Unmasking Oral Malodor: A Review

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Abstract:

Oral malodor is one of the major growing concern of patients today as it is fundamental to their overall personality. Although the majority of malodor is of oral origin, there are multiple other systemic causes that have to be addressed. Correct diagnosis of the cause of the malodor and prompt treatment can render the patient satisfied. There have been newer developments in faster and more efficient detection of the levels of malodor, and an array of treatment options are present in the market today. It is crucial for the dentist to have a sound understanding of this prevalent oral condition and provide effective intervention programs. This article reviews the various causes and the diagnostic modalities which will help us treat this multifaceted condition.

Key Words: Halitosis, Periodontal disease, Volatile sulphur compounds, Oral malodor.

Introduction:

In today’s era, the way a person is perceived is the way he presents himself. Halitosis is a matter of concern for many individuals who want to be presentable among his peers and in the social arena. Humans emit a variety of volatile and nonvolatile molecules that are influenced by genetics, diet, stress and disease (Whittle et al, 2007). The word halitosis is derived from the Latin word halitus, which means exhalation. Halitosis can be defined as any disagreeable odor in expired air, regardless of whether the odorous substances originate from oral or non-oral sources (Tangerman, 2002). Fetor ex ore, fetor oris and stomatodysodia (dysodia in Greek refers to stench), are other terms that have been used in the literature to describe halitosis (Ongole & Shenoy, 2010).

Epidemiology:

Halitosis is common and can affect people of all ages. The prevalence of persistent oral malodor in a Brazilian study was reported to be 15%, was nearly three times higher in men than in women (regardless of age). The risk was slightly more than three times higher in people over 20 years of age compared with those aged 20 years or under, controlling for gender (Tessier & Kulkarni, 1991). The large majority of studies report that about 30% of people have halitosis but some studies estimate that more than 50% of the population has halitosis (Nadanovsky et al, 2007).

Classification:

I. True Halitosis:

A. Physiologic (Transient or Temporary): Halitosis caused by dietary components, deleterious habits, Morning breath and Secondary to xerostomia caused by physiologic factors.

B. Pathologic: Secondary to pathologic conditions or oral tissues like gingival and periodontal diseases like Acute Necrotizing Ulcerative Gingivitis; Residual post-operative blood; Debris under dental appliances; Ulcerative lesions of the oral cavity; Halitosis associated with coated tongue; due to xerostomia secondary to salivary gland diseases and Tonsilloliths.

II. False Halitosis or Halitophobia

Etiology:

Physiological halitosis: Morning halitosis, Oral malodor is common on awakening (morning breath), and is transient and rarely of any special significance. It may be because of increased microbial metabolic activity during sleep that is aggravated by a physiological reduction in salivary flow, lack of nocturnal physiologic oral cleansing (e.g. movement of the facial and oral muscles) and variable oral hygiene procedures prior to sleep. Starvation can lead to a similar malodor. These
forms of oral malodor can be readily rectified by eating, oral cleansing and rinsing the mouth with fresh water (Faveri et al., 2006).

**Pathological halitosis:**

(a) **Intraoral causes:**

There are various factors that have been implicated in causing halitosis. These include causes due to the dentition, periodontal infections, xerostomia, tongue and its coating.

(i). **Dentition:** Possible causes with the dentition are deep carious lesions with food impaction and putrefaction, extraction wounds filled with blood clot, and purulent discharge leading to putrefaction. Interdental food impaction in large interdental areas and crowding of teeth favour food entrapment and accumulation of debris. Acrylic dentures, especially when kept in the mouth at night and not regularly cleaned, can also produce a typical smell associated with candidiasis. The denture surface facing the gingival is porous and retentive for bacteria, yeasts, debris, and all factors that cause putrefaction.

(ii) **Periodontal infections:** Some scientific studies conducted during the past 50 years have shown that periodontal disease causes offensive odour. Elevated concentrations of volatile sulphur compounds (VSC) occur frequently in mouth air of patients with periodontal disease. Tonzetich (1978) demonstrated that the VSC concentration in mouth air increased with the pocket depth, and he found using gas chromatography method that he developed, that it was higher in patients with probing depths of 4 mm or more than in subjects with probing depths of less than 4 mm. In particular, the methyl mercaptan concentration was significantly higher in patients with periodontal disease than in controls. Volatile sulphur compounds increase the permeability of the oral mucosa and collagen solubility and decrease protein or collagen synthesis and thus must be considered to be involved in the pathogenesis of periodontal disease.

(iii) **Microflora associated with halitosis:** It is probably the microbial load that best predicts the total levels of biotransforming enzymes and microenvironments found in the mouth. However, it is clear that anaerobes and anaerobic environments are an important feature of biogenesis. The principle bacteria that are implicated in the creation of oral malodor include *Fusobacterium nucleatum, Prevotella intermedia* and *Tannerella forsythensis*. Other bacteria that have been implicated in the production of volatile sulphur compounds include *Prophyromonas gingivalis, Porphyromonas endodontalis, Treponema denticola, Aggregatibacter actinomycetemcomitans, Atopobium parvulum, Campylobacter rectus, Desulfovibrio species, Eikenella corroden*, *Eubacterium sulci, Fusobacterium species* and *Peptostreptococcus micros*. Isolates of *Klebsiella* and *Enterobacter* is reported to have emitted foul odors in vitro which resembled bad breath in denture wearers. These gram-negative proteolytic anaerobes are located in the relatively stagnant areas of the mouth, such as periodontal pockets, posterior dorsal surface of the tongue, and interdental regions (DeBoever & Loesche, 1995).

(iv) **Coating of the tongue:** is an important factor for oral malodor (80-90%) cases (Ongole & Shenoy, 2010). There is a relationship between bacterial numbers on the tongue (as measured by determining the colony-forming units per square centimeter) and oral malodor, so it does appear that the load of microbes per mouth (i.e. the thickness or aerial density of biofilms) is the most important feature of chronic oral malodor, rather than the presence or absence of specific microbial agent. Bosy et al (1999) suggested that individuals with history of oesophageal reflux disease and post nasal drip, predispose to build up of a substrate on the dorsal surface of the tongue. The papillae of the tongue, crevices associated with mucous glands and lingual tonsils increase the accumulation of bacteria and exfoliated epithelial cells. Deposits on teeth and periodontal diseases like acute necrotising ulcerative gingivitis can also contribute to oral malodor (Christensen, 1998).

(v) **Other oral causes:** Other relevant malodorous pathologic manifestations of the periodontium are pericoronitis, major recurrent oral ulcerations, herpetic gingivitis, and necrotizing gingivitis and periodontitis. Microbiologic observations indicate that ulcers infected with gram negative anaerobes (i.e., Prevotella and Porphyromonas species) are significantly more malodorous than non-infected ulcers.

(b) **Extraoral causes:**

Respiratory tract diseases (lung abscesses, necrotizing pneumonia and carcinomas of the
respiratory tract) can cause the breakdown of tissue leading to the production of volatile sulphur compounds. Other associated respiratory diseases like tonsillitis and postnasal drip caused by nasal infections, sinusitis or nasal polyps produce oral halitosis.

Liver disease can produce a variety of aromatic compounds, such as H$_2$S, aliphatic acids, CH$_3$SH, ethanethiol and (CH$_3$)$_2$S. Hepatic cirrhosis will produce a characteristic musty or 'mousey' odor (Feller & Blignaut, 2005).

Uremia that is caused by kidney failure also produces (CH$_3$)$_3$N along with dimethylamine. These individuals present with uremic breath having ammoniacal odour (Goldberg et al, 1997; Greenman et al, 2005). Patients with uncontrolled diabetes mellitus (diabetic ketoacidosis) can emit ketonic breath (also described as sweet 'fruity' smell or rotten apple breath), which is caused by a metabolic disturbance leading to the production of acetones and other ketones.

**Diagnosis:** Oral malodor can be assessed using direct and indirect methods.

1) **Direct methods**

a) Organoleptic Method:

Organoleptic measurement can be carried out by sniffing the patient’s breath and grading the level of halitosis. Though this technique is crude in nature, it is still the most reliable technique for assessing the level of oral halitosis. Assessment of oral halitosis should be carried out on two or three occasions for a reasonably accurate diagnosis. Smelling both nose and mouth air is important as malodor detectable from the nose alone (asking the patient to breathe while the mouth is closed) is likely to come from the nose or the sinuses, or from respiratory or gastrointestinal tracts. For purposes of fine quantification (for example, in clinical trials of the efficacy of antimalodor compounds), it has been suggested that organoleptic assessments should be performed by two or more different examiners. As a general rule in clinical practice, it is advisable that the patient abstains from eating odiferous foods for 48 hours before the assessment and that both the patient and the examiner refrain from drinking coffee, tea or juice, smoking and using scented cosmetics before the assessment (Ongole & Shenoy, 2010).

The organoleptic evaluation of oral malodor also includes other simple tests such as tongue odor test, dental floss odor test and saliva odor test.

<table>
<thead>
<tr>
<th>Rating</th>
<th>Odor Intensity</th>
</tr>
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<tbody>
<tr>
<td>Odor cannot be detected</td>
<td>0</td>
</tr>
<tr>
<td>Questionable malodor, barely detectable</td>
<td>1</td>
</tr>
<tr>
<td>Slight malodor, exceeds the threshold of malodor recognition</td>
<td>2</td>
</tr>
<tr>
<td>Malodor is definitely detected</td>
<td>3</td>
</tr>
<tr>
<td>Strong malodor</td>
<td>4</td>
</tr>
<tr>
<td>Very strong malodor</td>
<td>5</td>
</tr>
</tbody>
</table>

Table 1: Organoleptic intensity scale (based on Rosenberg & McCulloh, 1992).

(i) **Spoon test:** The spoon test is used to assess halitosis originating from the posterior part of the dorsum of the tongue. A sterile plastic spoon is used to scrape the dorsum of the tongue. After about 5 seconds, the odor from the contents of the spoon is assessed, holding the spoon about 5cms away from the nose.

(ii) **Dental floss odour test:** This test is used to assess the odour originating from the interdental regions. The examiner passes a sufficient length of unwaxed floss through the interdental regions of posterior teeth. The odour is assessed by holding the floss about 3 cms from the nose.

(iii) **Saliva odour test:** The patient is instructed to expectorate about 1-2ml of saliva into a glass tube. The tube is covered immediately and incubated at 37°C for five minutes. The glass tube is then held about 4 cms away from the nose for assessing odor.

b) **Gas Chromatography:**

Gas chromatography is considered by many researches to be the method of choice for differentiating and quantifying the volatile sulphur compounds and (especially, if it runs with a Mass Spectrometry Detector). It can also distinguish other classes of compound (e.g. indole). Traditional laboratory gas chromatography or gas chromatography–mass spectrometry are cumbersome, need inert column carrier gas (gas cylinders of nitrogen or helium) and require technicians or specialists with adequate training, and are thus clinically impractical (Scully & Greenman, 2008). However, a newly developed portable gas chromatograph (Oral Chroma TM, Abimedical, Osaka) has now been described, which does not use a special carrier gas (using air instead) and is highly sensitive yet relatively low cost compared with a standard gas chromatograph (Scully & Greenman, 2008).
c) Sulphide Monitors:

Sulphide monitor is a portable chair side equipment, that can assess oral malodor; these monitors are cost effective and commercially marketed as Halimeter® (Interscan, Chatsworth, California). The monitor is equipped with an electrochemical sensor. The patient is asked to exhale into a transparent tube that carries the breath to a suction pump which in turn carries the air to the monitor as shown in the figure below (Rosenberg et al, 1991; Fig. I). These monitors analyze the total sulphur content of the individuals’ breath but cannot differentiate between various sulfides. The instrument measures parts per billion levels of hydrogen sulfide and, to a lesser extent, methyl mercaptan. A measurement is taken once a peak reading has been reached.

Values:
- Less than 100 is normal,
- 100 to 180 is minor halitosis &
- Greater than 250 is chronic halitosis.

There may be false positive results due to other volatile vapours, such as acetone, ethanol, and methanol that do not contribute to oral halitosis.

d) Electronic nose:

The FF-1 odour discrimination analyzer (Electronic nose, Shimadzu Corporation) was used by Tanaka et al (2004). The set up comprised of a pre-concentrator, an array of 6 metal oxide semiconductor sensors selected for their different sensitivities and selectivity’s to fragrant substances, and a pattern recognition software. The instrument can be set to various modes such as the “all note measurement mode” which is the standard setting used for measuring all volatile substances and the “top note measurement mode” which primarily measures volatile substances with a low boiling point. The results of their preliminary study showed that main compounds related to oral malodor were volatile substances with a low boiling point (Mantini et al, 2000).

e) Dark field/phase contrast microscopy:

Gingivitis and periodontitis are typically associated with a higher incidence of motile organisms and spirochetes, so shifts in these proportions allow monitoring of therapeutic progress. Another advantage of direct microscopy is that the patient becomes aware of bacteria present in plaque, tongue coating, and saliva. High proportion of spirochetes in plaque has been associated with a specific acidic malodor (Quirynen & vanSteemberghe, 2006).

2) Indirect methods:

Bacterial culture, smears and enzyme assays are indirect methods of assessing oral halitosis. These methods will help in the identification of organisms that produce oral malodor. One such technique is (Benzoyl-DL-arginine naphthylamide) BANA test.

Benzoyl-DL-arginine naphthylamide test is a chair side investigation that assesses the proteolytic activity of anaerobic bacteria. It is a rapid chair side test for evaluation of non-sulfurous malodorous compounds.

To detect malodor, the tongue or inter dental region is wiped with a cotton swab. The sample is placed on the BANA test strip, which is then inserted into a slot on a small toaster-sized incubator as shown in the figure below (Kozlovsky et al, 1994; Fig. II). The incubator automatically heats the sample to 55°C for 5 minutes. If P. gingivalis, B. forsythus or T. denticola is present, the test strip turns blue. The bluer it turns, the higher the concentration and the greater the number of organisms. A color guide is printed on the container. It can also be used to evaluate the prognosis of the condition.

Pseudohalitosis

During diagnosis if no malodor can be found during the initial examination, the assessment for halitosis should be repeated on two or three different days. Thereafter, if halitosis is still not present, the patient can be considered to be affected by imaginary (pseudo-halitosis), which can be supported by established questionnaires. Experienced and intuitive
clinicians are well placed to suspect imaginary (pseudo-halitosis) at an early stage of the assessment. In general, such person may have obsessive behaviour or depression or phobic anxiety or paranoid ideation or have less social interaction and may have wrong interpretation of people’s actions as an indication that their breath is offensive (e.g. opening windows, covering their nose).

Newer developments in diagnosis:

There are many other portable VSC monitors that are compact and relatively inexpensive. As the mouth air is expired, the devices measure the amount of VSCs, regardless of type, and continue to provide a value in the diagnosis. Some of the VSC monitor are; Tanita breath alert, Osmoscope, Halimeter and diamond probe. Another chair side test kit (Halitox reagent kit) measures the halitosis linked toxins. It is quick, simple colorimetric test that detects both volatile sulphur compounds as well as polyamines (Vandana & Sridhar, 2008). In a recent study, Mathew & Vandana (2006) using Tanita breath alert, BANA and Halitox reagent kit, have shown that Tanita breath alert can be a useful tool in self assessment of malodor, but it is currently not available in India.

The diamond probe/Perio 2000 system is a dental device designed to detect sulphide concentration of various forms (S, HS, H₂S and CH₃SH) in gingival sulci. The system combines a conventional Michigan “O” Probe style dental probe with a sulphide sensor, which measures probing depth, bleeding on probing and sulphide levels. The micro-sulphide sensor responds to sulphide ions and measures metabolic products of many anaerobic bacteria and, indirectly bacterial activity. The reaction of the sulphide ions with the sensor generates a measurable voltage that is proportional to the sulphide concentration. Since sulphides are continually cleared from the pockets by crevicular fluid flow, the presence of high sulphide levels indicates a higher level of anaerobic bacterial activity (Zhou et al, 2004). The Research model of the Diamond Probe system was used according to manufacturer’s instructions. The probe tip was gently inserted into the base of the gingival sulcus and moved along with light pressure. As the probe moved along the sulcus, the three parameters were recorded. If the presence of sulphide was indicated above threshold (>0.5), the light on the front of the display panel would change colours depending on sulphide concentrations and an audible tone would sound (Zhou et al, 2004).

Treatment:

After a positive diagnosis for oral halitosis has been made, the treatment plan is implemented, which comprises the elimination of the causative agent and the improvement of the oral health status.

Oral prophylactic procedures such as supra and sub gingival scaling and elimination of periodontal pockets should be undertaken (Miyazaki et al, 1999; Porter & Scully, 2006). Carious teeth have to be restored. Teeth with periapical pathology should be endodontically treated. Abscesses of acute nature should be managed by using appropriate antibiotics.

Avoiding smoking, drugs and foods that might be responsible for halitosis is required. In addition, chewing gum, parsley, mint, cloves or fennel seeds, and the use of proprietary fresh breath preparations, may help. Cosmetic nonpharmacological methods, such as chewing gums, mints, flavored sprays, lozenges and some mouth rinses, however, merely provide a competing and temporary smell that may mask the unfavourable odor. Since dry-mouth can increase bacterial buildup and can cause or worsen bad breath, chewing sugarless gum can help in the production of saliva, and thereby help to reduce bad breath. Chewing may help particularly when the mouth is dry, or when one cannot perform oral hygiene procedures after meals (especially those meals rich in protein). This increases saliva, production, which washes away oral bacteria, has antibacterial properties and promotes
mechanical activity which helps further in cleaning the mouth. Some chewing gums contain special anti-odor ingredients. Chewing fennel seeds, cinnamon sticks, mastic gum, or fresh parsley are common folk remedies.

Mouthwashes can be used for many preventative and therapeutic purposes (West & Moran, 2008). Mouthwashes containing chlorhexidine gluconate, ceptlypyridinium chloride or triclosan, a two-phase oil:water mouthwash, may be beneficial (Scull & Greenman, 2008). Good short-term results have been reported with chlorhexidine, essential oils and ceptlypyridinium chloride for up to 2 or 3 h. Metal ions and oxidizing agents, such as hydrogen peroxide, chlorine dioxide and iminium chloride, can actively neutralize volatile sulfur compounds. Zinc seems to be an effective and safe metal at concentrations of at least 1%; at present, a combination of low concentrations of zinc and chlorhexidine seems to be the most efficient way to remove the volatile sulfur compound that causes bad breath (Tharne et al, 2007). Toothpastes containing triclosan and a copolymer provide effective control of breath odor at 12 h after brushing the teeth (Sharma et al, 2007). There is significant, immediate antimalodor activity also for a 0.454% stabilized SnF2 sodium hexametaphosphate dentifrice (Farrell, 2007). The first active ingredient of Anti Halitosis Mouthwash (AHM) is highly oxidizing sodium chloride (600 ppm of chlorite ion) which oxidizes the sulfides of the VSC’s to non-odorous sulfates and raises the oxidation/reduction ratio of the saliva toward the more oxidizing state. Chlorine dioxide as a mouth rinse neutralizes volatile sulfur compounds in mouth air. One study demonstrates that a one time use of a chlorine dioxide-containing mouthrinse significantly improves mouth odor pleasantness and reduces mouth odor intensity for at least 4 hours (Frascella et al, 1998).

In recalcitrant cases, the specialist empirically may use a 1-week course of metronidazole (200 mg three times daily) in an effort to eliminate unidentified anaerobic infections; metronidazole may reduce tongue microbiota and odor levels (Hartley et al, 1999).

**Conclusion:**

This review gives an overall insight into the various aspects of malodour. As halitosis is a common complaint of the patient and is a cause of distress, a thorough knowledge and its clinical application becomes mandatory. It is important for a practitioner to address this problem in the overall maintenance of oral health.

**Bibliography:**