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Comparison of Cuff Pressure Increase upon Nitrous Oxide Exposure in air-Q® Single Use, LMA-Supreme®, and LMA-ProSeal®; a Simulation Study

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Abstract

Purpose: A simulated lung model was used to compare the nitrous oxide-mediated increase in cuff pressure among three supraglottic devices air-Q® laryngeal airway single use (air-Q), LMA-Supreme® (Supreme), and LMA-ProSeal®(ProSeal).

Methods: The cuff pressure was initially adjusted to 10, 20, and 30 cmH_2O. We changed the flow from without nitrous oxide (nitrous oxide 0%, oxygen 100 %) to with nitrous oxide (nitrous oxide 80%, oxygen 20%).

Results: The cuff pressure of air-Q, Supreme and ProSeal were measured 15 and 30 minutes later. The cuff pressure of the air-Q and Supreme was significantly lower than that of the ProSeal after 15 and 30 minutes, regardless of the initial pressure ($P<0.05$). air-Q also showed significant lower cuff pressure than Supreme ($P<0.05$).

Conclusion: These findings suggest that the air-Q may be more effective for preventing hyperinflation of cuff in response to nitrous oxide exposure.

Keywords: Nitrous oxide; Cuff pressure increase; Air-Q®; Supreme®; ProSeal®

Introduction

Supraglottic devices (SGD) are recommended by professionals for easy and definitive airway management and also airway rescue in cases of failed intubation [1,2]. Conventional types of laryngeal masks, such as the LMA-Classic®, LMA-ProSeal® (ProSeal) have been reported to be useful for airway management during anesthesia or resuscitation. Compared to old types, air-Q® laryngeal airway single use (air-Q) or LMA-Supreme® (Supreme) has various enhanced features. These new SGDs contain rigid airway tube for prevention of kinking and folding. Furthermore, the anatomical curve of the airway tube facilitates reliable insertion [3]. Additionally, the air-Q does not need large cuff volume compared to conventional SGD [4].

An important concern when using the laryngeal mask airway during nitrous oxide supplemented anesthesia is laryngo-pharyngeal morbidity caused by intracuff pressure increase and cuff overinflation [5]. Too much cuff increase is related to ventilation trouble due to the malposition of the SGD, or postoperative pharyngeal pain [6]. As there are no reports about the cuff pressure change about nitrous oxide in air-Q or Supreme, we decided to compare the pressure change with that of conventional ProSeal.

In this study, we utilized simulation study to evaluate the effect of nitrous oxide exposure on the cuff pressure of air-Q, Supreme, and ProSeal.

Materials and Methods

The ALS simulator® manikin (Laerdal, Stavanger, Norway), which was designed to represent the anatomy of adult man was applied for three SGD placement. Size 4.5 single use air-Q, size 4 Supreme or ProSeal was used for the evaluation of cuff pressure change upon nitrous oxide exposure. We inserted the three SGDs and 20 ml of air was inserted to Supreme or ProSeal. No air was inserted for air-Q. After confirmation of over 15 cmH_2O sealing pressure by manual ventilation, we adjusted the cuff pressure to 10, 20, 30 cmH_2O which was maintained with an automated cuff pressure controller (Mallinckrodt Pressure Control™, COVIDIEN, USA). We initiated ventilation with 600 ml 12 times/min in volume controlled mode. We changed the flow from without nitrous oxide (nitrous oxide 0%, oxygen 100%) to with nitrous oxide (nitrous oxide 80%, oxygen 20%), and measured the cuff pressure after 15 or 30 minutes. A total of five trials were performed in each setting.

The volume of leakage was compared by two-way repeated measures analysis of variance (ANOVA), followed by Tukey's multiple comparisons. Results are expressed as mean ± standard deviation (SD). $P<0.05$ was considered significant.

Results

The cuff pressure change is shown in Figure 1. Regardless of initial cuff pressure, the cuff pressure increased significantly after 15 or 30 minutes than start point ($P<0.05$) in all three SGDs. The cuff pressure of the air-Q and Supreme was significantly lower than that of the ProSeal after 15 and 30 minutes, regardless of the initial pressure. Air-Q also showed significant lower cuff pressure than Supreme ($P<0.05$). Regardless of initial cuff pressure, the cuff pressure of ProSeal exceeded 70 cmH_2O after 30 minutes exposure of nitrous oxide. In air-Q trial, the cuff pressure was under 40 cmH_2O after 30 minute nitrous oxide exposure in all initial settings.

Discussion

The relationship between SGDs used for general anesthesia and the frequency and severity of laryngopharyngeal complications is well known. High SGD intracuff pressures produced mild alterations in the

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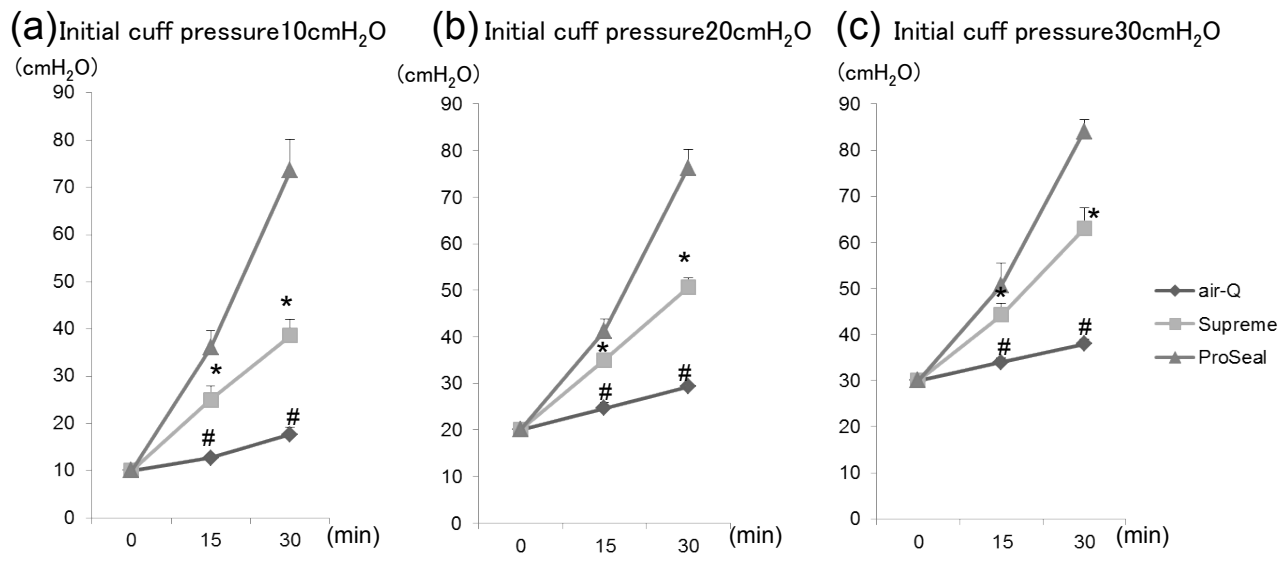

Figure 1: Cuff pressure change increase upon nitrous oxide exposure (a) initial cuff pressure 10 cmH_2O, (b) initial cuff pressure 20 cmH_2O, and (c) initial cuff pressure 30 cmH_2O. #P<0.05 comparing the air-Q to Supreme or ProSeal, *P<0.05 comparing the ProSeal.

laryngopharyngeal mucosa [7]. The pressure produced on the pharynx by the SGD when the cuff is inflated with the maximum recommended volume of air is usually higher than the mucosal capillary perfusion pressure. Theoretically, an inflated SGD cuff could produce sufficient compression to cause a reduction in blood flow in the pharyngeal mucosa and induce direct tissue trauma. Consequently, a sore throat may be experienced in such cases.

In our study, cuff pressure increase was significantly higher in ProSeal than in air-Q or Supreme. One reason of cuff pressure increase is considered to be the material of these SGDs. Supreme or air-Q is composed of polyvinyl chloride, and ProSeal silicone rubber. There result is compatible the cuff pressure change comparison between silicone rubber and polyvinyl chloride cuff [8-10].

Though air-Q or Supreme is consisted of the same material polyvinyl chloride, air-Q showed significant lower cuff pressure increase compared to Supreme. The reason may be attributed to the smaller air volume in the cuff of air-Q compared to ProSeal or Supreme. For the comparison of TaperGuard and high-volume low pressure cuff upon nitrous oxide exposure, the lower increase of TaperGuard tracheal tube cuff pressure was attributed to the smaller cuff volume. The lower increase rate of air-Q cuff pressure may be attributed to same mechanism.

This study has several limitations worth noting. First, the study was performed on an airway simulation model, not real patients. Second, we could not evaluate the postoperative pharyngeal pain in simulation. Our findings suggest the need for clinical trials addressing the air-Q in reducing the incidence of cuff pressure increase upon nitrous oxide exposure.

Conclusion

In conclusion, air-Q showed lower cuff pressure increase than Supreme or ProSeal. Our findings suggest that the air-Q may be more effective for preventing hyperinflation of cuff in response to nitrous oxide exposure.

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