

## The effect of chlorhexidine mouthwash on plaque accumulation in fixed orthodontic appliance users

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### Abstract

**Background:** The use of fixed orthodontic appliances can affect oral health as it may hinder proper tooth brushing and limit areas of the teeth with low saliva flow, increasing the likelihood of bacterial attachment and biofilm (plaque) formation. The use of chlorhexidine (CHX) mouthwash is one way to reduce plaque accumulation in the oral cavity.

**Objective:** The aim of this article is to assess the impact and mechanism of CHX mouthwash on the oral health of users of fixed orthodontic appliances, particularly in terms of plaque accumulation.

**Results:** Ten articles met the criteria and were used as secondary data in this article. The research types varied from randomized controlled trials (RCTs), cross-sectional studies, to literature and systematic reviews. Users of fixed orthodontic appliances are at high risk for plaque formation, even with regular tooth brushing. CHX mouthwash can significantly reduce the number of bacterial colonies responsible for plaque formation in orthodontic users.

**Conclusion:** CHX mouthwash is considered an effective material to reduce plaque in users of fixed orthodontic appliances. However, the dosage of CHX should be carefully considered to minimize side effects.

**Keywords:** Chlorhexidine; Mouthwash; Plaque; Fixed orthodontic appliance

### 1. Introduction

The use of orthodontic appliances aims to achieve good occlusal function and dental aesthetics. Several factors must be considered during orthodontic treatment, one of which is oral hygiene. Fixed orthodontic appliances, due to the presence of brackets and wires, facilitates the accumulation of food debris and causes certain areas to receive minimal saliva flow, leading to the formation of biofilm. This also makes oral cavity cleaning, such as tooth brushing, more difficult [1][2]. The presence of plaque around fixed orthodontic appliances can cause several issues in the oral cavity, including white spot lesions (WSL) and tooth decay [3].

The side effects of orthodontic treatment related to biofilm are common and can significantly affect the quality of treatment outcomes as well as the patient's quality of life. Therefore, it is important for dentists to gain insight into where dental biofilm accumulates. Understanding the locations at risk for biofilm formation can assist orthodontists and patients when implementing preventive strategies to minimize the development of white spot lesions (WSL) [4].

The most effective strategy for minimizing plaque formation involves mechanical interventions. Brushing and flossing are well-established methods for maintaining oral hygiene by effectively cleaning the oral cavity. Additionally, supportive measures such as rinsing with mouthwash can complement these practices to enhance overall oral health [1].

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Mouthwash has therapeutic functions that can reduce plaque, decrease gum inflammation, address tooth decay, and can also be used in surgical procedures [5]. CHX is a commonly used antimicrobial in mouthwash. CHX can combat various microorganisms, including gram-negative bacteria, gram-positive bacteria, and fungi. Its minimal side effects make CHX a preferred antimicrobial choice used by many clinics and hospitals for years [6].

## 2. Material and method

Data collection was carried out through databases such as PubMed, Google Scholar, ScienData collection was carried out through databases such as PubMed, Google Scholar, ScienceDirect, and other relevant sources over the past 10 years, from 2013 to 2023. The keywords used in the data search were "Chlorhexidine," "fixed orthodontics," and "plaque accumulation." Inclusion criteria: (1) Studies published in both Indonesian and English; (2) Studies focused on the effect of CHX mouthwash on plaque accumulation in users of fixed orthodontic appliances. Exclusion criteria: (1) Studies with irrelevant titles; (2) Studies unrelated to the effect of CHX mouthwash on plaque accumulation in users of fixed orthodontic appliances. The articles obtained were then examined, including the removal of duplicate articles across the two databases, the relevance of the publication year, the relevance of the research topic, and the suitability of the research findings for this literature review. The final result of the examination was 10 articles, which will be used as secondary data in this article.

## 3. Result

Table 1 shows the data extracted from the 10 articles used in this review. These articles provide data to complement the discussion on the effect of CHX-based mouthwash on the oral health of users of fixed orthodontic appliances, specifically regarding plaque accumulation, which will be discussed in more detail in the discussion section.

**Table 1** Effect of CHX-based mouthwash on oral health of fixed orthodontic appliance users in terms of plaque accumulation

No.	Author	Method	Parameter	Hasil
1	Mei, <i>et al.</i> (2017)	Cross-sectional study	Plaque accumulation in fixed orthodontic appliance users	Patients using fixed orthodontic appliances had the highest plaque accumulation on maxillary lateral incisors and maxillary canines, especially in the gingival area and the area behind the wire arch. Less plaque was found in female patients, adults, and in patients who brushed more frequently.
2	Shilpa, <i>et al.</i> (2019)	Randomized controlled trial	Plaque index in fixed orthodontic appliance users	Of the three interventions performed, namely regular toothbrushing, more powerful toothbrushing, and toothbrushing combined with using CHX mouthwash, the plaque index in the group of subjects who brushed their teeth and also used CHX mouthwash showed lower results than the other two groups.
3	Al-Sayagh, <i>et al.</i> (2013)	Randomized controlled trial	Effects of CHX mouthwash on plaque and gingival index in fixed orthodontic users	The use of CHX-based mouthwash reduced bacterial plaque accumulation, pocket depth and improved gingival index. The results showed that plaque and gingival indices on days 0, 14 and 30 decreased substantially on average. CHX mouthwash is recommended by orthodontists to be used once a day as a supporting treatment for fixed orthodontic users in addition to brushing and flossing.
4	Dehghan <i>i, et al.</i> (2019)	Randomized controlled trial	Comparison of plaque accumulation and gingival condition in fixed orthodontic appliance users using	CHX is the gold standard in studies focusing on the effects of mouthwash. In this study, the effect of CHX mouthwash was slightly better than propolis mouthwash. Both resulted in a significant reduction in all three gingival health

			propolis and CHX mouthwash	indices studied, one of which was the plaque index.
5	Yeturu, et al. (2015)	Randomized controlled trial	Comparison of plaque and gingival scores after the use of aloe vera, chlorine dioxide, and CHX mouthwash in fixed orthodontic users	There was a significant reduction in the mean plaque and gingival scores in the aloe vera, chlorine dioxide, and CHX mouthwashes compared to the baseline scores. A significantly higher reduction in plaque and gingival scores was found in the CHX mouthwash compared to the aloe vera group.
6	Deus & Ouanounou. (2022)	Literature review	CHX pharmacology, uses and side effect	The antimicrobial properties of CHX make it an ideal prophylaxis when mechanical debridement is not possible. CHX mouthwash is seen to be more effective than the gel. Concentrations of 0.12% to 0.2% are recommended; any mouthwash with concentrations above 0.2% will unnecessarily increase unwanted side effects.
7	Leonarto & Habar. (2017)	quasi-experimental	Effect of CHX on plaque-causing bacterial colony counts in fixed orthodontic users	CHX has the ability to reduce the number of plaque-causing bacterial colonies in users of fixed orthodontics. Mouthwash containing CHX 0.2% significantly affects the number of plaque-causing bacterial colonies in users of fixed orthodontics ( $p < 0.05$ ) with a percentage reduction of 61.84% within 14 days. .
8	Karaman i, et al. (2022)	Systematic review	Effect of CHX mouthwash on plaque and gingivitis of fixed orthodontic users	CHX mouthwash led to reduced plaque accumulation and gingival inflammation during orthodontic treatment. However, at the same time, some control group mouthwashes were considered equally effective.
9	Sobouti, et al. (2018)	Randomized controlled trial	Comparison of plaque index in fixed orthodontic appliance users using CHX mouthwash and herbal mouthwash	Both mouthwashes demonstrated comparable efficacy, outperforming the placebo in reducing Plaque Index (PI) and Gingival Bleeding Index (GBI). A reduction in plaque accumulation and gingival bleeding was observed in patients using both CHX mouthwash and Persica herbal mouthwash.
10	Hussain, et al. (2022)	Randomized clinical trial	Effects of CHX on periodontal tissue health of orthodontic appliance users	The use of CHX mouthwash during fixed orthodontic appliance treatment has been shown to effectively reduce gingival inflammation, improve plaque control, and decrease pocket depth. However, its use requires careful consideration, particularly in pediatric and adult orthodontic patients. Recommendations should account for variability in patient responses, cost-effectiveness, and the potential for adverse effects.

#### 4. Discussion

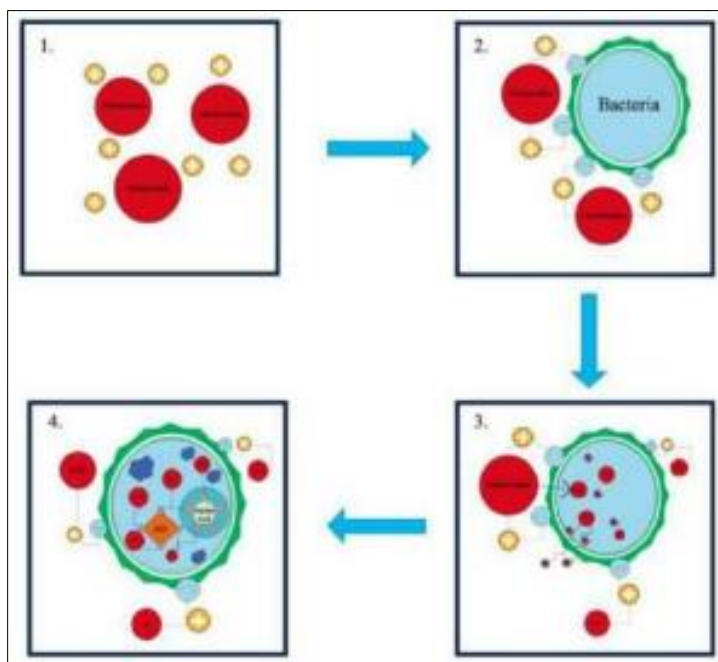
The use of fixed appliances in the oral cavity not only increases the formation of biofilm but also raises the number of acidogenic bacteria within the biofilm, resulting in a higher cariogenic challenge around the brackets and orthodontic bands. If patients are unable to maintain good oral hygiene during orthodontic treatment, the acids produced by the bacteria in the dental biofilm will eventually lead to enamel demineralization and the formation of white spot lesions

(WSL). While some superficial soft WSLs can remineralize, most will persist even after the removal of the fixed appliances [4].

The study conducted by Shilpa et al [7] showed that both plaque index and gingival index significantly decreased at both 1-month and 2-month intervals in subjects who used manual toothbrushes combined with mouthwash, compared to those who only brushed their teeth at the same intervals. Gingival bleeding scores also significantly decreased at 1 month and 2 months compared to baseline, although there was no significant difference between the 1-month and 2-month intervals. Similar results were found in studies conducted by Dehghani et al [8], Sobouti et al [9], and Al-Sayagh et al [10], which showed a decrease in plaque index in orthodontic patients using CHX mouthwash.

A study by Yeturu et al [11] evaluated the effectiveness of Aloe vera mouthwash, CHX, and chlorine dioxide on plaque and gingivitis over a 15-day period in patients undergoing fixed orthodontic treatment. The antimicrobial action of CHX has been proven in many studies. The mechanism of action of CHX primarily involves binding to microbial cell membranes and disrupting the surface structure, causing osmotic imbalance and cytoplasmic precipitation, which leads to cell death.

CHX mouthwash has been extensively studied and proven to be the most effective plaque and gingivitis agent currently available [12]. Deus and Ouanounou [13] stated in their research that CHX demonstrates rapid antimicrobial and antifungal activity, and CHX can maintain its effectiveness even at low concentrations. CHX can affect both aerobic and anaerobic bacteria. It can destroy DNA and RNA viruses and inactivate lipophilic enveloped viruses. Below is the mechanism of action of CHX in combating bacteria.



**Figure 1** MoA (*mechanism of action*) dari CHX (Deus & Ouanounou, 2021)

In stage 1, CHX, which carries a positive charge, is attracted to the negative charge on the bacterial cell wall. Next, CHX forms specific and strong adsorption on the molecules located on the bacterial cell surface. Stage 3 is the bacteriostatic phase, where CHX penetrates through the bacterial cell wall and disrupts the integrity of the bacterial cell wall. This leads to the leakage of low-molecular-weight cytoplasmic components, such as potassium ions, and inhibition of the activity of several enzymes associated with the cytoplasmic membrane. The next stage is the bactericidal phase. In stage 4, cytoplasmic coagulation and precipitation occur

by forming complexes with phosphorylated compounds, such as adenosine triphosphate (ATP) and nucleic acids [13].

According to a study by Leonarto and Habar [14], CHX has the ability to reduce the number of plaque-causing bacterial colonies in users of fixed orthodontic appliances. The percentage reduction in plaque-causing bacterial colonies was 61.84% on day 14, 31.32% on day 7, and 44.43% between days 7 and 14. The longer CHX mouthwash is used, the higher

the percentage of reduction in plaque-causing bacterial colonies, indicating a positive effect on the oral hygiene of patients.

Karamani et al [1] conducted a study to summarize the available data on the effects of chlorhexidine (CHX) mouthwash in treating gingivitis during treatment with fixed orthodontic appliances. The experimental solutions were 0.06%, 0.12%, or 0.2% CHX mouthwash, with a control group that included either placebo mouthwash or a selection of various other mouthwashes. The duration of treatment ranged from 1 day to nearly 5 months, and the follow-up period varied from 1 minute to 5 months. [1], CHX mouthwash resulted in reduced plaque accumulation and gingival inflammation during orthodontic treatment. However, some of the control group mouthwashes were considered equally effective. A similar study was conducted by Hussain et al [15], with the aim of assessing the efficacy of CHX-containing mouthwash in maintaining gingival health among orthodontic patients with fixed appliances. The use of CHX mouthwash during fixed appliance treatment was associated with improved gingival inflammation, plaque control, and pocket depth. However, caution and recommendations regarding the use of CHX during orthodontic treatment are necessary. The dosage for both children and adults should be considered based on the heterogeneous patient response, cost-effectiveness, and potential side effects [15].

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## 5. Conclusion

CHX mouthwash is considered an effective material for reducing plaque in users of fixed orthodontic appliances. However, the dosage of CHX should be carefully considered to minimize potential side effects.

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## Compliance with ethical standards

### *Disclosure of conflict of interest*

No conflict of interest to be disclosed.

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