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Gingivitis Control

Kirsten J Wade and Alison M Meldrum
University of Otago
New Zealand

1. Introduction

The term periodontal disease generally includes both chronic periodontitis and gingivitis. Gingivitis is the inflammatory response in the gingival tissues to the presence of a plaque biofilm on the tooth surface at the dento-gingival junction. When gingivitis has developed the marginal gingival tissues show the clinical signs of inflammation which include redness, swelling due to the formation of oedema, and bleeding on probing. Although inflammation is present there is no alveolar bone loss and no apical migration of the junctional epithelium beyond the cementum enamel junction (CEJ).

Since the experimental gingivitis studies of Harald Loe and colleagues in 1965, dental plaque has been recognised as the sole cause of gingivitis. Treatment therefore must involve the removal of plaque, the re-establishment of a healthy oral environment by removal of the factors which retain or hinder the removal of plaque, and the maintenance of this healthy environment by proper oral hygiene procedures.

Fig. 1. Gingivitis

2. Aetiology of gingivitis

Dental plaque is the sole aetiological agent in the initiation and progression of gingivitis. It can be defined as;

"the soft, adherent, structured deposits that form on teeth and other hard surfaces in the mouth, consisting of continually growing microbial colonies in an inter-microbial matrix."

This definition is virtually identical to that of a microbial biofilm and in this context dental plaque is now considered to be a biofilm, The prevention and treatment of gingivitis therefore must be aimed at the regular removal and disruption of this continually forming biofilm (Slots, 2002). Poor oral hygiene and lack of plaque control not only leads to the development of gingivitis but may also increase the risk of its possible progression to chronic periodontitis. There have indeed been many studies on the importance of adequate oral hygiene on the long-term maintenance of periodontal health (Axelsson et al 1981,1991). The pivotal study of Loe and colleagues (1965) showed that the cessation of oral hygiene measures in individuals with clinically normal gingival tissues resulted in gross accumulation of plaque and the development of gingivitis. The time to develop this clinical gingivitis varied from 10-21 days. They further showed that the removal of this accumulated plaque led to the resolution of the inflammation.

The development of gingivitis was first described by Page and Schroeder (1976). Broadly speaking, soon after the initial colonization of the acquired pellicle by Streptococci, bacterial enzymes and metabolic end products increase the permeability of the junctional epithelium and the so-called Initial Acute Lesion develops. This subclinical lesion is characterized by the formation of oedema, the accumulation of polymorphonuclear leukocytes (PMNs) and the loss of connective tissue immediately subjacent to the junctional epithelium. Approximately 2-5 days after, the the formation of the Initial Acute Lesion the so-called Early Lesion develops in which the nature of the lesion changes to one with increased numbers of lymphocytes and macrophages. At the same time the vascular changes become more pronounced and perivascular inflammatory infiltrates develop. Immunohistological analysis has shown that the development of gingivitis follows a similar pattern to that of a controlled delayed type hypersensitivity (DTH) response and that it is primarily a T cell/macrophage lesion. In contrast chronic periodontitis is characterised by large numbers of B cells and plasma cells (reviewed in Ohlrich et al., 2009).

3. Management rationale

Gingivitis is a ubiquitous oral disease. Many of those affected are unaware since it is painless and in its early stages not associated with obvious clinical symptoms. Its effect on the periodontium however, can be reversed with adequate plaque control.

Effective plaque control remains the cornerstone of disease control but it can be difficult and depends on factors such as motivation, knowledge and manual dexterity (Robinson et al,.2009).

Dental plaque must be physically removed. It cannot be rinsed off and regular tooth brushing, flossing and other interdental cleaning practices are required for effective removal. Chemical or antimicrobial agents, which aid in plaque and gingivitis reduction, should be thought of as supplementary home care practices. Gingivitis prevention however, demands an holistic patient view as successful uptake of oral health advice depends largely on individual behavioural variables.

Fig. 2. Flossing

4. Mechanical plaque control

The toothbrush remains the principal method for the mechanical removal of dental plaque. The toothbrush when used correctly removes dental plaque and food debris. It may also remove stained pellicle through the addition of an abrasive dentifrice. Efficacy and efficiency of tooth brushing is influenced by three main components; tooth brush design, the skill of the individual using the brush, and the frequency and duration of its use (Frandsen et al., 1972).

Various tooth brushing techniques are documented (Echeverria and Sanz, 2003), however it is the Bass technique and its adaptation that seem most favoured by dental professionals. Studies comparing the plaque removal efficacy of different tooth brushing techniques have typically shown little or no difference between them (Echeverria and Sanz , 2003). There is little then to be gained from introducing particular tooth brushing techniques unless the patient's current method is proving inefficient in the removal of plaque or is causing trauma to the teeth or gingival tissues. Advice and professional recommendations are better directed at modifying a patient's existing technique to improve plaque removal in neglected areas (Frandsenet al., 1972) and in correcting traumatic techniques. This may include addressing the stiffness of brush bristles. Current consensus for optimal tooth brushing frequency is that twice per day is consistent with maintenance of gingival health (Davies et al, 2003). Optimal duration of tooth brushing is two minutes (Cancro and Fischman, 1995), however it is recognised that most individuals rarely brush for longer than 60 seconds (Davies et al, 2003). With the addition of timers to many powered tooth brushes users can be aware of the duration of their tooth brushing (van der Weijden et al, 1993).

4.1 Manual tooth brushes

There are several important considerations in the selection of a well designed manual tooth brushes. These include bristle stiffness (soft is optimal for the removal of plaque and minimizes gingival trauma), handle size (should be appropriate to the size, age and hand dexterity of the user), head size (should be appropriate to the size of the users' mouth), and bristle pattern (should enhance plaque removal in the approximal spaces and along the gingival margin) (Egelberg and Claffey, 1988).

To date there is little evidence to indicate any one manual tooth brush is more effective than another (Jepsen, 1998). There are suggestions however that higher plaque scores are associated with natural bristles, whereas nylon bristles gave significantly better plaque removal. Lower plaque scores, less gingival recession and tooth brush abrasion have also been found in patients using toothbrushes with soft bristles (Anaise, 1976).

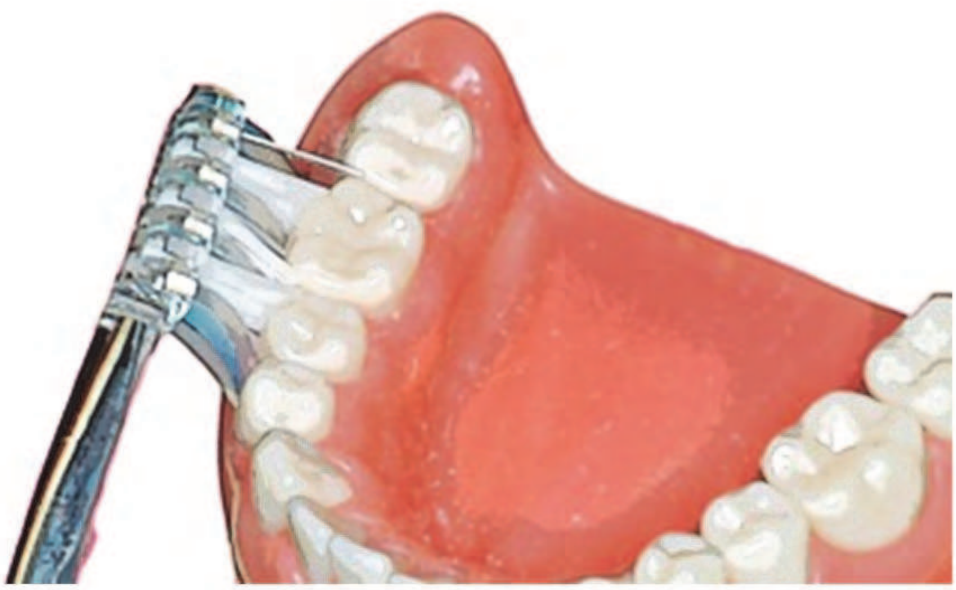

Fig. 3. Manual Tooth Brushing

4.2 Interdental cleaning aids

Interdental cleaning aids are important in controlling dental plaque and hence gingivitis since dental plaque accumulation and growth occurs on the interproximal surfaces of all teeth including the molars and premolars (Lang et al, 1973; Quirynen and Steenberghe, 1989). Interdental aids should be easy to use and efficient in removing dental plaque without causing damage to the hard or soft tissues. Interdental aids include dental floss or tape, toothpicks, automated interdental devices and interdental brushes. All of these aids have been shown to remove plaque and hence reduce inflammation (Axelsson, 1991; Lang et al, 1994).

The use of dental floss in conjunction with tooth brushing results in twice as much dental plaque removal than tooth brushing alone (Kinane, 1998). The use of floss has been shown to remove 80% of proximal dental plaque including subgingival plaque when correctly used (Waerhaug, 1981). Different types of floss have not been shown to be more effective than others. Some patients find floss difficult to manoeuvre without damage to the soft tissues. This is likely to include patients with poor dexterity, large hands or small oral cavities and those in whom the teeth are crowded or malaligned. Automated flossing devices may be easier for some patients to use. Flossettes and floss holders may enhance interdental cleaning by reducing the required level of manual dexterity. Interdental brushes may also be easier for some patients to manage as long as the gingival tissue can accommodate them without causing trauma. While current concensus is that interdental aids are crucial in the control and prevention of plaque induced gingivitis and the choice of aid is dependent on individual patient requirements and needs, but none are universally superior (Kinane, 1998).

Interdental brushes are designed specifically to target the interproximal spaces between the teeth. Early research found they were able to remove plaque from 2-2.5mm subgingivally (Waerhaug, 1981). Interdental brushes are available in a variety of sizes and forms, with individual small handles or long handles. The choice of handle is usually based on patient preference or dexterity requirements. These manual tooth brushes also have novel designs and filaments of different sizes and shapes.

Early research in these brushes showed evidence that a V-shaped brush better removes interdental plaque than a straight multi-tufted variety over a 12 day period (Bergenholtz et al, 1984). It is important to note that in the healthy mouth where teeth are aligned and interdental papillae completely fill the interdental area, interdental brushes are contraindicated because of the blunting trauma they can cause to the tip of the papilla. In these cases dental floss is the preferred interdental aid.

Interdental rubber-tipped stimulators are also widely available and have been shown to reduce bleeding scores and gingivitis (Yankell et al, 1992). Another variety of brush designed for specific, difficult to access, areas of the mouth is the 'end-tufted brush'. This can be used effectively in the distal and lingual aspects of molars, posterior to the last molar, in quadrants where third molars are present and in furcation areas.

Fig. 4. Interdental Cleaning Brush

Toothpicks can provide effective plaque and food debris removal in wide open interproximal spaces. A triangular rather than rectangular design is better suited to the interdental space (Mandel, 1990). These aids must be used correctly to avoid potential blunting or depression of the interdental papilla (Echeverria and Sanz, 2003).

4.3 Powered tooth brushes

Powered tooth brushes first became available in the 1960s (Deacon et al, 2009) and early models had a simple back and forth action. Later designs were rotary action brushes and most recently ultrasonic powered tooth brushes have been developed with higher frequency vibrations (van der Weijden et al, 1998). There are no definitive conclusions regarding the superiority of one mode of powered tooth brush over any other (Deacon et al, 2009). The main benefit of powered tooth brushes is considered to be the rotary head movement which it is claimed will increase interdental cleaning (Walmsley, 1997).

The relative effectiveness of manual versus powered tooth brushing has recently been summarised, with powered brushing thought to have a higher efficacy in the removal of plaque and a greater reduction of gingivitis (Robinson et al., 2009). This review also found that powered tooth brushes whose action is rotation-oscillational reduced plaque and gingivitis by 11% and 6% respectively in the short term, with a reduction of gingivitis of 17% at more than three months (Robinson et al., 2009). This appears to be related to the capacity of the brush to reduce plaque and in particular with the counter-rotational and oscillating-rotating brushes rather than sonic brushes (Sicilia et al, 2002).

A systematic review by the Deery et al., (2004) categorised powered tooth brushes into six groups dependent on their design and mode of action. They were assessed for their plaque and calculus removing efficacy along with how well they maintained gingival health compared with manual tooth brushes. There was no statistical difference between manual and powered tooth brushes in plaque reducing capabilities, however rotation oscillation powered tooth brushes did show a greater degree of plaque and gingivitis reduction over both short and longer term periods. (Deery et al,. 2004)

The effect of an oscillating/rotating/pulsating powered tooth brush on plaque and gingivitis compared with manual tooth brushing found the powered toothbrush maintained statistically significant lower plaque levels for nine months compared with the manual tooth brush (Rosema et al, 2008). The powered tooth brush also showed significant benefits in preventing gingival bleeding versus manual brushing alone. Deacon et al, (2009) suggest there is no evidence that any particular mode of powered tooth brush is superior.

Perhaps the ultimate advantage of powered versus manual tooth brushes lie in the belief of the population that they are easy and simple to use. Many studies have shown high compliance rates even six months after purchase (Stalncke et al,. 1995). The role of the dental professional remains important regardless of the type of brush but if individuals are more likely to accept powered tooth brushes or believe they are easier to operate this may enhance uptake of oral hygiene advice. Irrespectively, powered tooth brushes will remain important when manual dexterity is compromised. Deacon et al., (2009) further suggests individuals may choose to use powered brushes for reasons unrelated to clinical outcomes such as avoidance of bad breath, improving the appearance of teeth and because they like to use technology.

As powered tooth brush bristle movement is not able to be directly controlled by the user, these brushes tend to lead to a greater probability of damage to the gingival tissues. Nevertheless a number of studies have reported that any trauma is transient (Deacon et al,. 2009).

5. Oral health behavioural change

Oral hygiene advice is largely aimed at personal plaque control efforts through tooth brushing and interdental cleaning (Suomi et al 1973). This process however, is dependent on behavioural changes and changes in relation to thoughts and beliefs regarding oral health (Tedesco, et al., 1991). Patient compliance is necessary for the successful outcome of preventive or treatment recommendations (Blinkhorn, Non-compliance with oral self-care recommendations is the key problem in the prevention of poor oral health (Widström, 2004). Unwillingness to perform self-care (Weinsteinet al,. 1983), lack of motivation (Syrjala, et al., 1994), and poor dental health beliefs (Kuhner & Raetzke, 1989) may all contribute to poor oral health outcomes. Interventions aimed at improving compliant oral health behaviour must therefore be supported by strategies that enable implementation of behavioural change. If these changes can be made, oral health promotion, in the form of individual oral hygiene instruction is effective for plaque removal (Dahlen, et al., 1992; Kay & Locker, 1997). Evidence suggests however, that these behavioural changes are short-term and not sustained (Kay & Locker, 1997).

Behavioural science theory provides the basis for understanding why people do the things they do. It is only through conceptualising these principles that professionals are then able to provide the motivation to facilitate behavioural change. Health behaviour theories provide a framework on which to base professional guidance. As motivation has been defined as “the impulse that leads an individual to action” (Darby & Walsh, 1995, p. 85), effective health advice must first identify and utilise that impulse.

The most basic theory of health behaviour change assumes that knowledge of healthy behaviour can directly effect changes in attitudes and behaviour (Kallio, 2001). Traditional educational interventions have been shown to be of little help in achieving long term behavioural change (Renz et al, 2008). In the changing social context of medicine the oral health professional’s message must shift from “expert pronouncement” toward informed choice, non-directive counselling and a non-judgemental perspective. Because of this shift in focus in oral health education practitioners must attempt to both explain process and predict outcomes in order to influence oral health behaviour. Intrapersonal factors and characteristics such as prior knowledge and experience, attitudes and belief systems make this a complex and individualised process.

Behaviour change is a process - not an event. Individuals are at varying levels of motivation or readiness to change, and interventions must be tailored to an individual’s current status. This helps explain why standard, routine and rigid oral hygiene instruction does not always produce effective compliance with home care instruction. If patients are actively involved in their oral health, the responsibility to adopt appropriate oral health behaviours is personalised. Oral health professionals can enhance this process and improve maintenance of the gingival tissues by giving patients positive feedback about the success of their plaque removal efforts (Tedesco et al 1991). Studies have shown that patients who receive sporadic care may deteriorate over time. In a study of periodontal health status in young US Navy personnel it was reported that appropriate preventive therapies should be provided and repeated at intervals specific to individual need (Diefender et al, 2007). Individually tailored oral health educational programmes have been shown to be efficacious in improving long-term adherence to good oral hygiene practice (Jonsson et al., 2010). Targeted planning in interventions to increase compliance to flossing has also been successful (Schuz, et al., 2006), but continued monitoring and reinforcement is also required to maintain this level (McCaul et al., 1992).

Rarely will behaviour change on the basis of good advice alone (Watt, 2002). Positive reinforcement from an oral health professional is pivotal in building the patient confidence and self-esteem to maintain and improve oral health enhancing behaviours (Kallestai et al., 2000; Macgregor et al., 1997). Hope of success and satisfaction with life should be considered as predictors of good oral health behaviour and status (Dumitrescu et al., 2010). In children, psychological predisposition and family environment can significantly influence tooth brushing behaviour (Ayo-Yusuf et al., (2009) and in young adults preventive programmes can demonstrably help reduce plaque and gingival inflammation (Hugosen et al., 2007).

Psychological models may provide the basis for intervention studies relating to oral health behaviour. It is noted however that for clinical benefit to be measured, changes in oral hygiene behaviour must be maintained over long periods of time and to date most studies have had short follow-up periods (Renz et al, 2008).

6. Chemotherapeutic / antimicrobial agents

Chemical or antimicrobial agents which reduce plaque and gingivitis should be thought of as supplementary to the principal home care practices of regular tooth brushing and interdental cleaning. The patient who is unable to manage mechanical cleaning or is reluctant to perform this may benefit from the use of chemotherapeutic agents. The use of mouthwash together with mechanical oral hygiene, health orientation and motivation assisted in the maintenance of oral hygiene in orthodontic patients (Alves et al, 2010). As adjuncts chemotherapeutic agents may assist in the prevention of gingivitis by changing plaque composition in such a way that health cannot convert to disease (Kornman, 1979).

In order for an antimicrobial agent to be effective in the elimination or reduction and control of subgingival plaque micro-organisms it must reach the target without being diluted by saliva and then remain at sufficient concentration without being washed away by the gingival crevicular fluid. Despite the dilution action of saliva antimicrobial and antiseptic agents can provide excellent prevention of supragingival plaque accumulation (Walker et al, 2004). Modes of delivery of chemotherapeutic agents include toothpaste, chewing gum and varnishes.

6.1 Mouthwashes

Mouthwash use dates back over 6000 years as evident in recipes of Ebers Papyrus of 1500 BC. They were concocted from ingredients which included mice intestines, honey, white wine and stale urine (Addy, 2003). Historically they have been used to reduce plaque formation and so prevent or delay the onset of gingivitis. Recent evidence suggests mouth washes in conjunction with tooth brushing is more beneficial than daily flossing with respect to interproximal plaque reduction (Zimmer et al, 2006). Specifically tested were 0.06% chlorhexidine and 0.025% fluoride and 0.1% cetylpyridinium chloride and 0.025% fluoride.

Chlorhexidine is regarded as the gold standard among mouthwashes for its plaque inhibitory, anti-plaque and anti-gingivitis ability (Parnell et al, 2010). It is the most effective antimicrobial agent available for reducing gingivitis and plaque in humans (Marsh, 1972; Jones, 1997). Chlorhexidine is a bisbiguanide originally developed as a disinfectant for skin and mucous membranes. Clinical trials consistently show a 60% reduction in plaque and gingivitis in short-term studies and a 55% reduction in plaque and a 45% reduction in gingivitis.(Cianco, 1989). The mode of action of chlorhexidine is to bind to hydroxyapatite and glycoprotein to prevent pellicle formation. It alters the bacterial cell wall causing cell lysis and disrupts adsorption of bacteria. It is highly substantive which means it binds to both hard and soft surfaces in the mouth and remains active for up to 12 hours. It is poorly absorbed by the gastrointestinal tract and considered to have low toxicity. Possible side effects include staining of the teeth, tongue and anterior restorations, taste alteration, soft tissue ulcerations and increased calculus formation. Some formulations contain alcohol and this may be a consideration in its use. It is best used short term but is safe in the longer term except for aesthetic issues due to staining and possible taste alteration (Perry & Beemsterboer, 1996).

Phenolic Compounds (Essential Oils) – Listerine® is the most thoroughly studied of these mouth rinses. Long-term studies showed it to be effective in reducing plaque by 25-28% and gingivitis by 30% (Ciancio, 1989). More recently Tufekci et al., (2008) found Listerine® use can reduce the amount of plaque and gingivitis in patients undergoing orthodontic treatment. It was also found to have greater antiplaque and antigingivitis efficacy than a cetylpyridinium chloride containing mouthwash (Amini et al., 2009). In subjects with mild to moderate gingivitis essential oils have reduced the effects of orally induced bacteraemia (Fine et al, 2010).

Listerine® is a mixture of three phenolic-derived essential oils, thymol, menthol and eucalyptol which are combined with methysalicylate. The mechanism of action is to alter the bacterial cell wall (Ciancio, 1987). It has been found effective against both supra and subgingival plaque (Fine et al, 2010). Listerine® mouthwash has low substantivity and side effects include burning sensation, bitter taste and possible staining of the teeth.

Mouth rinses containing essential oils often have significant amounts of alcohol, have a strong flavour and are often less costly than chlorhexidine mouth washes.

Quaternary Ammonium Compounds – Daily use of Cetylpyridinium chloride has been found to reduce plaque and gingivitis in short-term studies (Silva et al, 2009). Its mechanism of action is by increasing bacterial cell wall permeability, decreasing cell metabolism and reducing cell attachment to tooth surfaces (Ciancio, 1987). It significantly reduces the anaerobic bacteria of supragingival plaque (Hu et al.,, 2009), and at 0.05% has been demonstrated to provide 12-hour protection against plaque and gingivitis. (Silva et al, 2009).

6.2 Toothpastes

The use of toothpaste in conjunction with tooth brushing is to facilitate plaque removal and to apply therapeutic or preventive agents to the tooth surface (Echevarria and Sanz, 2003). The addition of abrasive agents further enhances plaque and stain removal. The addition of these agents cannot negatively influence the balance of normal flora, as this could increase the risk of bacterial resistance, the development of super infections and could also result in hypersensitivity reactions (Seymour & Heasman, 1992; Paraskevas & van der Weijden, 2006)

The most common additive ingredient in toothpaste is fluoride but as this does not benefit plaque removal or gingivitis per se, other antibacterial agents are added.
As chlorhexidine's highly active cationic structure is inactivated by detergents and flavouring agents it cannot be formulated into a toothpaste (Sanz et al, 1994). Triclosan is a phenolic compound and also used as a toothpaste additive. It is usually combined with either zinc citrate or a copolymer of methoxyethylene and maleic acid, in which form it is effective in reducing plaque and gingivitis (Ciancio, 1987). A non-ionic phenol derivative, Triclosan has a broad spectrum antimicrobial activity against gram positive and gram negative bacteria and has been shown to be beneficial in toothpaste (Pires et al., 2007).
Triclosan acts on the microbial cytoplasmic membrane to induce leakage of cellular constituents and bacteriolysis (Rolla et al., 1996). Triclosan is most effective when combined with a copolymer. Gunsolley (2006) found that the 2.0% addition of the copolymer Gantrez (methoxyethylene and maleic acid) was crucial as triclosan preparations without this ingredient were not as effective. The copolymer enhances the antibacterial activity of Triclosan through improved binding to the tissues of the oral cavity and a subsequent significant increase in oral retention. Triclosan has been shown to significantly reduce new supragingival plaque development and moderately reduce existing plaque levels and established gingivitis (Linde et al., 1993). It appears to have more effect on gingivitis in cases where oral hygiene is poor. Effects increase over time with maximum results seen 3-6 months after its use is initiated (Saxton et al, 1987).
Stannous Fluoride – Well known in dentistry for its caries-inhibiting effects, there is evidence that stannous fluoride has properties which altering cell metabolism and cell adhesion (Tinanoff, 1990). Stannous ion enters the cell and affects the growth and adherence of the bacteria. Paraskevas & van der Weijden (2006) in a systematic review of the effects of stannous fluoride on gingivitis, concluded that stannous fluoride toothpaste resulted in a reduction in gingivitis and plaque compared with the control, sodium fluoride toothpaste. This effect however was relatively small. Gunsolly (2006) reports that although stannous fluoride shows a statistically significant antiplaque and anti-gingivitis effect, only the anti-gingivitis effect is clinically significant. He suggests the main action of stannous fluoride is its ability to alter the effect the plaque has on gingivitis, rather than its composition or virulence.

Fig. 5. Healthy Gingivae

7. Acknowledgment

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8. Conclusion

Gingivitis is a reversible disease of the oral cavity. Many adjuncts may assist in the control of pathogenic dental plaque to prevent disease or to reduce its expression. Appropriate behavioural change however is a prerequisite to improving oral health and reducing gingivitis. Mechanical plaque control through effective oral health behaviour remains the essence of effective management of the disease.

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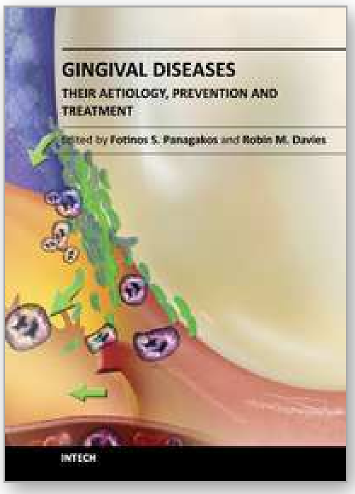

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Gingival diseases are a family of distinct pathological entities that involve the gingival tissues. These signs and symptoms of these diseases are so prevalent in populations around the world that they are often considered to be â€œnormalâ€ features. The diseases are now classified into two main groups namely: Plaque-Induced and Non-Plaque Induced Gingival Diseases. This book provides dentists, dental hygienists, dental therapists and students with a comprehensive review of gingival diseases, their aetiology and treatment.

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InTech Europe
University Campus STeP Ri
Slavka Krautzeka 83/A
51000 Rijeka, Croatia
Phone: +385 (51) 770 447
Fax: +385 (51) 686 166
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中国上海市延安西路65号上海国际贵都大饭店办公楼405单元
Phone: +86-21-62489820
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