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**Prevention and therapy of periodontal diseases and oral malodour**

van der Sluijs, E.

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*Citation for published version (APA):*

van der Sluijs, E. (2017). Prevention and therapy of periodontal diseases and oral malodour: Brush, rinse and cool DIDES

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# 1

## General introduction

# General introduction

Dental plaque is the major etiological factor for of gingival inflammation and contributes to bad breath (1). This thesis focuses on plaque removal, prevention of periodontal diseases and oral malodour. Different oral hygiene instructions, oral rinsing interventions and cooling solutions are evaluated. The common theme among all of these is water, which is why the general concept of water is introduced with a focus on its relation to the oral cavity. This chapter concludes with a description with the flow of this thesis.

## **Water and life**

Much of the universe's water is produced as a by-product of star formation. There are two prevailing theories. One is that the earth held onto some water when it was formed. The second is that the oceans are the result of collisions between ice-rich asteroids. No matter how it was formed, water can be found everywhere on the planet and 70% of the earth's surface is covered with water. Only 3% is fresh water, and only a fraction of 1% supports all life on the land. Water is one of only a number of substances that can exist as a solid, liquid and gas within a relatively narrow range of temperatures. Moreover, it is a transparent and nearly colourless in its liquid state, which prevails at standard ambient temperature and pressure. The major feature of water is that it can dissolve nearly anything. This specific chemical property of water makes it indispensable for living. Large amounts of water are contained within the body tissues, blood and bones of human beings. It comprises a significant portion of the body, both by weight and volume (2). The average human adult is approximately 70% water and even an individual's bones are watery (31%) (3). An important aspect of homeostasis is fluid balance, which ensures that the proper amount of body water is maintained (4).

## **Water and the oral cavity**

The World Health organisation (WHO) (5) has stated that 'safe and readily available water is important for public health, whether it is used for drinking, domestic use, food production or recreational purposes'. In 2010, the United Nations explicitly recognised the human right to water and acknowledged that clean drinking water and sanitation are essential (6). Between 50 and 100 litres of water per person per day are needed to ensure that an individual's most basic needs are met and few health concerns arise (7). Moreover, water can be used for different purposes and could be meaningful for maintaining oral health. It cleans the mouth and quenches thirst. While a majority of fluids present within the oral cavity originate from the salivary glands, the gingival crevicular fluid also contributes, in a small volume, to the formation of what is designated 'whole saliva' (8). The main functions of saliva is to protect and maintain the integrity of oral mucosal health through lubrication, buffering action, antibacterial and antiviral activity as well as food digestion. The sensation of a dry mouth can be the result of low saliva rate (9) and the simple act of drinking water can hydrate the mouth when its salivary flow supply runs low (10). Rinsing with plain water after meals is suggested to help reduce bacteria and remove food debris (11). Furthermore, water is calorie-free and as such, does not risk the health of one's teeth like sweetened

drinks (12). Although it may be considered a relatively simple home remedy, drinking a glass of water or rinsing with water could maintain and/or improve oral health.

### **Water and oral hygiene**

Oral hygiene is the key to oral health. Mechanical methods of oral hygiene are considered the gold standard method of plaque control (13) and it is well established that controlling dental plaque is fundamental to accomplishing and maintaining periodontal health (14). For this purpose, toothbrushing is effective for reducing dental plaque (15). Dental care professionals generally recommend to brush twice-daily for two minutes each time (16) for primary prevention of periodontitis in 'low risk' groups (17). A longer brushing duration is required for 'higher risk' patients and secondary prevention (17). Already in 1960, reactions to brushing teeth with water alone were evaluated (18). Of the study population, almost 50% did not like brushing their teeth without a dentifrice and 88% stated that they preferred to brush with a dentifrice. A clinical study revealed however, that the use of a dentifrice did not significantly increase mechanical plaque removal compared to brushing with water alone (19). This confirmed the finding of a recent systematic review, which demonstrates that brushing with a dentifrice does not provide an added effect for the mechanical removal of dental plaque (20). A dentifrice, on the other hand, is an ideal vehicle for active ingredients to prevent oral diseases because it is used on a daily basis (21).

Despite the emphasis placed on mechanical methods of plaque control, the prevalence of gingival inflammation remains high. For this reason, other oral hygiene agents such as mouthwash with anti-plaque and/or anti-gingivitis properties may have clinical value (13). Chemotherapeutic agents have the potential to improve oral health beyond toothbrushing alone (22). Most types of mouthwash use either a water or water-alcohol base, with flavour, surfactant, humectants and active ingredients. Several formulations with specific chemical agents for the management of plaque and gingivitis are marketed. When compared to negative controls (frequently water) only a small number of them provide statistically significant improvements within plaque and gingivitis indices (23,24).

### **Water and oral malodour**

The whole oral fluid present in the mouth helps food and water pass through the mouth and throat (9). The salivary glands of a healthy individual, produces roughly 0.75 to 1.5 litres of saliva each day (25). During sleep, saliva production is however significantly reduced. Furthermore, microbial metabolic activity can be increased during sleep due to a lack of physiologic oral cleansing through the movement of the facial and oral muscles (26). This phenomenon can cause morning bad breath (MBB) (27), which contains elevated concentrations of volatile sulphur components. Morning bad breath is considered a surrogate target for interventions on breath quality (28) and has been accepted as an alternative model for testing treatment strategies for halitosis (29). A quick internet search claims that eliminating MBB is rather simple: drink water, eat breakfast, perform oral hygiene and rinse your mouth with water or mouthwash. In a facultative manner, one could also eat more raw foods such as carrots, celery and apples; gargle with a glass of water containing cinnamon powder; or chew sugarless gum. Another suggestion is to drink water just before

going to bed. Since no food or fluids are consumed during sleep, the mouth can dry out. Moreover, one could drink water when waking up during the night. Laymen's literature has suggested drinking a glass of water and swirling it around the mouth for a moment. Nevertheless, the main goal is to remain hydrated and to drink water regularly. Staying hydrated is especially important before and after heavy exercise, when rapid breath can increase the likelihood of dry mouth (30). However, none of these recommendations have been supported by scientific evidence. Professional advice for oral malodour has focused on improving oral hygiene practices, including toothbrushing and interdental cleaning. Additionally, the use of a tongue cleaning device when tongue coating is present is advised (31,32) and the use of chemical agents with proven efficacy is also recommended (27,33,34).

### **Water as a cooling solution**

Just as showering with water below body temperature is a well-known method for staying cool on hot days. A water coolant system is often used in dentistry to reduce frictional heat caused by various dental devices and protect against damage to the pulp, the tooth and its surrounding tissues. These devices include dental burs, laser systems and ultrasonic tips (35). To prevent overheating from a device and prevent that the produced heat is transferred to the opposing surface, a coolant fluid is used (36). An ideal coolant for dental devices has high thermal capacity, low viscosity, is low-cost, non-toxic, chemically inert and neither causes nor promotes corrosion of the cooling system (37). Pressurised air flow is a common form of coolant (37), while water is the most common liquid (38). During periodontal treatment and the use of ultrasonic scaling procedures, excessive heat production will occur if the water flowrate is insufficient over the tip (39). The flow of water helps lavage the area treated for dental deposit removal, allowing for a favourable tissue response (35-40). If the water flow is inadequate, there may be discomfort for the patient or potential damage to the tooth.

## The flow of this thesis

The purpose of this thesis is to investigate the different uses of water or rinses in relation to brushing, rinsing and cooling in preventing and treating periodontal diseases and oral malodour. The efficacy of toothbrushing is assessed using dental plaque scores; the clinical parameters of gingivitis and periodontal inflammation are also included. Oral malodour is measured by the organoleptic score and volatile sulphur compounds are measured using two specific apparatuses. Patient reported outcomes related to the various interventions are also evaluated. The following specific questions are addressed within this thesis:

- ◊ Can a specific brushing sequence influence plaque removal efficacy?  
**(Chapter 2)**
- ◊ Does pre-rinsing with water affect plaque removal during toothbrushing?  
**(Chapter 3)**
- ◊ Does dry brushing improve plaque removal? A secondary analysis.  
**(Chapter 4)**
- ◊ What is the effect of rinsing or drinking water on morning bad breath?  
**(Chapter 5)**
- ◊ What is the effect of mouthwash and mechanical tongue cleaning on morning oral malodour?  
**(Chapter 6)**
- ◊ Which chemical mouthwash agents control plaque and gingivitis?  
**(Chapter 7)**
- ◊ What is the effect of periodontal inflammation on clinical parameters using ultrasonic sub-gingival instrumentation in combination with water or antimicrobial cooling solutions?  
**(Chapter 8)**

The majority of the chapters in this thesis have already been published in scientific dental journals. As some of the studies concern a similar topic there are inevitably considerable overlaps between chapters. Different journal requirements have also created some variations in terminology from one chapter to the next. For editorial reasons, the chapters in this thesis are not arranged chronologically.

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