Research Paper Medical Science

The Effect of Three Commonly Consumed Soft Drinks on Bracket Bond Strengths, Microleakage And Adhesive Remnant Index: An In-Vitro Study

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ABSTRACT

This study aims to simulate and evaluate the effects of 3 commonly consumed soft drinks in India on bracket bond strength, microleakage beneath brackets and adhesive remnant index after exposure to these drinks in a controlled environment. 48 extracted human premolars were preserved in artificial saliva and brackets were bonded onto them using composite resin. They were separated into 4 groups. GROUP I was stored in artificial saliva, GROUP II was tested with Coca-Cola™, GROUP III was tested with Sprite™ & GROUP IV was tested with Mazaa™. The teeth were stored in Artificial Saliva and dipped in the drinks 3 times daily for 15 minutes at equal intervals for 15 days and then tested for bond strength, ARI and microleakage values using the universal Testing machine, modified ARI index and methylene blue staining respectively. Statistical analysis for shear bond strength was done using the Kruskal-Wallis test which showed clinically insignificant results (p>0.05). Statistical evaluation for the Adhesive remnant index scores was done using the Chi-Square and Fisher's Exact Test which showed insignificant results (p>0.05). Stereomicroscopic pictures showed maximum dye penetration in teeth dipped in Coca-Cola™ and the least dye penetration in those dipped in artificial saliva. There is an increase in microleakage beneath the orthodontic brackets during exposure to commercial soft drinks.

KEYWORDS Microleakage, Soft Drinks, Shear Bond Strength (SBS), ARIndex

INTRODUCTION

The term 'soft' drinks refers to all drinks except alcohol, mineral water, fruit juice, tea, coffee, or milk-based drinks, which may or may not be carbonated (Varnam and Sutherland, 1997).Recently, the consumption of soft drinks has increased (West et al., 2000). They are damaging not only because of the high levels of sugar they contain but also because most have pH levels below the critical limit for enamel demineralization (pH <5.5; Dinçer et al., 2002). Moreover, frequently consumed soft drinks have been shown to cause extreme dental erosion (Hunter et al., 2000). Dental erosion is defined as the acid-induced loss of hard tissue, a chemical process in whichbacteria play no part; for this reason, it is not associated with dental plaque. In an in vivo study, Jensdottir et al. (2006) found that the prevalence of dental erosion increased as the pH levels of the studied drinks decreased and as consumption increased. Other studies using scanning electron microscopy (SEM) have shown that soft drinks produce large areas of enamel decalcification (Rytömaa et al., 1988; Meurman and Frank, 1991a; Grando et al., 1996).

The appearance of white spot lesions caused by the demineralization of tooth enamel is a clinical problem associated with orthodontic treatment (Arikan et al., 2006). Its prevalence is between 2 and 96 per cent in patients with fixed appliances (Arhun et al., 2006) and is the result of demineralization processes occurring around and beneath the brackets due to a decrease in pH (Øgaard et al., 1998). Various authors have suggested that microleakage around brackets might contribute to the formation of white spot lesions beneath the brackets (Arhun et al., 2006; Arikan et al., 2006). However, the literature dealing with microleakage and its clinical consequences in orthodontics remains scarce (James et al., 2003; Arhun et al., 2006; Arikan et al., 2006) and Navarro et. Al.carried out a study to check microleakage beneath orthodontic brackets. Nevertheless, studies that use SEM to evaluate the effect of soft drinks on enamel sealed with orthodontic adhesives have observed areas of enamel showing adhesive loss after exposure to soft drinks (Steffen, 1996; Dinçer et al., 2002). This suggests that soft drink consumption may provoke an increase in microleakage beneath brackets and also compromise bond strength. However they did not affect the shear bond strength of brackets and adhesive remnant index.

Goje et al. compared the in-vitro resistance provided by four orthodontic cements on 100 extracted sound human premolars, namely (1) zinc phosphate, (2) zinc polycarboxylate, (3) conventional GIC and (4) resin modified GIC and (5) not banded which served as control group. Teeth banded with conventional GIC and resin modified GIC had the least amount of demineralization followed by zinc polycarboxylate and zinc phosphate.

Steffen M J. in 1996 studied the effects of cola soft drinks on enamel of 27 extracted teeth. The study concluded that dark cola drinks containing phosphoric acid should be seen as a true hazard for patients with fixed appliances.

Oncag G.4 in 2005 investigated the effects of acidic soft drinks on the resistance of metal brackets to shear forces in vitro and in vivo. The results indicated that acidic soft drinks such as Coca-Cola® and Sprite® had a negative effect on bracket retention against shearing forces and enamel erosion.

Fig1. (from left to right) The control, artificial saliva, and the three soft drinks being test, namely Coca-Cola®, Sprite® and Mazaa®.

Fig2. Microleakage underneath bracket bases which appear here as white spot lesions, areas of demineralization.

MATERIALS & METHODS

A total of 48 human premolar teeth would be required satisfying the following inclusion criteria:

- Free from enamel cracks
- No caries present
- No fillings
- Absence of Fluorosis
- No visible dental defects

The teeth were cleaned and polished with pumice before mounting. All the teeth collected were stored in distilled water before the start of the study. After all samples were collected they were mounted on a plaster slab with plaster covering the apical foramen of teeth . After mounting, MBT 0.022" maxillary right first premolar brackets were bonded on the teeth using TransBondXT™ Light cure Composite resin after etching with 37% orthophosphoric acid for 30 secs followed by priming with TransBondXT™ Light cure primer. After Bonding the teeth were stored in 4 groups of storage media, namely, 1) Control group which was Artificial Saliva, 2) Coca-Cola™, 3) Sprite™ and 4) Mazaa™. Groups 2, 3 and 4 were stored in artificial saliva for the most of the day and dipped in the cold drinks 3 times daily for 15 minutes, separated by equal intervals. The artificial saliva medium was changed daily and the cold drinks were refrigerated and used. This schedule wasfollowed for 14 days after which the teeth were subjected to SBS, ARI and microleakage testing.

For microleakage testing, half the samples were dipped in 1% methylene blue solution for 24hrs. after which teeth were sectioned using a round diamond saw and examined under 10X magnification stereomicroscope. For SBS testing, half the sample teeth were mounted on a hollow steel casing with clear acrylic and numbered with different colors to distinguish the various groups being tested on the Instron™ Universal testing machine. Modified adhesive remnant index after debonding, the enamel surface was examined under 10X magnification to determine how much residual adhesive remained on the tooth according to the following scale:

1= all the composite remained on the tooth
2= more than 90% of the composite remained on the tooth
3= more than 10% but less than 90% remained on the tooth
4 = less than 10% remained on the tooth
5= no composite remained on the tooth.

Table 1. Scoring criteria for the Modified Adhesive Remnant Index

Fig3. Sample teeth polished with pumice and mounted on a plaster slab.

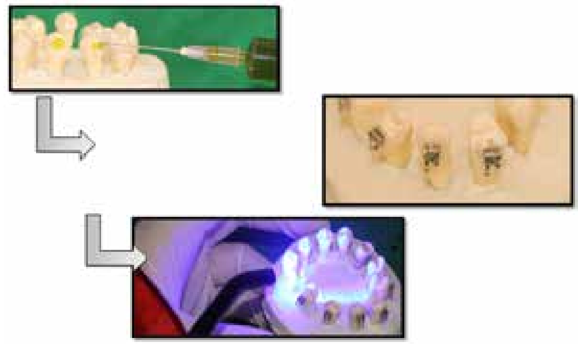

Fig 4. After mounting, the teeth are etched, and brackets are placed on the centre of the clinical crown, followed by light curing of the resin.

Fig 5. Materials used in bonding

Fig 6. After bonding, the plaster slabs with sample teeth were submerged in different soft drinks for the regulat-

ed time intervals. The soft drinks were refrigerated and replaced daily.

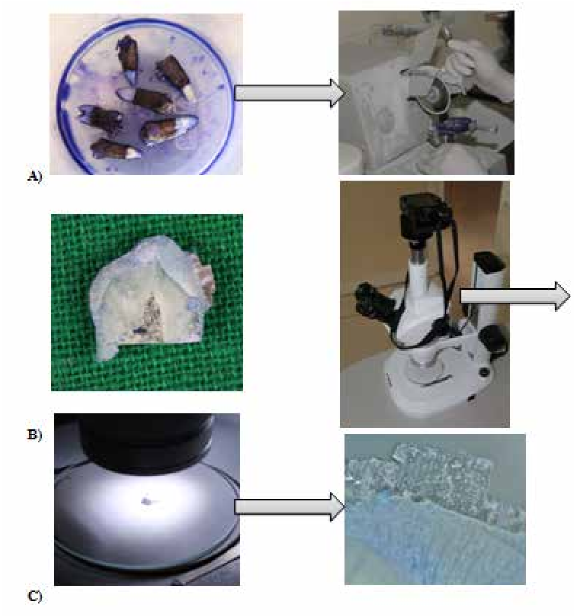

Fig 7. A) After the immersion period, half of the sample teeth dipped in 1% methylene blue dye to test for microleakage and then sectioned longitudinally using a diamond blade. B)Section of the tooth through the bonded bracket, which is then examined under a stereomicroscope. C) Section being examined under the stereomicroscope and digital photograph at 10x zoom at the bracket-tooth interface.

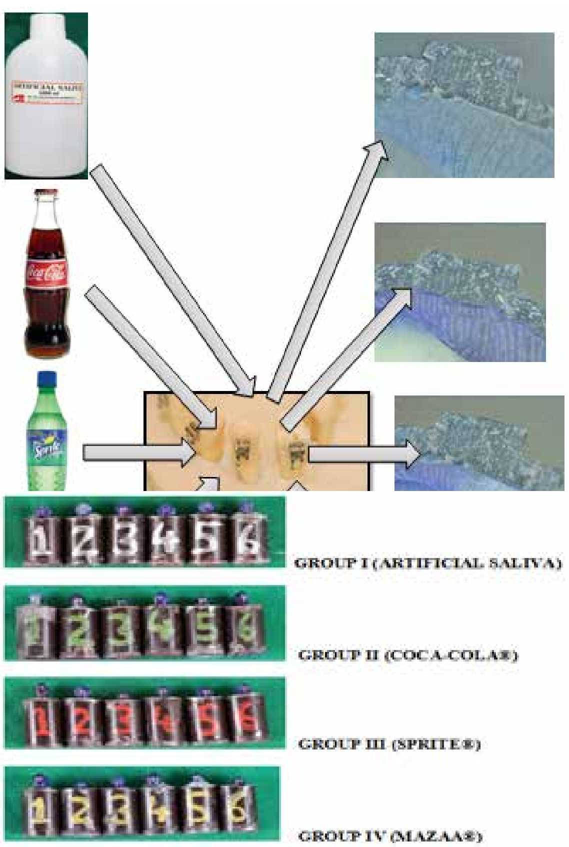

Fig 9. After the immersion period, the other half of the sample than previous discussed is removed from the plaster slab and mounted onto metallic rings with cold cure acrylic in preparation for testing the shear bond strengths. The metallic rings are color-coded depicting the different drinks being tested.

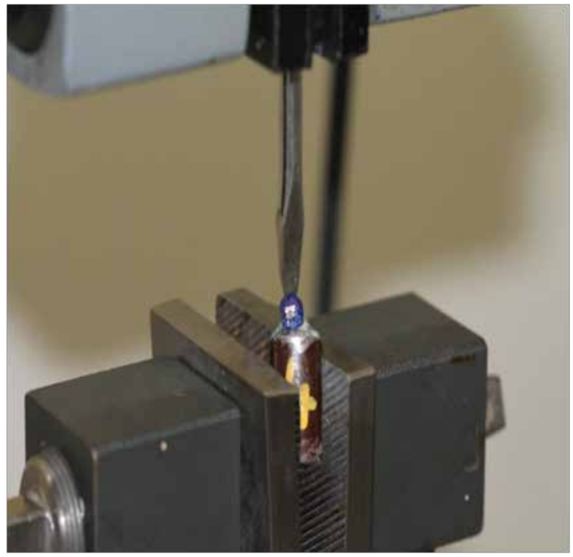

Fig 10. The sample teeth on the metallic rings are then tested with an Instron™ Universal Testing machine to record any changes in the shear bond strength after being immersed in soft drinks.

GROUP_NAME		maxforce	stress	Strain
A	N	5	5	5
	Minimum	87.24	7.70	4.21
	Maximum	138.25	10.93	122.62
	Mean	110.1941	9.0400	40.4370
	Std. Deviation	21.10531	1.35026	48.36247
B	N	5	5	5
	Minimum	80.24	7.45	3.26
	Maximum	110.85	9.34	30.79
	Mean	92.9275	8.1500	13.6760
	Std. Deviation	11.95679	.76593	10.72151
C	N	5	5	5
	Minimum	79.24	7.29	1.06
	Maximum	115.15	9.43	19.12
	Mean	96.5693	8.2560	7.5091
	Std. Deviation	13.08729	.79378	7.05634

D	N	5	5	5
	Minimum	95.71	8.25	1.39
	Maximum	129.13	9.90	40.99
	Mean	108.5502	8.9100	16.9105
	Std. Deviation	14.90611	.73780	16.52641

Table 2. Tabulation of data collected after testing with Instron™ Universal Testing Machine for shear bond strength. Statistical analysis reveals the mean SBS of different groups, A=control, B=Coca-Cola®, C=Sprite® & D=Mazaa®.

RESULTS

Statistical analysis for shear bond strength was done using the Kruskal-Wallis test and Chi-square tests which showed clinically insignificant results (p= 0.320).

Statistical evaluation for the Adhesive remnant index scores was done using the Pearson's Chi-Square and Fisher's Exact Test which showed insignificant results (p= 0.759).

The microleakage was evaluated under the stereomicroscope, and showed higher amount of microleakage underneath teeth immersed in soft drinks than the control groups, highest microleakage being in the Coca-Cola™ group.

DISCUSSION

In recent years there has been an increase in the consumption of soft drinks among children and adolescents. The present study used these four drinks as these are the most preferred class of soft drinks in young adolescent patients and they are known to have pH below the critical level for enamel demineralization. The immersion schedules used in previous studies were higher; whereas in the present research an immersion schedule was used that would reproduce as closely as possible the situation in vivo. In this way, assuming that these drinks are consumed three times a day and that it might take around 45 minutes to consume one drink, the specimens were submerged in the drinks for 15 minutes at a time and afterwards in artificial saliva, a procedure that was repeated three times a day. The teeth were kept in saliva between immersions in the drinks in order to reproduce normal oral environment conditions and also to allow the possible remineralizing effects of saliva on enamel to take place.

The study did not show significant difference between Shear Bond Strength and Adhesive remnant Index between the 4 groups but photographic analysis of stereomicroscope pictures show that the microleakage was least in the control group (group I). All the other groups showed varying degrees of increased microleakage beneath the brackets. It can clearly be noticed that all drinks with acidic pH and high sugar content predispose the teeth to demineralization and reduce the strength of adhesive which bonds the bracket on tooth surface.

The method of analyzing the microleakage is by visual analysis of the dye penetration underneath the brackets as seen on stereomicroscopic images of the sectioned brackets, however, no specific method of quantitative analysis of the dye penetration is present in literature and further studies into this field would greatly help to statistically analyze the amount of microleakage underneath the orthodontic brackets. Due to limitations in the study statistical analysis of microleakage was not done, however, a larger sample is being processed for which I shall be trying to device a method for obtaining statistical data on microleakage underneath orthodontic brackets.

Although the results were statistically insignificant, even 1MPa of reduce shear bond strength can lead to adverse effects on bracket bonding and must be taken into account. Similar studies should be carried out with wider range of drinks and higher sample to conclusively determine the amount of damage these drinks cause to the teeth and bonding of orthodontic bracket systems.

CONCLUSION

Effect of the different soft drinks on the shear bond strength of orthodontic brackets was statistically insignificant, although variations in the mean SBS in all groups were evident, highest being in the Control group (9.04MPa) and least in the Coca-Cola™ group (8.15MPa).

The Adhesive remnant index for each group was found to be statistically insignificant.

Microleakage was seen to be higher in the soft drink groups than in the control group, and more so in the Coca-Cola group compared to Sprite or Mazaa.

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