Case Report

Capsula Eburnea

EMERGENCY VENTILATORY SUPPORT IN THE BRAINSUITE

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SUMMARY

BrainSuite is an operating room for neurosurgery, characterized by the presence of Magnetic Resonance Imaging (MRI) equipment and by the peculiar position of the patient that allows for a correct neuronavigation and facilitates access to the surgical site. In this report, we describe a case of accidental tracheal extubation in a meningioma patient, during the necessary maneuvers for surgical field preparation in the BrainSuite. This situation was successfully managed by inserting a Laryngeal Mask Airway (LMA) Fastrach, while maintaining the patient in the initial position, thus avoiding losing the MRI sequence. LMA Fastrach was the device of choice since its use allowed us to overcome all complications posed by the BrainSuite setting: the magnetic field does not influence this device, its insertion is easy and quick, and its use allows the insertion of a tracheal tube without the need for head or neck manipulation.

Introduction

The BrainSuite is a neurosurgical operating room, whose key feature is the presence of a Magnetic Resonance Imaging unit (MRI) (1). The room is also equipped with other high technology tools:
- neuronavigational system
- operating microscope
- data processing system, used for management and fusion of the images, along with treatment planning.

The MRI permits the execution of various scannings at several different intervals, allowing for a greater precision and, at the same time, for a minimally invasive surgery, especially in brain tumor resection. Pre-operative scanning and neuronavigation permit to accurately identify the tumoral mass (by identifying the fiducial markers) and to program the surgical procedure precisely (2). Intra- and post-operative scanning are valuable tools in tumor resection control. If residual tumor tissue is still found during these procedures the tumor resection area is immediately extended. Although the introduction of BrainSuite has lead to these advantages in neurosurgery, some dilemmas have arisen in the anesthetic management. In particular, MRI compatible instrumentation is essential. The decision of which equipment to use in the BrainSuite is based on three principal criteria (3); in particular, the equipment:
- must not be dangerous for the patient and/or the room staff;
- must not disturb the MRI procedures, or alter the quality of the images;
- must work correctly even in the presence of a magnetic field.

In the BrainSuite, moreover, the patient (pt) requires careful positioning to allow for accurate neuronavigation and to facilitate the access to the surgical site (4). To correctly

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position the patient, the following steps are required:
- the patient's head is fixed with four pins to a metallic MRI-compatible support, which is an integrating part of the mobile operating table;
- the patient's body is immobilized with fabric belts;
- insulating material, with a minimum thickness of 1 cm, is inserted where necessary (e.g. between body parts in contact with each other or the operating table).

Even in emergency situations it is necessary to opt for measures that are as compatible with the presence of the magnetic field as possible. Below, we describe an emergency situation that arose in the BrainSuite, during which accidental extubation of the patient occurred. Moreover, the ventilator support technique used for resolving this situation by our surgical team will be described.

Clinical Case

A 61-year-old man, with a weight of 78 Kg, was set to undergo surgical excision of a left fronto-parietal meningioma.

The pre-operative assessment did not preventively highlight potential difficulties in the execution of intubation (no congenital or acquired malformation of the airway was present, the head and the neck mobility of the patient was good, with a grade II Mallampati score) (5). The patient's general condition was evaluated according to the American Society of Anesthesiology (ASA) classification: he was graded as ASA Class II. Upon arrival to the pre-operating room, the patient was positioned on the operating table. Routine monitoring procedures, including non-invasive blood pressure (NIBP) and oxygen saturation (SpO2) measurements, as well as an electrocardiogram (ECG) with MRI-compatible electrodes were performed. Anesthesia was induced with Propofol 2 mg/Kg, Fentanyl 300 mcg, Vecuronium 0,1 mg/Kg, with in the patient being ventilated through a facial mask in the meantime. After a complete loss of consciousness and an appropriate neuromuscular blockade were obtained, tracheal intubation was executed using a Macintosh Laryngoscope (with a size 4 curved blade). An 8 mm preformed tracheal tube was easily inserted and fixed in place with silk plaster. The patient was then connected to a mechanical ventilator. The ventilation parameters were set up according to the patient's weight and the age (Tidal Volume 600ml, Breathing Frequency 14/min), assuring a moderate hypocapnia: End-Tidal Carbon Dioxide (EtCO2) was 30-35 mmHg. A second venous access was prepared and the invasive blood pressure monitoring set was arranged. Finally, the patient's head was fixed with four pins to the mobile operating table. Once the preparation was completed, the patient was disconnected from the automatic respirator and led inside the operating room; during the transfer, the patient's ventilation was carried out with an Ambu Bag. Inside the operating room, the operating table was hooked to the rotating structure of the MRI and the patient connected to the ventilator (Aestva/5 MRI), through seven meter long corrugated tubes. Appropriate length cables assured that the patient was adequately connected to the monitoring equipment. Anesthesia was maintained with Sufentanil (0,6 mcg /Kg/h), Norcuron (0,03 mg/Kg/h) and Sevorane (1,5%). Subsequently, pre-operative scanning and neuronavigation were executed, identifying the fiducial markers.

Once the scanning was completed, the table was rotated 180° and brought within the 5 Gauss line, where the operation could begin. During the preparation of the surgical field, we observed the disappearance of the square wave capnograph trace with a subsequent onset of the low pressure alarm of the automatic ventilator. Immediately, we suspected that the patient had become disconnected from the anesthetic circuit. Prompt removal of the sheets wrapping the patient's head, confirmed the accidental extubation. Ventilation was resumed immediately with a facial mask, through the manual breathing unit, ensuring that parameters were kept stable (oxygen saturation (SpO2): 99%, EtCO2: 30mmHg). The decision was made to employ an LMA Fastrach (size 4) in order to be able to continue the operation without losing the MRI sequence for neuronavigation. After adequate lubrication, the widest part of the mask was introduced into the oral cavity. Given that the tube curvature allows to closely follow the anatomical curve of the palate and the posterior pharyngeal wall, no head or neck manipulation was required. The cuff was inflated with air (25ml), and the LMA Fastrach was connected to the anesthetic circuit, while the patient was oxygenated with gentle manual ventilation. A 7,5 mm conventional tracheal tube was inserted through the Fastrach. Appropriate placement and ventilation were determined by examination of chest wall movement, auscultation of breath sounds, square-wave capnograph trace and oxygen saturation levels. Using the LMA Stabilizer Rod, the Fastrach was removed with the tracheal tube remaining in place. Finally the tracheal tube cuff was inflated and the patient connected to the anesthetic circuit, allowing the surgical intervention to continue.

Discussion

An accidental extubation in the particular environment of the BrainSuite represents an unexpected and difficult to manage airway situation for the anesthetist for the following reasons:
- the patient's head is firmly fixed to the operating table;
- the position of the patient's head must remain unaffected, in order to avoid losing the fiducial Markers obtained by pre-operative scanning;
- the anesthetist's actions are limited by the fact that all standard instruments must remain beyond the 5 Gauss line;
- the rotating structure of the MRI, to which the operating table is hooked, does not allow a great deal of movement or easy patient transfer to a more suitable environment for a straightforward intubation;
- instruments in ferromagnetic material must not be used, because these are affected by influence of the magnetic field.

Tracheal intubation under direct laryngoscopy was not feasible because:
- the fixed position of the head and the neck does not permit extension of the atlanto –occipital joint (6);
- the laryngoscope at our disposal at the time was not MRI compatible due to quick battery drainage and the instrument's response to magnetic pull.

For the same reasons a nasotracheal intubation procedure was not possible; moreover this method often requires the use of a Magill forceps (7). Alternative devices, such as Fiberoptic Bronchoscope and the Trachlight (8), cannot be used inside the BrainSuite, due to some of their components. In our case, the LMA Fastrach (9) was chosen due to the fact this device was able to overcome all complications posed by the difficult environment of the BrainSuite for the following reasons:
- the magnetic field does not influence on this device;
- its insertion is easy and quick;
- it enables the insertion of a tracheal tube without head or neck manipulation;
- the simplicity of the procedure allows for a short execution time.

Moreover, various studies have shown the validity of the LMA Fastrach in intubation when neck and head movements are not possible.

Komatsu and colleagues (10) demonstrated that blind intubation through LMA Fastrach is a reasonable strategy for controlling the airway in patients (pt) who are immobilized with a rigid cervical collar. They have studied 50 patients with a rigid Philadelphia collar in place, undergoing elective cervical spine surgery, and 50 patients undergoing other surgical procedures under general anesthesia. The analysis of the results show that in the collar group, LMA Fastrach insertion times were longer (30 pt , 25s vs 22 pt, 6s), with more patients requiring a second insertion attempts (15 vs 3); additionally, ventilation adequancy resulted inferior in the collar group. However, there were no statistically significant differences between the patients with collars and controls in terms of total time required for intubation (60 pt, 41s vs 50 pt, 30s), number of intubation attempts, overall intubation success rate (96% vs 98%), or the incidence of intubation complications. In conclusion, the Fastrach approach permits tracheal intubation even in patients with immobilized cervical spine, especially when urgency of treatment excludes a fiberoptic approach.

Agarwal and colleagues (11) also affirms that in patients with unstable cervical spine, tracheal intubation through LMA Fastrach is easy, fast and associated with fewer complications.

In our case, the limitations posed by the presence of the magnetic field needed to be taken into consideration even in the selection of the tracheal tube. A conventional tracheal tube (Rusch polyvinyl Chloride Tube, PVCT), lubricated with sterile vaseline oil was used. The LMA-Fastrach silicone wire-reinforced tube (FIST), designed for tracheal intubation through the

LMA, and the Rusch latex armoured tube (LAT) can both be affected by the magnet pull, and during scanning they can also cause tracheal burns due to overheating induced by the RF (radio-frequency).
Kundra et al. (12) studied 150 patients undergoing elective surgery under general anesthesia. FIST (for 50 patients), PVCT (50 pt), and LAT (50 pt) were used for tracheal intubation through the LMA Fastrach. A significantly higher success rate in tracheal intubation was achieved with PVCT and FIST (96%) compared with the LAT (82%). Incidence of a successful tracheal intubation on the first attempt was similar for PVCT and FIST (86%). Esophageal placement was more frequent with the LAT (29,7%) when compared to PVCT and FIST (1.8% and 7.4% respectively).
The authors conclude that a PVCT can be successfully used to accomplish tracheal intubation through LMA. However, the tip of the PVCT can cause trauma to the glottis and vocal cords (13).
Different techniques have been investigated to avoid traumas. Joo and Rose (14) recommend backward insertion of the tracheal tube into the LMA Fastrach, so that the concave bend faces down. This technique allows the tube to follow a more anatomical direction compared to conventional insertion (15). Kundra et al. (12) kept the PVCT immersed in a sterile water bath at 40°C for 1 min, softnening the tube. Most importantly, during tracheal intubation with LMA Fastrach, using excessive force should be avoided whenever the tracheal tube encounters resistance.

Conclusion

When facing an emergency situation in the BrainSuite, a prompt evaluation of which instruments and techniques to use is necessary, due to the limitations imposed by this particular environment.
The anesthetist's task in such situations is to ensure that every procedure is an compatible with the presence of the magnet as possible at the same time being safe for the patient and the staff. Incidence of trauma can be significantly reduced by gently performing a blind tracheal intubation. In conclusion, our experience confirms that PVCT can be used as successfully as FIST for blind tracheal intubation through Fastrach.

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