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INTUBATION OF THE NEUROLOGICALLY INJURED PATIENT

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☐ Abstract—Background: Intubation of the neurologically injured patient is a critical procedure that must be done in a manner to prevent further neurologic injury. Although many different medications and techniques have been used to meet specific needs, there is little to no evidence to support many claims. Objective: To review the literature regarding important topics relating to intubating patients with neurologic injury. Discussion: Airway management requires ideal preoxygenation and airway maneuvers to minimize manipulation of the larynx and to maximize first-pass success. There is no evidence that lidocaine pretreatment decreases intracerebral pressure (ICP). Fentanyl can be used to help blunt the hemodynamic response to intubation. Esmolol is another medication that can blunt the hemodynamic response. Ketamine can be used and is possibly the ideal agent, having a neutral hemodynamic profile. A prefasciculation dose for neuromuscular blockade has not been shown to have any effect on ICP. Conclusions: Ideal intubation conditions should be obtained through the use of airway manipulation techniques and appropriate medication choice for rapid sequence intubation in patients who are neurologically injured. © 2015 Elsevier Inc.

☐ Keywords—airway management; intracerebral hemorrhage; neurologically injured patients; rapid sequence intubation; traumatic brain injury

INTRODUCTION

Airway management is one of the most important skills that emergency physicians perform. There are certain situations where we can potentially cause further harm if it is not done in an appropriate manner. The intubation of a patient with a severe traumatic brain injury, subarachnoid hemorrhage, or other intracranial pathology must be performed in a careful approach with the proper medications and techniques. This article will review the current understanding of the physiology of intracranial hemorrhage and how it relates to the process of intubation.

DISCUSSION

Pathophysiology

The pathophysiology of the neurologically injured patient is multifactorial. The brain, as an organ, requires a significant amount of oxygen and blood flow to maintain metabolism. Through the process of autoregulation, the brain is able to maintain its own perfusion based upon detected pH, pO₂, pCO₂, and intravascular volume (1). This process can be roughly measured via the cerebral perfusion pressure (CPP), as it is very difficult to measure brain perfusion directly. The CPP is measured by subtracting the intracerebral pressure (ICP) from the mean arterial pressure (MAP) (2). A normal ICP is <15 mm Hg.

Patients sustaining neurologic injury have loss of autoregulatory functions secondary to the injury or to other situations, such as mass effect from a hematoma. These patients may be unable to autoregulate, and as a result, ICP increases. As ICP increases, CPP is decreased as

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cerebral blood flow drops precipitously due to an inability of the MAP to exceed the pressure required to perfuse the brain. This results in decreased neurologic perfusion and anoxic injury (2). The brain is able to maintain autoregulation over a range of CPP from 50–100 mm Hg (3). However, in the setting of traumatic brain injury, perfusion of the brain becomes sensitive to slight changes in CPP (4).

Cerebrospinal fluid (CSF) surrounds the brain and spinal cord inside the cranium and spinal canal. There is approximately 150 mL of CSF, 100 mL of blood, and <1300 mL of brain tissue inside the skull of an adult (2). Under the Monro-Kelli hypothesis, when one compartment has an acute increase in value, the other compartments must shrink in compensation to accommodate the increased volume (5,6). When this is not possible, ICP increases, which in turn decreases CPP and brain perfusion.

In traumatic brain injury, subarachnoid hemorrhage, or other intracerebral mass lesions and hemorrhages, the ICP increases to a point where CPP decreases and causes ischemia. Many of these patients require airway management. Measures to minimize the rise in ICP during airway management will be discussed as well as the role, if any, of medications to blunt the hemodynamic response.

Airway Management

Management of the airway in patients with neurologic injury is of paramount importance. Even one episode of hypoxia has been shown to increase mortality in the management of patients with severe traumatic brain injury (7). Therefore, it is paramount to minimize any hypoxia that might occur during airway management.

Preoxygenation of these patients is a critical maneuver. There are multiple methods to preoxygenate patients. The most commonly taught maneuver is to place the patient on a nonrebreather mask at 15 liters per minute (lpm) and allow the patient to take tidal volume ventilation for 3–5 min. However, in critically ill patients, time to desaturation is quicker (8,9). Time permitting, critically ill head-injured patients require longer periods of time for preoxygenation. Furthermore, they may not be able to take tidal volume ventilation due to decreased mental status. Bag valve mask ventilation may be required to preoxygenate these patients due to mental status.

Weingart and Levitan detail a method of preoxygenation involving nasal cannula apneic oxygenation (10). They describe placing patients on a nasal cannula at 15 lpm or higher prior to induction of sedation and neuromuscular blockade. Although it may be uncomfortable for patients, this flow of oxygen allows for passive oxygenation to occur in the alveoli. This technique has been extrapolated from the anesthesia literature; it improves

preoxygenation and prevention of desaturation while intubating patients. Furthermore, there is recent literature showing the feasibility, safety, and decrease in desaturation of this practice during intubation in the prehospital setting and the emergency department (ED) (10–12). This is a simple method that can improve preoxygenation, and its utilization is highly recommended during any intubation.

In addition, positioning of patients during preoxygenation is critical. Head-of-the-bed elevation is a simple technique that can have significant benefit to preoxygenating patients. It has been found in the anesthesia literature to improve preoxygenation in obese and nonobese patients (13). Patients can be preoxygenated with the head of the bed up 30°, or ideally, sitting upright, for maximal effect. This allows for the dependent alveoli as well as the most superior alveoli to be entirely saturated with oxygen. This may be helpful in the neurologically injured patient to improve preoxygenation. Likewise, it is also recommended to decrease the ICP, although the evidence for this is more limited (14,15). However, these techniques can be difficult to do, especially in patients who may have unstable spinal injuries, or who are uncooperative with preoxygenation techniques due to altered mental status.

Noninvasive preoxygenation methods, specifically bilevel positive airway pressure or continuous positive airway pressure, has been shown to improve preoxygenation in critically ill patients (16–18). The data also show that it is safe and effective. There are limited data from case reports and case series in the trauma literature to support the use of noninvasive positive pressure ventilation in patients with thoracic trauma or multiple injuries (19,20). However, this must be done under carefully controlled circumstances due to the risk of vomiting and aspiration in patients with decreased mental status. The provider must not leave the bedside, and must be vigilant and able to rapidly perform rapid sequence intubation (RSI) if the patient vomits.

Patients who are uncooperative with conventional preoxygenation may require alternative methods to optimize airway management. Weingart et al. describe a method called "delayed sequence intubation," which is essentially procedural sedation for the purpose of preoxygenation (21). Patients are given a dissociative dose of ketamine (1–2 mg/kg intravenous [i.v.] push) to allow for optimal oxygenation. This will provide ample time to preoxygenate the patient, as ketamine has a long half-life combined with a large tissue distribution (22). It has been shown to increase the postmedication oxygen saturation prior to intubation attempts. This method could be very useful to prevent desaturation prior to intubation of these patients.

There is a significant increase in hemodynamic properties when performing laryngoscopy on patients. Perkins

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