ORIGINAL RESEARCH PAPER

Dental Science

"COMPARATIVE EVALUATION OF PULSE RATE, OXYGEN SATURATION AND RESPIRATORY RATE AMOUNG DENTAL SURGEONS USING N95 FFR AND HALF FACEPIECE ELASTOMERIC RESPIRATORS: A CLINICAL STUDY"

KEY WORDS: N95 FFR, Elastomeric respirators, Oxygen saturation.

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ABSTRACT

Introduction: Filtering facepiece respirators (FFR) are the most commonly used with the N95 FFR being the most popular overall. The number 95 signifying that it is at least 95% efficient in filtering particles. Elastomeric respirators are available as alternatives to disposable half mask filtering facepiece respirators (FFRs), such as N95 FFRs, comparatively elastomeric respirators have been found to have 60% higher filtration performance. Previous reports highlighted that difficulty in breathing resulted in limited tolerability when the N95 face mask was used for a prolonged period.

Objectives: To evaluate and compare the physiological effect of N95 FFR and 3M elastomeric respirators on dental surgeons.

Methodology: The study included 48 participants divided into 2 groups of 24 subjects each. Group 1 and Group 2 included participants using 3M elastomeric respirators and N95 FFR and respectively. Non-smokers and systemically healthy participants were included and the oxygen saturation, pulse rate and respiratory rate readings were taken before the start of the procedure, 30 mins after the start of the procedure and after the completion of procedure with a standard fingertip pulse-oximeter.

Conclusion: N95 FFR is acknowledged by the majority of dental professionals, although the majority experienced several perceived side effects. 3M elastomeric respirators have few advantages over the conventional N95 masks and can be an effective alternative to N95 FFR.

INTRODUCTION:

Filtering facepiece respirators (FFR) are the most commonly used respirators in US private industry and health care, with the N95 class of FFR (N95 FFR) being the most popular overall.[1] The N95 face-mask protects against respiratory droplets, the number 95 signifying that it is at least 95% efficient in filtering particles with a median diameter >0.3 *l*m2, and the letter N that the mask is not resistant to oil.[2]

Headaches arising from the sustained compression of peri-cranial soft tissues by donning of objects with tight bands or straps around the head have been previously reported in the literature.[3] Apart from the mechanical effects, adverse effects such as difficulty breathing has also been reported.[2] Previous reports highlighted that pain or discomfort (headache, facial pain, and/or ear lobe discomfort) arising from tight-fitting face masks as well as elastic head straps resulted in limited tolerability when the N95 face mask was used for a prolonged period.[4] Elastomeric respirators have more commonly been used in industrial and mining settings, but can be considered for use in the health care setting during times of increased demand such as during infectious disease outbreaks.

Elastomeric respirators, such as half facepiece or full facepiece tight-fitting respirators where the facepieces are made of synthetic or natural rubber material, can be repeatedly used, cleaned, disinfected, stored, and re-used. They are available as alternatives to disposable half mask filtering facepiece respirators (FFRs), such as N95 FFRs.[5]

Elastomeric respirators also differ from disposable N95 masks in that they have a separate exhale vent, and exhaled air does not travel through the contaminated filter and re-aerosolize trapped viral particles.[6] Compared to disposable respiratory masks of the same filter efficiency, elastomeric respirators have been found to have 60% higher filtration performance and better seal.[7], Although both types of masks selected in this study have reported to take a toll on the surgeons physiologically & psychologically, this study is an attempt to re-enforce the findings clinically.

OBJECTIVES:

- To evaluate and compare the physiologic effect among dental surgeon using N95 FFR and 3M elastomeric Respirators.

MATERIALS AND METHODS:

Materials required:

- Finger-tip pulse oximeter.
- N95 filtering facepiece respirators.
- 3M Half facepiece elastomeric respirators.

Inclusion criteria

- Procedure lasting more than 30 mins
- Systemically health subjects
- Non-smokers

Exclusion criteria

- Short lasting procedures
- Subjects with history of cardiorespiratory illness.
- Subjects with blood disorders which could reduce the oxygen carrying capacity.

The subjects were divided into 2 groups. Group 1 included subjects who used 3M elastomeric respirators during the

procedure and Group 2 included subjects who used N95 FFR during the procedure. Each group will have a sample size of 24 participants. The oxygen saturation, pulse rate and respiratory rate readings were recorded before, 30 mins after the start of the procedure and after the completion of procedure with a standard fingertip pulse-oximeter.

FIGURE 1: N95 FFR mask

FIGURE 2: 3M half facepiece elastomeric respirator

Statistical analysis:

The data was collected, coded and fed in SPSS (IBM version 23) for statistical analysis. The descriptive statistics included mean and standard deviation. The inferential statistics included Independent t test for the comparison between two groups. The level of significance was set at 0.05 at 95% Confidence Interval.

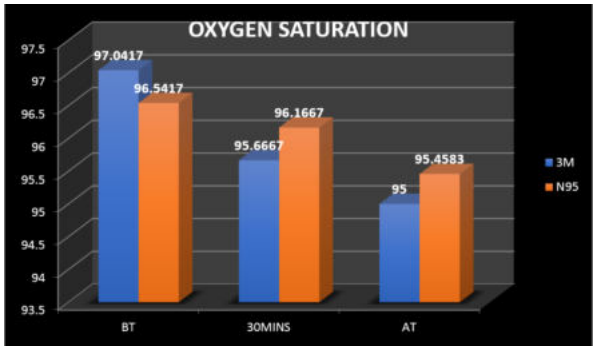

FIGURE 3: Graphical representation of oxygen saturation comparison between 3M elastomeric respirators and N95 FFR

TABLE 1: Intergroup oxygen saturation comparison of 3M elastomeric respirators and N95 FFR before treatment,30 min after the start and after completion of the treatment.

OXYGEN SATURATION		MEAN	STANDARD DEVIATION	T	P VALUE
BT	3M	97.0417	1.45898	1.060	0.536(N.S)
	N95	96.5417	1.79320		
30MIN	3M	95.6667	1.90347	-1.148	**0.048(S)**
	N95	96.1667	.96309		
AT	3M	95.0000	2.46718	-0.836	**0.043(S)**
	N95	95.4583	1.06237		

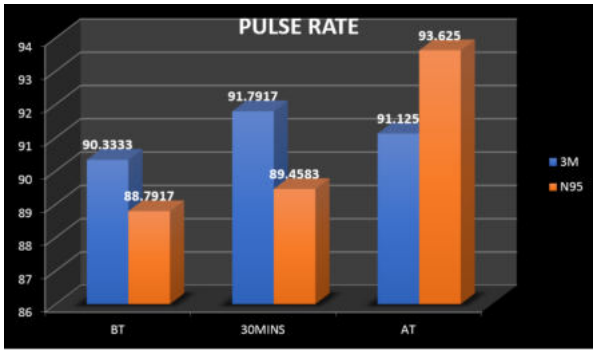

FIGURE 4: Graphical representation of pulse rate comparison between 3M elastomeric respirators and N95 FFR

TABLE 2: Intergroup Pulse rate comparison of 3M elastomeric respirators and N95 FFR before treatment, 30 min after the start and after completion of the treatment.

PULSE RATE		MEAN	STANDARD DEVIATION	T	P VALUE
BT	3M	90.3333	16.39105	0.406	**0.001(H.S)**
	N95	88.7917	8.78229		
30MIN	3M	91.7917	15.28563	0.694	**0.001(H.S)**
	N95	89.4583	6.12890		
AT	3M	91.1250	15.21530	-0.739	**0.008(H.S)**
	N95	93.6250	6.59257		

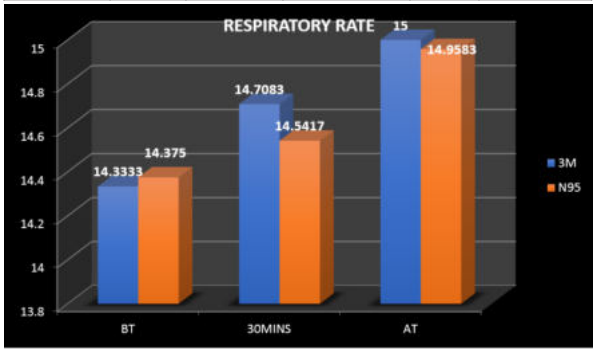

FIGURE 5: Graphical representation of respiratory rate comparison between 3M elastomeric respirators and N95 FFR

TABLE 4: Intergroup oxygen saturation comparison of 3M elastomeric respirators and N95 FFR before treatment,30 min after the start and after completion of the treatment.

RESPIRATORY RATE		MEAN	STANDARD DEVIATION	T	P VALUE
BT	3M	14.3333	.56466	-0.238	0.370(N.S)
	N95	14.3750	.64690		
30MIN	3M	14.7083	.95458	0.663	0.501(N.S)
	N95	14.5417	.77903		
AT	3M	15.0000	1.17954	0.130	0.553(N.S)
	N95	14.9583	1.04170		

RESULTS:

48 participants were included in the study and grouped into two groups one which uses N95 FFR and another using 3M elastomeric respirators. Table 1 represents intergroup comparison of 3M elastomeric respirators and N95 FFR respirators in terms of oxygen saturation and its was not statistically significant (P=0.536) before the initiation of the

treatment between both the groups. However, the values were found to be statistically significant at 30 mins after the initiation of treatment (P=0.048) and after the completion of the treatment (P=0.043).

Table 2 represents intergroup comparison of 3M elastomeric respirators and N95 FFR respirators in terms of pulse rate and statistically its was found to be highly significant before the initiation of the treatment, 30 mins after the initiation of treatment and after the completion of the treatment with *P* values at 0.001, 0.001 & 0.008 respectively.

Table 3 represents intergroup comparison of 3M elastomeric respirators and N95 FFR respirators in terms of respiratory rate and its was not statistically significant at neither of the three readings.

DISCUSSION:

Our study aims to assess and evaluate the key physiological changes in the body during the use of N95 FFR or 3M elastomeric respirators which is part of the PPE kits. Although the protective mechanisms of respirators are largely physical and sometimes chemical, wearing respirators come with a host of physiological and psychological burdens. [8] These can interfere with task performances and reduce work efficiency.

Respirators may appear to be rather simple, but they can interfere with[9]:

1. Respiration
2. Thermal equilibrium
3. Vision
4. Communication
5. Feelings of well-being
6. Personal procedures such as eating and sneezing
7. Other equipment

Guidance from the WHO states that "health care workers should wear a medical face mask (herein after termed medical mask) when entering a room where patients suspected or confirmed of being infected with SARS-CoV-2 are admitted and in any situation of care provided to a suspected or confirmed case". The use of a particulate respirator at least as protective as a US National Institute for Occupational Safety and Health (NIOSH)-certified N95, European Union (EU) standard FFP2, or equivalent, is recommended when performing aerosol-generating medical procedures. [10,11]

Strict adherence to the use of administrative controls and using medical masks as a component of PPE were shown to be effective with no reported transmission events to Health care workers (HCWs) during the SARS outbreak in 2003. [12]

Studies have demonstrated side effects associated with the use of particulate respirators including facial dermatitis from the respirator components, increased work of breathing, respiratory fatigue, impaired work capacity, increased oxygen debt, early exhaustion at lighter workloads, elevated levels of CO2, increased nasal resistance, and increased noncompliance events leading to self-contamination (adjustments, respirator or face touches, under-the-respirator touches, and eye touches). [13,14,15,16,17,18,19] NIOSH reported that the N95 filtering facepiece respirators had the highest inhaled CO2 concentrations (3.6%) and the lowest mean inhaled O2 concentration (16.8%). [20]

Our data indicates a no significant drop in O2 concentration at the initiation of treatment with either type of the mask used (*P=0.536)*. Although, significant difference was noted 30 mins after the start of the procedure and after the completion of the treatment (*P=0.048 & P=0.043)* respectively. The literature reports CO2 is weakly narcotic at 3%, giving rise to reduced acuity of hearing and increasing blood pressure and pulse. Kaye et al. demonstrated that acute exposure to CO2, traditionally used in psychiatry to stimulate anxiety, can produce mood disorders and the increased frequency of cardiovascular complications associated with chronic stress.

The principal psychological changes seen by Kaye et al. were a dose-dependent increase in subjective feelings of anxiety, breathlessness, and a few specific somatic symptoms of fear (i.e., difficulty concentrating, dizziness/light headedness, blurred or narrowed vision and feeling hot or flushed). [21] At lowered O2 levels potential adverse health effects include increased heart rate, some decrease in coordination, increased breathing volume, and impaired thought processes. [22] The data in our study confirms this where in a highly significant difference was noted in the pulse rate right from the starting of the treatment procedure, and the values kept falling 30 mins after the start and after the completion of the procedure (*P=0.001, P=0.001, P=0.008)* respectively.

When considering the respiratory rate of the treating dentists no significant change was noted in either of the group suggesting the subjects were compliant with both the type of masks.

Limitations of the current study include relatively small number of human subjects who were young and healthy and may have performed better compared to elderly, those with cardiopulmonary complications. Similarly, because the subjects were tested for an average of around 40-45 mins the data may potentially differ from those performing procedures with longer time requirement.

CONCLUSION

Measures to prevent infections are necessary in the current pandemic. Face masks have been considered a first step to prevent and contain the spread of the disease. N95 FFR respirators without valves are currently recommended in order to prevent COVID-19 spread and preserve HCW wellbeing. The practitioners wore the N95/FFP2 respirator for prolonged periods of time and the perceived side effects, such as breathing difficulties, headaches, and concentration problems, lead to an impaired working ability. Elastomeric face masks have several advantages over reusing disposable N-95 masks. They provide safe reusable protection, can be easily cleaned, and have lower risk of transmitting infection between patients. While not originally designed for hospital use, they provide an excellent solution to the shortage of disposable N-95 masks during this COVID-19 pandemic.

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