Meta-analysis

Effects of mechanical tongue cleaning on halitosis: A meta-analysis

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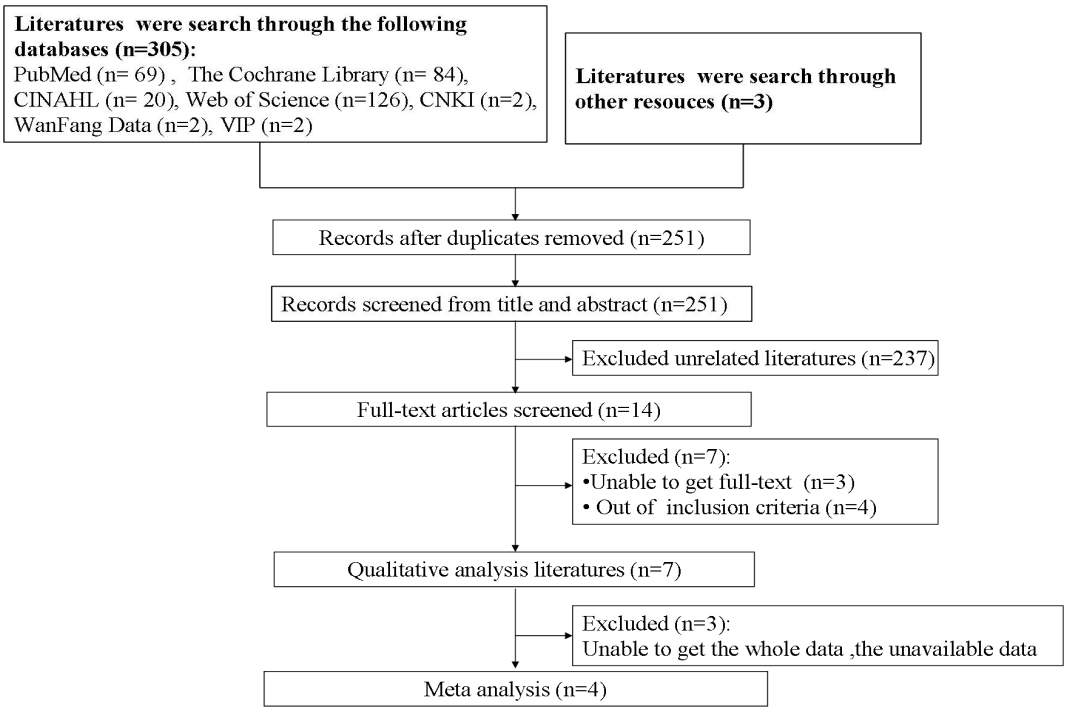
Highlights

This meta-analysis systematically evaluatd the efficacy of mechanical tongue cleaning on halitosis, and showed that treatment combined with mechanical tongue cleaning could reduce risks of halitosis and Winkel Tongue Coating Index.

Editor's Summary

Mechanical tongue cleaning is effective in reducing volatile sulphur compounds. However, there is insufficient evidence indicate the effective of mechanical tongue cleaning on preventing halitosis. This article found that mechanical tongue cleaning could reduce Winkel Tongue Coating Index and improve improve overall oral health condition.



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ABSTRACT

Objective: To systematically review the effects of mechanical tongue cleaning on halitosis. **Methods:** Searching and collecting the RCTs about treatment combine with mechanical tongue cleaning from inception to May 2017 in the databases, like CNKI, VIP, WanFang Data, PubMed, the Cumulative Index to Nursing and Allied Health Literature, The Cochrane Library, Web of Science. Two reviewers screened the literatures according to inclusion and excluding criteria, extracted the data independenly, assessed bias risks. In case of disagreement, the discussion shall be settled by the third reviewer. Meta-analysis was conducted by RevMan 5.3. **Results:** A total of 4 RCTs with 185 volunteers were included. The results of Meta-analysis showed that treatment combine with mechanical tongue cleaning has an advantage over the control group in the levels of Winkel Tongue Coating Index [MD = 2.15, 95%CI(0.93,3.36), = 0.0006], Organoleptic Assessment [MD = -0.71, 95%CI(-0.95,-0.48), ＜ 0.00001], but no significant differences between two groups in Volatile Sulphur Compounds [SMD = -1.13, 95%CI(-2.91,0.65), = 0.21], Bleeding On Probing [MD = -1.01, 95%CI(-7.05,5.03), = 0.74]. **Conclusion:** Treatment combined with mechanical tongue cleaning could reduce risks of halitosis and Winkel Tongue Coating Index.

Key words: Mechanical tongue cleaning, Halitosis, RCT, Meta-analysis

摘要

目的：系统评价机械性舌部清洁对口臭的影响。

方法：从 CNKI，VIP，万方数据，PubMed，CINAHL，Cochrane Library，Web of Science 等数据库中检索和收集各数据库从建库到 2017 年五月发表的、有关机械性舌部清洁对口臭影响的随机对照试验。两名研究员根据纳入和排除标准筛选文献，独立提取数据，评估偏倚风险。如有不同意见，由第三位研究员裁决。采用 RevMan5.3 软件进行 Meta 分析。

结果：总共纳入 4 项随机对照试验，包括 185 名研究对象。Meta 分析结果显示，采用机械性舌部清洁的患者，温克尔舌苔指数[MD = 2.15, 95%CI (0.93, 3.36), = 0.0006]和口腔感官性评价[MD = -0.71, 95%CI (-0.95, -0.48), ＜0.00001] 明显优于对照组，但是挥发性硫化物和探诊出血与对照组没有显著的差别。

结论：结合机械清洗舌苔的治疗可以减少口臭和温克尔舌苔指数。

关键词：机械性舌部清洁；口臭；随机对照试验；Meta 分析

关键词：机械性舌部清洁；口臭；RCT；Meta 分析

Abbreviations: VSCs, Volatile sulphur compounds; WTCI, Winkel Tongue Coating Index; RCTs, Randomized controlled trials; ORG, Organoleptic Assessment; BOP, Bleeding On Probing.

Competing interests: The authors declare that there is no conflict of interests regarding the publication of this paper.

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1. Introduction

Halitosis is commonly known as an unpleasant and repulsive odor emanating from the mouth, nasal cavity, pharynx [1]. Of the halitosis, 80% - 90% depend on the health condition of the whole mouth [2]. Under the action of bacterias, food debris in mouth get spoilage, digest and produce volatile sulphur compounds (VSCs), such as Methyl mercaptan, dimethyl sulphide, hydrogen sulfide. Moreover, the development of halitosis is closely related to the thickening of tongue coating, periodontitis, oral candidiasis and so on [3-4]. National epidemiological surveys have shown that halitosis prevalence rates as high as 30% [5-7]. 30 percents of all American, about 90 million people were suffering from halitosis [5]. In Japan, bad breath ranked fourth in oral hygiene problems. It was reported that 37% of Japanese complained of halitosis. As a research in a sample of 805 Chinese white-collar individuals shown, the prevalence of oral malodor was 33.2% [8]. Bad breath seriously affects the normal interpersonal communication, social interaction and quality of life and other aspects of people's life. An early study published in the Cochrane Libirary in 2006 which meta analyzed 2 clinical randomized controlled trials (RCTs) of mechanical tongue cleaning demonstrated that mechanical tongue cleaning was effective in reducing VSCs. However, there is insufficient evidence indicated the effective of mechanical tongue cleaning on preventing halitosis [9]. We conducted systematic review and meta-analysis to analyze the present clinical randomized controlled trials and investigate the effects of mechanical tongue cleaning.

2. Materials and methods

2.1 Inclusion criteria

(1) Patients. Patients with halitosis. No limits to ages, gender and ethnic.

(2) Intervention. The control group: tooth brushing. The trial group: tooth brushing plus mechanical tongue cleaning. Mechanical tongue cleaning includes mechanical tongue brushing and mechanical tongue scraping.

(3) Primary outcomes. Winkel Tongue Coating Index (WTCI), VSCs, Organoleptic Assessment (ORG), Bleeding On Probing (BOP).

(4) Study type. RCTs which were written in Chinese or English published publicly in major databases at home and abroad. No limits to blind and allocation concealment.

2.2 Exclusion criteria

(i) Redundant publication; (ii) Self-comparison; and (iii) The articles were incomplete and unusable.

2.3 Search strategy

In May 2017, two researchers searched CNKI, VIP, WanFang Data, PubMed, CINAHL, The Cochrane Library, Web of Science for articles. The databases were searched up to and including May 2017 using the search terms presented in Box 1.

Box 1.Search Strategy for Studies on Inter-examiner Reliability Using Medical Subject Headings and Text Words

#1 tongue clean* OR tongue scrap* OR tongue brush* OR tooth brush* OR oral hygiene OR mouth hygiene OR TS OR TB

#2 morning breath odour OR halitosis OR oral malodor OR bad breath OR volatile sulfide compounds OR VSC OR hydrogen sulfide OR methyl mercaptan OR dimethyl sulfide

#3 tongue coating OR tongue coating score

#4 random*

#5 #2 OR #3

#6 #1 AND #4 AND #5

2.4 Literatures screening and data extraction

Two researchers used the same search strategy, searched and screened the literature independently, and then extracted and cross-checked the original data. If there is a disagreement, the discussion will be settled or settled by a third researcher. Finally, we formed a document extraction form. The contents of literature extraction includes as following aspects: the basic information of literatures enrolled, such as the title, the date of publication, first author, the journal; the basic features of participants, such as sample size, ages, country, the ratio of male to female; details of the intervention: intervention program, frequency, the procedure duration, intervention periodicity; primary outcomes, such as WTCI, VSCs, Organoleptic Assessment, BOP. The key elements of bias risk assessment.

2.5 Bias risk assessment

According to RCTs bias risk assessment in Cochrane Handbook (5.1.0), two reviewers used the tool to evaluate literatures [10].

2.6 Statistic analysis

We used RevMan 5.3 to meta analyze the data. In our study, we used common effect sizes, such as mean and standard deviation. We analyzed the heterogeneity of data using chi-square test. It was accepted and analyzed by fixed-effect model when $P > 0.1$, $I^2 < 50\%$. Conversely, there was heterogeneity among the data. We needed to analyze the origin of clinical and methodological heterogeneity, used random-effect model to combined effect. When the heterogeneity is obvious, subgroup analysis, sensitivity analysis or descriptive analysis would be used.

3. Results

3.1 Results of literatures search

Through primary search, we get 305 literatures. Through hand search, we got 3 literatures. Combined two ways of search, there were 308 literatures. Removing duplicates

and narrowing down, 4 concerning inclusion criteria were selected for summarized and analyzed. The search and selected progress of literatures was presented in Figure1.

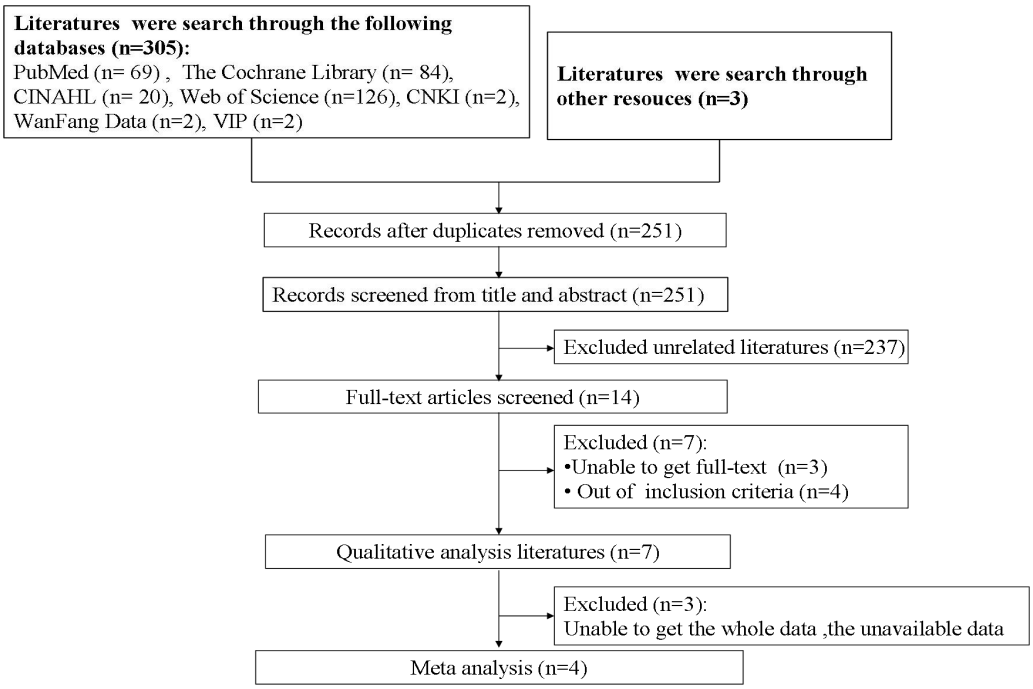

Figure 1: The search and selected progress of literatures.

3.2 Basic characters of literatures included and results of bias risk assessment

We included 4 articles which contained 5 RCTs [11-14]. The publication time ranged from 2006 to 2017. Finally, 185 patients were included in total across the 5 RCTs. Four RCTs reported the percentage of males and females [11, 13, 14]. The ages of sample ranged from 5 to 37 years old. One research study was to expand from the children [13]. The objects of other RCTs were adult patients [11, 12, 14]. Two RCTs were conducted in Asian nations, like China and Japan [12, 14], and two RCTs were conducted in Brazil [11], and one RCT was conducted in Turkey [13]. Basic characters of literatures included were presented in Table 1.

According to RCTs bias risk assessment in Cochrane Handbook (5.1.0), four articles were evaluated by two reviewers. 4 articles adopt a method to random groups of patients [11-14]. One RCT divided 30 patients into treatment group and control group with every 15 patients, according to random number table [12]. One RCT clearly stated that patients were divided into groups by using draw lots [14]. Only one article was unclear in reporting blinding [14]. Three articles were evaluated by single blinded. No articles have patients drop out [11-13]. Results of bias risk assessment were presented in Table 2.

3.3 Results of Meta analysis

(1) Volatile sulfide compounds. Three articles reported their findings that for 155 halitosis patients contrasted mechanical tongue cleaning with tooth brushing on the effect of VSCs [11, 13, 14]. The follow-up time and the unit of major outcomes which were inconsistent, we used the standardized mean difference and random-effect model ($P < 0.00001$, $I^2 = 95\%$) to merge the results showed that both groups reduced VSCs and no significant difference compared with the control group [SMD = -1.13, 95%CI (-2.91, 0.65), $P = 0.21$] (Figure 2). Nevertheless, results lowering of VSCs was more effective in mechanical tongue cleaning group than control group.

(2) Winkel Tongue Coating Index. Two articles reported their findings that for 99 halitosis patients contrasted mechanical tongue cleaning with tooth brushing on the effect of VSCs [12-13]. We used fixed-effect model ($P = 0.64$, $I^2 = 0\%$) to merge the results showed that combined tooth brushing and mechanical tongue cleaning was superior to tooth brushing on reducing tongue coating and there was significant difference compared with the control group [MD = 2.15, 95% CI(0.93, 3.36), $P = 0.0006$] (Figure 3). Therefore, the combined application of tooth brushing and mechanical tongue cleaning could reduce tongue coating.

(3) Organoleptic Assessment. One articles showed results that the both groups affected ORG [11]. We used fixed-effect model ($P = 0.84$, $I^2 = 0\%$) to analyze the data as follows: compared with the control group, the combined application of tooth brushing and mechanical tongue cleaning had an advantage and there was significant difference in both groups [MD = -0.71, 95%CI (-0.95, -0.48), $P < 0.00001$] (Figure 4). Therefore, the combined application of tooth brushing and mechanical tongue cleaning could reduce the scores of organoleptic assessment.

(4) Bleeding On Probing. Two articles showed results that the both groups affected BOP [12-13]. We used fixed-effect model ($P = 0.44$, I2 = 0%) to analyze the data as follows: about BOP, there was no significant difference

Table 1: Basic Characters of Literatures Included

Study	Age	Male (%)	Sample		Intervention		Details of Intervention				Outcomes	Country
			T	C	T	C	Frequency	Duration	Measure time	Follow -up		
Faveri 2006 (a) [11]	19-22	31.57	19	19	B+TS	B	TID	n.r.	n.r.	1w	①③	Brazil
Faveri 2006 (b) [11]	19-22	31.57	19	19	B+TS+DF	B+DF	TID	n.r.	n.r.	1w	①③	Brazil
Aung 2015 [12]	19.8±2.9	n.r.	15	15	B+TB	B	BID	30s	14:00-17:00	2w	②④	Japan
Ileri 2015 [13]	5-12	43.48	34	35	B+TB	B	BID	n.r.	9:00-11:00	2w	①②④	Turkey
Wang 2017 [14]	24-37	20.00	5	5	B+TS	B	BID	n.r.	8:30-10:00	8w	①	China

T: Trial Group; C: Control Group; B: Tooth Brushing; TB: Tongue Brushing; TS: Tongue Scraping; DF: Dental floss; BID: Two times a day; TID: Three Times a day; ①: VSCs; ②: WTCI; ③:ORG; ④:BOP; n.r. = not reported.

Table: 2 Assessment of Bias Risk

Study	Randomization	Allocation	Blinded	Integrity of outcomes	Selective reporting	Other origin of risk
Faveri 2006[11]	Unclear	Unclear	Single blinded	Integral	No	Unclear
Aung 2015[12]	Random number table	Unclear	Single blinded	Integral	No	Unclear
Ileri 2015[13]	Unclear	Unclear	Single blinded	Integral	No	Unclear
Wang 2017[14]	Unclear	Unclear	Unclear	Integral	No	Unclear

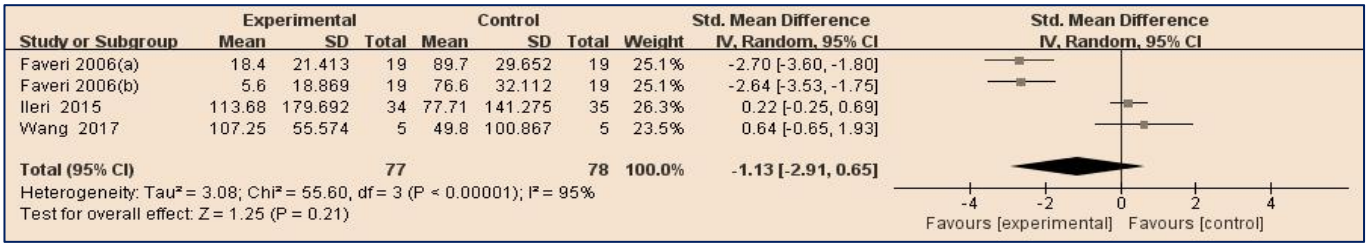

Figure 2: Mechanical tongue cleaning affects VSCs.

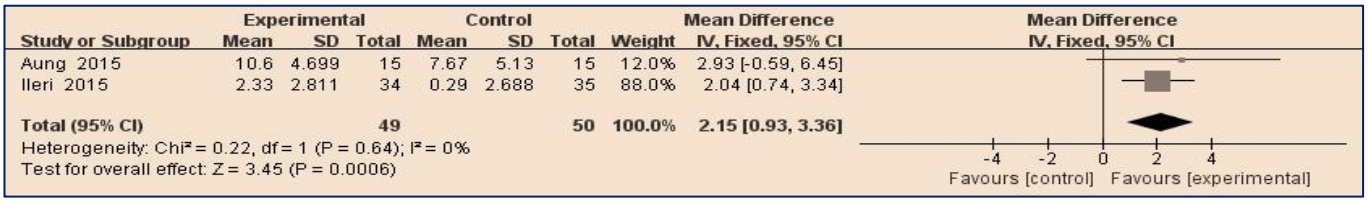

Figure 3: The combined application of tooth brushing and mechanical tongue cleaning affects WTCI.

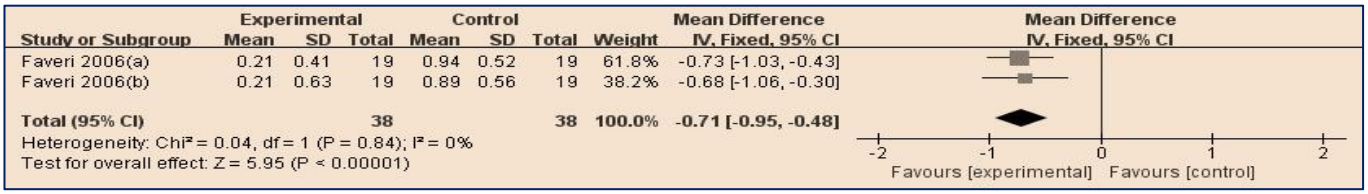

Figure 4: The combined application of tooth brushing and mechanical tongue cleaning affects ORG.

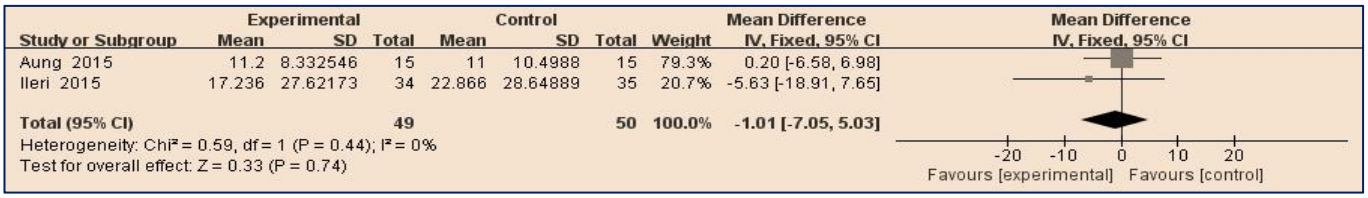

Figure 5: The combined application of tooth brushing and mechanical tongue cleaning affects BOP.

in both groups [MD = -1.01, 95%CI (-7.05, 5.03), *P* = 0.74] (Figure 5). Therefore, the combined application of tooth brushing and mechanical tongue cleaning had little effect on BOP.

4. Discussion

Our systematic review and meta analysis on the effects of mechanical tongue cleaning on halitosis showed that mechanical tongue cleaning included tongue brushing and tongue scraping could lower the VSCs, WTCI and improve periodontal status. So that, mechanical tongue cleaning could prevent bad breath and improve patients' life. Although, there was no significant statistical difference in two groups on the indexes of WTCI, ORG and BOP. But the experiment group was superior to the control group.

Although, Keceli and Kuo both evaluated the test results systematically with flaws, such asnon-random controlled trials, low quality of evaluated articles, incomplete date and primary outcomes [15-16]. On this basis, this study eliminated non-random controlled trials. Finally, 4 articles contained 5 RCTs were selected for

summarized. Cochrane Handbook was be used to define methodological quality in the meta-analysi. All inclusion articles provided complete data, baseline characteristics were comparable. But no articles describe how to perform an adequate allocation and conceal the sequence. Two articles reported methods of randomization [12, 14], three articles were single-blind-random tests [11-13]. While a statistically significant result may indicate a problem with heterogeneity affected the reliability of the results for some reasons as follows: Inclusion articles and sample size were little in number, primary outcomes were not intensively, intervention programs were inconsistent.

Intervention programs were used for further analysis to get intervention program, frequency, the procedure duration, intervention periodicity and so on. Three article applied mechanical tongue cleaning in adult patients [11, 12, 14], only one articles applied mechanical tongue cleaning in children [13]. Three trials used tongue scraper [11, 14], two trials used toothbrush to clean the tongue [12-13]. Mechanical tongue cleaning could be applied once or twice a day, continued for about 30s per time. Usually, bad breath appears in morning. Therefore, main outcomes were measured majority in morning. Most researchers deemed mechanical tongue cleaning could make the oral cavity remain clean, but over a period of time without cleaning, dental hygiene would get the initial condition of oral. All trails obtain the revisit, the mean follow-up time were one or two weeks, shortest for 3 days. It was recommended that intervention programs must be modified according to different groups (age, gender etc.). This would be a beneficial attempt to standardization and scientization of management of theoral nursing care.

4.1 Meta-analysis of the combined application of tooth brushing and mechanical tongue cleaning affects bad breath

VSC is the main ingredient of bad breath, could be tested through ORG and Halimeter®. ORG was an easy way to test, but Halimeter® provided more accurate and credible data. Two trails used ORG to assess halitosis and proved that mechanical tongue cleaning could ease bad breath [11]; four trails provided oral health education and reminded some of the attention of oral health in systematic and effective way before using Halimeter® to test VSCs [11, 13, 14]. Tonzetich and Faveri demonstrated that tongue scraping and tongue brushing can lower VSC concentration, subsequently reducing oral malodor [15, 16]. Tongue scraping could lower more VSCs by 75%. Tongue brushing may cause nausea, trauma and so on. We performed a meta-analysis of 4 RCTs to survey whether there was a significant statistical difference in lower VSCs between two groups. Although it proved that there was no significant statistical difference between two groups, but the combined application of tooth brushing and mechanical tongue cleaning could achieve better clean result in lower VSCs and prevent oral malodor. So, it would be necessary perform a comparative analysis between tongue scraping and tongue brushing in battling bad breath.

4.2 Meta-analysis of the combined application of tooth brushing and mechanical tongue cleaning affects WTCI

Previous studies suggested that tongue coating was the main source of bad breath [19]. WTCI was positively correlated with the level of VSCs [20]. Because of the surface of the tongue nipple and inadequate cleaning, food particles and bacterias could be left on the back of tongue [21-22]. The back of tongue, particularly the rear part, became the main source of VSC and anaerobic bacterias [21]. Proper oral care could reduce WTCI and the risk of pneumonia [23]. Mechanical tongue cleaning was recommended as a supplement in oral care to reduce tongue coating and bad breath which was consistent with the results of meta-analysis in this study [20, 24]. Since the accretion of tongue coating, we suggested that it would be essential that performing mechanical tongue cleaning the same frequency as brushing tooth which could reduce WTCI and prevent oral malodor.

4.3 Meta-analysis of the combined application of tooth brushing and mechanical tongue cleaning affects BOP

Several articles demonstrated the relationship between periodontitis and bad breath [3-5, 20, 21]. At present, most studies believed that they influence each other. BOP was an important indicator of periodontal disease. Two trails reported that those in trial group concomitantly received tongue brushing for twice a day with 2 weeks follow-up time [12-13]. Thus, we could draw a conclusion that tongue brushing had no influence on BOP. Since relevant domestic research datas were less, we suggested that BOP could be the primary counter to observe in the future research. So that, we could explore the relationship between tongue brushing and periodontal disease.

5. Conclusion

In conclusion, we systematically reviewed and meta analyzed the combined application of tooth brushing and mechanical tongue cleaning on oral malodor to prove that this method could reduce VSCs, WTCI and improve improve overall oral health condition. Meanwhile the specification of tongue cleaning operation time and frequency could help keep oral cavity in good condition. Owing to methodological quality and limitations of study design, we are looking forward to get the large samples data, multi-center RCTs, more strictly design and higher methodological quality to verify the results from this study.

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