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Efficacy of a casein phosphopeptide amorphous calcium phosphate (CPP-ACP) paste in preventing white spot lesions in patients with fixed orthodontic appliances: A prospective clinical trial

ABSTRACT

Aim *The aim of this prospective study was to test the efficacy of casein phosphopeptide amorphous calcium phosphate (CPP-ACP) paste applied in-office to prevent white spot lesions (WSL) in patients undergoing fixed orthodontic treatment.*

Methods *Study design: this study was designed as a randomised controlled clinical trial. Fifty-seven patients undergoing nonextraction fixed orthodontic treatment were enrolled and divided randomly into two groups (control n = 28, experimental n = 29). The pretreatment plaque, gingival and bleeding indices, and oral hygiene habits were recorded. One group received CPP-ACP paste (GC Tooth Mousse) at each monthly orthodontic follow-up examination; the control group received routine orthodontic treatment. The mean patient age was 16.9 years in the experimental group and 17.1 years in the control group. The periodontal indices, decayed, missing, and filled teeth (DMFT), decayed, missing, and filled surfaces (DMFS), and the WSL prevalence pre- and post-treatment were measured and compared between the groups. Statistics: differences between groups in normally distributed data between groups were assessed by the paired-t test, and the Wilcoxon Signed Rank test was used to compare variables that were not normally distributed.*

Results *There was a lower incidence of WSL in the experimental group compared to the control group. Most of the WSL occurred at the maxillary incisors, mandibular canines and premolars.*

Conclusion *The in-office application of CPP-ACP paste did not prevent WSL development completely; however, it did significantly decrease the number of WSL compared to the control patients.*

Keywords *CPP-ACP paste; Fixed orthodontic treatment; White spot lesions.*

Introduction

Fixed orthodontic appliances such as brackets, bands, and arch wires create retention fields for dental plaque accumulation surrounding the brackets [Artun and Brobakken, 1986]. Therefore, patients undergoing fixed orthodontic treatment have an increased risk of developing caries. The earliest sign of caries is enamel decalcification, known as white spot lesions (WSL) [Ogaard et al., 1988]. These lesions are especially common on the buccal and labial tooth surfaces. The prevalence of these demineralised lesions reportedly varies from 2% to 96% of tooth surfaces in orthodontic patients [Gorelick et al., 1982; Mitchell, 1992; Enaia et al., 2011]. Enaia et al. [2011] reported that with only standardised general prophylactic measures, new WSL on the maxillary incisors during fixed orthodontic treatment remains a frequent complication. Although some decalcifications may remineralise after debonding, WSL remain visible and are aesthetically undesirable for patients [Ogaard et al., 1988].

Several methods have been suggested to treat WSL that occur after fixed orthodontic therapy [Hamdan et al., 2012; Chen et al., 2013], but the focus has recently shifted to prevent WSL development during the fixed orthodontic treatment [Enaia et al., 2011; O'Reilly et al., 2013]. Certain materials have become popular in efficacy studies to prevent enamel demineralisation. Remineralisation of WSL may be possible with a variety of currently available agents containing fluoride, bioavailable calcium, and phosphate. The positive effects of numerous agents on WSL have been reported in multiple studies including mouthwashes, dentifrices, elastics with fluoride, varnishes primarily containing flouride, chlorhexidine, casein phosphopeptide, fluoride gels, and fluoride-releasing glass ionomer cement for bonding orthodontic brackets [Gorton and Featherstone, 2013]. Topical fluoride application

Material	Manufacturer	Composition	Lot number	Application procedure
GC Tooth Mousse	Hasunuma-cho, Itabashi-ku Tokyo, JAPAN	Pure water, Glycerol, CPP-ACP, D-Sorbitol, Silicon Dioxide, CMC-Na, Propylene glycol, Titanium dioxide, Xylitol, Phosphoric acid, Guar gum, Zinc Oxide, Sodium Saccharin, Ethyl p-hydroxybenzoate, magnesium oxide, Butyl p-hydroxybenzoate, Propyl p-hydroxybenzoate.	174-8585	1. Apply a sufficient amount of GC Tooth Mousse to the tooth surfaces using an application swab. 2. Leave GC Tooth Mousse undisturbed for 3 min. 3. Instruct the patient to use the tongue to spread the remaining GC Tooth Mousse throughout the mouth. Request the patient to hold in the mouth for additional 2 min avoiding expectoration and delaying swallowing. 4. Ask the patient to expectorate and avoid rinsing. Any GC Tooth Mousse remaining on the surface can be left to gradually dissipate. Advise the patient not to eat or drink for 30 minutes following application.

TABLE 1 The composition, manufacturer, lot number and application procedures of the tested CPP-ACP paste.

has been shown to induce deposition of a calcium fluoride-like material on the enamel surface [Ogaard, 2001]. In the 1980s, it was shown that casein phosphopeptide amorphous calcium phosphate (CPP-ACP), which is derived from milk casein, could affect the carious progression. CPP-ACP is a delivery system that allows free calcium and phosphate ions to attach to the enamel, generating calcium phosphate crystals [Reynolds, 1997]. Recent studies have shown that CPP-ACP systems have anticariogenic effects, promote regression of lesions, and prevent WSL [Reynolds, 2008; Sudjalim et al., 2006]. The topical anticariogenic effect of these products has been shown to move free calcium and phosphate ions from the CPP-ACP into the enamel rods and as free apatite crystals [Reynolds, 1997].

Several *in vitro* and *in vivo* studies have investigated the effects of CPP-ACP on post-orthodontic WSL, but their results are inconsistent. Most studies showed a positive effect of products containing CPP-ACP [Ferrazzano et al., 2012], but a few did not demonstrate any difference between the experimental and control groups [Uysal et al., 2010; Altenburger et al., 2010; Bröchner et al., 2011]. A recent systematic review reported a lack of reliable evidence supporting the effectiveness of remineralising agents for the prevention and treatment of post-orthodontic WSL [Chen et al., 2013]. Studies evaluating CPP-ACP products to prevent WSL development have employed at-home products used by patients. However, the effect of at-home agents is generally patient-dependent because the effectiveness relies on accurate and appropriate implementation by the patient. Therefore, the aim of this study was to evaluate the efficacy of in-office application of CPP-ACP paste on teeth with orthodontic brackets during fixed orthodontic treatment.

Material and methods

Ethical approval was granted by the Ethical Committee of the Medical Faculty and consent forms were signed by all patients at the start of this study.

The following inclusion criteria were applied to form the study groups: no previous orthodontic treatment, permanent dentition, minimal or moderate crowding (3–6 mm), planned nonextracted fixed orthodontic therapy, good oral hygiene, no previous periodontal treatment, no teeth with any visible decalcification on the buccal surface, and no history of any bleaching procedure. At the start of this study, power analysis (G Power 3.0.10, Franz Faul, Universität Kiel, Germany) was used to determine the sample size, and 50 individuals were determined to be necessary totally for 90% power. Initially, a total of 130 patients referred to the orthodontic clinic in 2012 (Caucasian population) requiring fixed orthodontic treatment were examined. Five patients requiring orthognathic surgery, 3 patients with a cleft lip and palate, 27 patients requiring extractions, and 38 requiring 2-phase treatment were excluded from the study. Fifty-seven patients – 28 in the control group and 29 in the experimental group – were included in this study. The mean patient age was 16.9 years and 17.1 years for the experimental and control groups, respectively. All included patients received general oral hygiene instruction at the start of treatment. Patients were instructed to avoid fluoride products such as fluoride mouth rinse or fluoride gels, except fluoride tooth paste.

Before treatment, the periodontal indexes (Silness and Löe plaque and gingival index), decayed, missing, and filled teeth (DMFT) score, and decayed, missing, and filled surfaces (DMFS) score were determined by a single investigator (EUC) who had ten years of experience in Restorative Dentistry, and a Roth braces system (Omniarch, Dentsply GAC, USA) was applied using Transbond XT (3M Unitek, Monrovia, CA, USA) in the remaining 57 patients (T0) [Silness and Löe, 1964]. Ligature wires were used in all patients. The patients were randomly divided into two groups. A paste containing CPP-ACP (GC Tooth Mousse, Tokyo, Japan) was applied to patients in the experimental group once monthly at each orthodontic follow-up by a single investigator (EB), who had five years of experience in Orthodontics. The CPP-ACP paste was applied to all tooth surfaces including the buccal areas around the brackets according to the manufacturer's instructions

FIG. 1 Intraoral images of two different patients after orthodontic treatment in the control group and severity of WSLs according to Gorelick's scale. a: score 2 (slight) and score 3 (severe); b: score 4 (cavitation).

(Table 1). The second group was treated routinely after applying the fixed orthodontic appliances without applying any additional products.

Eleven patients were excluded from the study because of poor cooperation, and 6 patients were excluded for failing to attend the follow-up appointments appropriately. As a result, 40 patients (control n = 20, experimental n = 20) were subjected to the final analysis comprising 546 teeth (546 tooth surfaces) in the CPP-ACP paste group and 542 teeth (542 tooth surfaces) in the control group. The recall rate was 70%.

One month after debonding, the same dental parameters were recorded by clinical examination (T1). The presence and severity of WSL in each tooth (labial surface) in both groups were recorded before and after the fixed orthodontic treatment according to the Gorelick scale (Fig. 1). The mean enamel decalcification index was calculated for both groups [Mizrahi, 1982]. All patients were examined by a single investigator (EUC).

Statistical analysis

Data analysis was performed using SPSS for Windows, version 20.0 (IBM Corporation, New York, USA). The WSL scores were calculated in only 31 patients with WSL at the study conclusion. Their scores were compared using the t-test, and no statistical difference was found between the two clinicians.

The normality of continuous variables was determined using the Shapiro Wilk test. Homogeneity of variance was analyzed by the Levene's test. Data were expressed as the mean ± SD or median for continuous variables, or the number and percentage for nominal date. The difference in normally distributed data according to location was evaluated by the Student's t-test, and the Mann-Whitney U test was used to compare variables that were not normally distributed. Differences between groups in normally distributed data between groups were assessed by the paired-t test, and the Wilcoxon Signed Rank test was used to compare variables that were not normally distributed. Nominal data were analyzed using the Pearson's chi-square test. A p-value of less than 0.05 was considered statistically significant.

Results

At the start of the prospective clinical trial, there were no WSL in any of the patients at baseline. Numerous WSL developed in both groups at the end of the fixed orthodontic treatment. The CPP-ACP paste used in the present study decreased the occurrence of WSL during the fixed orthodontic treatment. The mean treatment duration was 24.9 months for the CPP-ACP paste group and 25.1 for the control group, which were not statistically different.

The DMFT and DMFS scores, the plaque and gingival indices, age at the start of treatment, and treatment duration were analysed in both groups (Table 2). The mean DMFT, DMFS, plaque, and gingival indices at the start of the fixed orthodontic treatment were similar between the groups. The mean values of all parameters before and after treatment in both groups and their significances are shown in Table 3. The DMFT, DMFS scores, gingival index and WSL prevalence were significantly increased in both groups at the end of treatment (p < 0.000), but the mean plaque index was unchanged. The change in the DMFT, DMFS, plaque, and gingival indices were similar between the groups, but the number of WSL were significantly different between the groups (p = 0.033, Table 4).

Fifteen patients in the CPP-ACP paste group and 16 patients in the control group exhibited at least one WSL at the end of treatment, resulting in a WSL incidence during fixed orthodontic treatment of 75% and 80% in the experimental and control groups, respectively. The number of WSL was significantly higher in the control group (Table 5). Of the 546 and 542 total surfaces examined, 38 and 83 tooth surfaces showed WSL in the CPP-ACP paste and control groups, respectively. Incidence affected by WSL was 6.96% and 15.31% in the paste and control groups, respectively. The CPP-ACP paste decreased the WSL incidence by 46% compared to the control group. Furthermore, the WSL incidence on the maxillary incisors was 34.2 % and 28.9% in the CPP-ACP paste and control groups, respectively (Table 5). Most of the WSL occurred at the maxillary incisors,

	Groups		
Pretreatment (T0)	CPP-ACP mean±SD/median	Control mean±SD/median	p value (t/z)
DMFT	1.5	4.0	ns †
DMFS	1.5	4.0	ns †
Plaque index	3.7±0.7	4.2±0.8	ns ‡
Gingival index	2.8±0.7	2.9±0.9	ns ‡
Age	16.94±1.1	17.09±1.1	ns ‡
†: Mann Whitney-U test, ‡: Independent–t test, ns: non significant			

TABLE 2 Pretreatment mean/median values of parameters and their comparisons between the groups.

Parameters	Groups					
	CPP-ACP			Control		
	T0 mean±SD/median	T1 mean±SD/median	p value (t/z)	T0 mean±SD/median	T1 mean±SD/median	p value (t/z)
DMFT	1.5	3.0	p=0.000 ¶	4.0	4.5	p=0.000 §
DMFS	1.5	3.0	p=0.000 ¶	4.0	5.5	p=0.000 §
Plaque index	3.7±0.7	3.8±0.6	ns ¶	4.2±0.8	4.2±1.0	ns §
Gingival index	2.8±0.7	3.2±0.6	p=0.001 §	2.9±0.9	3.5±0.9	p=0.001 §
WSL	0	1.9±1.5	p=0.001¶	0	4.1±4.0	p=0.000 ¶
§: paired t-test, ¶: Wilcoxon Signed Ranks, ns: non significant						

TABLE 3 The changes between pre and post-treatment mean/median values and intragroup comparisons.

	Groups		
Posttreatment (T1)	CPP-ACP mean±SD/ median	Control mean±SD/ median	p value (t/z)
DMFT	3.0	4.5	ns †
DMFS	3.0	5.5	ns †
Plaque index	3.8±0.6	4.2±1.0	ns ‡
Gingival index	3.2±0.6	3.5±0.9	ns ‡
WSL	1.9±1.5	4.1±4.0	p=0.033 ‡
Treatment Duration	24.9±5.3	25.05±5.6	ns ‡
†: Mann Whitney-U test, ‡: Independent–t test, ns: non significant			

TABLE 4 Intergroup comparisons at T1 (post-treatment).

mandibular canines and premolars.

The WSL mean severity according to the Gorelick scale was 1.49 in the control group and 1.34 in the CPP-ACP paste group, a difference that was not statistically significant ($p > 0.05$, Table 6). However, the groups did show differences in the distribution of severity. In the control group, 4 teeth (4.8%) were scored 3, and 1 tooth (2.6%) in the CPP-ACP paste group was scored 3. These teeth were identified as molars with bands. The number of teeth scored at 2 was 32 (38.6%) and 15 (39.5%) in the control and CPP-ACP paste groups, respectively. Finally, 47 (56.6%) teeth in the control group were scored 1, and 21 (57.9%) teeth in the CPP-ACP paste group were scored 1.

Discussion

The incidence of WSL can be significantly higher in orthodontic patients, especially those with poor oral hygiene [Burkland, 1999]. However, some patients maintain good oral hygiene at the start of the treatment and experience deterioration during orthodontic treatment. Therefore, preventive measures before or during orthodontic treatment may be required to minimise the risk of developing unaesthetic WSL. Many products have been recommended to prevent decalcification or remineralisation of the tooth surfaces including dental materials such as glass ionomer or resin sealants, and fluoride products such as fluoride varnishes, mouthwashes, or toothpaste. Different orthodontic materials used to bond devices have also been investigated previously, but the effects of CPP-ACP products have becomes popular in recent studies [Benham et al., 2009; Ladhe et al., 2014]. However, many studies are retrospective, and the prospective studies are generally *in vitro*. There are few prospective *in vivo* studies investigating the effects of CPP-ACP during fixed orthodontic treatments, and the observation period is very short in the few available [Uysal et al., 2010; Altenburger et al., 2010; Robertson et al., 2011]. Furthermore, many of the products assessed were used at-home; the efficacy of these products depends on patient compliance and thus may not be reliable for scientific analysis [Yap et al., 2014]. Therefore, the present study employs a prospective design and in-office application without needing to rely on patient compliance to demonstrate any positive effects of the CPP-ACP paste. A short-term benefit of CPP-ACP products has been reported in vivo [Ogaard, 1989; Uysal et al., 2010; Ltenburger et al., 2010]. This is the first known prospective study evaluating the efficacy of in-office application of a CPP-ACP product during fixed orthodontic therapy.

The reported prevalence of WSL varies from 2% to 96% in orthodontic patients [Gorelick et al., 1982; Ogaard, 1989; Mitchell, 1992; Ogaard, 2001; Chapman et al., 2010]. This wide variation may reflect the different patient age groups and demographics in the available studies. Although it was not practically possible to study homogeneous groups in each clinical trial, strict patient selection criteria are of great importance when designing in vivo studies. In the present study, patients were selected according to their malocclusions, the amount of crowding, oral hygiene, and the need for a similar treatment and identical bracket and bonding systems as soon as possible. Another baseline criterion was the presence of WSL or any decalcification of the enamel. Undoubtedly, enamel decalcification or WSL occurrence are affected by multiple factors including oral hygiene habits, saliva properties, dietary habits, use of orthodontic appliances, auxiliary attachments, bonding agents and additional protective materials, as well as unknown factors yet to be investigated. The

Parameters	CPP-ACP (n=20)	Control (n=20)	Groups		
			CPP-ACP	Control	Total
Patients effected	15	16	75%	80%	77.5%
Surfaces monitored	546	542	-	-	-
Surfaces affected (number and incidence)	38	83	6.96% (WSL/sm)	15.31% (WSL/sm)	11.1% (WSL/sm)
Maxillary					
Incisors I/II	5/8	10/14	34.2%	28.9%	30.5%
Canines	2	9	5.2%	10.84%	9.0%
Premolars	5	6	13.1%	7.2%	9.0%
Molars	3	8	7.8%	9.6%	9.0%
Mandibular					
Incisors	3	6	7.8%	7.2%	7.4%
Canines	5	12	13.1%	14.4%	14.0%
Premolars	5	10	13.1%	12.1%	12.4%
Molars	2	8	5.2%	9.6%	8.2%
WSL: white spot lesions, sm: surfaces monitored, pe: patients effected					

TABLE 5 The number, percent and distribution of the WSL in both groups.

	CPP-ACP			Control		
	Score 1 (%57.9)	Score 2 (%39.5)	Score 3 (%2.6)	Score 1 (%56.6)	Score 2 (%38.6)	Score 3 (%4.8)
Maxillary						
Centrals	5	0	0	10	0	0
Laterals	5	3	0	5	9	0
Canines	1	1	0	7	2	0
Premolars	2	3	0	3	3	0
Molars	0	2	1	2	4	2
Mandibular						
Incisors	3	0	0	6	0	0
Canines	3	2	0	7	5	0
Premolars	3	2	0	5	5	0
Molars	0	2	0	2	4	2
Total (number of the teeth)	21	15	1	47	28	4
The mean of the score		1.34			1.49	ns
ns: non significant between CPP-ACP and control groups, Mann-Whitney U Test.						

TABLE 6 WSL scores of all teeth in both groups.

WSL prevalence before treatment has been reported between 15.5% to 85% for untreated patients, and WSL developed in at least 1 tooth in 24% of patients who did not undergo orthodontic treatment [Gorelick et al., 1982; Artun and Brobakken, 1986; Enaia et al., 2011; Khalaf, 2014]. Hence, the primary factor triggering WSL may not always be orthodontic treatment. Benson et al., in a study summarizing the methods for evaluating WSL, emphasised that WSL was caused by mineral loss in enamel by acid demineralization during orthodontic treatment, but an opacity may occur before the appliance is placed, which can result from numerous causes [Benson et al., 2004]. Therefore, in the present study, patients with any opacity before undergoing orthodontic treatment were excluded in order to monitor the WSL occurrence after orthodontic treatment and to determine the effects of the CPP-ACP paste.

In previous reports, inadequate oral hygiene at the initial pretreatment examination and the number of failures for poor oral hygiene during treatment were considered risk factors for developing WSL [Chapman et al., 2010]. In the present study, the pretreatment plaque and gingival indices scores were under 1 in all patients and statistically similar between the groups. This similarity reflects the effort to ensure adequate oral hygiene condition before beginning orthodontic treatment and simplified the data interpretation.

Assessment of the plaque and gingival indices after orthodontic treatment showed that the mean plaque index score was very low in both groups, while gingival index score significantly increased from the pretreatment values. These findings demonstrate that the oral hygiene of the patients deteriorated during orthodontic treatment even though the plaque index was unchanged. However, most of the patients may provide oral care just before the orthodontic routine control. Furthermore, at the end of fixed orthodontic treatment, WSL developed significantly in both groups but were much more numerous in the control group.

In the present study, after fixed orthodontic treatment, 75% of patients in the CPP-ACP paste group and 80% of the patients in the control group exhibited at least one WSL. This high incidence may be due to the long follow-up period. WSL can form in as little as 4 weeks in the presence of fermentable carbohydrates yet, most studies evaluated their development over a short duration [Ogaard et al., 1988]. We identified WSL in 8.7% (38 teeth) of patients in the CPP-ACP paste group and 19% (83 teeth) of the control group in the present study. The number of WSL that developed was approximately two times higher in the control group than in the CPP-ACP paste group, a finding similar to that of Robertson et al., who reported that WSL occurrence was 53.5% lower in patients using MI paste [Robertson et al., 2011]. In the CPP-ACP group, 34.2% of all WSL occurred on the maxillary incisors, followed by 13.1% each in the maxillary and mandibular premolars, and the mandibular canines (Table 5). Similarly, in the control group, most of the WSL (28.9%) occurred in the maxillary incisors and was nearly twice the incidence in the CPP-ACP paste group. This supports previous studies showing that the maxillary incisors are more frequently affected [Gorelick et al., 1982; Mizrahi, 1983]. The maxillary lateral teeth were also frequently affected teeth consistent with previous studies [Gorelick et al., 1982; Mizrahi, 1983]. Interestingly, in the CPP-ACP paste group, the maxillary canines were comprised 5.2% of affected teeth, and were 10.84% of the control group. Hence, the CPP-ACP paste protected the maxillary canine teeth twice as much as those in the control group.

Most previous studies focused on the treatment method after developing WSL, and few of them investigated preventative effects of certain agents against WSL during treatment [Behnan et al., 2010; Yap et al., 2014]. Altenburger et al. [2010] and Bröchner et al. [2011] did not find any remineralisation effect of the CPP-ACP paste administered to orthodontic patients after treatment. This can be explained by variation in the saliva between the patients. Apparently, in the present study, although CPP-ACP paste significantly decreased the WSL incidence, it failed to protect the entire enamel surface. It seems that the protective activity of this CPP-ACP particular paste is more effective than its remineralising activity.

In a few studies, a fluoride or CPP-ACP product was applied for 6 months during orthodontic treatment due to the difficulty in matching the treatment duration between the two groups. In the present study, CPP-ACP was applied monthly, and the treatment duration was similar between the groups because they both had Class I malocclusion with minimum or moderate crowding. Hence, all patients underwent approximately the same number of applications during orthodontic treatment. This similarity is considered an advantage of the prospective study design.

One of the most important findings of this study concerned the WSL severity. Most of the patients had mild lesions after treatment. The patients in the paste group had a mean WSL severity score of 1.34, while the control group had a mean score of 1.49. Although there was no statistical difference between the groups in the WSL severity, the mean WSL severity was numerically lower in the experimental group than in the control group. Notably, all the teeth that scored 3 were molars with bands in both groups, highlighting the relationship between the bonding area and WSL occurrence. Although molar teeth are not considered a part of the aesthetic simile by many patients, they should not be overlooked as these teeth are at risk of developing enamel cavitation.

The CPP-ACP paste group had fewer WSL, but the distribution of the WSL scores based on the tooth location in the groups was similar. Enaia et al. [2011] found that two-thirds of patients had mild lesions after fixed orthodontic treatment, and other studies have observed mild to moderate lesions after treatment in patients who did not receive any intervention, similar to our findings in the control group [Gorelick et al., 1982; Ogaard, 1989; Mitchell, 1992; Enaia et al., 2011]. In the present study, over half of the lesions were mild in both groups (55.9% and 56.6%), and approximately 40% of the WSL were moderate (score 2) severity. Severe lesions developed in only 4 teeth in the control group and 1 tooth in the CPP-ACP paste group.

It is often assumed that a longer fixed orthodontic treatment duration increases the risk of WSL development, which may mask the true prevalence [Khalaf, 2014]. In the present study, both the CPP-ACP paste and control groups were treated for a similar duration. This similarity may resulte from the patient selection criteria, which includes nonextraction Class I anomalies. Despite this, one patient with no WSL in the control group underwent 35 months of treatment, and another patient with 14 WSL in the same group underwent 29 months of treatment, suggesting that there may not be any correlation between WSL development and the treatment duration. Notably, a previous study found no difference in the WSL incidence associated with the treatment duration [Gorelick et al., 1982].

A limitation of this study may be the relatively small sample size. Future studies are needed that evaluate these lesions in a larger sample population with a different methodology.

Conclusions

1) After fixed orthodontic treatment, WSL developed in 75% and 80% of the CPP-ACP paste and control groups, respectively. However, WSL were significantly fewer in the CPP-ACP paste group than in the control group.
2) The maxillary lateral incisor was the tooth most frequently affected by WSL, followed by the lower canine and premolar teeth. The most severe lesions occurred in the first molar in both the CPP-ACP paste and control groups.
3) The WSL severity in the paste group was slightly but not significantly lower than the severity in the control group.
4) The in-office application of CPP-ACP paste to prevent WSL during fixed orthodontic therapy may serve as a major advance in the clinical management of this problem. CPP-ACP should only be applied in areas at high risk of demineralisation. This relatively inexpensive technique can be easily incorporated into monthly orthodontic examination.

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Conflict of interest

None to declare

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