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Original Article

Comparative Impact of Chlorhexidine and Fluoride Varnish on White Spot Lesion Prevention in Orthodontic Patients

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ABSTRACT

Early enamel caries lesions usually appear as white, opaque spots with a softer texture than the surrounding healthy enamel and become more prominent when dry. This study aims to investigate the effectiveness of Cervitec® Plus and Fluor Protector® varnishes in minimizing the occurrence of white spot lesions in orthodontic patients. A prospective controlled trial was conducted, including 30 participants in a split-mouth study design. Cervitec® Plus varnish was used in the first quadrant, while Fluor Protector® varnish was used in the second quadrant. Enamel fluorescence values were recorded using a Diagnodent pen at three intervals: T0 (pre-bonding), T1 (one month after strap-up), and T2 (two months after strap-up). A t-test showed a significant decrease in enamel fluorescence values between T0 and T2, as well as between T1 and T2, in both varnish groups. However, a Mann-Whitney test comparing the two groups found no statistically significant difference in effectiveness between Cervitec® Plus and Fluor Protector®. The findings suggest that both varnishes are equally effective in reducing white spot lesions during orthodontic treatment. Therefore, their use is recommended in the prevention and management of white spot lesions in orthodontic patients.

Keywords: Chlorhexidine varnish, Dental varnish, Fluoride varnish, Orthodontic treatment, White spot lesion (WSL)

Introduction

Malocclusion is a frequently encountered dental issue in clinical practice. With growing awareness among individuals about its implications, there has been a noticeable rise in the number of patients seeking orthodontic treatment. However, orthodontic appliances, such as wires, brackets, and modules, create challenges in maintaining proper oral hygiene, leading to changes in oral microflora and an increased risk of plaque accumulation. One of the major concerns during orthodontic treatment is enamel demineralization around brackets, which can result in the formation of white spot lesions (WSLs). These lesions develop due to excessive plaque buildup on the surface in the absence of adequate oral hygiene practices. Studies report that the prevalence of WSLs in orthodontic patients varies widely, ranging from 2-96% [1].

Fluoride (F-) has been found to offer protection against WSLs by inhibiting demineralization around orthodontic brackets [2]. Additionally, orthodontic patients tend to have higher levels of Streptococcus mutans in their saliva, increasing their susceptibility to caries formation. Due to the complexity of cleaning around fixed appliances, maintaining optimal oral hygiene becomes more challenging for these patients [3, 4]. Clinically, demineralized areas present as white, opaque spots, which may compromise the aesthetic outcome of orthodontic treatment [5]. White spot lesions can begin to appear within a month of bracket placement, although it may take up to six months before carious lesions become clinically evident. The characteristic whitish appearance of these lesions is caused

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by changes in scattered light reflecting off decalcified enamel. While they rarely progress into cavities, WSLs are not recorded as caries requiring restorative treatment in the DMFT/S (decayed, missing, or filled teeth) index [6]. These lesions are most commonly found near orthodontic brackets, particularly along the gingival buccal and gingival margins [7].

Fluoride-releasing materials have been proposed as a beneficial adjunct in preventing enamel demineralization during orthodontic treatment. Previous studies have suggested that applying calcium fluoride to the tooth surface can help in this regard [8]. Additionally, chlorhexidine has been found to inhibit acid production in plaque, thereby lowering pH levels and reducing the risk of demineralization [9]. Research conducted on banded premolars has demonstrated that daily rinsing with a combination of fluoride and chlorhexidine is more effective in preventing enamel demineralization than fluoride mouthwashes alone [10].

However, the use of chlorhexidine mouthwash is associated with certain drawbacks, including taste alteration and discoloration of teeth and soft tissues [11]. Moreover, previous studies indicate poor compliance with fluoride mouthwash use, with adherence rates were 15% [12]. To address these challenges, researchers have explored the effectiveness of varnishes containing chlorhexidine and thymol in controlling demineralization and bacterial growth [13-16].

This trial aims to evaluate and compare the effectiveness of Cervitec® Plus varnish and Fluor Protector® varnish in reducing the incidence of white spot lesions (WSLs) among orthodontic patients.

Materials and Methods

This study was designed as a non-randomized, prospective, single-blinded control trial using a split-mouth approach with patient participation obtained through informed consent. Ethical approval was granted by the Institutional Review Board and the Human Ethical Committee of the University.

The required sample size was determined based on statistical analysis from prior research, ensuring a study power of 95%. Using G-Power software for sample size calculation, 30 patients (n = 120 per group) were initially selected. To account for potential dropouts, an additional 5 patients (n = 20 per group) were included.

An orthodontist was responsible for screening patients based on the predefined inclusion and exclusion criteria. Patients seeking orthodontic treatment at the university's Department of Orthodontics were evaluated, and those meeting the study criteria were selected. Comprehensive pre-treatment records were obtained for all participants. This method of patient allocation helped minimize selection bias. Before their inclusion in the study, all shortlisted patients were provided with detailed information regarding their participation.

The eligibility criteria for patient participation in this study were carefully defined to ensure consistency and reliability in the research findings. Patients who met the inclusion criteria were those with a fully developed permanent dentition and who required fixed orthodontic treatment. Additionally, participants needed to have a maximum anchorage requirement and demonstrate a cooperative attitude, willingly consenting to take part in the study.

On the other hand, patients who did not meet the study requirements were excluded based on specific conditions. Those with mixed dentition, active periodontal disease, or existing carious lesions were not considered for participation. Furthermore, individuals with a history of periodontal disease or prior carious lesions were also excluded to eliminate potential biases. Patients with systemic health conditions were not included in the study to ensure the safety and accuracy of the research outcomes.

As part of the study protocol, comprehensive orthodontic records were obtained for each selected patient. These records included a detailed case history, intraoral and extraoral photographs, lateral cephalograms, and panoramic radiographs. After gathering this information, a precise diagnosis was established, followed by the formulation of an individualized treatment plan tailored to the patient's needs.

The study required the use of specific materials and equipment to assess and compare the effectiveness of different varnishes. The materials included **Fluor Protector® varnish** and **Cervitec® Plus varnish**, both of which were applied using an applicator tip. Additionally, a **DIAGNOdent pen** (KaVo Dental Corporation, Lake Zurich, Ill) was utilized to measure enamel fluorescence, ensuring accurate detection of demineralization and white spot lesions **(Figures 1-3)**.

Figure 1. Fluor Protector® varnish

Figure 2. Cervitec®Plus varnish

Figure 3. DIAGNOdent (KaVo dental corporation, Lake Zurich, Ill)

To minimize the influence of potential confounding variables such as dietary habits, oral hygiene practices, and systemic health factors, a split-mouth study design was implemented. This approach allowed for a more controlled comparison of treatment effects within the same patient. The study focused exclusively on the upper arch, as the lower arch presented a higher risk of salivary contamination and potential crossover effects following varnish application.

A single-blinded trial was conducted, ensuring that both the patient and the observer were unaware of the specific intervention applied. To assess the incidence of white spot lesions, enamel fluorescence was measured around orthodontic brackets using a DIAGNOdent pen (KaVo Dental Corporation, Lake Zurich, Ill), which employs laser fluorescence technology to detect changes in enamel mineralization.

Before each patient's assessment, the DIAGNOdent pen was calibrated to ensure accurate readings. Enamel fluorescence values were recorded in a structured manner across three-time intervals. T0 represented the baseline measurement taken before bonding, T1 was recorded one month after bonding, and T2 was measured three months post-bonding. Baseline readings at T0 were essential, as bonding procedures, including tooth surface etching, could significantly influence fluorescence values.

For each tooth, fluorescence measurements were taken at four specific sites—cervical, incisal, mesial, and distal—to capture a comprehensive assessment of enamel demineralization. The final fluorescence value for each tooth was determined by calculating the average of these four measurements **(Figure 4)**.

Figure 4. Laser fluorescence value noted using DIAGNOdent (Kavo dental corporation, Lake Zurich, Ill) pen

In this study, Cervitec® Plus varnish was applied to the first quadrant, while Fluor Protector® varnish was used in the second quadrant. The varnishes were dispensed in separate applicators for each patient visit to ensure consistency and hygiene. The application was performed using applicator tips, focusing on the labial surface of the teeth around the brackets. Patients were instructed to refrain from eating or drinking for 30 minutes following the varnish application to allow for optimal absorption and effectiveness.

During each follow-up visit, the archwire was removed, and the bracket-adjacent surfaces were gently cleaned using a wet cotton swab to remove any debris. Following this, enamel fluorescence values were recorded using a DIAGNOdent pen, ensuring accurate monitoring of any demineralization changes over time.

Before participating in the study, consent was obtained as we informed the participants after they were thoroughly briefed on the clinical trial's purpose, and procedures, and any concerns they had were addressed. No additional oral hygiene instructions were provided beyond the standard guidelines given to all orthodontic patients. These included maintaining proper oral hygiene through regular brushing with toothpaste and using a toothbrush effectively to ensure plaque removal and overall dental health.

The findings from this study are presented in **Tables 1-3**. For each tooth, four enamel fluorescence values were recorded using the DIAGNOdent pen. To analyze the statistical significance of changes over time, a T-Test was conducted to compare the values recorded at T0 (pre-bonding), T1 (one-month post-bonding), and T2 (three months post-bonding). The results indicated a statistically significant difference when comparing T0 vs T2 and T1 vs T2 groups, suggesting notable changes over time.

To further assess the enamel fluorescence values in both Cervitec® Plus and Fluor Protector® groups, Wilcoxon's Signed Rank test was used to evaluate the changes across the three-time points. Individual comparisons of the Cervitec® Plus and Fluor Protector® groups showed similar trends to those observed in the combined sample. Significant differences were again noted between T0 and T2 as well as T1 and T2, but no significant reduction was observed between T0 and T1.

Additionally, a Mann-Whitney test was applied to compare the effectiveness of Cervitec® Plus and Fluor Protector® in reducing the incidence of white spot lesions by lowering enamel fluorescence values. The results indicated no statistical difference between the two varnishes, suggesting that both were equally effective in preventing or managing white spot lesions during orthodontic treatment. The detailed statistical analysis is presented in **Tables 1–3**.

Table 1. T-test comparing the Cervitec®Plus and Fluor Protector® group

	SIDE	Mean	Std. deviation	Asymp. Sig. (2-tailed)
T0	Cervitec®Plus	3.3741	2.70707	.115
	Fluor Protector®	3.0659	2.57398	
T1	Cervitec®Plus	2.5162	1.57718	.280
	Fluor Protector®	2.8381	1.98930	
T2	Cervitec®Plus	2.1205	1.21671	.385
	Fluor Protector®	2.2818	1.43359	

Table 2. T-test Cervitec®Plus

		Mean	N	Std. deviation	Asymp. Sig. (2-tailed)
Pair 1	T0	3.3741	139	2.70707	.058
	T1	2.5162	139	1.57718	
Pair 2	T0	3.3741	139	2.70707	.000
	T2	2.1205	139	1.21671	
Pair 3	T1	2.5162	139	1.57718	.045
	T2	2.1205	139	1.21671	

Table 3. T-test Fluor Protector®

		Mean	N	Std. deviation	Asymp. Sig. (2-tailed)
Pair 1	T0	3.0659	139	2.57398	.766
	T1	2.8381	139	1.98930	
Pair 2	T0	3.0659	139	2.57398	038
	T2	2.2818	139	1.43359	
Pair 3	T1	2.8381	139	1.98930	.000
	T2	2.2818	139	1.43359	

Although the average of the 4 DIAGNOdent readings was used to represent the enamel fluorescence value for each tooth, it was observed that the cervical region consistently showed higher readings compared to the other areas, regardless of the varnish type used. Additionally, premolar regions exhibited higher fluorescence values than the incisors, indicating that teeth that are more challenging to maintain oral hygiene on are more susceptible to demineralization.

The findings from this study revealed not much difference between the Fluor Protector® and Cervitec®Plus groups in terms of effectiveness. However, the application of the varnishes led to a reduction in laser fluorescence values recorded by the DIAGNOdent, and this reduction was statistically significant. The laser fluorescence (LF) method, which utilizes a DIAGNOdent device, enables early detection of dental caries by emitting infrared light (655 nm wavelength), which is absorbed by both organic and inorganic tooth structures [17]. The DIAGNOdent values range from 0-99.20, and the results indicated that, regardless of whether the varnish was applied, patients with poor oral hygiene maintained higher fluorescence values [18].

Our current results align with previous research, such as a study on tri-monthly fluoride application, which demonstrated that applying varnish to the tooth surfaces was an effective strategy for reducing white spot lesions (WSLs) during fixed orthodontic treatment. This study found a 44.3% reduction in the demineralization index in the fluoride varnish-treated group compared to the control group. Additionally, earlier studies have shown that a combination of chlorhexidine and fluoride was effective in reducing the occurrence of WSLs, especially on the maxillary incisors. This effect was partly attributed to chlorhexidine's inhibitory action on Streptococcus mutans [19].

To mitigate the side effects associated with prolonged use of Chlorhexidine mouthwash in orthodontic patients, using natural substances, such as fruit extracts like watermelon, has been explored as an alternative to reduce bacterial growth. Research has demonstrated that watermelon possesses significant antibacterial properties against bacteria like Lactobacillus and Streptococcus mutans, which play a key role in the development of white spot lesions (WSLs).

In the context of orthodontic treatment, the mean level of S. mutans in plaque was notably lower in the Cervitec®Plus® group compared to the control group during the bonding period. Furthermore, after twelve weeks, the S. mutans levels remained significantly reduced in the Cervitec®Plus® group when compared to the control group. However, there was no significant impact on other parameters over the 24-week study period [20]. These results are in line with previous studies showing that regular use of fluoride varnish can help prevent the development of white spot lesions [21, 22]. Specifically, applications of AF varnish every six weeks around the brackets during treatment have been shown to effectively reduce WSL formation, reinforcing the benefits of fluoride application for caries prevention in orthodontic patients [23].

A systematic review also further supported the combined use of Chlorhexidine varnish and fluoride varnish as an effective strategy to reduce the prevalence of WSLs in orthodontic patients. Currently, there are no bonding agents in the market, aside from bioactive glass-modified adhesives, that can inhibit WSL formation through the release of calcium and phosphate ions while maintaining optimal bond strength [24]. One study evaluating the use of a chlorhexidine/thymol-containing varnish (Cervitec®Plus) alongside two fluoride-releasing sealants (Maximum Cure® and Pro Seal®) found that these products provided a higher level of caries prevention, though carious lesions still formed despite the use of the chlorhexidine/thymol varnish [25].

Earlier studies on chlorhexidine-containing varnishes have highlighted their potential. One study, in particular, demonstrated that monthly use of a one percent chlorhexidine and one percent thymol varnish was an effective method for preventing plaque-induced oral diseases.

One study emphasized the necessity for additional high-quality clinical trials to assess the efficacy of chlorhexidine varnish in preventing caries during orthodontic treatment [26]. Looking back from 1988 to the present, various approaches have been explored; however, none have succeeded in delivering the required mechanical and physical properties needed to qualify as a suitable orthodontic agent while also demonstrating anti-cariogenic potential [27].

Conclusion

This study led to the following conclusions:

- White spot lesions are more commonly observed in orthodontic patients.
- Patients undergoing orthodontic treatment must follow meticulous oral hygiene routines, including proper brushing techniques.
- The addition of oral hygiene aids is beneficial in preventing white spot lesions.
- DIAGNOdent can be used to detect early carious lesions in patients with orthodontic appliances.
- Cervitec®Plus® and Fluor Protector® varnish are effective in lowering the occurrence of white spot lesions during orthodontic treatment.

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