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Saliva In Orthodontics: A Comprehensive Review

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Abstract

Saliva is certainly one of the most important component in the oral environment and an integral component of oral health. The quality and quantity of saliva play a crucial role in the equilibrium between demineralization and remineralization of enamel in a cariogenic environment. All these salivary properties become of utmost importance during orthodontic treatment with fixed appliances when an increased chance of plaque retention and greater difficulty in optimal oral hygiene maintenance is thought to develop white spot lesions. The aim of this review article is to emphasize the role of saliva during orthodontic treatment.

Keywords: Saliva, Orthodontics, Salivary proteins, Friction, Corrosion

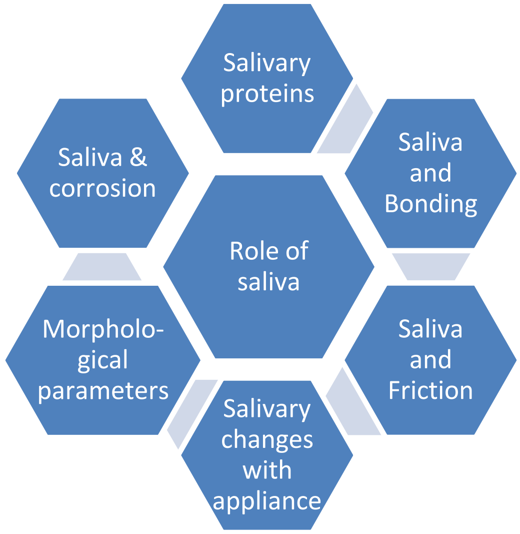
Introduction

Saliva is a thick, colorless, opalescent fluid that is constantly present in the oral cavity of humans and other vertebrates. The presence of saliva is vital to the maintenance of teeth and oral mucosa. Malocclusion is one of the most common dental disorders and can increase the risk of periodontal disease and dental caries, if oral hygiene is not properly maintained[1]. However, the complex design of fixed orthodontic appliances can affect oral hygiene by influencing several parameters including the saliva properties and microbial count. An understanding of saliva and its role in orthodontics will help to promote awareness among dentists of the problems arising when the quantity or quality of saliva changes; this awareness and understanding are important to the prevention, early diagnosis, and treatment of the condition.

APPLIED ASPECTS OF SALIVA DURING ORTHODONTIC TREATMENT:

The role of saliva in Orthodontics can be discussed under the following headings shown in Figure 1

Figure 1: Role of saliva in Orthodontics



Salivary Proteins

1. A major component of the salivary proteome is derived from the carotid artery blood vessels. As saliva contains most of the same compounds found in the blood, changes in saliva's protein composition can indicate not only local but also systemic changes associated with certain diseases.
2. About 2 to 5 mg/mL which constitutes about 3% of the protein concentration of blood.

Salivary Biomarkers

These are quantifiable attributes that can identify biological processes, whether they are pathogenic or normal, and/or metabolic processes. The forces induced by orthodontic therapy stimulate periodontium cells to release many chemical intermediaries like cytokines.

Protein	Known function
1.Protein S100-A9 (S100 calcium-binding protein A9) (Calgranulin-B)	1. Calcium-binding protein. 2. At the sites of wounding, it promotes phagocyte migration and infiltration of granulocytes. 3. Takes part as a proinflammatory mediator in acute and chronic inflammation.

2.Serum albumin precursor	1. It binds with water, Ca^{2+}, Na^{+}, K^{+}, fatty acids, hormones, bilirubin, and drugs. 2. The main function is to regulate the colloidal osmotic pressure of blood. 3. Major zinc transporter in plasma.
3.Immunoglobulin J chain	1. Links two monomer units of either IgM or IgA. 2. Helps in binding IgM or IgA to a secretory component.
4.Ig alpha-1 chain C region	1. A major immunoglobulin class in the body secretions. 2. Serves as a defense against local infection and prevents access of foreign antigens.
5.Cysteine-rich secretory protein 3 precursors (CRISP-3)	1. Innate immune response 2. Potential biological marker for prostate cancer
6.Haemoglobin subunit beta (Haemoglobin beta chain) (Beta-globin)	Role in the transportation of oxygen from the lung to the various peripheral tissues.

7.14-3-3 protein σ (Stratifin) (Epithelial cell marker protein 1)	1. An adapter protein. 2. Results in the modulation of the activity of a large number of binding partners.

Saliva And Friction

The introduction of a lubricant results in reduced static and kinetic coefficients of friction.During mechanical therapy, the friction between the bracket-arch wire interface could prevent the action of forces required for a particular movement. Studies demonstrated that approximately 12 to 60% of the force used to move a tooth is dissipated in the form of friction.[2]

The most important factors that may have an impact on friction are the composition of the bracket; the archwire alloy; the cross-sectional size of the archwire; the type of ligation system and the surface roughness of the bracket-archwire assembly. Specifically, with regard to the cross-sectional size of the archwire, some authors reported that friction in brackets augments with the increased size of rounded wire cross-section.

So we can say that in addition to the factors related to the orthodontic appliances, saliva is considered to be a biological variable associated with friction, as it acts as a lubricant during sliding mechanics. Various studies showing the effect of saliva on friction are discussed in Table 1.

Table 1: Effect of saliva on friction

Various studies	Conclusion of the study
Baker et al. [2](1987)	Saliva decreases friction.
Stannard JG et al. [3] (1986)	Shown increased friction in presence of artificial saliva.
Ireland AJ et al.[4] (1991)	No significant differences between wet and dry conditions.
Riley JL et al.[5] (1979)	No significant differences between wet and dry conditions.

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Kratten,Popli, Germanine[6] (1990)	Conducted a similar type of research and found that saliva substitutes increased static friction for all combination tested.

Saliva And Bonding

Several steps are involved in orthodontic bonding, including etching, priming, and applying orthodontic adhesive. A change in surface morphology after bonding can influence both mechanical bond strength and Streptococcus mutans adhesion. The numbers of colony-forming units of Streptococcus mutans and S sobrinus per milliliter of paraffin-stimulated saliva were not influenced at a statistically significant level by fixed orthodontic appliance placement during the first 12 weeks of orthodontic treatment.

Salivary contamination during acid etching or the actual bonding procedure jeopardizes the chance of a successful bond through the precipitation of salivary proteins, which may physically clog and/or chemically react with the etched enamel surface.

Various studies were done to evaluate the effect of saliva on the shear bond strength of orthodontic adhesive used with moisture-insensitive and self-etching primer.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 and 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). 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 and 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.[7]

A study was done 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 bond 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[8].

Salivary Parameters During Orthodontic Tooth Movement (OTM)

Various study shows significant changes in the salivary flow rate, pH, buffering capacity, and total protein concentration as well as amylase, calcium, and glucose levels were observed before and after commencing treatment, indicating that the introduction of orthodontic appliances altered the properties of saliva in the oral cavity. Thus, patients undergoing fixed orthodontic treatment must maintain oral hygiene and reduce their susceptibility to periodontal disease. Various studies with their conclusions are described in Table 2.

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Table 2: Salivary parameters change during OTM

Various studies	Conclusion
1. Kuhta et al. [9]	Change in salivary levels of titanium, chromium, nickel, iron, zinc, and copper at 1 week after the beginning of the orthodontic treatment,
2. Petoumenou et al. [10]	Significant increase in salivary concentrations of potassium after orthodontic treatment and its subsequent reduction within 10 weeks after the start of the treatment
3. Li et al.[11]	Increase in concentrations of chlorine and sodium during the first month while the concentration of potassium, phosphorous and calcium decreased. The salivary concentration of all ions returned to normal at 3 and 6 months.

Salivary Changes With Different Appliances

A)Salivary Changes With Removable Orthodontic Appliances

It is the type of orthodontic appliance that is not permanently attached to the teeth and can be removed by the patient without orthodontist supervision. According to the study, orthodontic treatment with removable appliances didn't induce significant changes in the salivary concentrations of calcium, glucose, and total protein, while the inflammatory markers like Lactate dehydrogenase (LDH) and alkaline phosphatase (ALP) increased significantly which may reflect the effect of treatment on gingiva and periodontium. Salivary LDH and ALP concentrations were significantly increased in patients undergoing removable orthodontic treatment as compared to before treatment. There was also an increase in the glucose, total protein, and calcium concentrations but the differences were insignificant.

B) Self-Ligating Brackets (Slbs)

Among patients with conventional and self-ligating brackets, the total bacterial counts in the whole saliva did not differ significantly.

C) Clear Aligners

Orthodontic treatment with CA (clear aligner) appliances allows the maintenance of a better oral hygiene level, compared to Metal brackets (MB). Only 8% of CA participants against approximately 40% of MB participants showed high concentrations of S. Mutans after 6 months of treatment requiring additional strategies to maintain oral hygiene.

D) Lingual Appliances

Young adults, of typical age and gender distribution of lingual orthodontic patients, were chosen as good candidates to wear lingual appliances because they are more interested in aesthetic appliances According to many retrospective and prospective studies of the literature, wider lingual brackets cause a reduced inter bracket distance and make oral hygiene procedures very difficult with consequent risk for plaque accumulation and gingivitis. Wearing SLB lingual orthodontic appliance had more plaque retention 4 and 8 weeks after bonding, while there were more gingival inflammation and more S. mutans counts 8 weeks after bonding.[13] No significant differences were found between the two groups as regards the Lactobacillus counts, the salivary flow rate, and saliva buffer capacity.

Saliva And Corrosion

The oral environment is an excellent climate for the corrosive assault of orthodontic equipment due to its microbiological and enzymatic phenomenon. In orthodontic appliances, stainless steel, cobalt-chromium, and titanium alloys are used to form a passive surface oxide film to withstand corrosion. It is prone to mechanical and chemical interruptions.

A galvanic cell exists in the oral environment, which causes metals making up orthodontic appliances to create potential differences between 200 and 1000 millivolts, causing corrosion. Studies have screened the effect of artificial saliva on various alloys, such as stainless steel, titanium, nickel-titanium, as well as coated archwires. Park and Shearer reported an average release of 40 µg of nickel per day from a simulated full-mouth fixed appliance.[14] According to a study, the average oral intake of nickel in the diet is 200–300 µg [15].

Jithesh et al. [16] studied nickel ion release from ceramic bracket with metal slot, conventional and recycled stainless steel brackets and reported that Metal slot ceramic bracket release is significantly less in case of nickel ions compared to other groups.

Conclusion:

Saliva plays a variety of functions, including mechanical cleansing, demineralization, and remineralization of enamel, protecting against oral microbial flora, and buffering oral acids. Maintenance of oral hygiene is difficult in individuals with fixed orthodontic appliances, and this leads to plaque accumulation, gingival inflammation, dental caries, and other periodontal conditions. Previous studies have reported changes in oral microbial counts and in the properties of saliva following fixed orthodontic treatment significant changes in the salivary flow rate, pH, buffering capacity, and total protein concentration as well as amylase, calcium, and glucose levels were observed before and after commencing treatment, indicating that the introduction of orthodontic appliances altered the properties of saliva in the oral cavity. Hence, patients undergoing fixed orthodontic treatment must adopt additional measures to maintain oral hygiene and reduce their susceptibility to developing caries and other periodontal conditions.

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