Is immediate muscle relaxation still forbidden?

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Abstract

Background: The purpose of this study was to confirm that muscle relaxation can be safely induced before attempting face mask ventilation (FMV), like the updated guideline for the management of tracheal intubation in critically ill adults recommends. In the past, the rule was only inducing muscle relaxation after having confirmed that FMV could be successfully performed. Even several studies could show in recent years that this approach is not appropriate anymore; most institutions still refuse the concept of the early relaxation.

Methods: Applying the currently available data we modified our standard anesthesia induction procedure regarding when the neuromuscular blocking agent (NMBD) was injected. All patients in whom no difficulties with FMV were expected were given the NMBD immediately after induction of anesthesia without first assessing if FMV was possible. The data was later collected from our Patient Data Management System (PDMS).

Results: A total of 3,801 patients were included in this study. FMV was not possible in only one patient (0.026%), but the airway was secured with a laryngeal mask airway (LMA). FMV without an oropharyngeal airway (OA) was difficult in 2.4% of the patients and in a further 1.9% when the OA was employed.

Conclusion: Muscle relaxation can be safely induced without first assessing the ease of FMV, because it doesn't make FMV more difficult, as only 0.03% of the FMV were impossible. So, it is about time that anesthesia departments will adapted their anesthesia induction procedures to the current literature and guidelines.

Keywords: Neuromuscular blockade, Face mask ventilation, Patient safety, Anesthesia guideline.

Abbreviations: BW: Body Weight; DMV: Difficult Mask Ventilation; FMV: Face Mask Ventilation; LMA: Laryngeal Mask Airway; MR: Muscle Relaxation; NMBD: Neuromuscular Blocking Drugs; OA: Oropharyngeal Airway; SB: Spontaneous Breathing: PDMS: Patient Data Management System.

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Introduction

The ability to ventilate the patient with a face mask (face mask ventilation, FMV) is essential to prevent hypoxemia in the patient after inducing anesthesia. To avoid this adverse event, muscle relaxation is still often only induced once FMV has been shown to be possible. The rationale behind this approach is the idea that the patient would soon resume spontaneous breathing (SB) that would provide enough oxygenation if FMV were unsuccessful [1]. The question of whether FMV itself might not be easier under muscle relaxation is basically already solved, because some studies did show that muscle relaxation can simplify FMV. Recently published data not only confirm that muscle relaxation should be started right after anesthesia induction [2-5], but it appears that even the tidal volume attainable with FMV might also increase after application of an Neuromuscular Blocking Drugs (NMBD) [6]. Despite these promising data, most institutions worldwide still refuse the recommendation of early relaxation.

We therefore altered our anesthesia induction procedure regarding the timing of NMBD administration to determine that this was not associated with a higher incidence of difficult FMV, so the defined outcome parameter was a possible high number of difficult FMV.

The following hypotheses were tested:

a) Immediate muscle relaxation simplifies FMV.

b) Immediate muscle relaxation, before attempting FMV is save and does not increase patient morbidity and mortality.

Materials and Methods

Patients

The study was conducted with the approval of the local ethics committee. The data was obtained in the operating theatres of the Department of Anesthesiology, Intensive Care, Emergency Medicine and Pain Management at the Augusta Hospital Bochum Mitte, Bochum, Germany.

All patients who underwent abdominal, gynecological, vascular or urological surgery in the period from March 2016 until the end of February 2017 and who had been managed with FMV

during the anesthesia induction period were included in this study. Patients not receiving a general anesthetic (i.e., regional anesthesia, sedation), patients with a laryngeal mask airway, and patients with a known difficult airway were excluded from the analysis. All patients with a necessary FMV received the muscle relaxant right after anesthesia induction. In case of a known difficult airway an awake fiberoptic intubation was performed.

The definition of Difficult Mask Ventilation (DMV) in this study was DMV:

1. Age>57 yrs;
2. BMI>30;
3. History of snoring;
4. Presence of beard;
5. Mallampati class III or IV;
6. Limited mandibular protrusion;
7. Thyromental distance <6 cm.

Patient care

Anesthesia was induced with a bolus injection of propofol (1.5-2 mg/kg/BW) or etomidate (0.25 mg/kg/BW) after starting a continuous infusion of remifentanil (0.25 µg/kg/min^{-1}) or administering a bolus injection of sufentanil (0.6 µg/kg-0.4 µg/kg). Muscle relaxation was induced immediately after anesthesia induction with rocuronium (0.3 mg/kg/BW), or with cisatracurium (0.12 mg/kg/BW) in patients with impaired renal function, without first assessing the ability to ventilate by face mask. Succinylcholine (100 mg) was used for very short procedures if there were no contraindications against its use.

Face Mask Ventilation (FMV)

Our department guidelines recommend the insertion of an oropharyngeal airway (OA) after anesthesia induction, but it was left to the discretion of the attending anesthesiologist to use one or not. The correct size of the face mask was selected, by trial and error. The mask had to sit perfectly over the bridge of the patient's nose with the upper border aligned with the pupils. The sides of the mask were supposed to seal just lateral to the nasolabial folds with the bottom of the face mask sitting between the lower lip and the chin.

FMV was considered difficult in the event of:

1. Inadequate mask seal;
2. Excessive gas leak (gas flow>15 l/min);
3. Lack of chest movement and no CO_2 trace in capnography;
4. Two hands required for ventilation;
5. The unassisted anesthesiologist was unable to maintain oxygen saturation >90% using 100% oxygen and positive pressure.

Study design

The study is a user trial, with the objective to show if the recommended approach of an immediate muscle relaxation after anesthesia induction is in general advisable.

Data acquisition

Patient data were extracted from the anesthesia charts in our patient data management system (PDMS; LOWTeq GmbH, Cologne, Germany).

Results

There were 10,151 surgical cases during the study period. Of these, 4,762 patients were managed with an LMA, and 1,588 had either a regional anesthesia or sedation with spontaneous breathing (Figure 1). The data of the remaining 3,801 were extracted for analysis. FMV was difficult, but still possible, in 92 (2.42%) patients when an OA was not used, and in 73 (1.92%) with an OA. FMV was not possible in one patient (0.026%), but an LMA was successfully inserted, and subsequent ventilation was uneventful.

Discussion

The main finding of the study is that it was safe to induce muscle relaxation without having first verified that FMV was possible, because the incidence of difficult face mask ventilation was not higher than in previous published data and furthermore the amount of impossible FMV was very low (0.026%). Mask ventilation is one of the most fundamental skills in airway management because it might be the only available rescue technique for ventilation if intubation fails (cannot intubate). The incidence of DMV described in the literature is between 0.7 and 15% [7-12]. The incidence of DMV of ca. 2% in our study is similar to that in some other studies, while the 0.026% incidence of the "cannot ventilate" event in our study is quite low compared to others [13,14]. Kheterpal et al. described an incidence of unsuccessful FMV of 0.37% in their study in 22,000 [13] and in 0.16% in their study in 50,000 patients [14].

The reason for the different reported incidences of DMV is probably due to the use of different definitions of a DMV [8,11,15,16]. The definition set out by the ASA in 2003 includes the following criteria: inadequate mask seal, excessive gas leak, and excessive resistance to the ingress or egress of gas. Langeron [8] looked for clinical signs that might predict DMV and was able to define the following five factors:

1. Age>55 yrs;
2. Body Mass Index (BMI)>26 kg/m^2;
3. Lack of teeth;
4. History of snoring;
5. Presence of a beard.

The presence of two or more factors indicated a substantial likelihood of DMV. Kheterpal et al. [13] identified the following predictive factors for DMV:

1. Age>57 yrs;
2. BMI>30;
3. History of snoring;
4. Presence of beard;
5. Mallampati Class III or IV;
6. Limited mandibular protrusion;
7. Thyromental distance<6 cm.

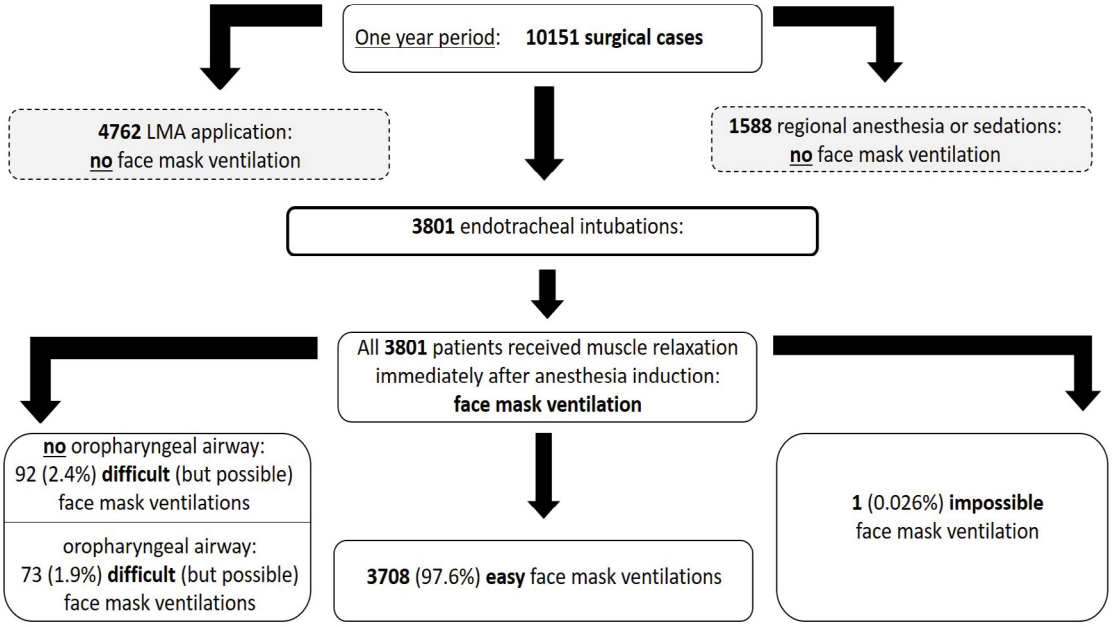

Figure 1. *Flow chart for data extraction.*

Either method can be used in the clinical routine, but the important issue is that one identifies patients with a potentially DMV during the premedication rounds. If the probability of DMV is high and if there are other findings that indicate difficulties in intubation (cannot intubate-cannot ventilate) an awake fiberoptic intubation should be performed. Persisting muscle tone can be a reason for a DMV. Waters et al. [3] showed that FMV improved after relaxation and that muscle relaxation improved the ease of FMV dramatically, especially in patients with overt DMV. Similar results were shown by Joffe et al. they also described a significant improvement in tidal volume after relaxation [17]. Another important fundamental finding of the study was that FMV never worsened after administration of NMBD. The results of the study by Amathieu et al. [18] in more than 12,000 patients were similar and they also indicated that muscle relaxation never worsened, but rather facilitated FMV.

Thorax rigidity or glottis closure following opioid administration are further causes of difficult FMV, and Abrams and Bennet et al. have shown that muscle relaxation can resolve these problems [19,20]. Laryngospasm can also render FMV impossible and is resolved by muscle relaxation [20]. The widely held conviction that non-paralyzed patients will resume breathing if FMV is unsuccessful might be true for induction with volatile anesthetics. However, this is more than questionable when anesthesia in induced with a hypnotic and an opioid, because critical hypoxemia will probably ensue before spontaneous breathing returns. It is, of course, possible to reverse the effects of the opioid and of the NMBD rocuronium, but not of the hypnotic. This approach might not be advisable in any case because it might increase the risk of laryngospasm, and because a light plane of anesthesia itself can be the cause of DMV. It is known that one can facilitate FMV and intubation with a higher dose of propofol and opioids without using an NMBD [21]. However this approach can cause significant cardiovascular depression [22] and cannot be generally recommended.

In their survey, Goodwin et al. asked experienced anesthesiologists if they routinely performed FMV before inducing muscle relaxation, to which almost half replied that this was not the case [2]. However, one should bear in mind that NMBD can not only facilitate FMV but also improve the ease of endotracheal intubation [23]. In an earlier study, in which we investigated the incidence of a difficult intubation in a surgical ICU, we found that one factor that influenced the likelihood of a difficult intubation was the lack of muscle relaxation [24]. Rizk et al. showed in their study that NMBD can improve the laryngeal view significantly [25], but surprisingly NMBD did not affect in their study the ease of FMV. Last but not least, muscle relaxation also facilitates the insertion of a supraglottic airway device [26], which is the first choice in the ASA algorithm when a "cannot intubate, cannot ventilate" situation occurs.

In our opinion, it is about time to implement the recommendation [5] of an early relaxation in everyone's anesthesia induction sequences, since there is no evidence that muscle relaxation negatively affects FMV or endotracheal intubation. Quite the contrary; the results of several studies, including those of the present one, indicate FMV is not impaired, and can be even easier when the NMBD is administered immediately after the induction drugs.

Limitations

A limitation of the study is the retrospective use of our clinical data; the data might have been more precise had they be gathered prospectively. Furthermore, we didn't put the focus on demographic data and patient abnormalities, such as distinctive anatomical features, but we included all patients that received FMV over a one-year period, therefore our data is supposed to be representative. Another limitation is the missing control group, but that was not the goal of the examination, because we just wanted to find out, whether immediate NMBD worsens FMV.

Conclusion

Our study shows that it is safe to induce muscle relaxation immediately after anesthesia induction without first assessing the ability to ventilate by face mask in case of an expected normal airway, because impossible FMV after a neuromuscular block occurred only in one patient (0.026%). Because of our and previous studies, it is about time to change the timing of muscle relaxation.

Authors' Contributions

JFH, planed and designed the study. JFH and AB collected and analysed the data. Both authors participated in the analysis and Interpretation of the results. The final manuscript was drafted by JFH and was discussed and approved by all participating authors.

Conflict of Interest

The authors declare that they have no conflict of interests.

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