REVISTA DA FACULDADE DE ODONTOLOGIA DE PORTO ALEGRE
V. 64 (jan./dez. 2023) – REVISÃO DE LITERATURA
DOI: 10.22456/2177-0018.130690

REMINERALIZATION OF WHITE SPOT LESIONS IN ORTHODONTIC. IS THAT POSSIBLE? LITERATURE REVIEW

Remineralização de lesões de mancha branca em Ortodontia. Isso é possível? Revisão de literatura

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Data de envio: 08/03/2023 **Data de aceite:** 19/07/2023

ABSTRACT

Aim: The aim of this literature review is to describe the latest treatment available in the solution of this problem through remineralization. **Literature review**: A literature review was carried out in various electronic databases such as PubMed, MEDLINE, EBSCO, LILACS, EMBASE, Cochrane Library; from 1989 to 2022. The Medical Subject Headings (MeSH) terms used in the literature search were in English: “tooth reminaralization”, “dental white spot”, “orthodontic. **Discussion**: White spot lesions after orthodontic appliances is an undesired effect seen in dentistry. There is a wide option of agents that offer remineralization by the process of depositing calcium and phosphate ions into crystal voids in demineralized enamel, producing net mineral gain and preventing early enamel lesions progression, including fluoride toothpastes, fluoride varnishes, fluoride mouth rinses, and casein phosphopeptide-amorphous calcium phosphate (CPP-ACP). **Conclusion**: Fluoride-based prevention strategies are the agent with the strongest evidence for the treatment of WSL. The dental professional should offer this therapy in the earliest phase of the lesions so that it can be remineralized.

Keywords: Tooth remineralization. Dental caries. Orthodontics.

RESUMO

Objetivo: O objetivo desta revisão de literatura é descrever os mais recentes tratamentos disponíveis na remineralização de lesões de mancha branca. **Revisão da literatura:** Foi realizada uma revisão da literatura em várias bases de dados eletrônicas como PubMed, MEDLINE, EBSCO, LILACS, EMBASE, Cochrane Library; de 1989 a 2022. Os termos do Medical Subject Headings (MeSH) utilizados na busca da literatura foram em inglês: “tooth reminaralization”, “dental white spot”, “orthodontics”. **Discussão:** A lesão de mancha branca após utilização de aparelhos ortodônticos é um efeito indesejado observado na odontologia. Existe uma ampla opção de agentes que oferecem remineralização pelo processo de deposição de íons cálcio e fosfato nos cristais do esmalte desmineralizado, produzindo ganho mineral líquido e prevenindo a progressão precoce das lesões do esmalte, incluindo cremes dentais com flúor, vernizes com flúor, enxaguatórios bucais com flúor e caseína fosfopeptídeo-fosfato de cálcio amorfo (CPP-ACP). **Conclusão:** As estratégias de prevenção utilizando flúor constituem os agentes com mais evidências para o tratamento da mancha branca. O dentista deve oferecer essa terapia na fase inicial das lesões para que haja remineralização.

Palavras-chave: Remineralização dentária. Cárie dentária. Ortodontia.

INTRODUCTION

Caries progression or reversal is determined by the balance between pathological factors (that are related to demineralization) and protective factors (that enhance remineralization or reduce the bacterial challenge). Caries disease management aims to reduce the bacterial challenge if it is high and, conversely, to increase the remineralizing activity and enhance the natural repair of non-cavitated lesions[1].

Caries lesions can result in long-term esthetic disturbance, costly interventions, and even interrupted treatment[2]. Dental caries remains a major public health problem, especially for certain high-risk population groups[3].

Enamel subsurface lesions are commonly found in orthodontic patients with a prevalence of 5% to 97%[4]. White spot lesions (WSL) after orthodontic treatment with fixed appliances may present an esthetic problem, even more than 5 years after treatment[5]. Significant decalcification at 6 months after orthodontic bonding has been reported. Considering how quickly these lesions can develop and become irreversible, early diagnosis is of critical importance[6].

Subjects with malocclusion such as dental crowding and fixed orthodontic appliances have a greater number of retention sites and consequently difficulty in cleaning and a greater predisposition to caries. The prevention and resolution of this problem is the goal of any orthodontist because untreated WSL can lead to the formation of deeper dental caries and restorative treatment with the consequent compromise of patient satisfaction with the aesthetic result obtained at the end of the orthodontic treatment[7].

Fixed appliances and the bonding materials increase the retention of biofilm and encourage the formation of WSL. Management of these lesions begins with a good oral hygiene regime and needs to be associated with the use of fluoride agents (fluoridated toothpaste, fluoride-containing mouth rinse, gel, varnish, bonding materials, elastic ligature), casein phosphopeptide amorphous calcium phosphate fluoride (CPP-ACP), antiseptics, LASER, tooth whitening, resin infiltration, micro-abrasion[8].

The aim of this literature review was to describe the available therapeutics to remineralize the initial lesions in orthodontic.

MATERIALS AND METHODS

A literature review was carried out in various electronic databases such as PubMed, MEDLINE, EBSCO, LILACS, EMBASE, Cochrane Library; from 1989 to 2022. The Medical Subject Headings (MeSH) terms used in the literature search were in English: “tooth reminaralization”, “dental white spot”, “orthodontic”, combined with the Boolean operators OR and AND.

After the search, 121 articles were found, of which only 41 met the inclusion criteria. For this literature review, the inclusion criteria were clinical guidelines, systematic reviews, meta-analyses, longitudinal observational studies, case-control observational studies, cross-sectional observational studies, *in vitro* studies and reviews. Case reports, book chapters, letters and opinion articles were excluded.

The number of articles included consisted of:

Clinical guidelines (1), systematic reviews (5), meta-analyses (3), longitudinal observational studies (3), case-control observational studies (1), cross-sectional observational studies (7*), in vitro* studies (2) and review (9).

The number of articles and documents excluded was:

Case reports (15), book chapters (29), letters (10) and opinion articles (26).

A total of 41 articles met the inclusion criteria, the majority were from the last 10 years (80,48%). Most studies have concluded the use of various agents such as fluoride toothpastes, fluoride varnishes, fluoride mouthrinses, and casein phosphopeptide-amorphous calcium phosphate (CPP-ACP) due to the number of benefits it provides.

LITERATURE REVIEW

Caries risk assessment should be incorporated into initial evaluations of orthodontic patients, and risk-specific prevention and management protocols can help to eliminate or minimize this clinical problem[9]. Therefore, it is crucial to assess accurately both a patient’s caries risk before treatment and their suitability for orthodontic treatment[10].

Dental providers should be skilled in assessing an individual patient's risk for dental caries so that effective and minimally invasive preventive strategies can be employed to address the etiology of dental caries[11].

It is important to improved remineralizing therapy, including delivery systems. Also, antibacterial agents are necessary for high-risk individuals, since remineralization alone is insufficient to deal with the caries challenge. Methods of disrupting the biofilm beneficially are needed for high-caries-risk individuals[1].

Remineralization

Human enamel once formed cannot be biologically repaired or replaced. Saliva has a significant role in remineralization of dental enamel. It not only has a buffering capacity to neutralize the oral cavity's low pH generated after acidic encounters but also acts as a carrier of essential ions, such as fluoride, calcium and phosphate, which have a positive role in enamel's remineralization[12].

The emphasis currently given to new technologies for enamel remineralization suggests that the changes in the understanding of the dental caries disease, which occurred in the last century, were either not yet adopted or were forgotten. Just like in the past, when the disease was "treated" by restoring cavities, there is presently a misunderstanding on the concept of incipient lesion remineralization[13].

Dental remineralization represents the process of depositing calcium and phosphate ions into crystal voids in demineralized enamel, producing net mineral gain and preventing early enamel lesions progression[14]. Despite the large number of studies on the effect of braces on teeth, there is no information on the dynamics of the state of the ultrastructure of the hard tissues of teeth during orthodontic treatment[15].

Remineralization of caries lesions is naturally achieved by salivary ions, and it can be enhanced by external factors or elements such as fluoride. Numerous studies have demonstrated the re-mineralizing efficacy of fluoride therapies as well as the limitations with some groups of the population. Consequently, developing new remineralization therapies to close this gap in efficacy has been a priority for the last 2 decades. Most new therapies try to enhance the effect of fluoride by adding other potentially active ingredients to the formulation, such as calcium, phosphate, stannous, xylitol, and arginine. Other remineralization strategies have focused on creating re-mineralizing scaffolds within the lesions (e.g., self-assembling peptides). While several of the new remineralization

strategies have progressed significantly in recent years, for most of them, the evidence is still insufficient to assess their true clinical potential[16].

Dental caries is a highly prevalent diet-related disease. A goal of modern dentistry is to manage non-cavitated caries lesions non-invasively through remineralization in an attempt to prevent disease progression and improve aesthetics, strength, and function. Recently, a range of novel calcium-phosphate-based remineralization delivery systems has been developed for clinical application. These delivery systems include crystalline, un-stabilized amorphous, or stabilized amorphous formulations of calcium phosphate[17].

The era of preventive and minimally invasive dentistry clearly dictates the need for developing newer approaches to re-mineralize enamel caries lesions. While fluoride-mediated natural repair of early lesions can occur by influencing oral hygiene and diet, this is dependent on variables such as saliva quality and patient compliance. Nonfluoride remineralization systems are less reliant on such factors and can also significantly improve the structure, aesthetics, and acid resistance of the re-mineralized lesion[1].

Therapeutics in available in remineralization

In modern dentistry, minimally invasive management of early caries lesions or earlystage erosive tooth wear with synthetic remineralization systems has become indispensable. In addition to fluoride, which is still the non-plus-ultra in these early caries treatments, a number of new developments are in the test phase or have already been commercialized[18].

There are many agents like fluoride toothpastes, fluoride varnishes, fluoride mouth rinses, and casein phosphopeptide-amorphous calcium phosphate (CPP-ACP) frequently used for the remineralization of WSLs. However, there is no consensus in the literature concerning the success rates of these agents[19]. Self-applied and professional fluorides are key elements to limit caries-related side-effects during orthodontic treatment with fixed appliances[20].

Also, it has been promoted that multiple applications (4-20 times) of fluoride varnish or daily use of fluoride mouthwash or high-fluoride toothpaste seem to reduce WSL in patients undergoing orthodontic treatment. However, single use of fluoride varnish was

not effective. Further research is needed to establish the required number of fluoride applications for the prevention of WSL during orthodontic treatment[21].

The exposures to both low-potency, high-frequency fluoride preparations and high-potency, high-frequency fluoride preparations serve to prevent the appearance of moderate to severe demineralization in patients who undergo orthodontic therapy. A single daily exposure of a high-potency fluoride dentifrice or a twice-daily exposure to a high-potency gel appears to give equal protection in patients who exhibit white-spot pathology[22].

To overcome the limited bioavailability of calcium and phosphate ions, calcium phosphate-based remineralization systems such as amorphous calcium phosphate (ACP), calcium sodium phosphosilicate bioactive glass, and casein phosphopeptide-stabilized ACP were developed[23]. The use of CPP-ACP can be more beneficial than fluoride rinse for postorthodontic remineralization. Micro abrasion is an effective treatment for cosmetic improvement of long-standing white spot lesions[24]. Also, CPP-ACP pretreatment, micro abrasion of the enamel, and the combination of these two methods improve the bonding to demineralized enamel[25].

Although the partial or total masking effect of enamel whitish discoloration has been shown with resin infiltration, there is no strong evidence to support this technique based on the present clinical studies. Enamel whitish discolorations in esthetically compromised areas are clinically undesirable[26].

Currently, most commercially available non-fluoride remineralizing systems are aimed at enhancing fluoride efficacy and minimizing the potential risks associated with fluoride. However, a biomimetic strategy for enamel regeneration may well be the future, where organized enamel apatite crystals with robust attachment to the tooth surface are grown to replace demineralized tissue[1].

DISCUSSION

Research conducted to evaluate de number of WSL showed the orthodontically treated subjects had more teeth with WSL than the untreated subjects. The highest prevalence was noted on the first molars in both groups. In the orthodontic group, the mandibular canines and premolars and the maxillary lateral incisors were also affected[5].

Tufekci et al.[27] found most of the patients undergoing orthodontic treatment had at least one WSL in a mild form, but a few patients presented with moderate or severe demineralization. The prevalence of WSL was 38% in the 6-month group, whereas it was 46% in the 12-month group[27].

Since past decades, the use of fluorides has been promoted globally for the prevention of dental caries lesions[28-30]. Alexander and Ripa compared the effectiveness of toothbrushing followed by fluoride rinsing, fluoride gel brushing, or fluoride gel dentifrice brushing alone in controlling the demineralization that often follows orthodontic treatment. Reversal of WSL occurred in 15% of sites that exhibited pathology as a result of the fluoride and preventive regimen. These results indicate that daily use of a 5000-ppm fluoride gel along with toothbrushing with a fluoride paste or brushing twice daily with a 5000-ppm fluoride dentifrice alone provides greater protection beyond that of toothbrushing with a fluoride paste (1000 ppm) and rinsing with a 0.05% sodium fluoride rinse. Regarding the effects of self-applied fluoride rinses, gels, and dentifrice applications on orthodontic patients, the following can be concluded: reversal of white lesions at the end of active care occurred in 11% and 15% of patients who exhibited demineralization as early as 1 month into treatment and during the course of treatment, respectively[22]. Fluoride-based strategies remain the standard for caries prevention and management, with some evidence that boosting the effects of fluoride by the use of prebiotic strategies is a promising possibility[3].

Additionally, a clinical trial was conducted to test whether, in a post-orthodontic population using fluoride toothpastes and receiving supervised fluoride mouth rinses, more lesions would regress in participants using a re-mineralizing cream containing casein phosphopeptide- amorphous calcium phosphate compared with a placebo. Significantly more post-orthodontic WSL reversed with the re-mineralizing cream compared with a placebo over 12 weeks[23].

As well, topical treatment of WSL after debonding of orthodontic appliances with a casein phosphopeptide-stabilised amorphous calcium phosphate agent resulted in significantly reduced fluorescence and a reduced area of the lesions after 4 weeks as assessed by quantitative light-induced fluorescence[31].

A systematic review carried out to evaluate the efficacy of CPP-ACP for the prevention and remineralization of WSLs in orthodontic patients in human randomized controlled clinical trials (RCT) concluded both agents can decrease the prevalence and increase the remineralization of WSLs during/after orthodontic treatment[4]. Another systematic review evaluated the efficacy of casein phosphopeptide-amorphous calcium phosphate (CPP-ACPF) varnish for remineralization of WSLs "*in vitro*" in human teeth and concluded CPP-ACPF varnish appears to be equally effective as other fluoride varnishes in re-mineralizing artificially induced WSLs, but the quality of evidence is low[32].

Although Sing et al.[19] observed that the additional use of fluoride varnish and CPP-ACP plus crème to daily use of fluoride toothpaste was more effective in reducing the severity of WSLs, this effectiveness was comparable with the remineralization efficacy of fluoride toothpaste alone. Thus, orthodontists can routinely prescribe traditional fluoride toothpaste for the management of post-orthodontic WSLs. However, more similar studies are required to confirm the present findings. Nevertheless, for better results, the mean visual and DIAGNOdent scores for each tooth would have been calculated separately and considered for statistical analysis. The summary: the use of 1000 ppm of fluoride toothpaste twice daily was effective in the remineralization of post-orthodontic WSLs, the use of 5 % NaF varnish in addition to twice daily use of 1000 ppm of fluoride toothpaste had no additional beneficial effect in the remineralization of post-orthodontic WSLs. And twice daily use of CPP-ACP plus crème along with twice daily use of 1000 ppm of fluoride toothpaste had no added benefit in the remineralization of post-orthodontic WSLs[19].

In a RCT was found MI Varnish released the highest levels of calcium, phosphate and fluoride ions. MI Varnish containing fluoride and CPP-ACP was superior to the other varnishes in protecting against enamel demineralization[33].

The effects of single application of a conventional versus light-curable fluoride varnish (LCFV) on prevention of enamel demineralization during fixed orthodontic treatment were evaluated over a 4 months period. The results indicate that a single application of LCFV (Clinpro™ XT) can prevent enamel demineralization for longer duration (for up to 4 months) of time as compared to conventional fluoride varnish (Duraphat™, 45 days) during fixed appliance therapy[34].

A RCT evaluated Icon® resin infiltration and Clinpro™ XT varnish on color and fluorescence changes of WSL. The results showed Clinpro™ XT varnish had significantly better improvement than Icon® resin infiltration in restoring the color and lightness of the WSLs at 3 and 6 months. The fluorescence loss significantly recovered with both intervention methods between immediate application and at 6 months. However, Clinpro™ XT varnish-treated WSLs showed a statistically significant difference compared to the adjacent sound enamel at 6 months[35]. In other research, statistically significant differences were obtained in the color change outcome, but not in the brightness outcome in the subgroup analysis after six months of icon resin infiltration[36].

Lee et al.[37] compared three treatments to restore the appearance of existing WSL on tooth surfaces as close as possible to that of the original healthy enamel. WSLs in each group were treated respectively by bleaching, infiltration or micro-abrasion following the manufacturer's instructions. Among the three treatment modalities investigated in this study, resin infiltration was the most effective in masking the WSLs[37].

Although highly promising, the currently available clinical evidence for most of the non-fluoride enamel re-mineralizing systems is either poor, equivocal, or limited to a few early studies. Well-designed RCT are vital to clarify whether these new age re-mineralizing approaches provide any additional benefit over traditional fluoride remineralization, and these studies are especially needed for the products already in the market[1]. Biomimetic approaches to stabilization of bioavailable calcium, phosphate, and fluoride ions and the localization of ions to non-cavitated caries lesions for controlled remineralization show promise for the non-invasive management of dental caries[17].

In Germany, a survey was carried out to investigate the current strategies against enamel demineralization during multibracket therapy. Orthodontists graduating after 2000 tended to recommend and apply fluoride-containing materials more often than their senior colleagues. Participants from private practices applied fluoride varnish or gel more frequently than those from university clinics. Fluoridation was the most common treatment for WSL after multibracket therapy, followed by resin infiltration. The nonnegligible prevalence of individuals with WSL emphasizes the need for dental education and health care reform[38].

Patients, parents, orthodontists, and general dentists had similar perceptions regarding the significance, prevention, and treatment of WSL. Beyond all the involucrate persons in orthodontic treatment, it is clear that patients are the most responsible for the prevention of WSL[39]. Treatment with fluoride supplements and motivating and training patients to practice good oral hygiene will help achieve this goal[40].

Orthodontists should increase their awareness and commitment to instructing their patient on how to maintain good oral hygiene in order to prevent caries and periodontal disease during orthodontic treatment[41]. Not only orthodontists but also general and pediatric dentists need to learn how to correctly prevent and treat this unsightly problem[7].

Therefore, the use of 1000 ppm of fluoride toothpaste twice daily was effective in the remineralization of post-orthodontic WSLs[19]. Regular applications of an ammonium fluoride varnish reduced the prevalence of advanced WSL during treatment with fixed orthodontic appliances[20]. The size of a WSL can reduce over time; CPP-ACP and fluoride agents support increased remineralization of the demineralized enamel[24].

CONCLUSION

Fluoride-based prevention strategies are the agent with the strongest evidence for the treatment of WSL. The dental professional should offer this therapy in the earliest phase of the lesions so that it can be re-mineralized. The progress of the lesions will determine the most appropriate treatment. Combining other systems with fluoride offers additional benefits for re-mineralized WLS.

Although there is a wide supply of agents that provide enamel remineralization benefits, more well-designed randomized clinical trials are needed to support their use.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

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