Future Dental Journal

Volume 7 | Issue 2 Article 3

2021

Resin Infiltration Versus Acid Micro-Abrasion In The Treatment Of White Spot Lesions In Fixed Orthodontic Patients

Hend S. ElSayed
National Research Centre, Dokki, Cairo, Egypt., hs.hafez@nrc.sci.eg

Ahmed Mahran
Beni Suef Univesity, Egypt., Ahmed_mahran@dent.bsu.edu.eg

Wagih Kadry
Cairo University, Egypt., Wagihkadry1951@hotmail.com

Fady Fahim
Cairo University, Egypt., Fady.hussein@dentistry.cu.edu.eg

Recommended Citation

ElSayed HS, Mahran A, Kadry W, Fahim F. Resin Infiltration Versus Acid Micro-Abrasion In The Treatment Of White Spot Lesions In Fixed Orthodontic Patients. *Future Dental Journal*. 2022; 7(2):90-94. doi: https://doi.org/10.54623/fdj.7023.

Future Dental Journal Volume 7, Issue 2 (2021) 90—94

Contents lists available at Arab Journals Platform

Future Dental Journal

Journal homepage: https://digitalcommons.aaru.edu.jo/fdj/

Resin Infiltration Versus Acid Micro-Abrasion in The Treatment of White Spot Lesions in Fixed Orthodontic Patients

Hend S. El-Sayed[a,*], **Ahmed Mahran**,[b] **Wagih Kadry**,[c] **Fady Fahim**[c]

a National Research Centre, Dokki, Cairo, Egypt
b Beni Suef Univesity, Egypt
c Cairo University, Egypt

ARTICLE INFO

Discipline:
Orthodontics

Keywords:
Icon infiltrant,
Resin infiltration,
Opalustre, acid micro-abrasion,
White spot lesions,
Fixed orthodontic appliance

* Corresponding author.
E-mail address:
hs.hafez@nrc.sci.eg
(Hend S. El-Sayed).

ABSTRACT

***Background*:** White spot lesions (WSls) are frequently occurring side effects of fixed orthodontic treatment. The lesions may progress to cavities. Their treatment is costly and time-consuming. Icon infiltrant and Opalustre are painless micro-invasive procedures that improve the color of the WSLs.

Aim: The aim of this randomized clinical trial was to compare resin infiltration and acid micro-abrasion.

Materials and Methods: Twelve patients, with ninety post-orthodontic white spot lesions, were randomly divided into two groups. Icon resin infiltrant was applied in one group and Opalustre acid micro-abrasion in the other. The caries score was measured with ICDAS-II. The patients recorded their satisfaction on a VAS scale. Wilcoxon signed-rank test compared the two groups and the Friedman test compared the outcomes over time.

Results: Compared to the pre-treatment, the ICDAS-II scores statistically decreased immediately after treatment, after 3 months, and after 6 months, in both groups. Compared to pre-treatment, the patient satisfaction increased immediately after treatment, after 3 months, and after 6 months, in both groups.

Conclusion: Icon and Opalustre improve the color of WSLs. Color is stable over time. Patients are satisfied with the treatment results

1. INTRODUCTION

Fixed orthodontic appliances alter the balance in the oral cavity. Orthodontic patients have shown 2-3 times higher plaque accumulation compared to subjects without braces.[1] A recent study showed that fixed orthodontic appliances disrupt the balance of streptococcus mutans in a group of adolescents, which may put them at a higher risk of enamel demineralization.[2]

The development of white spot lesions (WSLs) and caries is a multifactorial process involving the host susceptibility including genetic predisposition and quality of enamel; the concentration and activity of cariogenic bacteria; salivary factors including salivary composition, flow, and pH; oral hygiene and diet.[3]

Various risk factors during orthodontic treatment predispose demineralization. These include a white ethnic group, poor oral hygiene at the pre-treatment examination, number of sites of poor oral hygiene, and starting the treatment at a young age.[4]

In susceptible patients, the demineralization process may be seen as early as four weeks after bracket placement.[5] The microflora in the dental plaque surrounding the brackets initiate sub-surface dissolution of enamel crystals. This increases enamel porosity and alters the light dispersion producing opaque white patches.[6]

Several methods have been applied to treat post-orthodontic white spot lesions. Some of these are somewhat invasive while others are not. Non-invasive enamel remineralization treatments have been effective using fluoride or calcium products.[7, 8]

Effective esthetic improvement of white spots has also been seen with micro- invasive procedures including resin infiltration,[9] micro-abrasion, [10] and bleaching.[11] Resin micro-infiltration uses acid etching to open the enamel prisms and facilitate the infiltration of the resin to fill the porosities created by demineralization.[9] The use of acid micro-abrasion removes enamel lesions of limited depth chemically and mechanically.[10] The use of acids in these procedures requires some extra safety procedures to protect the oral soft tissues adjacent to the teeth.

Like micro-abrasion, the application of bleaching materials does not only target the lesions but also the sound enamel around the white patches. The bleaching has greater effect on the sound enamel adjacent to the demineralized area, relatively masking the difference between them.[11]

The aim of the study was to compare patient satisfaction and the caries scores using the ICDAS-II for resin infiltration versus acid-microabrasion in the treatment of post-orthodontic white spot lesions.

2. MATERIALS AND METHODS

This study was carried out in the orthodontic outpatient clinic of the Faculty of Oral and Dental Medicine at Cairo University. Ethical approval was obtained from the institute's ethical review board before enrolling the patients.

Patients who showed white spot lesions, in the esthetic zone, after the completion of fixed orthodontic treatment and debonding were screened. They were included in the trial if they had white spot lesions in the anterior or premolar teeth, with a score of 1 or 2 on the ICDAS-II scale.[12] The patient had to have at least one lesion on each side of the arch. Patients were excluded if they were suspected to have enamel hypoplasia or dental fluorosis. Other exclusion criteria were WSLs in deciduous or previously restored teeth or cavitated lesions. The nature and benefits of the study were explained to eligible subjects. Patients and guardians who agreed to join the trial signed informed consent prior to the start of treatment.

A split-mouth randomized clinical trial was designed. Random.org online software was used to generate the random sequence and treatment allocation for ninety white spot lesions, in thirty-six quadrants. For allocation concealment, the randomization list was held by a resident not otherwise involved in the trial.

Ninety WSLs were treated (36 quadrants) in 12 patients. The patients had a mean age of 18.25± 5.3 years. Treatment was started after one month after debonding to allow spontaneous remineralization. According to the randomization list, teeth in group A received the resin infiltration using Icon infiltrant and group B received the acid-microabrasion using Opalustre.

The patient satisfaction and the ISDAS-II scores were assessed immediately before and after the treatment of the lesions, three months and six months after treatment. Pretreatment lesions with a score of 1 indicated "Opacity or discoloration hardly visible on a wet surface, but distinctly visible after air drying" affecting no more than 50% of the enamel. While score 2 showed "Opacity or discoloration distinctly visible without air drying" with no visible cavitations and "demineralization involving between 50% of the enamel and the outer third of dentin is visible".[12]

The patient satisfaction with the esthetics of the WSLs was recorded on a visual analouge scale, from zero to ten, where zero shows no satisfaction. International Caries Detection and Assessment System (ICDAS-II) for coronal Smooth Surface Caries was used to visually score the white spot lesions' severity. The scale is from zero to six, where zero indicates no visible change in enamel translucency with more than 5 seconds of air drying.[12] The ICDAS-II is a valid [12] and reliable [13] tool for demineralization and caries. Two examiners evaluated the ICDAS-II scores and inter-rater agreement was evaluated.

Prior to either treatment, all teeth were isolated with OptraGate (Ivoclar Vivadent, Buffalo, NY), cotton rolls, and saliva ejector. The methacrylate-based Icon infiltrant resin (DMG America, Englewood, NJ) was applied according to the manufacturer's instructions.[14] The enamel lesions were etched with 15% hydrochloric acid then dried with 99% alcohol followed by the application of the Icon infiltrant for three minutes then cured. A second layer was applied and cured.

Acid micro-abrasion using Opalustre (Ultradent, South Jordan, UT) was applied according to the manufacturer's instructions.[15] This is a slurry of 6.6% hydrochloric acid and 6.6% silicon carbide particles of 20-160µm. Using a slow- speed handpiece, the slurry was applied with pressure to the enamel lesions using the OpalCups Bristle for one minute. Three applications were performed and the surface was rinsed & dried.

Statistical analysis

Inter-rater agreement was tested for the ICDAS-II score. The data were checked for normality of distribution. The Wilcoxon-ranked sign test was used to compare the patient satisfaction and ICDAS-II scores between the two groups at each time point. While the Friedman test was used to compare the scores over time, within each group. The Wilcoxon signed-rank test was used for pair-wise comparisons, with Bonferroni's correction, when Friedman's test showed a significant difference.

3. RESULTS

The Inter-rater agreement for the ICDAS scores was moderate (Kappa; 0.738). The patient satisfaction and ICDAS scores showed a non-normal distribution. Descriptive statistics were reported as medians, ranges, means, and standard deviations.

The caries scores (Table 1) and the patient satisfaction (Table 2) before treatment show no statistical difference between the two groups. Compared to the before treatment scores, the ICDAS-II scores decreased statistically at all time points after treatment, in the Icon resin infiltrant group. (Table 1) There was no statistical difference between the scores immediately after treatment, 3-month, and 6-month after treatment. Similar results were seen in the Opalustre group. (Table 1)

No statistical difference was observed in the ICDAS-II scores between the two groups at different time points except immediately after treatment where the Icon infiltrant shows significantly a lower score than the Opalustre group.(Figure.1 &Table 1).

Compared to the before treatment scores, the patient satisfaction scores increased statistically at all time points after treatment, in the Icon resin infiltrant group. (Table 2) There was no statistical difference between the scores immediately after treatment, 3-month, and 6-month after treatment. Similar results were seen in the Opalustre group. (Table 2)

No statistical difference was observed in the patient satisfaction scores between the two groups at different time points except 3 months after treatment. The Icon shows significantly a higher score than the Opalustre group. (Table 2)

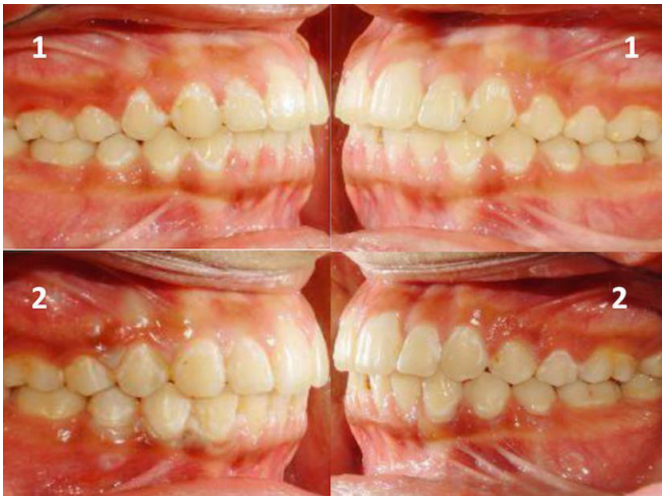

Figure (1) —Before (1) and after (2) treatment with Icon (right side) and Opalustre (left side).

https://digitalcommons.aaru.edu.jo/fdj/vol7/iss2/3
DOI: https://doi.org/10.54623/fdj.7023

Table 1:

Descriptive statistics and comparison of caries scores at different time points within and between the Icon Infiltrant and Opalustre groups.

	Icon resin Infiltrant		Opalustre (Acid micro-abrasion)		p-value
	Median (range)	Mean (SD)	Median (range)	Mean (SD)	
Before treatment	2.00 (1.00-2.00)	1.88 (0.32) a	2.00 (1.00-2.00)	1.91 (0.29) a	0.157
Immediately after treatment	0.00 (0.00-2.00)	0.28 (0.59) b	1.00 (0.00-2.00)	0.73 (0.75) b	0.003*
3-month after treatment	0.00 (0.00-3.00)	0.40 (0.74) b	1.00 (0.00-2.00)	0.66 (0.73) b	0.062
6-month after treatment	0.00 (0.00-3.00)	0.50(0.79) b	0.00(0.00-2.00)	0.60(0.81) b	0.408
p-value		<0.001*		<0.001*	

*SD: standard deviation, *: significant difference*

Table 2:

Descriptive statistics and comparison of patient satisfaction scores at different time points within and between the Icon Infiltrant and Opalustre groups.

	Icon resin Infiltrant		Opalustre (Acid micro-abrasion)		p-value
	Median (range)	Mean (SD)	Median (range)	Mean (SD)	
Before treatment	4.00 (2.00 -6.00)	4.11 (1.45) b	4.00 (2.00-6.00)	4.00 (1.58) b	0.317
Immediately after treatment	8.00 (5.00 -9.00)	7.67 (1.32) a	7.00 (4.00-9.00)	6.67 (1.73) a	0.071
3-month after treatment	8.00 (7.00-10.00)	8.00 (1.07) a	7.50 (4.00-10.00)	6.88 (2.03) a	0.041*
6-month after treatment	7.00 (7.00-10.00)	7.71 (1.11) a	7.00 (4.00-10.00)	6.86 (2.04) a	0.141
p-value		0.002*		0.013*	

*SD: standard deviation, *: significant difference*

4. DISCUSSION

White spot lesions are a common side effect of fixed orthodontic treatment in patients with high caries susceptibility, poor oral hygiene, and prolonged treatment time. In a recent study, 26% of 206 patients treated with fixed orthodontic appliances developed WSLs. Incidence was higher in maxillary teeth and canines.[16]

Careful monitoring of patient oral hygiene and early detection and remineralization of incipient lesions will limit post-orthodontic WSLs in susceptible patients.

The prognosis of white spot lesions in the retention phase showed spontaneous improvement in 68.4% of the lesions, 20.7% remained unchanged and 10.9% worsened.[17] In severe cases of non-compliant patients, where WSLs cannot be arrested, early termination of treatment may be considered, to prevent further damage to the teeth.[18]

Subsurface demineralization acts as a diffusion barrier which allows the leaching out of minerals in deeper enamel layers leading to the progression of the lesions and surface cavitation.

Several methods have been introduced to treat post-orthodontic WSLs. These treatments are either invasive and require some drilling or enamel preparation such as used in resin restorations and veneers. Other micro-invasive treatments include resin infiltration, micro-abrasion with or without acids, and bleaching. Also, non- invasive remineralization of the lesions is always indicated alone or adjunct to the micro- invasive modalities. The first attempt is to remineralize the lesion. Ideally, remineralization should penetrate to the subsurface zone.

Self and professionally applied topical fluorides of low and high concentrations and calcium and phosphorus-containing treatments have been used with varying degrees of success.[7, 8]

The use of a fluoride-containing toothpaste following debonding, in a prospective clinical trial, showed some improvement. However, this was not sustained through the six-month of the study.[19] There is limited low evidence that suggests that self-applied topical fluoride may produce remineralization of post-orthodontic WSLs.[20]

Remineneralization and caries arrest with high fluoride concentrations have been suggested in post-orthodontic white patches. However, this dense remineralization of the surface layers prevents further subsurface remineralization over time.[20] The esthetic outcomes are less favorable than remineralization with lower concentrations. Studies suggest that monthly 22,600 ppm fluoride varnish or 5% sodium fluoride application with daily use of fluoride toothpaste may produce better results in the long term.[21]

Studies have suggested etching the enamel or the use of acidulated fluorides to provide better penetration and remineralization of deeper layers of the lesion and better esthetics.[22]

The combination of Casein phosphopeptide-amorphous calcium phosphate (CPP-ACP) and fluorides enhanced the remineralization power.[23] The treatment of WSLs with fluoride varnish containing CPP-ACP has shown effective remineralization in a single application.[24] The combined effect of fluoride varnish and CPP-ACP produced superior remineralization than each treatment alone or the control which was a self-administered toothbrush with fluoride dentifrice, xylitol chewing gum, and antibacterial mouthwash for a 3 month period.[25]

Casein phosphopeptide-amorphous calcium phosphate (CPP-ACP) showed significant remineralization power of WSLs when evaluated with Quantitative light- induced fluorescence. Also, the surface roughness and hardness of the lesions improved.[26]

There is some evidence of the remineralizing effect of Novamin (calcium sodium phosphor silicate), a bioglass material. The results show that Novamin has no advantage over less costly fluoride toothpaste.[27]

Complete remineralization is usually not possible particularly in more severe non-cavitated lesions.[28] In such cases, micro-invasive treatment using resin infiltration will aim to fill the subsurface porosities which stops the diffusion process of minerals out of the tooth. This arrests the progression of caries and improves esthetics as the enamel refractive index is corrected. While micro-abrasion alone or combined with acids aims to remove incipient lesions and mask deeper ones.

Both of these techniques have the advantage of being minimally invasive and painless, requiring no drilling or anesthesia. Significant improvement of esthetics can be seen immediately after the treatment.

To maintain stable esthetic results, the resin infiltration technique may require some surface polishing with time to remove possible stains. While in acid micro- etched teeth, authors suggest that proper lip position is important to provide a moist tooth surface.[10]

Several studies have shown the efficacy of the Icon infiltrant in improving the appearance of the white spots. Recent systematic reviews suggest that Icon resin infiltration improves color, micro-hardness, and roughness.

Color improvement of the lesions is attributed to the deep penetration of the resin due to the low viscosity of the bisphenol A diglycidil dimethacrylate (BisGMA) and triethylene glycol dimethacrylate (TEGDMA) and the acid etching which gives better access to the resin into the subsurface defects.[9] There is moderate grade evidence that Icon resin infiltration masks WSLs better than fuoride varnish, particularly in more severe lesions.[29]

In a clinical trial, Icon effectively improved the color of the white spot lesions while insignificant change was reported for the Clinpro XT. Patient satisfaction was immediate after treatment in both groups. Their satisfaction decreased throughout the 1-year follow-up. However patient satisfaction with Icon was significantly higher than in the ClinPro XT, for all time points.[30]

In another trial where white spot lesions were treated with Icon infiltration, there was radiographic evidence of total caries arrest in most of the initial lesions.[31] Micro-abrasion is less frequently applied compared to resin infiltration in the treatment of post-orthodontic white spots. However, mechanical microabrasion has shown effectiveness in improving the esthetics of enamel defects.[32]

The use of acids and the safety of oral tissues has been of some concern. Modifications have been made to the composition of the acids to make them safer. Over time lower concentrations have been used with handpieces that allow precise slurry application which limits splattering.[10]

The combination of acids and microabrasion can remove initial lesions. Deeper enamel lesions are not completely removed. Yet, the Opalustre creates a lustrous prism-free enamel surface that masks the rest of the lesion.[10] The glassy surface of the treated enamel is also highly resistant to further demineralization. The study also recommends the surface application of 1% sodium fluoride for 4 minutes. This showed higher resistance to acid challenge.[33]

Bleaching has been suggested as an adjunctive treatment with acid micro-abrasion as the removal of enamel may cause the teeth to become slightly darker. This however was not observed in our study.[34]

In this study three applications of Opalustre have been used which remove less than 100µm (< 0.1mm) since one to ten applications remove 25 to 200µm, respectively.[35]

Our randomized clinical trial shows both Icon Infiltrant and Opalustre to be effective in the masking of the chalky white appearance of enamel demineralization. Within the short term follow-up of six months, both treatments were stable. Generally, the patient satisfaction was higher and the esthetics were better in the patients treated with Icon resin infiltration. This was not of statistical significance for all time points to make a clinical recommendation. However, the resin infiltration shows better esthetics immediately after treatment. (Fig. 1)

Although previous studies show clinical evidence that resin infiltration and acid micro-abrasion effectively improve post-orthodontic WSLs, the evidence is of low quality and further investigations are required. [20] Most of the studies evaluate the stability of resin infiltration for no longer than one year. There are some reports of 18 years of follow-up of acid micro-abrasion. None of which are controlled clinical trials. This suggests that long-term color stability and enamel seal require further investigation.[9]

This is a randomized clinical trial with a low risk of selection bias. The treatment protocols were standardized for all the patients decreasing the risk of performance bias. All the patients randomized to the treatment were followed to the end of the trial. However, the outcomes under investigation are subjective and show non-normal distribution affecting the precision of the results. Also the follow-up duration is 6 months.

Future trials may consider longer follow-up periods to evaluate the stability of color, occurrence of recurrent caries, and possible adverse effects on the tooth vitality.

5. CONCLUSIONS

1. The color of post-orthodontic white spot lesions improved with the application of Icon infiltrant and Opalustre.
2. Immediately after treatment, resin infiltration achieved better esthetics compared to the acid mico-abrasion technique.
3. Esthetic outcomes of Icon resin infiltration and opalustre show adequate stability for 6 months.

6. REFERENCES

1. Klukowska M, Bader A, Erbe C, Bellamy P, White D, Anastasia M, Wehrbein H. Plaque levels of patients with fixed orthodontic appliances measured by digital plaque image analysis. Am J Orthod Dentofac Orthop. 2011; 139: 463- 470.
2. Yang F, Dinis M, Haghighi F, He X, Shi W, Tran NC. Oral colonization of Candida albicans and Streptococcus mutans in children with or without fixed orthodontic appliances: A pilot study. J Dent Sci. In Press August 26, 2021.
3. Featherstone J. Prevention and reversal of dental caries: role of low level fluoride community. Dent Oral Epidemiol. 1999; 27: 31-40.
4. Chapman JA, Roberts W, Eckert GJ. Risk factors for incidence and severity of white spot lesions during treatment with fixed orthodontic appliances. Am J Orthod Dentofac Orthop. 2010;138: 188-94.
5. Ogaard B, Rolla G, Arends J. Orthodontic appliances and enamel demineralization. Part 1. Lesion development. Am J Orthod Dentaofac Orthop. 1988; 94:68-73.
6. Paris S, Meyer-Lueckel H. Masking of labial enamel white spot lesions by resin infiltration-a clinical report. Quintessence Int. 2009;40(9):713-718.
7. Puleio F, Fiorillo L, Gorassini F, Iandolo A, Meto A, D'Amico C, Cervino G, Pinizzotto M, Bruno G, Portelli M, Amato A, Giudice R. Systematic Review on White Spot Lesions Treatments. Eur J Dent. 2021. DOI https://doi.org/ 10.1055/s-0041-173193110.1055/s-0041-1731931.
8. Marinelli G, Inchingolo AD, Inchingolo AM, Malcangi G, Limongelli L, Montenegro V, Coloccia G, Laudadio C, Patano A, Inchingolo F, Bordea IR, Scarano A, Greco Lucchina A, Lorusso F, Di Venere D, Laforgia A, Dipalma G. White spot lesions in orthodontics: prevention and treatment. A descriptive review. J Biol Regul Homeost Agents. 2021;35(2 Suppl.1):227-240.
9. Soveral M, Machado V, Botelho J, Mendes J, Manso C. Effect of resin infiltration on enamel: A systematic review and meta-analysis. J Funct Biomater. 2021; 12(48):1-16.
10. Sundfeld R, Croll T, Briso AFL, De Alexandre R, Sundfeldneto D. Considerations about enamel microabrasion after 18 years. Am J Dent. 2007; 20(2): 67-72.
11. Knösel M, Attin R, Becker K, Attin T. External bleaching effect on the color and luminosity of inactive white-spot lesions after fixed orthodontic appliances. Angle Orthod. 2007; 77: 646-652.
12. Ismail AI, Sohn W, Tellez M, et al. The International Caries Detection and Assessment System (ICDAS): An integrated system for measuring dental caries: Methods. Community Dent Oral Epidemiol. 2007;35(3):170-178.
13. Jablonski-Momeni A, Stachniss V, Ricketts DN, Heinzel-Gutenbrunner M, Pieper K. Reproducibility and accuracy of the ICDAS-II for detection of occlusal caries in vitro. Caries Res. 2008;42(2):79-87.
14. DMG America online product instructions. https://www.dmg- america.com/fileadmin/DMG_America/IFU/IFU_Icon_091808_us_version_for_printing.pdf Accessed on October 10, 2019.

https://digitalcommons.aaru.edu.jo/fdj/vol7/iss2/3
DOI: https://doi.org/10.54623/fdj.7023

15. Ultradent online product instructions. https://assets.ctfassets.net/wfptrcrbtkd0/77KvbclixWh3aRJxFgS2mu/08af481 61fd164eaffb-d11888a193dbb/Opalustre-IFU-55424-UAR12.pdf. Accessed on February 26, 2020.
16. Buschang P, Chastain D, Keylor C, Crosby D, Julien K. Incidence of white spot lesions among patients treated with clear aligners and traditional braces. Angle Orthod. 2019;89:359–364.
17. Enaia M, Bock N, Ruf S. White-spot lesions during multibracket appliance treatment: A challenge for clinical excellence. Am J Orthod Dentofac Orthop. 2011; 140: e17-24.
18. Heymann G, Grauer D. A Contemporary Review of White Spot Lesions in Orthodontics. J Esthet Restor Dent. 2013; 25:85-95.
19. Hoffman D, Clark A, Rody Jr. W, McGorray S, Wheeler T. A prospective randomized clinical trial into the capacity of a toothpaste containing NovaMin to prevent white spot lesions and gingivitis during orthodontic treatment. Progress in Orthod. 2015; 16(25): 1-6.
20. Sonesson M, Bergstrand F, Gizani S, Twetman S. Management of post-orthodontic white spot lesions: an updated systematic review. Eur J Orthod. 2017; 39 (2): 116–121.
21. Höchli D, Hersberger-Zurfluh M, Papageorgiou S, Eliades T. Interventions for orthodontically induced white spot lesions: a systematic review and meta- analysis. Eur J Orthod. 2017; 39(2): 122–133
22. Linton JL. Quantitative measurements of remineralization of incipient caries. Am J Orthod Dentofacial Orthop. 1996; 110: 590-597.
23. Imani M, Safaei M, Afnaniesfandabad A, Moradpoor H, Sadeghi M, Golshah A, Sharifi R, Mozaffari H. Efficacy of CPP-ACP and CPP-ACPF for prevention and remineralization of white spot lesions in orthodontic patients: a systematic review of randomized controlled clinical trials. Acta Inform Med. 2019; 27(3): 199-204.
24. Savas S, Kavarík F, Ebru Kucukílmaz E. Evaluation of the remineralization capacity of CPP-ACP containing flouride varnish by different quantitative methods. J Appl Oral Sci. 2016;24(3):198-203.
25. Güçlü ZA, Alaçam A, Coleman NJ. A 12-Week Assessment of the Treatment of White Spot Lesions with CPP-ACP Paste and/or Fluoride Varnish. BioMed Res Intl. 2016 doi: 10.1155/2016/8357621. Epub Oct 11, 2016.
26. Ma X, Lin X, Zhong T, Xie F. Evaluation of the efficacy of casein phosphopeptide-amorphous calcium phosphate on remineralization of white spot lesions in vitro and clinical research: a systematic review and meta- analysis. BMC Oral Health. 2019; 19:295: 1-11.
27. Khijmatgar S , Reddy U, John S, Badavannavar A, D Souza T. Is there evidence for Novamin application in remineralization?: A Systematic review. J Oral Biol Craniofac Res. 2020; 10: 87-92.
28. Andersson A, Skold-Larsson K, Hallgren A, Petersson LG, Twetman S. Effect of a dental cream containing amorphous cream phosphate complexes on white spot lesion regression assessed by laser fluorescence. Oral Health Prev Dent. 2007; 5:229–233
29. Bourouni S, Dritsas K, Kloukos D, Wierichs R. Efficacy of resin infiltration to mask post-orthodontic or non-post-orthodontic white spot lesions or fluorosis - a systematic review and meta-analysis. Clin Oral Invest. 2021; 25:4711-4719.
30. Rohym S, Harhash A, Riad MF. One Year Clinical Evaluation of White Spot Lesions with Newly Introduced Resin Modified Glass-Ionomer in Comparison to Resin Infiltration in Anterior Teeth: a split mouth randomized controlled clinical trial from Egypt. Braz Dent Sci. 2021; 24(1): 1-13.
31. Pancu G, Ilie M, Andrian S. Iovan G, Topoliceanu C, Pancu I, Gheorghe A, Moldovanu A, Stoleriu S. Clinical and radiographic study regarding treatment if incipient carious lesions with Icon infiltration method. Romanian Oral Rehab. 2012;4(3): 43-47.
32. Ramalho KM, Eduardo Cde P, Rocha RG, Aranha AC. Ramalho KM, et al. A minimally invasive procedures for the esthetic achievement: enamel microabrasion of fluorosis stains. Gen Dent. 2010; 58(6): e225-9.
33. Segura A, Donly K, Wefel J. The effects of microabrasion on demineralization inhibition of enamel surfaces. Quintessence Intl. 1997:28:463-466.
34. Sundfeld RH, Mauro SJ, Briso ALF, Komatsu J, Castro MAM, Vidotti MAL, Martins FC. Smile recovery. II. Effects of microabrasion techniques on dental whitening. Rev Bras Odontol 1999; 56:311-318.
35. Sundfeld R, Briso ALF, Mauro SJ. Smile recovery. IV. External whitening of traumatized teeth. J Bras Clin Estet Odontol 2000;5:29-35.