Journal of Research in Medical and Dental Science
2022, Volume 10, Issue 9, Page No: 191-196

Available Online at: www.jrmds.in
eISSN No. 2347-2367: pISSN No. 2347-2545

The Effect of Magnetized Water as a Mouthwash on the Shear Bond Strength of an Orthodontic Brackets Bonded by 3M Transbond XT Orthodontic Adhesive

Sanaa Ammar Qassabbashe* and Afrah Khazal Al-Hamdany**

**Ninavah Health Directorate, Mosul, Iraq.*
*** Department of Pedodontics, Orthodontics and Preventive Dentistry, College of Dentistry, University of Mosul, Iraq.*

ABSTRACT

Background: An orthodontic bonding should be durable to minimize inadvertent debonding, minimize enamel damage, and enabling the removal of the bracket with little to no harm to the tooth.

Objectives: The objective of this study was to investigate the effect of magnetized water as a natural mouthwash on the shear bond strength of an orthodontic adhesive in comparison to chlorhexidine.

Materials and Methods: A total of 30 extracted premolars for orthodontic intention were gathered and used in this study. After bracket bonding, the samples were randomly distributed into three groups. Group 1: Samples were immersed in magnetized water, group 2: samples were immersed in chlorhexidine Digluconate (0.2 %) mouthwash, and group 3: samples were immersed in Distilled water. Brackets were debonded after 2 weeks of immersion, measuring the shear bond strength by universal testing machine (Gester, China). The adhesive remnant index for each sample was determined. One-Way ANOVA and Duncan's multiple range test were used for comparison of the significant difference between the groups for shear strength. While Kruskal-Wallis test was used for comparison of significant difference between the groups for adhesive remnant index.

Results: Distilled water group had the highest mean value of shear bond Strength, followed by the experimental group magnetized water, while the Chlorhexidine group significantly showed the lowest mean value.

Conclusion: It can be supposed that magnetized water as a mouthwash has comparable effect that is not significantly differ from the distilled water, while significantly higher than Chlorhexidine mean values of shear bond strength.

Key words: Adhesive remnant index, Magnetized water, Shear bond strength, Chlorhexidine, Natural mouthwash

HOW TO CITE THIS ARTICLE: Sanaa Ammar Qassabbashe, Afrah Khazal Al-Hamdany, The Effect of Magnetized Water as a Mouthwash on the Shear Bond Strength of an Orthodontic Brackerts Bon*ded by 3M Transb*ond X*T Orthodo*ntic Adhesive, J Res Med Dent Sci, 2022, 10 (9):191-196.

Corresponding author: Sanaa Ammar Qassabbashe

e-mail✉: sanaa.20dep47@student.uomosul.edu.iq

Received: 19-Aug-2022, Manuscript No. JRMDS-22-75045;

Editor assigned: 22-August-2022, PreQC No. JRMDS-22-75045(PQ);

Reviewed: 6-Sep-2022, QC No. JRMDS-22-75045(Q);

Revised: 09-Sep-2022, Manuscript No. JRMDS-22-75045(R);

Published: 16-Sep-2022

INTRODUCTION

The use of the fixed orthodontic appliances (FOAs) is one of the most familiar orthodontic treatments, which consist of bonding brackets and bands or molar tubes that are fixed on the teeth surfaces, for a period of approximately 2 years [1]. Implementation of the FOAs within the oral cavity will seriously affect the oral hygiene by intensifying the retention of food debris, which ultimately results in plaque buildup, as the FOAs provide favorable conditions for the colonization of oral microorganisms because the major parts of these devices (brackets, bands, ligatures, and orthodontic wires) might inhibit the physiological mechanism of self-cleaning by the tongue or cheeks and offer many spaces for oral microorganisms to bind [2,3]. Gingivitis and enamel decalcification around the FOAs are regular problems if the necessary preventive programs are not prepared, It has been assessed that the primary goal for preventing and/or treating the problems listed above is the elimination of plaque [3,4]. Focusing on good oral hygiene measures a number of chemical plaque management techniques have been used as supplementary therapy along with different dentifrices, gels, and mouthwashes [5,6]. Chlorhexidine (CHX), the antibacterial agent that has been verified to bring the levels of microorganisms down , is the most popular antimicrobial mouthwash, however, long-term usage of CHX may have certain possible drawbacks like bitter

flavor, light brown discoloration of the teeth, altered taste sensation and progression of resistant microorganisms, oral mucosal erosions and this has established the necessity for substitutes that can be affordable and appropriate as well as they should be acceptable [6,7]. The advantages of different natural products therapy, such as herbs, and plant extracts have been studied to avoid the negative drawbacks of CHX gluconate [6].

In the field of physics, magnetism is well known and the magnetic force has a pronounced effect on living organism [8]. Magnets appear to be an effective preventive measure and strong barrier against disease [7]. When a permanent magnet is retained in constant contact with suitable amount of water, for suitable period of time, the water is not only affected by the magnetic flux, but also comes to be magnetized and obtains magnetic properties and this magnetized water (MW) has its influence on human body [8]. The plaque inhibitory effect of MW and its effect on oral microorganisims also were studied in many researches [7-9], which were concluded that MW can be effectively used as a supplement to the mechanical plaque control to prevent gingivitis and other oral diseases. As the MW is biocompatible, well accepted by all subjects without any side-effects as with CHX [7], therefore by taking in consideration the previous facts of the MW, this research was directed to investigate the probable effect of natural mouthwash (MW) as alternative to the available synthetic mouthwashes (as CHX) that are associated with variable side effects in the hope that this MW will bring the benefits of both safety and less effects on shear bond strength (SBS) of the adhesive.

MATERIALS AND METHODS

Teeth samples preparation

A total of 30 extracted upper premolars for orthodontic intention were gathered from Iraqi patients, and used in this in vitro study, the age group was (15-25) years old. The samples were chosen according to inclusion criteria, all the selected premolars had intact buccal surface with no cracks or fractures and no dental caries nor previous dental fillings. All the samples were cleaned from the debris, and they were stored in daily changed distilled water (DW) to avoid bacterial growth. All the samples were mounted in acrylic block, a plastic poly vinyl chloride (PVC) rings were used with predetermined dimensions (20mm outside diameter, 18mm inside diameter and 30mm height). The PVC rings were filled with dental stone (Zhermack, Italy) to approximately half of the ring's height and after setting of the stone each premolar sample fixed by sticky wax (Annhua, Turkey) in the center of the rings, then the long axis of each tooth sample adjusted by using the dental surveyor (Gerdent, Syria) in a manner that the buccal surface of each sample parallel to the analyzing rode of the surveyor [10]. After that, auto polymerizing cold cure acrylic resin (Veracril, Colombia's) was used to fill PVC rings up to the level of the cement-enamel junction and they had been left until setting of the acrylic. Each tooth sample was polished by flouride-free pumice (Bilkim CO., Turkey) with a rubber cup (QD, England) on a low-speed hand-piece (NSK, Japan) for 10 seconds then each sample was copiously rinsed with water for 10 seconds to remove any remnant of pumice and other debris, then the samples were dried with an oil-free air stream.

The bonding procedure

Phosphoric acid gel 37% (Any-Etch, Mdclus, Korea) was applied on the buccal surface of each tooth, and each sample was etched for 15 seconds, then it was rinsed by DW for 30 seconds and dehydrated by compressed air till a chalky appearance would be observed. Next the Transbond XT (3M / Unitek, U.S.A.) liquid primer was employed to the enamel surface of each tooth with the brush and an oil-free air stream from triple syringe was applied on the surface for a period of 5 seconds to remove any excess primer and light cured for 10 seconds [11]. The bracket (Standard edgewise, Dentarum, Germany) was hold by the bracket holder and the adhesive paste (3M/ UNITEK, U.S.A.) was applied to the bracket's base and evenly distributed by the dental explorer, after which the bracket was placed in the middle of the buccal surface, and the whole sample was positioned on the articulator (Iriqa, China). In order to produce equal thickness of the resinous material between the bracket's base and the tooth surface and to prevent air voids entrapment, a load of 200 gm was tied to the arm of the articulator and directed at a right angle to the bracket slot [12]. Using a sharp dental explorer, extra adhesive material was scraped off the brackets outside edges. Then the curing process was started by using an LED light curing device (RayDent, IOS, USA) with wave lengths(385-510 nm) and intensity between (1500-1700 mw/[cm]^2), for 20 seconds on the mesial side and 20 seconds on the distal side. The mesial and the distal edges of the bracket base were 2 mm apart from the curing LED's tip [13].

Preparation of magnetized water

In this *in vitro* present study, the DW was magnetized by a locally made device. In glass containers 100 ml of DW was prepared and each container was surrounded by two magnets [14]. The pair of magnets were arranged in a north-north poles which were in a state of revulsion and the strength of magnets was measured by using the Gauss meter [7]. The strength of the magnetic field was approximately 1000Gs. Each 100ml of DW was magnetized for the duration of 72 hours [9]. Then the PH and electrical conductivity were checked to make sure that the DW became magnetized [7,8]. MW was freshly prepared avoiding any loss of magnetization.

The immersion procedure

The samples were randomly divided into three groups depending on the solution used for immersion procedure as follows:

Magnetized water (MW): Which includes the teeth were immersed twice a day in magnetized water prepared at the power of 1000Gs magnetic field.

Chlorhexidine group (control positive) (CHX): Which includes the teeth was immersed twice a day in CHX gluconate (0.2 %) mouthrinse.

Distilled water group (control negative) (DW): Which includes the teeth were immersed twice a day in DW.

After that the all samples were incubated at 37°C for a period of 24 hours, they were removed from DW and immersed inside glass containers filled with MW, CHX and DW, then incubated inside the same incubator at 37°C. The immersion period inside mouthrinse solutions was for 1 min, twice a day [15]. After the end of immersion period; the specimens were returned to their previous DW container and incubated again at 37°C until next mouthrinse immersion period. The whole incubation period was two weeks [15].

Measuring SBS

The SBS test was calculated by the utilization of the Universal testing machine (Gester, China) in the Department of Operative Dentistry/ College of Dentistry of Mosul University with a crosshead speed of 0.5mm/ min. The essential loading which causes debonding or initiate failure of the brackets would be registered in Newton unit and would be transformed to MPa unit according to this equation:

SBS in (MPa) unit=Force in newton's unit/Surface area of bracket Base in mm^2

Adhesive remnant index

The Adhesive Remnant Index (ARI) was used in the present study to determine the amount of adhesive material left on the bracket bases and enamel surface of the teeth after debonding and to assess the site of bond failure among enamel, bracket base and the adhesive. All the bracket bases and teeth samples for the SBS were examined under ×10 magnifying glass (Thatyro, China) after the debonding procedure, the site of bond failure was defined in accordance to particular scores defined by Artun, et al. 1984, and these scores are:

Score 0: No adhesive remained on the surface of the tooth.

Score 1: Less than 50% of the adhesive remained on the to surface of the tooth.

Score 2: More than 50% of the adhesive remained on the surface of the tooth.

Score 3: All of the adhesive remained on the surface of the tooth, with a well-defined impression of the bracket's mesh [16].

Statistics

All findings and results were registered and assessed as mean, standard deviation (SD), range, minimum and maximum values of the three groups were included in the study (n=10) as viewed in Table 1 and Table2. Statistical analysis was achieved by using SPSS software (version 18.0) with analysis of variance (One-Way ANOVA) and post-hoc Duncan's multiple range tests were utilized for comparison of the significant difference between the groups in SBS. While analysis of the findings achieved from the Kruskal-Wallis test for comparison of the significant difference between the groups in ARI. A P-value of ($P \leq 0.05$) was regarded as statistically significant.

RESULTS

The SBS values of the three groups: CHX, MW and DW, were analysed and it was found that the highest mean value was in the DW group followed by the experimental group MW, while the CHX group showed the lowest mean value among the groups . The result achieved from (ANOVA) statistical test revealed a significant difference at ($P \leq 0.05$) viewed in Table 3. Analysis of the Duncan's

Table 1: Descriptive statistic for SBS of the study groups.

Groups	N	Mean	SD	Range	Minimum	Maximum
MW	10	12.82	2.89	7.51	9.48	16.99
DW	10	14.41	2.43	7.09	10.67	17.76
CHX	10	9.5	1.26	3.55	7.6	11.15
N: Number of samples in each group						
MW: Magnetized Water group						
DW: Distilled Water group						
CHX: Chlorhexidine group						
SD: Standard Deviation						
SBS in Mpa						

Table 2: Descriptive statistic for the adhesive remnant index of the study groups.

Groups	N	Mean	SD	Range	Minimum	Maximum
MW	10	2.5	0.7	2	1	3
DW	10	2.1	0.87	3	0	3
CHX	10	1.6	0.96	2	1	3
N: Number of samples in each group						
MW: Magnetized Water group						
DW: Distilled Water group						
CHX: Chlorhexidine group						
SD: Standard Deviation						

multiple range test findings showed a significant difference between the CHX and the other remaining groups in this study (P ≤ 0.05) viewed in Table 4.

The ARI scores of the three groups: CHX, MW and DW, were analysed and it was discovered that the highest mean value was in the experimental group MW then followed by the DW and the CHX groups respectively viewed in Table 2. The result achieved from the Kruskal-Wallis test revealed a significant difference at (p ≤ 0.05) between all the groups showed in Table 5.

DISCUSSION

One of the major complications during orthodontic treatment is debonding of the orthodontic brackets, as rebonding of these brackets requires additional clinical chair time which in turns prolonged the duration for the orthodontic treatment as well as further cost to the patients [17]. The present study showed that the DW group had the highest SBS, while the CHX group had the lowest SBS. However, all the groups produced SBS values greater than the proposed bond strength (5 to 8 MPa) according to Reynolds, (1975) review which determined that 5-8 Mpa of bond strength to be suitable clinically to the orthodontic brackets [18]. Therefore the DW had the lowest negative effect on the bond strength, on the other hand CHX had the greatest negative effect on the strength of bracket's bonding, this might be owing to the active chemical ingredients in the CHX mouthwash (Glycerin, limonene, hydrogenated castor oil and sodium saccharin), while there were no chemical contents in the groups of DWand MW. SBS depends on many constitutes, such as the bonding materials qualities, the attachment at various interphases, such as the interphase between the composite and the bracket and the composite to the tooth, together with the polymerization of the composite bonding material [19]. When CHX used an obvious increased of Firmicutes and proteobacteria was noticed , while reduction in the amount of Bacteroidetes, TM7, SR1 and Fusobacterium was observed, this shift was connected with a significant reduction in saliva pH and buffering capacity, attached with an increase in saliva lactate and glucose levels. According to the study demonstrated by Bescos, et al. concluded that mouthwash containing CHX is correlated with a significant shifting in the oral microbiota, which causes extra acidic conditions and less nitrite availability in healthy people [20]. This rise in oral acidic conditions, exemplified by lower salivary pH after using CHX mouthwash may cause negative effect on the SBS. On the other hand, pure DW should have a pH of 7, which is neutral. However, Magnetized water have a high pH value and it is alkaline, which can have a pH as high as 9.2 [8]. The pH of saliva should typically range from 6.2 to 7.6, with 6.7 serving as the average. The oral cavity's resting pH does not drop below 6.2 [21]. According to the previously mentioned rinsing the mouth with CHX will cause a reduction in salivary PH and acidic oral environment while rinsing the mouth with DW or MW will cause an elevation in the salivary PH and approximately neutral oral environment. In study by Toodehzaeim, et al. concluded that decreased salivary pH due to frequent consumption of acidic beverages may be responsible for orthodontic bracket bond failure [22]. Another study by Oncag, et al. studied

Table 3: One way (ANOVA) for the mean values of SBS among the study groups.

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	125.36	2	62.68	11.834	0
Within Groups	143	27	5.29		
Total	268.36	29			
DF: Dgree of Freedom					
F: F test					
Sig. significant level at (p≤ 0.05).					

Table 4: Duncan's multiple range tests for determining the significant difference between the groups.

Groups	N	Mean	Std.Error	Duncan Groups
MW	10	12.82	0.91	B
DW	10	14.41	0.77	B
CHX	10	9.5	0.4	A
N: Number of samples in each group				
MW: Magnetized Water group				
DW: Distilled Water group				
CHX: Chlorhexidine group (control positive) group				
Different litters mean significant difference at (p≤0.05). While same letters mean no significant difference.				

Table 5: Kruskal wallis test for the mean values of adhesive remnant index among the study groups.

Kruskal-Wallis H	6.58
df	2
Asymp. Sig.	0.037
DF: Dgree of Freedom	
Sig. is significant level at (p≤0.05)	

the effect of acidic soft drinks on SBS of orthodontic brackets and concluded that lower shear resistance found when acidic drinks causing reduction in salivary PH in both the in vitro and in vivo groups [23].

ARI is one of the most frequently utilized methods for assessing the value of adhesion between the composite and the tooth and further between the bracket base and composite [1]. In this study we noticed that ARI score was larger in the experimental group MW followed by DW and CHX groups . The ARI scores have Clinical significance, and it has been found that the enamel surface is exposed to higher stress when there is a higher rate of failure at the enamel-adhesive interface [24]. A lower risk of enamel fracture is indicated by a higher ARI score, which indicates that the mode of failure is closer to the bracket-adhesive contact [25]. In this study the ARI scores showed that bond failure in the experimental group MW occurred with adhesive -bracket interface which mean that stresses on the enamel surface was diminished and less possibiliy for enamel fracture.

CONCLUSION

According to this research's findings, it can be discovered that MW can be used as natural mouthwash and it has comparable effect on the SBS not significantly differ from the DW. MW had less effect on bond strenth of orthodontic adhesive than the CHX.

REFERENCES

1. Shaik MS, Pattanaik S, Pathuri S, et al. Shear bond strength of different adhesive materials used for bonding orthodontic brackets: Acomparative in vitro study. Ortho J Nebal 2018; 5:22-26.
2. Miethke RR, Vogt S. A comparison of the periodontal health of patients during treatment with the Invisalign system and with fixed orthodontic appliances. J Orofac Orthop 2005; 66:219-229.
3. Cerroni S, Pasquantonio G, Condò R, et al. Orthodontic fixed appliance and periodontal status: An updated systematic review. Open Dent J 2018; 18:14-22.
4. Yetkin ZA, Sayın MO, Ozat Y, et al. Appropriate oral hygiene motivation method for patients with fixed appliances. Angle Orthod 2007; 77:85-89.
5. Pithon MM, Santanna LIDA, Baiao FCS, et al. Assesment of the effectiveness of mouthwashes in reducing cariogenic biofilm in orthodontic patients: A systemic review. J Dent 2014; 2-12.
6. Papadopoulou C, Karamani L, Gkourtsogianni S, et al. A systematic review on the effectiveness of organic unprocessed products in controlling gingivitis in patients undergoing orthodontic treatment with fixed appliances. J Clin Exp Dent Res 2021; 7:664–671.
7. Kini V, Thakur M, Sharma R, et al. Comparative evaluation of the plaque inhibitory effect of a herbal extract containing fluoridated dentifrice to a fluoridated dentifrice: A clinical and microbiological study. J Contemp Dent 2017; 7:57-61.
8. Goyal AK, Rathore AS, Garg M, et al. Effect of magnetized water mouthrinse on *Streptococcus mutans* in plaque and Saliva in children: An in vivo study. Int J Clin Pediatr Dent 2017; 10:35-39.
9. Bhayya D, Prajapati R, Shyagali TR, et al. Evaluation of effect of 0.2% chlorhexidine, 0.2% magnetized RO water mouth rinse on *Streptococcus mutans* in children: A prospective cross-sectional study. J Pediatr Dent 2021; 7:65-71.
10. Tonetto MR, De Campos EA, Fernandez E, et al. Bond strength and adhesive remnant index of experimental brackets bonded with self-adhesive resin cement. Rev Clin Periodont Implantol Rehab Oral 2017; 10:115-117.
11. Mirzakouchaki B, Kimyai S, Hydari M, et al. Effect of self-etching primer/adhesive and conventional bonding on the shear bond strength in metallic and ceramic brackets. Med Oral Patol Oral Cir Bucal 2012; 17:164-170.
12. Degrazia FW, Genari B, Leitune VC, et al. Polymerisation, antibacterial and bioactivity properties of experimental orthodontic adhesives containing triclosan-loaded halloysite nanotubes. J Dent 2018; 69:77-82.
13. Blöcher S, Frankenberger R, Hellak A, et al. Effect on enamel shear bond strength of adding microsilver and nanosilver particles to the primer of an orthodontic adhesive. BMC Oral Health 2015; 15:42.
14. Alrahman MSA, Mhammed GA, Dawood SN. Comparison between magnetized water and sodium hypochlorite as disinfectant in root canal instrumentation (In vitro study). Int J Sci Res 2015; 4:2277.
15. Enita N, Dzemidzic V, Tiro A, et al. Antimicrobial activity of chlorhexidine in patients with fixed orthodontic appliances. Braz J Oral Sci 2011; 10:80-82.
16. Artun J, Bergland S. Clinical trials with crystal growth conditioning as an alternative to acid-etch enamel pretreatment. Am J Orthod 1984; 85:333-340.
17. Atashi MHA, Khosravi S, Goshaderoo A, et al. Clinical bonding durability assessment of rebonded brackets considering ARI score. Int J Med Invest 2018; 7:21-29.
18. Reynolds IR. A review of direct orthodontic bonding. Br J Orthod 1975; 2:171-178.
19. Banerjee S, Banerjee R. A comparative evaluation of the shear bond strength of five different orthodontic bonding agents polymeruzed using halogen and light-emitting diode curing lights: An in vitro investigation. Indian J Dent Res 2011; 22:731.
20. Bescos R, Ashworth A, Cutler C, et al. Effects of chlorhexidine mouthwash on the oral microbiome. Sci Rep 2020; 10:5254.
21. Singh S, Anuradha P, Sahana S, et al. Comparative evaluation of mouth rinsing with plain water and an antibacterial mouth rinse on salivary pH: A randomized clinical trial. J Indian Assoc Public Health Dent 2017; 15:302-305.
22. Toodehzaeim M, Khanpayeh E. Effect of saliva pH on shear bond strength of orthodontic brackets. J Dent 2015; 12:257-262.
23. Oncag G, Tuncer AD, Tosun YS. Acidic soft drinks effects

on the shear bond strength of orthodontic brackets and a scanning electron microscopy evaluation of the enamel. Angle Orthod 2005; 75:247-253.

24. Cezairli NS, Kücükekenci AS, Basoglu H. Evaluation of shear bond strength between orhodontic bracketes and three aged bulk fill composite. Int J Dent Sc 2019; 21:89-99.
25. Oztas E, Bagdelen G, Kilicoglu H, et al. The effect of enamel bleaching on the shear bond strength of metal and ceramic brackets. Eur J Orthod 2012; 34:232-237.