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In Vitro Effect of Two Alcohol-Free and Alcohol-Containing Listerine Mouthwashes on the Shear Bond Strength of Orthodontic Brackets

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Background and objectives: This study aimed to investigate the in vitro effects of two Listerine mouthwashes—one alcohol-free and the other containing alcohol—on the shear bond strength of orthodontic brackets.

Materials and methods: This experimental study was accomplished on 45 healthy human premolars that were extracted for orthodontic treatment. The teeth after mounting in acrylic blocks were bonded with metal orthodontic brackets (MBT/0.22) by composite and randomly divided into three groups: 1) alcohol-containing Listerine mouthwash (ACLM), 2) alcohol-free Listerine mouthwash (AFLM), 3) artificial saliva (control). 15 samples were placed in each group. After keeping teeth in the solutions, the shear bond strength of orthodontic brackets was measured by the universal testing machine at a speed of 1 mm/min, and the information was compared using one-way ANOVA analysis.

Results: In general, the average shear bond strength of 45 premolars was evaluated as 20.92 ± 6.8 MPa. Shear bond strength was reported as 18.32 ± 7.33 MPa in the first group (Listerine containing alcohol), 22.33 ± 7.27 MPa in the second group (Listerine without alcohol), and 22.22 ± 5.27 MPa in the third group (control group). The highest and lowest mean shear bond strength of the bracket to the tooth surface were shown in the alcohol-free Listerine and the alcohol-containing Listerine groups, respectively. The results of one-way ANOVA showed no statistically significant difference in terms of shear bond strength among the three groups (P-value > 0.05).

Conclusion: Since both alcohol-containing and alcohol-free Listerine mouthwashes are effective in reducing viral and oral microbial loads, the lack of significant impact on bracket bond strength supports the recommendation of these mouthwashes in orthodontic practice.

Keywords: Mouthwashes, Listerine, Shear Bond Strength, Orthodontic brackets.

1. Introduction

The proper bonding strength of orthodontic brackets to enamel is one of the elements predicting the success of fixed orthodontic treatment. Prior studies have documented a failure rate ranging from 0.5% to 16% in orthodontic treatment, highlighting poor bonding strength as a significant contributing factor to these outcomes (1, 2). The potential factors behind the orthodontic bond failure include insufficient technique, saliva contamination, enamel surface variation, masticatory forces, and even nutritional stimulation and drinks. Previous studies identified a relationship between the shear bond strength orthodontic brackets and the basic pH of soft drinks (1, 3, 4).

The tendency to use mouthwash in order to protect oral health in orthodontic patients is increasing and these products are diversified in terms of alcohol content and pH. The alcohol component of mouthwashes can soften the composite resin and as a result, reduce the shear bond strength of orthodontic brackets (1, 5, 6). The antimicrobial properties of compounds found in mouthwashes contribute to the reduction of microbial load within the oral cavity (7). Mouthwashes are efficacious in cleansing areas that are challenging to reach with a toothbrush, freshening the oral cavity and eliminating microorganisms that may not be eradicated by toothpaste alone (8). The antiviral properties of mouthwashes have also been documented. Nasal disinfectants and mouthwashes can reduce the number of aerosolized active particles containing the virus in the nasal and oral cavities, reducing the risk of transmission. A series of mouthwashes containing membrane-destructive agents such as ethanol, chlorhexidine, cetylpyridinium chloride, hydrogen peroxide, povidone iodine, and Listerine are used in dentistry. In several studies, Listerine mouthwash has shown a specific antiviral property against enveloped viruses through its effect on the lipid-rich outer membrane of the virus (9). According to a recent meta-analysis, the use of mouthwashes has been shown to effectively reduce indices related to plaque accumulation and gingivitis, thereby contributing to the overall improvement of oral hygiene (10).

One of the recent studies in 2021 exhibited the lowest level of toxicity in the use of Listerine mouthwash compared to chlorhexidine, povidone iodine, and hydrogen peroxide mouthwashes (11). In an in vitro study on the inactivating effect of mouthwashes, Listerine and povidone-iodine showed a significant reduction effect on SARS-CoV-2, but this effect was not exhibited by chlorhexidine and hydrogen peroxide. In the above study, two types of Listerine, alcoholic and non-alcoholic, were investigated, both of which were effective in coronavirus deactivation, although the alcoholic version had a greater effect (12). A 2021 systematic review found that gargling Listerine and 1% povidone-iodine mouthwashes effectively reduced saliva viral load, whereas this effect was not reported for 1% hydrogen peroxide, 0.075% cetylpyridinium chloride, 0.5% povidone-iodine, and 0.2% chlorhexidine mouthwashes. Using these mouthwashes during the covid-19 pandemic is a simple intervention that can reduce cross-infection during dental examinations and procedures (13). Multiple studies have identified Listerine mouthwash as one of the most effective in reducing the salivary viral load in an infected person. In previous studies, the effect of alcohol-containing mouthwashes in declining the shear bond strength of orthodontic brackets compared to alcohol-free mouthwashes has been suggested. Available data indicate the effectiveness of both alcohol-containing and alcohol-free Listerine mouthwashes in reducing oral microbial load, with the alcohol-containing variant being slightly more effective. Both types of mouthwash exhibit very low toxicity and are feasible for daily use. Given the importance of maintaining the shear bond strength of orthodontic brackets, this study aimed to evaluate the laboratory shear bond strength of bonded orthodontic brackets following the daily use of alcohol-containing and alcohol-free Listerine mouthwashes.

2. Materials and methods

This study has been approved by the ethics committee of Shahid Sadoughi University of Medicine (Ethical code: IR.SSU.REC.1400.038). In this experimental study, 45 extracted human premolars were collected and kept in a physiological saline solution. All patients were notified of the use of teeth for research purposes, and consent was obtained. Teeth with decalcification, caries, enamel crack, hypoplastic softness, enamel corrosion, previous endodontic treatment, and filling were excluded from the study. Tissue remnants were removed from the tooth surfaces and kept in Thymol 0.1% weight solution for one week.

The teeth were vertically mounted in acrylic blocks (Figure 1), and their buccal surfaces were cleaned by a prophylaxis brush without using a pumice for 10 seconds. Then they were mildly rinsed with an air-water syringe for 15 seconds, followed by drying with compressed air for 15 seconds. They were etched with 37% phosphoric acid for 30 seconds, and after washing for 30 seconds, they were dried for 15 seconds with an oil-free air syringe until the frosty appearance was observed on the teeth. Then the primer was applied to the etched surfaces of the teeth with a brush and spread by gentle air. A layer of light cure adhesive for orthodontic bonding (American orthodontics, Washington, USA) was placed by the tip of the syringe on the mesh metal base of the MBT 0.22-inch slot of orthodontic bracket (American orthodontics, Washington, USA). The brackets were placed in the correct position in the middle part of the buccal surface of the teeth and pressed. The excess adhesive was removed by a sharp probe. Violet light was irradiated for 10 seconds on each side of the bracket with an angle of 45° and the shortest possible distance with a light cure device (Bluedent LED Smart, Bulgaria) with an intensity of 1900. Based on the placement solution, the teeth were randomly divided into three equal groups (Figure 2). The samples were placed in one of the solutions of alcohol-containing Listerine mouthwash (ACLM group), alcohol-free Listerine mouthwash (AFLM group) and artificial saliva (control group) for 12 hours. Mouthwashes manufactured by BAKIM AGIZ in Turkey were purchased under the name of cool mint, zero alcohol and alcohol-containing. The reason for choosing "12 hours" in this study was to simulate the application of mouthwash for one minute a day for two years of orthodontic treatment (14). The samples were shaken once every hour in the relevant solution and kept at 37 °C. After removing from the solutions and washing with water, the samples were kept in distilled water before the shear bond strength test. The shear bond strength of the bonded brackets was measured using universal testing machine (Figure 3) at a speed of 1 mm per minute.

The device measured the fracture force in newtons (N), which was converted into Megapascal units by dividing the fracture force by the base surface of the bracket according to the formula P(Mpa)= F(N)/A(mm). The surface of the bracket base was measured by a digital caliper. The average shear bond strength of brackets in three groups was compared and analyzed by statistical tests using SPSS statistical software (V.22). The significance level in this study was considered 0.05.

3. Results

In general, the average shear bond strength of 45 premolars was evaluated as 20.92 MPa with a standard deviation of 6.8. Shear bond strength was reported as 18.32±7.33 MPa in the ACLM group, 22.33±7.27 MPa in the AFLM group, and 22.22±5.27 MPa in the control group. Based on the obtained results, the highest and lowest mean shear bond strength of the bracket to the tooth surface were shown in the AFLM and the ACLM groups, respectively. Since the distribution of shear bond strength in the studied groups followed a normal distribution, a one-way ANOVA statistical test was used. The results of this test showed no statistically significant difference in terms of shear bond strength among the three groups (P=0.19) (Table 1 and Figure 4).

Figure 1. Mounting of samples by self-hardening acrylic resins

Figure 2. Classification of samples into three categories (n=15) for placing in three different solutions

Figure 3. Placement of samples in the universal testing machine

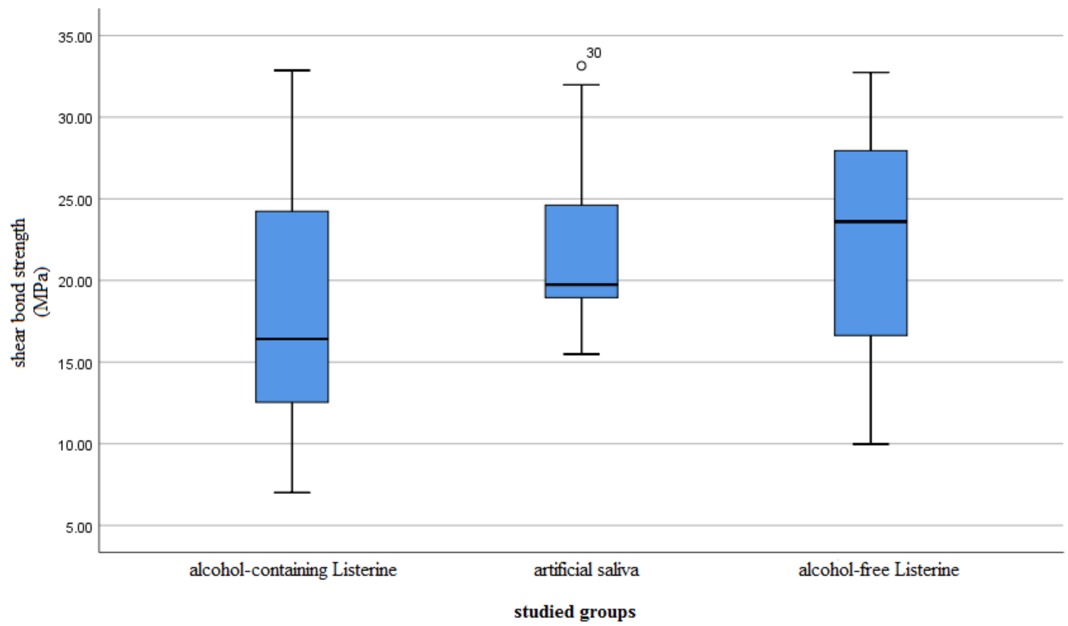

Figure 4. Comparison of shear bond strength in the studied groups.

Table 1. Comparison of shear bond strength in the studied groups.

	frequency	shear bond strength mean ± SD (MPa)	minimum	maximum	P-Value
alcohol-containing Listerine (ACLM)	15	18.32 ± 7.33	7.01	32.86	0.19
alcohol-free Listerine (AFLM)	15	22.23 ± 7.27	9.98	32.74	
artificial saliva (control)	15	22.22±5.27	15.49	33.15	
Total	15	20.92±6.8	7.01	33.15	

4. Discussion

One of the common problems in fixed orthodontic treatments is the high probability of the bracket-tooth bond failures. On the other hand, placing brackets also increases the possibility of plaque accumulation and periodontal problems. One of the ways to control these conditions is to use different types of mouthwash. In this study Listerine mouthwashes in two forms alcohol-containing and alcohol-free were investigated. Listerine is a type of mouthwash with compounds of phenol, cyclohexanol, alcohol, methanol, methyl salicylate, thymol, and octane (15). A series of mouthwashes that contain membrane-destroying agents including chlorhexidine, ethanol, hydrogen peroxide, cetylpyridinium chloride, Listerine, and povidone iodine are used in dentistry. In some studies, Listerine mouthwash has shown antiviral activity specifically against enveloped viruses through its effect on the lipid coating of the virus. In one of the studies conducted in 2021 on the toxicity of mouthwashes, Listerine mouthwash enclosed the lowest level of toxicity compared to chlorhexidine, betadine, and hydrogen peroxide mouthwashes (9, 11). Studies by VanLeeuwen et al. (16), Alshehri et al. (17), and Spuldaro et al. (18) stated that this type of mouthwash is one of the most effective chemical agents to control plaque with emphatic evidence for anti-plaque and anti-gingivitis effects that can be used alongside brushing.

The results of this study indicated that the average shear bond strength of brackets exposed to alcohol-free Listerine mouthwash was similar to the control group. On the other hand,

this amount was lower in alcohol-containing Listerin mouthwash than in the control and alcohol-free Listerine groups, although these differences were not significant.
Shear bond strength less than ideal will cause the continuous failure of the bracket during treatment, so the bond must have a standard strength that does not cause these concerns (19). Since the minimum acceptable shear bond strength reported by researchers such as Reynolds et al. (20) is 6 to 8 MPa, the shear bond strength is clinically acceptable in all studied groups.
As mentioned at the beginning of the discussion, very limited research has been accomplished on the influence of Listerine mouthwash on the bracket shear bond strength, which makes it challenging to compare the findings with the previous outcomes. A recent study comparing several different mouthwashes (Listerine, Himalaya, and Rexidine) showed that Listerine mouthwash has the least negative effect on the shear bond strength of orthodontic brackets (21). Another study demonstrated that the impact of Listerine mouthwash on the shear bond strength of orthodontic brackets is not significantly different from that of other mouthwashes (22).
In 2011, Jamilian et al. (23) investigated the effect of two types of mouthwash, Oral-B and Orthokin, on the shear bond strength of orthodontic brackets. Their approach was identical to the present study because they similarly examined 45 healthy human premolars extracted for orthodontic reasons in private practice in an experimental study. The research method was also consistent with the present study. They showed that both Orthokin and Oral-B mouthwashes enclosed a significant negative effect on the bond strength of orthodontic brackets after bonding. In such a way the shear bond strength in the control group (27.15 MPa) was significantly higher than the others, with the lowest value in the Orthokin group (7.59 MPa). It was also found that the mouthwashes had a reducing effect on the shear bond strength, which was greater in Orthokin than in Oral-B. In addition, when comparing these two types of mouthwash, Oral-B was preferable to Orthokin. They cited the explanation for this difference in the shear bond strength of the brackets related to the chemical components of the mouthwashes. Meanwhile, in the current study, alcohol-containing and alcohol-free Listerine mouthwashes did not show a significant effect on the shear bond strength of orthodontic brackets. Therefore, in terms of significance, there is a difference between the two studies, the reason for which can be the difference in the type of mouthwash used. Since the average shear bond strength was higher than 6-8 MPa, the values mentioned in the two studies were clinically acceptable. Singh et al. (24), analyzed the shear bond strength of orthodontic brackets after using mouthwash with a similar approach. They investigated four solutions with equal samples (N=15), including artificial saliva as a control group, alcohol-containing Listerine, chlorhexidine, and herbal mouthwashes. In this study, the highest shear bond strength was reported in the artificial saliva group (14.27 MPa), and similar to the present study, the lowest average shear bond strength was revealed in the alcohol-containing Listerine mouthwash group, with the difference that this reduction was not significant in the present study. Therefore, regarding the significance of shear bond strength between groups, Singh et al. reported conflicting results with the current study. Meeran et al. (25), studied on the effect of available mouthwashes on the shear bond strength of orthodontic brackets. The approach of this study was the same as the current investigation, and the differences were the wider sample and the type of mouthwashes. In the mentioned study, two alcohol-free solutions and two alcohol-containing solutions were used. The strength of the bond in alcohol-containing mouthwashes was significantly lower than in alcohol-free groups, which was different from the present study in terms of significance, which may be explained by the difference in the type of mouthwashes used. Meeran et al., along with Singh et al. (24), stated that alcohol-containing mouthwashes should be avoided as much as possible in fixed orthodontic treatments. Meeran et al. (25), have demonstrated that alcohol-containing mouthwashes reduced the shear bond strength of orthodontic brackets more than alcohol-free mouthwashes. The shear bond strength of alcohol-free chlorhexidine was higher than Colgate (hydrogen peroxide) containing 12% alcohol, which was higher than Listerine containing 26% alcohol. Therefore, there was an alignment with the present study in terms of reducing the average shear bond strength in alcohol-containing mouthwashes, and there was an inconsistency in terms of significance. It appears that these contradictions may be due to the difference in the quality of Listerine mouthwashes and its ingredients, which led to different results.
Known benefits of Listerine mouthwash include its efficacy against coronavirus, as well as its low toxicity and acceptability for reducing microbial plaque in periodontal tissue. Due to the dichotomy with some past findings and a large number of mouthwashes available in the market, it is suggested to conduct more studies on the effect of Listerine mouthwashes on the shear bond strength of orthodontic brackets and microleakage. So that this type of mouth rinse can be prescribed with greater confidence to orthodontic patients.

5. Limitations

This study had an experimental design and its results may not be directly applicable to clinical settings, so it is suggested that clinical studies be conducted in this field.

6. Conclusion

The results of this study did not confirm the significant effect on the shear bond strength of orthodontic brackets with the application of either alcohol-containing or free-alcohol Listerine mouthwashes. Therefore, in addition to paying attention to the necessity of conducting more studies on the effect of Listerine mouthwash on shear bond strength, its use is recommended due to its satisfactory impact on the viruses, prevention of gingivitis, and its low toxicity compared to other mouthwashes.

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Authors' contribution

Mohammad Hossein Toodehzaeim: Conceptualization, Writing – Review & editing, Methodology, Project administration, Supervision, Validation.
Pedram Toodehzaeim: Investigation, Data curation, Resources, Software, Visualization, Writing – Original draft
Fariba Zadbin: Conceptualization, Investigation, Writing – Review & editing.

Conflict of Interest

None.

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