Dental Research Journal

Original Article

Bacterial colonization on coated and uncoated orthodontic wires: A prospective clinical trial

Seyed Hamid Raji[1], Hasan Shojaei[2], Parinaz Saeidi Ghorani[3], Elahe Rafiei[4]

[1]Torabinejad Research Center and Department of Orthodontics, School of Dentistry, [2]Department of Microbiology, School of Dentistry, Isfahan University of Medical Sciences, Isfahan, [3]Department of Orthodontics, School of Dentistry, Ahvaz Jundishapour University of Medical Sciences, Ahvaz, [4]Department of Orthodontics, School of Dentistry, Shahid Sadoughi University of Medical Sciences, Yazd, Iran

Received: August 2013
Accepted: November 2013

Address for correspondence:
Dr. Elahe Rafiei,
Department of Orthodontics, School of Dentistry, Shahid Sadoughi University of Medical Sciences, Yazd, Iran.
E-mail: rafiei@dnt.mui.ac.ir

ABSTRACT

Background: The advantages of coated orthodontic wires such as esthetic and their effects on reduced friction, corrosion and allergic reaction and the significant consequences of plaque accumulation on oral health encouraged us to assess bacterial colonization on these wires.

Materials and Methods: A total of 18 (9 upper and 9 lower) epoxy resin coated 16 × 22 nickel-titanium wires (Spectra, GAC, USA) and 18 (9 upper and 9 lower) non-coated 16 × 22 nickel-titanium wires (Sentalloy, GAC, USA) with isolated packages were selected and sterilized before application. The samples were divided randomly between upper and lower arches in 18 patients and hence that every patient received one coated and one uncoated wire at the same time. Samples were removed and cut in equal lengths after 3 weeks and placed in phosphate buffered saline buffer. After separation of bacteria in trypsin and ethylenediaminetetraacetic acid solution, the diluted solution was cultured in blood agar and bacterial colony forming units were counted. Finally, the data was analyzed using the paired *t*-test and the significance was set at 0.05.

Results: Mean of bacterial colonization on uncoated wires was more than that of coated wires ($P < 0.001$).

Conclusion: Bacterial plaque accumulation on epoxy resin coated nickel-titanium orthodontic wires is significantly lower than uncoated nickel-titanium wires.

Key Words: Bacterial colonization, coating, nickel-titanium wire

INTRODUCTION

Recently the demand for esthetic treatments has increased. These esthetics are important in every stage of treatment. The esthetics of orthodontic appliances is a major concern for patients.[1] After the introduction of the tooth–colored brackets, the only metal part remaining were the wires. It was favorable that this part becomes tooth-colored also.[2] Esthetic archwire is highly desirable to complement esthetic brackets in clinical orthodontics.[3] The metallic wires have the most favorable characteristics for orthodontic treatment due to their strength, hardness and malleability, therefore it seems that the best way for removing the metallic appearance, is to coat them with tooth-colored materials. Various non-metallic materials are used to coat wires, but only few are commercially available.[2] The available wires are usually coated with teflon or epoxy resin.[4]

The amount of force applied during treatment is also very important in orthodontics.[5] A lot of efforts have been made to decrease the friction between the wires and brackets. The primary intention in producing coated wires is esthetics, but now it has been proved that when used with ceramic brackets, these wires generate lower amounts of friction compared to normal wires.[6,7]

Besides the esthetic reasons, another concern is that the oral cavity represents a harsh environment for a

Access this article online

Website: http//:drj.mui.ac.ir

metallic orthodontic appliance of any kind. Corrosion of orthodontic appliances has been thoroughly studied.[8] It has been confirmed that coating the wires decreases their corrosion in the oral cavity and also decreases allergic reaction to nickel.[9]

Another important issue in orthodontics is to prevent the accumulation of microbial plaque on tooth and orthodontic appliance surfaces.[10-12] Microbial plaque formed on orthodontic appliances not only poses oral health risks,[13,14] but is also important in technical aspects because microbial plaque on elastics and elastomeric chains can severely decrease their force and tooth movements.[5]

Microbial plaque accumulation on orthodontic appliances could affect the frictional resistance during tooth movement. The aforementioned advantages of coated wires make the clinicians use them in orthodontic practice despite their higher cost.[15]

The advantages of using coated wires such as esthetics, reduced friction, reduced corrosion and allergic reactions on one hand and the importance of microbial plaque accumulation on orthodontic appliances regarding oral health, friction increase and force decay of elastomeric materials on the other hand prompted us to evaluate the amount of bacterial colonization on these wires.

MATERIALS AND METHODS

This prospective clinical trial was performed on patients visiting the Orthodontic Department of School of Dentistry, Isfahan University of Medical Sciences.

. The samples were chosen using the non-randomized simple method. The chosen patients had finished the first phase of treatment and were ready to enter the second part and their teeth were aligned. This study was approved by the Ethics and Research Committee of the School of Dentistry, Isfahan University of Medical Sciences.

The wires used in this study were 16 × 22 coated Ni-Ti (Spectra, GAC, USA) and 16 × 22 uncoated Ni-Ti (Sentalloy, GAC, USA). After sterilizing the wires in an autoclave, coated wires in the upper arch and uncoated wires in the lower arch, were used in 9 patients and the opposite for 9 other patients. After 3 weeks, the patients were recalled and the wires were removed cautiously to avoid any contact with oral mucosa.

They were cut in equal lengths and then they were placed in sterile plates containing phosphate buffered saline to keep the bacteria alive until they were transferred to a microbiology laboratory. In the laboratory the specimen were placed in a 25% tripsine and ethylenediaminetetraacetic acid solution and shook for 45 min. This process releases the bacteria and creates an adequate suspension of them.

Then, the suspension was rarefied. For this purpose, a volume of 10 µl of the suspension was mixed with 2.99 ml sterile saline so the total volume was 3 ml. The primary suspension was diluted 300 times. The achieved solution was uniformed using a shaker machine and 10 µl of it was poured in another tube with 0.99 ml saline, so the suspension was diluted another 100 times. A total volume of 10 µl of the final suspension was transferred to a blood-agar culture plate. After the rarefying processes, the amount of bacteria on the plate was $\frac{1}{3000000}$ of the initial amount. The bacteria from coated and uncoated wires were cultured on different plates and the number of the patient and wire type was recorded on each plate for future result evaluation. The plates were incubated at 37° for 24 h. Afterwards, the amounts of bacterial colonies were counted by a blinded laboratory technician. The process was repeated 3 times for each sample and the mean amount was recorded. The final amount of bacteria was calculated by multiplying the mean amount of the three tests in the concentration coefficient and the volume percentage of the initial suspension. The previous studies have reported that surface roughness is an important factor in absorbing microbial plaque,[12-17] therefore, both groups of wires were sent to Flight Industries physics laboratory and the surface roughness of each sample was evaluated by a roughness testing machine (Mahr, Germany).

Finally, the data were analyzed with the SPSS software (version 11) (SPSS Inc. Chicago, IL, USA) using the paired *t*-test and the significance was set at 0.05.

RESULTS

The mean amounts of colonies counted are showed in Table 1. There was a significant difference between the amounts of bacteria in two groups. The uncoated group showed more bacterial colonies ($P < 0.001$).

The *t*-test analysis showed that the bacterial accumulation on the upper and lower arches have no

significant difference. This is true for coated ($P = 0.7$) and uncoated ($P = 0.9$) wires [Table 2].

Surface roughness comparison showed that uncoated wires had higher surface roughness.

DISCUSSION

The results of this study showed that the difference between the coated and uncoated surface of wires affects the amount of bacterial plaque with the coated wires absorbing less bacteria.

A study done by Faltermeier *et al*.[11] compared four polymer bracket types regarding the amount of *Streptococcus mutans* accumulation and reported that the type of material in contact with bacterial colonies is determinant in the amount of bacterial absorption, which is consistent with the results of this study.

Maetani *et al*. in their study[18] stated that coating intra-oral instruments with teflon reduces the amount of plaque accumulation and eases plaque removal. This study also proves that surface characteristics of intra-oral instrument are an import factor in microbial plaque accumulation.

It seems that the difference between materials in absorbing microbial plaque is due to the difference between their surface characteristics such as surface energy and surface roughness.[12,17] In our study, we compared the surface roughness between coated and uncoated wires and the results showed that coated wires had lower surface roughness and also lower amounts of bacterial plaque. Therefore, it can be concluded that one reason for less bacterial plaque accumulation on uncoated wires could be their lower surface roughness.

Lee *et al*.[12] evaluated the surface characteristics of orthodontic materials and the effect of these characteristics on *S. mutans* adhesion. They reported that higher surface roughness and surface energy leads to more *S. mutans* absorption. They concluded that the increase in surface area and retention points associated with surface roughness leads to higher plaque accumulation. They also stated that changes in surface energy interrupts acid-alkaline and vanderwalls reactions which is critical for initial bacterial adhesion.

Quirynen[17] also showed that a decrease in surface energy and surface roughness reduces plaque formation and that the role of surface roughness is more significant, which confirms the results of the present study.

Bourauel *et al*.[19] compared the surface roughness of various orthodontic wires. They showed that Ni-Ti wires had a wide range of surface roughness from different manufacturers. The authors explain that different manufacturing techniques and final polishing are the reasons for different surface roughness values. In this study, the wires were from the same company, therefore, different technique types couldn't be the reason for different surface roughness values and the major reason for this difference could be the epoxy resin coating.

We also compared the amount of bacterial plaque accumulation in the lower and upper arches. The results showed that there was no significant difference between the arches. The previous studies also have reported that plaque formation is similar in different oral regions.[16,20]

Table 1: Average number of colonies formed on coated and uncoated wires

	Coated wires	Uncoated wires	*P* value
	Mean ± SD**	Mean ± SD**	
Total colony count	533.3±240.88	671±336.94	<0.001

*Paired *t*-test; **Numbers in the mean ± SD column should be multiplied in 10^5; SD: Standard deviation

Table 2: Average total bacterial colonies formed on upper and lower arch wires

Wire type	Jaw		*P* value
	Upper jaw	Lower jaw	
	Mean ± SD**	Mean ± SD**	
Coated wires	550±278.28	516.6±212.69	0.7
Uncoated wires	695±354.07	647±338.51	0.9

*Paired *t*-test; **Numbers in the Mean ± SD column should be multiplied in 10^5; SD: Standard deviation

CONCLUSION

Based on the above study, it can be concluded that bacterial plaque accumulation on epoxy resin coated nickel-titanium orthodontic wires is significantly lower than uncoated nickel-titanium wires. Future studies can compare the different types of coating polymers regarding microbial plaque accumulation on orthodontic wires.

ACKNOWLEDGMENTS

The authors gratefully acknowledge that this report is based on a thesis submitted to the School of Dentistry, Isfahan University of Medical Sciences, in partial fulfillment of

the requirement for a MS degree (Grant No.388109). This study was financially supported and approved by the Isfahan University of Medical Sciences, Iran.

REFERENCES

1. Hershey HG. The orthodontic appliance: Esthetic considerations. J Am Dent Assoc 1988;117:29E-34.
2. Satyajit B, Jerold SH, Robrt PE. Aesthetic Orthodontic Arch Wire. US Patent 5454716, Oct. 3, 1995.
3. Iijima M, Muguruma T, Brantley W, Choe HC, Nakagaki S, Alapati SB, *et al*. Effect of coating on properties of esthetic orthodontic nickel-titanium wires. Angle Orthod 2012;82:319-25.
4. Elayyan F, Silikas N, Bearn D. *Ex vivo* surface and mechanical properties of coated orthodontic archwires. Eur J Orthod 2008;30:661-7.
5. Nanda RS, Ghosh J. Biomechanical considerations in sliding mechanics. In: Nanda R, editor. Biomechanics in Clinical Orthodontics. Philadelphia: W.B.Saunders; 1997. p. 188-217.
6. Husmann P, Bourauel C, Wessinger M, Jäger A. The frictional behavior of coated guiding archwires. J Orofac Orthop 2002;63:199-211.
7. El-Kader HM, Ahmed MN, Ibrahim AS. Frictional resistance of teflon coated nitinol wires as combined with wire bending effect during tooth movement. A comparative study. Egypt Orthod J 1994;9:81-92.
8. Bravo LA, de Cabañes AG, Manero JM, Rúperez E, Gil FJ. NiTi superelastic orthodontic archwires with polyamide coating. J Mater Sci Mater Med 2014; 25: 555-60.
9. Kim H, Johnson JW. Corrosion of stainless steel, nickel-titanium, coated nickel-titanium, and titanium orthodontic wires. Angle Orthod 1999;69:39-44.
10. van Gastel J, Quirynen M, Teughels W, Coucke W, Carels C. Influence of bracket design on microbial and periodontal parameters *in vivo*. J Clin Periodontol 2007;34:423-31.
11. Faltermeier A, Bürgers R, Rosentritt M. Bacterial adhesion of *Streptococcus mutans* to esthetic bracket materials. Am J Orthod Dentofacial Orthop 2008;133:S99-103.
12. Lee SP, Lee SJ, Lim BS, Ahn SJ. Surface characteristics of orthodontic materials and their effects on adhesion of mutans *Streptococci*. Angle Orthod 2009;79:353-60.
13. Levin L, Samorodnitzky-Naveh GR, Machtei EE. The association of orthodontic treatment and fixed retainers with gingival health. J Periodontol 2008;79:2087-92.
14. Boyd RL. Longitudinal evaluation of a system for self-monitoring plaque control effectiveness in orthodontic patients. J Clin Periodontol 1983;10:380-8.
15. Riley JL, Gurret SG, Moon PC. Frictional forces of ligated plastic and metal edgewise brackets. J Dent Res 1971;58:A21.
16. Auschill TM, Hellwig E, Sculean A, Hein N, Arweiler NB. Impact of the intraoral location on the rate of biofilm growth. Clin Oral Investig 2004;8:97-101.
17. Quirynen M. The clinical meaning of the surface roughness and the surface free energy of intra-oral hard substrata on the microbiology of the supra- and subgingival plaque: Results of *in vitro* and *in vivo* experiments. J Dent 1994;22 Suppl 1:S13-6.
18. Maetani T, Miyoshi R, Nahara Y, Kawazoe Y, Hamada T. Plaque accumulation on Teflon-coated metal. J Prosthet Dent 1984;51:353-7.
19. Bourauel C, Fries T, Drescher D, Plietsch R. Surface roughness of orthodontic wires via atomic force microscopy, laser specular reflectance, and profilometry. Eur J Orthod 1998;20:79-92.
20. Arweiler NB, Hellwig E, Sculean A, Hein N, Auschill TM. Individual vitality pattern of *in situ* dental biofilms at different locations in the oral cavity. Caries Res 2004;38:442-7.

How to cite this article: Raji SH, Shojaei H, Ghorani PS, Rafiei E. Bacterial colonization on coated and uncoated orthodontic wires: A prospective clinical trial. Dent Res J 2014;11:680-3.

Source of Support: Nil. **Conflict of Interest:** None declared.