



AIRWAY MANAGEMENT IN NEUROANESTHESIA

Tamara Murselović¹ and Alka Makovšek²

¹Department of Anesthesiology, Resuscitation and Intensive Care Medicine, Sveti Duh University Hospital, Zagreb, Croatia;

²Department of Anesthesiology, Resuscitation, Intensive Medicine and Pain Therapy, Zagreb University Hospital Center, Zagreb, Croatia

SUMMARY – Neurosurgical patients have specific airway management. Various conditions and diagnoses make intubation difficult and may also cause neurological damage. Spinal pathology, neurotrauma, cervical spine surgery, and pituitary gland surgery are just some examples. The aim of this review article is to present a broad spectrum of neurosurgical operations and potential complications in maintaining airway patency related to these issues. Quality perioperative preparation is a prerequisite to avoid the potentially irreversible consequences of difficult airways with a poor neurological or even fatal outcome. Patients with tumors of the pituitary region who present with Cushing's disease are prone to difficult ventilation, tracheal obstruction and difficult intubation. Awake craniotomy is also a challenge for the anesthesiologist, given that access to the airway is problematic due to the fixed frame. Unstable cervical spine occurs in cases of rheumatoid arthritis or blunt trauma, requiring precautions to be taken with spinal stabilization during intubation and induction. Pharyngeal edema and hematomas, possible complications of cervical spine surgery can endanger airway patency after extubation; postoperative patient supervision is thus required. Due to the potential threat to the patient's airway during neurosurgical procedures, quality anesthetic preoperative preparation is necessary to avoid irreversible damage and death.

Key words: Neuroanesthesia; Difficult airway; Intubation

Introduction

By definition, difficult airway is one with which a trained anesthesiologist faces difficulty during mask ventilation and/or tracheal intubation¹. When oxygen saturation cannot be maintained above 90% during facemask ventilation, this is considered difficult mask ventilation; this occurs at an incidence of approximately 1 *per* 700 attempts¹. Although there is no universal definition of difficult tracheal intubation, multiple at-

tempts at intubation or a change in plan automatically make intubation difficult. Airway management in neuroanesthesia does not differ much from airway management in other fields of anesthesia. However, there are specific factors related to neurosurgical procedures and underlying neurological diseases that can present an obstacle to ventilation and airway patency maintenance. Since airway management is a basic competency of anesthesiologists, they are skilled in a variety of techniques to manage the airway safely. In addition to difficult mask ventilation and intubation, difficult extubation is also worthy of note. In order to safely attempt intubation, the patient should be assessed, and an intubation plan made and reviewed prior to per-

Correspondence to: *Tamara Murselović, MD, PhD*, Department of Anesthesiology, Resuscitation and Intensive Care Medicine, Sveti Duh University Hospital, Sveti Duh 64, HR-10000 Zagreb, Croatia
E-mail: murselovict@yahoo.com

forming the induction. Indications for neurosurgical patient could be immediate (persistent apnea, airway obstruction or inability to ventilate), urgent if Glasgow Coma Score (GCS) is 8 or less, anticipated occlusion by hematoma, edema or laryngotracheal fracture, and relative if control of intracranial pressure *via* PCO_2 is needed. The OBESE acronym contains identifiable predictors of difficult ventilation and intubation (O = body mass index [BMI] >26 kg/m²; B = bearded; E = elderly, age >55 ; S = snorer; E = edentulous) with sensitivity of 72% and specificity of 73%². Extubation criteria for neurosurgical patients are somewhat problematic since successful extubation requires satisfying pulmonary function, ability to maintain airway patency, as well as intact central respiratory drive. They include spontaneous breathing trials, rapid shallow breathing index (RSBI), strong cough reflex, and minimal secretion³. In this article, the authors present obstacles and problems with airway management in relation to a number neurosurgical procedures and patient conditions. According to data, approximately 200 000 patients in the United States require mechanical ventilation secondary to neurological pathology, with significant medical and economic implications, therefore it is important to emphasize, disclose and review pitfalls and problems related to difficult airway in neurosurgical patients⁴.

Methods

This paper was created on the basis of 52 articles from the PubMed database with all elective or urgent neurosurgical patients as the including criteria and pediatric population as the excluding factor.

Discussion

Pituitary surgery

Airway management for pituitary surgery can be demanding. The main concern involves the types of hormone secreted. Overabundant secretion of growth hormone results in a condition known as acromegaly. This same oversecretion leads to generalized visceromegaly, but more importantly for the anesthesiologist, to swelling and hypertrophy of the parapharyngeal tissue, soft palate swelling, macroglossia, vocal cord thickening and paresis, epiglottal hypertrophy, maxillary and mandibular hypertrophy, and tracheal compression⁵. These anatomic and physiologic changes

result in an increased risk of difficult direct laryngoscopy in 9%-40% of patients with acromegaly. As compared to the general patient population, of whom only 2%-6% of patients are at risk of difficult intubation regardless of Mallampati score, mouth opening, or thyromental distance, acromegaly poses a significant obstacle to the anaesthesiologist⁶⁻¹⁰. Some authors state an even higher incidence of difficult intubation (62.5%)¹¹. Patients with acromegaly are also more prone to obstructive sleep apnea (OSA), which increases their risk of difficult extubation and insufficient postoperative ventilation. Constant use of airway pressure devices after trans-sphenoidal pituitary resection could cause pneumocephalus¹². Cushing's disease as a consequence of excessive secretion of adrenocorticotropic hormone presents with a spectrum of morphological changes such as central obesity, moon face, oropharyngeal muscle myopathy, and buffalo hump. These clinical manifestations may make laryngoscopy more difficult. These patients can also present with OSA⁵.

Functional surgery

Functional surgery is another example of potentially difficult airway management. Interventions such as awake craniotomy or stereotaxic surgery require the anesthesiologist to cautiously assess the airway, even in the absence of an endotracheal tube. During asleep-awake-asleep craniotomy, the anesthesiologist's main concern is ensuring airway patency and managing its possible loss, while reducing patient discomfort and stress with conscious sedation or general anesthesia¹³. Depending on the form of awake craniotomy employed, the anesthesiologist may have to instrument the airway in a suitable manner. Anesthesia for stereotaxic surgery has a similar approach to airway maintenance during surgical procedures. An *in situ* stereotaxic frame can compromise access to the airway. The emergent need for intubation with a stereotaxic frame in place presents a great challenge, while immediate access to the patient's head is limited. A number of complications may arise during functional surgery, including seizures, loss of airway patency, and changes in the neurological state, all of which demand quick airway management.

Spinal surgery

An unstable cervical spine is a common problem in spinal surgery^{14,15}. Reduced neck mobility due to trau-

ma (protective collar) or cervical pathology (rheumatoid arthritis) may hinder classic laryngoscopy and intubation. Immoderate force on the neck may result in permanent spine damage¹⁶. Patients with rheumatoid arthritis present with morphological changes in their temporomandibular joints and cervical spine. Aside from the problems with mouth opening, these patients may also present with atlanto-axial subluxation, which can cause spinal cord damage during intubation¹⁷. The pathology of cervical spine includes discopathy, sclerosis, and instability of vertebral joints. Cricoarytenoid dysfunction is another obstacle; patients may present with symptoms such as dysphagia, hoarseness, stridor, or even airway obstruction¹⁷. Involvement of the ligaments and odontoid can cause atlanto-axial instability without clinical manifestation. Some authors advocate routine x-rays of the cervical spine prior to elective surgery for those patients with rheumatoid arthritis in their history¹⁸. The incidence of cervical spine injury is estimated to be 1.8% after blunt trauma¹⁴. The most common level of injury is at C2 level, followed by C6 and C7 levels¹⁹. Patients having both blunt trauma and associated head trauma with a depressed GCS are more likely to have cervical spine injury than patients suffering from blunt trauma alone^{15,20-22}. Established guidelines exist in emergency medicine to screen for cervical spine trauma and take appropriate precautions until spinal injury is ruled out. Manual in-line stabilization has been adopted as routine practice to immobilize the spine when cervical collar must be removed for airway management²³. When correctly applied, manual in-line stabilization is effective in various motion of the cervical spine and airway maneuvers²⁴⁻²⁸.

Extubation of difficult airways

Loss of airway patency after extubation represents extubation failure. Soft tissue edema and laryngospasm are the most frequent mechanisms of upper airway obstruction. Conditions such as cervical spine surgery, major head and neck surgery, obesity and OSA, among others, carry a significantly higher risk of extubation failure²⁹. In this context, it is important to understand distinction between extubation failure and weaning failure. The anesthesiologist must focus on airway patency using the pre-extubation test while also evaluating the ability of the patient to breathe spontaneously. Extubation failure is defined as the inability to tolerate removal of the translaryngeal tube; it is generally

treated with tracheal reintubation³⁰. A variety of complications lead to airway obstruction causing extubation failure. Upper airway edema, spasm, and hematoma compressing the trachea cause 'extubation related airway complications'³¹⁻³³. If the ability of the patient to maintain airway patency and/or oxygenation after tracheal extubation is uncertain, it is defined as an 'at-risk' extubation³⁴. The term 'difficult extubation' can also denote difficulty in physically removing the endotracheal tube from the trachea. This may be caused by unrecognized subglottic stenosis, severe edema physically preventing removal of the tube³⁵, or even an accidental surgical stitch keeping the endotracheal tube attached to the tracheal wall. In both the postoperative setting and in the intensive care unit, reintubation after extubation occurs most frequently within the first 2 hours post-extubation, and on rare occasion after 24 hours³⁶⁻⁴². In the case of extubation and awakening after pituitary surgery, the patient's nose is usually packed at the end of the operation, resulting in discomfort during emergence from anesthesia. It is important to avoid hypertension and coughing (Valsalva maneuvers) during this stage to avoid bleeding and cerebrospinal fluid leak⁴³. Complications after spinal surgery in the form of upper airway obstruction are well known. The potential threats are pharyngeal edema, hematoma, cerebrospinal fluid leak, angioedema, and graft or plate dislodgement. Risk factors are prolonged operative time (greater than 5 hours) or blood loss of more than 300 mL (both indicating the extent and complexity of the surgery), manipulation above the C4 vertebra, myelopathy, operations during which more than three vertebral bodies are exposed, a combined anterior-posterior approach, and revision surgery. A long procedure means a longer period of retraction and an increase in local tissue trauma and swelling. Surgery above the C4 vertebra also includes forceful retraction underneath the mandible and more tissue damage. An anterior approach in cervical spine surgery can lead to recurrent laryngeal nerve palsy and overflexion during cervical fixation, mainly if the C0-C2 (occipito-atlanto-axial) joint is involved; this may cause the C2 vertebral body to protrude into the pharyngeal wall⁴⁴⁻⁴⁶. In this case, the immediate repercussion is pharyngeal stenosis and upper airway obstruction after extubation. The prone position during spinal surgery is also a risk factor for laryngeal edema and therefore an extubation complication³¹.

Standard management of the difficult airway

At present, most pituitary surgeries are performed using a transnasal, trans-sphenoidal approach that requires orotracheal intubation. Awake fiberoptic intubation with target-controlled sedation is the method of choice when a difficult airway is predicted⁴⁷. Elective cervical spine surgery with an unstable cervical spine, e.g., in the case of arthrosis, is best managed with a flexible fiberoptic or video laryngoscope⁴⁸. Flexible scopes are the best choice for cervical trauma intubation because they cause minimal cervical displacement and reduce the need to remove cervical collar. Since it is more time-consuming and requires a fully cooperative patient with minimal or no blood and secretion in the upper airway, this technique is indicated for stable patients scheduled for elective surgery. The video laryngoscope is more suitable for urgent intubation⁴⁹. Supraglottic airway devices used during awake surgeries are a feasible option. According to some authors, these should be the first choice for emergency airway management, followed by fiberoptic intubation through the laryngeal mask airway⁵⁰.

Conclusion

Due to the potential threat to the airway in certain neurosurgical procedures, and considering the very nature of the disease and the procedure to which the patient is exposed, quality anesthetic preparation is necessary to avoid irreversible damage and death. Neuroanesthesiologists must be aware of the risks and be well trained in different techniques to manage the airway safely and efficiently. Non-conventional patient positions and an abundance of surgical devices create barriers that interfere with access to the patient's airway. A carefully planned strategy to manage the airway throughout the surgery is mandatory. This includes choosing the optimal way to intubate, extubate, and resolve any unexpected complications that may arise.

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Sažetak

ZBRINJAVANJE DIŠNOGA PUTA U NEUROANESTEZIJI

T. Murselović i A. Makovšek

Zbrinjavanje dišnoga puta je u neurokirurških bolesnika specifično. Različita stanja i dijagnoze čine intubaciju otežanom, a isto tako mogu uzrokovati i neurološka oštećenja. Spinalna patologija, neurotrauma, operacije vratne kralježnice, operacije tumora pituitarne žlezde samo su neki od primjera. Cilj ovoga preglednog članka je prikazati širok spektar vrsta neurokirurških operacija i uz njih vezane potencijalne komplikacije održavanja dišnoga puta. Dobra priprema bolesnika, kao i dobra priprema anestezije preduvjet je da se izbjegnu potencijalno ireverzibilne posljedice otežane intubacije s lošim neurološkim ili eventualno smrtnim ishodom. Bolesnici s tumorima pituitarne regije koji se prezentiraju Cushingovom bolešću skloni su otežanoj ventilaciji, opstrukciji dišnoga puta i otežanoj intubaciji. Budna kraniotomija predstavlja također izazov za anesteziologa s obzirom na to da je pristup dišnom putu otežan zbog učvršćenog okvira na glavi. Nestabilna vratna kralježnica se javlja kod reumatoidnog artritisa, tupe ozljede glave i vratne kralježnice te zahtijeva mjere opreza uz stabilizaciju kralježnice tijekom intubacije. Faringealni edemi i hematomi koji su komplikacije operacija vratne kralježnice mogu ugroziti dišni put nakon ekstubacije te je potreban i poslijeoperacijski nadzor neurokirurških bolesnika. Zbog potencijalne ugroze dišnoga puta potrebna je kvalitetna anesteziološka priprema kako bi se izbjegla ireverzibilna oštećenja i smrt.

Ključne riječi: *Neuroanestezija; Otežani dišni put; Intubacija*