Comparison of tongue coating removal methods: A preliminary study with a systematic review

Madoka Funahara (macloca02@gmail.com)
Kyusyu Dental University https://orcid.org/0000-0002-1188-7570

Akari Nakamura
Kyushu Shika Daigaku

Soh Inho
Kyushu Shika Daigaku

Hiromi Honda
Kyushu Shika Daigaku

Yuka Kojima
Kansai Ika Daigaku Fuzoku Byoin

Sakiko Soutome
Nagasaki Daigaku

Masahiro Umeda
Nagasaki Daigaku

Hisako Hikiji
Kyushu Shika Daigaku

Research article

Keywords: Tongue coating, Tongue brushing, Povidone iodine, Hydrogen peroxide, Number of bacteria

Posted Date: April 17th, 2020

DOI: https://doi.org/10.21203/rs.3.rs-21594/v1

Abstract

Background

It is known that tongue coating is one of the main causes of halitosis, as well as various diseases such as aspiration pneumonia. However, no method for removing tongue coating has been established.

Materials and methods

We first performed a systematic review of 32 papers that compared the effects of multiple tongue coating removal methods. Next, we conducted a preliminary, randomized controlled trial on the effect of three disinfectants on tongue cleaning. Thirty-two patients were randomly assigned to the following four groups; 1) benzethonium chloride group (BC group), 2) povidone iodine group (PI group), 3) hydrogen peroxide group (HP group), and 4) tap water group (TW group). Tongue cleaning was performed using a toothbrush with the 4 test drugs, and the number of bacteria on the dorsum of the tongue before and after tongue cleaning was measured using the Rapid Oral Bacteria Quantification System.

Results

The systematic review suggested that, 1) mechanical tongue cleaning reduced the tongue coating, 2) some antibacterial mouthwashes reduced the tongue coating, and 3) some diets, chewing gums and tablets also reduced the tongue coating. The randomized controlled trial showed that the number of bacteria decreased significantly when tongue brushing was done using povidone iodine and hydrogen peroxide solution, while, 0.2% benzethonium chloride and tap water did not decrease the bacterial count.

Conclusions

Tongue brushing with povidone iodine or hydrogen peroxide is the most effective method of reducing the bacterial count of tongue coating.

Trial Registration

The study was registered in the University Hospitals Medical Information Network Clinical Trials Registry (UMIN-CTR), UMIN000038544 on November 11, 2019: https://upload.umin.ac.jp/cgi-open-bin/ctr/ctr_view.cgi?recptno=R000043924.

Background

Tongue coating is a white, yellowish-brown, or black moss-like deposit on the dorsum of the tongue, caused by increased keratinization of the cells on the tongue surface and elongation of the lingual papillae, as well as bacteria, exfoliated epithelium, and food residues. It is affected by the functional state and amount of secretion of the salivary glands, state of the secretion fluid, resident bacteria in the oral cavity, physical condition, etc. An abnormal quantity and quality of the tongue coating may be due to dry mouth, decreased immunity, oral respiration, poor oral hygiene, smoking, aging, stress, systemic diseases, and side effects of drugs. It has also been suggested that tongue coating is a major cause of halitosis and that bacteria on the tongue surface may be mediated by saliva to supply bacteria to plaque and periodontal pockets [1, 2].

Some investigators stated that tongue coating is one of the defense reactions and therefore should not be removed, while others advocated that tongue coating should be removed because it increases the number of bacteria in saliva and is significantly related to the development of pneumonia [3, 4]. However, there is currently no established method for removing tongue coating.

In this study, we first conducted a systematic review of literature on effective tongue coating removal methods. Next, we compared the effects of using three distinct disinfectants (hydrogen peroxide, povidone iodine, and benzethonium chloride) for tongue cleaning on the bacterial count reduction of tongue coating.

Methods

1. A systematic review

We searched articles with the keywords “tongue coating” in the PubMed electronic database published before January 31, 2020. There was a total of 436 papers, out of which 60 non-English papers were excluded. Of the remaining 376 papers, 45 compared the effects of several tongue coating removal methods. Except for studies on halitosis and other outcomes, 32 papers that performed multiple removal methods and conducted macroscopic or bacteriological observations of tongue coating were included in this review [5–36].

2. Evaluation of tongue coating removal methods

Participants

The subjects consisted of 32 adult patients who visited the Department of Oral Health, Kyushu Dental University Hospital for the treatment of dental caries, periodontal disease, or for regular maintenance, from April to September 2019. All the patients were able to gargle and protrude the tongue. Patients with a history of hypersensitivity to the following test drugs were excluded from the study. Patients were enrolled in this study after written informed consent was obtained.

Allocation

Participants were randomly assigned to the following four groups using a computer software; 1) benzethonium chloride group (BC group), 2) povidone iodine group (PI group), 3) hydrogen peroxide group (HP group), and 4) tap water group (TW group).

Treatment

A toothbrush was moistened with a test drug and rubbed from the back to the front of the dorsum of the tongue for 10 seconds. After rubbing the tongue, gargling was performed with 20 ml of tap water for 5 seconds; this was repeated three times. The test drug was 0.2% benzethonium chloride (Neostelin® Green 0.2% mouthwash solution, Nihon Shika Yakuhin Co., Ltd., Yamaguchi, Japan) in the BC group, 7% povidone iodine (ISODINE® gargle solution 7%, SHIONOGI & CO., LTD., Osaka, Japan) in the PI group, 3% hydrogen peroxide solution (Oxydol, Showa Seiyaku Co., Ltd., Osaka, Japan) in the HP group, and tap water in the TW group. The head of the toothbrush used for cleaning the tongue was 20 mm × 9 mm in size, with normal bristle hardness, flat type, and straight grip.

Data collection

The following data were collected to describe the patient characteristics: Age, sex, body mass index (BMI), number of remaining teeth, mouth breathing, diabetes, smoking and drinking habit within the last one year, O'Leary Plaque Control Record (PCR), taste of test drug, and oral wetness. Taste of the test drug was categorized into three levels: no problem, slightly bad, and bad, according to interviews with patients. Oral wetness was measured three times at the surface of the buccal mucosa using the oral hydrometer (Moisture Checker Mucus®, Life Co., Ltd., Saitama, Japan) and the median value was adopted.

Endpoint

The endpoint was the bacterial count on the dorsum of the tongue before and after tongue cleaning in the four groups. The number of bacteria on the tongue was measured using the Rapid Oral Bacteria Quantification System (Panasonic Healthcare Co. Ltd., Osaka, Japan), which is based on dielectrophoresis and impedance measurements [37, 38]. To collect a sample on the tongue, a sterile cotton swab was set on the attached constant-pressure sample collection device and pressed in parallel against the back of the tongue, and the center of the dorsum of the tongue was rubbed back and forth for approximately 2 cm.

Statistical analysis

Statistical analyses were performed using SPSS software version 24.0 (Japan IBM Co., Ltd., Tokyo, Japan). Differences of patient characteristics between each group were analyzed using the Kruskal-Wallis test. Differences in bacterial counts in each group were analyzed using the Wilcoxon signed-rank test.

Ethics

Ethical approval for this study was obtained from the Medical Ethics Committee of Kyushu Dental University, Fukuoka, Japan (No. 18-68). The study was registered in the University Hospitals Medical

Information Network Clinical Trials Registry (UMIN-CTR), UMIN000038544 on November 11, 2019: https://upload.umin.ac.jp/cgi-open-bin/ctr/ctr_view.cgi?recptno=R000043924.

Results

1. The systematic review

Tongue coating removal methods in the 32 reviewed studies were divided into four categories: 1) mechanical method, 2) gargle, 3) drug or food, 4) their combination or others (Table 1). Most investigators reported that mechanical cleaning of the dorsum of the tongue using a tooth brush or plastic tongue scraper reduced the tongue coating score.

The effect of various gargles on the removal of tongue coating was examined, such as mouthwash containing chlorine dioxide, chlorhexidine, chlorhexidine-alcohol, sodium fluoride, cetylpiridinium chloride, benzethonium chloride, zinc-lactate, ingredients associated with oxygenation, and amine fluoride. Gargling had a certain effect in reducing halitosis, but in most reports, each mouthwash had little effects on reducing tongue coating and the bacterial count on the tongue.

Various foods and medicines were also examined for tongue coating removal effects, such as daiokanzoto sherbets, hangeshashinto sherbets, French pine bark extract chewing gum, ayurveda tablets, lactferrin and lactoperoxidase tablets, high-fiber diet, tulsi leaf, mint leaf, curry leaf, cysteine protease containing tablets, eucalyptus-extract chewing gum, and Chinese herbal decoctions. Most of them were effective in reducing halitosis, but were reported to have little effect on reducing tongue coating or bacterial count on the tongue. On the other hand, there have been no studies on the effect of mechanical tongue cleaning using antiseptic drugs.

2. Evaluation of tongue coating removal methods

Patient characteristics are shown in Table 2. Five patients were men and 27 were women, with an average age of 70.9 ± 11.2 years old. There were no significant differences between the background factors of the four groups.

The Log average number of bacteria on the tongue before tongue cleaning was 6.79 ± 0.51 CFU/mL, and there was no significant difference between the four groups. Bacterial count after tongue cleaning in the BC and TW groups did not significantly differ compared to that before tongue cleaning, while in the PI and HP groups, the number of bacteria on the tongue after cleaning was significantly lower than that before tongue cleaning (Fig. 1).

In almost all patients, the taste of the test drug was acceptable. Only one patient in PI group answered “slightly bad”, and one case in BC group answered “bad” (Table 3).

Discussion

There are more than 500 microorganisms in the oral cavity [39, 40]. *Streptococcus mutans* is one of the causative bacteria of dental caries, while *Porphyromonas gingivalis* is considered to be the most toxic for periodontal disease. These bacteria not only cause dental diseases, but *S. mutans* causes infectious endocarditis, valvular heart disease and cerebral hemorrhage, and *P. gingivalis* causes atherosclerosis, diabetes, rheumatism, etc. Further, representative diseases affected by oral bacteria include aspiration pneumonia. The main causative bacteria of aspiration pneumonia are resident bacteria in the oral cavity, and oral streptococci and anaerobic bacteria such as *Peptstreptococcus*, *Prevotella*, and *Fusobacterium* are known as bacteria classified at high frequency. These bacteria are also present on tongue coating, and thus, some authors stated that cleaning tongue coating might reduce the risk of aspiration pneumonia [3, 4].

Various methods for tongue cleaning have been reported, including mechanical cleaning using a tongue scraper or toothbrush, and the application of some mouthwashes, diets, chewing gums, and tablets. The results of the previous studies are summarized as follows: 1) mechanical tongue cleaning reduced tongue coating, 2) some antibacterial mouthwashes reduced tongue coating, and 3) some diet, chewing gum and tablets also reduced tongue coating. However, many of the reported diets, gums and tablets are not commercially available in Japan. The most effective method for removing tongue coating is considered to be the combination of mechanical cleaning and disinfectant, therefore, we decided to conduct this preliminary study.

Disinfectants approved for use on the oral mucosa in Japan include 10% povidone iodine, 0.2% benzethonium chloride, and 3% hydrogen peroxide solution. However, 0.12% chlorhexidine, which is commonly used overseas to prevent VAP in intubated patients is contraindicated for mucosal use, because anaphylaxis was reported in Japan. Therefore, in this study, we selected povidone iodine, benzethonium chloride, and hydrogen peroxide solution, and water as a control, and compared their effect in reducing tongue coating bacteria when brushing the tongue with a toothbrush. Our results showed that the bacterial count was significantly decreased when brushing with povidone iodine and hydrogen peroxide solution, while 0.2% benzethonium chloride and tap water did not decrease the bacterial count. It is necessary to further study the concentration and action time of benzethonium chloride.

Povidone iodine has strong ionicity and adheres well to mucous membranes, therefore, it was considered to have a strong disinfecting effect on oral bacteria. Although there are some disadvantages such as iodine allergy, the possibility of coloring the teeth with long-term use, and the unsatisfactory taste, the use of povidone iodine for removing tongue coating was still recommended. Next, the hydrogen peroxide solution through catalase decomposes tissues, bacteria, blood, pus, etc., generates oxygen, and exhibits a bactericidal action. It was considered that the bacterial count on the tongue was decreased by the foaming reaction at the time of the decomposition, because the deposit on the tongue was physically removed and mechanically washed, and in addition, a bactericidal action was performed. The taste was also acceptable as compared to iodine, and it was considered as a recommended disinfectant for removing tongue coating.

This study had some limitations. First, this is a preliminary study using a small sample size, and it is therefore difficult to generalize the results. Next, because these methods were intended for patients with dental disease but without a systemic disease, it is unknown whether it can be applied for the removal of pathological tongue coating. In the future, it will be necessary to conduct an intervention study using a larger sample size, to evaluate the effects of removing tongue coating in patients with diseases such as aspiration pneumonia.

Conclusion

The randomized controlled trial showed that the number of bacteria decreased significantly when tongue brushing was done using povidone iodine and hydrogen peroxide solution, while, tongue brushing with 0.2% benzethonium chloride and tap water did not decrease the bacterial count.

List Of Abbreviations

BC Benzethonium chloride

PI Povidone iodine

HP Hydrogen peroxide

TW Tap water

BMI Body mass index

PCR O'Leary Plaque Control Record

Declarations

Ethics approval and consent to participate

Ethical approval for this study was obtained from the Medical Ethics Committee of Kyushu Dental University, Fukuoka, Japan (No. 18-68). The study was registered in the University Hospitals Medical Information Network Clinical Trials Registry (UMIN-CTR), UMIN000038544 on November 11, 2019: https://upload.umin.ac.jp/cgi-open-bin/ctr/ctr_view.cgi?recptno=R000043924.

Written informed consent was obtained from all patients.

Consent for publication

This article does not include personal information.

Availability of data and materials

The datasets collected and/or analyzed during the current study are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests.

Funding

The authors declare that they have received no funding for this study.

Authors' contributions

All authors contributed to the study conception and design. Material preparation was performed by Sakiko Soutome, Yuka Kojima, and Masahiro Umeda. Data collection was performed by Madoka Funahara, Akari Nakamura, and Hiromi Honda. Analysis were performed by Soh Inho and Naoko Hikiji. The first draft of the manuscript was written by Madoka Funahara, Akari Nakamura, and Masahiro Umeda, and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

Acknowledgements

We gratefully thank the patients for their willing participation in this study. We thank the medical staff of the Kyushu Dental University Hospital and the School of Oral Health Sciences, Kyushu Dental University. We would like to thank Editage (www.editage.com) for English language editing.

References

1. Danser MM, Gómez SM, Van der Weijden GA. Tongue coating and tongue brushing: a literature review. Int J Dent Hygiene. 2013;1:151–8.
2. Gross A, Barnes GP, Lyon TC. Effect of tongue brushing on tongue coating and dental plaque scores. J Dent Res. 1975;54:1236.
3. Abe S, Ishihara K, Adachi M. Okuda K. Tongue-coating as risk indicator for aspiration pneumonia in edentate elderly. Arch Gerontol Geriatr. 2008;47:267–75.
4. Takeshita T, Tomioka M, Shimazaki Y, Matsuyama M, Koyano K, Matsuda K, et al. Microfloral characterization of the tongue coating and associated risk for pneumonia-related health problems in institutionalized older adults. J Am Geriatr Soc. 2010;58:1050–7.
5. Quirynen M, Avontroodt P, Soers C, Zhao H, Pauwels M, Coucke W, et al. The efficacy of amine fluoride/stannous fluoride in the suppression of morning breath odour. J Clin Periodontol. 2002;29:944–54.
6. Yonezawa H, Takasaki K, Teraoka K, Asaka T, Sato C, Tsuchiya K. Effects of tongue and oral mucosa cleaning on oral candida species and production of volatile sulfur compounds in the elderly in a

nursing home. J Med Dent Sci. 2003;50:1–8.

7. Winkel EG, Roldán S, Van Winkelhoff AJ, Herrera D, Sanz M. Clinical effects of a new mouthrinse containing chlorhexidine, cetylpyridinium chloride and zinc-lactate on oral halitosis. A dual-center, double-blind placebo-controlled study. J Clin Periodontol. 2003;30:300–6.
8. Roldán S, Herrera D, Santa-Cruz I, O'Connor A, González I, Sanz M. Comparative effects of different chlorhexidine mouth-rinse formulations on volatile sulphur compounds and salivary bacterial counts. J Clin Periodontol. 2004;31:1128–34.
9. Quirynen M, Avontroodt P, Soers C, Zhao H, Pauwels M, van Steenberghe D. Impact of tongue cleansers on microbial load and taste. J Clin Periodontol. 2004;31:506–10.
10. Quirynen M, Zhao H, Soers C, Dekeyser C, Pauwels M, Coucke W, et al. The impact of periodontal therapy and the adjunctive effect of antiseptics on breath odor-related outcome variables: a double-blind randomized study. J Periodontol. 2005;76:705–12.
11. Li RX, Zhou Y, Li JL, Li J, Chen Y. Clinical study on application of Chinese herbs during the perioperative period of laparoscopic cholecystectomy. Chin J Integr Med. 2007;13:59–61.
12. Peruzzo DC, Salvador SL, Sallum AW, da Nogueira-Filho GR. Effects of sodium lauryl sulphate (SLS), present in dentifrice, on volatile sulphur compound (VSC) formation in morning bad breath. J Int Acad Periodontol. 2008;10:130–6.
13. Peruzzo DC, Salvador SL, Sallum AW, Nogueira-Filho Gda R. Flavoring agents present in a dentifrice can modify volatile sulphur compounds (VSCs) formation in morning bad breath. Braz Oral Res. 2008;22:252–7.
14. Conceição MD, Marocchio LS, Tárzia O. Evaluation of a new mouthwash on caseous formation. Braz J Otorhinolaryngol. 2008;74:61–7.
15. Tanaka M, Toe M, Nagata H, Ojima M, Kuboniwa M, Shimizu K, et al. Effect of eucalyptus-extract chewing gum on oral malodor: a double-masked, randomized trial. J Periodontol. 2010;81:1564–71.
16. Shinada K, Ueno M, Konishi C, Takehara S, Yokoyama S, Zaitsu T, et al. Effects of a mouthwash with chlorine dioxide on oral malodor and salivary bacteria: a randomized placebo-controlled 7-day trial. Trials. 2010;11:14.
17. Ramesh G, Nagarajappa R, Madhusudan AS, Sandesh N, Batra M, Sharma A, et al. Estimation of salivary and tongue coating pH on chewing household herbal leaves: A randomized controlled trial. Anc Sci Life. 2012;32:69–75.
18. Nohno K, Yamaga T, Kaneko N, Miyazaki H. Tablets containing a cysteine protease, actinidine, reduce oral malodor: a crossover study. J Breath Res. 2012;6:017107.
19. Matsui M, Chosa N, Shimoyama Y, Minami K, Kimura S, Kishi M. Effects of tongue cleaning on bacterial flora in tongue coating and dental plaque: a crossover study. BMC Oral Health. 2014;14:4.
20. Kuo YW, Yen M, Fetzer S, Lee JD, Chiang LC. Effect of family caregiver oral care training on stroke survivor oral and respiratory health in Taiwan: a randomised controlled trial. Community Dent Health. 2015;32:137–42.

21. Yadav SR, Kini VV, Padhye A. Inhibition of tongue coat and dental plaque formation by stabilized chlorine dioxide vs chlorhexidine mouthrinse: A randomized, triple blinded study. J Clin Diagn Res. 2015;9:ZC69–74.
22. Van der Sluijs E, Slot DE, Bakker EW, Van der Weijden GA. The effect of water on morning bad breath: a randomized clinical trial. Int J Dent Hyg. 2016;14:124–34.
23. Soares G, Castagna L, C Weyne L, Silva D SG, E V Falabella M, Tinoco MB. E. Effectiveness of full- and partial-mouth disinfection on halitosis in periodontal patients. J Oral Sci. 2015;57:1–6.
24. Wälti A, Lussi A, Seemann R. The effect of a chewing-intensive, high-fiber diet on oral halitosis: A clinical controlled study. Swiss Dent J. 2016;126:782–95.
25. Iwamura Y, Hayashi J, Sato T, Sato S, Murakami T, Fujimura T, et al. Assessment of oral malodor and tonsillar microbiota after gargling with benzethonium chloride. J Oral Sci. 2016;58:83–91.
26. Patil S, Acharya S, Hathiwala S, Singhal DK, Srinivasan SR, Khatri S. Evaluation of the efficacy of G32 (commercially available Ayurvedic preparation) in reducing halitosis - A randomized controlled trial. J Clin Diagn Res. 2017;11:ZC79–83.
27. Laleman I, Koop R, Teughels W, Dekeyser C, Quirynen M. Influence of tongue brushing and scraping on the oral microflora of periodontitis patients. J Periodontal Res. 2018;53:73–9.
28. Nakano M, Wakabayashi H, Sugahara H, Odamaki T, Yamauchi K, Abe F, et al. Effects of lactoferrin and lactoperoxidase-containing food on the oral microbiota of older individuals. Microbiol Immunol. 2017;61:416–26.
29. Morita Y, Ishikawa K, Nakano M, Wakabayashi H, Yamauchi K, Abe F, et al. Effects of lactoferrin and lactoperoxidase-containing food on the oral hygiene status of older individuals: A randomized, double blinded, placebo-controlled clinical trial. Geriatr Gerontol Int. 2017;17:714–21.
30. Kobayashi K, Ryu M, Izumi S, Ueda T, Sakurai K. Effect of oral cleaning using mouthwash and a mouth moisturizing gel on bacterial number and moisture level of the tongue surface of older adults requiring nursing care. Geriatr Gerontol Int. 2017;17:116–21.
31. Pham TAV, Nguyen NTX. Efficacy of chlorine dioxide mouthwash in reducing oral malodor: A 2-week randomized, double-blind, crossover study. Clin Exp Dent Res. 2018;4:206–15.
32. Moriyama S, Hinode D, Yoshioka M, Sogawa Y, Nishino T, Tangoku A, et al. Impact of the use of Kampo medicine in patients with esophageal cancer during chemotherapy:a clinical trial for oral hygiene and oral condition. J Med Invest. 2018;65:184–90.
33. Acar B, Berker E, Tan Ç, İlarslan YD, Tekçiçek M, Tezcan İ. Effects of oral prophylaxis including tongue cleaning on halitosis and gingival inflammation in gingivitis patients-a randomized controlled clinical trial. Clin Oral Investig. 2019;23:1829–36.
34. Watanabe K, Hiramine H, Toyama T, Hamada N. Effects of French pine bark extract chewing gum on oral malodor and salivary bacteria. J Nutr Sci Vitaminol (Tokyo). 2018;64:185–91.
35. Van der Sluijs E, Van der Weijden GA, Hennequin-Hoenderdos NL, Slot DE. The effect of a tooth/tongue gel and mouthwash regimen on morning oral malodour: A 3-week single-blind randomized clinical trial. Int J Dent Hyg. 2018;16:92–102.

36. Dwivedi V, Torwane NA, Tyagi S, Maran S. Effectiveness of Various Tongue Cleaning Aids in the Reduction of Tongue Coating and Bacterial Load: A Comparative Clinical Study. J Contemp Dent Pract. 2019;20:444–8.
37. Suehiro J, Yatsunami R, Hamada R, Hara M. Quantitative estimation of biological cell concentration suspended in aqueous medium by using dielectrophoretic impedance measurement method. J Phys D Appl Phys. 1999;32:2814–20.
38. Hirota K, Inagaki S, Hamada R, Ishihara K, Miyake Y. Evaluation of a rapid oral bacteria quantification system using dielectrophoresis and the impedance measurement. Biocontrol Sci. 2014;19:45–9.
39. Paster BJ, Boches SK, Galvin JL, et al. Bacterial diversity in human subgingival plaque. J Bacteriol. 2001;183:3770–83.
40. Moore WE1, Moore LV. The bacteria of periodontal diseases. Periodontol 2000. 1994; 5:66–77.

Tables

Due to technical limitations, Tables 1-3 are provided in the Supplementary Files section.

Figures

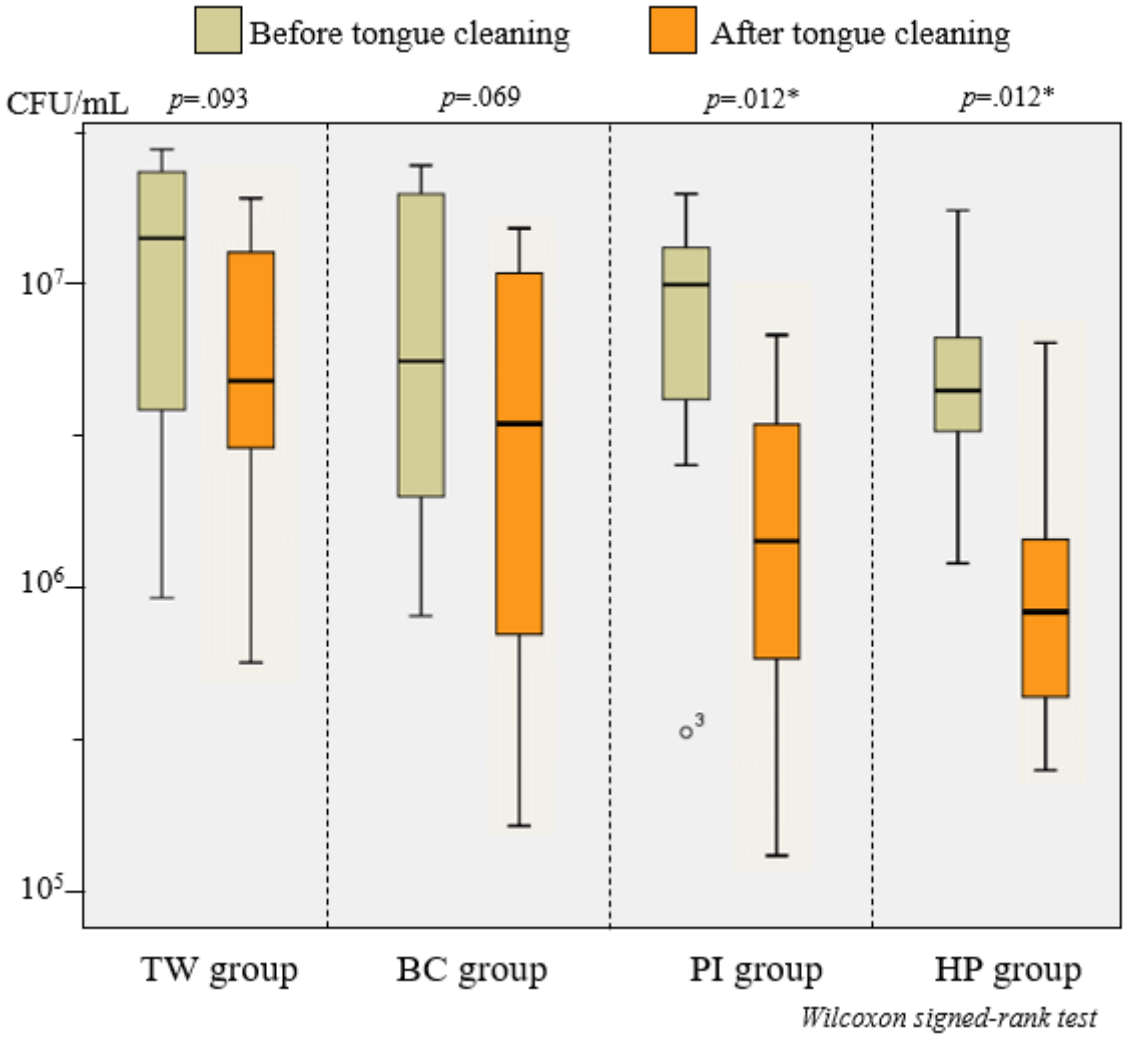

Figure 1

Number of bacteria on the tongue

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- Table3.xlsx
- Table1.xlsx
- Table2.xlsx