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Verification

How much Extra-Oral Suction (EOS) can prevent dental aerosols?

Fluid dynamic analysis of aerosols with EOS

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Translation courtesy of Professor Takashi Fujibayashi, DDS, PhD of Tokyo, Japan

Abstract:

Intra-oral suction (IOS) works in big-volume and high-speed suctioning with the tube 10-20mm diameter. The particle more than several 10μm in diameter can be suctioned but smaller particles can be distributed into to surroundings by the air turbulence caused by IOS. Extra-oral suction (EOS) has been used in order to reduce aerosols for the purpose of infection control in dental treatment. However, the effect of the apparatus to reduce the airborne contamination has never investigated in the dynamic motion.

The present study was performed in fluid dynamic analysis of aerosols particles with images taken by a high-speed camera using IOS alone and IOS with EOS. In addition, the measurement of aerosol particle number and aerosol bacterial colony count were also performed and analyzed them comparing between IOS alone and IOS with EOS.

Translation courtesy of Professor Takashi Fujibayashi, DDS, PhD of Tokyo, Japan

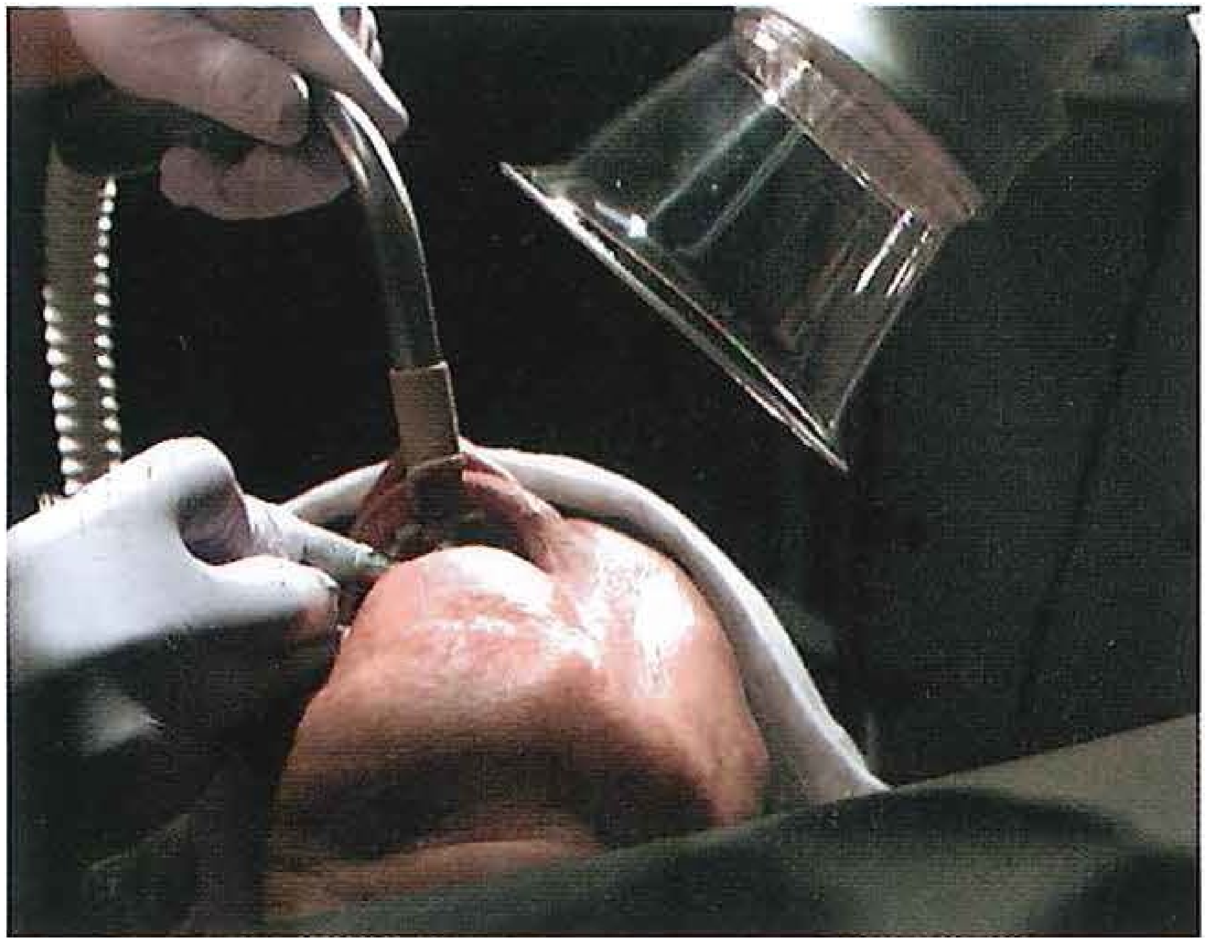
Materials and Methods

The present study was performed under the permission of 57-year-old male patient who was treated by scaling to the palatal periodontal pockets in right upper incisors and canine. The aerosols during the treatment were investigated.

Extra-oral suction (EOS) was performed by Free-Arm Forte-S (Tokyo Giken Inc.). The working time of the equipment and scaling time were set in 3 min. The suction cup of EOS was set at 5 cm high from the treating area angled at 45 degree.

The suctioning motion of aerosols contamination in Intra-oral suction (IOS) and EOS was observed by High-speed Camera Miro 4 Color Type (Phantom Inc.), and the fluid dynamic motion of aerosols was analyzed by CFdesign V10 (CFdesign Japan K.K.).

The aerosol particle (0.5μ) number was measured by a laser particle counter, and the aerosol bacterial colony count was calculated by biological basic air.

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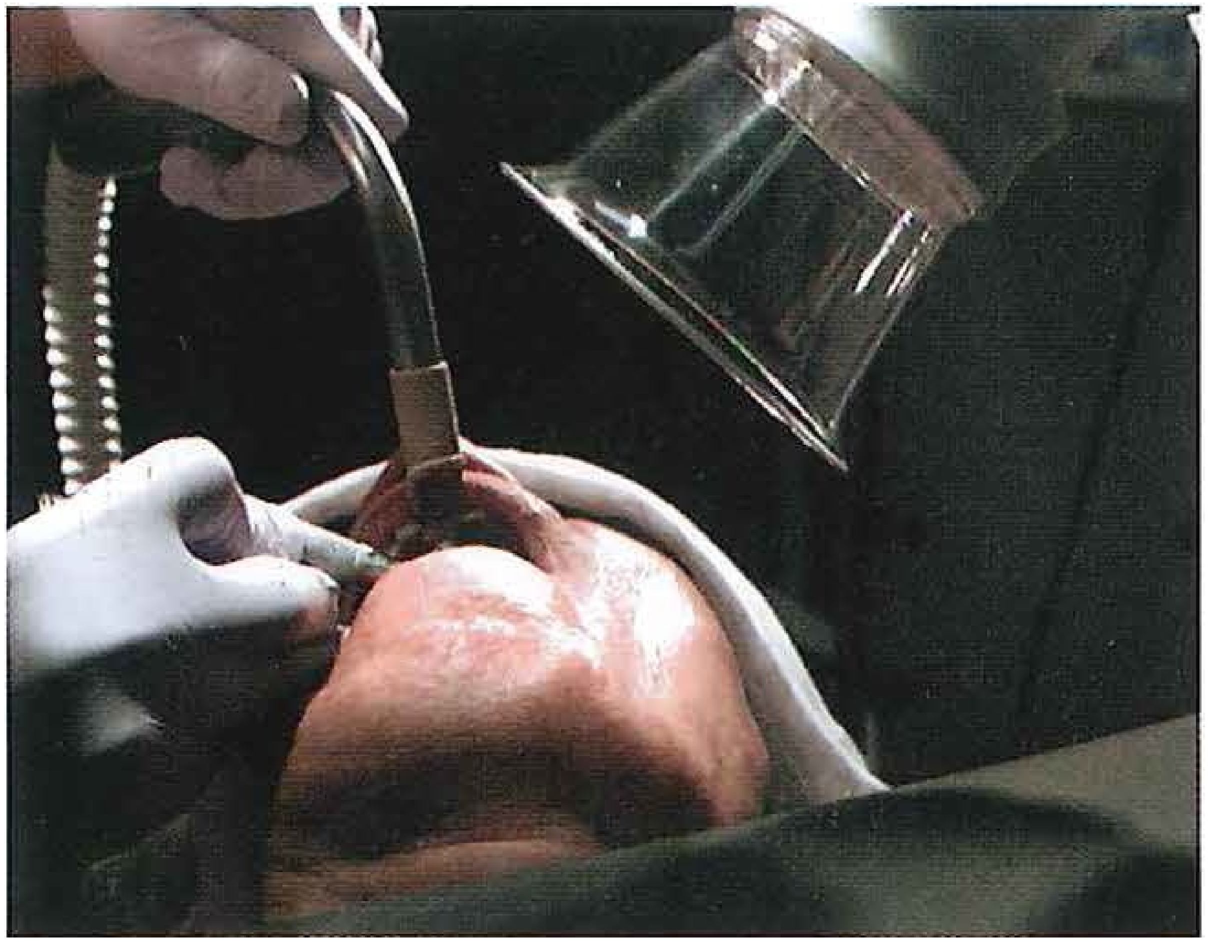
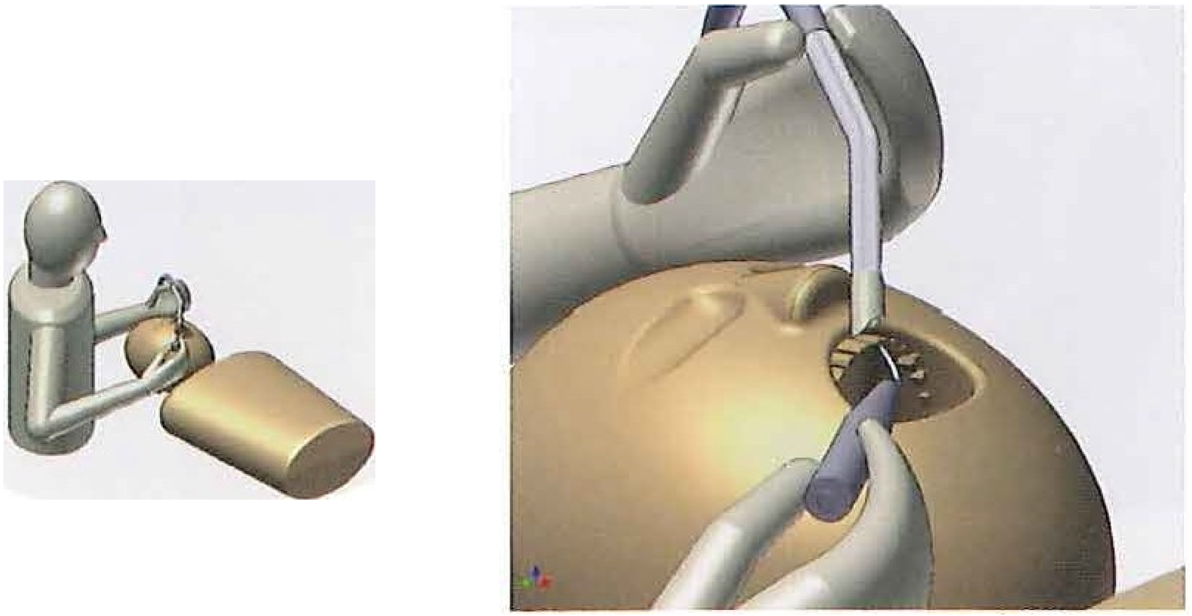
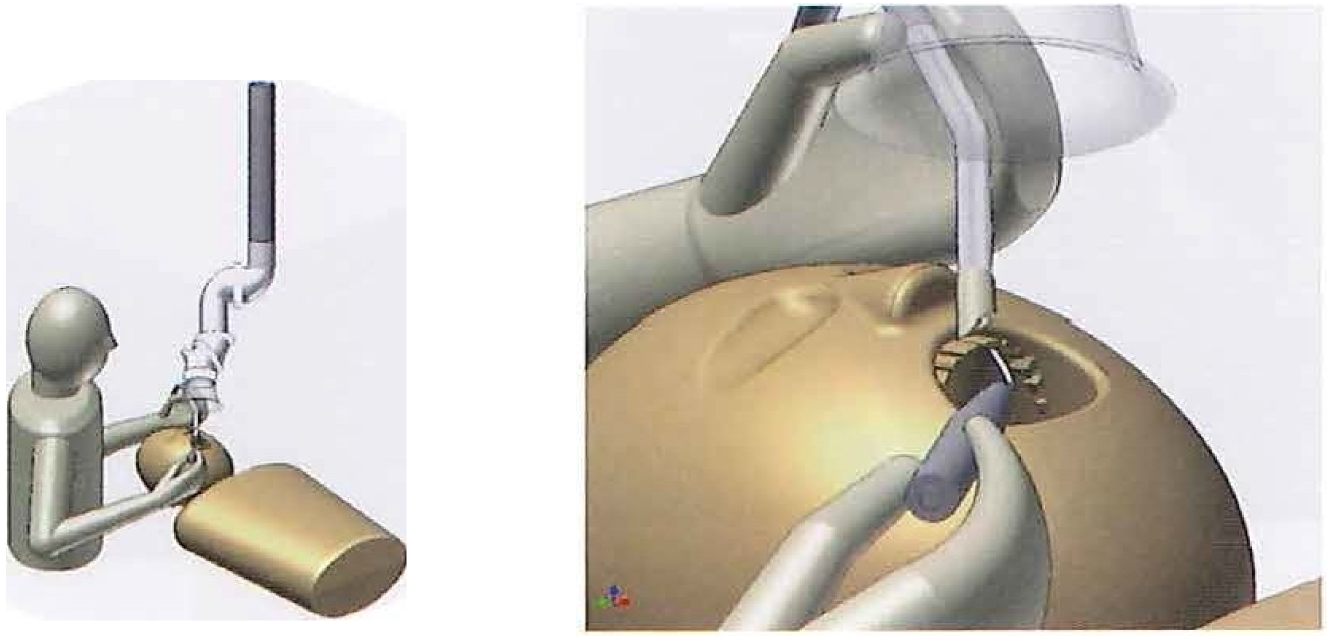


Model of fluid dynamic analysis

Intra-oral suction (IOS) alone



Intra-oral suction (IOS) with Extra-oral suction (EOS)



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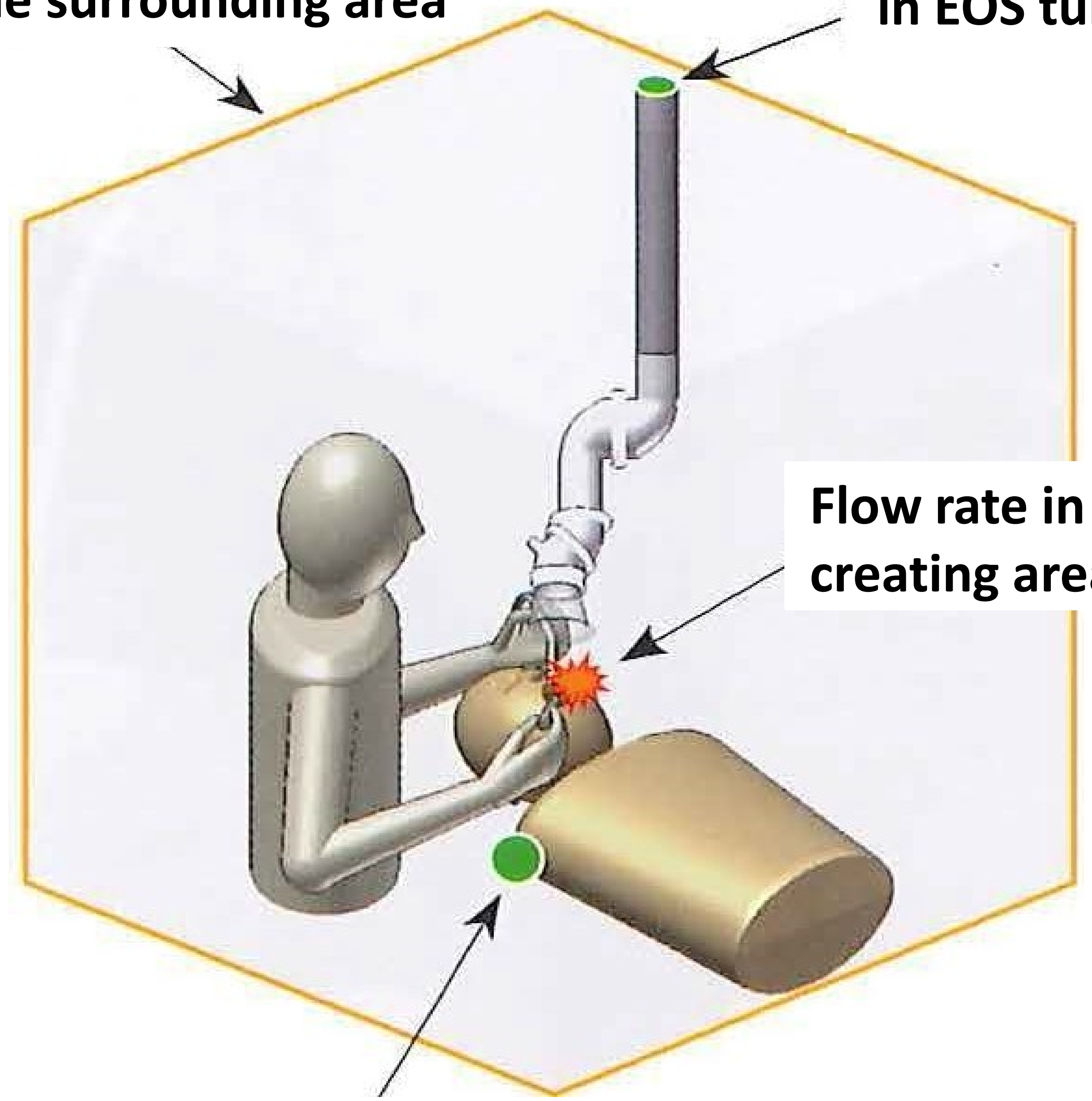
Condition of experimental circumstance

- Suction flow rate in EOS tube 3 m^3/min
- Suction flow rate in IOS tube 0.18 m^3/min
- Flow rate in aerosol creating area 50 L /min
- Atmospheric pressure in the surrounding area



Condition of aerosol particles

All aerosol particles were made of water,
particle density : 1.0 g/cm^3
particle diameter : ϕ1 μm ～ϕ10 μm
(increase with 1 μm)
gravity : acceleration of gravity 9.807 m/s^2

The trail of the particle movement was investigated

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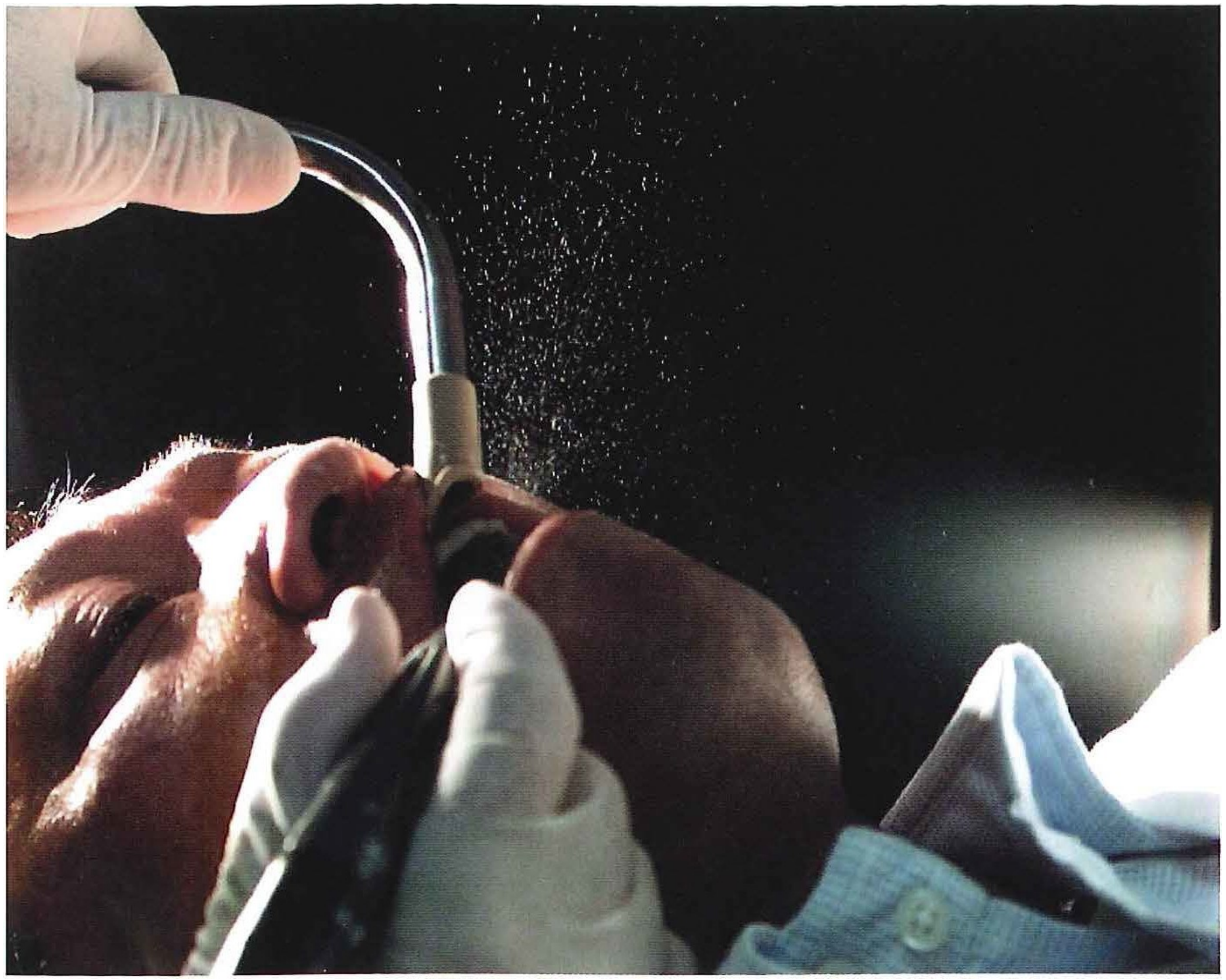
Result 1

Imaging in dynamic motion of aerosol particles by high-speed camera using IOS alone/ IOS with EOS



IOS alone

Aerosol particles were seen distributing around the face

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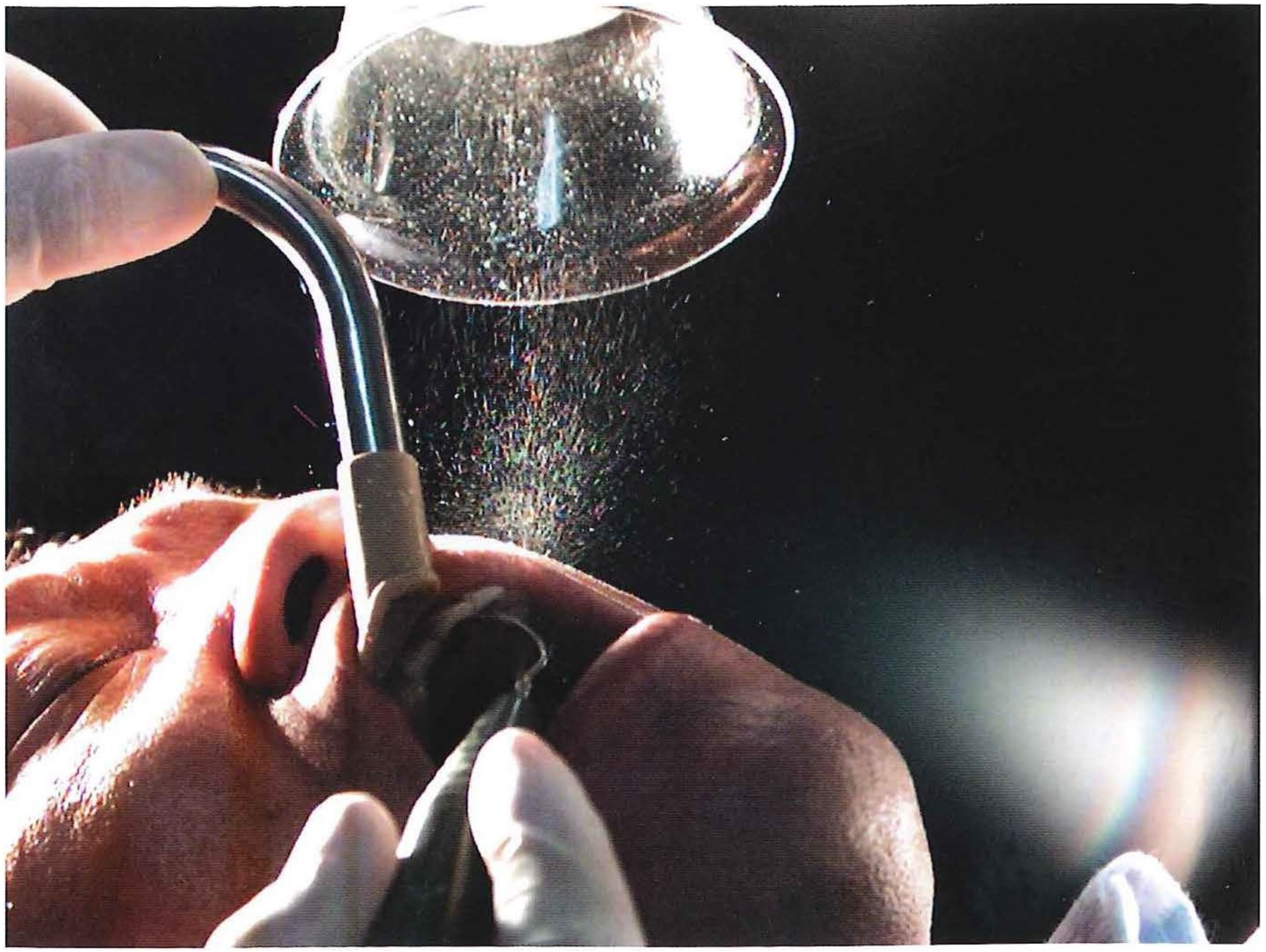
IOS with EOS

Distributed aerosol particles were being suctioned by EOS



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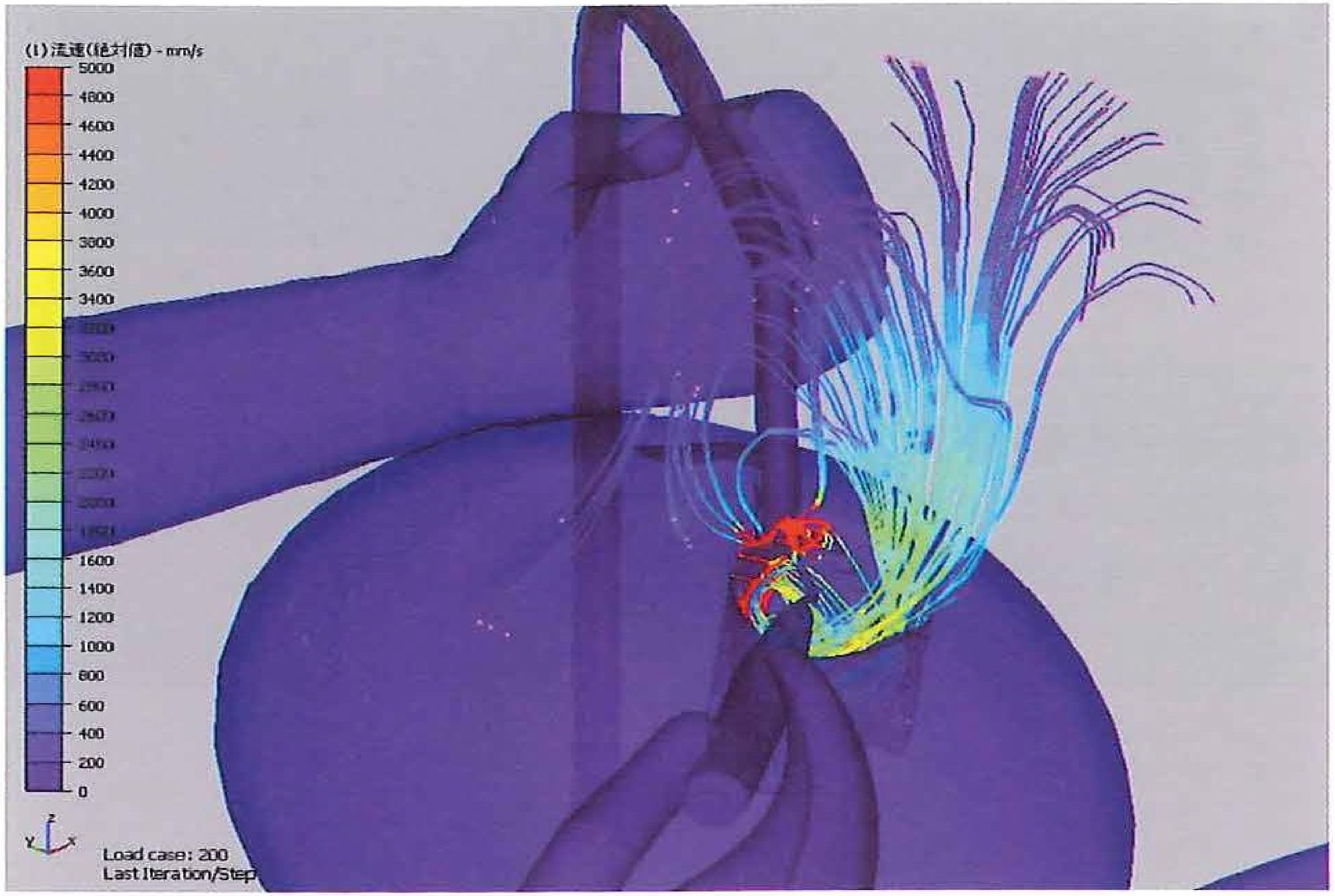
Result 2 Model of fluid dynamic analysis, The trail/distribution imaging of aerosol particles

[The trail of aerosol particles (particle diameter ϕ5 μm)]



IOS alone

Aerosol particles went upward around the mouth then fall down

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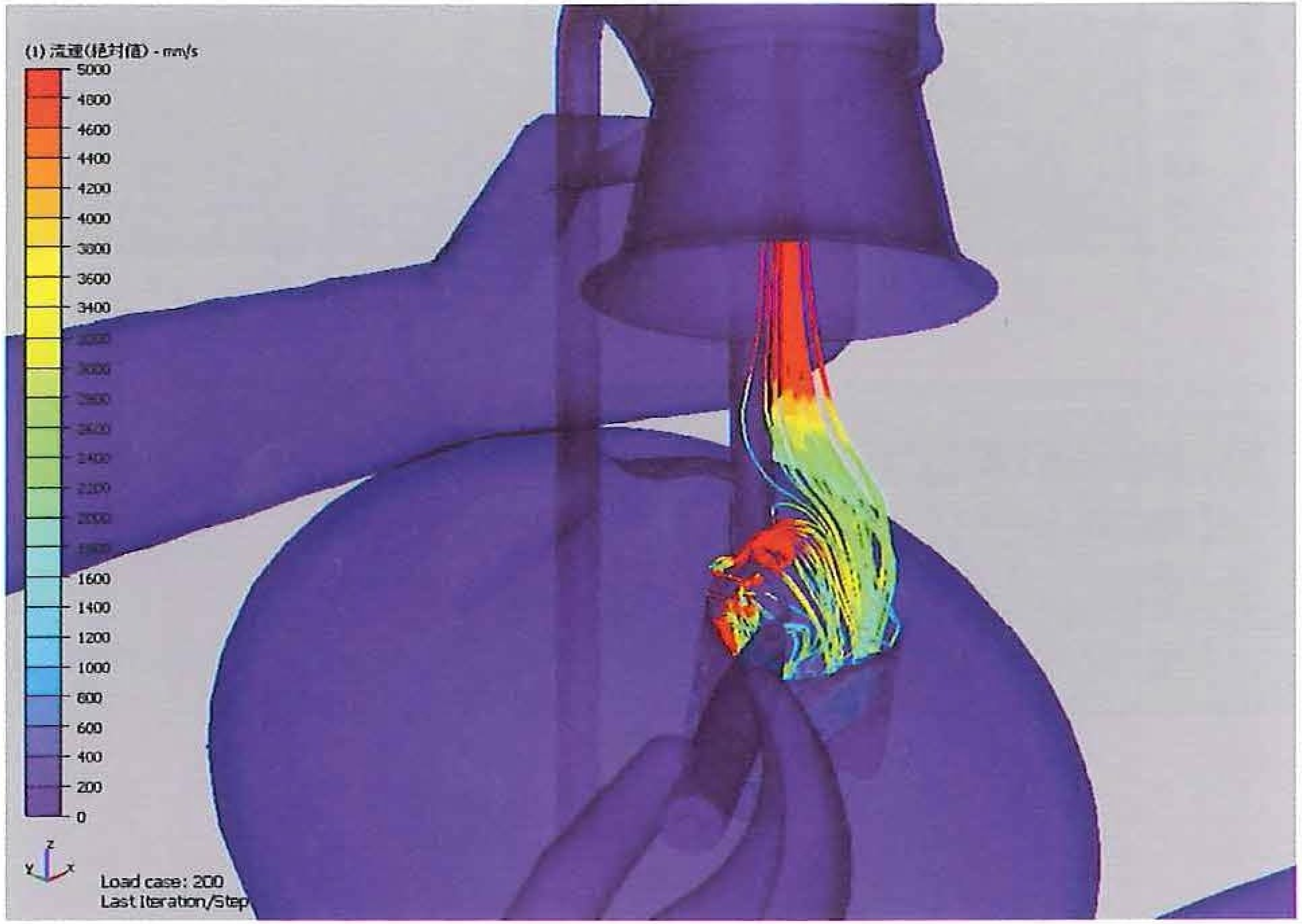
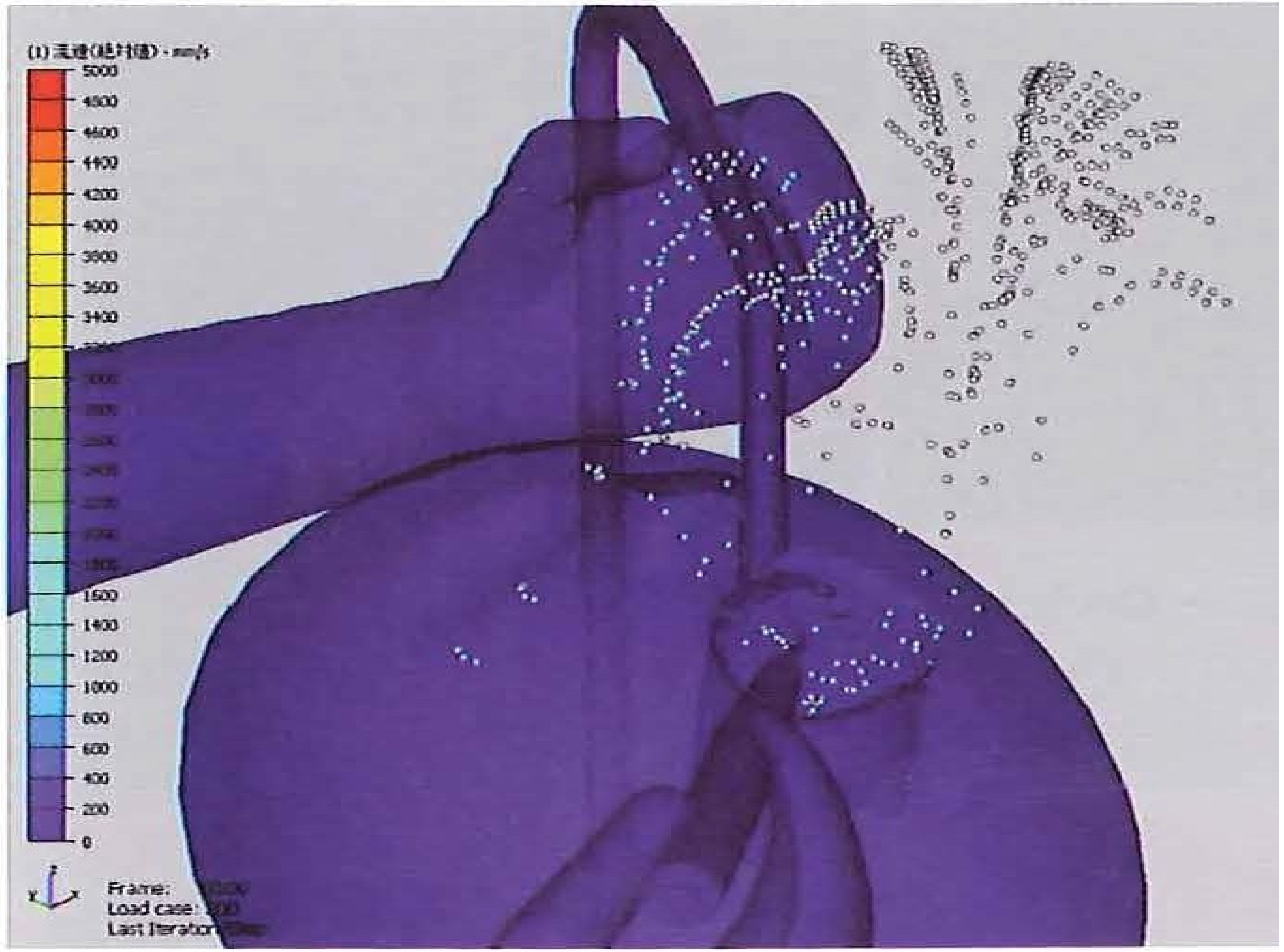


IOS with EOS

Aerosol particles went up toward EOS

Translation courtesy of Professor Takashi Fujibayashi, DDS, PhD of Tokyo, Japan

[The distribution imaging of aerosol particles (particle diameter ϕ5 µm)]



IOS alone

Aerosol particles were distributed around the face

Translation courtesy of Professor Takashi Fujibayashi, DDS, PhD of Tokyo, Japan

IOS with EOS

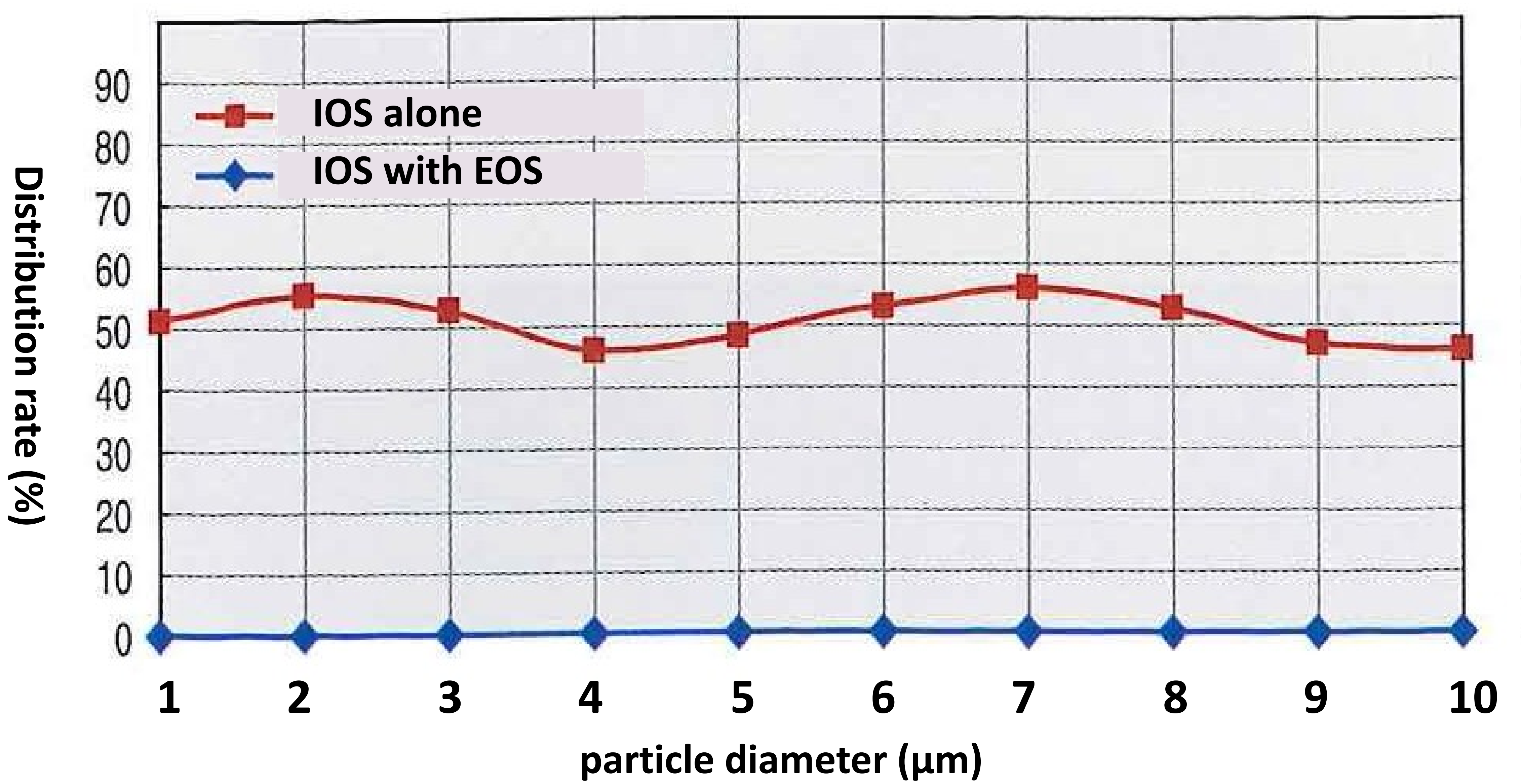
Aerosol particles were not distributed around the face

Translation courtesy of Professor Takashi Fujibayashi, DDS, PhD of Tokyo, Japan

Result 3

Distribution rate/ collection rate of aerosol particles

[Distribution rate of aerosol particles]



Distribution rate of aerosol particles

Aerosol particles were distributed in 40-60% with IOS alone, but no distribution under IOS with EOS

Distribution rate = number of particles distributed without suctioning / total number of particles trail chased

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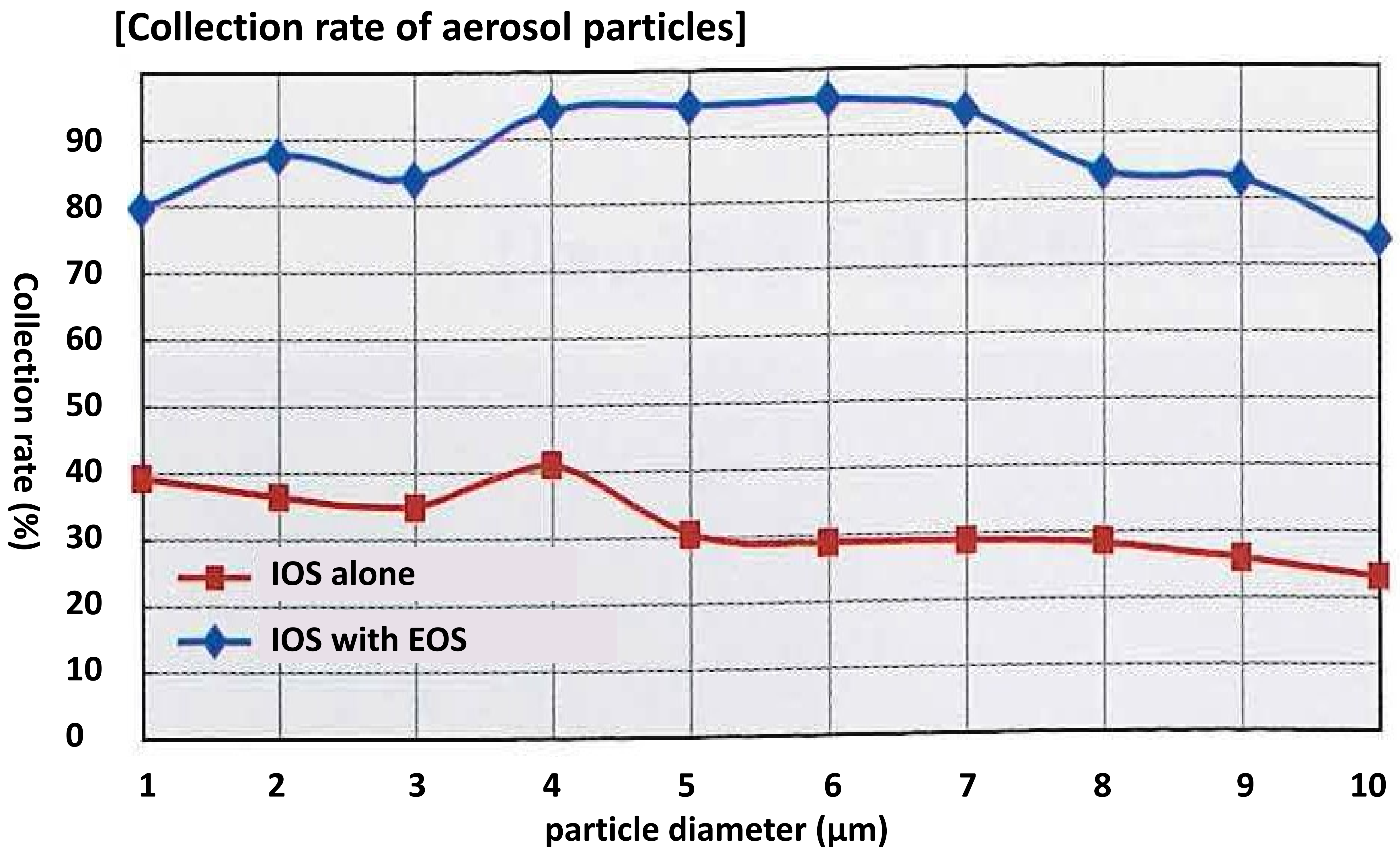

Collection rate of aerosol particles

Collection rates of aerosol particles were bigger in 40-60% under IOS with EOS than that of IOS alone

Collection rate = total number of particles collected with suctioning / total number of particles trail chased

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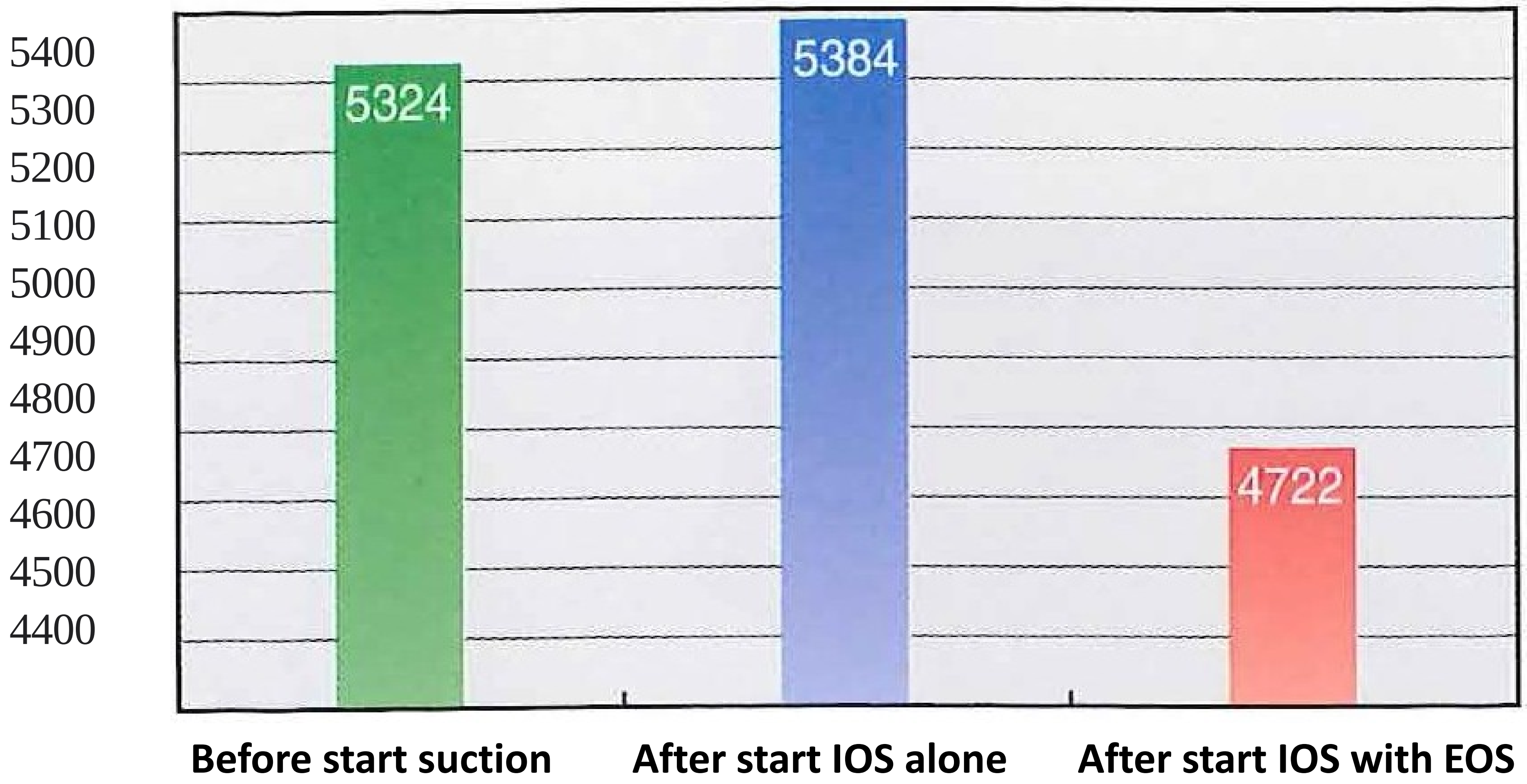
Result 4

Measurement of aerosol particle number



Aerosol particle (0.5 µm) number decreased under the IOS with EOS

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Calculation of aerosol bacterial colony count

IOS alone

IOS with EOS

Aerosol bacterial colony count decreased under IOS with EOS

Summary: The fluid dynamic analysis of aerosol particles by a high-speed camera imaging proved apparently smaller area of aerosol distribution when using IOS with EOS than IOS alone. The usage of EOS is necessary for the prevention of aerosols contamination during dental treatments.

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Summary:

The fluid dynamic analysis of aerosol particles by a high-speed camera imaging proved apparently smaller area of aerosol distribution when using IOS with EOS than IOS alone. The usage of EOS is necessary for the prevention of aerosols contamination during dental treatments.

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