AN EXPERIMENTAL STUDY ON THE EFFICIENCY OF A LOCAL VENTILATION SYSTEM AND THE PROTECTING FACE MASKS IN DENTAL LABORATORIES

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Ⅰ. Introduction

It is obivious that the health and working efficiency of laborer is affected by laborenvironment(CHA, 1977)[1]

Korean Dental Technician's Association was established in 1966 and its medical service has been expanded recent years. The number of Dental Technicians is 6,500 at present.

The primary factors that endanger the health of technicians are harmful gases and polluted air produced from various operations such as burn-out, casting or pickling and polishing. Dust particle dispersed into the air during work can be inhaled by human body, and cause not only health problem but also problems for the instruments (LEE, 1971)[2].

Lob and Hugonnaud 19773), Moffa, Guckes, Okawa and Lilly4), Brune and Beltes brekke(1980)[5]. Brune and Beltesbrekke(1979)[6] have done experiments on the states of dust produced during dental work operations, and reported that the quantity of the dust had been considerably exceeded Threshold Limit value(1976)[7].

Brune and Beltesbrekke(1977)[8], Strand (1980)[9] reported that dust produced during polishing dental restorations is composed of particles with dimension of 0.2-5 ㎛, and defined as ' respirable ' dust according to the Johannesburg Convention in 196010). Therefore they recommended the use of a local ventilation system to reduce respirable dust hazard.

The purpose of this exiperiment is to study the efficiency of local ventilation system which is used to reduce dust levels produced from various operations, such as cutting, grinding, or polishing chromium-cobalt, nickel, or gold alloys, resin, gypsum, Porcelain, and the efficiency of face mask for the provention of dust partlicle infiltration is also teslted.

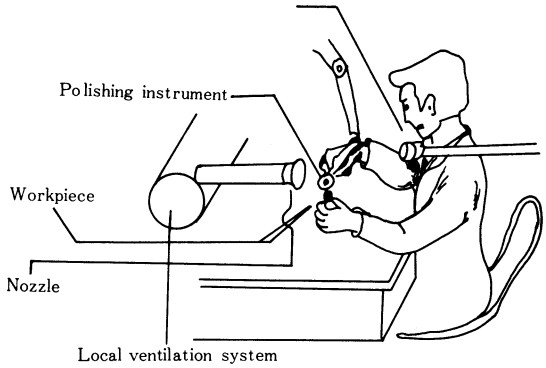
Ⅱ. Materials and methods

A. Materials and installations

1. Local ventilation system

The local ventilation system contained a tube with a diameter of 50 mm and possessed exhausting capacity of 50 liters per second.

이 논문은 제2회 국제치과기공학술대회(1988. 11. 3 5, 일본 교토 국립경도 국제회관)에서 발표된 것임.



LOCAL VENTILATION SYSTEM

2. Dust sampler

Dust was collected on Membrane Filter* with a pore size of 0.22 ± 0.02 ㎛ and a diameter of 47 mm.

Membrane Fiters were attached on the sampler, which was connected to a vacuum pump** with a maximum capacity of 40 ℓ min. The air quantity was set 70 ℓ for 5minutes iintegrating air flow meter.

3. Installation of nozzle

To increase the efficitncy of the ventilation system, a nozzle of 100 mm diameter with angle inclination of 33 degress was installed.

4. Materials used for the test

Chromiur·····	Nobilium alloy Nobilium product, Inc., made in U.S.A.
Nickel based alloy·····	Rexillium
Gold alloy ·····	20 carat dental casting gold alloy
Denture base materials (acrylic resin)	MOYCO INDUSTRIES INC., made in U.S.A.
Gypsum	G-C'S PLASTON, G-C DENTAL IND. CORP.
Porcelain	Ceramco Vacuum porcelain, Ceramco Inc.

5. Face masks

Two types of commercial mask were prepared for reduction of dust produced.

Mask I : A conventional face mask made with cotton.

Mask ll: A conventional face mask lined with a cotton pad.

B. Method

The efficiency of the local ventilation system and the Ice masks was measured in breathing air. The size of the laboratory space was on an averge 10 ㎥(2×2×2.5)per pereon. To minimize current convection of the air in the laboratory room, the room was encapsulated with a vinyl coyer.

Chromium-cobalt, nickel and gold alloys were submitted to cutting, coarse and fine grinding and polishing, denture base material was submitted to coarse and fine grinding and Polishing; gypsum and procelain were coarse and fine gringing.

Polishing speed was 20,000RPM and dust was collected on Membrane Filter operating a vacuum pump.

The efficiency of the local ventilation system was evaluated on the basis dust weight reduction.

* Schleicher & Schull, W. Germany

** DURP DENTAL 7120 Bietigheim Germany

1. Efficiency of local ventilation system

Dust amounts collected on the sampler with the local ventilation system and without it were measured and compared. The distance from the workpiece to the sampler was about 30 cm and that from the workpiece to the inlet of the local ventilation system was about 10 cm.

2. Variation of the efficiency of the local ventilation system according to mounting a nozzle and to the distance from the inlet to the workpiece.

Dust amounts collected on the sampler, operating the local ventilation system moonted with a nozzle and without it were measured and compared. The distances from the workpiece to the sampler was about 30 cm and that from the workpiece to the inlet of the nozzle was about 5 cm, 10 cm and 15 cm, respectively. The material used was porcelain.

3. Variation of the efficiency of local ventilation system due to the distance from the sampler to the workpiece.

Dust amounts collected on the sampler with the local ventilation system and without it were measured and compared.

The distance from the workpiece to the sampler was about 20 cm, 30 cm and 40 cm, respectively, and that from the workpiece to the inlet of the local ventilation system was about 10 cm. The material used was poreelain.

4. Efficiency of face masks

With and without operation of the loco ventilation system, dust collected on the sampler covered with face masks of two types and on the without it were measured and compared. The distance from the work-piece to the sampler was about 30 cm and that from the workpiece to the inlet of the local ventilation system was about 10 cm. The material used was porcelain.

III. Results

1. Efficiency of local ventilation system

Table 1 showes the amounts of collected dust by materials and local ventilation systems. Dust amounts were distributed in the range of 0.40 mg/m^3 to 97.79 mg/m^3. Dust level of resin collected on the sampler was the highest when the system was operated, while that of gypsum was the highest when the system was not operated.

Dust levels collected were significantly rediced when the system was operated. The reduction of dust level was also significantly varied according to the materials.

Efficiencies of the local ventilation system for reducing the dust level according to materials are presented in Fig 1. With the local ventilation system, the highest efficiency was obtained for gypsum, with 98.9 % while the lowest with 43.8% for resin.

A mean efficiency was 79.6% on the whole.

Table 1. The amounts of collected dust by materials and local ventilation

(Unit : mg/m^3)

Materials	With Ventilation		Without Ventilation	
	Mean	S. E.	Mean	S. E.
Cr-Co Alloy	0.40	0.23	4.63	0.91
Ni-based Alloy	2.40	0.68	6.71	0.88
Resin	6.88	0.58	13. 25	0.87
Gold Alloy	1.31	0.52	6.92	0.72

Gypsum	1.04	0.37	97.79	12.84
Porcelain	2.00	0.50	24.61	1.29

*The sample size of each group is nine

Two way Anova Test

Source	Sums of squares	Degree of freedom	Mean square	F
Within group	28, 676. 59	5	5, 735. 32	44. 73 (P<0.
Between group	14, 465. 51	1	14, 465. 51	112. 82 (P<0.
Interaction	30, 387. 48	5	6, 077. 50	47. 40 (P<0.
Residual	12, 309. 30	0	128. 22	
Total	85, 838. 88	107		

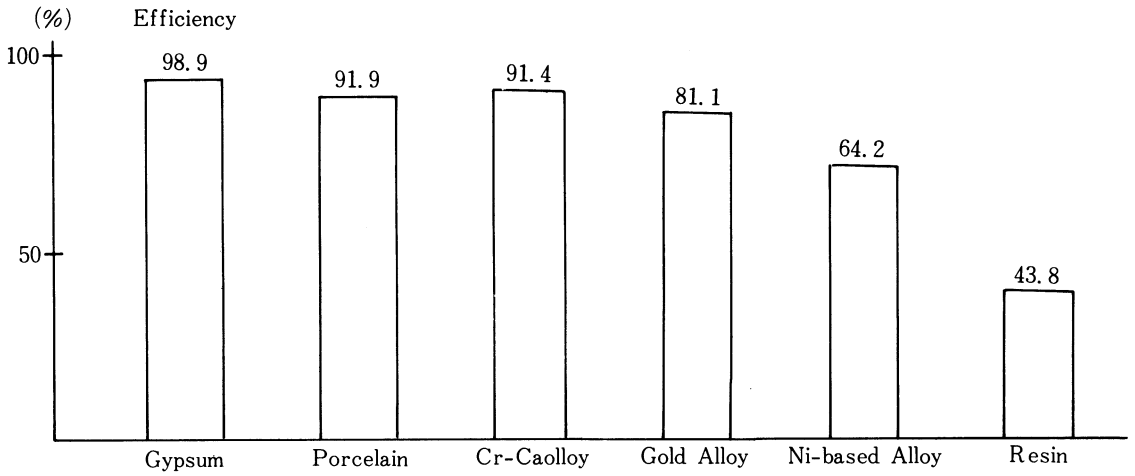


Fig 1. Efficiencies of the local ventilation system for reducing the dust level according to materials.

2. Variations of the efficiency of the local ventilation system according to mounting a nozzle and to the distance from the inlet to the workpiece.

Variations of the efficiencies of the local ventilation system according to mounting a nozzle and to the distance from the inlet to the workpiece are given in table II .

Dust amounts were distributed in the rango of 0.95 mg/m^3 to 4.45 mg/m^3. Without a nozzle, the highest dust level of 4.45mg/m^3 was obtained when the distance from inlet to the workpiece was 15 cm, and the lowest of 0.95 mg/m^3 was obtained with a nozzle when the distance from inlet to the wokpiece was 5cm.

Dust amounts collected were significantly affected by the distance from the inlet to the workpiece and with the nozzle mounting.

3. Variations of the efficiency of the local ventilation system by the distance from the sampler to the workpiece

As shown in table 3, dust amounts distributed in the range of 1.00 mg/m^3 to 34.00 mg/m^3. The highest dust level of 34.00mg/m^3 was obtained when the sampler was positioned at a distance of 20 cm from the workpiece not operating the local ventilation while the lowest dust level of 1.00mg/m^3 was obtained when the

sampler was positioned at a distance of 40 cm from the workpiece operating the ventilation system.

Dust amounts collected were significantly affected by the distance from the sampler the sampler to the workpiece.

Table 2. Variation of the efficiencies of the local ventilation system according to mounting a nozzle and to the distance from the inlet to the workpiece. (Unit : mg/m³)

Distance	With nozzle		Without nozzle	
	Mean	S. E.	Mean	S. E.
5cm	0.95	0.34	1.68	0.53
10cm	2.00	0.50	2.94	0.41
15cm	2.28	0.60	4.45	0.45

* The sample size of each group is nine

Two Way Anova Test

Source	Sums of squares	Degree of freedom	Mean square	F
Within group	21.22	2	10.61	5.53 (P < 0.01)
Between group	10.32	1	10.32	5.58 (P < 0.05)
Interaction	0.20	2	0.10	0.05 (P < 0.05)
Residual	92.01	48	1.91	
Total	123.75	53		

Table 3. Variation of the efficiencies of local ventilation system by the distance from the sampler to the workpiece. (Unit : mg/m³)

Sampling Distance	With ventilation nozzle		Without nozzle		Without ventilation	
	With Mean	S. E.	Without Mean	S. E.	Mean	S. E.
20cm	5.36	0.56	5.57	0.68	34.00	2.06
30cm	2.00	0.50	2.94	0.41	24.61	1.29
40cm	1.00	0.36	2.24	0.44	13.52	0.97

* The sample size of each group is nine

Two Way Anova Test

Source	Sums of squares	Degree of freedom	Mean square	F
Within group	1,193.78	2	596.89	80.00 (P < 0.01
Between group	7,387.80	2	3,918.90	525.32 (P < 0.01
Interaction	847.58	4	211.90	28.40 (P < 0.01
Residual	536.82	72	7.46	
Total	10,415.98	80		

4. Efficiency of the face masks

As shown in table 4, dust amounts collectted were distributed a range of 0.72 gm/m³ to 24.61 gm/m³. The highest dust level of 24.61gm/m³ was obtained when the sampler was not covered with a mask, and the local ventilation system was not operating.

The lowest dust lovel of 0.72 gm/m³ was obtained when the sampler was covered with a mask II, a cotton pad lined one, with the local ventilation system.

Regardless that type of face masks used, the dust levels were significantly decreased when the sampler was covered with a mask and there was also a significant difference in the dust level in use of mask I and Mask II.

Table 4. Efficiency of the face masks (Unit : mg/m³)

Mask	With ventilation		Without ventilation	
	Mean	S. E.	Mean	S. E.
Mask I	1.01	0.36	8.22	0.83
Maks II	0.72	0.32	6.39	0.51
Without Mask	2.00	0.50	24. 61	1.29

*The sample size of each group is nine

Two Way AnovaTest

Source	Sums of squares	Degree of freedom	Mean square	F
Within group	1030. 46	2	515. 23	111. 04 (P<0.01)
Between group	1888. 72	1	1888. 72	407. 05 (P<0.01)
Interaction	789. 16	2	394. 58	84. 04 (P<0.01)
Residual	222. 82	48	4. 64	
Total	3931. 16	53		

IV. Discussion

1. Efficiency of the local ventilation system for reducing dust level

Dust produced from various operations in dental workroom is known as respirable ' dust and able to cause varios pulmonary problems.

In study, dust amounts produced through cutting, grinding, or polishing chromium-cobalt, nickel or gold alloys; porcelain; gypsum models; or denture base materials varied according to the materials used.

When the local ventilation system was not operated, dust levels of gypsum, Porcelain and resin became relatively higher than that of metals such alls gold, nickel-based and chormium-cobalt alloys.

The efficiency of ventilation system for reducing the dust level also significantly varied according to the materials used; (relatively hgher for gypsum, procelain and caromium-cobalt alloy while lower for gold alloy, nickel-based alloy and porcelain), with system used dust amounts could be reduced to a significantly lower levels compared to the one without it.

Consequently adequate local ventilation system for reduction the dust levels is strictly necessary to insure workroom safety

2. Variations of efficiency of the local ven tilation system according to mounting a nozzle and to the distance from the inlet to the workpiece

Mounting a nozzle on the inlet of the local ventilation system improves the efficiency significantly and the effect is considerably reduced when the distance increased from the inlet to the workpiece.

3. Variation of efficiencies of the local ventilation system according to the distance from the sampler to the workpiece

Dust amounts collected on the sampler varied significantly according to the distance from the workpiece to the sampler;with incaease of distance dust leyels were considerably reduced.

Consequently, the operator should keep an adequate distance from the workpiece not to inhale the dust produced during the finishing and polishing procedures.

4. Efficiency of the face masks

The face masks showed a capacity of reducing the dust amounts to a significantly lower level.

A considerable reduction of dust amounts was noted when the sampler was covered with a mask, particularly the one lined with a cotton pad lined, and when a local ventilation system with a nozzle was operated.

V. Summary

This study was performed to study the efficiency of a local ventilation system, installed in dental laboratories, and of two types of protecting face masks.

The dust originatlng from the workpiece as well as from the wheels and stones was collected on air filters in the cutting cycle during coarse and fine grinding, and in the subsuquent polishing procedures of each specific dental material.

The efficiency of the ventilation system was measured on the basis of weight reduction of dust in the breathing air at a distance about 20-40 cm from workpiece.

The results were as follows:

1. Use of the local ventilation system reduced the amounts of respirable dust to an average level of 21.4%, although the efficiency of the local ventilation system varied depending upon materials used.
2. Mounting a nozzle on the tube improved the efficiency of the ventilation system considerably. The efficiency of the local ventilation system also increased as the workpiece was closing to the tube inlet.
3. With or without the local ventilation system, the distance between the position of the workpiece and sampler greatly affected the dust level.
4. The face masks covering the sampler improved the efficiency of the ventilation system considerably.

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