An *In vitro* Evaluation of Effects of Different Mouthwashes on Frictional Resistance of Orthodontic Bracket and Archwire: An Original Research Study

Ruchi Saini[1], Mir Yasser Abdullah[2], Neha Thakur[3], Varun Kashyap[4], G. Dinesh Nandakumar[5], Aveek Ghosh[1]

[1]Department of Orthodontics and Dentofacial Orthopedics, Institute of Dental Sciences and Technologies, Modi Nagar, Ghaziabad, Uttar Pradesh, India.
[2]Private Practitioner (Orthodontist), Srinagar, Kashmir, India.
[3]Department of Orthodontics and Dentofacial Orthopedics, Kalka Dental College, Meerut, Uttar Pradesh, India
[4]Department of Orthodontics and Dentofacial Orthopedics, Uttaranchal Dental and Medical Research Institute, Dehradun, India.
[5]Department of Orthodontics and Dentofacial Orthopedics, Best Dental Science College, Madurai, Tamil Nadu, India.

Abstract

Background: The exclusive aim of this *in vitro* study was to evaluate the effects of two commercially available mouthwashes (Colgate Ortho Defense Phos-Flur Fluoride Rinse and Vitis Orthodontic Mouthwash) on frictional resistance of orthodontic bracket and archwire.

Materials and Methods: A total of 30 sample teeth (maxillary premolars) were collected for the study. Two commonly used popular mouthwashes to control gingivitis in the orthodontic patients were selected. These were Colgate Ortho Defense Phos-Flur Fluoride Rinse and Vitis Orthodontic Mouthwash. Artificial saliva was preferred as a control immersion medium. All teeth were cleaned carefully and mounted individually on auto-curing pink acrylic resin cube of 15 mm side. The orthodontic brackets were bonded at sample teeth individually by Self-Cure Bonding Adhesive. Archwires were ligated on the stainless steel brackets. The static frictional resistance between orthodontic bracket and archwire was considered by universal testing machine.

Results: The primary data were subjected to suitable statistical tests to obtain p values, mean, standard deviation, Chi-square test, standard error, and 95% CI. Group III samples illustrated maximum mean frictional resistance (2.11N). Group II samples showed mean frictional resistance (1.98N) and Group I samples showed significantly smaller values of mean frictional resistance (1.01N). Level of significance (p value) was reported to be significant for the samples of Group III (Vitis Orthodontic Mouthwash). Two sample t-tests for comparison of variables between all three groups revealed highly significant *P* value.

Conclusion: Within the study limitations, it was concluded that clinical usage of mouthwashes increases the frictional resistance between orthodontic bracket and archwire. Colgate Ortho Defense Phos-Flur Fluoride Rinse showed lesser static frictional resistance compared to Vitis Orthodontic Mouthwash. However, the difference was insignificant.

Keywords: Colgate Ortho Defense Phos-Flur Fluoride Rinse, Frictional resistance, Orthodontic bracket, Vitis Orthodontic Mouthwash.

Introduction

It is a well-established fact that friction during fixed orthodontic therapy is produced by the relative movement between the archwire and bracket. This frictional force should be ideally overcome before force can be transferred from the orthodontic appliance to the teeth. It is very imperative for orthodontists to recognize the accurate frictional forces run into the bracket wire junction. In general, frictional forces are of two types.[1,2] A static frictional force is the force required to begin the relative sliding of two interfaces. The second type of frictional force is the kinetic frictional force. This comes into play when the tooth moves in the direction of the applied force. Many of the researchers have emphasizes that this is very significant to consider number of factors that

Access this article online

Website:
www.jrad.co.in

DOI:
https://doi.org/10.53064/jrad.2021.12.5.58

Address for correspondence: Dr. Ruchi Saini,
Department of Orthodontics and Dentofacial Orthopedics, Institute of Dental Sciences and Technologies, Modi Nagar, Ghaziabad, Uttar Pradesh, India.
E-mail: drruchisaini@yahoo.co.in

Received: Jun 01,2021; **Accepted:** Jun 23,2021; **Published:** Aug 05, 2021

How to cite this article: Saini R, Abdullah MY, Thakur N, Kashyap V, Nandakumar GD, Ghosh A. An *In vitro* Evaluation of Effects of Different Mouthwashes on Frictional Resistance of Orthodontic Bracket and Archwire: An Original Research Study. J Res Adv Dent 2021;12(5):1-242

potentially affect the magnitude of frictional forces.[3,4] These are primarily type of material of brackets and archwires, bracket and wire spacing, size of the archwire, archwire cross-sectional configuration, and rotator force acting at the bracket archwire junction. Moreover, few pioneer workers have proved other responsible factors including surface conditions of the archwires and bracket slot. In addition, the changes of temperature and pH triggered by different diet, digestion of macromolecules, and oral microorganisms are also significant factors.[5,6] Overall, combined effects of these factors finalize clinical performance of orthodontic elements that present in the oral cavity for months or years. In South East Asian continent, people are having habit of consuming citrus-based food and beverages such as lemon, orange, and sweet lemon. In literature, there are clear controversial concepts given by many researchers regarding the effects of these acids the performance and characteristics of orthodontic appliances.[7] Few of the workers have reported that rising acidity (reducing pH), more and more elements released from the alloy resulting into corrosion. This corrosion, in turn, increases the frictional force between wires and steel brackets.[8,9] Therefore, in most of the cases, these frictional forces negatively affect the treatment procedure by hampering tooth movement, which can result in ultimate failure of anchorage. The ultimate aim of this *in vitro* study was to evaluate the effects of two commercially available mouthwashes (Colgate Ortho Defense Phos-Flur Fluoride Rinse and Vitis Orthodontic Mouthwash) on frictional resistance of orthodontic bracket and archwire by universal testing machine.

Materials and Methods

This study was designed and executed on *in vitro* basis. A total of 30 sample teeth were collected for study. These were maxillary premolars extracted for miscellaneous reasons. Only samples with sound tooth structure were included in the study. All carious, fractured, malformed, teeth with iatrogenic damage, restored teeth, congenitally defected, and developmentally defected teeth were excluded from the study. In addition, teeth with grounded enamel or dentine were also not entertained for study. These samples were preserved immediately after extraction by keeping them into distilled water. Two commonly used popular mouthwashes to control gingivitis in the orthodontic patients were chosen. These were Colgate Ortho Defense Phos-Flur Fluoride Rinse and Vitis Orthodontic Mouthwash. Artificial saliva was preferred as a control immersion medium. For categorization and analysis, samples were studied into three groups of 10 each. All teeth were cleaned meticulously and mounted individually on auto curing pink acrylic resin (DPI RR Cold Cure, Mumbai, India) cube of 15 mm side. This was to ensure accurate reading without any minute movements while their inspection under testing machine. Basic standardization was followed for all samples to have uniformity in results. The orthodontic brackets (All Star Orthodontics, Vancouver, Washington, USA) were bonded at the center of the clinical crown of sample individually. Orthosource Superbond Self-Cure Bonding Adhesive (Libral Traders) was used for adhesion purpose. Archwires (Ortho Organizer, USA) were ligated on the stainless steel brackets. First, study group was control in which 10 sample teeth were immersed into artificial saliva. Artificial saliva preparations are intended to copy natural saliva both chemically and physically. They are anticipated to have a viscoelastic behavior similar to normal human saliva to offer same viscosity and related properties. Group 2 and Group 3 samples were immersed into Colgate Ortho Defense Phos-Flur Fluoride Rinse and Vitis Orthodontic Mouthwash, respectively (Figure 1). All samples were immersed in the respective solutions and incubated at 37°C for 1.5 h. This time was equivalent to 3 months of 1 min daily application of these mouthwashes. This was as per recommendations of the study conducted by Walker *et al*.[10] After these samples were taken out, rinsed well with distilled water, and placed individually into clean and labeled glassware. The static frictional resistance between orthodontic bracket and archwire was considered by universal testing machine (Instron Hounsfield, Tinius Olsen Ltd., Honeycrock Lane, Redhill, UK). Testing was based on the current American National Standard/American Dental Association Specification No. 32 for orthodontic wires. Data thus received were compiled in table and subjected to basic statistical analysis. $P < 0.05$ was considered statistically significant ($P < 0.05$).

Results

In this study, all obvious results and data were sent for statistical analysis using statistical software Statistical Package for the Social Sciences version 21 (IBM Inc., Armonk, New York, USA). The source data were subjected to suitable statistical tests to obtain p values, mean, standard deviation, Chi-square test, standard error, and 95% CI. Table 1 shows that Groups I, II, and III have artificial saliva, Colgate Ortho Defense Phos-Flur Fluoride Rinse, and Vitis Orthodontic Mouthwashes, respectively. All study groups have 10 teeth samples each. Table 2 demonstrates basic statistical representation with the level of significance assessment using Pearson Chi-square

Figure 1: Group II and Group III mouthwashes studied in the study

test (for Groups I, II, and III). Group III samples illustrated maximum mean frictional resistance (2.11N). Group II samples showed mean frictional resistance (1.98N) and Group I samples showed significantly smaller values of mean frictional resistance (1.01N). Level of significance (*P* value) was reported to be significant for the samples of Group III (Vitis Orthodontic Mouthwash). Table 3 demonstrates comparison of frictional resistance among the three study groups using one-way ANOVA (for Groups I, II, and III). The level of significance was noted to be very significant for the ANOVA test between the groups (0.002). Table 3 also demonstrates two sample *t*-test for comparison of variables between Group I, Group II, and Group III. The *P* value was noted to be highly significant (0.001).

Discussion

One of the most practiced methods among orthodontists is sliding mechanics. Friction is one of the most significant prominent factors in this mechanics as it's negatively affects sliding mechanism.[11,12] Usually, this frictional force badly affects the therapeutic procedure by diminishing or even stopping tooth movement. Such events can eventually lead to loss of overall anchorage. According to earlier studies, the sliding friction decreases the applied force up to 50%.[13,14] Ideally, total eradication of this frictional force is desirable, even if it is not feasible to achieve. Literature has well evidenced that several factors influence the assessment of friction rates. These are oral atmospheric factors, wire and bracket size, wire and bracket material, and surface characteristics.[15,16] Long-term corrosion processes can also changes the surface configuration. Such changes can lead to alterations in the physical properties of the material. Changes in these parameters can eventually affect the clinical efficiency and performance. Several researchers in the literature have shown that about 50% of the force necessary for tooth movement is exhausted to conquer the friction force.[17,18] Hence, the accurate selection of brackets and wires for particular patient is an essential step in orthodontic therapy. Many of the orthodontic patients have already high caries index; therefore, mouthwash is being advised for them to control mechanical plaque control and management.[19,20] Similarly, few patients experience high caries and periodontal activity after installation of orthodontic appliances such as archwire and brackets.[21-23] This is particularly true for cases of fixed orthodontic appliances. In spite of their valuable effects, mouthwashes can alter the mechanical and surface properties of archwires and brackets and enhance the microhardness and friction. In addition, our study results clearly showed that usage of commercial mouthwash increases corrosion. We studied two mouthwashes and both significantly imparted in corrosion process. Corrosion may considerably alter the surface properties of metals as well. Nickel titanium is one of the most frequently used wire materials in orthodontic therapy. Normally, nickel–titanium wires are believed to be corrosion resistant. This property is mainly due to presence of protective passive film of titanium oxide.[24,25]

Table 1: Sample allocation and groups

Group	*n*	Mouthwash
I	10	Artificial saliva (control)
II	10	Colgate Ortho Defense Phos-Flur Fluoride Rinse
III	10	Vitis Orthodontic Mouthwash

Table 2: Basic statistical representation with the level of significance evaluation using Pearson Chi-square test (for Groups I, II, and III)

Parameters	Mean frictional resistance (Newton)	Std. deviation	Std. error	95% CI	Pearson Chi-square Value	df	Level of significance (*P* value)
Group I	1.01	0.930	0.290	1.96	1.025	1.0	0.086
Group II	1.98	0.682	0.636	1.43	1.183	2.0	0.500
Group III	2.11	0.029	0.927	1.09	1.376	1.0	0.010*

***P**<0.05 significant

Table 3: Comparison of frictional resistance among the three study groups using one-way ANOVA (for Groups I, II, and III) and two sample *t*-test for comparison of variables between Group I, Group II, and Group III

Variables	Degree of freedom	Sum of squares ∑	Mean sum of squares m∑	F	Level of significance (*P* value)
Between groups	3	4.049	1.541	4.671	0.002*
Within groups	36	12.039	0.870		-
Cumulative	571.43	19.847		-	

Two sample *t*-test

Variables	Group I		Group II		Group III		*P* value
	Mean	S.D.	Mean	S.D.	Mean	S.D.	
Frictional resistance (Newton)	1.01	0.930	1.98	0.682	2.11	0.029	0.001*

**P*<0.05 significant

Conclusion

Within the limitation of the study, it was concluded that Colgate Ortho Defense Phos-Flur Fluoride Rinse has lesser static frictional resistance compared to Vitis Orthodontic Mouthwash. In general, both of the studied mouthwashes have increased the frictional resistance considerably. However, the difference was not very significant. Hence, it is very clear that clinical usage of these mouthwashes increases the frictional resistance between orthodontic bracket and archwire. Selection of suitable mouthwash must be based on overall assessment of oral cavity and ongoing orthodontic treatment. Our study outcomes should be taken as suggestive for assuming prognosis for similar clinical situations. Nevertheless, we look forward to have some other large-scale studies that may further establish certain crucial and concrete norms in these regards.

Funding

No external funds were allocated for this study.

Statement of Conflicts of Interest

In the opinion of the author, there were no conflicts of interest.

References

1. Wajahat M, Moeen F, Husain SW, Siddique S, Khurshid Z. Effects of various mouthwashes on the orthodontic Nickel-Titanium wires: Corrosion analysis. J Pak Dent Assoc 2020;29:30-7.
2. Garma NM, Hussien HM, Nahidh M. Effect of mouthwashes on frictional properties of gold-plated and ordinary stainless steel orthodontic brackets. World J Dent 2018;9:489-94.
3. Bednar JR, Gruendeman GW, Sandrik JL. A comparative study of frictional forces between orthodontic brackets and arch wires. Am J Orthod Dentofacial Orthop 1991;100:513-22.
4. Kusy RP, Whitley JQ. Friction between different wire-bracket configurations and materials. Semin Orthod 1997;3:166-77.
5. Cacciafesta V, Sfondrini MF, Ricciardi A, Scribante A, Klersy C, Auricchio F. Evaluation of friction of stainless steel and esthetic self-ligating brackets in various bracket-archwire combinations. Am J Orthod Dentofacial Orthop 2003;124:395-402.
6. Baker KL, Nieberg LG, Weimer AD, Hanna M. Frictional changes in force values caused by saliva substitution. Am J Orthod Dentofacial Orthop 1987;91:316-20.
7. Kusy RP, Whitley JQ, Prewitt MJ. Comparison of the frictional coefficients for selected archwire-bracket slot combinations in the dry and wet states. Angle Orthod 1991;61:293-302.
8. Tselepis M, Brockhurst P, West VC. The dynamic frictional resistance between orthodontic brackets and arch wires. Am J Orthod Dentofacial Orthop 1994;106:131-8.
9. Al-Mansouri N, Palmer G, Moles DR, Jones SP. The effects of lubrication on the static frictional resistance of orthodontic brackets. Aust Orthod J 2011;27:132-8.
10. Walker MP, Ries D, Kula K, Ellis M, Fricke B. Mechanical properties and surface characterization of beta titanium and stainless steel orthodontic wire following topical fluoride treatment. Angle Orthod 2007;77:342-8.
11. Kao CT, Ding SJ, Wang CK, He H, Chou MY, Huang TH. Comparison of frictional resistance after immersion of metal brackets and orthodontic wires in a fluoride-containing prophylactic agent. Am J Orthod Dentofacial Orthop 2006;130:51-9.
12. Leal RC, Amaral FL, França FM, Basting RT, Turssi CP. Role of lubricants on friction between self-ligating brackets and archwires. Angle Orthod 2014;84:1049-53.
13. Danaei SM, Safavi A, Roeinpeikar SM, Oshagh M, Iranpour S, Omidkhoda M. Ion release from orthodontic brackets in 3 mouthwashes: An *in vitro* study. Am J Orthod Dentofacial Orthop 2011;139:730-4.
14. Carson CF, Hammer KA, Riley TV. *Melaleuca alternifolia* (Tea tree) oil: A review of antimicrobial and other medicinal properties. Clin Microbiol Rev 2006;19:50-62.
15. Rahman B, Alkawas S, Al Zubaidi EA, Adel OI, Hawas N. Comparative antiplaque and antigingivitis effectiveness of tea tree oil mouthwash and a cetylpyridinium chloride mouthwash: A randomized controlled crossover study. Contemp Clin Dent 2014;5:466-70.
16. Cox SD, Mann CM, Markham JL, Gustafson JE, Warmington JR, Wyllie SG. Determining the antimicrobial actions of tea tree oil. Molecules 2001;6:87-91.
17. Groppo FC, Ramacciato JC, Simões RP, Flório FM, Sartoratto A. Antimicrobial activity of garlic, tea tree oil, and chlorhexidine against oral microorganisms. Int Dent J 2002;52:433-7.
18. Santamaria M Jr., Petermann KD, Vedovello SA, Degan V, Lucato A, Franzini CM. Antimicrobial effect of *Melaleuca alternifolia* dental gel in orthodontic patients. Am J Orthod Dentofacial Orthop 2014;145:198-202.
19. Takarada K. P29 the effects of essential oils on periodontopathic bacteria and oral halitosis. Oral Dis 2005;11:115.
20. Forrer M, Kulik EM, Filippi A, Waltimo T. The antimicrobial activity of alpha-bisabolol and tea tree oil against *Solobacterium moorei*, a Gram-positive bacterium associated with halitosis. Arch Oral Biol 2013;58:10-6.
21. Graziano TS, Calil CM, Sartoratto A, Franco GC, Groppo FC, Cogo-Müller K. *In vitro* effects of *Melaleuca alternifolia* essential oil on growth and production of volatile sulphur compounds by oral bacteria. J Appl Oral Sci 2016;24:582-9.
22. McLaughlin RP, Bennett JC, Trevisi HJ. Systemized Orthodontic Treatment Mechanics. St. Louis: Elsevier Health Sciences; 2001.
23. Schumacher HA, Bourauel C, Drescher D. The effect of the ligature on the friction between bracket and arch. Fortschr Kieferorthop 1990;51:106-16.
24. Riley JL, Garrett SG, Moon PC. Frictional Forces of Ligated Plastic and Metal Edgewise Brackets. Richmond, VA: Virginia Commonwealth University, Medical College of Virginia; 1979.
25. Barrett RD, Bishara SE, Quinn JK. Biodegradation of orthodontic appliances. Part I. Biodegradation of nickel and chromium *in vitro*. Am J Orthod Dentofacial Orthop 1993;103:8-14.