Streptococcus: An orthodontic point of view

Danya Lizeth Soto Gomez, Arturo Santoy Lozano, Hugo Felix Madla Alanis, Guadalupe Rosalia Capetillo-Hernandez, Evelyn Guadalupe Torres Capetillo, Sergio Eduardo Nakagoshi Cepeda and Juan Manuel Solis-Soto

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Abstract

Introduction: Streptococcus mutans and S. sobrinus are the main causative agents of human dental caries. Objective: To analyze the literature on different genera of Streptococcus such as S. mutans, S. gordonii, S. sanguis, S. sobrinus and S. salivarius in relation to orthodontics. Methodology: Articles on the subject published through the PubMed, SCOPUS and Google Academic databases were analyzed, with an emphasis on the last 5 years. It was carried out with the words “Streptococcus mutans”, “S. gordonii”, “S. sanguis”, “S. sobrinus”, “S. salivarius”. Results: S. mutans: produces dental caries and demineralization of the enamel. It can be controlled with proper brushing techniques and oral hygiene. S. gordonii: predominates in the oral microflora and triggers cariogenic biofilms, present in the formation of white spots around brackets and its development can be inhibited with fluoride-containing rinses. S. sanguis: present in orthodontic appliances, they have adverse effects that help the formation of dental plaque, mouthwash with nanioTiO2 and a good mechanical and chemical cleaning help to eliminate them. S. sobrinus: forms white spots, demineralizes enamel and causes dental caries. S. salivarius: its acid-base physiology plays an important role, the use of orthodontic appliances can produce an increase in bacteria which is associated with metal alloys. Conclusion: Streptococcus species are a problem in orthodontics, they can be eliminated by using Enlight composite resin, 0.02% chlorhexidine rinses, mouthwash with nanioTiO2 and a good mechanical and chemical brushing technique.

Keywords: Streptococcus mutans, S. gordonii, S. sanguis, S. sobrinus, S. salivarius

1. Introduction

Orthodontic appliances promote the accumulation of supragingival and subgingival biofilms, which alter the oral microbiome and hinder dental hygiene. Orthodontic treatment may be associated with adverse effects such as enamel decalcification, gingivitis and periodontal disease. Studies have reported high levels of Streptococcus mutans and periodontal pathogenic bacteria in patients undergoing orthodontic treatment [1]. The streptococcus genus are Gram-positive cocci-shaped, chain-organized bacteria, and are pathogens found in humans and animals [2]. Poor oral hygiene can induce biofilm formation on orthodontic appliances and cause gingivitis and dental caries [3]. Dental caries is a biofilm disease and infection that affects oral and systemic conditions, natural bacteriostatic products are recommended for daily use to prevent this disease [4]. Bacterial colonization in the oral cavity is fundamental for the effective action of probiotics [5]. Dental caries is the disease of calcified tissues of teeth, it is the action of microorganisms on carbohydrates which is characterized by decalcification of a tooth and disintegration of the organic portion [6]. The oral microbiota has been one of the most relevant topics in recent years, they are present in daily clinical practice especially in orthodontic appliances such as bands, in which there is an increased risk of caries and presence of periodontal disease [7]. Fixed orthodontics presents a series of adverse effects on dental enamel, this is due to the formation and accumulation of dentobacterial plaque and colonization of microorganisms. However, invisible orthodontics behaves differently in the formation of dentobacterial plaque.
and colonization of bacteria, as they presented low results during treatment. Knowledge of salivary films in orthodontic appliances provides a better understanding of microbial adherence \(^9\). Currently there is no adequate review about Streptococcus in the orthodontic area so in this work the literature about different Streptococcus genera such as \(S.\) \(mutans\), \(S.\) \(gordonii\), \(S.\) \(sanguis\), \(S.\) \(sobrinus\) and \(S.\) \(salivarius\) in relation to orthodontics was evaluated.

2. Materials and methods

Information from articles published in PubMed, Science Direct, Springer and EBSCO was analyzed with emphasis on the last 5 years. The quality of the articles was analyzed based on the PRISMA guidelines, i.e., identification, review, choice, and inclusion. The quality of the review was assessed using the measurement instrument for evaluating systemic reviews (AMSTAR-2). The search was performed using Boolean logical operators AND, OR and NOT. It was realized with the words “Streptococcus”,”orthodontics”,”epidemiology”, “diagnostic methods”, “oral manifestations”, “treatment”, in conjunction with logical Boolean operators OR y AND.

3. Results & Discussion

3.1 Streptococcus mutans

3.1.1 Etiology

\(S.\) \(mutans\) contributes to enamel demineralization \(^{10}\) and is a major player in the formation of dental caries \(^{11}\) which affects more than 90% of the world's population \(^{12}\). Orthodontic brackets that are made of stainless steel material were introduced in dentistry, although they present less ability to reduce enamel demineralization and are not successful in preventing microbial and biofilm growth \(^{13}\).

3.1.2 Diagnosis

In a study the hypothesis of the levels of Streptococcus mutans occurring in different types of orthodontic ligatures, elastomers, steel ligature crossed over the arch, steel ligature crossed under the arch and steel ligature crossed in eight under the archwire, were tested. ANOVA and Turkey-kramer test were used to compare and evaluate the differences of \(S.\) \(mutans\) between the different groups. After 7 days the ligatures were removed and high levels of \(S.\) \(mutans\) in the different orthodontic ligatures were witnessed \(^{14}\). It has been proven that patients who want to keep their teeth straight after orthodontic treatment should use retention, however, the presence of foreign material increases the risk of bacterial colonization and carries formation of which \(S.\) \(mutans\) is the most common \(^{15}\).

3.1.3 Treatment

The efficacy of photodynamic inactivation (PDI) with hematoporphyrin IX (H) and modified hematoporphyrin IX (MH) was evaluated using an LED light-emitting diode. In vitro planktonic cultures with the use of H, MH and LED exerted antimicrobial activity, no effect on \(S.\) \(mutans\) film was observed in any of the types of Brackets with the use of H. MH showed better results, indicating a promising use against dental caries and white spot lesions \(^{16}\). A study of 60 patients scheduled for orthodontic treatment was conducted and plaque samples were collected to determine the presence of \(S.\) \(mutans\) before orthodontic placement, at two months and three months after placement using the Dentocult SM kit. The results showed that orthodontic appliances increase colonization of \(S.\) \(mutans\) and Candida albicans in the oral cavity during orthodontic treatment, but can be controlled with proper and timely brushing \(^{17}\). In patients with conventional orthodontic appliances compared to self-ligating orthodontics, it was demonstrated that self-ligating orthodontics should be preferred since conventional orthodontics is a latent influencing factor \(^{18}\).

\(S.\) \(mutans\) is one of the main bacteria found in oral cavity that causes dental caries, demineralization of enamel and increases its colonization to the use of orthodontic treatment. It can be controlled with a proper brushing technique and oral hygiene, it is recommended to use orthodontics without elastomers to reduce the formation of \(S.\) \(mutans\).

3.2 Streptococcus gordonii

3.2.1 Etiology

Streptococcus gordonii is a predominant member of the oral microflora and has been isolated from root canals of teeth with refractory apical periodontitis, it participates in the early formation of dental biofilms \(^{19}\). L-arginine, an amino acid ubiquitously present in human saliva, serves as a substrate for alkali production by arginolytic bacteria (\(S.\) \(gordonii\)). It has been shown that 1.5% l-arginine is clinically effective in modulating cariogenic biofilms through alkali production by arginolytic bacteria \(^{20}\).

3.2.2 Diagnosis

Early detection of white spot lesions (WSL) around brackets during orthodontic treatment is important for treatment and prevention. The role of this bacterial coexistence and WSL formation during one year of fixed orthodontic therapy has been evaluated, and the presence of \(S.\) \(gordonii\) and \(P.\) \(gingivalis\) bacteria before and after orthodontic placement is observed, in addition \(S.\) \(gordonii\) could also play a role in enamel demineralization \(^{21}\). Saliva detection frequencies and amounts of caries-associated bacteria from patients with orthodontic braces were investigated. PCR indicated that amounts of \(S.\) \(gordonii\) and \(S.\) \(mutans\) were significantly higher in Streptococcus gordonii and \(S.\) \(mutans\) were significantly higher in orthodontic patients than in control-only individuals \(^{22}\). Composite brackets were also shown to be more susceptible to adhesion and colonization by \(S.\) \(gordonii\), while gold brackets were shown to be less prone to colonization \(^{23}\).

3.2.3 Treatment

Decontamination with adjunctive antiseptic agents, such as chlorhexidine, is often recommended for the treatment of infections \(^{24}\). Bacterial activity of bonding agents was investigated to predict the ability to inhibit the development of white spots during orthodontic treatment, standardized and sterilized discs were continuously rinsed for up to 180 days in saline flow. The antibacterial and anti-biofilm activities of \(S.\) \(gordonii\) and other bacteria were evaluated, the decrease in antibacterial activity was 10-60 days in materials with fluoride and slower (90 days) in those containing benzalkonium chloride, chlorhexidine and zinc oxide \(^{25}\). Streptococcus gordonii predominates in the oral microflora and triggers cariogenic biofilms, it has been shown that \(S.\) \(gordonii\) is present in the formation of white spots around brackets and its development can be inhibited with fluoride-containing rinses in a shorter time.

3.3 Streptococcus sanguis

3.3.1 Etiology

The oral microbiota is extremely diverse and more than 700 different species of bacteria have been detected on the tongue,
3.3.2 Diagnosis
The characteristics of dental plaque microecology can be used as a basis for the construction of a diagnostic algorithm, with the monitoring of patients with dentoalveolar anomalies, for the purpose of the upcoming planning and implementation of effective orthodontic treatment. The application of Bayes’ theorem in medical diagnostics includes such an important step as derivation for each symptom and values of finite probability or a posteriori diagnostic data of germ presence, e.g., S. sanguis, in patients receiving orthodontic treatment [29]. The antibacterial properties of a conventional orthodontic adhesive containing three different concentrations of silver/hydroxyapatite nanoparticles were evaluated against S. sanguis, S. mutans, and Lactobacillus acidophilus. The results of the biofilm inhibition test showed that all study groups reduced the viable bacterial count compared to the control group [29].

3.3.3 Treatment
The antibacterial effects of colloidal solutions containing zinc oxide (ZnO), copper oxide (CuO), titanium dioxide (TiO2) and silver nanoparticles (Ag) on S. sanguis and S. mutans were evaluated, and the results were compared with those of chlorhexidine and sodium fluoride mouthwashes. The nanoTiO2-containing mouth rinse proved to be an effective antimicrobial agent which can be considered as an alternative to chlorhexidine or sodium fluoride mouth rinses, provided that it does not exhibit cytotoxic and genotoxic effects on biological tissues [30]. In another study, the antimicrobial and mechanical properties of resins composed of TiO2 nanoparticles (NPs) were evaluated, for S. sanguis and S. mutans the concentration of TiO2 NPs caused a reduction in colony count [31]. The effectiveness of mechanical and chemical cleaning on the removal of microorganisms from Essix retainers of 3 cleaning methods, brushing with fluoride toothpaste, chlorhexidine gel and immersion in chlorhexidine solution was determined. All 3 cleaning methods effectively removed 99% of microorganisms from Essix retainers [32]. Streptococcus sanguis is present in oral cavity which has an important role in the formation of dental caries. Orthodontic appliances have adverse effects that help the formation of dentobacterial plaque, but it has been shown that mouthwash with nanoTiO2 and good mechanical and chemical cleaning help in the elimination of microorganisms.

3.4 Streptococcus sobrinus

3.4.1 Etiology
Streptococcus sobrinus and Streptococcus mutans are the main causes of dental caries [33]. They are harmful microorganisms that accelerate caries and produce acid faster. In addition, there is some kind of communication or synergy between these 2 bacteria [34].

3.4.2 Diagnosis
The main problems in the crown of the tooth during orthodontic treatment are white spots, enamel demineralization and dental caries [35]. The number of S. mutans and S. sobrinus microorganism in stimulated saliva samples does not appear to be significantly different between patients with stainless steel brackets and patients with plastic brackets [16]. Enlight orthodontic composite resin has less adhesion of S. sobrinus and S. mutans which may reduce enamel demineralization and risk of white spot formation [37].
3.5.3 Treatment
It was determined that 0.12% chlorhexidine gluconate mouth rinse can be used to decrease the bacterial density in the oral flora before disunion procedures [46]. In another study, the antimicrobial efficacy of triple and quadruple combinations of Acacia nilotica, Murraya koenigii, Eucalyptus and Psidiumguajava were analyzed, all triple and quadruple combinations of the plant extracts were found to be of great antimicrobial benefit, superior or comparable to 0.2% chlorhexidine against S. salivarius, as well as S. mutans and S. sanguis [47]. Recently, the use of medicinal herbs and plant extracts as a substitute for chemical drugs has become increasingly common. It was studied that the water extract of Rhus coriaria L. had significant antibacterial properties against 5 bacteria, of which S. salivarius is found, and was able to inhibit the formation of bacterial biofilms on orthodontic wire [48].

Streptococcus salivarius are present in oral cavity and causes an alkaline environment, the use of orthodontic appliances produces an increase of this bacterium. In the treatment, it indicates that chlorhexidine is of great antimicrobial benefit along with herbal medicine.

4. Conclusions
Streptococcus genus such as S. mutans, S. gordonii, S. sanguis, S. sobrinus and S. salivarius are present in the oral cavity, which trigger diseases such as dental caries, enamel demineralization, dentobacterial plaque and formation of white spots around the brackets during orthodontic treatment. This is because the presence of foreign material increases the risk of bacterial colonization. However, it has been shown that the use of Enlight composite resin, 0.02% chlorhexidine rinses, nanoTiO2 mouthwash and a good mechanical and chemical brushing technique will help prevent the formation of white spots and dental caries.

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