Research Paper Medical Science

Malodor and Periodontitis: Casual or Causal?

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ABSTRACT

Halitosis can be a crippling social problem.However, in the last 5 to 6 years, it has come to the forefront of public and dental professional awareness.The mouth is home to hundreds of bacterial species that produce several fetid substances as a result of protein degradation. Volatile sulfur compound (VSC)-producing bacteria colonizing the lingual dorsum, gingival pockets, and tonsillar crypts have recently been implicated in the generation of halitosis. Understanding causes, assessment, and treatment of oral malodor can help dental professionals find ways to decrease its prevalence and increase their patients' well-being. This artical reviews the etiology and various connections among periodontal pathogenic microorganisms, periodontal disease and oral malodor from a periodontal perspective.

KEYWORDS : halitosis, volatile sulphur compounds, periodontitis

INTRODUCTION:

Halitosis is a medical term first coined by **Listerine Company in 1921**, used to describe "unpleasant, offensive, stale or foul smelling breath emitted from the mouth regardless of whether the odorous substances in the breath originate from oral or extra-oral sources."

This condition is commonly responsible for social embarrassment, emotional and psychological distress leading to a lack of self-esteem, self-image and self-confidence. Furthermore it may signal the presence of disease.

Oral halitosis or oral malodor is the term, especially used to describe bad breath with an origin within the oral cavity. In fact most adult subjects have socially unacceptable bad breath when waking up in the morning. This problem is transitory and attributed to physiologic causes such as reduced salivary flow during sleep. Although these transitory problems are easily controlled, persistent bad breath may be indicative of either oral disease (i.e. Periodontal disease, the presence of bacterial reservoir in mouth) or indicative of systemic disease (i.e. Hiatus hernia, hepatic cirrhosis, renal failure, diabetes mellitus etc.).

ETIOLOGY

The etiology of oral malodor is multifactorial. In the presence of adequate substrate with appropriate conditions, a sequence of events leads to the release into the oral cavity of pungent gases that pollute exhaled air and are perceived as bad breath. Research has identified several microorganisms that produce these offensive odors and provided a fair explanation of the conditions necessary for their production. In addition to the presence of certain types of bacteria, the type and amount of substrate, and oxygen and pH levels influence the occurrence and severity of oral malodor.

Certain chemical end-products of bacterial putrefaction known as volatile sulfur compounds (VSCs) are foul smelling and have been found to be the primary culprit of engendering oral malodor.[1-4] Non-sulfur-containing compounds such as cadaverine, putrescine, indole and skatole [5,6] have also been implicated in the foul smell of oral malodor, but their contribution is thought to be limited.[7] VSCs such as hydrogen sulfide, methyl mercaptan and dimethyl disulfide make up more than 90 percent of the putrid odors from the mouth.[8] Two of these VSCs, hydrogen sulfide and methyl mercaptan, account for approximately 90 percent of the total VSCs identified with putrid odors from the mouth.[9]

Source of VSC production in periodontitis patients

Anaerobic bacteria, oxygen depletion, alkaline pH and sulfur-containing substrates are some of the requirements for oral malodor to occur .The bacteria that produce these VSCs can be found by evaluating biofilm and scraped specimens from the lingual dorsum, gingival pockets, and tonsillar crypts.[7] **(fig. 1)**VSCs are produced by gram-negative anaerobic bacteria that live on the lingual dorsum.[8] These bacteria can thrive on the tongue because food debris accumulates rapidly on the tongue's large surface area and papillae. Periodontal pathogens have been positively correlated with oral malodor.[1-4,10] Several periodontal pathogens including Treponema denticola, Porphymonas gingivalis and Bacteroides forsythus have been identified, with BANA hydrolysis, on the posterior tongue, contributing to oral malodor.[11] Additional periodontal pathogens, including Fusobacterium nucleatum and Bacteroides melanogenicus have been identified as VSC formers.[8] These microorganisms produce copious amounts of hydrogen sulfide, methyl mercaptan and dimethyl disulfide. However, other compounds in mouth air may also be offensive such as diamines (e.g. Putrescine, cadaverine), indole, skatole and butyric or propionic acid. Most of these compounds results from proteolytic degradation by oral microorganisms of peptides present in saliva, shed epithelium, food debris, gingival crevicular fluid, interdental plaque, post-nasal drip and blood.

Breath malodor, a significant social and/or psychological handicap, may be caused by several intra- and extraoral factors.

Intraoral causes:

1. Tongue coating (primary source of malodor)
2. Dentition
3. Carious lesion

4. Food impaction
5. Extraction wounds filled with blood clots
6. Periodontal infections like Pockets, ANUG, Purulent discharge from gums
7. Xerostomia

Extra oral Causes:
Halitosis of the upper respiratory tract: Chronic sinusitis, Nasal obstruction, nasopharyngeal abscess, Carcinoma of larynx

Halitosis of the lower respiratory tract: Bronchitis, Bronchiectasis, Pneumonia, Carcinoma of the lungs

Causes of blood borne halitosis:

Systemic diseases: Hepatic failure/ Liver cirrhosis, Ureamia/Kidney failure, Diabetic ketoacidosis/Diabetes mellitus

Metabolic disorders: Isolated Persistant Hypermethioninemia, Fish odor syndrome,

Medication: Disulfiram, Dimethyl sulphoxide, Cysteamine,

Food: garlic, onion, alcohol, tobacco

ASSOCIATION BETWEEN HALITOSIS AND PERIODONTAL DISEASE

Periodontal disease result from the combination of many factors present in vivo. These processes include chronic activation of immune system, alteration in connective tissue metabolism production of proteinases and cytokines, direct destruction of host tissue by bacterial enzymes, and virulence factors and a multitude of other mechanisms. One of these volatile sulfur compounds (VSCs) not only be associated with oral malodor but probably contribute to the etiology of both gingivitis and periodontitis. Different lines of evidence have demonstrated this association between halitosis and periodontal disease.

An increase in production of VSCs from periodontal pockets provides a plausible explanation for the intensification of oral malodor observed in patients with periodontal disease. Several studies suggest that periodontitis increases the severity of oral malodor.[7] One possible explanation is the increased amount of substrate available to be metabolized. In patients with periodontitis, more sulfur-containing protein substrate is available through increased exfoliation of epithelial cells and crevicular effusion of leukocytes. Yaegaki and Sanada found that bleeding on probing and periodontal pocket depth positively correlated with the production of VSCs.[4]

In contrast to the view that periodontal disease contributes to oral malodor, Bosy and colleagues found that oral hygiene levels and not periodontal pockets were more indicative of oral malodor,[11] which supports the concept that oral malodor may be an independent entity.

Certainly, some gram-negative anaerobic bacteria, which are not known to be periodontal pathogens (Fusobacterium polymorphum, Veillonella alcalescens, Bacteroides fundiliformis and Klebsiella pneumoniae) have been identified with oral malodor.[12,13] The bacteria contributing to oral malodor in healthy individuals are most commonly located on the posterior dorsal tongue surface as opposed to in periodontal locations.[6]

As currently understood, periodontal disease progression consists of a shift in the bacterial plaque from a gram-positive aerobic flora to a gram-negative anaerobic and motile flora. Some studies suggest that the production of VSCs by these microorganisms may contribute to the progression of periodontal disease via breakdown of the oral mucosa leading to bacterial invasion.

This finding suggests that the VSCs of oral malodor could contribute in the pathogenesis of periodontitis.

TRANSITION FROM HEALTH TO GINGIVITIS:-

Gingivitis is characterized by an immune response to antigens in bacterial plaque as well as by alteration in connective tissue (Fig 2).One of the earliest events associated with disease is enhanced permeability of the lining epithelium with the gingival sulcus. VSCs are potentially capable of altering permeability of the gingival tissues, including inflammatory response and modulating functions of gingival fibroblast. **Rizzo (1970)** indicated that a facilitating agent is required to allow lipolysaccharides (LPS) to penetrate healthy gingival epithelium and subsequently initiate an inflammatory response.[14] Studies demonstrated that thiol participate in early stages of the inflammatory response and may be important initiator of gingivitis. Gingivitis results from the induction of an immune response and may be accompanied by alteration in fibroblast function. Methyl mercaptan (CH_3SH) has been shown to induce secretion of interleukin-1β (IL-1β) from mononuclear cells. Methyl mercaptan has also been shown to act synergistically with both LPS and IL-1β to increase secretion of prostaglandin E_2 and collagenase, important mediators of inflammation and tissue destruction.[15]

VSCs have direct effect on the formation of extracellular matrix by human gingival fibroblast. In addition they lower total protein production by these cells.

The effect of methyl mercaptan (CH_3SH) on collagen metabolism is a reflection of both decreased synthesis and increased degradation of protein. This increased degradation is likely to be associated with inhibition of procollagen peptidase enzymes which are essential for procollagen processing and for cross linking to form mature collagen fibrils.

TRANSITION FROM GINGIVITIS TO PERIODONTITIS:

In the change from gingivitis to periodontitis, there is a continuation of all the events in the oral malodor and gingivitis section as well as a new group of events that occur in the development of periodontitis (Fig.2). Periodontitis results from destruction of both the soft and hard tissue structures which support teeth. The transition from gingivitis to periodontitis is mainly an anatomical difference in which the disease progresses into the underlying bone. Since the periodontal ligament cells are associated with the formation and maintenance of the mineralized supporting structures, effects of thiols on these ligament cells are particularly relevant. Increase in probing pocket depth and bleeding on probing with increase in methyl mercaptan in these pocket are also relevant. The effects resulting from exposure to CH3SH become increasingly important in periodontitis.[1]

Yaegaki & Sanada showed a correlation between increases in CH_3SH/H_2S concentration ratio and increases in periodontal pocket depth.[10]

Studies have shown that PDL cells exposed to methyl mercaptan (CH_3SH) alter their intracellular pH and become more acidic. In addition, they exhibit decreased motility, lowered protein synthesis, and alteration in collagen metabolism. These changes are predominantly determined to the ability of these cells to maintain or regenerate mineralized tissues. In addition there is substantial reduction in amount of type III collagens.[16] This observation is significant since periodontally involved tissue are known to exhibit substantial losses of type III collagens which decrease from 20-30% to 4% of total collagen.[17] Fibronectin in PDL cell are also affected by VSCs.

Severity of periodontitis

In periodontitis, different studies have shown a correlation between VSC concentration in mouth air and increased pocket depth.[3,6,10] However **De Boever (1996)** found that tongue odor was negatively correlated with probing depth suggesting an inverse relationship between malodor and periodontal parameters.[2] Similarly **Bosy et al. (1994)** did not find a relationship between periodontal disease and the prevalence or severity of halitosis.[11]

Correlation between the presence of a pathogenic microflora in the subgingival microbiota & Halitosis

In **1994, Bosy et al.** found a moderately strong correlation between the BANA (Benzoyl- DL-arginine-2-Napthylamide) scores with floss odor based on trypsin like activity detected by the BANA test . They also found that 87.5% of tooth sites were BANA positive as compared with 74.5% of tooth sites positive in healthy individuals.[11]

A significant correlation has been found between the presence of motile organisms and P. intermedia on the tongue dorsum in individual with periodontitis as opposed to periodontally-healthy subjects. This indicates that the tongue may act as a reservoir for some periodontopathogens that contribute to oral malodor.

Tonzetich found the pathogenic, proteolytic strains of Bacteroides melanogenicus produced more VSCs than non-proteolytic strains.[18] Treponoma denticola, Porphyromonas gingivalis, Porphyromonas endodontalis, Prevotella intermedia and Bacteroides loescheii produced significantly higher amount of sulfides than other bacteria.[19] Other bacterial species recovered from periodontal pockets such as Enterobacteriaeceae, Bacteroides forsythus, Centipeda periodontii, Eikenella corrodens, Fusobacterium periodonticum etc.also had high capability to generate VSCs in vitro[19, 20].

FUTURE PERSPECTIVE:

VSC in periodontal pockets might be used as a predictor of periodontal disease. Many authors have proposed to utilize hydrogen sulfide, one of causative periodontal pathogens' products as an indicator for disease severity. The value of this hypothesis remains to be elucidated. It is also interesting to determine the degree of contribution by pocket VSC to whole mouth odor. For this study, we have to measure VSC level in periodontal pockets quantitatively. Then multifactor analysis including pocket VSC level and odor level of the tongue and the other parts of oral cavity will provide us useful information in management of patients with oral malodor.

CONCLUSION:

An estimated 80 percent to 90 percent of all bad breath odors originate from the mouth and are caused by bacteria. The accumulation of plaque and debris and the stagnation of saliva occur most commonly in areas where tooth and tissue crevices, posterior dorsum tongue, interdental spaces and subgingival areas lend themselves to stagnant microenvironments.

Although oral malodor is probably not caused by periodontal disease; there is ample evidence to suggest that periodontal disease increases the severity of oral malodor. Periodontitis worsens the severity of oral malodor by providing additional sites of VSC production (interdental and subgingival), an increased availability of sulfur-containing substrate (exfoliated epithelial cells and leukocytes) and an increased rate of methionine metabolism (precursor to methyl mercaptan). Periodontitis contributes to an increased tongue coating with higher VSC production. There is evidence to suggest that VSCs, i.e., oral malodor, may contribute to the progression and pathogenesis of periodontal disease via increased mucosal permeability.

This article outlines the efficacy of volatile sulphur compounds in causing malodor and showing the casual and causal association among periodontal pathogenic microorganisms, periodontal disease and oral malodor which has been strongly implicated but not proved.

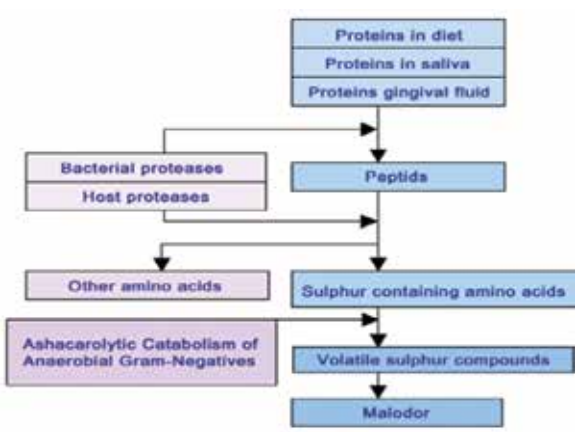

Fig 1. Production of volatile sulfur compounds (VSCs).

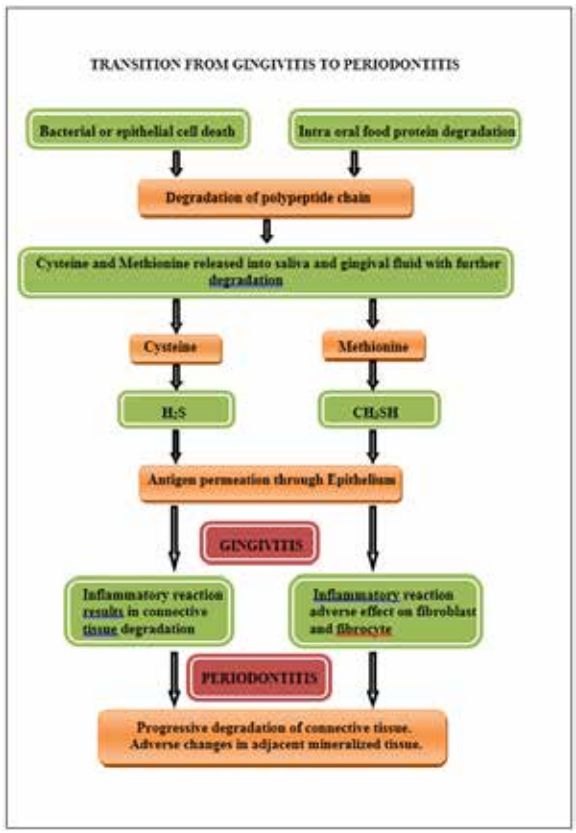

Fig. 2 Effects of sulfur compounds which may potentiate gingivitis and periodontitis

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