Letter to the Editor

Quantification of aerosol production during phacoemulsification and pars plana vitrectomy

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Editor,

Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) is the pathogen responsible for the 2019–2020 COVID-19 pandemic. The virus has the potential to be transmissible via aerosols (World Health Organization, 2020), which are tiny particles (≤5 μm in diameter) suspended in air that are invisible to the human eye (World Health Organization, 2014). Phacoemulsification and pars plana vitrectomy (PPV) are common intraocular surgical procedures which utilize high-speed devices. High-speed devices have the potential to generate aerosols across an air-fluid interface yet to date there has been no study quantifying whether these procedures generate aerosols. We used an experimental setup, involving model eyes and an optical particle counter,

Figure 1. (A) The MET ONE A2400 optical particle counter probe (black arrow) was positioned 16 cm above the model eye to measure particle concentration during each procedure (B) Mean particle concentration during phacoemulsification - sculpting (C) Mean particle concentration during phacoemulsification – quadrant removal (D) Mean particle concentration during pars plana vitrectomy. n = 5. Error bars are the standard error of the mean.
to quantify the degree of aerosol production that occurs during phacoemulsification and PPV.

For phacoemulsification, we used an advanced cataract model eye (Phillips Studio, Bristol, UK). A divide and conquer technique through a 2.2 mm corneal wound and side paracentesis was performed with the CENTURION System (Alcon, Geneva, Switzerland). Aerosol production was measured during sculpting and quadrant removal.

For PPV, a vitreoretinal model eye was used (GWB International, Marshfield Hills, MA, USA). The PPV was performed through three 25G valved port canulas, using the CONSTELLATION System (Alcon) at a cut-rate of 4000 cpm. All experiments were performed in an operating room with a ventilation rate of 25 air changes per hour. A Met One A2400 optical particle counter (Hach Co, Loveland, CO, USA) sampling at a rate of one cubic foot per minute was used to measure particle concentration (Fig. 1A). The use of optical particle counters is an established method for the quantitative measurement of aerosols (Pazienza et al. 2014). For each of the three procedures, the particle count was measured at baseline with the handpiece or vitrector deactivated, and then during the procedure with the instrument activated. This was repeated five separate times.

The mean concentration of particles sized 1–5 μm was compared with the corresponding baseline for each procedure using the Welch’s t-test. Statistical significance was defined as p < 0.05. Mean particle concentrations for each procedure and the preceding baseline are presented in Fig. 1. During sculpting (Fig. 1B), there was a 193% increase [mean change 1932 counts/ft³, standard deviation (SD) 1451] in the mean particle concentration from the baseline, which was statistically significant (p = 0.04). For quadrant removal (Fig. 1C), there was an 83% increase (mean change 817 counts/ft³, SD 697) in the mean particle concentration from the baseline, which was statistically significant (p = 0.04).

There was no statistically significant change (p = 0.14) in the mean particle concentration during PPV compared to baseline (mean change –129 counts/ft³, SD 174; Fig. 1D).

The findings from our study suggest that aerosols may be produced during phacoemulsification but not during PPV. Although phacoemulsification may generate aerosols, currently there is no evidence showing the presence of SARS-CoV-2 in aqueous humour. Even if the virus was present, the aqueous is first replaced with viscoelastic and then with balanced salt solution (BSS) at the start of phacoemulsification. Consequently, by the time sculpting commences, it is BSS that is aerosolized rather than aqueous. We therefore support the rationale behind national (Royal College of Ophthalmologists, 2020) and international guidance (American Academy of Ophthalmology, 2020) on intraocular surgery during the COVID-19 pandemic, which suggests that the risk of aerosolized virus during phacoemulsification is likely to be very low. We did not measure a significant rise in particle concentration during PPV. This could be explained by virtue of this procedure being performed through valved port canulas, within a closed system, such that any aerosol generated is contained within the eye.

A limitation of our approach is the use of model eyes, which do not possess the same biomechanical properties as human eyes. Additionally, we used an optical particle counter which does not distinguish between infectious and non-infectious particles. Nevertheless, our study yields the first quantitative data on aerosol generation during intraocular surgery. Further research to confirm our model eye findings in a human eye is warranted.

References


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