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The role of different adjunctive plaque control modalities in orthodontic patients with gingivitis

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Abstract:

The plaque accumulation is the main cause of gingivitis, patients who wear fixed orthodontic appliances must practice meticulous oral hygiene procedures to prevent a range of problem, such as tooth decay, gingival inflammation, excessive gingival growth, and periodontal disease. manual tooth brush alone insufficient for orthodontic patient, so additional cleaning aids need like interdental brush, single tufted brush and water irrigator, the gingival health can be evaluated by periodontal parameters like plaque index, bleeding on probing and gingival index or by estimation the salivary or GCF concentration of cytokine by Enzyme-linked immunosorbent assay ELISA.

Keywords: Cytokine, Gingivitis, Orthodontic, Plaque, Mechanical plaque control, Toothbrushes.

Introduction:

A bacterial infection is typically the cause of gingivitis. Unlike periodontitis there is no attachment loss. Disease only affects gingival epithelium and connective tissue soft tissues(Marchesan et al., 2020). Gingivitis is the most prevalent among all periodontal disorders. Gingivitis can manifest in several forms depending on its clinical presentation, duration of infection, severity, and underlying cause. Nevertheless, the most common type of gingivitis is the chronic form produced by plaque. Orthodontic treatment generates additional areas for plaque accumulation and heightens the likelihood of gingival inflammation. Hence, physicians are concerned about a higher probability of periodontal diseases in patients receiving orthodontic therapy(Pandis et al., 2010). Patients who wear fixed braces must practice meticulous oral hygiene procedures to prevent a range of issues, such as tooth decay, gingival inflammation, excessive gingival growth, and periodontal disease (Anuwongnukroh et al., 2017). Orthodontic patients can maintain optimal oral hygiene by employing a range of tools, including dental floss, electric toothbrushes, interdental brushes, conventional manual toothbrushes and toothpaste, as well as oral irrigators such as water floss (Jahn, 2010).

Dental biofilm induced gingivitis:

This is the predominant form of gingivitis. Dental plaque is a thin layer that develops on the surface of teeth as a result of inadequate oral care. Dental plaque biofilm-induced gingivitis is a condition characterized by inflammation at the site level. The occurrence is a result of the interplay between the biofilm of dental plaque and the immune-inflammatory response of the host. This inflammation is limited to the gingiva and does not spread beyond the mucogingival junction. It can be reversed by reducing the amount of dental plaque at and apical to the gingival margin(Murakami et al., 2018). Gingivitis is either localized which is defined as patient presenting with BOP 10%-30% or generalized which is defined as patient presenting with BOP > 30%(Chapple et al., 2018).

Dental plaque:

Dental plaque is a complex biofilm that covers tooth enamel and other hard oral tissues. Plaque colonization is a controlled process, even though there are over 500 unique bacterial species involved. This process starts when the colonizer initially attaches to the enamel salivary pellicle. Bacterial adherence occurs, facilitating further colonization(Rosan et al., 2000). Clinically, the dental plaque is a durable, adhesive, yellowish-grey film that develops on the hard surfaces of the oral cavity, encompassing both permanent and removable dental restorations. The resilient extracellular matrix renders the removal of plaque unfeasible by the utilization of sprays and rinses(Newman et al., 2023). The plaque formation process can be categorized into multiple stages shown in (Figure 1)(Abdulkareem et al., 2023).

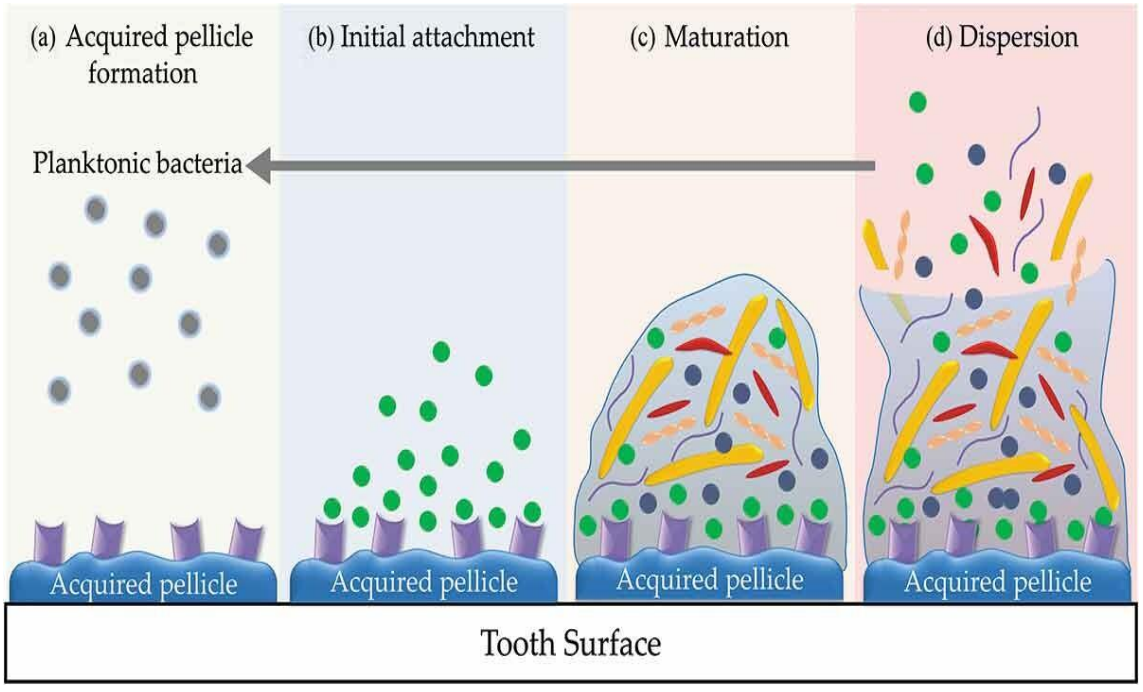

Figure 1: Formation of dental plaque biofilm a. acquired pellicle formation; b. initial attachment; c Colonization and Plaque Maturation; D. Dispersion of biofilm cells(Abdulkareem et al., 2023)

The correlation between orthodontic treatment and gingival health:

Orthodontics is a branch of dentistry that focuses on treating dental and skeletal disorders. It has been demonstrated through research that malocclusion has a detrimental effect on the periodontal

health (Shivakumar et al., 2010). Orthodontic treatment aims to improve dental health and extend tooth longevity and minimizes or eliminates occlusal trauma and corrects dental irregularities, resulting in improved oral hygiene. These factors suggest that orthodontic therapy enhances periodontal health and the teeth that are properly aligned would be more easily cleaned. In addition, ensuring that all teeth are properly aligned and centered within the alveolar cavity may help maintain the periodontium healthy(Bollen et al., 2008). Nevertheless, orthodontic appliances have a significant impact on oral hygiene and periodontal health. Using mechanical orthodontic devices poses the potential danger of inducing soft tissue reactions in the gingiva. Plaque buildup, the closeness of orthodontic appliances to the gingival sulcus, and the difficulty of maintaining good oral hygiene all make treatment more difficult (Willmot, 2008). When orthodontic devices are put into the mouth, they can cause long-lasting infections like inflammatory hyperplasia, permanent bone loss (loss of attachment that can't be repaired), and gingival recession(Hollender et al., 1980) .

Oral Hygiene among Fixed Orthodontic Patients:

Good oral hygiene was required for successful orthodontic therapy. The challenge of preventing problems caused by plaque in orthodontic patients is complex because most patients are adolescents and teenagers, who are especially likely to have low adherence to treatment. Ensuring adequate oral hygiene in orthodontics is a crucial element associated with compliance(Aljabaa et al., 2015).Evaluating oral hygiene behaviors is essential for fully understanding patients' oral healthcare requirements (Al-Shammari et al., 2006).Hadler-Olsen et al. discovered that it is difficult to establish a comprehensive oral hygiene routine for orthodontic patients(Hadler-Olsen et al., 2012).Patients wearing fixed orthodontic appliance experience increased plaque accumulation as a result of the difficulties associated with maintaining proper oral hygiene(Travess et al., 2004). Despite careful oral hygiene practices during the treatment period, the majority of patients usually experience the development of generalized gingivitis(Hadler-Olsen et al., 2012). Retention of plaque may result in eventual oral health concerns such as decalcification, caries, periodontal disease, halitosis, and tooth discoloration (Laing et al., 2008). White spot lesions were found higher in fixed appliance patients (Hadler-Olsen et al., 2012). Both patients and dental professionals should take an active role in minimizing plaque buildup by practicing good oral hygiene. Plaque control and removal can be accomplished via mechanical or chemotherapeutic methods. Mechanical plaque removal tools include toothbrushes, dental floss, and interdental brushes. Mouthwashes and toothpaste are chemotherapeutic agents(Laing et al., 2008). Regular use of fluoride toothpaste and mouth rinses has a cariostatic action, which can help prevent or decrease enamel decalcifications(Travess et al., 2004).

Evaluation the gingival health in orthodontic patient:

The gingival health in evaluated by bleeding on probing (BOP), plaque index (PI), gingival index (GI), and probing pocket depth (PD), which all are clinical parameters of gingival inflammation (Abusafia et al., 2023) .And analyzing the levels of cytokines in various physiological fluids, such as serum, blood, stool, saliva, and GCF by ELISA test, allows for the diagnosis with an excellent ability to predict gingival health from disease (Mahmood, 2024, Mohammed Hussein and Ali, 2024). Suggesting a chair-side method to check the healing ability of gingival tissue for orthodontic patients. Since measurement of clinical parameters requires expert dentists and is time-consuming(Akram, 2015, Mahmood and Omer, 2016, Mohammed et al., 2023).

Microphage inhibitory factor:

Macrophage migration inhibitory factor (MIF) is a pleiotropic inflammatory mediator that is recognized as the earliest known cytokine activity(David, 1966). Multiple studies have demonstrated an elevated number of macrophages in the periodontium during the state of periodontitis, as compared to the periodontal health condition. Macrophage activation factor (MAF), macrophage migratory inhibitory factor (MIF), and macrophage chemotactic factor (MCF) are the three primary factors that control macrophage activation, recruitment, and activity(Nakajima et al., 1987, Taniyama, 1999) The MIF biomarker could be an early diagnostic tool for identifying gingivitis and predicting the progression of periodontal disease (Alhammadi et al., 2023). The elevated levels of MIF in gingival fluid and saliva may be due to the identified shift in microbial composition from Gram-positive to Gram-negative bacteria when the transition occurs from a healthy state to periodontal disease(Palaska et al., 2016).It is most be measured when the participants were at the linear stage, not in the early stage of orthodontic treatment, to exclude orthodontic tooth movement in the early stage that might affect the patient's salivary cytokines level(Ren et al., 2007) .

Enzyme linked immunosorbent assay (Elisa):

The catalytic characteristics of enzymes are used by enzyme immunoassays (EIAs) to identify and measure immune responses. In clinical analyses, the heterogeneous EIA technique known as enzyme-linked immunosorbent assay (ELISA) is employed. One of the reaction components is covalently or nonspecifically bonded to the surface of a solid phase, such as a plastic bead, magnetic particle, or microtiter well, in this kind of test. The separation of bound and free-labeled reactants is made easier by this connection. There are four major types of ELISA: Direct ELISA (antigen-coated plate; screening antibody),Indirect ELISA (antigen-coated plate; screening antigen/antibody),Sandwich ELISA (antibody-coated plate; screening antigen) and Competitive ELISA (screening antibody)(Aydin, 2015).

Mechanical plaque control:

Mechanical plaque control involves consistently removing microbial deposits that accumulate on the tooth surfaces, gingival margin, and other hard surfaces in the mouth (such as crowns and bridges). In order to maintain periodontal health and prevent the accumulation of plaque, this action is taken. There are two options available: self-care or professional dental care. The effectiveness of self-care mechanical plaque control relies on various factors, including motivation, knowledge, access to oral hygiene instructions, selection of oral hygiene equipment, and manual dexterity. A wide variety of oral hygiene tools are available for clinicians to consider. The clinician needs to assess the patient's individual needs and recommend appropriate tools accordingly(Axelsson et al., 2002, Ayoob and Abdulbaqi, 2024). Mechanical removal of plaque has proven to be the most often employed approach to plaque control(Toshniwal et al., 2022, Aydin, 2015). Manual toothbrushes are the predominant choice for dental hygiene . Tooth brushing, whether mechanical or powered, cannot reach the interproximal areas; therefore, dental floss, tape, wedges, or interdental brushes should be used to keep these areas clean. Although all of these pieces of equipment have proven useful, no single approach to interdental cleaning is suitable for all patients. Children and young adults with reasonably normal mesial-distal contact between their teeth and gingival papillae filling the interdental region may benefit from using dental floss or tape. Individuals with greater interdental spaces due to

gingival recession and/or loss of periodontal attachment may benefit from adequately sized interdental brushes(Löe, 2000).

Interdental brush:

Interdental brushes are slender wires with little cylindrical or cone-shaped bristles that can be inserted between the teeth. Their structure consists of flexible nylon filaments arranged perpendicular to a rigid central rod, typically made of coiled stainless-steel wire, resembling a bottle brush. A protective coating on the wire equips interdental brushes designed for cleaning around implants, preventing any implant damage or galvanic shock. They are offered in various widths to correspond to the gaps between teeth, and their form can be either conical or cylindrical. Most interdental brushes have a circular shape, while some options are available with a triangular cross-section. Dental experts initially prescribed interdental brushes to patients who had significant gaps between their teeth, known as embrasure spaces, resulting from the loss of interdental papilla, caused mainly by periodontal deterioration and for orthodontic patient (Slot et al., 2008). previous studies observed that using an interdental brush design reduced plaque scores and gingival inflammation more than a manual toothbrush alone in orthodontic patients(Anupama et al., 2019, Bourgeois et al., 2016) .

Single tufted brush:

Brushing the teeth with a conventional toothbrush will not completely eliminate biofilm from all surfaces(Bergenholtz and Brithon, 1980). Hence, depending on the size, form, and ease of access to the area that has to be cleaned, supplementary tools like dental floss or tape, interproximal brushes, and/or single-tuft brushes may be necessary. Single-tuft brushes may be advised in certain locations because of their delicate nature. It is used in Furcation area , the distal surfaces of molars, areas with severed roots, crowded areas, buccal or lingual surfaces with an uneven gingival border and in orthodontic patients. Furthermore, because it is extremely simple to guide STB to the gingival sulcus, it may be the most effective way to eliminate biofilm from deep pockets(Lindhe et al., 2008) .

Water irrigator:

Patients seeking orthodontic treatment can access a range of services to support them in maintaining optimal dental hygiene. Oral irrigators, manual and electric toothbrushes, dental floss, interproximal brushes, and toothpaste comprise this collection(Jahn, 2010). The American Dental Association (ADA) has confirmed that water flossers have undergone extensive testing and have been proven to be both safe and effective in the removal of plaque, a leading cause of cavities and gingival disease. Furthermore, a water irrigator has the capability to diminish gingivitis, which is the initial stage of gingival disease(Sawan et al., 2022). As demonstrated in a study conducted by Sharma et al. using a manual brushing in combination of a water irrigator led to a significant decrease in bleeding on probing scores by 41.2% within a 28-day timeframe(Sharma et al., 2012). The water irrigator's pulsating motion exerts pressure on the gingival tissue, causing it to compress and decompress. This allows for the irrigation of water into the areas below the gingival line and between the teeth, effectively eliminating plaque, bacteria, and debris, particularly in areas that are difficult to reach with regular toothbrushes(Newman et al., 1994). Several clinical studies have shown that water irrigators are effective in lowering gingival inflammation, bleeding, and the prevalence of harmful bacteria. However, most of these studies have mostly focused on patients who do not need

orthodontic treatment, such as people with periodontal disease, dental implants, crowns, bridges, or diabetes(Stauff et al., 2018, Akram, 2015, Tuna et al., 2019).

Conclusion:

Orthodontic patients need special oral hygiene measures to prevent many of plaque associated problem the additional cleaning aids needed, many previous studies show there is no superiority in the different three cleaning aids. But the effect of three adjunctive aids depending on the skill of the patients and their compliance more than the type of it. Furthermore, MIF shows an excellent ability to predict outcome of gingival inflammation and plaque control for orthodontic patients

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