Journal of Korean Society of Oral Health Science
2022, December. 10(4): 35-40
pISSN: 2288-6079 / eISSN: 2635-6538
https://doi.org/10.33615/jkohs.2022.10.4.35

Protective Effect of 0.1% Chlorhexidine Gluconate Solution Pre-Rinse against Oral Bacteria and Bacterial Aerosol Contamination during Ultrasonic Scaling

Kyeung-Ae Jang[1], Se-Hyun Hwang[2‡]
[1]Dept. of Dental Hygiene, Silla University, Assistant Professor
[2]Dept. of Dental Hygiene, Dongseo University, Lecturer

Objectives: This study was conducted to determine the antibacterial effect of 0.1% chlorhexidine gluconate solution (CGS) against oral microorganism and to confirm contamination of personal protective equipment and environment of dental clinic by bacterial aerosol during ultrasonic scaling.

Methods: Scaling was performed by a dental hygienist after 0.1% CGS pre-rinse to a total of 18 healthy subjects without oral inflammation. Samples were taken from personal protective equipment and environment to confirm contamination by bacterial aerosol.

Results: The most contaminated area with bacterial aerosol was the dental hole towel of patient and followed by the chest, cap, gloves, and dental apron of personal protective equipment. The areas with high CGS pre-rinse effect after scaling were cap, gloves, ultrasonic scaler handle, and dental hole towel.

Conclusions: 0.1% CGS pre-rinse is an effective method to consistently reduce the risk of periodontitis and contamination by bacterial aerosol in dental treatment including scaling.

Keywords Bacterial aerosol, Chlorhexidine gluconate solution, Contamination, Personal protective equipment, Ultrasonic scaling

Received on Oct 10, 2022. Revised on Nov 06, 2022. Accepted on Nov 07, 2022.

‡ Corresponding Author (E-mail: hsk4740@nate.com)

Ⅰ. Introduction

As interest and awareness about infections have increased, the importance of nosocomial infection is emerging. Hemorrhagic dental procedure is mainly performed in dental clinics and in particular, through a procedure that uses the blowing force of compressed air, various microorganisms in the patient saliva and blood exist in the air the form of an aerosol, and bacterial aerosol contaminates the surfaces of dental equipment and instruments of the dental clinics, patients, dentists and dental hygienists, thereby the infection rate in the dental clinics is increased[1]. Particles with a diameter of 50 ㎛ or more generated by dental instruments were defined as splatter, and those with a diameter of 50 ㎛ or less were defined as dental aerosol[2]. Dental instrument that generates aerosol includes a handpiece, ultrasonic scaler and air-water syringe, among them, the ultrasonic scaler generates a greater amount of contaminated aerosol compared to other instruments[3]. Aerosol stays in the air for a long time and can penetrate deep into the human respiratory system and the splatter, which is larger in diameter than aerosol, can also penetrate into the respiratory system by vaporizing into smaller particles while containing microorganism in the air[4]. In addition, due to its small particle size, aerosol can spread up to several meters and remain in the air in the clinic for up to 30 minutes[5]. In order to treatment gingivitis and periodontitis in dentistry, surgical and non-surgical periodontal treatment should be performed to physically remove biofilm and calculus of the supra-gingival and subgingival[6] and for this, a hand scaler and an ultrasonic scaler are used. The ultrasonic scaler is widely used for periodontal treatment by reducing the bleeding index and the pocket depth, and removing the subgingival calculus, as well as reducing the time for treatment and the fatigue of operator in comparison with the use of various types of hand instruments including periodontal curette[7-9]. However, the ultrasonic scaler continuously sprays water from the tip to reduce the heat generated by the vibrating tip, this

contaminates the clinic by generating aerosols including the saliva, blood and oral microorganisms of patient during scaling for periodontal treatment and it can endanger health by increasing the infection of aerosol in the operator and the patient[10,11]. Personal protective equipment can be used to protect the operator and treatment coordinator from infection by bacterial aerosol and a high-volume evacuator can be attached to the ultrasonic scaler to reduce the diffusion of aerosol into the air [12]. Nevertheless, it is difficult to prevent aerosol of small particles from penetrating into the body with personal protective equipment such as protective eyewear, mask and face-mask[13].

Chlorhexidine gluconate solution(CGS) is effective in plaque control and inhibition of gingivitis, and is widely used as an antibacterial agent applied to the oral cavity[14]. Oral rinsing with a CGS can reduce bacteria in saliva and aerosol-induced infections during dental treatment[15]. In addition, oral rinse with CGS before periodontal treatment using an ultrasonic scaler has been reported to reduce the number of oral bacteria[16]. This study was conducted to determine the antibacterial effect of 0.1% chlorhexidine gluconate solution(CGS) against oral microorganism and to confirm contamination of personal protective equipment and environment by bacterial aerosol during ultrasonic scaling.

Ⅱ. Materials and Methods

1. Preparation of Personal Protective Equipment

Sterilized personal protective equipment, surgical gown (Dasol International, Siheung-si, Korea), medical hair cap (Dasol International), protective shields for medical treatment, eyewear (OTOS®, Soul, Korea), dental mask (Yuhan-Kimberly Co., Soul, Korea) and latex surgical glove (Dasom medical Co., Seoul, Korea) were used to determine the degree of contamination of operator by bacterial aerosol. The dental light handle and the ultrasonic scaler handle were treated three times with 70% isopropyl alcohol (Duksan, Co., Gwangju-si, Korea) and used sterilized dental hole towel (KM Healthcare Co., Guri-si, Korea) and dental apron (KM Healthcare Co.) to determine the degree of contamination in the clinic environment by bacterial aerosol.

2. Sample Collection

A total of 18 healthy 20-year-olds without dental caries and periodontal disease were pre-rinsed the oral cavity with DW and 0.1% CGS (Hexamedine sol; Bukwang Pharm. Co., Seoul, Korea) and scaling was performed. The same two dental hygienists performed scaling to reduce the error caused by the scaling. After scaling, 10 pieces ($3\times3cm^2$)cut out from the sterilized personal protective equipment and sterilized gauzes ($10\times9cm^2$) cleaned the dental light handle and ultrasonic scaler handle were placed in 10ml DW. All instruments for sample collection were sterilized or sterilized products were used.

3. Antimicrobial Activity Against Oral Microorganism

The oral microorganisms used in this study were purchased from the Korea Microbiological Conservation Center(KCCM) and the Korean collection for type cultures (KCTC). *S. mutans* (KCCM 40105) was cultured in brain heart infusion (BHI, MB cell, Korea) agar and broth, *L. casei* (KCCM 12452) and *A. actinomycetemcomitans* (KCTC 2581) in MRS (MB Cell) agar and broth, E. coli (KCTC 1039) in Luria Bertani (Difco LB, MILLER, USA) agar and broth, and *C. albicans* (KCCM 11282) were in potato dextrose agar (PDA, MB cell) and broth (PDB, MB cell) for 24 h, respectively. The oral microorganism diluted according to the previous study[25] were smeared on agar plates, and the sterilized paper disc sabsorbed with 0.1% CGS and DW, and antimicrobial susceptibility disk of penicillinG(10mcg, Oxoid Ltd., Hampshire, United Kingdom) and ampicillin(10 IU, Oxoid Ltd.) were placed in 36.5℃ incubator (vision Scientific Co., Dejeon, Korea) for 24 h, and then clear zone formed around the disk was measured.

4. Cultivation of Salivary Microorganism

To investigate the changes over time in saliva oral microorganism according to application of DW and CFS,100㎕ saliva was smeared on agar plate (Difco LB Agar, MILLER) and cultured

in an incubator at 36.5℃ incubator (vision Scientific Co.) for 24 h, and then the number of colonies was measured and CFU/ml was calculated.

Ⅲ. Results

1. Inhibition zone by 0.1% chlorhexidine gluconate solution (CGS) and antibiotics using disk diffusion test

Representative oral bacteria, *S mutans*, *L casei*, *A actinomycetemcomitans* and *E. coli*, and an opportunistic fungus, *C. albicans* living in the oral cavity were smeared on agar plates. 0.1% CGS-treated paper disc is placed on a smeared agar plate, and the measurements of the clear zone after 24 h incubation were shown in <Figure 1>.

0.1% CGS showed antibacterial effects in the order of *E. coli, A. actinomycetemcomitans, L. casei* and *S. mutans*, but no antifungal effect in *C. albicans* <Table 1>. CGS was most effective in reducing E. coli transiently present in the oral cavity and more effective against periodontitis causing bacteria, *A. actinomycetemcomitans* than than a representative dental caries causing bacteria, *S. mutans* and matured dental caries related bacteria *L. casei*.

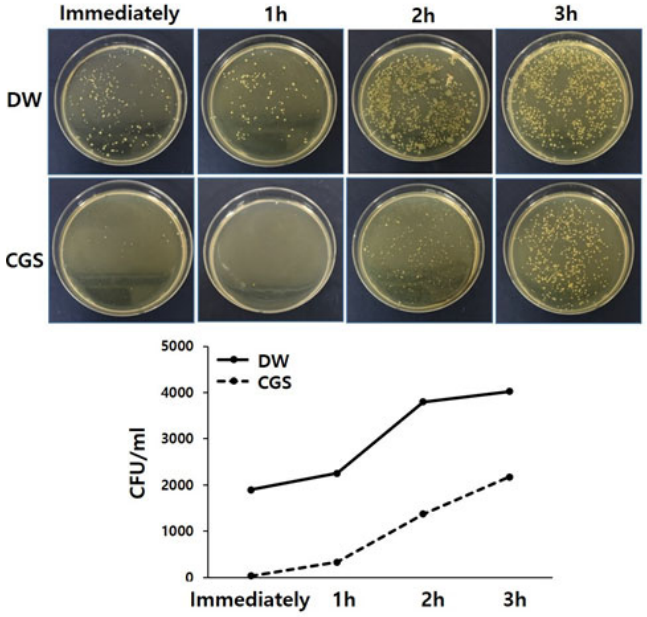
<Table 1> Inhibition zone by 0.1% chlorhexidine gluconate solution (CGS) and antibiotics using disk diffusion test

Oral microorganisms	Inhibition zone (mm)			Ratio	
	CGS	Penicillin G (10 mcg)	Ampicillin (10 IU)	CGS : Penicillin	CGS : Ampicillin
Streptococcus mutans	1.1	2.6	3.0	0.42 : 1	0.37 : 1
Lactobacil casei	1.2	2.7	3.4	0.44 : 1	0.35 : 1
Aggregatibacter actinomycetemcomitans	1.2	2.4	2.7	0.50 : 1	0.44 : 1
Escherichia coli	1.4	1.1	2.0	1.27 : 1	0.70 : 1
Candida albicans	0.0	0.0	0.0	-	-

2. Changes in colony of saliva microorganisms with time after 0.1% chlorhexidine gluconate solution pre-rinse

The persistence of the effect of CGS on oral microorganism in saliva was shown in <Figure 2>. 0.1% CGS pre-rinse consistently reduced oral microorganism compared to DW application. Therefore, CGS pre-rinse is effective to prevent infection by oral microorganism in patient during oral treatment with frequent bleeding including scaling.

<Figure 1> Inhibition zone by 0.1% chlorhexidine gluconate solution and antibiotics using the disk diffusion test



<Figure 2> Changes in colony of saliva microorganisms with time after 0.1% chlorhexidine gluconate solution pre-rinse

3. Contamination by bacterial aerosol after scaling

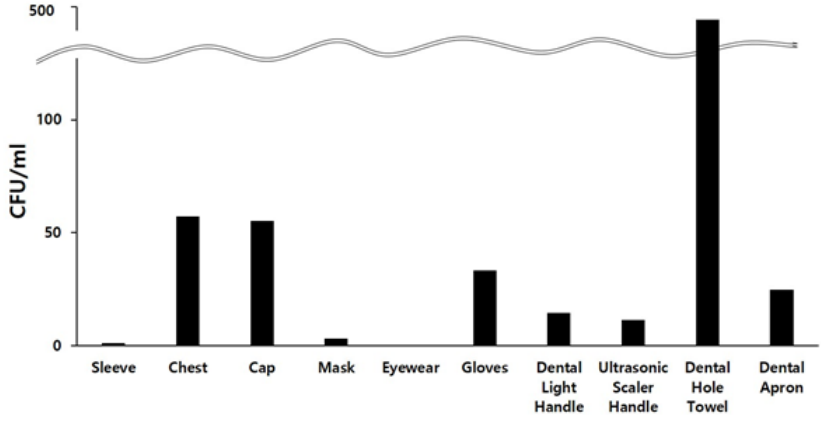
The degree of contamination of sterilized personal protective equipment and environment by bacterial aerosol after scaling is shown in <Figure 3>. The most common exposure to bacterial aerosol during scaling was dental hole towel, followed by chest, medical hair cap, gloves and dental apron of the personal protective equipment for dentist and dental hygienist.

4. The contamination by bacterial aerosol according to 0.1% chlorhexidine gluconate solution pre-rinse in scaling

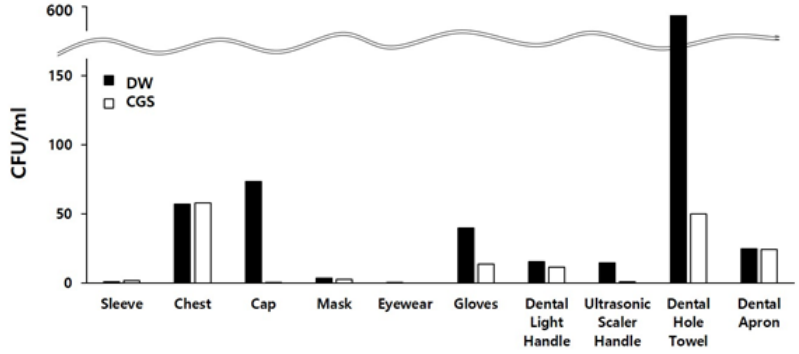
Comparing results of the bacterial aerosol contamination before and after 0.1% CGS pre-rinse is shown in <Figure 4>. Medical hair cap, gloves, ultrasonic scaler handle and dental hole towel had great CGS pre-rinse effect.

Ⅳ. Discussion

The importance of preventing cross-infection between dental staff and patients has been noted by previous studies[13,17]. Infection of medical staff and patients plays a role as an infection pathway causing infection in patients and their families[18]. Various microorganism exists in the saliva or blood of a patient, and it is possible to spread contamination by bacterial aerosol caused by dental treatment tools such as an ultrasonic scaler[10,11,19]. Dentist and dental hygienist working in aerosol-occurring clinic have more symptoms of aerosol-induced infection compared to personnel such as receptionist working in non-clinic[20]. Dental staff using ultrasonic scaler for more than 60 minutes a day showed higher hypersensitivity reactions and infection in eyes, skin, and upper and lower airways than those of no using ultrasonic scaler, and personal protective equipment, such as face-mask and protective eyewear, has limitations to prevent small particles in aerosol state



<Figure 3> Contamination by bacterial aerosol after scaling



<Figure 4> Comparison of the contamination by bacterial aerosol according to 0.1% chlorhexidine gluconate solution pre-rinse in scaling

from penetrating into the body[13].

This study investigated the antibacterial effect of 0.1%CGS against oral microorganism and contamination of personal protective equipment and environment by bacterial aerosol during ultrasonic scaling. In this study, 0.1%CGS was most effective in reducingE. coli transiently present in the oral cavity and more effective against periodontitis causing bacteria, *Aggregatibacter actinomycetemcomitans* than a representative dental caries causing bacteria, *S. mutans* and matured dental caries related bacteria *L. casei,* but did not show effects on a representative opportunistic fungus, *Candida albicans* <Figure 1, Table 1>, so it was different from the previous report[21] that CGS showed a wide range of anti-microbial activity against Gram-negative and positive bacteria, fungi and hepatitis B virus. Also, CGS consistently reduced oral microorganism in saliva <Figure 2>. This may be because chlorhexidine not only induces precipitation in bacterial cytoplasm bacterial causing cell death and binds strongly to the bacterial cell membrane [22] but also is well adsorbed to the dental pellicle on the tooth surface and once adsorbed, maintains bacteriostatic activity for more than 12h[23]. These results indicate that the application of 0.1% CGS pre-rinse in dental treatment with frequent bleeding including scaling can effectively and consistently reduce the risk of periodontitis.

The most contaminated area with bacterial aerosol was the dental hole towel of patient and followed by the chest, cap, gloves, and dental apron of personal protective equipment <Figure 3>and the areas with high 0.1% CGS pre-rinse effect after scaling were cap, gloves, ultrasonic scaler handle, and dental hole towel <Figure 4>. These results were similar to the previous results for wash with water and essential oil before using the air-polishing device generating aerosol[24] and the results for the number of bacteria contained in aerosol according to oral rinsing with chlorhexidine before periodontal treatment using an ultrasonic scaler[6]. This indicates that several areas of the patient and operator can be contaminated by bacterial aerosol and CGS pre-rinse has a great effect of reducing contamination by bacterial aerosol.

V. Conclusion

0.1% CGS pre-rinse can effectively and consistently reduce the risk of periodontitis and contamination by bacterial aerosol in dental treatment including scaling. The wearing of dental hole towels for patients and personal protective equipment of dentists and dental hygienists is essential to prevent microbial infections and cross-infections during dental treatment.

REFERENCES

1. Anuradha P, Shikha S: Aerosols and oral health. Unique Journal of Medical and Dental Sciences 3(2):11-13, 2015.
2. Micik RE, Miller RL, Mazzarella MA, Ryge G: Studies on dental aerobiology. I. Bacterial aerosols generated during dental procedures. Journal of Dental Research 48(1):49-56, 1969.
   DOI: 10.1177/00220345690480012401
3. Legnani P, Checchi L, Pelliccioni GA, D'Achille C: Atmospheric contamination during dental procedures. Quintessence International 25(6):435-439, 1994.
4. Harrel SK, Barnes JB, Rivera-Hidalgo F: Aerosol and splatter contamination from the operative site during ultrasonic scaling. Journal of American Dental Association 129(9): 1241-1249, 1998.
   DOI: 10.14219/jada.archive.1998.0421
5. Drisko CL, Cochran DL, Blieden T, et al.: Position paper: sonic and ultrasonic scalers in periodontics. Research, science and therapy committee of the american academy of periodontology. Journal of Periodontology 71(11):1792-1801, 2000.
   DOI: 10.1902/jop.2000.71.11.1792
6. Son WK, Shin SY, Kye SB, Yang SM: The effect of chlorhexidine on reduction of viable organisms in aerosol produced by ultrasonic scaler. Korean Academy of Periodontology 39(3):303-310, 2009.
   DOI: 10.5051/jkape.2009.39.3.303
7. Badersten A, Nilveus R, Egelberg J: Effect of nonsurgical periodontal therapy. I.Moderately advanced periodontitis. Journal of Clinical Periodontology 8(1):57-72, 1981.
   DOI: 10.1111/j.1600-051x.1981.tb02024.x
8. Boretti G, Zappa U, Graf H, Case D: Short-term effects of phase I therapy on crevicular cell populations. Journal of Periodontology 66(3):235-240, 1995.

DOI: 10.1902/jop.1995.66.3.235
9. Lee ES, Moon IS, Chai JK, Kim JK: The comparative study of the effectiveness of ultrasonics and curette for the removal of calculus on the root surface. Journal of Periodontal and Implant Science 20(1):153-154, 1990.
10. Bentley CD, Burkhart NW, Crawford JJ: Evaluating spatter and aerosol contamination during dental procedures. Journal of American Dental Association 125(5):579-584, 1994. DOI: 10.14219/jada.archive.1994.0093
11. Miller RL, Micik RE: Air pollution and its control in the dental office. Dental Clinics North America 22(3):453-476, 1978.
12. Harrel SK, Barnes JB, Rivera-Hidalgo F: Reduction of aerosols produced by ultrasonic scalers. Journal of Periodontology 67(1): 28-32, 1996. DOI: 10.1902/jop.1996.67.1.28
13. Allsopp J, Basu MK. Browne RM, Burge PS, Matthews JB: Survey of the use of personal protective equipment and prevalence of work related symptoms among dental staff. Occupational and Environmental Medicine 54(2):125-134, 1997. DOI: 10.1136/oem.54.2.125
14. Lang NP, Brecx MC: Chlorhexidine digluconate-an agent for chemical plaque control and prevention of gingival inflammation. Journal of Periodontal Research 21(16):74-89, 1986. DOI: 10.1111/j.1600-0765.1986.tb01517.x
15. Ciancio S: Expanded and future uses of mouth rinses. Journal of American Dental Association 125(8):29-32, 1994. DOI: 10.1016/s0002-8177(94)14005-7
16. Muir KF, Ross PW, MacPhee IT, Holbrook WP, Kowolik MJ: Reduction of microbial contamination from ultrasonic scalers. British Dental Journal 145(3):76-78, 1978. DOI: 10.1038/sj.bdj.4804123
17. Rosen S, Schmakel D, Schoener M: Incidence of respiratory disease in dental hygienists and dietitians. Clinical Preventive Dentistry 7(5):24-25, 1985.
18. Leggat PA, Kedjarune U, Smith DR: Occupational health problems in modern dentistry. Industrial Health 45(5):611-621, 2007. DOI: 10.2486/indhealth.45.611
19. Suppipat N: Ultrasonics in periodontics. Journal of Clinical Periodontology 1(4):206-213, 1974. DOI: 10.1111/j.1600-051X.1974.tb01259.x
20. Basu MK, Browne RM, Potts AJ, Harrington JM: A survey of aerosol-related symptoms in dental hygienists. The Journal of the Society of Occupational Medicine 38(1-2):23-25, 1988. DOI: 10.1093/occmed/38.1-2.23
21. Kolahi J, Soolari A: Rinsing with chlorhexidine gluconate solution after brushing and flossing teeth: a systematic review of effectiveness. Quintessence International 37(8): 605-612, 2006.
22. Hugo WB, Longworth AR: Some aspects of the mode of action of chlorhexidine. The Journal of Pharmacy and Pharmacology 16:655-662, 1964. DOI: 10.1111/j.2042-7158.1964.tb07384.x
23. Schiott CR, Loe H, Jensen SB, Kilian M, Davies RM, Glavind K: The effect of chlorhexidine mouth rinses on the human oral flora. Journal of Periodontal Research 5(2): 84-89, 1970. DOI: 10.1111/j.1600-0765.1970.tb00697.x
24. Logothetis DD, Martinez-Welles JM: Reducing bacterial aerosol contamination with a chlorhexidine gluconate prerinse. Journal of American Dental Association 126(12):1634-1639, 1995. DOI: 10.14219/jada.archive.1995.0111