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ORIGINAL RESEARCH

An *in vitro* Evaluation of Shear Bond Strength of Orthodontic Brackets after Mouth Rinse

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ABSTRACT

Aims: The aim of the study was to evaluate the shear bond strength (SBS) of orthodontic brackets after mouth rinsing.

Materials and methods: Sixty orthodontically extracted maxillary premolar teeth were used in the present study. Buccal surfaces of all the teeth were bonded with orthodontic bracket. Later, each tooth was embedded into acrylic resin and stored in distilled water. All the teeth were randomly divided into four groups (group I: Artificial saliva, group II: Alcohol mouth rinse—Listerine, group III: Chlorhexidine (CHX) mouth rinse—Hexidine, and group IV: Herbal mouth rinse—Befresh) and stored in each solution for 12 hours. Later, each tooth was subjected to SBS testing using universal testing machine. Brackets and enamel surfaces were examined under a stereomicroscope at 10× magnification for modified adhesive remnant index (ARI). The data were statistically evaluated using IBM Statistical Package for the Social Sciences (SPSS) Statistics for Windows, version 20.0 (IBM Corp., Armonk, New York, USA) and using one-way analysis of variance (ANOVA) and Chi-square test with significance of $p < 0.05$.

Results: Highest mean SBS was observed in artificial saliva control group (14.27 ± 0.52 MPa), followed by herbal Befresh group (11.14 ± 0.72 MPa) and CHX, and least was found in alcohol-Listerine group of 8.48 ± 0.52 MPa ($p < 0.001$). The ARI score showed highest bond failure for group I (ARI 14) compared to group II (ARI 11) ($p < 0.001$).

Conclusion: Alcohol-containing mouth rinses should be avoided in patients during fixed orthodontic treatment because it affects the bond strength.

Clinical significance: Shear bond strength is affected with the use of alcohol-based mouth rinse compared with herbal or CHX mouth rinses.

Keywords: Alcohol-based, Brackets, Chlorhexidine, Herbal rinse, Mouth rinse, Orthodontic, Shear bond strength.

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INTRODUCTION

Fixed orthodontic treatment is often associated with plaque accumulation, poor oral hygiene, white spot lesions, and risk of caries development. Hence, mouth rinse is advised as a means of chemical plaque control measure. Chlorhexidine or other herbal commercial mouth rinses are advised as a preventive method.[1,2]

Several studies have shown that CHX in high or low concentrations of 0.12 to 1% as a mouth rinse significantly decreases the *Streptococcus mutans* count.[1] The success of fixed orthodontic treatment depends on bond strength of orthodontic brackets to enamel of tooth. This bond failure (SBS) could be due to poor operator technique, masticatory forces, salivary contamination, use of mouth rinses, and soft drinks consumption. The bond failure of 0.5 to 16% has been reported in several studies.[3]

Many studies have assessed the effect of CHX on SBS of orthodontic brackets after mouth rinse.[4-6] Sachdeva et al[7]

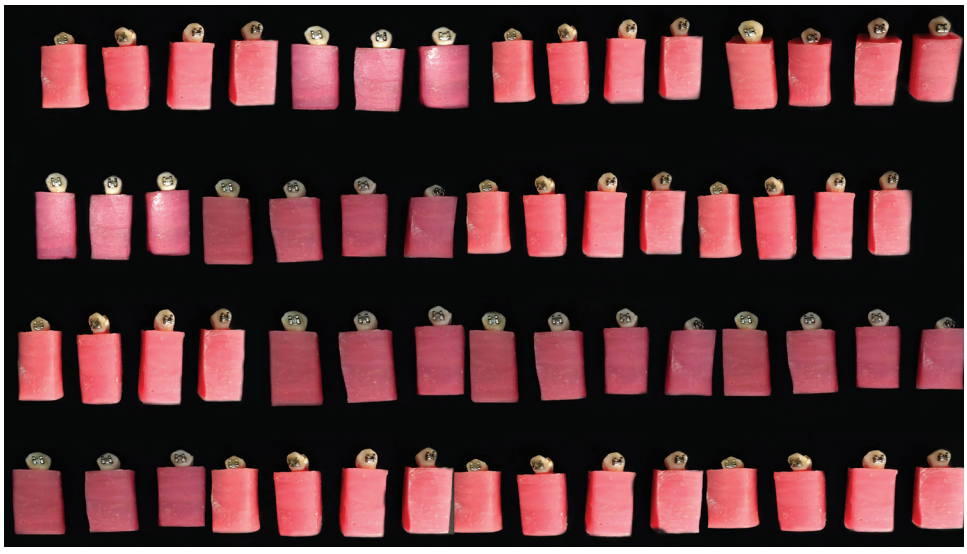


Fig. 1: Acrylic block of teeth with bonded orthodontic brackets

Fig. 2: Composite materials kit

evaluated the SBS of orthodontic brackets after storage in formalin, saline, ethanol, hydrogen peroxide, distilled water, and artificial saliva, and they observed clinically acceptable SBS with saline and distilled water compared with other storage media.

The present study was done to evaluate the SBS of orthodontic brackets after use of different types of commercial mouth rises (herbal, alcohol-based, and chlorhexidine-based).

MATERIALS AND METHODS

Sixty orthodontically extracted maxillary premolar teeth were used in the present study after obtaining informed consent from the subject. Ethical approval was obtained from Institutional Ethical Committee. Immediately after extraction teeth were cleaned from blood and stained with nonfluoridated pumice with rubber cups for 10 seconds and rinsed under water. Later teeth were stored in 1% thymol (which acts as an antibacterial agent) solution in room temperature and were used within 4 weeks after extraction. Exclusion criteria were teeth with hypoplastic defect, caries, and fracture. All the sample teeth were embedded in acrylic blocks (Fig. 1). Buccal surface of all the teeth were acid-etched with 35% orthophosphoric acid for 30 seconds and washed for 20 seconds and air dried. Composite material (3M ESPE, California) was applied on etched surface and cured with light cure and orthodontic MBT metal brackets (3M Unitek Gemini) were bonded with composite (3M ESPE Unitek) and it was light cured with light-emitting diode light device (Fig. 2) and stored in distilled water. All the teeth were randomly divided into four groups (groups I–IV) according to the mouth rinse used and stored in each solution.

Group I: Artificial saliva (Pickering Laboratories, Inc., California, USA) (Fig. 3A)

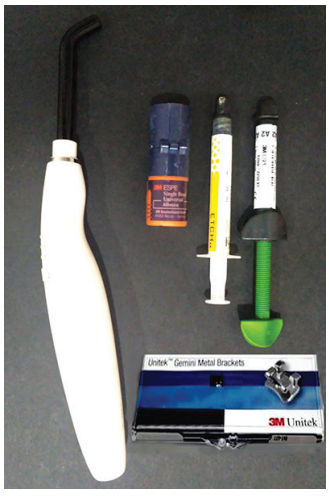
Group II: Alcohol mouth rinse Listerine (Johnson and Johnson Pvt. Ltd, Bengaluru, India) (Fig. 3B)

Group III: CHX mouth rinse—Hexidine 0.2% (ICPA Health Product Ltd, India) (Fig. 3C)

Group IV: Herbal mouth rinse—Befresh (Sagar Pharmaceuticals, Herbal Health care Division of BPRL Pvt. Ltd, Bengaluru, India) (Fig. 3D)

Twelve hours after storage in each mouth rinse, orthodontic bracket surfaces of all teeth were subjected to SBS test using universal testing machine (5980 series, Instron Corporation, Canton, Massachusetts, USA) (Fig. 4) at cross-head speed of 1 mm per minute. The failure load (N) was recorded at bond failure and converted into MPa by dividing the failure load by surface area of bracket base using the below formula:

$$\frac{\text{Stress at failure (N)}}{\text{Shear bond strength (MPa)}} = \text{Area of bracket base (mm}^2\text{)}$$



Figs 3A to D: (A) Artificial saliva and mouth rinses, (B) Listerine, (C) Hexidine, (D) Befresh

Fig. 4: Universal testing machine

The simulation time for 1 year is calculated for mouth rinsing for 2 minutes/day (2 minutes/day × 365 days = 730 min, i.e., 12 hours × 60 minutes = 720 minutes) as done by Gurgan et al[8] and Meeran and George.[9] We kept teeth for 12 hours, which simulates 1-year period of mouth rinsing.

Brackets and enamel surfaces were examined under a stereomicroscope (Olympus Flo View, Melville, New York USA) at 10× magnification for detection of any remaining adhesive according to modified ARI. Adhesive remnant index scoring was done according to the following criteria: 0—no adhesive left on the tooth, 1—less than half of the adhesive left on the tooth, 2—more than half of the adhesive left on the tooth, and 3—entire adhesive amount left on the tooth with an impression of the bracket mesh.

The collected data were statistically evaluated using IBM SPSS Statistics for Windows, version 20.0 (IBM Corp, Armonk, New York, USA) and using one-way ANOVA test. Adhesive remnant index score was analyzed with Chi-square test (χ^2).

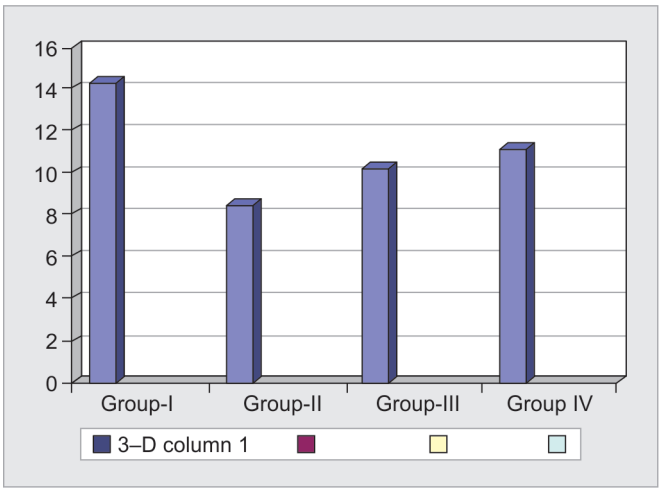
RESULTS

On comparing the three different mouth rinses with control group, highest mean SBS was observed in artificial saliva control group (14.27 ± 0.52 MPa), followed by herbal Befresh group (11.14 ± 0.72 MPa), CHX group (alcohol-free) of 10.22 ± 0.53 MPa, and least was found in alcohol-Listerine group of 8.48 ± 0.52 MPa (Table 1, Graph 1). The difference was statistically significant ($p < 0.001$). There was highest frequency of ARI score for three in group I (14 score) followed by groups III and IV (11 score) and least in group II. ARI score showed highest bond failure for group I (ARI 14) compared to group II (ARI 11) (Table 2). The difference was statistically significant ($p < 0.001$).

Table 1: Mean SBS value with the use of different mouth rinses

Groups	*Mean SBS*	*Confidential interval at 95%*	*p-value*
I	14.27 ± 0.52	13.8–14.6	0.001
II	8.48 ± 0.52	8.2–8.9	0.001
III	10.22 ± 0.53	10.01–10.7	0.001
IV	11.14 ± 0.72	10.4–11.9	0.001

$p < 0.001$; Test used: one-way ANOVA



Graph 1: Mean SBS value with the use of different mouth rinses

Table 2: ARI score with different mouth rinses

Groups	*ARI score 1*	*2*	*3*	*4*	*5*	*Number*
I	–	1	14	–	–	15
II	–	11	3	1	–	15
III	–	3	11	1	–	15
IV	–	2	11	2	–	15

$p < 0.001$; Test used: χ^2 test

DISCUSSION

Fixed orthodontic appliances frequently result in development of caries. These patients often present with

changes in oral microflora, lower pH, and increased food retention.[1] Hence, mouth rinses are frequently advised to control dental plaque, to prevent development of dental caries, and to improve oral health in orthodontic patients.

The present study was done to evaluate the effect of mouth rinsing on the SBS of orthodontic brackets. Several commercial mouth rinses are available in the market but we have tested the three different kinds of commercial mouth rinses, i.e., alcohol-based Listerine, alcohol-free CHX-based, and herbal mouth rinses.

Chlorhexidine is a potent antimicrobial agent against *Streptococcus mutans* and dental caries. It is commercially available as mouth rinse, varnish, and gel. As a preventive measure, 0.12% CHX is commonly advised in orthodontic patients.[1]

Several studies have showed that alcohol-containing mouth rises, such as Listerine are effective in reducing the plaque and improving oral health of orthodontic patients.[10] But its alcohol content can have side effect on SBS and burning sensation.[9]

Herbal mouth rinses are gaining importance because of staining effect of CHX and adverse effect of alcohol-containing Listerine mouth rinses. Several herbal mouth rinses are commercially available, such as HiOra, Befresh, Myrrh, and Parodontax.[11] Several studies have proven the effectiveness of herbal mouth rinses in reduction of plaque in improvement of oral health. Herbal mouth rinses are herbal derived and are free from alcoholic and other chemical ingredients.[12]

We found highest SBS with control group using artificial saliva followed by herbal and CHX containing mouth rinses. Least SBS was found with alcohol-based Listerine group (Table 1). Similar findings were observed by Jamilian et al[3] in their study. Jamilian et al[3] assessed the SBS of orthodontic brackets in an *in vitro* study after mouth rinse (Orthokin and Oral-B) for 60 seconds per day for 2 weeks and they found lowest SBS with Orthokin mouth rinse compared with control group (artificial saliva) and Oral-B mouth rinse. Wu and McKinney[13] concluded that alcoholic food can soften the microhardness of dental composites. Lee et al[14] observed reduction in SBS with diffusion of ethanol into composite, which resulted in microcracking.

Meeran and George[9] evaluated the various commercial mouth rinses (alcohol-containing and alcohol-free) on SBS of orthodontic metal brackets by an *in vitro* study and observed lower SBS with composite in alcohol-containing mouth rinse group, which is similar to our results. They observed reduced bond strength with 0.2% CHX mouth rinse for 12 and 24 hours compared with control group.

Most of the commercial mouth rinses contain 18 to 26% of alcohol as a preservative or solvent and semi-active ingredient. Mouth rinses vary in their alcohol content and pH. It has been observed that alcohol (ethanol) content of mouth rinses can soften the composite resin used to bond orthodontic brackets and it can wear composite resin by dissolving its bisphenol A glycidyl methacrylate content. This could be the reason for reduction of SBS of orthodontic brackets after alcohol-containing mouth rinsing.[3,9]

Catalbas et al[1] found no difference in SBS on etched surface after CHX mouth rinsing compared with control group. They observed lowest SBS with 1% CHX gel application. Durgesh et al,[11] in contrast to our results, observed lower SBS with Myrrh, a herbal mouth rinse, compared with Parodontox, Mirinda, and control group. We observed better SBS with herbal over Listerine and CHX but lower to control group. Khoda et al[15] observed no changes in SBS with soft drinks (Pepsi and yoghurt).

In our study, alcohol-containing mouth rinse Listerine has 21.6% of ethanol, hence, it showed reduction in SBS compared with control and nonalcoholic, herbal mouth rinses. Even this is supported by various studies.[3,9,16,17] Reynolds[18] stated that 5.9 to 7.9 MPa of bond strength is acceptable in the oral cavity.

The ARI score was highest for two in group II compared with other groups (Table 2). Meeran and George[9] found similar bond failure for all tested mouth rinse groups. They found more cohesive failure with Listerine group at 12 and 24 hours at bracket adhesive interface, but it was not statistically significant.

There are no reported studies on comparative evaluation of herbal mouth rinse, alcohol-containing, and alcohol-free CHX mouth rinse. Our study is unique because it tested the alcohol (Listerine), alcohol-free (CHX), and herbal (Befresh) mouth rinses on SBS of orthodontic brackets at resin tooth and bracket interface. Our results help in clinical implementation of mouth rinses, herbal or CHX, in orthodontic patients to preserve SBS as well as to aid preventive measures.

Limitation of our study is that it is an *in vitro* study, hence, it does not reflect the oral condition. Further *in vivo* or *ex vivo* studies are required to verify the bond strength of orthodontic brackets with alcohol-containing and alcohol-free mouth rinses.

CONCLUSION

Least SBS was observed with alcohol-based mouth rinse compared with nonalcoholic and herbal-based mouth rinses. Adhesive remnant index score was highest in alcohol-based group compared with others. It has been concluded that alcohol-based mouth rinses should be avoided in patients during fixed orthodontic treatment since it affects the bond strength.

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