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Aerosol generation through phacoemulsifcation

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Several surgical and anaesthetic procedures have been considered to be aerosol-generating in nature (AGPs). This classification is important because such procedures pose an increased transmission risk for respiratory pathogens, including the SARS-CoV-2 virus. The start of the COVID-19 pandemic saw assumptions being made on whether phacoemulsification should be considered as an AGP or not. At the time, there was a lack of robust evidence to support or dismiss the concern.

This poster describes one of the first bio-experiments conducted by our group at the Sussex Eye Hospital in April 2020 which aimed to quantify aerosol generation with phacoemulsification measuring ≤10μm.

Study design: ex vivo study of phacoemulsification on porcine eyes

Setting: Ophthalmic theatre at Sussex Eye Hospital

Funding: Brighton & Sussex University Hospitals National Health Service Trust Charity (Charity no. 1050864) funded the project

Sample size: 15 porcine eyes, 5 per experiment

Device: TROTEC PC200 (Trotec GmbH, Germany) optical particle counter, conforming to ISO-21501-4 standards was calibrated as per manufacturer instructions. Particle counts were recorded at a rate of 2.83 litres/min with the time limit for sampling set at 21 seconds (resulting in 0.99 litres of air being sampled). Particle counts were stored cumulatively in six channels with the following nominal diameters: 0.3μm, 0.5μm, 1μm, 2.5μm, 5μm, and 10μm. The values displayed against each channel number will depict the number of particles with sizes ≤0.3μm, >0.3-0.5μm, >0.5-1μm, >1-2.5μm, >2.5-5μm, and >5-10μm respectively

Baseline experiments were conducted for calibration and assessment of the particle counter apparatus.

1. To determine the counter efficacy, mean difference was ascertained between the baseline and after 10 puffs of saccharin solution (3 M FT-11 Sodium Saccharin Sensitivity Test Solution), sprayed within a qualitative fit-test hood (closed-environment) in theatre conditions.

2. To determine the placement of the particle counter for capturing the maximum aerosols counts, measurements were compared for when nebulized saccharin solution was sprayed from the side or directly facing towards to the particle counter.

Table 1: Torsional, longitudinal, and longitudinal phacoemulsification with HPMC aerosol production of various size

Particle size	Torsional phacoemulsification (Mean ± standard deviation) (95% confidence interval)		Paired t test (p value)	Longitudinal phacoemulsification (Mean ± standard deviation) (95% confidence interval)		Paired t test (p value)	Longitudinal phacoemulsification with HPMC (Mean ± standard deviation) (95% confidence interval)		Paired t test (p value)	ANOVA test (p value)
	Pre-phacoemulsification (25 measurements from 5 eyes)	During phacoemulsification (25 measurements from 5 eyes)	Pre vs. during phacoemulsification	Pre-phacoemulsification (25 measurements from 5 eyes)	During phacoemulsification (25 measurements from 5 eyes)	Pre vs. during phacoemulsification	Pre-phacoemulsification (25 measurements from 5 eyes)	During phacoemulsification (25 measurements from 5 eyes)	Pre vs. during phacoemulsification	Comparing torsional, longitudinal and longitudinal with HPMC during phacoemulsification
0.3μ	5838.87 ± 1230.38 5203.64, 6474.10	5439.10 ± 1183.13 4789.79, 6188.41	0.35	6058.24 ± 1138.01 5588.49, 6527.99	5641.36 ± 1047.13 5209.13, 6073.59	0.18	7115.35 ± 965.72 6595.69, 7635.01	7146.75 ± 871.52 6516.88, 7777.62	0.91	0.46
0.5μ	1243.36 ± 413.29 1072.76, 1413.96	1184.60 ± 472.08 989.73, 1379.47	0.64	1213.32 ± 300.92 1089.11, 1337.53	1070.36 ± 276.17 956.36, 1184.36	0.09	1395.88 ± 363.20 1245.96, 1545.80	1479.12 ± 432.69 1300.51, 1657.73	0.46	0.30
1.0μ	124.08 ± 54.23 101.70, 146.46	119.96 ± 58.80 95.69, 144.23	0.80	136.96 ± 50.49 116.12, 157.80	110.56 ± 42.81 92.89, 128.23	0.05	138.60 ± 47.81 118.86, 158.34	153.32 ± 54.65 130.76, 175.88	0.32	0.14
2.5μ	14.12 ± 7.63 10.97, 17.27	10.92 ± 8.25 7.51, 14.33	0.16	13.44 ± 7.71 10.26, 16.62	12.88 ± 4.82 10.89, 14.87	0.76	14.80 ± 6.88 11.96, 17.64	15.76 ± 8.28 12.34., 19.18	0.66	0.40
5.0μ	1.44 ± 1.16 0.96, 1.92	1.40 ± 1.19 0.91, 1.89	0.90	2.16 ± 1.62 1.49, 2.83	1.52 ± 1.53 0.89, 2.15	0.16	2.08 ± 1.89 1.30, 2.86	1.80 ± 1.83 1.05, 2.55	0.60	0.44
10.0μ	0.8 ± 0.87 0.44, 1.16	1.0 ± 0.76 0.68, 1.32	0.39	1.56 ± 1.00 1.15,1.97	1.04 ± 0.89 0.67,1.41	0.06	1.08 ± 1.04 0.65, 1.51	1.04 ± 0.93 0.65, 1.43	0.89	0.09

Phacoemulsification Experiments were conducted to assess the aerosol generation during phacoemulsification with predetermined torsional, longitudinal, and longitudinal settings with HPMC. (Table 1)

Three separate phacoemulsification experiments were conducted on 15 porcine eyes embedded in the orbit socket of a head mold (Philips Studio). There were 5 preprocedure sequential particle measurements and another 5 acquired during phacoemulsification for each porcine eye. Therefore, a total of 75 measurements were recorded for 15 porcine eyes. The 3 experiments included 5 porcine eyes that underwent phacoemulsification using 80% longitudinal setting only (no torsional) on continuous power mode and 5 porcine eyes that underwent phacoemulsification using 100% torsional setting only (no longitudinal) on continuous power mode. In addition, 5 porcine eyes underwent phacoemulsification using 80% longitudinal setting only (no torsional) on continuous power mode with copious application of HPMC (OcuCoat, Bausch & Lomb, Inc.) on the ocular surface at the start of phacoemulsification.



Figure 1: Theater setup with a simulation head-mold placed at the head end of the patient bed with porcine eye mounted in the eye socket.

Our study quantifies generation of aerosols measuring 10 μm and less during phacoemulsification. Smaller aerosols that measure less than 10 μm are of special interest because they can stay airborne for longer duration and can reach the lower pulmonary alveoli. For example, particles of sizes 0.5 μm and 1 μm will remain airborne for an average of 41 hours and 12 hours, respectively. This propensity to stay in air, coupled with extended survival times, can transmit the infective pathogen to secondary hosts directly and indirectly through fomites. It is also important to note that relative humidity and temperature of the environment also affect size of these emitted infectious particles.

Our study was able to conclude:

- Optical particle counters can be used for measuring aerosols less than 10 μm.
- Phacoemulsification did not significantly increase aerosol counts measuring 10 μm and less/
- The use of hydroxypropyl methylcellulose did not have an effect on aerosol generation.

References

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- Lee H, Naveed H, Ashena Z, Nanavaty MA. Aerosol generation through phacoemulsification. J Cataract Refract Surg. 2020 Sep;46(9):1290-1296. doi: 10.1097/j.jcrs.0000000000000288. PMID: 32569027.