Title: THE RISE OF ARTERIAL CARBON DIOXIDE DURING APNEA IN CHILDREN

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INTRODUCTION: A major risk of laser surgery is endotracheal tube ignition. To minimize that risk, the endotracheal tube can be removed for short periods of time which allows an unobstructed view of the airway without combustible material present. A possible drawback of this technique is the rise in arterial carbon dioxide tension ($PaCO_2$) during apnea. In adults $PaCO_2$ increases 6-8 torr in the first minute, and 3 torr thereafter (1). The metabolic rate of children is much higher than adults, and the rate of rise of $PaCO_2$ should also be higher. This has not been studied. The goal of this study is to determine a safe period of apnea in children by evaluating the rate of increase in $PaCO_2$ and the rate of decrease in PaO_2.

METHODS: After institutional approval and informed consent, eight patients ranging in age from 2 to 10 y and in weight from 15 to 57 kg with laryngeal papillomatosis (but otherwise healthy) undergoing airway laser surgery were studied. Anesthesia was induced either with intravenous thiopental (6 mg/kg), atropine (10 ug/kg), and succinylcholine (2 mg/kg), or inhaled oxygen, nitrous oxide, and halothane 3%. The trachea was intubated and anesthesia was maintained with oxygen and halothane 2%. Vecuronium was used for neuromuscular blockade. A 24 gauge angiocath was inserted into the non-dominant radial artery for blood gas collection. Blood pressure, electrocardiogram, end-tidal CO_2 (when able), and pulse oximetry were monitored. Fifteen min after maintenance of general anesthesia with halothane in oxygen, the endotracheal tube was removed and laser surgery begun. Peripheral oxygenation was monitored with an Ohmeda Biox 3700 pulse oximeter and at the first decrease in saturation the endotracheal tube was replaced and the lungs of the patient ventilated. The sequence was repeated as needed after oxygen saturations returned to baseline on 100% oxygen with halothane. Arterial blood gas samples were obtained immediately before apnea commenced, and then every minute during apnea. Analysis of variance was used to determine the relationship between $PaCO_2$ and duration of apnea.

RESULTS: The results of the individual patients are graphically displayed in Figures 1 and 2. The mean $PaCO_2$(torr) at baseline was 40.3 $\pm$ 9.9, at 1 min was 51.9 $\pm$ 6.0, at 2 min was 58.7 $\pm$ 6.2, and at 3 min was 59.9 $\pm$ 8.1. Surprisingly, there was no difference between a group of patients weighing <20 kg and other group >20 kg. The blood pressure and heart rate were unchanged throughout the study period.

DISCUSSION: The number of study subjects at the present time is small, but the initial data suggest that children have a greater initial rise in $PaCO_2$ during apnea than adults. We believe that this is due to a higher metabolic rate and consequent CO_2 production in children. One variable that was not quantitated in our study was depth of anesthesia, which is important in determining metabolic rate. All patients were anesthetized for fifteen min prior to surgery and all received neuromuscular blockade. Peripheral oxygen saturations were monitored throughout the apneic period and the measured PaO_2 confirmed the adequacy of oxygenation. These initial results suggest that although the $PaCO_2$ increases at a higher rate in children, this apneic technique limited by peripheral oxygen saturation is safe for procedures of 2 min or less.

REFERENCES

1. Eger EI, Severinghaus JW. The rate of rise of $PaCO_2$ in the apneic anesthetized patient. Anesthesiology 1961;22:419-25.

Fig. 1
PaCO2 vs Time

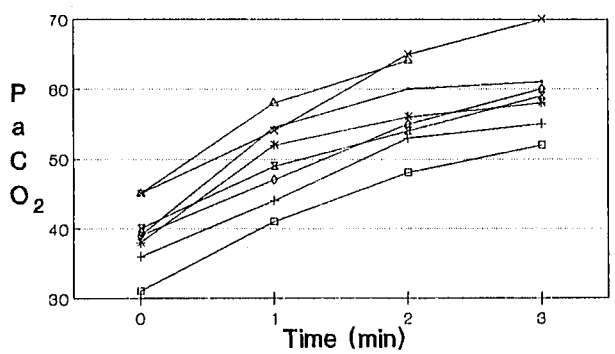

Fig. 2
PaO2 vs Time