Applied Aspect of Saliva in Orthodontics

Snigdha Pattanaik

Associate Professor, Department of Orthodontics and Dentofacial Orthopaedics, Institute of Dental Sciences, Siksha 'O' Anusandhan (Deemed to be University), Bhubaneswar, Odisha, India

Abstract

Saliva influences oral health both through its non-specific physicochemical properties, as well as through more specific effects. The proline-rich proteins, statherin and the histatins are salivary proteins that influence calcium phosphate chemistry, initial plaque formation and candida infection. Increases or decreases in mastication may affect saliva output. Fixed orthodontic appliances introduce an additional constituent to the oral cavity complex that may enhance the environment in a variety of ways. On the other hand, Orthodontic treatment leads to changes in the oral environmental factors that encourage changes in salivary flow rate, viscosity, pH, bacterial count, increased plaque index, and other more things which all are factors supplement the risk of caries activity and shake the stability of the oral environment. This manuscript highlights the effect of saliva on orthodontic treatment.

Keywords: *Orthodontic Treatment, Saliva, friction, brackets.*

Introduction

The quality and the quantity of saliva play a crucial role in the equilibrium between demineralization and remineralization of enamel in a cariogenic environment. Specific changes, such as increased pH, buffer capacity and flow rate, may contribute to decreased susceptibility to dental caries. All these salivary properties become of utmost importance during orthodontic treatment with fixed appliances, when an increased chance of plaque retention and a greater difficulty in optimal oral hygiene maintenance is thought to predispose to enamel demineralization and white spot formation. There is still no consensus on the way the quality and the quantity of saliva change during orthodontic treatment. So far, investigations have been confined to the first 6 months from the placement of fixed appliances, and no data are yet available in the long term. In this article we have discussed different aspects of saliva and its effect on orthodontic treatment[1].

I. **Friction:** It has been suggested that saliva or saliva substitute services as an excellent lubricant in the sliding of the bracket along the wire. Frictional changes in force values caused by saliva substitution were studied by Baker et al in1987 to determine the magnitude of frictional force changes between several sizes of stainless steel orthodontic archwires i.e. 018, 020, 018 x 025 and edgewise 022 x 028 slot when an artificial saliva medium was introduced. The teeth were bonded with brackets and wire assemblies and subjected to Instron universal testing machine and subjected to tension-type of force[2].

After tabulating results they concluded that Xero lube, saliva substitute as a lubricant provided a 15% to 19% reduction in force value requirement when using 018, 020, 018 x 025 wires. They also concluded that the saliva medium used has a viscosity of 14.0 centipoise at 37°C. They conducted similar research using glycerine which has a viscosity of 325.0 antipose but results obtained did not match to that obtained with xerolube artificial saliva.

Corresponding Author
Dr. Snigdha Pattanaik
Associate Professor, Department of Orthodontics and Dentofacial Orthopaedics, Institute of Dental Sciences, Siksha 'O' Anusandhan (Deemed to be University), Bhubaneswar, Odisha, India
e-mail: dr.snigdhapattanaik@gmail.com

To study the Frictional resistance of ceramic and stainless steel orthodontic brackets, Kratten, Popli, Germanine in 1990, conducted a similar type of research and found that saliva substitutes increased static friction for all combination tested. Saliva played an insignificant role in lubricating the surface of the wire or bracket slot. The explanation for the discrepancy may lie in the significance of loading forces used between the archwire and the brackets. At low load levels saliva acts as a lubricant, but at high loads saliva may increase friction if it's forced out from the contacts between the brackets and the arch wire[3].

The effect of artificial saliva on the frictional forces between orthodontic brackets and archwires was studied by Douning, Mc Cabe, Gordon in 1995. Here the effect of artificial saliva on the static and kinetic frictional forces of stainless steel and polycrystalline ceramic brackets in combination with 0.018 inch round end 0.019 x 0.025 inch edgewise archwire sizes and stainless steel, nickel-titanium and β-titanium archwire materials under a constant ligature force were investigated. In all the cases artificial saliva had the effect of increasing the frictional force when compared with the dry state. They concluded that artificial saliva played an insignificant role in lubricating the surface of the archwire in the bracket slot. The explanation they gave for this study was that archwire touches the bracket at only 2 points where the pressure is relatively great. The lubricant could be expelled from the areas of contact allowing no lubrication between the archwire and bracket to exist, hence increasing friction. Use of β titanium archwire produced the smallest percentage increase in frictional forces due to; stick and slip phenomenon[4].

II. Bonding: The Effect of saliva on shear bond strength of orthodontic adhesive used with moisture insensitive and self-etching primers was studied by Zoppieri IL, Chung CH, Maste to investigate the effect of saliva contamination on the shear bond strength of an orthodontic adhesive used with transbond–moisture Insensitive primer (MIP) and transbond plus- self-etching primer (SEP). Hydrophobic transbond XT primer was used as control. It was concluded that Transbond XT adhesive with XT primer and MIP in dry field yields similar bond strength which is greater than all other groups. Saliva contamination significantly lowers the bond strength of transbond MIP. Saliva has no effect on the bond strength of SEP Transbond XT adhesive with transbond MIP and SEP might have clinically acceptable bond strengths in either dry or wet fields.

The active ingredient of transbond SEP is a methacrylate phosphoric acid ester formed when phosphoric acid and a methacrylate group are combined into a molecule that etches and primes simultaneously. The conventional phosphoric acid-etched teeth are washed or rinsed after adequate etching time. Similarly the phosphate group in methacrylate phosphoric acid ester in SEP dissolves the calcium and removes it from the hydroxyapatite. The calcium then forms a complex with phosphate group, rather than being removed by rinsing and is incorporated into the network when the primer polymerizes. The acid group is neutralized by the reaction with calcium. Thus there is no need to rise the tooth because no etchant remains on the enamel[5].

Effect on a New Bonding agent in bond strength to saliva contaminated enamel was studied in 1994 to compare bond strengths of brackets applied to contaminated and uncontaminated enamel following pretreatment of contaminated enamel with Scotch bond MP bonding system. They concluded that bond strength was found to be equal in brackets bonded to saliva contaminated etched enamel treated with Scotch Bond MP primer and bonding agent applied to uncontaminated enamel. Scotch band MP works slightly differently. The primer composed of HEMA and polyalkeonic copolymer behaves similarly to the liquid of glass ionomer in that it forms stronger bonds to a moistened enamel or dentin surface[6].

Greer KS, Lindaver SI, Darling SG in 1996 developed a technique to prevent surface contamination of etched enamel. It has been recommended that a thin layer of primer be applied to the entire etched enamel surface before bonding to seal the enamel, protect it from decay, provide maximal bond strength. If the etched surface becomes contaminated by oral fluids before bonding the bond is likely to fail at resin enamel interface. Contamination can occur during the application of the primer if saliva or sulcular fluid is unintentionally spread by applicator brush. This is most likely to occur when bonding to surgically exposed palatally placed canines or to teeth with short clinical crowns. In such cases it's more effective to apply the primer directly to the adhesive resin on the back of orthodontic attachment. Bond strength in this technique was considered best in cases where there is poor visibility or limited exposure[7].

Isolation: The oral environment needs to be

adequately controlled to prevent from interfering with the execution of any dental procedure. This control is attained through isolation.

Various means of isolation are Fluid absorbents, Saliva ejectors, Rubber dam and Pharmacologic agents.

A. Fluid Absorbents: Here isolation can be achieved by absorption of salivary secretions by cotton rolls with holders, Gauze or throat shields or Absorbent wafers. These can be used for short periods when absolute dryness is not required.

B. Saliva Ejectors: They prevent the pooling of saliva in the floor of the mouth. There are twotypes of saliva ejectors: High volume – they remove metallic debris and Low volume. Based on the material from which they are manufactured; Metallic ones can be autoclaved, but requires delicate use to prevent injury whereas Plastic – disposable and in expensive[8].

Advantages:

- Provides adequate dry field.
- There is no dehydration of oral tissues

Precaution:

- Saliva ejector should be sterilized or disposed to prevent cross-contamination.
- Disposable types are preferred
- Patients should be instructed not to close his mouth with the lip in mouth since the backflow of contaminated solution into the mouth is possible.

C. Rubber Dam: Use of rubber dam provide a clean, visible field and Prevents aspiration of foreign bodies it also reduces the risk of cross-contamination and Improves properties of adhesive materials.

III. Salivary Clearance and Fixed Orthodontic Appliance: Since fixed ortho appliances have numerous recesses, pits, which entraps the food particles, the oral clearance rate is slowed. In 1992 Magnus Forsberg, lively A, Jagerlof F conducted a study to establish the possible influence of orthodontic therapy with fixed appliances on salivary clearance of sugar. The study aimed to evaluate the effect of fixed orthodontic appliances on the residual volume of saliva in the mouth and Salivary clearance of sugar. A total of 15 patients, 2 males and 13 females scheduled for orthodontic treatment with fixed appliances took part in the investigation. Unstimulated salivary flow rate, RESID, and salivary clearance of sugar were determined on two occasions i.e. before the start of treatment and 21 days after a fixed appliance was placed in the mouth. In the results it is seen that the salivary flow rate before the start of orthodontic treatment was 0.46 ml/min, after a wear of appliance for 21 days mean value increased to .57 ml min).

Orthodontic appliance had a similar effect on the residual volume of saliva in the mouth after swallowing. It is a well-known fact that a foreign body put in the mouth will initially increase the flow of saliva. The present study indicates that fixed appliances do not prolong the salivary clearance of sugar during the first month of treatment[9].

Further studies with longer duration claimed to have decreased or normal levels of salivary flow and RESID. Since the appliance consists of many retentive components that provide numerous recesses and minor pits where food particles may be trapped accounting for delayed clearance of sugars on long term treatment schedules.

Because of this factor caries and demineralization will continue to be matters of concern during orthodontic treatment.

The effect of polyol gums on dental plaque in orthodontic patients was studied by Isotupa et al in 1995. They conducted a study on 60 patients wearing fixed orthodontic appliances, who were given chewing gums containing polyol to find out the number of streptococcus mutans present in saliva. They concluded that patients chewing xylitol-containing chewing gums had less amount of *Streptococcus mutans* level and less incidence of caries. A clinical study was carried out IN 1996 to determine the acceptability of a sugar-free, low tack chewing gum by orthodontic patients. It was concluded that low tack sugar-free chewing gums can be used by orthodontic patients to increase saliva flow with the potential to remineralize and help reduce white spot lesion formation. Freedent peppermint gum, from Wrigley company, was the product they used in their study[10].

4. Experimental Salivary Pellicles on the Surface of Orthodontic Materials: Lee SJ etal conducted a study with a purpose to find out whether the composition of salivary pellicles that form on the

surface of orthodontic materials vary qualitatively concerning stainless steel, elastomeric ligature ring, bracket bonding resin. They concluded that the least amount of salivary pellicle which was cariogenic was found on stainless resin, followed by adhesive resin, the highest amount of cariogenic pellicle was found on elastomers[11].

5. **Effect of Salivary Ph on Orthodontic Polyurethane Chain Elastics:** The effect of hydrogen ion concentration on forces degradation rate of orthodontic polyurethane chain elastics was studied by Ferriter and Meyers. The effect of pH on force degradation rates of seven commercial orthodontic polyurethane chain elastics was evaluated in an in vitro study. The pH values of 4.85 to 7.26 were selected for testing because they represent values closes to the reported extremes of plaque and saliva pH. All specimens were equally stretched which delivered equal initial force levels. Force degradation rates were recorded after 4 weeks. They concluded that the force decay rate of polyurethane orthodontic chain elastics is inversely proportional to the pH of the oral environment with a corollary that pH levels above mentioned are more hostile to the polyurethane chain elastics thus increasing their force decay rates[12].

6. **Saliva and Corrosion:** Saliva acts as an electrolyte and hence aids in causing corrosion of metal components of fixed orthodontic appliances. When metal components of orthodontic appliances are in contact with an electrolyte such as saliva, metals corrode by a complex electrochemical process of oxidation and dissolution known as galvanic corrosion. The generation of an electric cell is simple when different metals are involved, but it can also occur within a single metal. Atoms at the grain boundary dissolve faster than those within the grain. Impurities, rough surfaces or irregularities can also alter the corrosion resistance of a metal.Corrosion-resistant metals are known as noble metals or cathodic.

Types of corrosion:

1. **Uniform corrosion:** Metal is attacked evenly and throughout, and its mechanical property diminishes proportionately. This type is rarely seen in orthodontics since all the parts of the appliance are not evenly exposed to corrosion agents.

2. **Localized or pitting corrosion:** The most common form seen in orthodontic attachments. Affects the mechanical property of the metal. This type is seen when several different metals are used.

3. **Galvanic corrosion:** The oral cavity because of saliva, with its salts provides a weak electrolyte. Galvanic corrosion is an important type of electrolyte corrosion which occurs when a combination of dissimilar metals lie in direct physical contact with each other.

4. **Stress corrosion:** If a stressed metal comes in contact with unstressed metals,stressed metal will become the anode of the galvanic cells and will corrode[13].

   Nickel and chromium levels in the saliva and serum of patients with fixed orthodontic appliances were studied by Agaogh, Arun T, Belgin Izgu to evaluate the concentrations of nickel and chromium ions in salivary and serum samples from patients treated with fixed orthodontic appliances. The second aim of the study was to determine any significant changes in these concentrations during any period of the treatment time. Saliva and blood samples were collected from 100 patients ranging in age from 12 to 33 years. The fixed appliances consisted of an average of 4 bands and 20 banded brackets. The results indicate certain differences in the amount of nickel and chromium released from fixed orthodontic appliances during different periods of treatment. In saliva samples, nickel and chromium reached their highest levels in the first month and decreased to their initial level in the rest of the groups. It can be concluded that a fixed orthodontic appliance releases a measurable amount of nickel and chromium when placed in the mouth. Most metals used in the oral cavity can be expected to undergo this type of corrosion. Saliva has a dynamic composition that may be affected by many physiologic variables such as diet, salivary pH, health conditions and salivary flow rate[14].

7. **Saliva and Demineralization (Caries):** The pH of saliva acts as a deciding factor, be it demineralization and induction of carries or remineralization. At pH value of 6.8 to 6.0 hydrogen ions react with phosphate ions in saliva and plaque. At pH value of 5.5 to 5.0 demineralization occurs wherein hydroxyapatite dissolves but fluorapatite forms in the presence of fluoride. At a pH of 4.5 to 3.5 (critical pH) both fluorapatite and hydroxyapatite dissolves. On the

contrary if pH rises to 5.5 from the critical pH and if H^+ ion are not exhausted remineralization occurs and fluorapatite forms[15].

Conclusion

With the innumerous number of functions of salivary glands and its secretion namely saliva that we have come across, we can arguably call this secretion namely saliva the champion among the factors that are involved in the homeostasis of our body. Since dentistry is a material science thorough knowledge is important for us to come out with innovations so that products we use render maximal service to the patient.

Conflict of Interests: None

Ethical Permission: Approved

Funding: Nil

References :

1. Baker KL, Nieberg LG, Weimer AD, Hanna M. Frictional changes in force values caused by saliva substitution. Am J Orthod Dentofacial Orthop. 1987 Apr;91(4):316-20.
2. Forsberg, Oliveby and lagerlof. Salivary clearance and orthodontic therapy. Am J Orthod Dentofacial Orthop. 1992;10: 527-530.
3. Pratten DH, Popli K, Germane N, Gunsolley JC. "Frictional resistance of ceramic and stainless steel orthodontic brackets". Am J Orthod Dentofacial Orthop. 1990;2:398-403.
4. Isotupa PK, Gunn S, Chen YC, Lopatin and Makinen KK. "Effect of polyol gums on dental plaque" Am J Orthod Dentofacial Orthop. 1995; 497-504.
5. MC Duffie MW, Brown FH and Raines WH. "Pneumoparotitis with treatment". Am J Orthod Dentofacial Orthop. 1993 April; 377-379.
6. Lombardo L, Yildiz YÖ, Gorgun Ö, Panza CG. Siciliani SG. Changes in the oral environment after placement of lingual and labial orthodontic appliances. Prog Orthod., 14 (2013), p. 28
7. Alesandri G, Incerti S, Garulli G, Gatto MR, Checchi L. Effect of fixed orthodontic appliances on salivary properties. Prog Orthod, 14 (2013), p. 13
8. Llena-Puy C. The rôle of saliva in maintaining oral health and as an aid to diagnosis. Med Oral Patol Oral Cir Bucal, 11 (2006), pp. E449-E455
9. LaraE, MontlelNM, SanchezL, AlanisJ. Effect of Orthodontic treatment on saliva, plaque and the levels of Streptococcus mutans and Lactobacillus. Med Oral Patol Oral Cir Bucal 2010:15 (6): 924-929.
10. Li Y, HuB, LiuY, DingG, ZhangC, Wang S. The effects of fixed orthodontic appliances on saliva flow rate and saliva electrolyte concentrations J Oral Rehabilitation 2009; 36 (11): 781-785
11. UlukapiH, Koray F, Efes B. Monitoring the caries risk of orthodontic patients Quintessence Int, 1997; 28 (1): 27-29.
12. PerosK, Mestrovic S, AnicS, Slaj M. Salivary microbial and nonmicrobial parameters in children with fixed orthodontic appliances.Angle Orthod, 2011; 81(5): 901-906.
13. ChangHS, WalshLJ, FreerTJ. The effect of orthodontic treatment on salivary flow, pH, buffer capacity, and levels of mutans streptococci and lactobacilli.Aust Orthod J., 1999;15(4):229-234.
14. Richter AE, Arruda AO, Peters MC, Sohn W. Incidence of caries lesions among patients treated with comprehensive orthodontics. Am J Orthod Dentofacial Orthop. 2011;139:657–64.
15. Varma S, Banerjee A, Barlett D. An in vivo investigation of associations between saliva properties, caries prevalence and potential lesion activity in an adult UK population. J Dent. 2008;36:294–9.