Supplementary data

ANNEX A: Influence of silicone tubing on particle distribution measurements

Materials and Methods

Sodium chloride (>95%) was purchased from Fisher Scientific, Leicestershire, UK. Ultra-pure water (>18.2 MΩ) was obtained by ultrafiltration of the municipal supply via a MilliQ Integral 3 (Millipore, MA, USA). Silicone tubing ("Tygon®") was purchased from the Cole-Parmer Instrument Co (Illinois, USA) and was reported to have the following dimensions: internal diameter 12.7 mm, outer diameter 17.5 mm, wall thickness 2.4 mm). The tubing was cut into 6 x 2m sections.

The Study was performed in a custom-built chamber (internal dimensions 7.6 m (h) x 4.6 m x 4.6 m; volume ~ 160. 8 m^{-3}) lined with a chemically resistant epoxy resin (Renotex Rollercoat, Renotex Ltd, Wakefield, UK) with a powder-coated, glass-reinforced plastic floor suspended at a height of 1 m from the base of the chamber. The chamber environment was maintained at constant temperature and humidity (21 ± 1° C, 40 ± 2 % RH) through an internally mounted air conditioning unit (iQool12, Aircon Direct, UK). Air was removed from the chamber via a stainless steel central duct ($\phi = 150$ mm; wind velocity at orifice ~ 3.15 m s^{-1}) below the suspended floor and was recirculated via five, overhead polypropylene ducts ($\phi = 110$ mm; velocity ~ 1.6 ms^{-1} at each duct orifice) suspended 0.2 m below the chamber ceiling. The recirculation rate was controlled by an in-line, variable speed pump (Model DV150, P&G Fabrications, Essex, UK). Air within the chamber was agitated using a metal-bladed electric fan (model W4E400-DS02-38, RS Components, UK) which produced a constant air speed of ~ 1.5 m s^{-1} at a distance of 1.5 m. Entry to the exposure chamber was via an air-lock, operating at an over pressure of ~5 mBar.

The aerosol was produced using a spray gun (DeVilbliss Cobra 1 automatic spray gun, Hitech Spray Ltd, UK) fitted with fluid nozzle and separator (SP-200S-12-K, Devilbliss) and air cap (SP-100-522-COM-K, DeVilbliss), with a 2.27 L pressure kettle (DeVilbliss KBII, Hitech Spray Ltd, UK; operating pressure 2.5 PSI) containing 20% (w/w) aqueous sodium chloride. Compressed air (90 PSI) was supplied from a compressor (ABAC Aria Compressa S.p.A., Model B 2800B, Robassomero, Italy). The output from the spray gun was directed through an impactor (comprising 1.2 m length of 10 mm diameter steel ducting bent through 180°) to remove large (>10 µm) particles. A small ($\phi = 8$ mm) vent was placed at the base of the impactor to drain excess fluid (~20% of the initial injection volume). Aerosol was generated within the chamber until the total particle concentration was 2.11 ± 0.16 x 10^6 cm^{-3}. The particle concentration and corresponding aerosol size distribution was measured using a high-resolution particle sizer (ELPI+, Dekati, Kangasala, Finland) at a sample acquisition rate of 1 Hz.

The study started with a 30 s baseline aerosol measurement by the particle sizer, after which the first silicone tube was attached to the particle sizer for a further 30 s period. The tube was then disconnected for 30 seconds and the process repeated three times before the tubing was changed (see study design; Figure 1). Each tube was positioned so that it was curved at the proximal and distal ends (Figure 2).

Figure S1: Outline study design indicating connection to particle sizer.

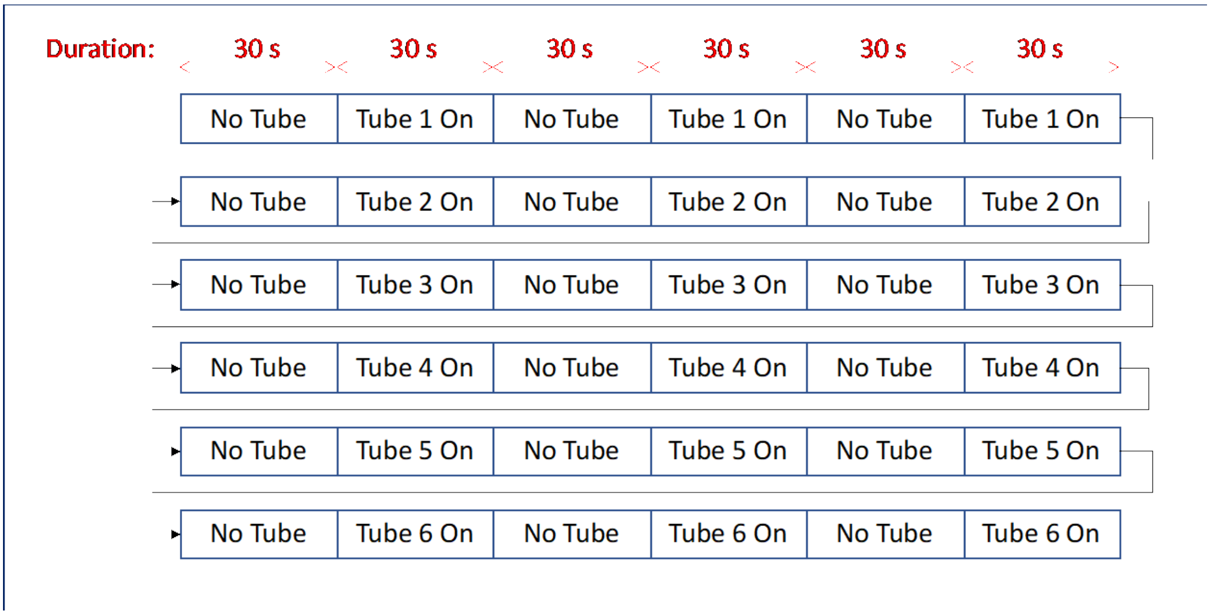
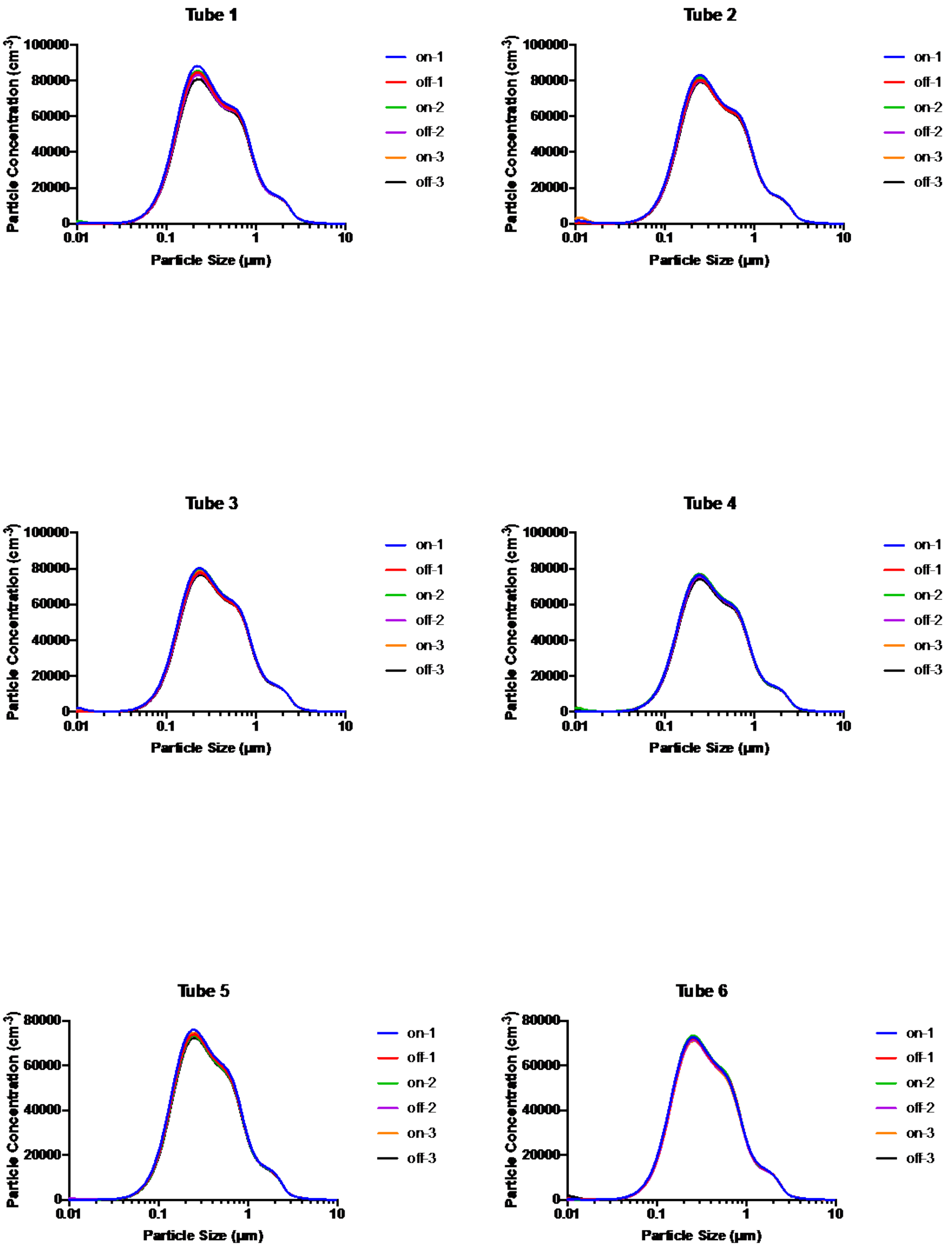


Figure S2: Position of silicone tube relative to the particle sizer.

Results

Triplicate cycles of connecting and disconnecting each tube had no observable effect on the measured particle size distribution (Figure S3).

Figure S3: Particle size distribution of salt aerosol measured in the presence ("on") or absence ("off") of tubes 1 – 6. Each tube was connected/disconnected in three cycles (1-3).



ANNEX B: Particle distribution histograms

Figure S4: Particle size distributions measured at Location 3 under intervention group A (Control) during procedures I to VI and at the end of the Decay period.

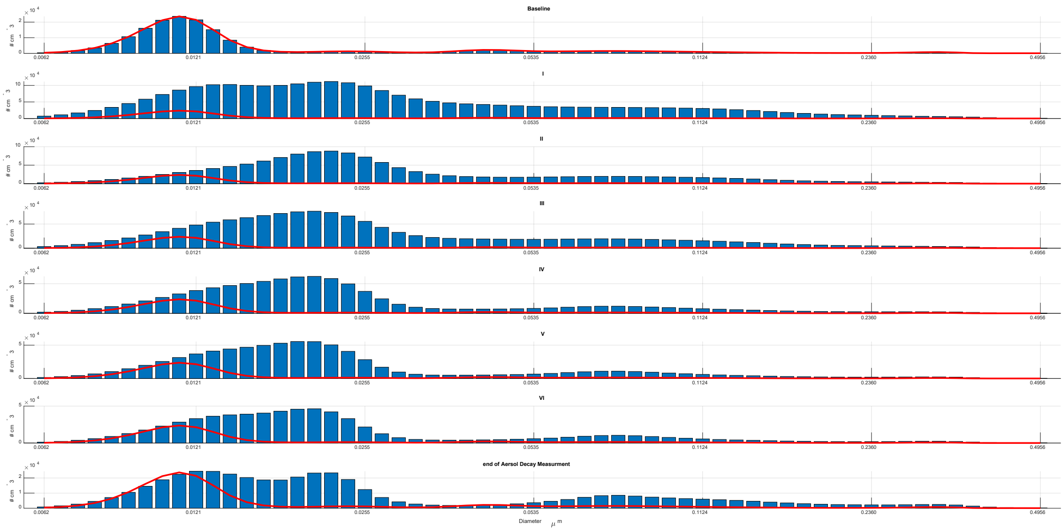
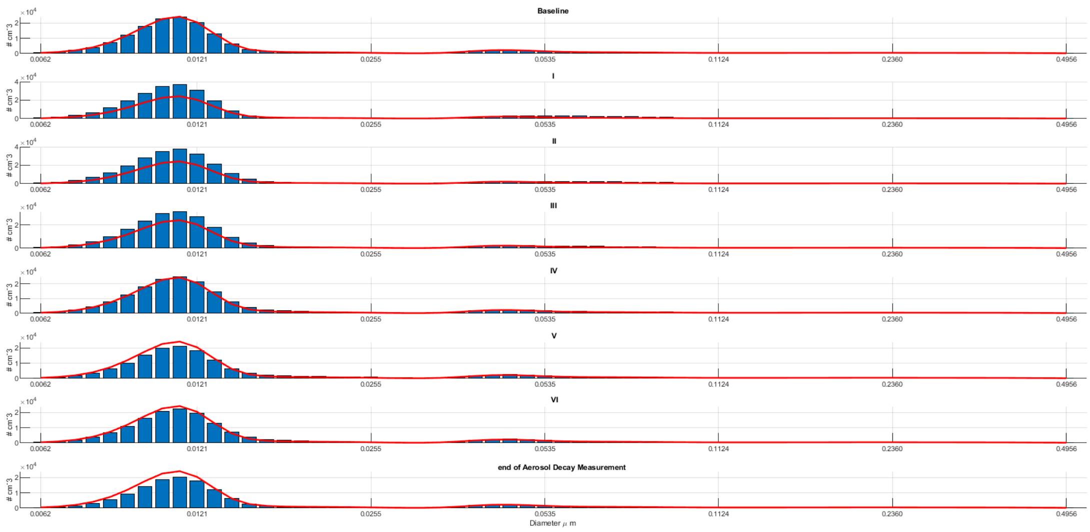
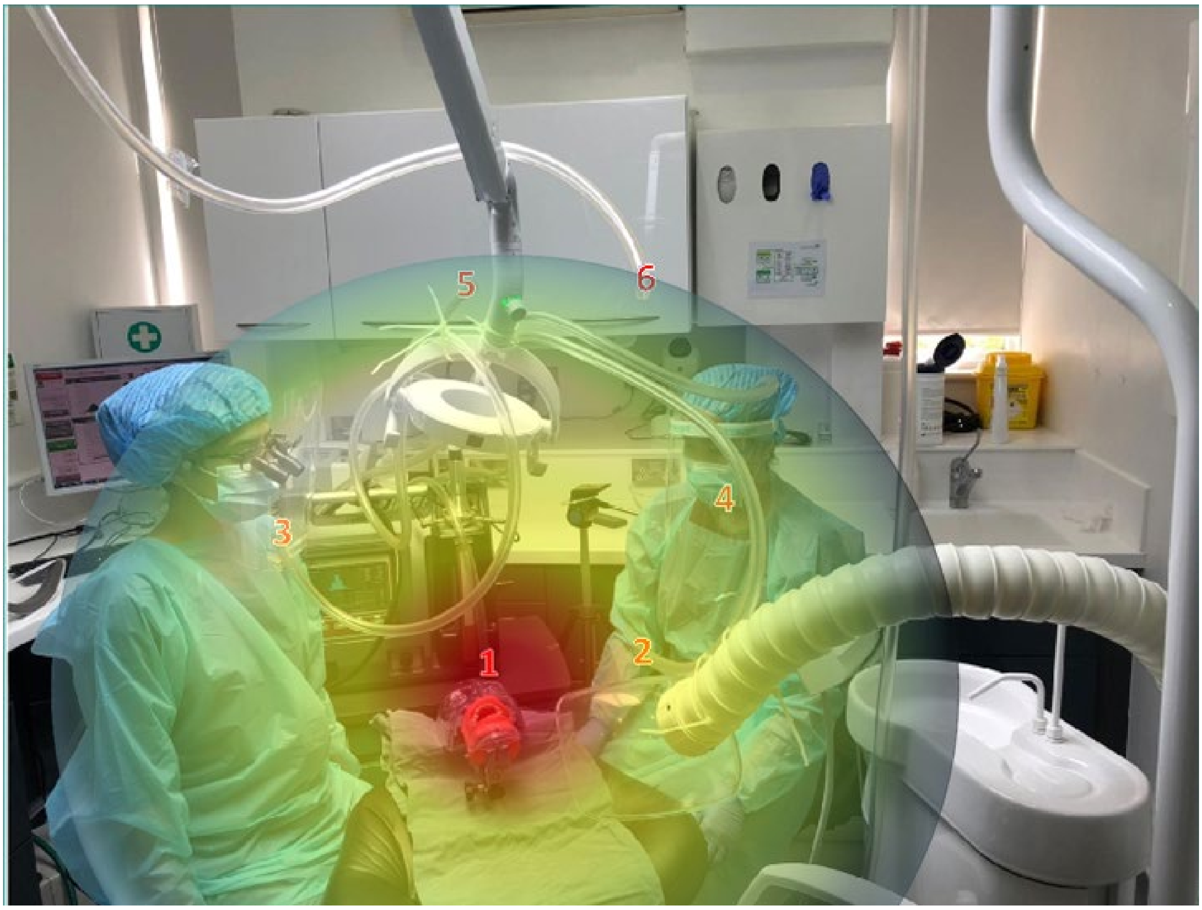


Figure S5: Particle size distributions measured at Location 3 under intervention group E (HVS(IO) + HVS (EO) + ACS) during procedures I to VI and at the end of the Decay period.



ANNEX C: Micro and macro environments

Figure S6: Diagram presenting the aerosol dispersion zones in a dental clinic. Red and yellow zones show the micro-environment with the highest aerosol concentration. The blue shading represents the interface between micro and macro environment, where lower aerosol concentrations were measured (Refer to Table S1 for sampling positions).



ANNEX D: Supplementary Figures

Figure S7: Total particle concentration generated during AGPs in the presence of HVS(IO) (intervention group B; Table S2) at each air sampling location (1 – 6; Table S1). Acquisition of air samples were performed during the baseline period (0 – 3 min), during the six procedures (3 – 21 min) and following cessation of procedures (21 – 36 min). Dotted lines indicate the upper and lower boundaries of the baseline data. Each data point represents the sum of particles measured by HR-ELPI over 1 second during each replicate (n=3).

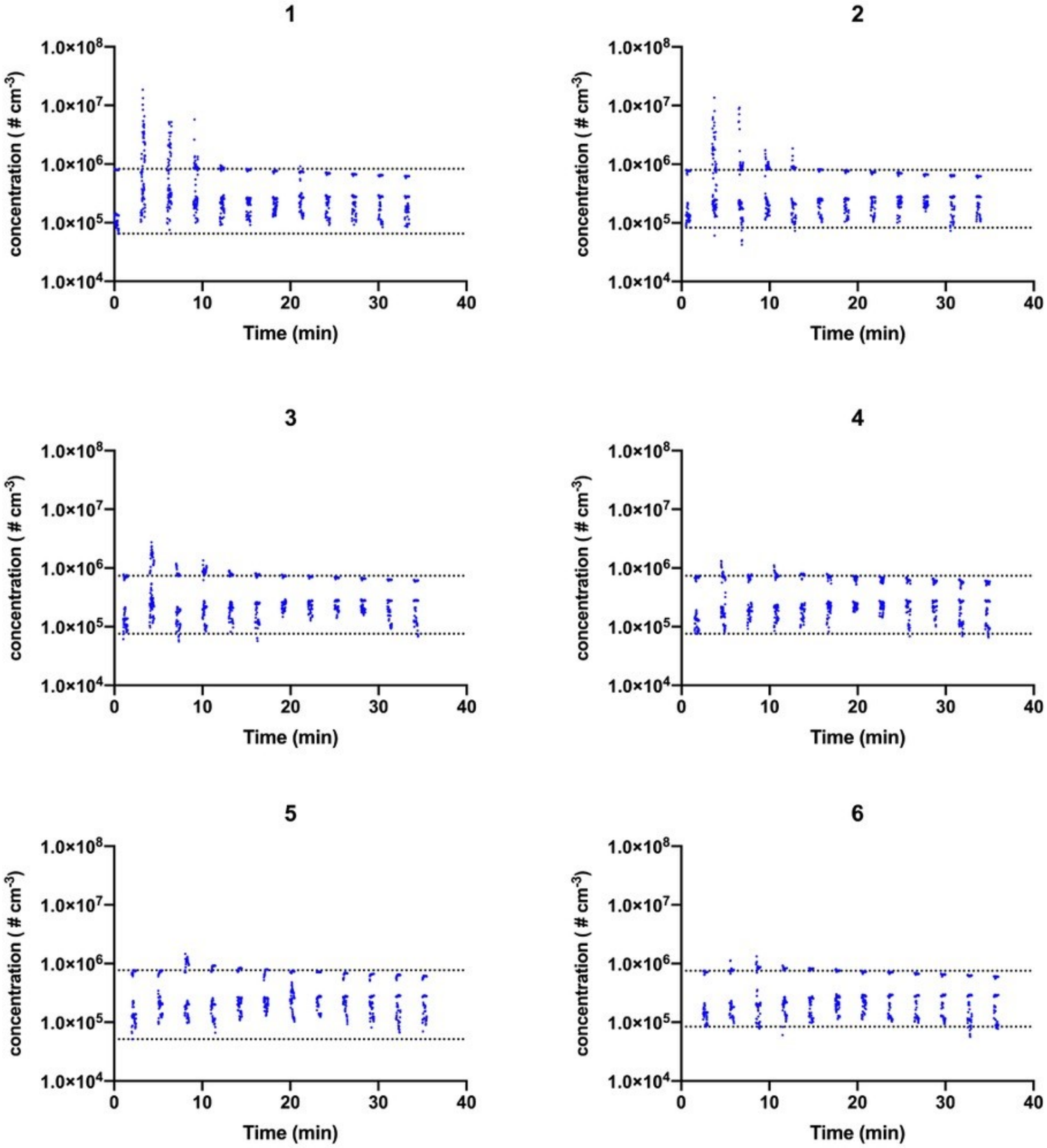


Figure S8: Total particle concentration generated during AGPs in the presence of HVS(IO) and ACS (intervention group C; Table S2) at each air sampling location (1 – 6; Table S1). Acquisition of air samples were performed during the baseline period (0 – 3 min), during the six procedures (3 – 21 min) and following cessation of procedures (21 – 36 min). Dotted lines indicate the upper and lower boundaries of the baseline data. Each data point represents the sum of particles measured by HR-ELPI over 1 second during each replicate (n=3).

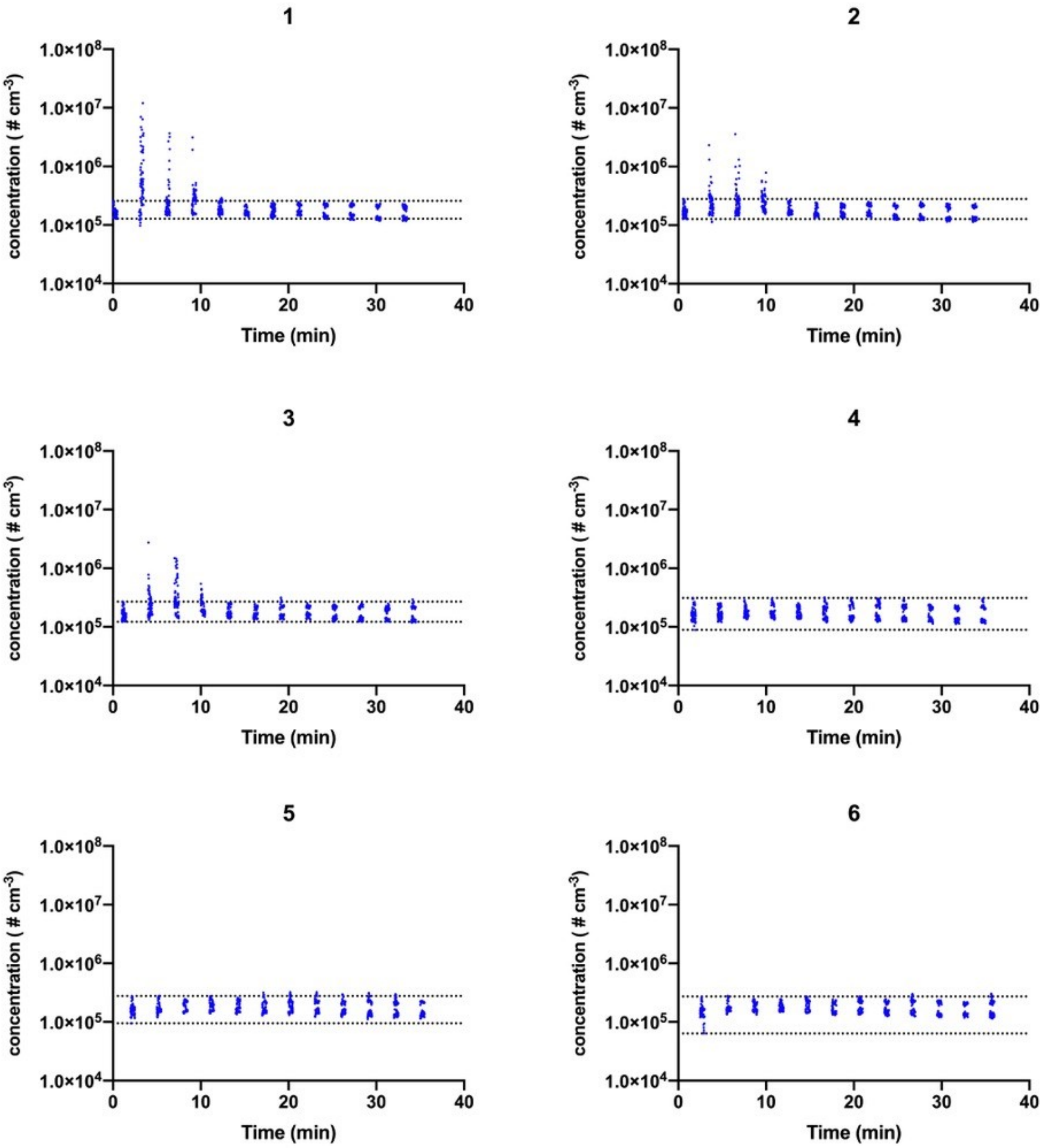


Figure S9: Total particle concentration generated during AGPs in the presence of HVS(IO) and HVS(EO) (intervention group D; Table S2) at each air sampling location (1 – 6; Table S1). Acquisition of air samples were performed during the baseline period (0 – 3 min), during the six procedures (3 – 21 min) and following cessation of procedures (21 – 36 min). Dotted lines indicate the upper and lower boundaries of the baseline data. Each data point represents the sum of particles measured by HR-ELPI over 1 second during each replicate (n=3).

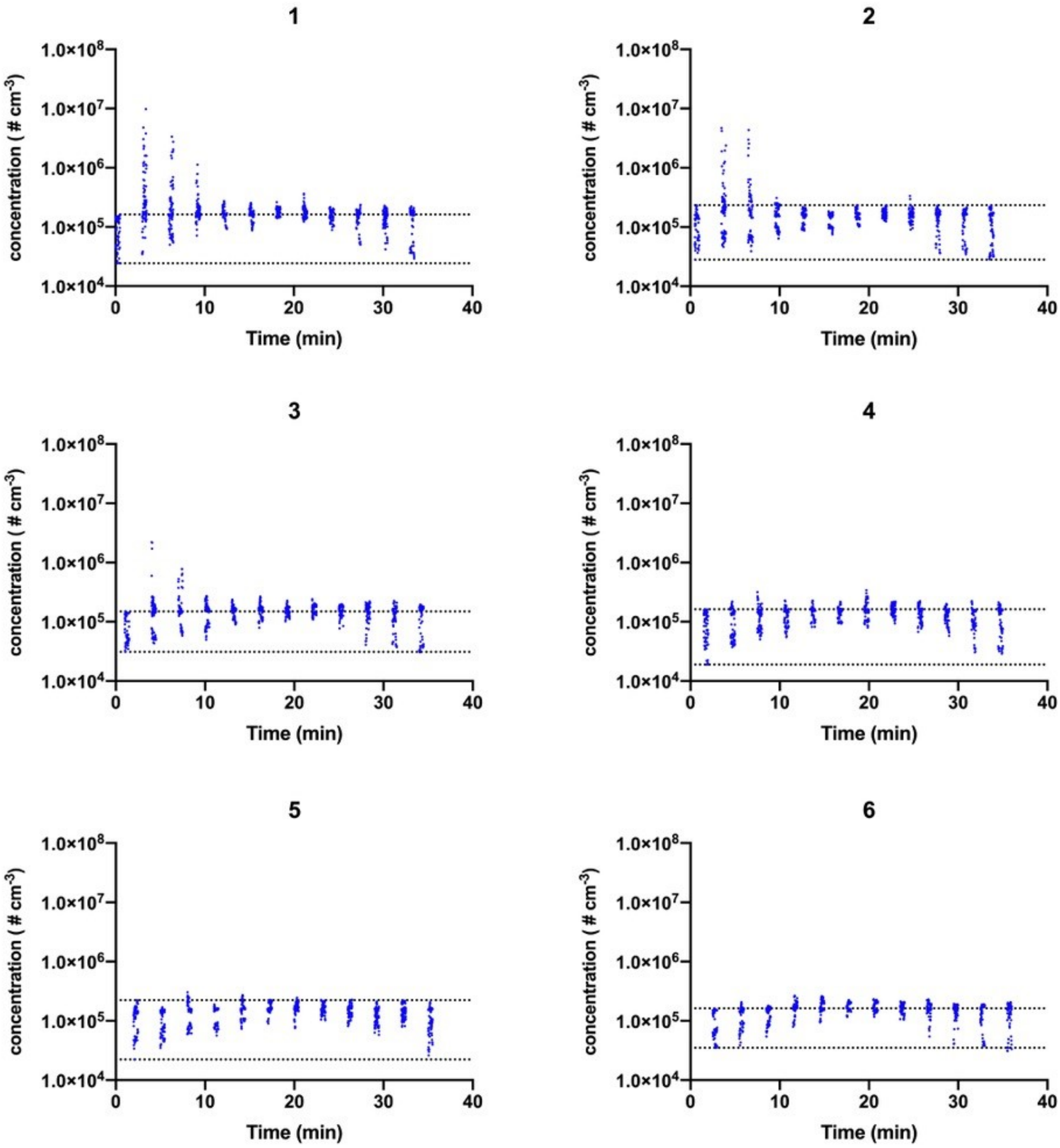
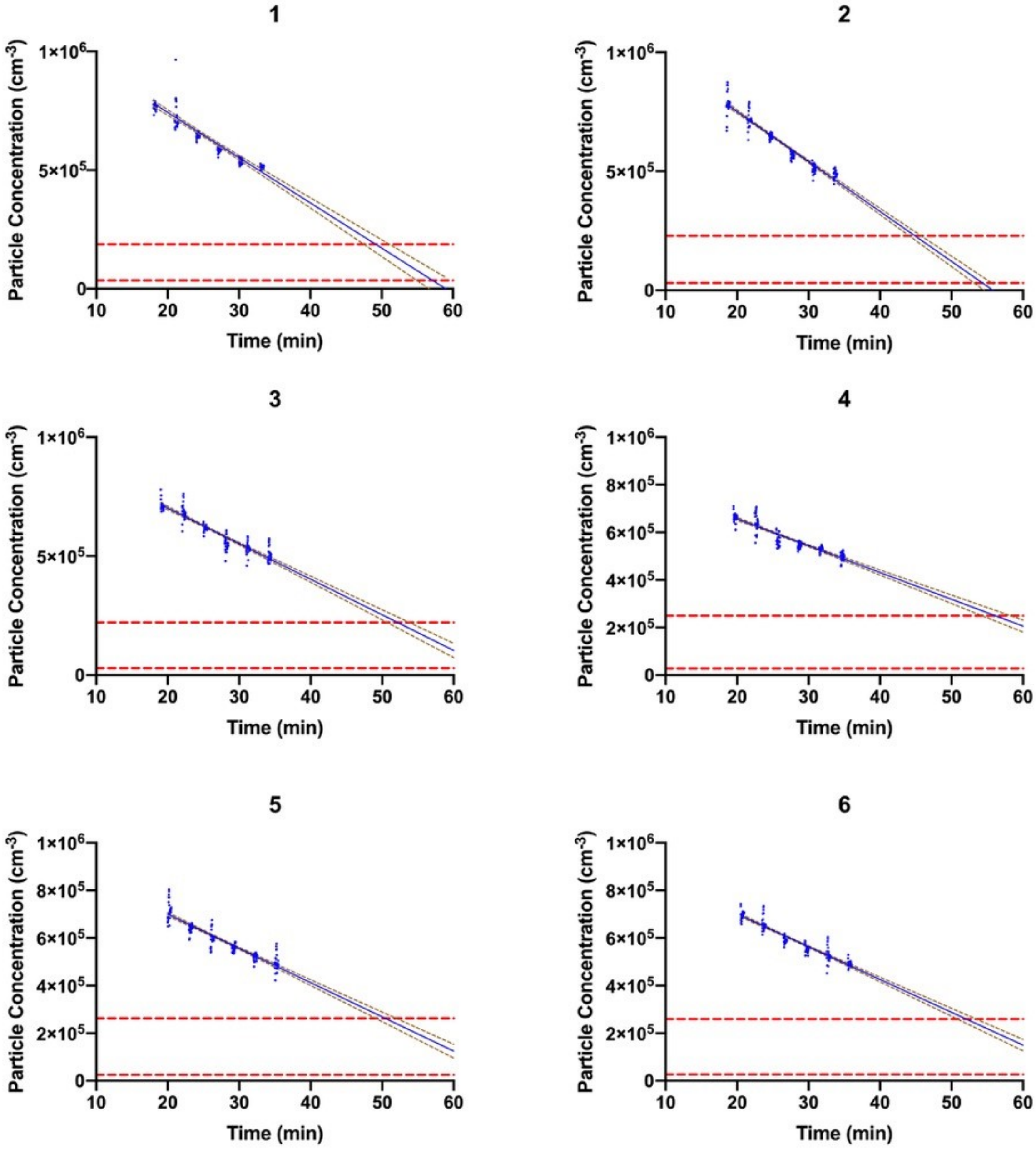


Figure S10: Linear regression (with 95% confidence intervals) of decay-phase particle concentration data. Each data point represents the median sum particle concentration measured by HR-ELPI per second during each replicate (n=3). Dotted line indicates baseline particle range.



Regression parameter	Location					
	1	2	3	4	5	6
Y-Intercept	1.1E+06	1.2E+06	1.0E+06	8.8E+05	9.9E+05	9.8E+05
Slope	-1.9E+04	-2.1E+04	-1.5E+04	-1.1E+04	-1.4E+04	-1.4E+04
r^2	0.7967	0.9218	0.8609	0.8273	0.8533	0.8827

D: Supplementary Tables

Table S1: Air sampling location coordinates, expressed relative to the phantom head (nominal coordinates x=0, y=0, z=0).

Sample Location No.	Name	Co-ordinates relative to phantom head (mm)			Linear Distance from source (mm)
		x	y	z	
1	Phantom head (source(mouth))	0	80	0	80
2	HVS (EO) in-take	135	-110	100	200
3	Dentist	-262	145	265	400
4	Assistant	354	160	300	500
5	Wall	0	900	1045	1480
6	Ceiling Light	726	-383	1495	1700

Table S2: Summary of aerosol removal interventions used in each experiment. Note that intra-oral low volume suction (LVS) was used in all treatment groups (including control) to represent standard practice and to prevent excess fluid accumulation within the phantom head.

	Interventions			
	LVS Low volume suction	HVS(IO) High Volume Suction (Intra-oral) with air filtration system.	HVS(EO) High Volume Suction (extra-oral).	ACS Air Cleaning System.
Intervention group				
A	X			
B	X	X		
C	X	X		X
D	X	X	X	
E	X	X	X	X

Table S3: Procedural equipment and corresponding coolant flow rates.

Procedure	Description	Handpieces RPM	Ultrasonic Scalers (kHz)	Coolant Flow Rate (mL min^{-1})
I	W&H Synea Vision TK94 hand-piece (Air Turbine) with long tapered bur	400,000		55
II	NSK Ti Max Z95L hand piece (Electric) with long tapered bur	200,000		67
III	Sirona T1 Control hand-piece (Air turbine) with long tapered bur	420,000		56
IV	3 in1 syringe from Belmont Cleo II chair			82
V	Cavitron Jet Plus Ultrasonic with 30K FSI-SLI tip		30	25
VI	NSK Vario Lux 2 (Piezo) with G8 tip		32	78

Table S4: Detail of preparations.

Procedure	Teeth	Detail
I	Air turbine handpiece - upper left quadrant (teeth 18 – 14)	Occlusal cavity preparations were performed for each tooth.
II	Electric contra-angle handpiece - upper anterior quadrant (teeth13 – 23)	Buccal class V cavities were prepared in the cervical region for each tooth.
III	Air turbine handpiece - upper right quadrant (teeth 24 – 28)	Occlusal cavity preparations were performed for each tooth.
IV	Three in one syringe - lower left quadrant (teeth 38 – 34)	The syringe was moved around gently, in an elliptical fashion over the quadrant in an occlusal orientation.
V	Ultrasonic scaler - lower anterior quadrant (teeth 33 – 43)	Ultrasonic procedures were performed at the labiogingival margin interface for anterior teeth and buccogingival margin interface for posterior teeth.
VI	Ultrasonic scaler - lower right quadrant (teeth 44 – 48)	