EVALUATING SPATTER AND AEROSOL CONTAMINATION DURING OPENING OF ACCESS CAVITIES IN ENDODONTICS

Avaliação da contaminação por salpicos e aerossóis durante a abertura da cavidade de acesso em endodontia

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Abstract

OBJECTIVE: The aim of this work was to evaluate the distribution of bacterial aerosols generated by high-speed dental hand pieces with water supplies during the opening of access cavities in Endodontics. **MATERIALS AND METHODS**: The procedure was carried out in 20 human patients in three different groups: group A - with a rubber dam; group B - without a rubber dam and without a mouth rinse; group C - without a rubber dam, but with a previous mouth rinse with chlorhexidine. Blood agar culture plates were placed at six predefined positions next to the patient, and at other two places away from the patient. Contamination by oral bacterial species was indicated by the detection of alpha haemolytic *streptococci* colonies. **RESULTS**: There were significant statistical differences between the number of cfus before and after the dental procedure in the plates next to the patient. Between the three groups, the differences were not statistically significant. We found contamination in the plates away from the patient, showing that bacterial aerosols will also settle a long distance from the patient after the conclusion of the procedure. **CONCLUSION**: There is a dissemination of bacterial aerosols when high-speed dental equipment is used, even when it is only used during the opening of access cavities. This presents a potential risk of disease transmission, so there is a need for barrier precautions.

Keywords: Access cavity; Aerosol contamination; Spatter.

Resumo

OBJETIVOS: *Os autores avaliaram a distribuição de aerossóis bacterianos gerados durante a execução da cavidade de acesso dos dentes, em endodontia, usando instrumentos rotativos de alta velocidade, acoplados a jatos de ar/água.* **MATERIAL E MÉTODO**: *O procedimento foi feito em 20 indivíduos, distribuídos em 3 grupos: grupo A – sem isolamento absoluto; grupo B – sem isolamento absoluto e sem bochecho prévio; grupo C – sem isolamento absoluto mas com bochecho prévio com clorohexidina. Placas de cultura agar-sangue foram colocadas em 6 posições predefinidas, próximo ao paciente e outras em 2 locais mais afastados. A contaminação por espécies bacterianas orais foi indicada pela detecção de colônias de streptococcus alfa-hemolíticos (cfus).* **RESULTADOS**: *Verificaram-se diferenças estatisticamente significativas entre o número de cfus antes e depois do procedimento dentário, nas placas próximo do paciente. Entre os 3 grupos A, B e C, contudo, as diferenças não foram estatisticamente significativas. Houve também contaminação nas placas colocadas mais afastadas em relação ao paciente, mostrando que os aerossóis bacterianos se depositam não só em regiões próximas ao paciente mas têm uma área de dispersão maior. Além disso depositaram-se mesmo depois de concluído o procedimento dentário.* **CONCLUSÃO**: *Há uma disseminação de aerossóis bacterianos quando se utiliza equipamento rotativo de alta velocidade acoplado a jato de ar/água, mesmo quando este é apenas utilizado durante a abertura da cavidade de acesso, em Endodontia. Há assim, mesmo nesses casos, um risco potencial de transmissão de doenças, donde a necessidade de não ser descurada a utilização das medidas de proteção mais adequadas.*

Palavras-chave: *Cavidade de acesso; Aerossol; Salpico.*

INTRODUCTION

Aerosols and spatter produced during many dental procedures are a potential source of transmission of various diseases to staff and patients in the dental clinic (1-4). Microorganisms in the mouth and respiratory tract can be transported in aerosols and may contaminate the skin and mucous membranes of the mouth, respiratory tract and eyes (5, 6). Micik and colleagues, referred to by several authors (1, 7), define aerosols as solid or liquid particles suspended in a gas with a diameter of less than 50 micrometers; airborne particles larger than 50 μm in diameter are defined as spatter.

The authors evaluated the distribution of bacterial spatter and aerosols generated by high-speed hand pieces with water spraying during the opening of access cavities in Endodontics. There was a special focus on clearly demonstrating to the undergraduate students of Endodontics the need for universal barrier precautions and effective infection control, which must be used routinely during the treatment of all patients.

MATERIAL AND METHODS

The study was carried out at the Faculty of Dental Medicine. The Ethics Committee of the Dental School approved a protocol describing this investigation and all patients gave their informed consent to participate in the study.

We investigated spatter and aerosols of oral microorganisms during the opening of access cavities using the same high-speed hand piece with water spray and the same dental unit in 20 human patients, aged 18 to 55 years. Each procedure was performed in the same dental surgery room (measuring 2 x 3 m), but on different days and by different students. The patient was seated in a reclining position, which was not exactly the same for everyone. A conventional salivary ejector and an evacuator of low diameter, with no high-volume evacuation, were used.

There were 3 different groups:

- group A – The access cavity was made after the placement of a rubber dam (6 patients);
- group B – The access cavity was made without a rubber dam, and without a previous mouth rinse (7 patients);
- group C - The access cavity was made without a rubber dam, but with a previous mouth rinse (7 patients).

The mouth rinse consisted of a 0.1% solution of chlorhexidine (Eludril®), applied for 1 minute before the dental procedure. The teeth were all anterior, with some pre-molars, and the treatments were performed by 5th year students of the Dental School of Porto (2nd year of Endodontics), who are only allowed to treat mono or birradicular teeth. The operator and assistant (both students) wore gloves and masks throughout the procedures. Blood agar culture plates (Columbia agar with 5% sheep's blood; Difco) were placed along six positions next to the patient (Figure1) in order to collect microbial samples:

1 – operator mask;
2 – right arm of the operator;
3 – assistant mask;
4 – right arm of the assistant;
5 – equipment light;
6 – chest of the patient.

FIGURE 1 - Blood agar culture plates placed along six positions next to the patient

The plates were exposed to air for 30 minutes before the treatment procedure (5) while the students were taking the medical history and performing the clinical examination. The patient was seated in the dental chair during normal conversation, but received no dental treatment. This was done to determine the levels of microbial contamination prior to the treatment. The plates were then removed and covered, and the masks and gloves changed.

New plates were exposed for 30 minutes during the cavity preparation (5) using a high- speed hand piece with water spraying. They were then covered, and the patient was moved to another area for completion of the treatment.

To evaluate the levels of airborne microorganisms remaining in the surgery room after each 30 minute cavity preparation, and those microorganisms which could settle later, other culture plates were placed on the floor. Two plates were placed at 1 meter and two at 1.5 meters from the head-rest of the dental chair and exposed for 10 and 15 minutes (5, 8, 9).

All of the plates were incubated aerobically for 48 hours at 37ºC and the number of colony-forming units (cfus) cultivable from air were counted. Contamination by oral bacterial species was indicated by the detection of colonies of alpha haemolytic *streptococci*.

The analysis of the data was carried out using the package SPSS/13.0. Descriptive statistics are provided including means, standard deviations and maximum and minimum, as well as analytical statistics (analysis of variance for repeated measures – GLM and Wilcoxon test).

RESULTS

The descriptive statistical analysis of the results performed in 20 patients are presented in Tables I and II (N=20). Bacterial counts are expressed as colony forming units (cfu).

TABLE 1 - Descriptive statistics analysis of the results

Number of alpha haemolytic *streptococci* colony-forming units (cfus)	N(size of the sample)	Minimum	Maximum	Mean	Std. Deviation	Variance
A	20	.00	30.00	7.0000	9.04375	81.789
B	20	.00	102.00	22.0000	27.15259	737.263
C	20	.00	6.00	.5500	1.46808	2.155
D	20	.00	17.00	1.1500	3.77352	14.239
Valid N (listwise)	20					

A – Number of alpha-haemolytic streptococci cfus before dental procedure (next to the patient).
B – Number of alpha-haemolytic streptococci cfus after dental procedure (next to the patient).
C – Number of alpha-haemolytic streptococci cfus, 10 minutes after dental procedure (away from the patient).
D – Number of alpha-haemolytic streptococci cfus, 15 minutes after dental procedure (away from the patient).

TABLE 2 - Descriptive statistics analysis of the results

	Groups	Mean	Std. Deviation	N
A	Without rubber dam/ without mouth rinse (B)	12,1667	13,07542	6
	Without rubber dam/ with mouth rinse (C)	5,1429	7,64697	7
	With rubber dam (A)	4,4286	4,42934	7
	Total	**7,0000**	**9,04375**	**20**
B	Without rubber dam/ without mouth rinse (B)	26,6667	39,31242	6
	Without rubber dam/ with mouth rinse (C)	23,5714	28,66390	7
	With rubber dam (A)	16,4286	12,81740	7
	Total	**22,0000**	**27,15259**	**20**

A – Number of alpha-haemolytic streptococci cfus before dental procedure (next to the patient).
B – Number of alpha-haemolytic streptococci cfus after dental procedure (next to the patient).

There are significant statistical differences at p d" 0.05 concerning the number of cfus obtained after and before treatment within the patients (p=0.015; Table III).

TABLE 3 - Teste of within subjects differences (ANOVA for repeated measures – GLM)

Source	COLONIES	Type III Sum of Squares	df	Mean Square	F	Sig.	Noncent. Parameter	Observed Power(a)
COLONIES	Linear	2231.058	1	2231.058	7.321	.015	7.321	.723
COLONIES *GROUPS	Linear	73.393	2	36.696	.120	.887	.241	.066
Error (COLONIES)	Linear	5180.607	17	304.742				

Measure: Colonies count (cfus) a Computed using alpha = ,05

However, the results show that this difference cannot be attributed to only group A (with rubber dam), B (without rubber dam and without mouth rinse) or C (without rubber dam but with mouth rinse) (p=0.887; Table III). In this case, the differences found must be attributed to the colony counts before and after the dental procedure (next to the patient). This can be confirmed by checking the results in table IV; there are no statistically significant differences between the 3 groups (p=0.643).

TABLE 4 - Test of inter-individual differences (between subjects)

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Noncent. Parameter	Observed Power(a)
Intercept	8638,076	1	8638,076	15,007	,001	15,007	,954
GROUP	522,440	2	261,220	,454	,643	,908	,112
Error	9785,560	17	575,621				

Measure: Colonies count (cfus)
Transformed Variable: Average a Computed using alpha = ,05

In the analysis of the levels of contamination away from the patient, the differences were not significant between the different periods of exposure (10 and 15 minutes) in either location (1 and 1.5 metres from the patient) at p d" 0.05 using the Wilcoxon test (Tables V and VI). However, contamination was found in those plates, showing that the dental procedure produced contaminated aerosols, and that some aerosols will settle later, after the conclusion of the procedure.

TABLE 5 - Test of inter-individual differences (between subjects)

		N	Mean Rank	Sum of Ranks
2ª post-procedural alpha-haemolytic count (away)	Negative Ranks	4(a)	4.38	17.50
	Positive Ranks	4(b)	4.63	18.50
1ª post-procedural alpha-haemolytic count (away)	Ties	12(c)		
	Total	20		

1ª – 10 min.
2ª – 15 min.
a – 2ª post-procedural alpha-haemolytic count (away) < 1ª post-procedural alpha-haemolytic count (away).
b – 2ª post-procedural alpha-haemolytic count (away) > 1ª post-procedural alpha-haemolytic count (away).
c – 2ª post-procedural alpha-haemolytic count (away) = 1ª post-procedural alpha-haemolytic count (away).

TABLE 6 - Wilcoxon test

	2ª alpha-haemolytic post-procedural count (away) 1ª alpha-haemolytic post-procedural count (away)
Z	-.071(a)
Asymp. Sig. (2-tailed)	.943

a – Based on negative ranks.
b – Wilcoxon signed ranks teste.

DISCUSSION

Microbial aerosols and spatter may be generated through several dental procedures, including the use of hand pieces and drills, ultrasonic scalers, and air and water syringing. Many studies have been done to investigate which procedure generates more airborne microbial contamination (5, 7-11). Ultrasonic scaling seems to be the greatest producer of contaminated aerosols and spatter (7, 10). In most of those studies the authors evaluated the number of bacteria during a single period of time, from 10 minutes to 3 hours. We followed the protocol of Bentley et al. (5), exposing all the plates for 30 minutes so that we could compare the results. With more exposure time, it is probable that the mean density of the microbial colonies would be higher.

Almost every study cited used a non-selective medium, such as blood agar. When an aerobic bacterium settles and grows as a colony, it is counted as a colony forming unit, or cfu. In most of the studies, the total number of cfus produced after the dental procedures were counted. This allows the quantification of viable bacteria settled, but does not give a specific indication of oral contamination.

This study used the same method of determination of air contamination, but it only counted, as in a few studies (5, 12), the cfus of alpha haemolytic *streptococci*, which has been proven to be the best indicator of oral contamination. This bacterium is easy to cultivate and recognize, is abundant in the mouth, is present only in low numbers in the general environment, and is able to survive on typical surfaces (12). Some of the cases that we have considered as having zero cfus had general colonies of other bacteria, but we did not take them into consideration here.

Previous studies (8, 9, 11, 13, 14) have shown that higher levels of bacterial aerosols are registered after dental procedures when compared to those determined pre-operatively. Our study corroborates those results, with significant statistical differences. Even away from the patient, the plates were contaminated, as in other studies (9, 14), demonstrating that aerosols can settle away from the operatory. This can be especially important when treating generally ill or immunocompromised patients in hospital environments.

The Wilcoxon test did not reveal any significant differences between the bacterial counts 10 and 15 minutes after the conclusion of the procedure. The same was reported by other authors (14), although this may be due to the small size of the samples involved. Other studies (10), however, have demonstrated that the peak of aerosol concentration dissipates within 10 to 30 minutes, particularly with scaling procedures.

Next to the patient, although without statistically significant differences, most of the aerosols have been found to be directed towards the patient's chest and the operator's mask. This is in accordance with the results found by other authors (5, 8). Although there were no statistically significant differences, there was a non-significant decrease in the levels of contamination with the use of the rubber dam or the pre-operative mouthwash. There was a decrease in the level of contamination between Group B (without a rubber dam and without a mouth rinse) and Group C (without a rubber dam but with a mouth rinse) and between Group C and Group A (with a rubber dam). These results are consistent with previous findings that the use of a rubber dam or the pre-procedural use of antimicrobial mouth rinses can significantly reduce the bacterial levels in aerosols produced during dental procedures (2, 8, 15, 16). Perhaps by increasing the number of patients, a significance could be found, as the power of the test is low (Observed power = 0.066; Table II).

CONCLUSIONS

There is a potential transmission of disease to personnel during dental procedures due to the dissemination of bacterial aerosols when high-speed dental equipment is used, even when it is only used during the opening of access cavities. After the procedure is finished, airborne bacteria can remain and settle later, away from the patient.

The need for universal barrier precautions is proven by our results. There is no single measure to adopt; we must combine all of them, including masks, gloves, mouth rinses, disposable covers, rubber dams and high-volume evacuation to achieve the best protection for staff and patients.

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