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RESEARCH ARTICLE

The effect of aerosol suction distance during brushing brackets of orthodontic patients on the presence of *Streptococcus* and *Staphylococcus*

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ABSTRACT

Dentists are one of the professions most at risk of infection transmission because dental care potentially produces many infectious aerosols for bacterial transmission. Using personal protective equipment and aerosol suction that meets the standards for dentists is vital to prevent cross-infection in patients in practice. This study aims to determine the effect of aerosol suction distance on the orthodontic patient bracket brushing process on total plate number and the presence of *Streptococcus* and *Staphylococcus* on the dentist's face shield. The method used is the swab method on the face shield used by dentists after brushing orthodontic patient brackets with variations in the distance of aerosol suction to the oral cavity of 10 cm, 15 cm, and 20 cm. After 2 x 24 hours of incubation, the total plate count was calculated, and *Streptococcus* and *Staphylococcus* were identified by analyzing the characteristics of the growing colonies and executing the catalase test. The results showed that the lowest total plate number found on a face shield with aerosol suction distance of 10 cm from the oral cavity, 1.23 ± 0.01 CFU/cm^2. The one-way ANOVA test obtained a significance value of $p < 0.05$, concluding that the variation of the aerosol suction distance affects the total face shield plate number. The presence of bacteria on the face shield was negative for *Streptococcus* and positive for *Staphylococcus*.

Keywords: face shield; *Staphylococcus; Streptococcus;* total plate number

INTRODUCTION

Most dental care procedures generate aerosols, which are small liquid droplets that float in the air. Dentists always use instruments that produce aerosols, such as high-speed handpieces, ultrasonic scalers, polishing cups, brushing, and air-water syringes used in the patient's oral cavity with various microorganisms originating from saliva, blood, and dental plaque.[1] Those transmitted by aerosol are *Staphylococcus aureus, Methicillin-resistant Staphylococcus aureus* (MRSA), *Streptococcus pneumoniae, Haemophilus influenzae, Neisseria meningitidis, Corynebacterium diphtheriae, Bordetella pertussis, Legionella pneumophila and Mycobacterium tuberculosis.*[2,3] The presence of these bacteria will potentially cause contamination for dentists, nurses, and patients, because aerosolized bacteria can remain in the air for long periods and are inhaled into the lungs of susceptible individuals and aerosols can float in the air for some time before being inhaled by the dentist, dental nurse or patient.[2,4]

In orthodontic treatment, when the patient performs routine control, brushing the teeth on the patient bracket uses a micro brush that is moved with a low-speed handpiece and will cause aerosol contamination. By Dentist Guidelines in the new normal era, personal protective equipment (PPE) and aerosol suction are significant to reduce the potential for aerosol contamination.[5] In dealing with patients during the COVID-19 pandemic, dentists are advised to use extraoral suction (EOS)/ aerosol suction with a saliva ejector or intraoral suction (IOS). It is in line with a study by Motegi that testing the effectiveness of using IOS and EOS can reduce the amount of aerosol distributed around the patient's face when handling teeth and mouth.[6,7]

The recommended PPE for dentists to use in their practice is PPE level 3, which consists of eye protection (goggles or face shields), head cap, N95 mask or equivalent, surgical scrub, gown all

cover, apron, sterile double gloves, and boots. Eye protection, goggles, or face shields protect mucous membranes from exposure to droplets or aerosols that arise when performing oral dental care. Protection of mucous membranes from the eyes, nose, and mouth is the standard of care for patients who have an infection by droplet spread. The face shield should be made of translucent plastic to provide good visibility for health workers and patients, and an adjustable headband, preferably one that is resistant to dew formation and can be reused after disinfection or single use.[4,8,9]

Utilizing EOS/aerosol suction and PPE in dental care which potentially causing aerosols is crucial to prevent microorganism contamination. Setting of EOS/aerosol suction distance is needed to determine how much microorganism contamination is on the face shield used by dentists. The aim of this study is determining the effect of aerosol suction distance on the brushing process of the orthodontic patient's bracket towards the total plate number and the presence of Streptococcus and Staphylococcus on the dentist's face shield.

MATERIALS AND METHODS

Sampling was collected on the face shield used by the dentist after brushing the orthodontic patient bracket at the Dental Clinic, Universitas Gadjah Mada Academic Hospital. There are five orthodontic patients in the dental clinic of Universitas Gadjah Mada Academic Hospital, aged 17 - 22 years, with no caries, and moderate OHIS, and the orthodontic treatment stage is leveling and unraveling. Before being treated, the patient fills in and signs informed consent as consent to the action given to the patient. Each patient will be given four brushing treatments according to their group: group 1: face shield without aerosol suction, group 2: face shield with aerosol suction 10 cm apart, group 3: face shield with aerosol suction 15 cm apart, group 2: face shield with aerosol suction 20 cm apart. Sample testing was carried out at The Universitas Gadjah Mada Integrated Research and Testing Laboratory (LPPT).

The research stage is preparing tools and materials for the sampling and testing process that must be sterilized first. Sampling using the swab method on a face shield used by dentists to perform orthodontic patient bracket brushing by grouping: sample without aerosol suction when brushing and use aerosol suction with a distance of 10 cm, 15 cm, and 20 cm from the patient's oral cavity when brushing. The next step is inoculating samples on the Plate Count Agar (PCA) medium, which calculates the total plate number and Baird Parker Agar (BPA) medium for identifying *Streptococcus* and *Staphylococcus*. The total plate count (TPC) was calculated after 2 x 24 hours of incubation, and identification of *Streptococcus* and *Staphylococcus* was carried out after 1 x 24 hours of incubation by observing the characteristics of the growing colonies and catalase test.

RESULTS

The results of the TPC calculation on the face shield with aerosol suction at a distance of 10 cm from the oral cavity showed the lowest TPC value of 1.23 ± 0.001 CFU/cm^2, and the face shield without aerosol suction had the highest TPC value of 7.25 ± 0.003 CFU/cm^2 when compared to other TPC face shields. This figure is still below the quality standard No. 1204/MENKES/SK/X/2004, which is 5 - 10 CFU/cm^2.[10] The one-way ANOVA test obtained a significance value of $p < 0.05$, concluding that the variation of the aerosol suction distance affects the total face shield plate number. Table 1 presents the result after sampling and calculating TPC in the treatment group. Table 2 presents the result after sampling and testing the presence of *Streptococcus* and *Staphylococcus* on the face shield used by the dentist after brushing the bracket for orthodontic patients.

Streptococcus test results showed negative results with no growth of *Streptococcus* colonies in the medium. However, there was a growth of *Staphylococcus* in the medium, shown on the Blood Plate Agar medium (Figure 1), where colonies are arranged in groups like grapes. However, some are single cells or in pairs and are yellowish-white

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Table 1. Calculation of total plate count on face shield

No	Groups	Sample	TPC (CFU/cm^2)
1	Non-aerosol suction	5	7.25 ± 0.03
2	Aerosol suction 10 cm	5	1.23 ± 0.01
3	Aerosol suction 15 cm	5	2.78 ± 0.02
4	Aerosol suction 20 cm	5	3.15 ± 0 03

Table 2. The presence test results of *Streptococcus* and *Staphylococcus* on the face shield

No	Groups	Sample	Presence of bacteria	
			Streptococcus	*Staphylococcus*
1	Non-aerosol suction	5	negative	positive
2	Aerosol suction 10 cm	5	negative	positive
3	Aerosol suction 15 cm	5	negative	positive
4	Aerosol suction 20 cm	5	negative	Positive

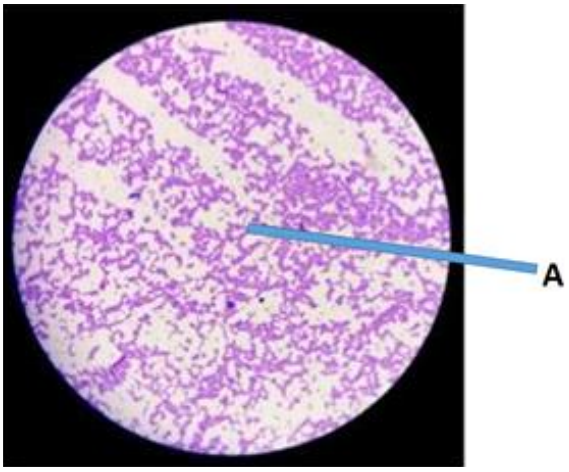

Figure 1. (A) *Staphylococcus sp.* on *the face shield*

in color. The following process is a catalase test to differentiate between *Streptococcus sp*. and *Staphylococcus sp.* species. Positive catalase is indicated by the presence of gas bubbles (O_2) produced by the genus *Staphylococcus*.[11]

The results of the catalase test on growing colonies showed positive results on face shield isolates. In this positive reaction, the catalase enzyme can hydrolyze hydrogen peroxide (H_2O_2) into water (H_2O) and gas bubbles (O_2). The positive catalase result was *Staphylococcus sp.* and catalase negative is *Streptococcus sp.*[11]

DISCUSSION

In treating patients at the dental clinic, dentists are advised to use Extra Oral Suction (EOS)/ Aerosol Suction with a saliva ejector or Intraoral Suction (IOS) to prevent aerosol contamination. Based on research by Motegi in 2010, testing the effectiveness of using IOS and EOS to reduce the amount of aerosol distributed around the patient's face when handling teeth and mouth showed that using IOS with EOS can prevent infection due to aerosols when handling teeth and mouth.[12]

The working principle of dental EOS starts from the suction of aerosol particles and droplets driven by the rotation of a vacuum motor. The inhaled aerosol and splashes of liquid will enter from the suction mouth and through a flexible pipe to the cyclone separator for the liquid and air separation process.[13]

Reduction of microbial contamination from aerosols produced when using a high-speed handpiece, air syringe, and ultrasonic scaler can be made by using a high-volume evacuator (HVE) or aerosol suction. HVE reduces the volume of aerosol emitted by the dental operator and the distance between them. HVE is a suction that can suck air up to 2.83 m^3 per minute. By using HVE,

aerosols can be inhaled so that contamination can be reduced by up to 90%.[14]

In a study that distinguishes the distance between the suction hood and the mouth with the average time of inhalation of all aerosol droplet particles, the fastest in one blow is at a distance of 20 cm with a time of 49.6 seconds.[12] This study's results indicate that the comparison of variations in the distance of aerosol suction with the oral cavity shows 20 cm, and the total plate number is 3.15 ± 0.026 CFU/cm^2.

The total plate count (TPC) is a quantitative method to determine the number of microbes present in a sample, with the final result of colonies that can be observed visually in the form of numbers in colonies/ colony forming units (CFU) per ml/g or colonies/100 ml.[12] TPC in all groups shows numbers that are still below the quality standard Number 1204/MENKES/SK/X/2004, 5 - 10 CFU/cm2.[10] Several things cause this, by using intra-oral suction and extraoral suction and the use of mouthwash for patients in the dental clinic. The mouthwash that is routinely used in the RSA dental clinic contains 1% Hydrogen peroxide or 0.2% povidone, which is recommended to reduce the microbes present in saliva during the COVID-19 pandemic.[14]

Research on *Streptococcus* and *Staphylococcus* bacteria used the catalase test to distinguish the species of *Staphylococcus sp.* and *Streptococcus sp.* Catalase positive indicated the presence of gas bubbles (O_2) produced by the genus *Staphylococcus*. The catalase test results showed positive results on all *Staphylococcus sp.* and negative for *Streptococcus sp.*

The presence of *Staphylococcus sp.* in the face shield indicated that some orthodontic patients had moderate OHIS with plaque around the orthodontic bracket. Fixed orthodontic appliances will result in plaque accumulation which can increase the number of microbes and change the composition of microbes. The microbes present in the plaque include *Staphylococcus aureus* and *Staphylococcus sp.* Husein et al identified the presence of *Staphylococcus aureus* and *Staphylococcus sp*. on subgingival plaque and oral cavities of individuals undergoing orthodontic treatment.[15] It supports the presence of *Staphylococcus sp.* on the face shield used by dentists in the orthodontic bracket brushing process.

Streptococcus sp. is a bacterium that has a significant role in the etiology of dental caries. *Streptococcus mutans* produce acid from carbohydrate fermentation metabolism, which makes the oral cavity environment acidic, thereby increasing the risk of caries. *Streptococcus* is the initial colony found within the first 4 hours on the dental biofilm, and the number of *Streptococcus* bacteria will increase in the presence of carbohydrates (sucrose). In this study, orthodontic patients did not have caries on their teeth, which supports the absence of *Streptococcus sp.* on the face shield used by dentists in the orthodontic bracket brushing process.

CONCLUSION

Based on the results of the study, it can be concluded that the total plate count on the face shield with the aerosol suction distance of 10 cm from the oral cavity shows a value of 1.23 ± 0.01 CFU/cm^2, still below the quality standard according the Ministry of Health Number 1204/MENKES/SK/X/ of 2004, which is 5 - 10 CFU/cm^2 and testing of *Streptococcus sp.* and *Staphylococcus sp.* on the face shield showed negative results and was free from *Streptococcus sp.* and positive for *Staphylococcus sp.*

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