Effects of Supplemental Oxygen Concentrations and Risk of Surgical Fires

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INTRODUCTION

Surgical fires are of substantial importance for practitioners completing procedures in the oropharyngeal complex. The classic “fire triad” for a surgical fire to ignite, as outlined in the fire triangle model include: 1. An oxidizer 2. An ignition source, and 3. A fuel. During a standard operation in the oral cavity, oxygen is present in the form of supplemental oxygen or nitrous oxide, heat is generated from electrosurgical units, lasers, or sparks from the dental handpiece, and endotracheal tubes or alcohol-based products act as a fuel source. During dental procedures using oxygen supplementation, a highly saturated oxygen environment is potentially created due to oxygen pooling in the oral cavity. High oxygen concentrations pose a serious threat due their link to increase flame ignition and prolonged flame. The Anesthesia Patient Safety Foundation has determined that oxygen concentrations higher than 30% pose a higher risk for oral fires during procedures. It is crucial to obtain a better understanding of the effects of supplemental oxygen during dental procedures and oxygen concentration levels in the oral cavity to prevent future surgical fires. The purpose of this study is to utilize an intraoral laboratory-based model to measure oxygen concentrations over time when delivering supplemental oxygen at 3 L/min.

METHODS

An acrylic dome/plastic hemisphere with volume of approximately 400cm^3 was used to simulate the oral cavity of a 10-year-old. A hole representing opening of the mouth was placed in the dome with two holes placed superiorly to allow for the nasal cannula to deliver oxygen at 3L/min. A single access hole was made for input of the Viasensor G210 Medical Gas Analyzer to monitor oxygen concentrations. The following three suctioning methods were individually placed 20 mm into the mouth opening: a 1000 PC high-speed dental suction tip, a surgical Yankauer suction tip, and a standard fixed tip saliva ejector. 6 sets of 20 trials were completed, each beginning with a brief 5 second suctioning period prior to time zero. Oxygen supplementation began at time zero, oxygen concentrations were recorded every 10 seconds for 2 minutes, at which point suctioning began and values recorded every 10 seconds for 1 minute, suctioning was terminated for 1 minute with values recorded every 10 seconds to allow for build-up of oxygen. The suction began once more, and values were recorded every 10 seconds for 1 minute. The high-speed dental suction tip, the Yankauer suction tip, and the standard fixed tip saliva ejector were tested in separate trials. The control group had no supplemental oxygen to simulate an intubated patient.

FIGURES

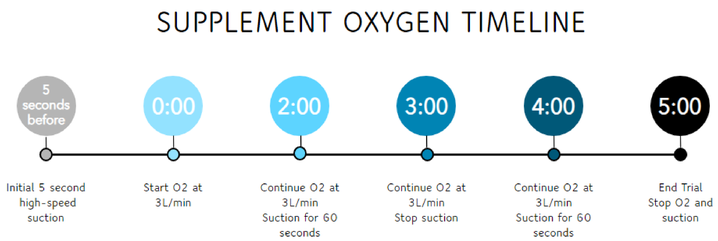

Figure 1 is a chart representing a timeline of the trials and when suction was turned on and off when supplement oxygen was delivered

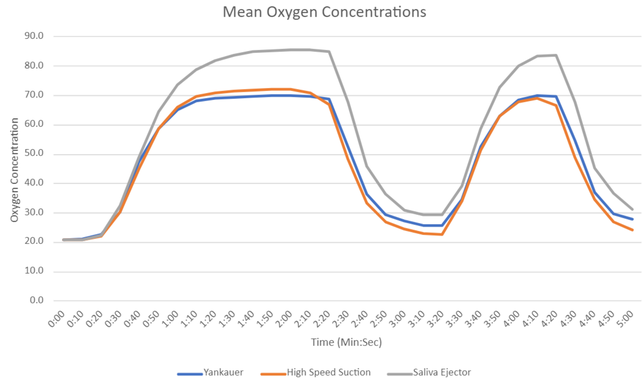

Figure 2 is a graph representing the mean oxygen concentrations of the different suction tips when supplemental oxygen is given to simulate a non-intubated patient

RESULTS

- Mean oxygen concentration levels in trials with simulated intubation maintained between 20.6 and 20.9.
- Slope for change (decrease) in O2 during suction was significantly higher for Fixed Tip Saliva Ejector than High Speed Suction ($p<.001$) and Yankauer Suction ($p<.001$), but High Speed Suction and Yankauer Suction were not significantly different ($p=0.319$).
- Mean oxygen concentration levels during suction were significantly higher for Fixed Tip Saliva Ejector than High Speed Suction ($p<.001$) and Yankauer Suction ($p<.001$), but High Speed Suction and Yankauer Suction were not significantly different ($p=0.275$ during suction 1 and $p=0.248$ during suction 2).
- Examining the individual time points for timing of O2 decrease, O2 decreased significantly ($p<0.05$) within 20 seconds after start of suction for High Speed Suction and within 30 seconds for Fixed Tip Saliva Ejector and Yankauer Suction.

DISCUSSION

- Limited studies have evaluated the effectiveness of the fixed tip saliva ejector in reducing high oxygen concentrations when delivering supplemental oxygen in non-intubated patients. This study determined the use of a fixed tip saliva ejector as an effective tool in mitigating high oxygen concentrations.
- The high speed suction can decrease oxygen concentrations significantly in 20 seconds, whereas the fixed tip saliva ejector and yankauer suction can reduce oxygen concentrations significantly in 30 seconds.
- All suction types were able to decrease oxygen concentrations below 30% within 1 minute. Therefore, in procedures with a non-intubated patient and supplemental oxygen, suction should be used for 1 minute in the mouth to decrease risk of oral surgical fire.

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REFERENCES

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