Research Article

Microhardness of pit and fissure sealant treated tooth after exposure to two different kinds of beverages – A Pilot study

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ABSTRACT

Background: Dissolution of the mineralized tooth structures occurs on contact with the acids that are introduced into the oral cavity. Soft drinks have many potential health problems. The inherent acids and sugars have both acidogenic and cariogenic potential, resulting in dental caries and potential enamel erosion. Soft drinks have a detrimental effect on the teeth on prolonged exposure. Acidic soft drinks cause enamel demineralization on etched tooth surfaces and also cause erosion of the restoration. **Aim:** This study aims to know the effects of soft drinks on microhardness in pit and fissure treated tooth. **Materials and Methods:** In this *in vitro* study, the molar teeth extracted for surgical or orthodontic treatment from the department of oral surgery, Saveetha Dental College, Chennai, were used. The teeth were cleaned by soaking them in 5% sodium hypochlorite. Four circular discs were prepared using autopolymerizing monomer and polymer with a diameter of 5 cm. Class 5 buccal cavity was prepared on the sample molar teeth and was restored with pit and fissure sealant and was light cured. These restored and cured samples were embedded in the center of the acrylic discs with restored surface facing upward. Microhardness was done using the method ASTM E384-2011 IN MICROLAB. **Results:** The microhardness of material was reduced after 7 days, but this reduction in the test groups was not significant as compared with the controls. Microhardness of the samples reduced more in Cola compared to the samples immersed in Minute Maid. This can also be explained by the pH of the beverage; the pH of Cola is less (2.52) compared to the pH of Minute Maid (3.8). **Conclusion:** The decrease in microhardness also depends on exposure time and chemical composition of composites and soft drinks. Hence, producing and introducing a new pit and fissure sealant with its compositions changed so that it resists the erosive action of the beverages is solution for the erosive action of the beverages on the sealants.

KEY WORDS: Beverages, Microhardness, Pit and fissure sealants

INTRODUCTION

Dental erosion is the irreversible loss of tooth structure due to chemical attacks by acids not of bacterial origin. Dissolution of the mineralized tooth structures occurs on contact with the acids that are introduced into the oral cavity from either intrinsic sources or extrinsic sources. The cause of dental erosion can be extrinsic or intrinsic. Extrinsic causes are due ego intake of acidic food, beverages, and environment exposure to acidic agents. Intrinsic causes are vomiting and regurgitation. Patient suffering from anorexia nervosa is more prone to dental erosion by intrinsic factors. Clinically, these dental erosions appear as broad concavities within smooth surface enamel, cupping of occlusal surfaces, leading to dentin exposure, increased incisal translucency, hypersensitivity, and tooth surfaces appear smooth and polished.[1-3]

Dental caries is the most common cause of irreversible loss of tooth structure. These lost structures are restored using restorative materials. Materials used may be gold, amalgam, dental composites, glass ionomer cement (GIC), or porcelain. Restoration is usually done to restore the lost tooth structures due to dental caries or fracture. The main goal of any restoration is not only restore the lost tooth structure but also restore its function, looks esthetically appealing, and has

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a longer life span. Any damage to the tooth surface will have direct effects on the life of the restoration. Sealants are a safe and painless way of protecting your teeth from decay. A sealant is a protective plastic coating, which is applied to the occlusal surfaces of the posterior teeth. The sealant forms a hard shield that keeps food and bacteria from getting into the tiny grooves in the teeth and causing decay. Teeth have grooves and fissures on their biting surfaces; the back teeth have fissures (grooves) and some front teeth have cingulum pits. Pit and fissure sealants are used in preventive dentistry. It seems simple, but its technique sensitive and its durability depend on various factors.

Soft drinks can damage the life of the restoration. The effect of the beverages may be stronger, depending on features such as chemical composition of the restorative materials or external features such as finishing and polishing of restoration. The physical properties of the restorative materials like the microhardness are most important to be considered since it determines the longevity of the restorations.[4] Moreover, the impact of a beverage on the materials may be directly related to the amount and frequency of its intake. Acidic soft drinks cause enamel demineralization on tooth surfaces. High intake of acidic drinks and fruits can be considered as the main cause of severe dental erosion and also changes in the restoration. Even the primary teeth are highly susceptible to the acidic drinks since the enamel in the primary teeth is softer than the enamel in the permanent teeth. Factors that cause surface changes on enamel can similarly influence certain properties of the dental restoration.

In recent years, the consumption of soft drinks and energy drinks has gained popularity.[2] Many researchers suggest that these drinks cause dental erosions in the normal tooth surfaces. Moreover, due to its low pH level, these are unfavorable to the restorative material.[5,6]

Hamouda, in 2011, did a study on the effects of soft drinks on the hardness, roughness, and solubility of esthetic restoration such as GIC, compomer, composite restoration, and resin-modified glass ionomer.[7] Light-cured glass ionomers are less resistant to softening by food-simulating solutions than microfilled composites. Light-cured glass ionomers that use acid monomers in place of polyalkenoic acid are more resistant to softening than other categories of light-cured glass ionomers.[8] Badra *et al*., in 2005, tested the influence of different beverages such as Coca-Cola, sugarcane spirit, coffee, and artificial saliva on the microhardness and surface roughness of resin composites microfilled, hybrid, and flowable resin composites, overtime. It was observed that the tested beverages somewhat altered ($P < 0.05$) the composites' microhardness and/or surface roughness. Knoop microhardness – for all resin composites, microhardness remained stable up to the 30-day record, decreasing significantly at the 60-day evaluation.[9]

Edwards *et al*. tested the effect of beverages on the restoration based on the buffering capacity of the drinks and concluded that the buffering capacities can be ordered as follows: Fruit-based carbonated < fruit juices and mineral water < sparkling mineral waters < non-fruit-based carbonated drinks < flavored mineral waters. It is concluded that fruit juices and fruit-based carbonated beverages, with their increased buffering capacities, may induce a prolonged drop in oral pH, thus leading to erosion.[10] West *et al*. tested the effect of orange juice on the tooth surface *in vivo* and *in vitro* and concluded that surface microhardness testing *in situ* and *in vitro* demonstrated statistically significant differences between exposed and unexposed areas after orange juice treatment. It is concluded that this method has confirmed the erosive potential of orange juice *in situ*. The method could have many applications to study dental erosion under highly controlled conditions and over realistic time periods.[11]

Many previous studies explain and evaluate the effect of soft drinks on many dental restorations such as composite restorations, GIC, and resin-modified GIC, but the beverages effect on pit and fissure sealant is still unclear. Restorations are done to restore the lost dental structures due to trauma, caries, or any other alterations in the tooth structures. Pit and fissure sealant is done to prevent the dental caries from deepening. Pit and fissure sealant is applied on the grooves and pits in the occlusal surface of the molars, which is the most common site prone to caries incidence. Application of the sealant makes the surface easy cleanable, thus preventing the accumulation of debris and plaque. Hence, the current study is to investigate the effects of two commonly used beverages, namely, Cola and Minute Maid on surface hardness of pit and fissure sealant.

MATERIALS AND METHODS

- Study sample: This was an experimental study
- Study sample: A sample of four permanent molar teeth extracted for surgical reasons was used in the study.

Eligibility Criteria

Inclusion criteria

Sound intact permanent molars were included in the study.

Exclusion criteria

Teeth with developmental anomalies, teeth involving occlusal surface caries, and teeth with extensive loss of crown structure due to caries or trauma were excluded from the study.

Ethical clearance

Before the start of the study, Ethical Clearance was obtained from the Institutional Ethics Committee, Saveetha University.

Collection and storage of extracted molars

In this *in vitro* study, the molar teeth extracted for surgical or orthodontic treatment from the Department of Oral Surgery, Saveetha Dental College, Chennai, were used. The teeth were cleaned by soaking them in 5% sodium hypochlorite. The remaining periodontal tissue and calculus were removed. All the teeth were then microscopically examined for caries and other possible cracks or defects.

The teeth which were not fulfilling the inclusion criteria were rejected while those fulfilling were included in the study. These selected teeth were stored in 10% formalin solution until further use. The final four selected molars were cleaned and polished with pumice slurry.

Study Area

The present *in vitro* study was conducted on the department of public health dentistry and microhardness was done using the method ASTM E384-2011 IN MICROLAB.

Armamentarium

1. Deep sensing microindenter
2. Test materials.
   - Pit and fissure sealant – Clinpro™ sealant
   - Extracted sound molar tooth
   - Modeling wax
   - Nail varnish
   - Paintbrush
   - Surgical gloves
   - Applicator tips
   - Cotton
   - Chip blower
   - Three-way syringe
   - Chemicals1 used: Acid etchant – 37% orthophosphoric acid and autopolymerizing monomer and polymer.

Preparation of Samples

Four circular discs were prepared using autopolymerizing monomer and polymer with a diameter of 5 cm. Class 5 buccal cavity was prepared on the sample molar teeth and was restored with pit and fissure sealant and was light cured. These restored and cured samples were embedded in the center of the acrylic discs with restored surface facing upward.

RESULTS

Before exposing the samples to the respective beverages, they were immersed in saline to check for the baseline value and the value was calculated. Then, the samples were immersed in their respective beverages and the result was calculated [Table 1].

There were significant differences in the hardness of the pit and fissure sealant in different immersion media. The interaction of the materials and immersion media was significantly different. The average surface hardness of the materials in saline water was significantly different from that measured for Minute Maid and Cola. The significant change in the microhardness was more in Cola immersed sample than in Minute Maid immersed sample.

This can also be caused due to the gas present in the Cola drink and also the pH of the Cola.

DISCUSSION

Steffen (1996) reported that it was the chemicals in Cola soft drink that affected the integrity of the enamel surface. Though enamel being the hardest material reported, is not spared of the devastating effects of Cola. It is no matter of surprise when tooth-colored materials with mechanical properties much inferior than enamel, exhibits higher vulnerability to the effects of Cola. The observed surface damage was attributed to softening or removal of portion of the set matrix by chemical in oral environment. Thus, interactions among substances in oral cavity have a negative impact on the durability of dental restorations.[12] Vanganarashimha, in 2011, did a study on effects of Cola on the microhardness and marginal integrity on resin-based restorations and composite restorations and concluded that the frequency of exposure to Cola is directly proportional to the marginal integrity and surface deterioration of the material studied. The two materials also showed reduction in surface microhardness under all the immersion regimes.[13] Watts and Bertenshaw (1995) reported that at pH 63, hardness decreased by a factor of 5. The pH of Cola soft drink is pH < 3. Hence, this low pH could have caused generalized reduction of microhardness.[14]

Chanothai Hengtrakool, in 2011, investigated the titratable acidity and erosive potential of acidic agents on the microhardness and surface micromorphology

Table 1: Microhardness of the tooth samples after immersion

Beverages	Hardness value (HV 100 g)	
	Baseline	After exposure
Cola	290	379
	305	307
	281	398
Minute Maid	359	455
	365	431
	371	444

of four restorative materials, metal-reinforced GIC (Ketac-S), resin-modified GIC (Fuji II LC), resin composite (Filtek Z250), and amalgam (ValiantPh.D) by immersing the samples in 4 different immersion medium four storage media; deionized water (control), citrate buffer solution, green mango juice, and pineapple juice. Statistical significance among each group was analyzed using two-way repeated ANOVA and Tukey's tests. The Fuji II LC and the Ketac-S showed the highest reduction in microhardness.[15] The Valiant-Ph.D. and the Filtek Z250 showed some minor changes over the period of 7 days. The mango juice produced the greatest degradation effect.[15]

Somayaji and Amalan, in 2016, studied the effect of different acidic beverages – Appy Fizz, Nimbooz, and Thumbs Up on microhardness of nanohybrid composite, giomer, and microhybrid composite, the specimens were dipped in Appy Fizz, Nimbooz, and Thumbs Up for 50 s and washed with saline. This cycle was continued for 6 times each day and was carried out in regular intervals, that is, 7, 14, and 21 days. As a result, there was reduction in hardness after 7 and 14 days but no significant difference ($P > 0.05$). There was a significant difference after 21 days of experimental models for glass ionomer, ceramic, and spectra.[16]

Maganur *et al*., in 2013, studied the effect of a soft drink and a fresh fruit juice on microleakage as well as surface texture of flowable composite (Filtek™ Flow 3M Dental products) and resin-modified GIC (Vitremer™ 3M Dental products). The teeth and the pellets showed statistically significant microleakage and surface roughness, respectively, as the immersion regime increased. Thus, the study conclusively proves that the "sipping habit" associated with commonly available low pH beverages is detrimental to the longevity of restorations.[17] Studies on polyacid modified resin composites by Attin *et al*. (1998) and Watts and Bertenshaw (1995) proved that these materials are surface softened by an acidic environment. The acidic attack resulted in a loss of structural ions from the glass phase of polyacid modified composites.[18] A study was on the factors that influence the color stability of composite restorations done in the year 2017, this article reviews the various factors that affect the color stability of composite restorations, the patients major concern are the color of the restoration and any changes to this can make the patient feel that the treatment is worthless. Thus, proving the awareness of various factors that influence the color stability of composite restorations is beneficial.[19] All the effects caused on the restorative material are not just due to the beverage alone but the joint role of agitation and frequency of intake of the beverage,[20] pH of beverage, etc.

CONCLUSION

The microhardness of material was reduced after 7 days, but this reduction in the test groups was not significant as compared with the controls. Microhardness of the samples reduced more in Cola compared to the samples immersed in Minute Maid. This can also be explained by the pH of the beverage; the pH of Cola is less (2.52) compared to the pH of Minute Maid (3.8). The decrease in microhardness also depends on exposure time and chemical composition of composites and soft drinks. Hence, producing and introducing a new pit and fissure sealant with its compositions changed so that it resists the erosive action of the beverages is solution for the erosive action of the beverages on the sealants.

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