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Oral Malodor: A Review of the Literature

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Oral malodor or halitosis is any unpleasant odor emerging from the mouth that is detected by others. Many patients experience extreme discomfort and embarrassment and therefore seek help for this problem.

Oral causes, such as poor oral hygiene, periodontal disease, tongue coating, food impaction, unclean dentures, faulty restorations, and dry mouth, are far more common than nonoral causes of malodor. Management may include simple measures such as scaling and root planing, instructions in oral hygiene, tongue cleaning, and mouth rinsing.

This paper reviews the current knowledge, etiology, diagnosis, and possible treatment strategies for oral malodor. Emphasis is placed on the recognition of the dental hygienist as a specialist in aspects of patient care and instruction, which relate to the prevention and control of oral malodor.

Keywords: Bad breath, malodor, halitosis, volatile sulfur compounds

Introduction

Oral malodor, also called halitosis or bad breath (fedor ex ore) is a universally experienced condition affecting humankind since ancient times. Historic references include the Jewish Talmud, as well as Greek and Roman writings.¹ Islam stresses the importance of fresh breath as part of good oral hygiene.² Ladanum (mastic), a resin derived from the 'Pistacia lentiscus' tree used in the Mediterranean region for breath freshening for thousands of years, has been mentioned in the book of Genesis.³ Parsley, cloves, guava peels and egg shells have been considered as traditional remedies for bad breath in various countries across the world.³

The overall prevalence of oral malodor in the adult population is uncertain. According to Tonzetich and Ng,⁴ bad breath is a common condition found in approximately 50% of the adult population as a severe chronic problem.^{5,6} Most individuals experience personal discomfort and social embarrassment leading to emotional distress.⁷ The consequences of oral malodor may be more than social; it may signal the presence of disease.⁷

Review of the Literature

Etiology of Oral Malodor

Offensive odors emanating from the oral cavity have been attributed to a variety of etiologic factors, including local and systemic disorders. Oral malodor caused by normal physiologic processes and behaviors is usually transitory.⁸ Extrinsic causes include tobacco, alcohol, and certain foods, such as onions, garlic, and certain spices.^{9,10} Substances absorbed into the circulatory system may be released in pulmonary air or saliva as volatile odoriferous compounds.¹¹ These are best controlled by eliminating the intake of such offensive substances.¹⁰

Intrinsic causes¹² of bad breath are both oral (90%) and systemic in origin (10%).¹ Oral sites in which microbial accumulation and putrefaction occur are suspect.¹³ These may include the interdental and subgingival areas, faulty restorations, dentures, sites of food impaction, and abscesses.^{3,10,14} The coating on the dorso-posterior region of the tongue is also a primary cause for halitosis.^{15,16} The bacteria on the tongue were found to correlate strongly with malodor.⁶

Extraoral sources¹⁷ of odor may include sinusitis, mucous secretions, polyps, postnasal drip, tonsillitis, etc. An increased oral malodor in some women during ovulation, menstrual cycles, pregnancy, and menopause has been reported.¹⁸ Many non-oral diseases, including bronchial and lung infections, kidney failure, various carcinomas, trimethylaminuria, metabolic dysfunction, and biochemical disorders, can result in bad breath.¹⁴ Furthermore, there are people who do not have bad breath, but are convinced that they have oral malodor (halitophobia).¹⁹ However, all these diseases taken together affect a very small percentage of people.³

Certain chemical end products of bacterial putrefaction known as volatile sulfur compounds (VSCs) smell foul and have been determined to be responsible for the offensive odor.²⁰ Volatile sulfur compounds, such as hydrogen sulfide (H₂S), methyl mercaptan (CH₃SH), dimethyl sulfide ((CH₃)₂S), dimethyl disulfide, and sulfur dioxide (SO₂), make up more than 90% of the putrid odors from the oral cavity.²⁰ Methyl mercaptan has a lower threshold of objectionability and is more unpleasant than hydrogen sulphide. Concentrations greater than 0.5ng of methyl mercaptan and 1.5ng of H₂S per 10 ml of air sample have been found objectionable.²⁰ Nonsulfur containing compounds such as cadaverine, putrescine, indole, and skatole have also been implicated in oral malodor.²¹

Relationship of Periodontal Disease to Oral Malodor

The accumulation of plaque and debris and the stagnation of saliva occur most commonly in areas where tooth and tissue crevices lend themselves to stagnant micro-environments, like the posterior dorsum of the tongue, interdental spaces, and subgingival areas. Dental plaque progresses from aerobic, gram-positive colonization to one that is anaerobic, favoring gram-negative growth.²² As the bacterial plaque matures, the oxygen level drops to zero, favoring reduced conditions and the production of odoriferous volatiles.²³ Oxygen depletion is attributed to the bacteria that use oxygen to oxidize substrates (anerobes) from saliva and crevicular fluid.²³

Yaegaki and Sanada²⁴ found that bleeding on probing and periodontal pocket depths positively correlated with production of volatile sulfur compounds (VSCs). Deep periodontal pockets tend to harbor and promote the growth of VSC-producing gram-negative microorganisms like *T.denticola*, *P. gingivalis*, *T. forsythensis* and *Fusobacterium nucleatum*.²⁵ Bosy et al,⁶ have found oral hygiene levels and not periodontal pockets to be more indicative of oral malodor.

Studies have suggested that periodontitis increases the severity of oral malodor.^{15,25} The bleeding tendency of the periodontal tissues may provide essential substrates for odor production.²⁶ The inflamed periodontal tissues provide more methionine, which is converted into methyl mercaptan at a higher rate than in healthy gingival tissues.¹⁵ The increased gingival crevicular

fluid flow in periodontitis may be a continual source of methionine.¹⁵ Increased salivary putrefaction may occur due to a higher concentration of disintegrated epithelial cells.²⁶ Some studies suggest that the production of VSCs by these gram-negative microorganisms may contribute to the progression of periodontal disease via breakdown of the oral mucosa leading to bacterial invasion.²⁷

The average amount of tongue coating was also 6 times greater in individuals with periodontal disease.²⁴ This coating is comprised of epithelial cells, leukocytes, and microorganisms released from periodontal pockets.²⁸

Diagnosis of Oral Malodor

A number of methods have been used to detect the presence of oral malodor.³ Direct tests include sniffing of bad breath and determination of the odoriferous sulfur containing substances by halimetry or gas chromatography.²⁹ Indirect methods identify the odor producing microorganisms or assess their by products in vitro.²⁹ The primary reference standard for the detection of oral malodor is the human nose (organoleptic or hedonic assessment).³⁰ The organoleptic evaluation of oral malodor depends on the person who makes the evaluation and the technique used.

Whole mouth breath assessment (method of choice)²

The subject is instructed to breathe out through the mouth at a distance of approximately 10 cm from the nose of the judge, who is blinded.

Spoon test (assesses odor from the dorsum of the posterior tongue)³

A plastic spoon is used to scrape and scoop material from the back region of the tongue dorsum. The spoon odor is evaluated after five seconds at a distance of approximately 5 cm from the examiner's nose.

The dental floss odor test³ (determines the presence of interdental plaque odor)

Unwaxed floss is passed through interproximal contacts of the posterior teeth and the examiner assesses the odor by smelling the floss at a distance of approximately 3 cm.

The saliva odor test

The subject expectorates approximately 1 to 2 milliliters of saliva into a Petri dish. The dish is covered immediately, incubated at 37°C for five minutes and is then presented for odor evaluation at a distance of 4 cm from the examiner's nose.³¹

A scale commonly used in malodor research is the 0-5 intensity scale used by Rosenberg et al.³² In this organoleptic scale,³³ 0 indicates a concentration of odorant that is below a threshold, and 5 indicates concentrations that are extremely strong. (0-absence of odor, 1-questionable odor, 2-slight malodor, 3-moderate malodor, 4-strong malodor, 5-severe malodor.)

Objective instrumental analysis includes the use of gas chromatography to measure the presence of specific volatile sulfur compounds in expelled mouth air.²⁴ Gas chromatography²⁴ coupled with flame photometry detection is considered the gold standard for measuring oral malodor, because it is specific for volatile sulfur compounds, the main cause of oral malodor.^{15,34,35} The disadvantage, however, is the high cost, time, expertise required, and lack of portability.¹⁶ Odoriferous gases such as cadaverine,²¹ putrescine, and skatole can also be detected by gas or liquid chromatography.

Sulfide monitors^{2,36} analyze total sulfur content of the subject's mouth air using an electrochemical, voltametric sensor, which generates a signal when it is exposed to sulfide and mercaptan gases, measuring the concentration of H₂S gas in parts per billion. Advantages include its portability, low cost, rapid analysis time, and training required.²⁹ The main disadvantages are that it is incapable of distinguishing among individual sulfide compounds, and that measurements are not reliable in the presence of alcohol or essential oils.³⁷

The 'Electronic Nose' is a handheld device, developed to rapidly classify the chemicals in unidentified vapor.³⁸ It has the potential to be used as a diagnostic tool to detect odors.³⁸

Attempts have also been made to measure oral malodor using indirect methods, such as cultures of bacterial isolates, direct bacterial smears, and detection of periodontal pathogens using BANA hydrolysis.³⁹ BANA test is used chairside to determine the proteolytic activity of certain oral anaerobes that contribute to oral malodor.³⁹ Samples of plaque or tongue scrapings are incubated with N - benzoyl - DL - arginine - naphthylamide (BANA), which is a synthetic trypsin substrate.^{16,22} If the organisms have enzymes that degrade BANA, a colored compound is produced within roughly 5 minutes to 15 minutes that indicates a positive BANA test.²⁹ This test may be useful for patient education.^{16,39}

Indices were developed to compare the severity of oral malodor with the extent of coating on the tongue.^{8,5} The Winkel Tongue Coating Index (WTCI) divided the dorsal surface of the tongue into sextants, 3 in the posterior and 3 in the anterior part of the tongue. (Scoring criteria: 0-no coating, 1-presence of light coating, 2-presence of a distinct coating.) The resulting WTCI is obtained by adding all 6 scores.⁸ A greater thickness/extension of tongue coating was assumed to be associated with increased oral malodor. The Miyazaki Index was used to assess the efficacy of various treatment procedures in reducing oral malodor by reducing the coating on the tongue.⁵ A single score for the entire tongue, as well as score per area (anterior and posterior to the sulcus terminalis, each region further divided into left and right sides) is given. The scores ranged from 0 to 3. (0-no coating, 1- < 1/3, 2- < 2/3, and 3- > 2/3 of the surface coated)⁵

Treatment of Oral Malodor

Oral malodor is a multifactorial problem that requires a well-defined approach to diagnosis and treatment. Identification of the major and minor contributing factors and institution of appropriate measures is essential for successful treatment.²⁹ A thorough medical, dental, and halitosis history is necessary to determine whether the patient's complaint of bad breath is due to oral causes or not. If it is determined that the source of malodor is not in the oral cavity, the patient should be referred to a physician for further treatment.^{22,40}

The simplest way to distinguish oral from nonoral etiologies is to compare the smell coming from the patient's mouth with that exiting the nose.³ If the odor is primarily from the mouth, an oral origin may be inferred.³ The first step in treating oral malodor is to assess all oral diseases and conditions that may contribute to oral malodor, including large carious lesions.²⁹

For disease-free people, the aim of treatment is to reduce the overgrowth of microorganisms in the oral cavity, with concomitant reduction in the formation of volatile compounds.⁴⁰ This may be accomplished by mechanical or chemical methods.⁸ Mechanical reduction⁴¹ of microorganisms through improved oral hygiene procedures, both professional and personal, has been associated with reduced oral malodor.^{7,42,43} All patients should be instructed in proper toothbrushing, flossing, use of interdental aids, and tongue cleaning.

The dorso-posterior surface of the tongue has been identified as the principal location for the intra oral generation of volatile sulfur compounds (VSCs).²⁴ Fissures and crypts of the tongue harbor large amounts of *Porphyromonas gingivalis*, *P. intermedia*, spirochetes, etc.¹⁶ These surface irregularities protect the bacteria from the flushing action of saliva and possess low oxygen levels, which facilitate their growth.²⁶ This is an excellent putrefactive habitat for gram-negative anaerobes that metabolize proteins as an energy source.⁴⁴ The bacteria hydrolyze the proteins to amino acids containing sulfur functional groups, which are the precursors to volatile sulfur compounds.⁸

Brushing the tongue significantly reduced concentrations of VSCs, such as methyl mercaptan, and to a lesser extent, hydrogen sulfide.⁴⁵ Some papers suggest a significant reduction in bacterial load^{46,47} in contrast to others, which showed that bacterial load on the tongue was not influenced by intense periodontal therapy including tongue brushing.²⁶ The

beneficial effect of tongue cleaning on oral malodor is therefore primarily related to the removal of the substratum for bacteria, and not to the reduction of the bacterial load.⁴⁴ Taste sensation also improved by removing the thick layer of tongue coating.⁴⁴ Hence, cleaning the tongue is a very effective measure for improving physiologic halitosis.

Use of either a toothbrush or scraper for tongue cleaning is debatable. People, generally, accept a brush to clean the tongue because it does not require an additional tool.⁴⁸ The toothbrush bristles sweep between papillae and remove microorganisms reducing malodor effectively.⁴² Various scrapers were examined for reduction of VSCs following tongue cleaning.⁴⁹ All the scrapers were found to be less effective than tongue brushing.⁴⁹ However, plastic loop scrapers resulted in less gagging and more comfort.⁴⁴ Pedrazzi et al compared the tongue cleaning efficacy of a tongue scraper and soft bristle toothbrush. The tongue scraper showed a 75% reduction in VSCs while the toothbrush only achieved a 45% reduction in VSCs. Patients complained of nausea and tongue mucosal trauma with the toothbrush.⁷ In another study, hemoglobin was detected in saliva after 3 brush strokes among subjects who brushed the dorsal surface of their tongues with a regular toothbrush and 100g force.⁵⁰ The results indicated that use of a regular toothbrush could damage the dorsal tongue and cause microbleeding.⁵⁰ An infant toothbrush would thus be more appropriate.⁵¹

Tongue cleaning is best done before going to bed, because scraping early during the day may induce retching.¹⁰ It must be performed gently in order to remove the mucous and lightly bound debris without doing any damage to the tongue itself.¹⁰ Patients with psychological conditions may overzealously scrape or brush the tongue till bleeding starts.⁵¹ It is important to demonstrate to patients the position of the terminal sulcus of the tongue and the anatomical limits for cleaning.⁵¹ Patients should be instructed to brush from the terminal sulcus to the front of the tongue.⁵² Cleaning the tongue before brushing or asking the patient to momentarily stop breathing may prevent a gag reflex.⁵²

Treatment of periodontal disease⁵³ and improved oral hygiene measures⁴¹ can reduce malodor considerably. It is imperative to correct overhanging restorations and treat deep periodontal pockets for maintenance of periodontal health.³ Scaling and root planing procedures can be effective for patients with periodontitis.⁵³ Scaling and root planing of all pockets in combination with chlorhexidine irrigation resulted in dramatic improvement in the organoleptic malodor ratings.²⁶ This one-stage, full-mouth disinfection resulted in significant improvement when compared to a fractionated periodontal therapy.²⁶

Various chemical plaque control agents have been used as a supplement to combat oral malodor. Chlorhexidine digluconate^{54,55, 56} is useful in decreasing plaque and gingivitis and therefore has shown significant improvement in reducing oral malodor when compared to periodontal therapy alone. Reduced breath odor with significant reduction in microbial load could be observed only when mechanical therapy was combined with chlorhexidine or chlorhexidine-CPC mouthrinsing.⁴³ Mechanical debridement and improved plaque control alone resulted in minor reduction in anerobic species.⁴³ However, routine use of chlorhexidine is discouraged because of reported side effects.⁵⁷

The use of zinc rinses has also been recommended.⁵¹ VSCs are inactivated and converted into non malodorous compounds by formation of zinc salts.^{35,8,58,59} A zinc containing mouthwash reduced VSCs by 80% to 90% for 3 hours after rinsing.⁶⁰ Baking soda^{61,62} and/or zinc-containing toothpastes greatly reduced VSCs in mouth air.^{61,62} Chlorine dioxide mouthrinse eliminates odorogenic microorganisms.^{10,45,63,64} Commercially available mouthrinses contain sodium chlorite since chlorine dioxide readily loses its activity.⁵⁸ Other antiseptics, such as triclosan rinses,¹⁰ cetylpyridinium chloride,⁸ essential oils,³⁷ and hydrogen peroxide,⁶⁵ have also been tried. Hydrogen peroxide mouthwash was effective in reducing oral malodor, but its oxidative activity may be harmful to the oral soft tissues.⁵¹ Oral rinsing with 3% hydrogen peroxide produced impressive reductions in three breath sulfur gases, which persisted for 8 hours.⁴⁵ A combined zinc and triclosan rinse had a cumulative effect reducing malodor, which increased with duration of the product use.⁵⁸

Certain lozenges,⁶⁶ chewing gums and mints, toothpastes, and breath strips have been reported to reduce tongue dorsum malodor. Seventy percent of people who are concerned with halitosis use chewing gum in order to reduce their malodor.⁶⁷ Chewing gum increases salivation and thus oral cleanliness.^{1,10} Chewing gum containing sugar was shown to reduce VSCs in mouth air by altering the pH of the oral cavity.¹³ Mint did not change the concentration of methyl mercaptan, and sugarless chewing gum increased it slightly.⁵² Gum has only short-term effects, masking halitosis with its flavors.⁶⁸

The use of probiotics to suppress oral malodor is now being recognized. Probiotics, as defined by the Food and Agriculture Organization (FAO), are live microorganisms administered in adequate amounts that confer a beneficial health effect on the host.⁶⁹ Kazor et al compared the bacterial populations on the dorsal surface of the tongue in healthy subjects and people with halitosis.⁷⁰ *Streptococcus salivarius* was found to be the predominant species in healthy subjects, but was typically at low levels or absent in those subjects suffering from halitosis.⁷⁰ Hence, probiotic bacteria may have potential application as adjuncts for the prevention and treatment of halitosis.⁷¹

Other methods of managing malodor include chewing parsley, mint, cloves, or fennel seeds.^{1,10} Some herbs like alfalfa, cardamom, chamomile, myrrh, rosemary, and sage are also known to reduce halitosis.¹⁰

Since bad breath is worse when the mouth dries out, patients should be encouraged to drink ample amounts of water.³ Salivary stimulation or use of saliva substitutes, nasal mucous control methods, avoidance of odoriferous foods, and the medical management of systemic diseases have also been recommended as measures to control halitosis.¹⁰

Role of the Dental Hygienist

Oral hygiene care as provided by the dental hygienist becomes an integral part of the total care of the patient.⁷² The dental hygienist may be responsible for recording information for use in diagnosis and treatment planning and for comparison during continuing care evaluations. Early recognition of lesions may prevent the development of conditions favoring malodor. Specific clinical procedures, such as oral prophylaxis, scaling and root planing, correction of overhangs, and temporary restorations can aid in eliminating areas where food debris and plaque are retained, thereby preventing halitosis. In conjunction with these specific clinical procedures, the dental hygienist provides instructions and supervises the patient in assuming plaque control measures. They assist in motivating the patient to develop adequate habits for personal oral care. They may demonstrate the use of proper brushing technique, tongue cleaning, and method of flossing or even assist the patient in selecting a suitable toothbrush or interdental device. The dental hygienist has the best opportunity to communicate and educate the patient regarding avoidance of smoking, odoriferous foods, such as onions, garlic, cabbage, and radishes. Patients with halitophobia need counseling, which will help them achieve self confidence.

Patients debilitated from medical illnesses such as arthritis, dementia, stroke, or other neurologic disorders may not be able to brush and floss properly.⁷³ Regressive changes in the salivary glands affect the quantity and quality of saliva in the elderly.⁷⁴ Therefore, oral malodor is also of concern for the chronically ill, handicapped, or elderly patients.^{73,74} In these situations, dental hygiene techniques can be performed effectively at the bedside with manual instruments and powered toothbrushes. The vast array of chemical plaque control agents may also be used.

Conclusions

Oral malodor or feter ex ore is a foul or offensive odor emanating from the mouth and is a frequent cause for patients to seek treatment. Dental hygienists will likely encounter patients who approach them with this problem.

Intraoral and extraoral factors have been attributed to halitosis. In most cases bad breath originates from the oral cavity itself. Poor oral hygiene, periodontal pockets, faulty restorations, dry sockets, unclean dentures and abscesses are often overlooked as potential sources of volatile sulfur compounds (VSCs).^{3,10} VSCs result from proteolytic degradation by

anaerobic oral microorganisms found abundantly in periodontal pockets and on the surface of the tongue.^{22,29} A variety of methods like organoleptic assessment, gas chromatography, and sulfide monitoring have been used to assess oral malodor.¹⁹

To date, no specific treatment modality has shown consistent results in all cases because of the varied causes for oral malodor. Research is still underway to find a cure for this socially embarrassing problem. In most cases, good professional oral care combined with a daily regimen of oral hygiene, including interdental cleaning, tongue cleaning, and the optional use of a mouthrinse, can lead to improvement. Patient education about oral hygiene practices is crucial for treatment to be effective. Patient assistance and adequate oral health instructions by the dental hygienist can motivate patients to develop a greater interest in maintaining oral health. With increasing demand for dental care, and with continuing advances in dental education and research, there may be a greater potential for the dental hygienist to play a prominent role in the prevention and control of oral malodor.

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Notes

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