The Impact of Herbal Mouth Rinse on the Bond Strength of Orthodontic Brackets: An *In vitro* Study

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Abstract

Aim: The present study was conducted to evaluate the effect of herbal mouth rinse on the Shear Bond Strength (SBS) of orthodontic brackets to enamel surfaces.

Methods: Two herbal mouth rinses (Myrrh and Parodontax®) were used in the study. Artificial saliva was used as a negative control and carbonated soft drink as positive control. 60 extracted premolars (15 in each group) were used to study the SBS. Standard twin metal brackets were bonded on the center of the buccal surface of premolar. The SBS and Adhesive Remnant Index (ARI) of the groups were evaluated and the data were analyzed statistically.

Results: The orthodontic brackets exposed to myrrh showed significantly lower shear bond strength (12.60 ± 2.86 MPa) compared to the control group (artificial saliva). However Parodontax® had no impact on the SBS compared to the control. The ARI pattern showed bond failure at enamel adhesive interface.

Conclusion: It can be concluded that the oral rinses containing myrrh significantly reduced the SBS of the bonding of orthodontic brackets to the enamel surface. Further research is mandatory to substantiate the results of the present study.

Key Words: Myrrh, Shear bond strength, Bonding, Herbal mouth wash, Soft drinks

Introduction

Direct bonding of orthodontic brackets using a resin based composite is the most preferred method practiced by orthodontists. It has several advantages such as easy bracket placement, acceptable clinical success rate and reduction in chair side time. The demineralization of enamel surfaces and white spot lesion formation around orthodontic bracket as a result of fixed orthodontic appliance therapy is a primary concern of clinicians [1]. The fixed orthodontic appliances provide favorable conditions for the colonization of oral microorganisms because the appliances provide spaces for bacterial binding and patients have difficulty in maintaining adequate oral hygiene [2]. Various approaches using antibacterial agents have been investigated to control bacterial adhesion and plaque accumulation around the orthodontic brackets [3,4].

Premature debonding is an unfavorable side effect that can cause a delay in the treatment time. Most of the premature debonding occurs due to the failure of the bonding material, or from the unfavorable biting forces as well as the substances that comes in contact with them [5,6]. Studies have shown that the carbonated beverages lowers the intraoral pH value, thereby producing more tooth erosion [7,8]. The consumption of carbonated soft drinks is increasing among the population and various studies have shown its adverse effect on enamel and restorations [9-11].

The use of herbal tooth pastes and oral rinses are getting more popular because of the adverse effects reported with the long term use of some of the conventional products [12,13]. There is scarcity of scientific documentation about these tooth pastes and oral rinses that are labeled as ‘‘herbal’. They contain a range of natural products ranging from plant extracts, volatile oils, honey etc. [14].

Myrrh is one of the oldest known medicines which has been widely used by ancient Egyptians. The name myrrh is derived from the Arabic and Hebrew word mur, which means bitter [15]. It is an aromatic resinous exudate obtained from the plant Comniphora species (*Comniphora* molmol) [16]. Myrrh is used to treat conditions of the mouth, gingival tissues, throat and digestive system. Evidence suggests that toothpaste and mouthwashes containing myrrh preparations are effective for treating bleeding gums [17-19]. Parodontax® oral rinse is composed of sodium bicarbonate, sodium fluoride and herbal ingredients such as chamomile, Echinacea, sage and rhatany, myrrh, claimed to be a natural antiseptic; and peppermint oil, which has analgesic, anti-septic and anti-inflammatory properties.

Even though these mouthwashes have several advantages, it might adversely affect the bond strength of resins commonly used for bonding of orthodontic brackets [20]. Hence the objective of the present study is to investigate the impact of these herbal oral rinses on the bonding of brackets to the tooth surface. The bond failure is studied in an in vitro model by assessing the shear bond strength of bonded brackets exposed to these agents.

Materials and Methods

Sixty premolar teeth extracted for orthodontic purposes from

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young subjects (12-16 yrs. of age) were used for this study. Teeth with any enamel defects were excluded and replaced. The teeth were stored in one percent thymol solution to avoid dehydration and bacterial growth. The teeth were cleansed with pumice paste and dried with gentle air. The dried surface was etched with 38 percent phosphoric acid gel (Pulpdent Corp. Boston, MA, USA) for 15 seconds and later on washed and dried using water syringe and oil free compressed air. Standard twin metal brackets (Dentaurum, Pforzheim, Germany) were bonded on the center of the buccal surface of premolar with No-Mix composite (Unite, 3M Unitek Dental Products Division, Monrovia, CA, USA). A thin layer of sealant was applied on the etched enamel and metal base of the premolar metal brackets by a micro brush before applying the adhesive paste. The brackets were placed on the center of the tooth and pressed firmly to flush out the excessive adhesive. The excess resin was removed using a sharp scaler.

The sixty prepared specimens were randomly divided into four groups. The labeled samples were selected using a lottery method and grouped as follows.

Group 1: Control group - The samples were stored in artificial saliva for 4 weeks

Group 2: Myrrh - The samples were submerged in 10% myrrh for 60 seconds twice a day separated by an interval of 8 hours over a period of 4 weeks. The rest of the time the samples were kept in artificial saliva.

Group 3: Parodontax® mouth wash (GlaxoSmith-Kline, Middlesex, UK)-The samples were submerged in Parodontax mouth wash for 60 seconds twice a day separated by an interval of 8 hours over a period of 4 weeks. The rest of the time the samples were kept in artificial saliva.

Group 4: Mirinda Orange® (PepsiCo, Barcelona, **Spain**) - the samples were submerged in Mirinda orange® for 15 minutes twice a day separated by an interval of 8 hours over a period of 4 weeks. The rest of the time the samples were kept in artificial saliva.

The artificial saliva used in this study was prepared with inorganic ion concentrations similar to saliva [21]. The carbonated soft drink Mirinda® was used as a positive control.

Shear Bond Strength (SBS) testing

After 4 weeks of exposure, the teeth were mounted vertically in a cold-cure acrylic (Orthobond, Vernon-Benshoff Co., Albany, NY, USA). A mounting jig was used to align the buccal surface of the tooth to be perpendicular with the bottom of the mold. The brackets were debonded using a shear peel load on a universal testing machine (Instron Corporation, Canton, Massachusetts, USA) connected to a computer that recorded the results of each test and expressed the SBS-values in megapascals (MPa). An occluso-gingival load of 10kN was applied to the bracket by a knife- edged guillotine producing a shear force at the bracket-tooth interface. Shear bond strengths were measured at a crosshead speed of 1mm /min.

Evaluation of fracture sites

After shear mode testing, the bracket bases and the enamel surfaces were inspected independently by one evaluator, to determine the predominant bond failure site. All identification markings were covered, and the samples were chosen at random for examination. The teeth and debonded attachments were examined under a light-optical stereomicroscope (Nikon SM2-10, Tokyo, Japan) at x20 magnification to determine fracture sites, and to establish the character of the debonded surface. The sites were classified as Type 0, 1, 2 or 3, according to the Adhesive Remnant Index (ARI), described by Artun and Bergland [22]. This index determines the amount of bonding material remaining on the enamel surface after bond failure.

0. 0% on the enamel (No adhesive left on the tooth)
1. <50% on the enamel (Less than half of the adhesive left on the tooth)
2. >50% on the enamel (More than half of the adhesive left on the tooth)
3. 100% on the enamel (All adhesive left on the tooth, with distinct Impression of the bracket mesh)

Statistical analysis

The data was tabulated and analyzed using InStat® (Graph Pad InStat, GraphPad Software, San Diego, CA).The shear bond strength was analyzed using ANOVA. Dunnett's test was used to determine significant differences between control and the test groups. A value of $P<0.05$ was considered significant.

Results

The mean shear bond strength of the groups tested is depicted in *Table 1* and *Figure 1*. Samples exposed to myrrh showed significantly lower shear bond strength (12.60 ± 2.86) compared to the artificial saliva (19.43 ± 4.35). Although samples exposed to Parodontax mouth wash showed lower SBS (17.01 ± 4.85) compared to Saliva, the result was not statistically significant. The samples exposed to the carbonated soft drink also showed significantly lower shear bond strength compared to the control. Dunnett's test showed statistically significant ($p<0.05$) reduction of shear bond strength with

Table 1. *Shear bond strength (MPa) of the bracket exposed to the materials.*

Groups (n=15)	Shear bond strength Mean ± SD
Artificial Saliva	19.43 ± 4.35
Myrrh	12.60 ± 2.86
Parodontax®	17.01 ± 4.85
Mirinda®	15.74 ± 1.81

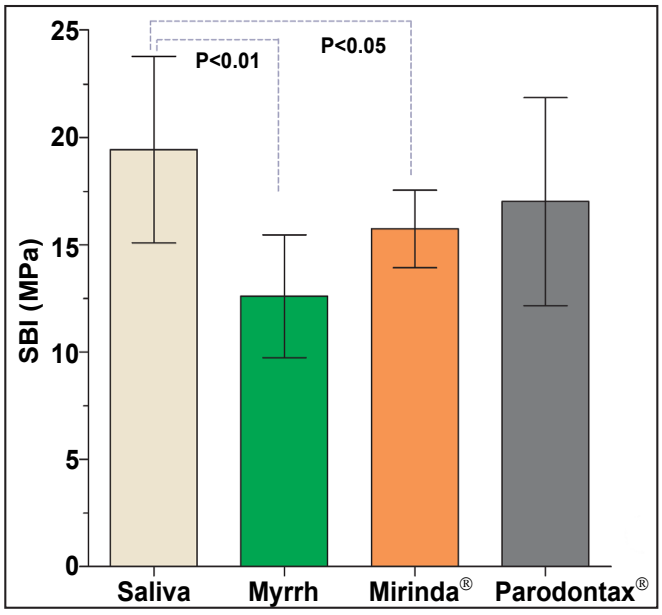

Figure 1*. Shear bond strength (MPa) of the bracket exposed to different solutions.*

the groups exposed to myrrh and the carbonated soft drink Mirinda®.

The location of the fracture for each group was evaluated with the Adhesive Remnant Index (ARI). The ARI scores are presented in *Table 2*, *Figure 2*. There was no major difference among the groups. All the groups showed that debonding occurred only at enamel adhesive interface. No instances of enamel fractures were noticed.

Discussion

Bond failure of brackets is a commonly encountered problem during orthodontic treatment. Several factors can contribute to bond failure, including variation in the enamel surface, saliva contamination, bracket properties, masticatory forces, poor operator technique, and patient behavior [5,6,23,24]. Acidic and alcoholic beverages can also be a causative factor for bond failure [25-28]. Frequent intakes of soft drinks which lower the pH of the oral cavity contribute to the enamel erosion [29]. In the present study the carbonated soft drink showed significant reduction in the shear bond strength. Earlier studies have showed that erosion of the enamel surface can decrease the retention of the brackets [30,31]. The soft drinks decreases the retention of brackets either by softening the enamel around the brackets or by degradation and softening of the adhesive resin [25,26]. As Mirinda® is known to have a deleterious effect on enamel bracket retention, it was selected as the positive control [8,27].

Fixed orthodontic appliances alter the oral environment by increasing stagnant, plaque retentive areas. Plaque accumulates particularly around brackets and bands [8]. Hence adjunctive use of mouth rinse is recommended along with other oral hygiene measures. Most of the currently available oral rinses are not suitable for long term use because of its side effects such as staining of the tooth, taste impairment, development of resistant strains etc. [32]. Hence there is a tendency to resort to the natural products such as "Miswak" and "Myrrh" containing oral rinses and tooth pastes in Saudi Arabia [33,34]. Even though Myrrh mouth wash is used, its effect on bonding of orthodontic brackets has not been studied earlier. The results of this in vitro study clearly indicate that it can significantly reduce the bonding of orthodontic bracket.

Due to the various factors that could influence the results we were forced to resort to an in vitro model. In this study a positive and negative controls were used for the accuracy and calibration of the shear bond strength of the test material. Similar in vitro conditions were done in the past by many researchers to test the shear bond strength of orthodontic brackets [35-38].

In this study the ARI scores were used to identify the amount of adhesive remaining on the teeth [39]. The results showed that myrrh and Paradox® had a pattern similar to carbonated drink. The majority of bond failures were ARI 1, that is, at the enamel resin interface. ARI score 1 can be interpreted as more adhesive been adhered to the bracket base and less adhesive remains on the tooth structure. So the contents of the myrrh have weakened the resin matrix which resulted in the leaching out of the filler and thereby decreasing the bond strength. The observation on the carbonated drink in the present study is in agreement with the earlier studies [24].

Table 2. *The Adhesive remnant index of the samples exposed to different solutions.*

Groups (n=15)	ARI SCORE - Number (%)			
	0	1	2	3
Artificial saliva	10 (67)	3 (20)	2 (13)	0 (0)
Myrrh (10%)	4 (27)	8 (53)	3 (20)	0 (0)
Parodontax®	6 (40)	8 (53)	1(7)	0 (0)
Mirinda®	3 (20)	9 (60)	3(20)	0 (0)

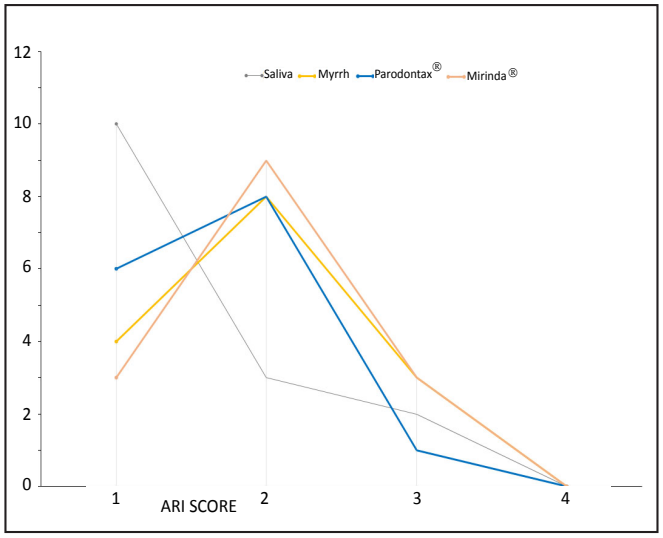

Figure 2*. The Adhesive remnant index of the samples exposed to different solutions.*

Conclusion

Within the limitations of the in vitro study, it can be concluded that the oral rinse containing myrrh significantly reduced the bond strength orthodontic brackets. Hence this indigenous herbal mouth rinses may be used with caution. Further studies with modifications of the current composition might help in overcoming these adverse effects and to help in developing better oral rinses for prolonged use in orthodontic patients.

Acknowledgments

The authors would like to extend their appreciation to the Research Centre, College of Applied Medical Sciences and the Deanship of Scientific Research at King Saud University for funding this research.

Conflict of interest

None declared.

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