Review Article

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Quick Response Code:

Website: www.jorthodsci.org

DOI: 10.4103/jos.jos_116_23

Effectiveness of fluoride mouthrinse in prevention of demineralization during fixed orthodontic treatment: A systematic review and meta-analysis

Awanindra Kumar Jha, Amit Vasant Mahuli[1], Santosh Kumar Verma[2], Surender Kumar[3], Om Prakash[4], Subia Ekram[4], Ankita Mathur[5] and Vini Mehta[5]

Departments of Orthodontics, [1]Public Health Dentistry, [2]Periodontics, [3]Prosthodontics and [4]Oral and Maxillofacial Surgery, Dental Institute, Rajendra Institute of Medical Sciences, Ranchi, Jharkhand, [5]Department of Dental Research Cell, Dr. D.Y. Patil Dental College and Hospital, Pimpri, Pune, Maharashtra, India

Address for correspondence:
Dr. Awanindra Kumar Jha, Department of Orthodontics and Dentofacial Orthopaedics, Room No-08, Dental Institute, Rajendra Institute of Medical Sciences, Ranchi - 834 009, Jharkhand, India.
E-mail: mybraces@yahoo.com

Submitted: 17-Jun-2023
Revised: 05-Sep-2023
Accepted: 05-Jan-2024
Published: 08-May-2024

Abstract

Enamel demineralization is a very common occurrence around bonded brackets in an orthodontic practice. Fluoride (FLR) applications have been used to prevent decalcification and further progression of white spot lesions. The purpose of this systematic review and meta-analysis was to systematically appraise available literature on the effectiveness of fluoride mouthrinse in the prevention of demineralization around fixed orthodontic appliances. A search was conducted for randomized controlled clinical trials among four electronic databases (MEDLINE, Google Scholar, PubMed, and Cochrane Review) through MeSH terms and keywords. Studies were excluded if random allocation was not conducted, or if they were animal or *in vitro* studies.About 146 articles were screened and 5 studies were selected for the present review. Only two studies were selected for MA due to variations in the measurement of outcomes among studies. This review concluded that rinsing with FLR in the course of the fixed orthodontic treatment lessens demineralization around the bracket. Using FLR mouthrinse to inhibit the formation of white spot lesions or dental caries in patients with multiple cavities or restoration can be considered in clinical practice.

Keywords:

Demineralization, fixed orthodontic treatment, fluoride mouth rinse, white spot lesions

Introduction

Enamel demineralization is a very common occurrence around bonded brackets in an orthodontic practice.[1] These decalcified enamels have a white chalky appearance and are termed white spot lesions (WSLs).[1,2] WSLs are the first sign of a carious lesion that is visible to the naked eye and used amongst terms such as incipient lesions.[2-4] WSLs are caused by an imbalance between the enamel's demineralization and remineralization processes, which is the outcome of a dietary carbohydrate- and saliva-modified bacterial infection. This is an interrupted process with periods of remineralization and demineralization, depending on the oral environment, bacterial plaque accumulation on the enamel surface, oral hygiene, and individual resistance.[2,5,6] Most patients require orthodontic treatment for aesthetic purposes but unfortunately at the end of the treatment span, WSL is commonly observed. Such patients are then advised restorative treatments, creating an additional financial burden for them.[7-9] Some patients undergoing fixed orthodontic treatment (FOT) have to discontinue treatment due to multiple caries.[9] WSL prevalence following the completion of orthodontic treatment is from 40% to 90%, leading researchers to develop a solution for the same.[10]

How to cite this article: Jha AK, Mahuli AV, Verma SK, Kumar S, Prakash O, Ekram S, *et al*. Effectiveness of fluoride mouthrinse in prevention of demineralization during fixed orthodontic treatment: A systematic review and meta-analysis. J Orthodont Sci 2024;13:22.

The prevention of demineralization and the promotion of remineralization of existing WSLs are both important aspects of the overall management of WSLs. Although it can be difficult to successfully treat patients who have already accumulated a substantial number of WSLs, preventative treatments should be given priority.[11] Most orthodontists think twice before advising FOT to patients who are unable to maintain oral hygieneas they create stagnation areas for plaque and make tooth cleaning more difficult.[12,13] There are two methods to reduce demineralization, an office-applied FLR regime and a self-administered regimen. The latter includes FLR mouthrinse, high FLR toothpaste, improvement of oral hygiene by regular brushing, and inter-dental aids.[14-16] FLR application have been used to prevent decalcification and further progression of WSLs. FLR mouthrinseis known to increase the rate of remineralization.[16-18] A decrease in the prevalence and severity of dental caries in the general population can be attributed to the use of different FLR products.[19] The purpose of this study was to help orthodontic experts with quantitative data on the effectiveness of FLR mouth rinse in the reduction of WSLs during multi-bracket FOT. This systematic review meta-analysis (SRMA) aimed to analyze results from randomized controlled trials (RCTs) in the literature available on the prevention of WSLs during FOT with the FLR mouthrinse.

Materials and Methods

Protocol and registration

The systematic literature search was carried out according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement guidelines.[20] This review was registered with the International Prospective Register of Systematic Reviews (PROSPERO). (Registration Number CRD42022310343). The review evaluated and analyzed the data available on the effectiveness of FLR mouthrinse in the prevention of demineralization around FOT appliances.

Search strategy

Two authors (A.J. and O.M.) performed an exhaustive literature search to evaluate the clinical parameters and outcomes of FLR mouth rinses in FOT. With an English language restriction, online electronic databases such as PubMed-Medline, Embase, and Scopus were used to search data from January 1990 to December 2022. Additional sources included Google Scholar, OpenGray, and conference proceedings. Downloading the search results into a bibliographic database facilitated the eradication of duplicate entries. The study design filter (randomized control clinical trials) was maintained throughout the search.

Contact was made with authors of any unpublished studies. To ensure a thorough screening, a manual search for relevant articles in journals related to orthodontology, periodontology, and oral pathology was also conducted. In addition, this review incorporates supplementary citations that were acknowledged in the lists of selected references and bibliographic links. Articles were searched using Medical Subject Headings (MeSH) terms, keywords, and other free terms combined with Boolean operators (OR, AND). Following the syntax standards of each database, identical keywords were utilized on all search platforms. The databases were searched using keywords including fluoride oral rinse, white spot lesion, fixed orthodontic treatment, and demineralization to obtain information and resources.

Eligibility criteria

RCTs that evaluated the effectiveness of FLR mouthrinse in the prevention of WSLs or dental caries during the treatment of FOTappliances were included in this review. Studies were excluded if random allocation was not effectuated, including animal studies and *in vitro* studies. The population-intervention-control-outcome (PICO) format was used for the inclusion of the review.

Population: Patients undergoing FOT for correction of malocclusion.

Intervention: Topical self-applied FLR mouth rinse application during braces treatment.

Control: Standard treatment, placebo control, or no intervention. Standard treatment was pre-defined as the use of any over-the-counter FLR dentifrice containing 1000/1250 parts per million (ppm) of FLR.

Outcome: Reduction in the number of WSLs or dental decay.

Screening and selection

The results of the article screening were imported into EndNote 20 and the titles and abstracts were reimported into the Excel Workbook. One reviewer (A.J.) independently scanned the articles to identify relevant studies, and two reviewers (A.J. and O.M.) independently screened the complete texts of the relevant studies to select eligible studies. No reviews, commentary, or case studies were included in the search of the literature. The articles were chosen for full-text reading if the search terms appeared in the article's title and abstract. Articles without abstracts but with titles pertinent to our objectives were also chosen for full-text inclusion screening. After selection, both reviewers (A.J. and O.M.) carefully read the full-text articles. The articles that satisfied the inclusion criteria were processed

for data extraction. Both reviewers (A.J. and O.M.) combed through the reference lists of each of the chosen articles to find additional relevant articles. According to Cohen's kappa (k) index, the level of agreement between the two reviewers was 0.92 for titles and abstracts and 0.90 for complete texts. Through discussions, disagreements between the two reviewers were resolved. If a disagreement persisted, the decision of a third reviewer (S.K) was deemed decisive.

Quality assessment and risk of bias

Two reviewers (A.J. and O.M.) examined the ROBin each included trial independently using the Cochrane Collaboration's tool for assessing the ROB,[21] with any disagreements resolved by discussion. This instrument primarily assesses bias resulting from the randomization process, bias resulting from deviation from the intended intervention, bias resulting from lacking outcome data, bias in the measurement of outcome, bias in the selection of results, and overall bias.

Data extraction

Two reviewers (A.J. and O.M.) extracted data independently using Microsoft Excel and custom-designed data extraction forms. Any disagreement was settled through author discussion. The curated information for data extraction included sample size, participant demographics, type of fluoride mouth rinse, type of fluoride chemical and fluoride concentration, type of control, and type of outcome measure.

Level of evidence

GRADE (Grading of Recommendation Assessment, Development, and Evaluation) approach was used to generate evidence regarding the function of FLR mouthrinse in the prevention of WSLs during FOT. All included studies were RCTs that were downgraded by one or two levels based on the ROB, inconsistency, imprecision, indirectness, or publication bias.

Data analysis

MA accounted for all evaluated variables, events in the trial arm and the control arm, Relative Risk, and 95% confidence interval. Using RevMan 5.4 (Copenhagen: The Nordic Cochrane Centre, Cochrane Collaboration), the MA was analyzed. Using dichotomous data of risk ratio and their associated 95% confidence interval, the outcomes were evaluated. NNT was calculated for statistically significant relative risks (RRs). By examining the target population, analogous interventions, control arm, and outcomes, clinical heterogeneity was evaluated. Using a random effect model, the I-square index was utilized to compute statistical heterogeneity. Studies with more than 50% I2 were deemed to have significant heterogeneity.

Results

During the screening of this review, 146 records were identified by searching four databases and 11 were screened for titles and abstracts after the removal of duplicates, out of which only 5 were considered for full-text reading. Finally, only five articles were included for qualitative analysisand two studies were eligible for quantitative analysis. Detailed steps for review are presented in the PRISMA flow chart [Figure 1]. Data extraction was performed for included studies. Those studies that reported outcomes in terms of relative risk and confidence interval are pooled for MA and the remaining studies are used for quantitative synthesis [Table 1].

Quality assessment

Two studies[23,26] were at low ROB [Figure 2]. In addition, according to the SCOPUS®, this manuscript was evaluated with the Fi-index instrument and received a score of 0.00 for the first author only on May 15, 2023.[27,28] The objective of the Fi-index tool is to assure the quality of the reference list and restrict the use of autocitations.

Discussion

Several RCTs have been conducted to assess the efficacy of a self-applied FLR regimen in the prevention of demineralization in patients having fixed braces and several SRMAs on different modes of FLR treatment such as gel, different concentration of mouthrinses, toothpastes, varnishes, and supplements.[29-32] Recent orthodontic RCTs have experimented with newer FLR materials such as orthodontic bonding agents, elastomeric modules, and ligature ties.[33-38] However, the present SRMA was conducted to understand the role of self-applied FLR mouth rinse in the prevention of demineralization during FOT.

The most recent Enerbaeek *et al*. study of 2022, showed a relative risk of 1.38% for the FLR mouth rinse group when comparedwith the control group.[26] The control group had only regular toothpaste and no FLR rinse. They suggested high FLR mouthrinse or toothpaste use during FOTreduced demineralization and prevented the formation of dental cavities or WSLs. Another RCT conducted by Vander Kaaij *et al*.[23] in 2015 found a relative risk of 2.6% and 95%CI (1.1–6.3) where the control arm had a FLR-free placebo rinse. This study also concluded that the use of FLR rinse during FOT prevents demineralization.

Some authors have conducted trials comparing FLR mouth rinses and other commercially available FLR products. Bangi *et al*.[24] in 2020 conducted a trial with acidulated phosflur mouthwash. The mean

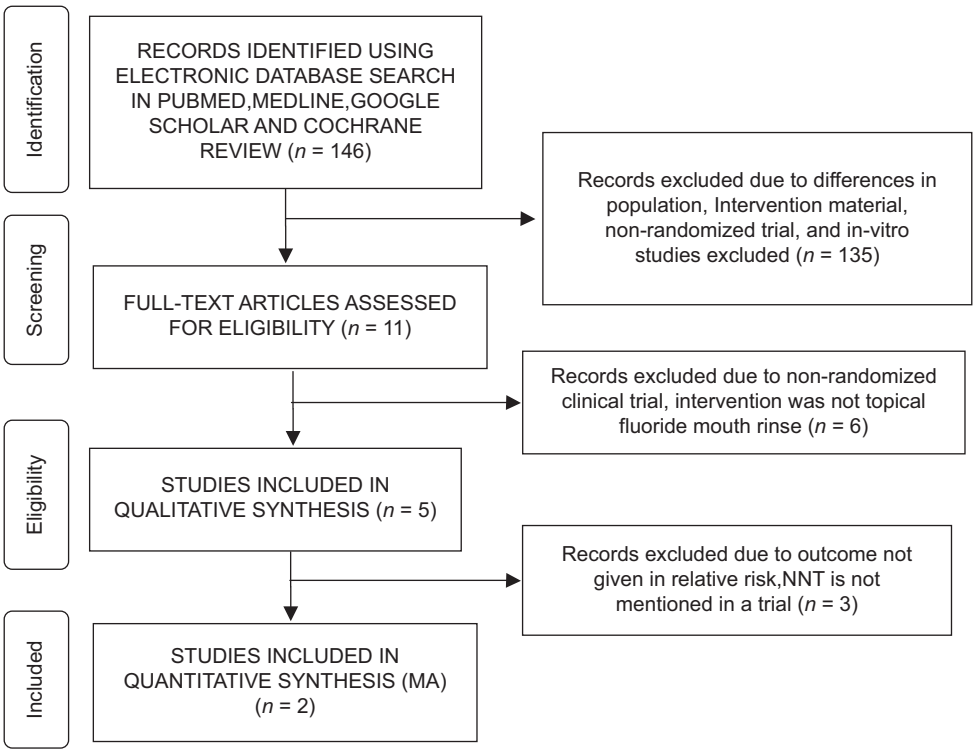

Figure 1: PRISMA flowchart

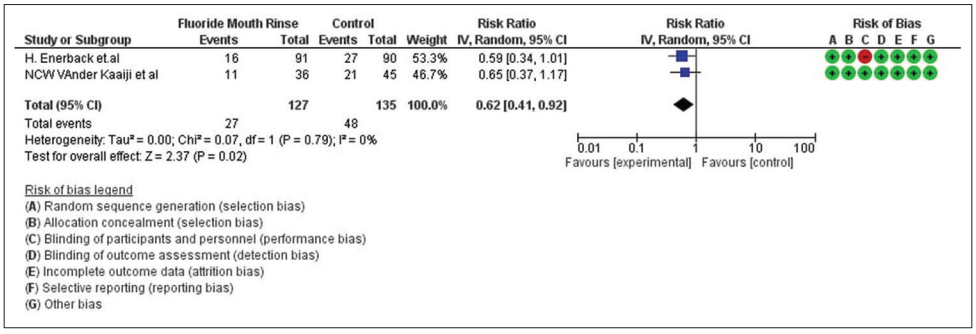

Figure 2: Risk of bias

demineralization after 6 months of FOT in the FLR mouth rinse group (0.72 ± 0.27) was less than that in the control group (1.18 ± 0.52). The RCT conducted by Ravikiran *et al*.[25] in 2021 observed that the mean difference in the prevention of WSLs in the FLR group was 0.46 compared to 0.55 in the control group. Patient compliance was also a major factor in understanding the role of FLR mouth rinse. The study by Geiger *et al*. in 1992 found that in the compliant and non compliant groups, 79% and 49% of patients had developed WSLs, respectively.[22]

The Cochrane review on the WSLs in FOT patients evaluated both self-administered FLR products and professionally applied FLR products.[39] The major reason cited for a variation in that type of study is patient compliance and the amount of FLR available in ppm. The result of the present MA suggests the use of FLR mouth rinse help in the prevention of WSLs or dental decay. Therefore, this SRMA provide evidence for the prevention of demineralization with regular oral hygiene and FLR mouth rinse.

Limitations

There were only two studiesthat published the outcome in terms of relative risk and 95% of the confidence interval. Other studies produce their results in terms of prevalence or mean difference, making it difficult to pool the data for MA. There are limited studies available in the English literature.

Conclusion

Many studies suggest that there is an increase in white spot lesions and dental cavities in fixed orthodontic treatment. The use of fluoride mouth rinse during this prolonged treatment prevents the formation of WSLs

Table 1: Data extraction of included studies

Author name and year	Title	Study design	Key findings	Conclusion
"Geiger *et al*., 1992[22]"	"Reducing White spot lesions in fluoride rinsing"	RCT	In the compliant group, only 21% of WSLs were compared to 49% in non-compliers.	Patients who are using FLR mouth rinse everyday had significantly fewer lesions during FOT.
"VanderKaaij *et al*.,2015[23]"	"A prospective randomized placebo-controlled trial on the effects of fluoride rinse on white spot lesion development and bleeding in Orthodontic patient"	RCT	Incidence rate ratio of demineralization in the placebo group vs Fluoride Group: 2.6 95% CI: 1.1–6.3	In this study, the authors expressed that FLR rinse helps to maintain better oral health and fewer demineralization during FOT.
"Bangi *et al*., 2020[24]"	"Evaluation of three commercially available materials in reducing the white spot lesion during fixed orthodontic treatment: a prospective randomized controlled trial"	RCT	Compared to the FLR rinse (Colgate Phosplour mouthwash and Colgate toothpaste. The WSL mean is 0.72+0.27 in fluoride rinse is less than the control group (1.18+0.52)	The authors in this research state that the usage of FLR rinse and other FLR products showed regression of WSLs.
"Ravikiran *et al*.,2021[25]"	"The effectiveness of amine fluoride mouthwash in preventing white spot lesions during fixed orthodontic therapy: A Randomised controlled trial"	RCT	The research states that FLR mouth rinses reduce the mean from 2 to 1.54 and the mean difference is 0.46.	The authors of the research explain that the FLR mouth rinse group has less number of WSLs.
"Enerback *et al*.,2021[26]"	"Effect of mouthrinse and a high-fluoride toothpaste in orthodontic patients: a randomized controlled trial"	RCT	The relative risk is 1.38 for the fluoride mouth rinse group compared to the control group. 95% CI (0.81–2.34)	"The authors of the research said that FLR mouth rinse in an FOT patient causes fewer Caries and demineralization".

or dental caries in patients.The advantage of a fluoride mouth rinse is that it can be a self-administered regimen for a patient, with reduced clinical dental chairside time and treatment cost as it mainly depends on patient compliance. However, more trials are needed to pool strong evidence.

Financial support and sponsorship
Nil.

Conflicts of interest
There are no conflicts of interest.

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