protects the airway from aspiration. There is no scientific evidence that extubation in supine semi-sitting position is as safe as the traditional one, but it is applicable in previously fasted patients in whom short-acting neuromuscular blocking agents (NMBA) were used[3]. Supine semi-sitting position facilitates reintubation and is recommended in patients at a high risk of difficult intubation and in obese patients. In these patients, as well as in those with chronic obstructive pulmonary disease or previous surgical procedures on upper airways, the supine half-sitting position facilitates spontaneous respiration and diaphragmatic expansion, assists cough-reflex effectiveness, increases functional residual capacity, helps lymph drainage and decreases airway edema[3]. Extubation in prone position is occasionally used after spinal surgery[3,5].

Extubation is usually performed at the end of inspiration, with the glottis completely open, in order to reduce trauma and prevent laryngospasm. Extubation is primarily performed in the operating theater as well as in recovery room and intensive care unit (ICU). Since there is evidence that extubated patients transported to the recovery unit arrive there with a lower oxygen saturation, it is recommended that 100% oxygen is administered before leaving the theater and high inspired oxygen given during transfer[3,5].

Problems related to extubation can be mechanical or result from a pathophysiological reaction (cardiovascular response, respiratory complications, airway obstruction, postoperative lung edema, tracheotomy, pulmonary aspiration)[3].

Patients at a risk of difficult extubation and reintubation are those who underwent multiple intubation attempts, patients with severe cardiovascular diseases, congenital or acquired airway pathology, morbidly obese, patients with obstructive sleep apnea syndrome and severe gastroesophageal reflux[3]. Additional surgical factors include recurrent laryngeal nerve damage (10.6% in malignant thyroids); hematoma (0.1%-1.1% in larynx or thyroid surgery); edema and distortion of anatomy following head and neck surgery[6]; posterior cranial fossa surgery; intermaxillary fixation and deep neck and dental abscess drainage[3].

Difficult extubation strategies

Many strategies for at risk extubation have been addressed in the literature: exchanging the tracheal tube for laryngeal mask airway (LMA) before emergence, extubation over a flexible bronchoscope, airway exchange catheter-assisted extubation, and extubation in the ICU.

Substituting a laryngeal mask for a tracheal tube

A laryngeal mask airway (LMA) exchange is performed while the patient is still anesthetized and paralyzed. LMA is inserted following tracheal extubation with the patient in a deeper plane of anesthesia. Muscle relaxation is then antagonized and, when spontaneous breathing resumes, the airway patency and adequacy of breathing are reconfirmed and the patient is compliant, the LMA is removed. This maneuver avoids coughing and pressure rise during extubation and at the same time involves less airway manipulation compared with deep anesthesia extubation with Guedel's oropharyngeal airway insertion[3].

Extubation over a flexible bronchoscope

This approach can be considered in patients with suspected laryngeal paralysis, tracheomalacia[7], or tube entrapment[3]. An LMA is inserted to substitute endotracheal tube in the aforementioned way and the patient is then allowed to resume spontaneous ventilation while still anaesthetized. A flexible bronchoscope is advanced through the LMA to enable visualization of the anatomy and assessment of laryngeal function. If required, reintubation can be assisted using an intubation cath-

eter (Aintree) which jackets the flexible bronchoscope[8]. The bronchoscope and the LMA are then removed and the patient is reintubated over the catheter.

Use of a tracheal tube exchange catheter (reversible tracheal extubation)

This strategy is especially useful for adult[9] and pediatric patients[10] expected to be difficult to reintubate. Tracheal tube exchangers (e.g., Cook) are long hollow catheters with connectors for jet and/or manual ventilation and respiratory monitoring, which continuously maintain the airway[2]. Most of them have depth-markers and radio opaque markers, and end or distal side apertures. They can be introduced through a tracheal tube, thus permitting extubation. Catheters allow spontaneous breathing, talking and coughing, and are well tolerated (up to 72 h)[2]. These devices are a valuable option considering that reintubation occurs in 0.4%-25% of cases in different surgical population groups[1].

There are currently no clear recommendations on the optimal duration for continuous airway maintenance using these catheters after extubation. Experts recommend a minimum of 30 to 60 minutes, or vaguely speaking, until the possibility of reintubation is lower[1]. In case of a periglottic edema, it is recommended to leave the catheter in place for 60 to 120 minutes[1]. It is known that periglottic edema most commonly develops in 10 to 45 minutes after extubation, while symptomatic laryngeal edema may appear even up to 8 hours after extubation[1]. When dealing with patients with a cardiovascular disease or other systemic disorder, it is sensible to prolong the continuous maintenance of the airway[11]. In patients with difficult airways who had passed unsuccessful extubation, it is wise to plan the timing for the next attempt of extubation by multiplying the previous extubation period by two or three times, to ensure the next successful extubation. In case of compromised mental or neurological status of the patient, especially as a result of cardiopulmonary constraints, prolongation of continuous airway maintenance to up to 12 to 24 hours may ensure safe management of the patient[1].

Extubation in the Intensive Care Unit

After anesthesia, the extubation risk patient can be transported to the ICU for extubation. Extubation at ICU can then be either protocol directed or unplanned[3]. Current figures say that we are not very good in predicting extubation in ICU. Successful extubation after planned extubation occurs in 80% of patients, while reintubation after planned extubation occurs in up to 20% of patients within 24 to 72 hours of extubation[3]. In addition, most unplanned extubations do not require reintubation[3]. However, since successfully extubated patients have lower mortality (2.5-10 times)[3], it is important to make extubation attempt successful.

DAS Difficult Extubation Algorithm

In 2011, the British Difficult Airway Society (DAS) suggested creation of extubation guidelines. The guidelines are now available at: http://www.das.uk.com/content/extubation-guidelines[12].

The guidelines consist of three algorithms: basic, low risk, and at-risk algorithm. Each of these algorithms has 4 steps: 1) plan extubation; 2) prepare for extubation; 3) perform extubation; and 4) post-extubation care. Strategies for difficult extubation are included in the at-risk algorithm[12].

The first step of the basic algorithm (plan extubation) involves assessment of the airway and general risk factors. Airway risk factors are known difficult airway, airway deterioration due to trauma, edema or bleeding, restricted airway access, obesity, and aspiration risk. General risk factors include cardiovascular, respiratory, neurological, metabolic, and special medical conditions as well as special surgical requirements[12].

The second step of the basic algorithm (preparation) is aimed at optimization of the patient (cardiovascular, metabolic, respiratory, neurological, temperature, neuromuscular) and other factors (location, finding skilled help/assistance, monitoring, equipment), and the patient is stratified into low-risk (fasted, uncomplicated airway, no general risks) or at-risk (ability to oxygenate uncertain, reintubation potentially difficult and/or general risk factors present)[12].

If the patient is characterized as low-risk, the low risk algorithm is followed. One chooses between extubation in deep anesthesia and awake extubation. Deep extubation requires advanced technique, experience of the practitioner, and vigilance until the patient is fully

awake. Awake extubation includes preoxygenation with 100% oxygen, suctioning as appropriate, insertion of a bite block (e.g., rolled gauze), positioning the patient appropriately, antagonizing neuromuscular blockade, establishing regular breathing, ensuring adequate spontaneous ventilation, minimizing head and neck movements, waiting until awake (eye opening/obeying commands), applying positive pressure, deflating the cuff and removing tube, providing 100% oxygen, checking airway patency and adequacy of breathing, and continuing oxygen supplementation[12].

In case the risk stratification has identified the patient to be at risk, the at-risk algorithm is followed. The key question is: is it safe to remove the tube? If the answer is "yes", one of the possible strategies is chosen: awake extubation, laryngeal mask exchange, remifentanil technique, or airway exchange catheter. Patients are transferred to the recovery unit, high dependency unit (HDU) or ICU for further optimization of patient related factors (safe transport, handover/communication, oxygenation and airway management, observation and monitoring, general medical and surgical management) as well as general ones (analgesia, staffing, documentation and equipment). Patients with airway exchange catheters are transferred to the HDU or ICU.

If the answer to the key question is "no", the extubation is postponed or tracheotomy is performed and the patient is transferred to the HDU or ICU for further optimization[12].

Conclusion

The period of extubation is very delicate and related to possible complications, especially if following difficult intubation. In order to avoid complications, it is wise to plan safe way of extubation in advance. Algorithms may help. Therefore, we encourage anesthesiologists and intensivists to use the existing extubation algorithms or to develop their own.

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Sažetak

STRATEŠKI PRISTUP EKSTUBACIJI NAKON OTEŽANE INTUBACIJE

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Osiguravanje dišnog puta odnosi se na razdoblje intubacije, održavanje endotrahealnog tubusa *in situ* i konačno na razdoblje ekstubacije. Problemi u vezi s otežanom ekstubacijom još uvijek predstavljaju značajan izazov za anesteziologe i intenziviste. Ovaj članak prikazuje suvremeni strateški pristup ekstubaciji nakon otežane intubacije. Smjernice i algoritmi mogu biti korisni za održavanje sigurnosti bolesnika u tom osjetljivom razdoblju osiguravanja dišnog puta.

Ključne riječi: *Osiguravanje dišnog puta; Otežana intubacija; Ekstubacija*