10.5005/jp-journals-10024-1167

ORIGINAL RESEARCH

In vitro Caries-Preventive Effect of Fluoridated Orthodontic Resins against Cariogenic Challenge Stimulation

Neeraj Patil, Bhushan Jawale, Rahul Redasani, Lalit Chaudhari, JB Garde, Vivek Singh Chauhan

ABSTRACT

Aim: The aim of the present study was to evaluate the *in vitro* caries preventive effect of fluoridated orthodontic resins under pH cycling with two types of acid demineralizing saliva.

Materials and methods: Brackets were bonded to 120 extracted human premolars, using Rely-a-bond (n = 40), Tru-Bond (n = 40) and Ortho-one (n = 40) orthodontic bonding agents. Each group of resin was divided into 2 subgroups (n = 20): immersion in remineralizing artificial saliva for 14 days and acid saliva with pH 4.3. After 14 days of pH cycling the caries preventive effect on the development of white spot lesion was evaluated considering the presence of inhibition zones to white spot lesions using two scores: 0 = absence and 1 = presence. Kruskal-Wallis ANOVA and Mann-Whitney U tests were used.

Results: Formation of white spot lesions was observed only under pH cycling using acid saliva with pH 4.3; with Rely-a-bond and Tru-Bond being significantly more effective in preventing the appearance of white spot lesions effect than Ortho-one.

Conclusion: The acidity of the demineralizing solution influenced the formation of white spot lesions around orthodontic brackets under highly cariogenic conditions. Rely-a-bond and Tru-bond presented higher caries-preventive effect than Ortho-one.

Clinical significance: The development of fluoride-containing materials cannot be regarded as a permanent means to control dental caries lesions, but a complement along with other preventive methods.

Keywords: pH cycling, Fluoride, White spot lesions, Orthodontic resins.

How to cite this article: Patil N, Jawale B, Redasani R, Chaudhari L, Garde JB, Chauhan VS. *In vitro* Caries-Preventive Effect of Fluoridated Orthodontic Resins against Cariogenic Challenge Stimulation. J Contemp Dent Pract 2012;13(4):452-455.

Source of support: Nil

Conflict of interest: None declared

INTRODUCTION

The toothbrush provides the means by which the dentifrice is distributed to a tooth's surface and it disrupts and dislodges plaque and oral debris from these surfaces. The effectiveness of the toothbrush, however, depends on any one individual acquiring the skills and having the personal motivation to use it properly.[1]

Personal oral hygiene is difficult to perform when fixed orthodontic appliances are in place. Failure to manage plaque removal increases the risk of decalcification, caries and periodontal disease.[2] Despite the worldwide decrease of dental caries prevalence, the development of white spot lesions around orthodontic brackets continues to be a problem, especially because orthodontic devices facilitate biofilm the retention of biofilm, frequently causing gingivitis.[3]

One of the most difficult problems encountered in orthodontic treatment with fixed appliance is the control of enamel demineralization around the brackets. This iatrogenically caused white spot leads to poor esthetics and in severe cases, needs restorative treatment.[4]

The role of fluoride in reducing the incidence of dental caries has been known for years. Fluoride-releasing bonding adhesives were introduced to aid in the prevention of demineralization adjacent to orthodontic brackets.[5]

The aim of the present study was to evaluate the *in vitro* caries preventive effect of fluoridated orthodontic resins under pH cycling with two types of acid demineralizing saliva.

MATERIALS AND METHODS

One hundred and twenty healthy premolars indicated for extraction for orthodontic treatment were used. Teeth with caries, restoration, fracture, developmental deformity, stains and fluorosis were excluded from the study. The adhesives used in the study were 'Ortho-one', a self-cured adhesive (Bisco Inc. USA), 'Tru-bond', a fluoride-releasing, self-cured composite (C. Dent Products Co. Ind. USA) and 'Rely-a-bond,' a fluoride-releasing, self-cured composite

(Reliance Orthodontic Products Inc. USA). *Etchant and Primer as* provided by the manufacturer were used. Stainless steel Begg's curved brackets (GAC, Europe) were used.

Specimen Preparation

Each sample was mounted on acrylic blocks (with the buccal surface available for bonding) with roots embedded in the fast-set polymethyl methacrylate resin. Silicon carbide abrasive papers with successive grits were used to remove excess resin and to expose the bonding area. The coronal portion was subjected to prophylaxis with prophylactic rubber cups at low speed, and extra-thin pumice for 5 seconds. Specimens were washed in deionized water for 15 seconds, and dried with an oil-free air jet and water vapor for the same period of time. Bonding procedure for each group was carried out by strictly adhering to the manufacturers' instructions.

The groups were:

Group A: 'Ortho one', a self-cured adhesive (Bisco Inc. USA).

Group B: 'Tru-bond,' a fluoride-releasing, self-cured composite (C. Dent Products Co. Ind. USA).

Group C: 'Rely-a-bond,' a fluoride-releasing, self-cured composite (Reliance Orthodontic Products Inc. USA).

Cariogenic Challenge Simulation

All specimens were randomly allocated to control and experimental groups 24 hours after bonding. Subgroups of 20 specimens of each resin were immersed in one of the following solutions:

a. Immersion in artificial remineralizing saliva (negative control groups);
b. pH cycling with high cariogenic challenge in acid saliva with pH 4.3.

The groups were subjected to modified cariogenic pH cycling according to Featherstone et al.[6] In the pH-cycling system, the specimens were immersed for 6 hours in a demineralizing solution (calcium 2.0 mmol L-1, phosphate 2.0 mmol L-1 and acetate buffer 75 mmol L-1pH 4.3) and for 18 hours, in a remineralizing solution (calcium 1.5 mmol L-1, phosphate 0.9 mmol L-1, potassium chloride 150 mmol L-1 and Tris buffer 20 mmol L- 1 pH 7.0), to simulate a situation of high caries challenge. During the period of pH cycling, the specimens were kept in an incubator at a constant temperature of 37°C in order to simulate the oral environment. This procedure was repeated for 14 days during which the artificial saliva was replenished every alternate day.

Evaluation of Caries-Preventive Effect

The caries-preventive effect was evaluated through the presence of opaque, roughness, white spot lesion. The presence or absence of white spot lesion inhibition zone around the orthodontic bracket by a single calibrated examiner.

Statistical Analysis

The readings were tabulated for each of the groups and statistical analysis was performed using Kruskal-Wallis ANOVA and Mann-Whitney U test for evaluation and comparison of demineralization between groups.

RESULTS

Significant difference in demineralization inhibition was observed between the fluoride releasing (Rely-a-bond and/or Tru-bond) and control (Ortho-one) groups. Greatest demineralization zone was seen with Ortho-one followed by Tru-bond and Rely-a-bond. The difference among the demineralization between the experimental and control groups was found to be statistically highly significant, with $p < 0.001$. There was statistically no significant difference between the two experimental groups. The results are depicted in Table 1 and Figure 1.

DISCUSSION

In orthodontic practice, white spot lesions are observed with relative frequency around orthodontic appliances, especially when oral hygiene is poor. Prevention of demineralization during orthodontic treatment is one of the greatest challenges faced by clinicians, despite modern advances in caries prevention.[7-9]

Caries lesions adjacent to brackets can be reduced or even eliminated when fluoride compounds are used.[10]

In the present study, the pH-cycling regimen was used to reproduce the oral dynamic situation, first suggested by Featherstone et al[6] (1986) and modified by Carvalho and

Table 1: Distribution of white spot lesions in the different study groups

White spot lesion		*Study groups*					
		Group A		*Group B*		*Group C*	
		RS	DS	RS	DS	RS	DS
Present		0	80	0	40	0	35
Absent		100	20	100	60	100	65
Kruskal-Wallis ANOVA	χ^2	54.044					
	p	0.000 (HS)					
Mann-Whitney U		Group A > group B = group C (significant)					

DS: Demineralizing solution; RS: Reminerizing solution

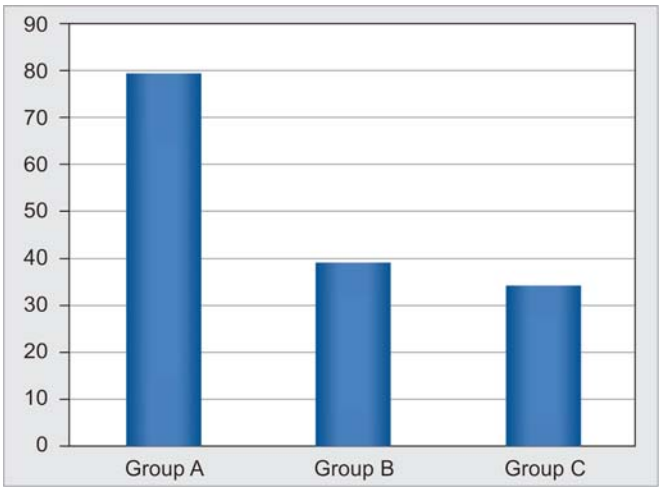

Fig. 1: Presence of white spot lesions in the various groups

Cury[11] (1999), establishing a correlation with the development of *in vivo* caries, in high cariogenic challenges. According to Ten Cate[12] (1990), this laboratorial model better simulates the variations of the pH in the oral environment.

In the present study, a significant difference in demineralization inhibition was observed between the fluoride releasing (Rely-a-bond and/or Tru-bond) and control (Ortho-one) groups. Greatest demineralization zone was seen with Ortho-one followed by Tru-bond and Rely-a-bond. The difference among the demineralization between the experimental and control groups was found to be statistically highly significant with $p < 0.001$. There was statistically no significant difference between the two experimental groups. This finding is in agreement with those of a study conducted by Lodaya S in 2011.[5]

The incorporation of fluoride in dental tissue reduces enamel solubility in acidic environments. This property is based on the capacity of fluoride to be incorporated into a crystalline lattice of the hydroxyapatite of hard dental tissues, resulting in a mineral phase that is less soluble and more acid resistant.[13]

Despite the fact that fluoride acts in reduction of WSL during orthodontic treatment, other studies have shown that the fluoride release of composite resins is 5 to 20% lower than that of glass ionomer cements.[14] Fluoride-releasing materials present a 'burst effect' pattern of fluoride release, with the largest amount of fluoride being released within the first few days of testing, followed by a rapid decline to much lower levels as a result of the small amount of incorporated fluoride.[15] The present study was conducted using artificial saliva, seeking an ionic balance and more similarity to the dynamics occurring in the oral cavity, particularly because it has been shown that fluoride release in artificial saliva is slower than it is in water.[16]

Because *in vitro* testing can never simulate oral conditions precisely, as in the present study, the results obtained cannot be extrapolated to assess the success of the material tested. Thus, variables present are numerous and the results need to be interpreted with care. Because different materials release different levels of fluoride at different intervals of time further research should focus on identifying the clinical relevance of fluoride released from the adhesives.[5]

CONCLUSION

The fluoride-releasing bonding agents showed a lesser degree of demineralization as compared with the conventional bonding agents. Both fluoride-releasing adhesives showed statistically significant lower enamel demineralization around the bracket when compared with the conventional adhesive. There was no statistically significant difference on comparing the demineralization between the two prototypes of fluoride-releasing adhesive.

CLINICAL SIGNIFICANCE

It is important to highlight, however, that the development of fluoride-containing materials cannot be regarded as a permanent means to control dental caries lesions, but a complement along with other preventive methods. For more efficient caries control in orthodontic patients, the combined use of fluoride releasing materials and external sources of fluoride has been recommended.

REFERENCES

1. Cancro LP, Fischman SL. The expected effect on oral health of dental plaque control through mechanical removal. Periodontology 2000,1995;8:60-74.
2. Wlicoxon DB, Ackerman RJ, Killoy WJ, Love JW, Sakamura JS, Tira DE. The effectiveness of a counter rotational-action power toothbrush on plaque control in orthodontic patients. Am J Orthod Dentofac Orthop 1991;99:7-14.
3. Gorton J, Featherstone JD. In vivo inhibition of demineralization around orthodontic brackets. Am J Orthod Dentofacial Orthop 2003;123:10-14.
4. Sondhi S, Saloum S. Preventing decalcification after orthodontic treatment. J Am Dent Assoc 1987;115:257-61.
5. Lodaya SD, Keluskar KM, Naik V. Evaluation of demineralization adjacent to orthodontic bracket and bond strength using fluoride-releasing and conventional bonding agents. Indian J Dent Res 2011;22(1):44-49.
6. Featherstone JDB, Oreilly MM, Shariati M, Brubler S. Enhancement of remineralization in vitro and in vivo. In: Leach, SA (Ed). Factors relating to demineralization and remineralization of the teeth. Oxford: IRL Press 1986:23-34.
7. Tufekci E, Dixon JS, Gunsolley JC, Lindauer SJ. Prevalence of white spot lesions during orthodontic treatment with fixed appliances. Angle Orthod 2011;81(2):206-10.

8. Ogaard B. Prevalence of white spot lesions in 19-year-olds: A study on untreated and orthodontically treated persons 5 years after treatment. Am J Orthod Dentofacial Orthop 1989;96(5): 423-27.
9. Benson PE, Shah AA, Millett DT, Dyer F, Parkin N, Vine RS. Fluorides, orthodontics and demineralization: A systematic review. J Orthod 2005;32(2):102-14.
10. Ogaard B, Rolla G, Arends J, ten Cate JM. Orthodontic appliances and enamel demineralization. Part 2. Prevention and treatment of lesions. Am J Orthod Dentofacial Orthop 1988; 94(2):123-28.
11. Carvalho AS, Cury JA. Fluoride release from some dental materials in different solutions. Oper Dent 1999;24(1):14-19.
12. Ten Cate JM. In vitro studies on the effects of fluoride on demineralization and remineralization J Dent Res 1990;69(Sp Issue):614-19.
13. Sudjalim TR, Woods MG, Manton DJ, Reynolds EC. Prevention of demineralization around orthodontic brackets in vitro. Am J Orthod Dentofacial Orthop 2007;131:705 e701-09.
14. Dijkman GE, de Vries J, Lodding A, Arends J. Long-term fluoride release of visible light-activated composites in vitro: A correlation with in situ demineralisation data. Caries Res 1993;27:117-123.
15. Cohen WJ, Wiltshire WA, Dawes C, Lavelle CL. Long-term in vitro fluoride release and rerelease from orthodontic bonding materials containing fluoride. Am J Orthod Dentofacial Orthop 2003 Nov;124(5):571-76.
16. Passalin P, Fidalgo TKS, Caldeira EM, Gleiser R, Nojima MCG, Maia LC. Preventive effect of fluoridated orthodontic resins subjected to high cariogenic challenges braz. Dent J 2010; 21(3):211-15.

ABOUT THE AUTHORS

Neeraj Patil

Professor, Department of Orthodontics, ACPM Dental College, Dhule, Maharashtra India

Bhushan Jawale (Corresponding Author)

Reader, Department of Orthodontics, Sinhgad Dental College and Hospital, Pune-411041, Maharashtra, India, e-mail: bhushanjawale1@gmail.com

Rahul Redasani

Reader, Department of Periodontics, School of Dental Sciences Krishna Institute of Dental Sciences, Deemed University, Karad Maharashtra, India

Lalit Chaudhari

Professor, Department of Oral Medicine and Radiology, ACPM Dental College, Dhule, Maharashtra, India

JB Garde

Professor and Head, Department of Oral and Maxillofacial Surgery Sinhgad Dental College and Hospital, Pune, Maharashtra, India

Vivek Singh Chauhan

Senior Lecturer, Department of Periodontology, Sinhgad Dental College and Hospital, Pune, Maharashtra, India