Comparison of Intraoral Sites Reached by Different Mouthwash Administration Methods

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Abstract

Preprocedural mouthwash has been recommended as a standard measure to reduce the number of microorganisms in dental aerosols, thereby decreasing the chance of infectious disease transmission. Different methods of mouthwash administration could affect how mouthwash reaches anatomical sites of the oral cavity, which may limit its efficacy and lead to unsatisfactory outcome. The objective of this study was to investigate the intraoral spread of mouthwash between three administration methods: oral rinse, oral gargle, and oral spray.

Thirty individuals participated in this cross-sectional study were asked to use mouthwash mixed with blue food dye by three application methods on three separate days. Dye visibility of nine intraoral areas (upper buccal vestibule, lower buccal vestibule, base of tongue, floor of mouth, hard palate, soft palate, uvula, anterior tonsillar pillar, and posterior tonsillar pillar) was independently assessed and scored (0 – 2) by two investigators. Mean and SD of dye scores were calculated for overall and each of anatomical sites. Statistical significance was determined using the Kruskal–Wallis test at $p < 0.05$.

The overall scores of dye coverage were 8.52 ± 2.71, 13.28 ± 2.88, and 11.77 ± 3.02 for oral rinse, oral gargle, and oral spray, respectively. Gargling provided the highest coverage in all nine anatomical areas tested, whereas rinsing was less effective in reaching the upper buccal vestibule and posterior oropharynx. The efficacy of oral spray on the intraoral coverage achieved was generally comparable to oral gargle.

Overall, oral gargle and spray appeared to be significantly better than oral rinse in term of mouthwash distribution. These can be translated to the clinical settings to prevent COVID-19 and other infectious disease transmission in dental practices.

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Introduction

Dental practice poses a potentially high risk of infection and disease transmission, especially during the COVID-19 pandemic. More than 700 microbial species have been detected in the oral cavity.[1] Additionally, saliva acts as a potential reservoir and primary transmission route of pathogens, including the recent COVID-19 virus (severe acute respiratory syndrome coronavirus 2; SARS-CoV-2).[2,3] Many routine dental treatments involving the use of high-speed handpieces, ultrasonic scalers, and air/water syringes are considered as aerosol-generating procedures (AGP), which micro-organisms can be aerosolized and disseminated throughout the dental office.[4-7] Contaminated aerosols can remain suspended in the air for prolonged periods and travel farther distances.[4,6,8] Evidence has shown that SARS-CoV-2 remains viable in aerosols for up to 3 hours.[9] These cause a major threat of disease transmission among dental health care personnel and patients.

Considering the nature of AGPs in dentistry, several interventions have been proposed to minimize aerosol production and reduce contamination in aerosols produced during dental procedures.[4,10,11] Preprocedural rinse with antiseptic mouthwashes, such as chlorhexidine gluconate (CHX), povidone-iodine (PVP-I), and cetylpyridinium chloride (CPC), have been regarded as one of the strategy to

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reduce microbial contamination in dental aerosols, thus decreasing the chance of transmission.[12,13] Previous studies showed that preprocedural mouthwashes significantly reduced the number of bacteria in dental aerosols generated via different dental procedures.[13-15] With the COVID-19 pandemic outbreak, the use of antiseptic mouthwashes has been widely implemented as a standard measure before any dental procedure to prevent SARS-CoV-2 transmission and infection.[5,16] Studies demonstrated that CPC and PVP-I could potentially reduce viral load and infectivity in the saliva of SARS-CoV-2 positive individuals.[17-21]

If preprocedural mouthwash effectively prevent disease transmission, it is important to identify the optimal method of mouthwash use as its effectiveness may depend in part on the ability of mouthwash to reach all reservoirs of infection. Although mouthwash could generally cover both intraoral and oropharyngeal areas, this requires proper using techniques. Current recommendation on the use of mouthwashes against the COVID-19 pandemic suggests gently gargle for 30 seconds in the oral cavity and 30 seconds in the back of the throat.[16] However, clinical experience has shown that not all individuals are using mouthwash in the same manner. It has been demonstrated that over one-third (35%) of frequent mouthwash users did not gargle mouthwash at all.[22] This could affect the intraoral spread and thus the efficacy of mouthwash.

There have been very limited studies on how different methods of mouthwash use reaches the anatomical sites of the oral cavity and oropharynx.[23,24] Moreover, previous studies primarily focused on the spread of mouthwash at the posterior oropharynx in relation to oropharyngeal gonorrhea prevention[23,24], while did not examine the buccal vestibules as well as the floor of mouth where are the openings of the major salivary glands. Thus, the aim of this study was to determine the proportion of nine intraoral sites, including oral vestibules and floor of mouth, reached by three mouthwash administration methods: oral rinse, oral gargle, and oral spray.

Materials and Methods

A cross-sectional study was conducted at the Oral Medicine Clinic, Dental Hospital, Faculty of Dentistry, Naresuan University from August 2022 to February 2023. The study was approved by Naresuan University Institutional Review Board (NU-IRB-COA No. 145/2021). Volunteers aged above 20 years old who had a Friedman tongue position (FTP) of class I or class II were eligible for the study. Exclusion criteria included individuals with history of allergy/sensitivity to food coloring, gag reflex and/or swallowing problems, and presence of oral lesions. Thirty subjects participated in this study. Informed consent was obtained from all the participants, and the study procedures were conducted in accordance with the Declaration of Helsinki.

Participants were asked to use the study mouthwash by three different methods (oral rinse, oral gargle, and oral spray) on three separate days. The study mouthwash was prepared by diluting 1 mL of food coloring (Winner's brilliant blue FCF color) into 14 mL of water.[23,24] For oral rinse and oral gargle methods, participants were asked to gently rinse or gargle 10 mL of the study mouthwash for 1 min without swallowing. For oral spray, the study mouthwash was provided in a 10-mL commercially-available clear spray bottle. Participants were asked to spray 20 squirts of the mouthwash inside their mouth without swallowing.

The oral cavity and oropharynx was then inspected immediately after each mouthwash used to assess dye distribution. Nine areas of interest included the upper buccal vestibule, lower buccal vestibule, base of tongue, floor of mouth, hard palate, soft palate, uvula, anterior tonsillar pillar, and posterior tonsillar pillar (Fig. 1).

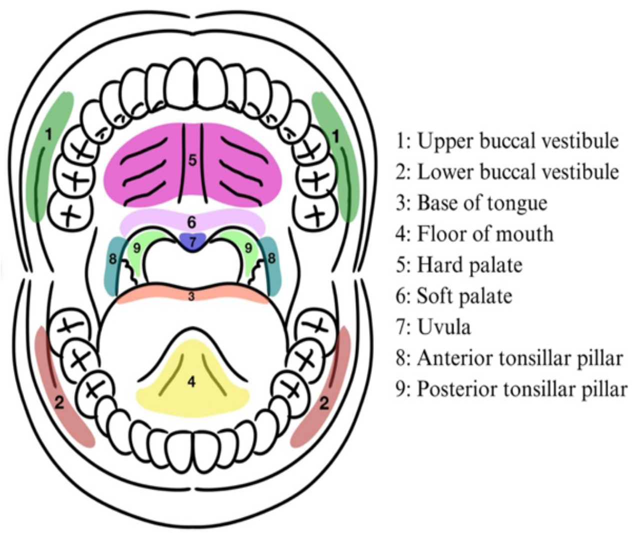

Figure 1. Nine anatomical areas of interest.

Assessments of the dye visibility were carried out by two independent assessors (C.C. and C.T.). A score (0 – 2) of visible dye coverage was given to each area, when 0 = no dye visibility, 1 = faint or less than 50% of area coverage, and 2 = clear dye visibility on more than 50% of area. A maximum score for each method was 18. The assessors were blinded to the participant's method of mouthwash administration during the scoring assessment.

Food coloring score were calculated for each mouthwash administration method and each of the nine anatomical sites. GraphPad Prism scientific software version 9.5.1 was used for statistical analysis. Statistical significance was determined using the Kruskal–Wallis test. Differences were considered as statistically significant at a value * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$, and **** $p < 0.0001$.

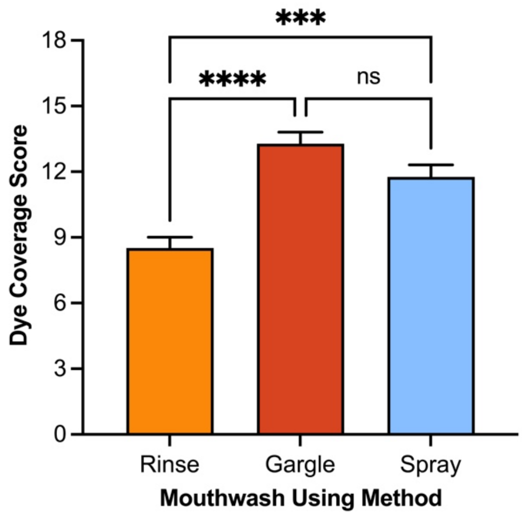

Figure 2. Comparison of means of dye coverage between three different mouthwash methods: oral rinse, gargle, and spray. Data are expressed as mean ± SEM. Statistical significance was determined by Kruskal–Wallis test. *** $p < 0.001$ and **** $p < 0.0001$.

Results

Thirty individuals (16 men (53.33%) and 14 women (46.67%)) were participated in the study. The efficacy of mouthwash administration methods on intraoral distribution was determined using blue food dye visibility as a marker. The overall scores of dye coverage were 8.52 ± 2.71, 13.28 ± 2.88, and 11.77 ± 3.02 for oral rinse, oral gargle, and oral spray, respectively. Both oral gargle and spray methods resulted in significantly higher food dye coverage when compared to oral rinse. There was no difference between oral gargle and oral spray (Fig. 2).

We further evaluated the mouthwash distribution at each anatomical areas of the oral cavity and oropharynx. Oral gargle method demonstrated the highest dye coverage scores in all areas (Fig. 3). Comparison of the dye coverage score at each sites showed that oral spray provided superior mouthwash distribution at the upper buccal vestibule, soft palate, uvula, and tonsillar pillars when compared to oral rinse, whereas there was no significant difference between oral spray and oral gargle (Fig. 3). However, oral gargle were found to be more effective than both oral spray and rinse in term of reaching the hard palate. As for the lower buccal vestibule, base of tongue, and floor of mouth areas, there was no statistical difference between each modality (Fig. 3).

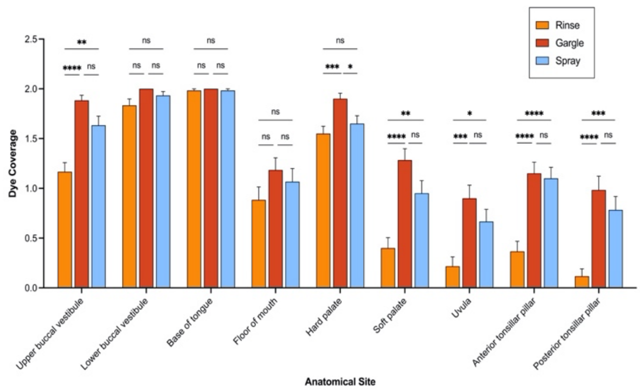

Figure 3. Comparison of means of dye coverage at each anatomical sites. Data are expressed as mean ± SEM. Statistical significance was determined by Kruskal–Wallis test. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$, and **** $p < 0.0001$.

Discussion

Preprocedural mouthwashes have been widely used in dentistry as a standard measure to prevent the transmission of infectious diseases.[16,25] They are shown to reduce the number of microorganisms in the oral cavity as well as those disseminated in aerosols generated via dental procedures, thereby reducing any risk of disease transmission.[13,15,26] Following the outbreak of the COVID-19 pandemic, the use of antiseptic mouthwashes prior to dental procedures has been specifically advocated as a cost-effective and easily implemented strategy against SARS-CoV-2 infection and transmission.[5,12,16,27]

The antimicrobial effectiveness of preprocedural mouthwashes could be attributed by the dosage, duration, and modes of delivery.[28] In order to achieve the most favorable antimicrobial effects, it is crucial for the mouthwash to reach all potential reservoirs of infection. For instance, SARS-CoV-2 has been shown to infect and replicate in salivary glands and epithelial cells of the oral mucosa.[29] Therefore, it is important to identify the optimal method of mouthwash use to maximize its coverage of the inaccessible intraoral areas, including the oral vestibules, floor of mouth, and posterior oropharynx, to ensure sufficient tissue contact. Therefore, in this study, we assessed the efficacy of three commonly-used mouthwash administration methods (i.e., oral rinse, oral gargle, and oral spray) in covering the hard-to-reach areas of the oral cavity and oropharynx.

Lin et al.[23] previously conducted a pilot study on the efficacy of oral rinses, gargles, and sprays on mouthwash distribution and concluded that both gargling and spraying methods result in a better oropharyngeal coverage than oral rinse. However, they did not determine the mouthwash coverage for each anatomical site but reported an overall score for the entire oral cavity instead. Another study by Maddaford et al.[24] investigated the efficacy of three mouthwash application methods to cover seven intraoral sites. They showed that while there was no statistically difference between spraying and gargling methods, oral spray has the highest coverage at the posterior pharyngeal wall. Nevertheless, none of the studies assessed mouthwash coverage at the buccal vestibules and the floor of mouth that are the major salivary gland openings.

Here, we demonstrated that oral gargle resulted in the highest coverage, even though the efficacy of oral sprays was generally comparable to gargles in terms of intraoral mouthwash distribution. The rinsing method was significantly inferior compared to gargling and spraying in reaching posterior areas and crevices of the oral cavity, including the upper buccal vestibule and posterior oropharyngeal wall. These findings are consistent with the previous studies which demonstrated that both oral gargle and oral spray have better efficacy in reaching the oropharynx than oral rinse.[23,24]

On the basis of our findings, we suggest that preprocedural mouthwash may be used by either gargling or spraying method, depending on the preference, as they are equally effective. However, gargling was previously described as the ‘difficult’ and ‘uncomfortable’ method.[24] Not surprisingly, during the experiments, we observed that some individuals did not understand the technique of gargling and rinsed instead, resulting in poor mouthwash coverage. Furthermore, special-needs patients, such as elderly people or people with cerebral palsy, may have problems with the gargling technique.[30,31]

Thus, oral spray might be an alternative method to effectively administer mouthwash in these particular population groups. On the other hand, a limitation of oral spray technique were that some might not be able to control the spray application to all the targeted areas. Consider this issue, it is essential for the health care personnel to provide precise and clear instructions on how to use the mouthwash to ensure that patients are able to use it properly.

There are some limitations concerning the results of this study. One limitation is that the study was performed only on individuals with FTP class I and class II, thus the results may not be applicable to those with FTP class III or IV. Ultimately, further studies are needed to verify whether distinct mouthwash delivery methods affect the effectiveness of mouthwash in reducing microbial loads in dental aerosols.

Conclusions

Preprocedural rinse with antiseptic mouthwashes is found to be effective in reducing the microbial burden in the oral cavity as well as in dental aerosols. Identifying the optimal method for administering mouthwash, particularly to the hard-to-reach intraoral sites, could be the key to achieve its most favorable effects in reducing the spread of infection. The present findings suggest that mouthwash delivery by both gargling and spraying methods are significantly better than rinsing in term of mouthwash distribution. These could be translated to the clinical settings to prevent COVID-19 and other infectious disease transmission in dental practices.

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Author Contribution

S.T.; Investigation, C.C. and C.T.; Writing-Original Draft Preparation, C.C.; Writing-Review & Editing, C.T., R.K., W.T., P.W., C.D. and S.T.; Supervision: R.K., W.T. and S.T.; Project Administration, C.C.; Funding Acquisition, C.C. All authors have made substantive contribution to this study and/or manuscript, and all have reviewed the final paper prior to its submission.

Declaration of Interest

The authors report no conflict of interest.

References

1. Caselli E, Fabbri C, D'Accolti M, et al. Defining the oral microbiome by whole-genome sequencing and resistome analysis: the complexity of the healthy picture. *BMC Microbiol.* 2020;20(1):120.
2. To KK, Tsang OT, Yip CC, et al. Consistent Detection of 2019 Novel Coronavirus in Saliva. *Clin Infect Dis.* 2020;71(15):841-843.
3. Li Y, Ren B, Peng X, et al. Saliva is a non-negligible factor in the spread of COVID-19. *Mol Oral Microbiol.* 2020;35(4):141-145.
4. Harrel SK, Molinari J. Aerosols and splatter in dentistry: a brief review of the literature and infection control implications. *J Am Dent Assoc.* 2004;135(4):429-437.
5. Peng X, Xu X, Li Y, Cheng L, Zhou X, Ren B. Transmission routes of 2019-nCoV and controls in dental practice. *Int J Oral Sci.* 2020;12(1):9.
6. Zemouri C, de Soet H, Crielaard W, Laheij A. A scoping review on bio-aerosols in healthcare and the dental environment. *PLoS One.* 2017;12(5):e0178007.
7. Sebastiani FR, Dym H, Kirpalani T. Infection Control in the Dental Office. *Dent Clin North Am.* 2017;61(2):435-457.
8. Deogade SC, Naitam D. COVID-19 and dental aerosols: The infection connection. *Avicenna J Med.* 2021;11(2):107-109.
9. van Doremalen N, Bushmaker T, Morris DH, et al. Aerosol and Surface Stability of SARS-CoV-2 as Compared with SARS-CoV-1. *N Engl J Med.* 2020;382(16):1564-1567.
10. Koletsi D, Belibasakis GN, Eliades T. Interventions to Reduce Aerosolized Microbes in Dental Practice: A Systematic Review with Network Meta-analysis of Randomized Controlled Trials. *J Dent Res.* 2020;99(11):1228-1238.
11. Giovanditto F, Soma D, Vaira LA, et al. Recommendations for a safe restart of elective aerosol-generating oral surgery procedures following the COVID-19 pandemic outbreak: An Italian multicenter study. *J Craniomaxillofac Surg.* 2022;50(5):462-467.
12. Weber J, Bonn EL, Auer DL, et al. Preprocedural mouthwashes for infection control in dentistry-an update. *Clin Oral Investig.* 2023:1-12.
13. Marui VC, Souto MLS, Rovai ES, Romito GA, Chambrone L, Pannuti CM. Efficacy of preprocedural mouthrinses in the reduction of microorganisms in aerosol: A systematic review. *J Am Dent Assoc.* 2019;150(12):1015-1026.e1011.
14. Mohd-Said S, Mohd-Dom TN, Suhaimi N, Rani H, McGrath C. Effectiveness of Pre-procedural Mouth Rinses in Reducing Aerosol Contamination During Periodontal Prophylaxis: A Systematic Review. *Front Med (Lausanne).* 2021;8:600769.
15. Kumbargere Nagraj S, Eachempati P, Paisi M, et al. Preprocedural mouth rinses for preventing transmission of infectious diseases through aerosols in dental healthcare providers. *Cochrane Database Syst Rev.* 2022;8(8):Cd013826.
16. Vergara-Buenaventura A, Castro-Ruiz C. Use of mouthwashes against COVID-19 in dentistry. *Br J Oral Maxillofac Surg.* 2020;58(8):924-927.
17. Ziaeefar P, Bostanghadiri N, Yousefzadeh P, et al. The efficacy of mouthwashes in reducing SARS-CoV-2 viral loads in human saliva: A systematic review. *New Microbes New Infect.* 2022;49:101064.
18. Alemany A, Perez-Zsolt D, Raïch-Regué D, et al. Cetylpyridinium Chloride Mouthwash to Reduce Shedding of Infectious SARS-CoV-2: A Double-Blind Randomized Clinical Trial. *J Dent Res.* 2022;101(12):1450-1456.
19. Sánchez Barrueco Á, Mateos-Moreno MV, Martínez-Beneyto Y, et al. Effect of oral antiseptics in reducing SARS-CoV-2 infectivity: evidence from a randomized double-blind clinical trial. *Emerg Microbes Infect.* 2022;11(1):1833-1842.
20. Farmaha JK, James JN, Frazier K, et al. Reduction of SARS-CoV-2 salivary viral load with pre-procedural mouth rinses: a randomised, controlled, clinical trial. *Br Dent J.* 2023;234(8):593-600.
21. D'Amico F, Moro M, Saracino M, et al. Efficacy of Cetylpyridinium Chloride mouthwash against SARS-CoV-2: A systematic review of randomized controlled trials. *Mol Oral Microbiol.* 2023;38(3):171-180.
22. Phillips TR, Fairley C, Maddaford K, et al. Duration of gargling and rinsing among frequent mouthwash users: a cross-sectional study. *BMJ Open.* 2020;10(9):e040754.
23. Lin CT, Raman R. Comparison of the efficacy between oral rinse, oral gargle, and oral spray. *J Prim Care Community Health.* 2012;3(2):80-82.
24. Maddaford K, Fairley CK, Trumpour S, Chung M, Chow EPF. Sites in the oropharynx reached by different methods of using mouthwash: clinical implication for oropharyngeal gonorrhoea prevention. *Sexually transmitted infections.* 2020;96(5):358-360.
25. Meyers C, Robison R, Milici J, et al. Lowering the transmission and spread of human coronavirus. *J Med Virol.* 2021;93(3):1605-1612.
26. Aiemyen N, Luangnam C, Suksan S, Payukaparp P, Kwansirikul J, Samnieng P. Effectiveness of Tongue Cleaning Plus Chemical Mouthwash Agents into the Number of Oral Microorganisms Caused Aspiration Pneumonia in Bedridden Elderly Patients: A Crossover Study. *J Int Dent Med Res* 2020;13(4):1341-1348.
27. Chen MH, Chang PC. The effectiveness of mouthwash against SARS-CoV-2 infection: A review of scientific and clinical evidence. *J Formos Med Assoc.* 2022;121(5):879-885.
28. Shehatta OM, Osman AL, Elsayed WS, et al. Antimicrobial Efficacy of Chlorhexidine and Hyaluronic Acid Mouthwashes on Streptococcus Viridans: An In-Vitro Study. *J Int Dent Med Res.* 2022;15(2):485-489.
29. Huang N, Pérez P, Kato T, et al. SARS-CoV-2 infection of the oral cavity and saliva. *Nat Med.* 2021;27(5):892-903.
30. Erasmus CE, van Hulst K, Rotteveel JJ, Willemsen MA, Jongerius PH. Clinical practice: swallowing problems in cerebral palsy. *Eur J Pediatr.* 2012;171(3):409-414.
31. Aslam M, Vaezi MF. Dysphagia in the elderly. *Gastroenterol Hepatol (N Y).* 2013;9(12):784-795.