Effects of Supplemental Oxygen Concentrations and Suction Methods on Oral Surgical Fires: an in vitro study

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BACKGROUND

- Operating room fires occur to at least 650 patients annually, resulting in at least two to three deaths per year.
- 3 essential components involved in the creation of the fire: an oxidizer, an ignition source, and a fuel; known as the "fire triad."
- Dental surgeries, as well as other oropharyngeal procedures, are considered especially "high-risk" to experience surgical fires
- All three aspects of the fire triangle are present, and in close proximity to one another, during any dental procedure

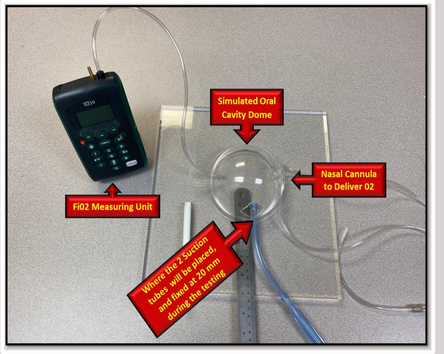
PURPOSE

Determine and compare the **times required to generate oxygen concentration levels above 21% as well as the effectiveness of the DryShield® isolation system (DS), the surgical Yankaeur suction tip (YS), and high-volume evacuator (HVE) in decreasing oxygen levels** using a simulated oral cavity to replicate the oral environment of a pediatric patient receiving 3L/min and 5L/min during dental surgery under deep sedation/GA.

Results from this research will attempt to provide practitioners performing dental treatment utilizing supplemental oxygen with a more thorough understanding of the contributing risks and parameters at which surgical fires can likely occur. Through this, practitioners have the tools and knowledge to prevent such occurrences and improve both patient and provider safety.

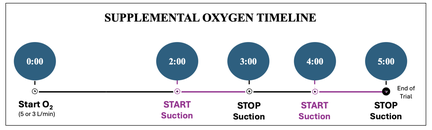
METHODS

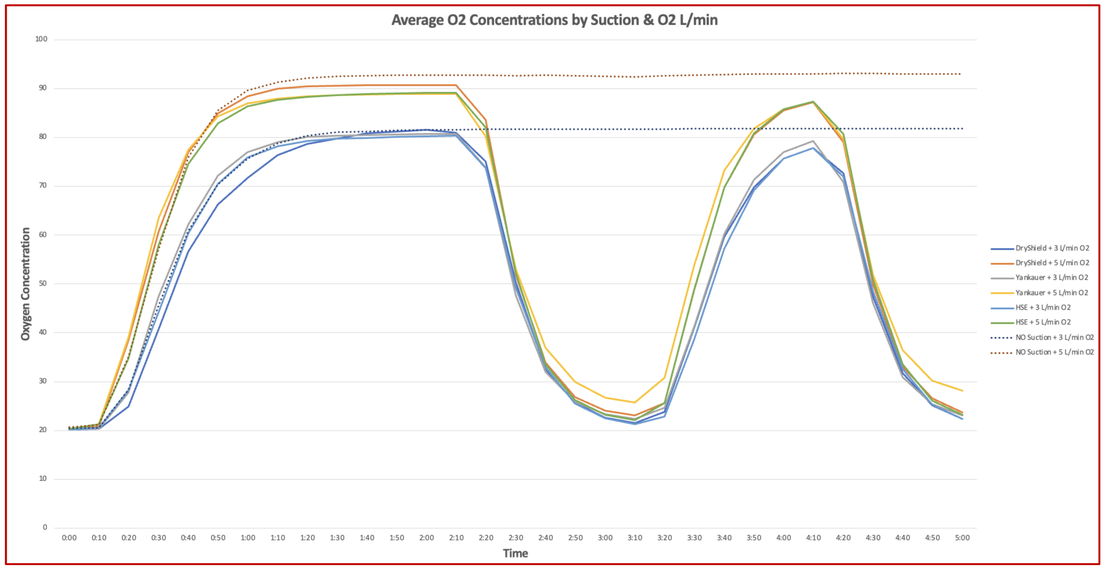
Testing protocol phase one. Oxygen supplementation of 3 L/min (experimental group 1) and 5 L/min (experimental group 2) was provided for 5 minutes without any suctioning periods. Oxygen readings were recorded at 10 second intervals. 5 minutes were used to complete each trial. **Testing protocol phase two:** Oxygen supplementation with suctioning periods. The following protocol periods were completed for experimental groups 2-8: **(1) Period one (oxygen supplementation period)**. Oxygen supplementation was provided at the predetermined rate (3 L/minute: experimental groups 3-5 or 5 L/min: experimental groups 6-8) with the appropriate suction device in place. Oxygen supplementation and O_2 readings began at time zero (readings continued to be recorded at 10 second intervals). This oxygen supplementation period was carried out for 2 minutes. **(2) Period two (first suction period)**. At 2 minutes, an oxygen reading was recorded and the suction turned on. Oxygen readings at 10 second intervals continued for the next 1 minute. **(3) Period three (second oxygen supplementation period).** At 3 minutes, an oxygen reading was recorded and the suction was turned off. Oxygen concentration readings at 10 second intervals continued for the next 1 minute. **(4) Period four (second suction period).** At 4 minutes, an oxygen reading was recorded and the appropriate suction turned on again. Oxygen readings at 10 second intervals were continued for the next 1 minute.



TABLES AND FIGURES

Experimental Group	# of Trials	Suction Tip in Place	Suction Periods Included?	Supplemental O^2 Flow Rate
1	10	None	No (O_2 supplementation for 5 minutes w/o suction)	3 L/min
2	10	None	No (O_2 supplementation for 5 minutes w/o suction)	5 L/min
3	20	DryShield® Isolation System (positioned to be centered within the "oral opening" of the testing unit)	Yes (4-step sequence w/ intermittent suction)	3 L/min
4	20	Surgical Yankauer Suction (anterior tip of suction positioned 20 mm into "oral opening" of testing unit)	Yes (4-step sequence w/ intermittent suction)	3 L/min
5	20	High-Speed Dental Suction (anterior tip of suction positioned 20 mm into "oral opening" of testing unit)	Yes (4-step sequence w/ intermittent suction)	3 L/min
6	20	DryShield® Isolation System (positioned to be centered within the "oral opening" of the testing unit)	Yes (4-step sequence w/ intermittent suction)	5 L/min
7	20	Surgical Yankauer Suction (anterior tip of suction positioned 20 mm into "oral opening" of testing unit)	Yes (4-step sequence w/ intermittent suction)	5 L/min
8	20	High-Speed Dental Suction (anterior tip of suction positioned 20 mm into "oral opening" of testing unit)	Yes (4-step sequence w/ intermittent suction)	5 L/min





RESULTS

1) The slope in increase of oxygen concentration was significantly higher for all trials with 5 L/min of oxygen supplementation without suctioning periods compared to trials with 3 L/min.

2) In trials with oxygen supplementation of ***3 L/min and the use of suctioning periods***, no significant difference was found in the slope of decrease in oxygen concentration during suction from the high volume evacuation, DryShield®, and Yankauer suction.

3) In trials with oxygen supplementation of ***5 L/min and the use of suctioning periods***,, the slopes of decrease in oxygen concentration from the high volume evacuation and DryShield® were significantly faster than with the Yankauer suction ($p<0.05$).

CONCLUSIONS

1) If 3 L/min of oxygen supplementation is able to be used, rather than 5 L/min or higher, the oral airway fire risk is significantly decreased.

2) The DryShield® isolation system was found to be just as efficient as the high volume evacuation in decreasing oxygen concentrations, with the HVE and DS proving to be more efficient than the YS. Therefore, the use of DS or HVE is recommended for reducing pooled oxygen to safe levels.

3) All three suctioning methods were efficient in decreasing oxygen concentrations to safe levels (<30%) within 1 minute and decreasing oral airway fire risk with oxygen supplementation of both 3 L/min and 5 L/min.

REFERENCES

INDIANA UNIVERSITY SCHOOL OF DENTISTRY INDIANAPOLIS