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Airborne Contamination in the Dental Operating Room

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Abstract

The purpose of this study is to assess airborne contamination of the dental operating room (DOR) in order to evaluate the risk of infection for the patients and dental staff. To examine DOR, a total of 744 air samples (0.01 Cubic Feet) collected in the particle counter hourly in 24 times a day for 31 days was used. Further, we investigated the change in the particle during tooth preparation (TP) with a high-speed hand-piece when using or not suction device.

The results were as follows:

1)In almost all time from 9:00 to 17:00, the number of 1.0μm, 2.0μm and 5.0μm particles in the treatment days (20 days), were significantly (Welch's t-test, $p<0.05$) greater than the closing office day (11 days).

2)The particle of 0.3μm, 0.5μm, 1.0μm, 2.0μm and 5.0μm during TP as compared to before TP, increased by 7.5 times, 50.0 times, 158.9 times, 144.6 times and 47.7 times, respectively. When using the intra-oral suction(IOS), these particles were remarkably reduced. When using the IOS and the extra-oral suction (EOS), 2.0μm and 5.0μm particles were further reduced to the level before TP, and were significantly (paired t-test, $p<0.05$) reduced compared to IOS alone.

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1 Purpose:

This study is to assess airborne contamination of the dental operating room (DOR) in order to evaluate the risk of infection for the patients and dental staff. The study includes the particle number in the air samples with each particle diameter in every hours, and the aerosol particle number in the air samples during tooth preparation with by air-turbine hand-piece.

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2 Materials and Methods:

To examine DOR, a total of 744 air samples (0.01 Cubic Feet) collected in the Particle Counter (RION Co. Ltd.; KC-01C type; air collection flow rate: 500mL/min) hourly in 24 times a day for 31 days was used. The particle in the air samples was classified in five different diameter size as 0.3µm, 0.5µm, 1.0µm, 2.0µm and 5.0µm and larger(>=5.0µm). The air samples was collected in the treatment days (Monday to Friday; 20 days) and also in the closing office days (Saturday and Sunday; 11 days).

Further, we investigated the change in the particle during tooth preparation (TP) with a high-speed air-turbine hand-piece (Osada-Electric Co. Ltd.; Smily-fine GM S221LL Type); when using three different types of suctioning conditions of saliva ejector alone, saliva ejector + intra-oral suction (IOS), and saliva ejector + IOS + extra-oral suction (EOS)(Free-Arm 12S (Tokyo Giken Inc.).

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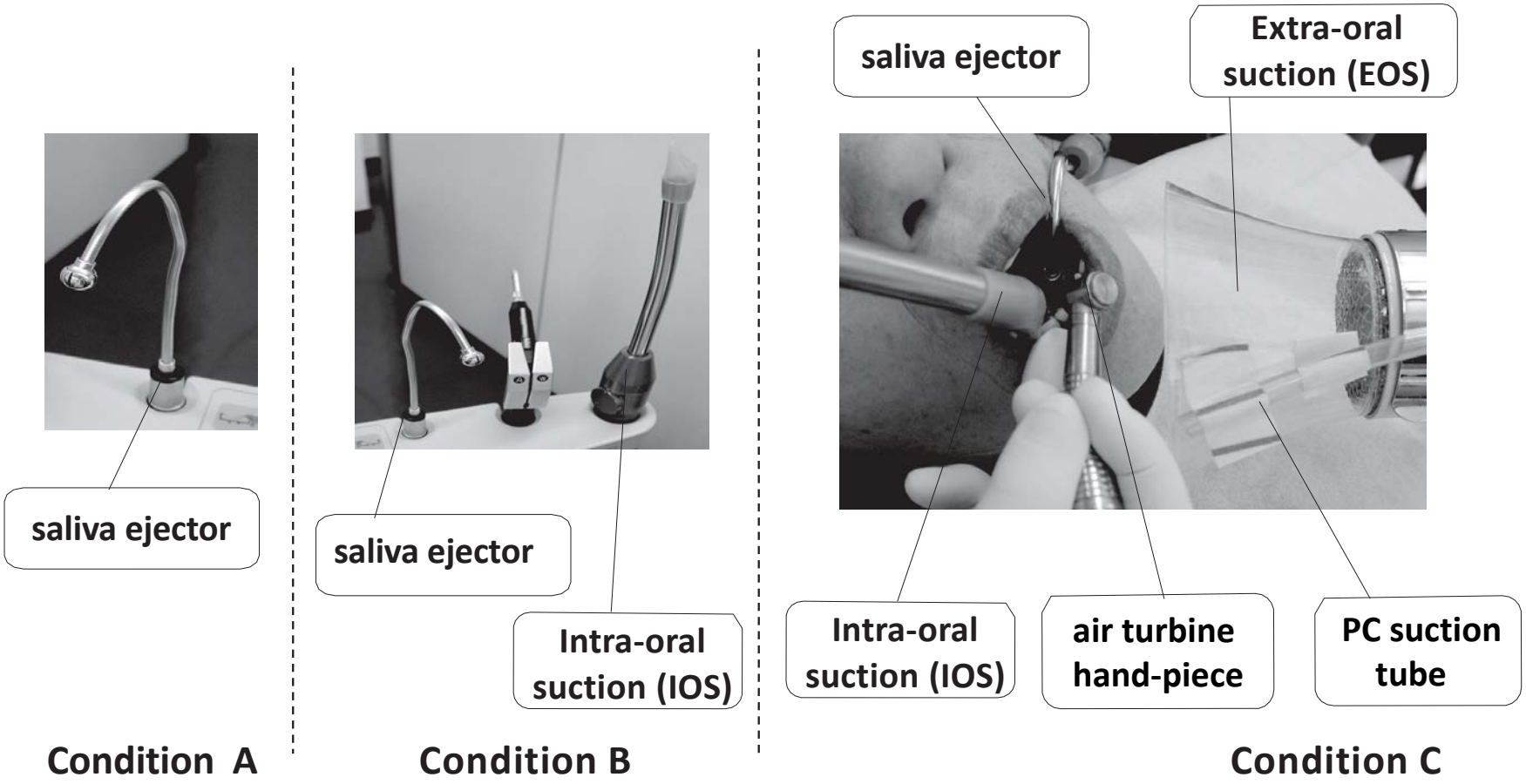

Condition A : saliva ejector alone

Condition B : saliva ejector + intra-oral suction (IOS)

Condition C : saliva ejector + intra-oral suction (IOS) + extra-oral suction (EOS)

Figure 1 Three types of condition of suction devices during tooth preparation

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3 Results:

1) The aerosol particle umber in the air samples in DOR (Fig.2, Tab. 1)

- Treatment days showed more number of particles than closing office days
- Statistically significant differences were found in 14:00 and 15:00 hours in 0.3μm, >=0.5μm particles between treatment and closing days
- The differences were significant in 10:00 ～ 16:00 hours in 1.0μm particle
- The number of 2.0μm particle showed difference I every 9 hours
- The >=5.0μm particle showed significant difference in 9:00～ 16:00 hours (Fig. 2)
- The mean particle number of 9 hours of treatment days and closing office days is listed on Table 1, which indicates the particle number was 1.7-, 3.6-, 15.5-hold greater in 1.0μm, 2.0μm and >=5.0μm, respectively in treatment days than in closing office days
- The difference became much bigger with increase of the particle diameter (Tab. 1)

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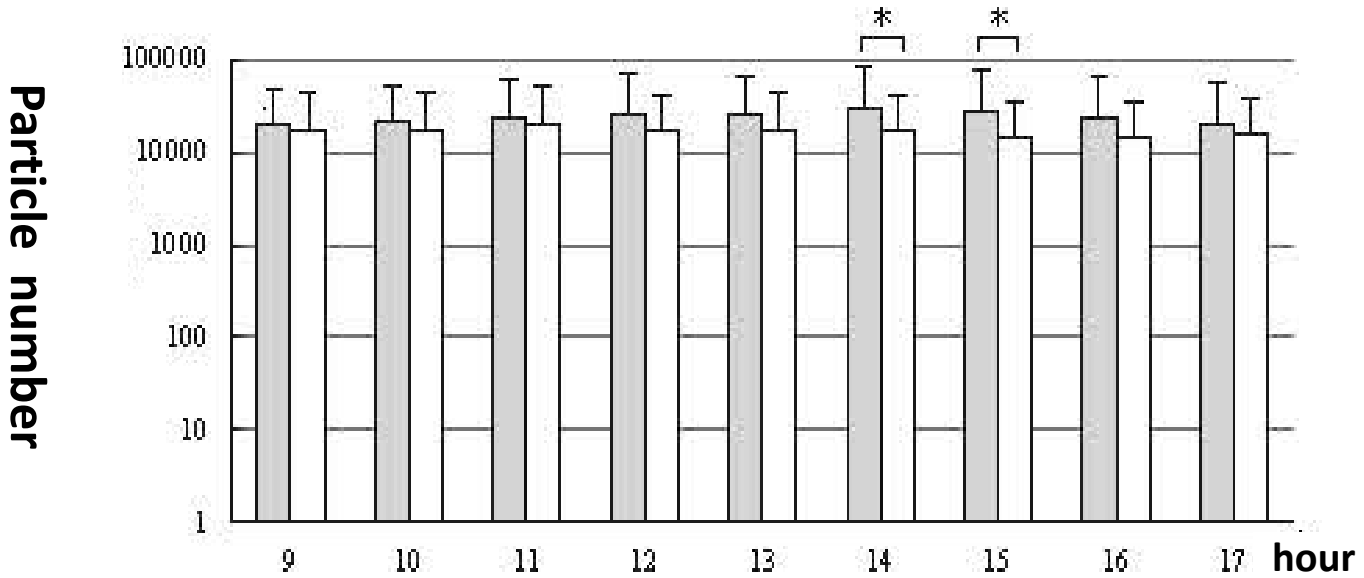
0.3 µm particle



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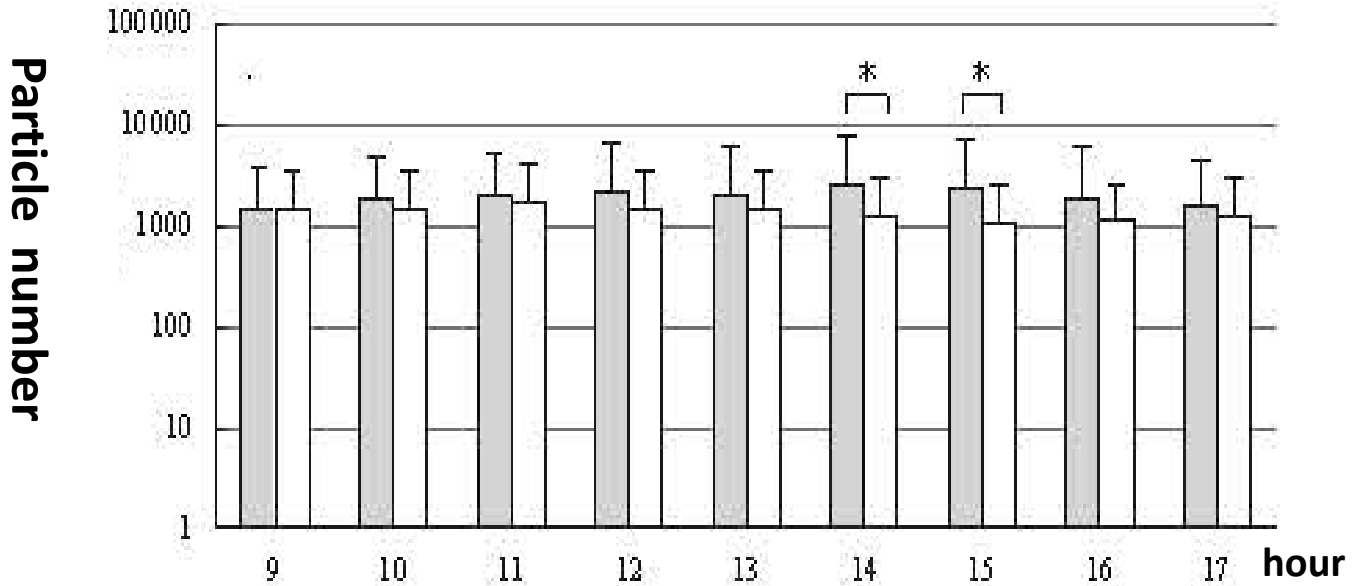
0.5 μm particle



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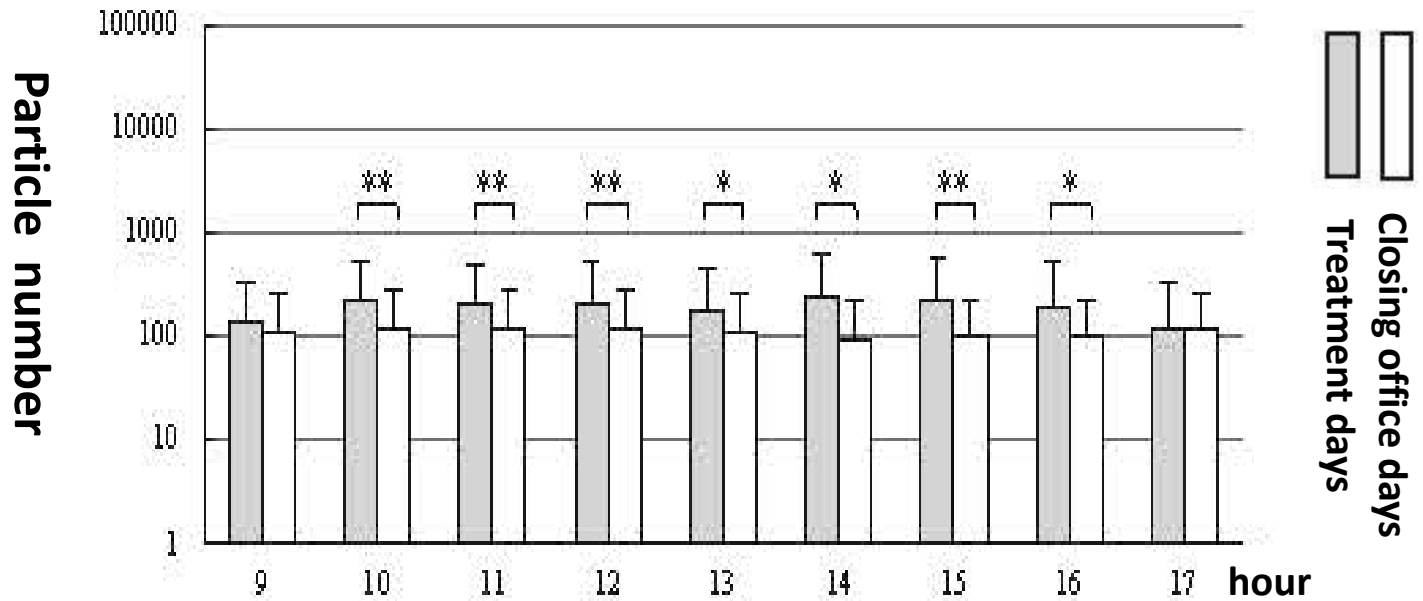
1.0 µm particle



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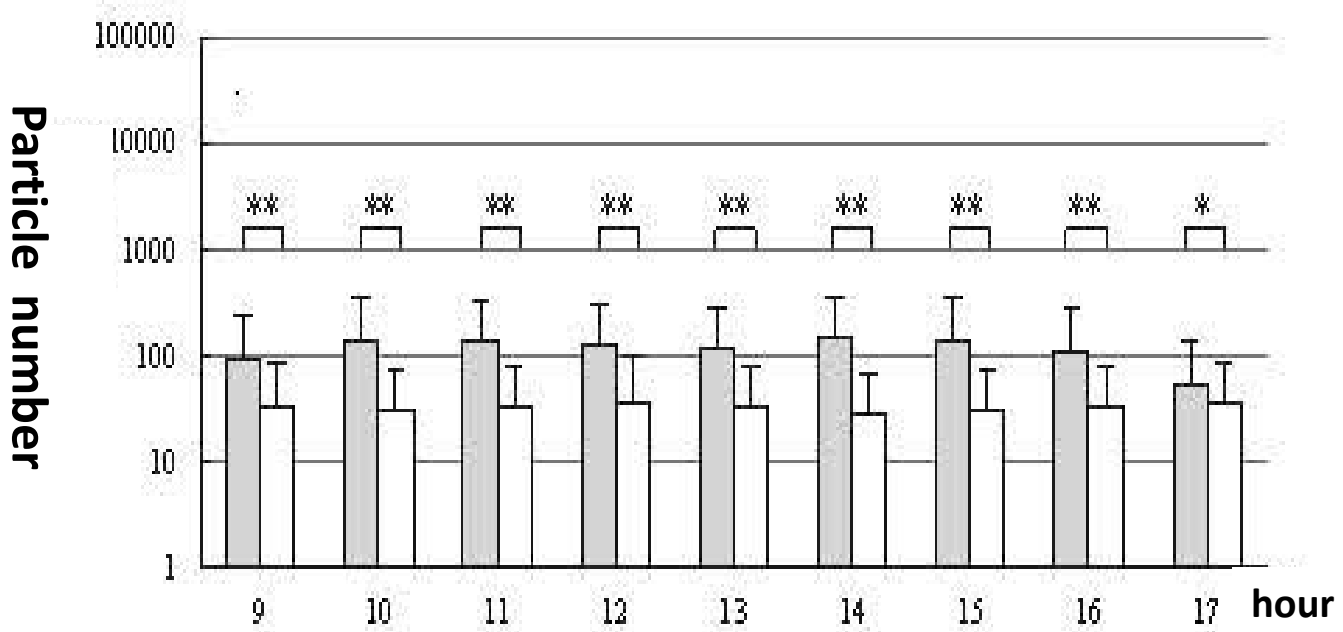
2.0 µm particle



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5.0 µm particle

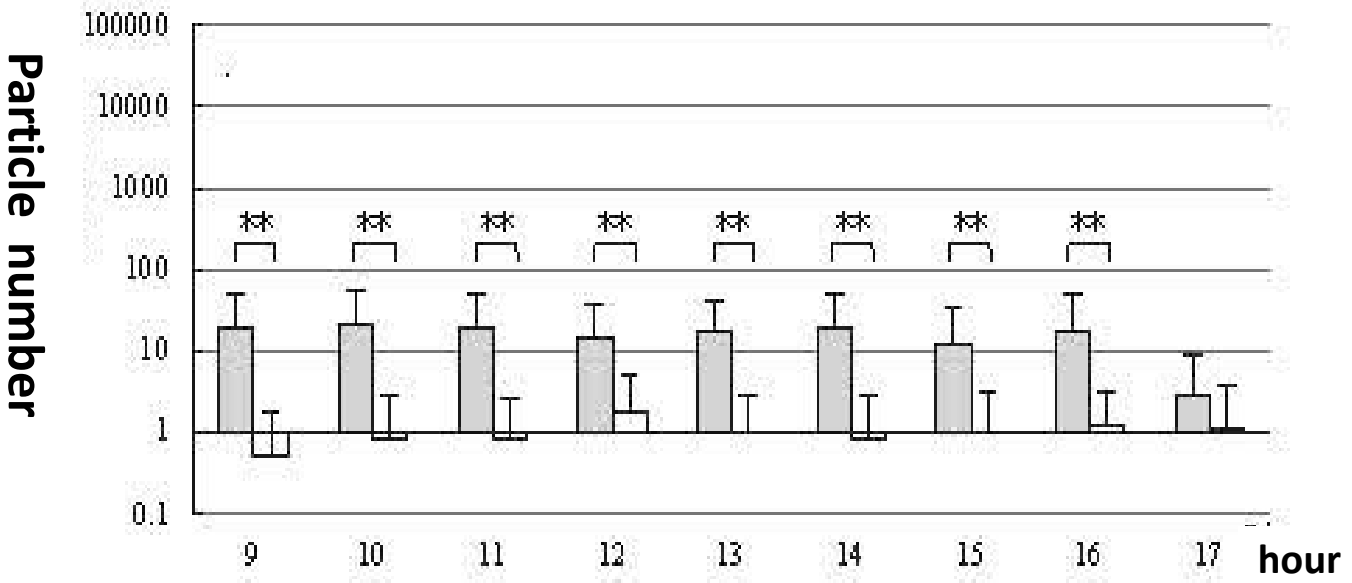

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Figure 2　Hourly changes of the particle number in air samples in the treatment days and the closing office days of the dental operating room

(the treatment days: 20 days, the closing office days: 11 days; 9:00～17：00　every hour,　mean ±SD)

***　：P <0.05（Welch's t-test）**

****：P<0.01（Welch's t-test）**

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Table 1 The particle number of air samples in the treatment days and the closing office days (9:00～17:00 hour, mean ± SD) unit: particle number

	Treatment days mean ±SD	Closing office days mean ±SD	
0.3μm粒子	23815.0±16715.0	16683.0±8274.0	
0.5μm粒子	2000.9±1822.6	1344.0±597.0	
1.0μm粒子	185.5±121.7	108.2±36.4	＊
2.0μm粒子	119.1±63.8	33.0±13.8	＊＊
5.0μm粒子	15.5±12.5	1.0±1.2	＊＊

＊ :P＜0.05 (Welch's t-test)
＊＊: P＜0.01 (Welch's t-test)

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3 Results:

2) The particle number in the air samples during tooth preparation (Changes with three different types of suctioning conditions)(Fig. 3)

- **Condition A: saliva ejector alone**

The particle number showed 7.5-, 50.0-, 158.9-, 144.6-, 47.7-hold increased with 0.3µm, 0.5µm, 1.0µm, 2.0µm and >= 5.0µm, respectively than before preparation. Air contamination by aerosol particles during tooth preparation can be high with this condition.

- **Condition B : saliva ejector + intra-oral suction (IOS)**

The particle number showed 2.2-, 4.8-, 8.5-, 4.7-, 1.3-hold increased with 0.3µm, 0.5µm, 1.0µm, 2.0µm and >=5.0µm, respectively than before preparation. The aerosol particle decreased much in compared with condition A.

- **Condition C : saliva ejector + intra-oral suction(IOS) + extra-oral suction (EOS)**

The particle number showed 1.6-, 1.9-, 2.2-, 1.1-, 0.1-hold increased with 0.3µm, 0.5µm, 1.0µm, 2.0µm and >=5.0µm, respectively than before preparation. Significantly higher suctioning effect was found in 2.0µm and >=5.0µm particles than condition B. (Fig.3)

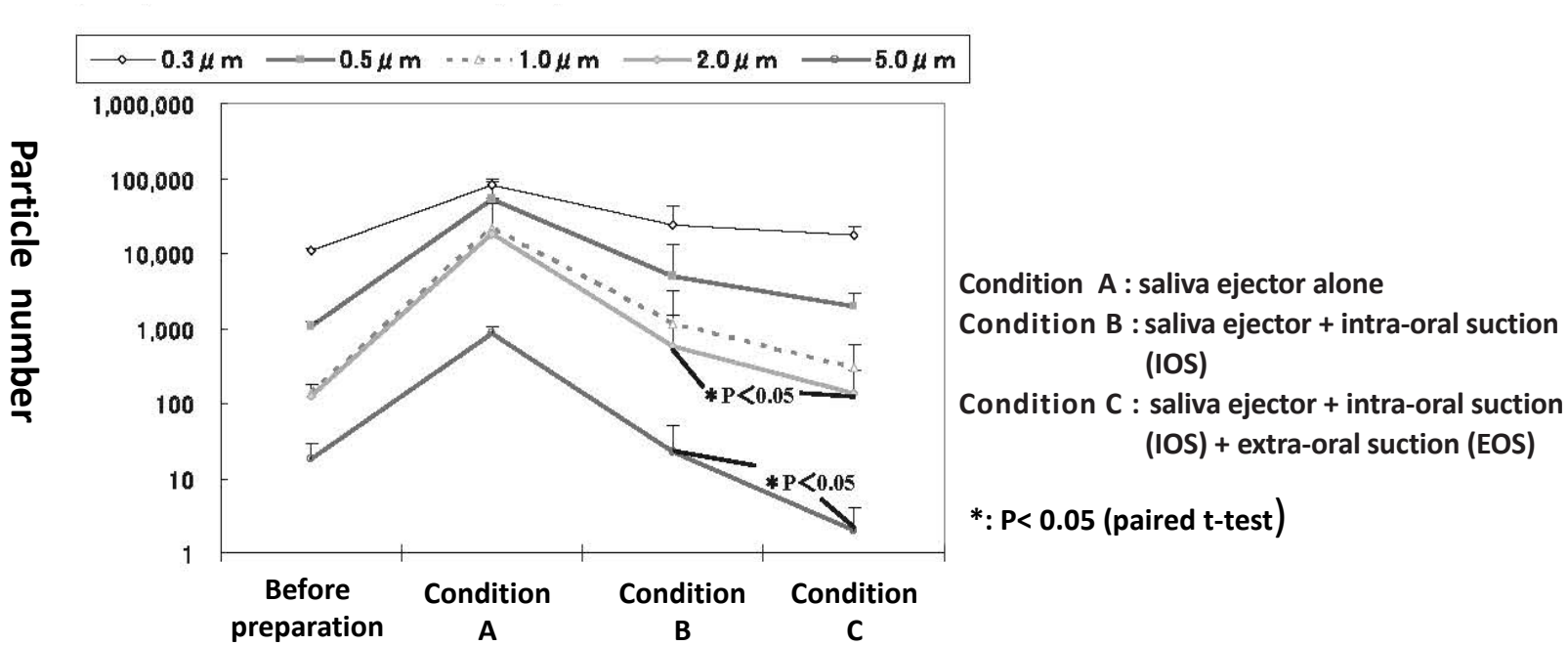

Figure 3 The particle number in the air samples during tooth preparation

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4 Discussion:

1） The aerosol particle umber in the air samples in DOR (Fig.2, Tab. 1)

- **The particle counter (PC) used in this study consists of 0.01 Cubic Feet with 34 seconds in sampling time, which can be considered suitable for counting aerosol particles in the air samples and samples during tooth preparation.**
- **The air samples in the treatment days showed significantly increased number of particles with >= 1.0 μm in diameter than the closing office days as the characteristic of DOR.**
- **The prevention of airborne contamination in DOR will be to reduce the number of particles with >= 1.0 μm in the treatment days close to the level of the closing office days.**

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4 Discussion:

2) The particle number in the air samples during tooth preparation (Changes with three different types of suctioning conditions)(Fig. 3)

- **During tooth preparation under Condition A (saliva ejector alone) the particle number very much increased than before preparation.**
- **In Condition B (saliva ejector + IOS) the reduction of the particle number in every size was observed compared with Condition A.**
- **By further adding EOS in Condition C (saliva ejector + IOS + EOS) the particle number showed much decreased to almost same level with before preparation in 2.0µm and 1/10 in >=5.0µm.**
- **The activity of IOS and EOS will depend on its flow rate. By measuring the flow rate the saliva ejector had 0.0004 m^2/min, IOS 0.1571 m^2/min, and EOS 3.5671 m^2/min, then showing 1: 392: 8918 in ratio. EOS was 23X stronger than IOS.**
- **By adding EOS it was evident with the reduction of larger size of aerosol particles (2.0µm and >=5.0µm), although the effect to minor particles (like 0.3µm and 0.5µm) was slight.**

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5 Conclusion:

The present investigation on the aerosol particle number in the air samples in DOR revealed that treatment days showed significantly increased number of particles with 1.0μm and larger(>= 1.0μm) in diameter than closing office days. The difference became much bigger with increase of the particle diameter.

The aerosol particle number in the air samples during tooth preparation much decreased by using IOS and EOS. The usage of EOS significantly reduced the number of large size of aerosol particles (2.0μm and >=5.0μm) when compared without EOS.

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