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Halitozis: Tanı ve Tedavide Güncel Yaklaşımlar

Halitosis: Current Approaches in Diagnosis and Treatment

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Özet

Araştırmanın Amacı ve Önemi: Halitozis, sadece biyolojik bir sorun değil, bireyin yaşam kalitesini, algısını ve sosyal iletişimini olumsuz etkileyen multidisipliner bir durumdur. Bu çalışmanın amacı; halitozisin etiyolojik faktörlerini (ağız içi ve ağız dışı), mikrobiyolojik mekanizmalarını, güncel tanı araçlarını ve tedavi yaklaşımlarını sistematik olarak değerlendirmektir. Özellikle psödohalitozis ve halitofobi gibi durumların ayırt edilerek kliniklerde gereksiz tedavi süreçlerinin önüne geçilmesi hedeflenmektedir.

Gereç ve Yöntem Çalışma: PRISMA (Sistematik İncelemeler ve Meta-Analizler için Tercih Edilen Raporlama Ögeleri) yöntemine uygun olarak tasarlanmış bir sistematik derlemedir. PubMed, Scopus ve Web of Science veri tabanları; "halitosis", "VSC", "etiology" ve "diagnosis" gibi anahtar kelimelerle taranmıştır. Tarama sonucunda belirlenen 1.452 makaleden, dahil edilme kriterlerini karşılayan 118 çalışma bilimsel analiz için seçilmiştir. Veriler; etiyoloji, tanı, mikrobiyoloji ve tedavi temaları altında gruplandırılarak anlatımsal (betimsel) sentez yöntemiyle analiz edilmiştir.

Bulgular: Etiyoloji: Vakaların %80-90'ının ağız içi kaynaklı olduğu ve en önemli faktörün dil kaplaması olduğu saptanmıştır. Ekstraoral nedenler (%10-20) arasında diyabet (aseton kokusu), böbrek yetmezliği (amonyak kokusu), karaciğer bozuklukları ve solunum yolu enfeksiyonları yer almaktadır.

Tanı yöntemlerinde organoleptik ölçüm (klinisyen değerlendirmesi) düşük maliyeti ve gerçek algıyı yansıtması nedeniyle hala "altın standart" kabul edilmektedir. Ancak, objektifliği artırmak için gaz kromatografisi, yapay zeka destekli elektronik burunlar, otofloresan görüntüleme (QLF-D) ve akıllı yutulabilir kapsül sensörleri gibi yeni teknolojiler öne çıkmaktadır.

Halitozisin tedavisinde mekanik dil temizliği ve plak kontrolü temel stratejidir. Kimyasal ajanlar arasında Kalay Florür (SnF_2) içerikli macunların sabah ağız kokusunu azaltmada etkili olduğu gösterilmiştir. Ayrıca probiyotikler ve lazer tedavileri de potansiyel seçenekler arasındadır.

Sonuç: Halitozis yönetimi, "tek faktör - tek tedavi" anlayışıyla yürütülemez; bütüncül bir strateji gerektirir. Başarılı bir klinik yönetim için standart tanı araçları, etiyolojiye yönelik mekanik ve kimyasal yöntemler ile hastanın psikososyal durumunun (anksiyete, özgüven kaybı vb.) birlikte değerlendirilmesi esastır. Tanı sürecinde anamnez, klinik muayene ve cihaz ölçümlerinden oluşan üçlü yaklaşım en güvenilir yoldur.

Anahtar Kelimeler: Halitozis, uçucu sülfür bileşikleri, dil kaplanması, organoleptik değerlendirme, periodontal hastalık.

JEL Kodları: I10; I12; I19

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Abstract

Aim and Significance of the Study: Halitosis is not merely a biological problem; it is a multidisciplinary condition that can negatively affect an individual's quality of life, self-perception, and social communication. The aim of this study is to systematically evaluate the etiological factors of halitosis (intraoral and extraoral), its microbiological mechanisms, current diagnostic tools, and treatment approaches. In particular, the study seeks to distinguish conditions such as pseudohalitosis and halitophobia in order to prevent unnecessary treatment processes in clinical practice.

Materials and Methods: This study is a systematic review designed in accordance with PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses). PubMed, Scopus, and Web of Science databases were searched using keywords such as "halitosis," "VSC," "etiology," and "diagnosis." From 1,452 identified articles, 118 studies meeting the inclusion criteria were selected for scientific analysis. Data were grouped under the themes of etiology, diagnosis, microbiology, and treatment, and were analyzed using a narrative (descriptive) synthesis approach.

Results: Etiology: It was determined that 80–90% of cases are of intraoral origin, with tongue coating identified as the most important contributing factor. Extraoral causes (10–20%) include diabetes (acetone-like odor), renal failure (ammonia-like odor), liver disorders, and respiratory tract infections.

Diagnostic Approaches: Organoleptic assessment (clinician-based evaluation) is still considered the "gold standard" due to its low cost and its ability to reflect real-life perception. However, to improve objectivity, newer technologies have become increasingly prominent, including gas chromatography, AI-supported electronic noses, autofluorescence imaging (QLF-D), and smart ingestible capsule sensors.

Treatment: Mechanical tongue cleaning and plaque control remain the cornerstone strategies in halitosis management. Among chemical agents, toothpastes containing stannous fluoride (SnF_2) have been shown to be effective in reducing morning oral malodor. In addition, probiotics and laser therapies are considered potential adjunctive treatment options.

Conclusion: Halitosis management cannot be approached with a "single factor–single treatment" mindset; instead, it requires a comprehensive strategy. Successful clinical management relies on standardized diagnostic tools, etiology-oriented mechanical and chemical methods, and simultaneous evaluation of the patient's psychosocial status (e.g., anxiety, loss of self-confidence). In the diagnostic process, a three-part approach consisting of anamnesis, clinical examination, and device-based measurements represents the most reliable pathway.

Keywords: Halitosis, volatile sulfur compounds, tongue coating, organoleptic assessment, periodontal disease.

JEL Codes: I10; I12; I19

Introduction

Halitosis is defined as the perception of the odor in a person's breath by the environment at a "socially unacceptable" level, and it should be considered not only as a biological problem but also as a condition that can affect the person's communication, self-perception, and quality of life (Aylikci et al., 2013; Wu et al., 2020). The most common presentation in patients who come to the clinic due to halitosis is halitosis caused by intraoral factors; however, halitosis may also be seen due to extraoral causes such as upper/lower respiratory tract pathologies, gastrointestinal diseases, certain metabolic disorders (such as kidney, liver, or dry mouth), systemic diseases such as diabetes, and medications. (Tangerman, 2002; van den Broek et al., 2007).

Studies on the biological aspect of halitosis started in the late 1970s and, in Tonzetich's study (1977), it was emphasized that volatile sulfur compounds (VSC) such as hydrogen sulfide, methyl mercaptan and dimethyl sulfide emerge from the breakdown of protein residues in the oral cavity by anaerobic microorganisms. This concept still remains current today; in particular, due to the papillary surface of the tongue dorsum being indented, protruded and having retentive niches, it causes deposits and shed cells to accumulate easily. This accumulation contributes to VSC production by anaerobic bacteria.

The biochemical basis of halitosis arises from the production of VSCs (especially hydrogen sulfide and methyl mercaptan) by the breakdown of organic substrates by intraoral microorganisms, and in this process the biofilm on the tongue dorsum, periodontal pockets and retention areas play a critical role (Persson et al., 1990; Loesche, 2003; Takeshita et al., 2012). In addition, in some patients, even if objectively no bad odor is detected, a perception of 'there is bad breath' may occur; this is called pseudohalitosis or halitophobia. Correct diagnosis in pseudohalitosis cases is important to prevent unnecessary and repeated treatments in the clinic (Yaegaki & Coil, 2000; Zaitsu et al., 2011).

When looking at the rates of occurrence of halitosis in patients, its prevalence may vary according to the society, the selected population, the cultural level and the diagnostic thresholds; this partly explains the differences seen in the literature. However, one of the most common findings is the inconsistency between a person's self-perceived halitosis and objective assessment. Self-report may vary according to psychosocial status and individual odor sensitivity. Therefore, this may lead to increased complaints in the absence of a measurable bad odor. Zaitsu et al. (2011), in their study, reported higher social anxiety scores in patients who presented to the clinic with concern about halitosis and, in subsequent studies, associated halitosis complaints with decreased confidence and impaired quality of life (Briceag et al., 2023).

In the diagnosis of halitosis, there are many different diagnostic methods ranging from simple subjective clinical assessment such as organoleptic measurements to device-based objective tests. Organoleptic measurement continues to be a method that is still frequently and widely used today, because it reflects real-world odor perception and is a low-cost method that does not require a device (Memon et al., 2022). However, by nature it is a subjective method and depends on the odor sensitivity of the examiner. In contrast to the subjectivity provided by the organoleptic method, tests such as gas chromatography objectively measure individual sulfur compounds, providing more precise results, and also help to distinguish odor profiles in the patient. Although tests such as gas chromatography provide more objective data, their clinical use is more limited due to cost and technical requirements. In these tests, portable devices offer practicality, but their sensitivity varies by compound type, which may affect the interpretation of the results (Wu et al., 2020).

Tests such as the Cysteine Challenge Test are used as auxiliary tests when clinical findings and patient complaints differ. With a cysteine mouth rinse, an amino acid that bacteria easily metabolize, the patient is asked to rinse and the sulfur production potential that bacteria can create by metabolizing it is examined, and it may help clarify whether the bad odor is primarily oral in origin or whether it points to a broader etiology in diagnostically difficult cases (Aydın and Günay, 2022).

Materials and Methods

This study, as a systematic review; evaluated the current evidence in halitosis by including current studies covering the etiological factors, microbiological mechanisms, diagnostic tools and treatment approaches of halitosis as well as valuable articles on the subject from the past. In the articles, the procedures of classification, screening, eligibility assessment and synthesis were planned in advance and carried out in accordance with the PRISMA method.

1. Study Design

The study was designed to collect and critically evaluate studies, reviews and meta-analyses in the accessible literature on halitosis, including epidemiology, classification, diagnostic methodology and intervention outcomes in halitosis. In the study design, a structured search strategy and predefined eligibility rules were used to minimize bias in article selection and to increase reproducibility. Articles were screened from relevant databases by 2 researchers using keywords.

2. Literature Search

Searches were carried out in these databases using keywords by using the PubMed, Scopus and Web of Science databases. Eligible publications included clinical and laboratory studies addressing topics such as the etiology of halitosis, diagnostic assessment, treatment effects or psychosocial dimensions, as well as secondary research (systematic reviews and meta-analyses).
In the search strategy, keywords and Boolean operators were used to narrow the search results in the database:

- “halitosis” or “oral malodor” or “bad breath”
- “volatile sulfur compounds” or “VSC”
- “etiology” or “diagnosis” or “treatment”
- “periodontal disease and halitosis”
- “pediatric halitosis”
- “psychogenic halitosis” or “halitophobia”
- “AI olfaction” or “electronic nose and halitosis”

For publication year, current studies from the last 5 years and foundational studies included in the references of these studies were included, and no strict limitation was applied; this approach allowed the joint interpretation of past foundational studies together with studies conducted with newer developments in today's technology.

3. Study Selection

3.1 Inclusion Criteria

The abstracts of the studies obtained from searches in the databases using keywords were screened according to the following criteria, and studies meeting the criteria were included:

• Addressing halitosis in relation to its etiology, classification, epidemiology, diagnostic methods and treatment.
• Clinical studies on humans related to halitosis, laboratory investigations, reviews, meta-analyses and articles discussing technological developments related to halitosis.
• Providing full-text accessibility.
• The full-text writing language of the article being English or Turkish.
• Meeting acceptable standards of methodological quality.

3.2 Exclusion Criteria
Studies meeting the following criteria were excluded:

• Articles whose abstract is related to halitosis but whose main topic in the full text is not halitosis,
• Articles published as conference abstracts, posters, letters to the editor or commentaries,
• Articles that are duplicate or alternative versions of the same publication,
• Articles that are clinical studies or meta-analyses but contain insufficient data or lack scientific rigor,
• Articles whose full text cannot be accessed.
Were not included in the study.

3.3 Selection Process Results
In the search process conducted with the help of keywords in the PubMed, Scopus and Web of Science databases, 1.452 articles were identified whose titles were thought to be related to or possibly related to the topic. After abstract review of these articles with identified titles, 263 articles were selected for full-text evaluation.

Of the 263 selected articles, full texts of 14 could not be accessed and, according to the exclusion criteria: 16 articles were excluded because they were in languages other than English or Turkish, 23 articles because they were based on non-current literature, 81 articles due to repetition of other articles or inconsistencies between the abstract and the main content, and 11 articles because the necessary methodological information related to the study could not be reached in the full text.
The remaining 118 articles were included in this review and used for scientific analysis.

4. Data Extraction
Data extraction was performed manually using structured forms for each included study. These forms recorded the following:

• Study title, authors and publication year.
• Study design (e.g., randomized controlled trial, cross-sectional, review, laboratory study).
• Sample size and population characteristics.
• Diagnostic tools used (organoleptic scoring, gas chromatography, Halimeter®, biomarker assessment).
• Microbiological findings (bacterial species, VSC production patterns).
• Treatment methods examined (chemical agents, probiotics, mechanical interventions, SnF_2 formulations, etc.).
• Primary outcomes and study limitations.

5. Data Synthesis and Analysis
Since the methodological design of the included studies differed substantially in terms of the population included in the study and outcome definitions, a quantitative pooling (meta-analysis) could not be performed; instead, the obtained findings were grouped under the themes of etiology, diagnosis, microbiology, treatment and psychosocial impact, and were combined using a narrative (descriptive) synthesis.

6. Quality Assessment

Quality assessment was conducted using criteria specific to each study type:
Randomized controlled trials: Randomization methods, blinding, management of missing data and completeness of outcome reporting.

Observational studies: Adequacy of sample size, validity and reliability of measurement tools, management of confounding variables.
Laboratory studies: Experimental standardization, reproducibility and clarity of methodological description.
Review articles: Breadth of coverage, methodological transparency and critical depth.
Were evaluated according to these criteria.

Results

The studies examined through full text cover a wide range of topics reflecting the multifactorial nature of halitosis. Collectively, these studies present various evidence on epidemiology, intraoral factors, microbial pathways underlying the production of VSC (volatile sulfur compounds), the performance of current diagnostic tools and the comparative effects of mechanical and chemical treatments.

1. Epidemiology and Prevalence of Halitosis

Although the prevalence of halitosis varies according to the population studied, the measurement methods used in the study and the threshold values used in diagnosis, the literature shows that halitosis is a frequently seen phenomenon both clinically and socially. Overall, since halitosis is noticeable not only in the clinical setting but also in the social setting, it helps explain why even patients with low objective measurements seek treatment (Wu et al., 2020).

Research focusing on halitosis in adolescents and young adults emphasizes that halitosis can lead to undesirable psychosocial outcomes in individuals. Among the reported outcomes, the most common results may include serious psychosocial behaviors such as decreased self-confidence and avoidance of close social interaction; this is consistent with observations of the negative effects of halitosis on quality of life (Briceag et al., 2023).

2. Etiology of Halitosis: Intraoral and Extraoral Sources

2.1 Intraoral Causes (Oral)

Intraoral factors causing halitosis are consistently identified in clinical studies and systematic reviews as the main cause of halitosis. Evidence presented in the articles shows that approximately 80–90% of all cases originate from the oral cavity (Memon et al., 2022; Aylikci et al., 2013).

Tongue Coating: Among the intraoral sources causing halitosis, the main factor has repeatedly been emphasized as tongue coating. The tongue dorsum, due to its broad and rough surface that retains substrate for anaerobic metabolism, becomes the primary site where bacteria colonize and enable VSC formation (Wu et al., 2020).

Periodontal Diseases: While inflammatory exudate and tissue breakdown products serve as a nutrient source for bacteria that cause halitosis, periodontal pockets create low-oxygen environments suitable for colonization by anaerobic bacteria that produce VSC.

Xerostomia (Dry Mouth): Saliva is a secretion that serves as a natural means of washing, cleaning and defense in the oral cavity. Decreased salivary flow reduces the mouth's natural cleansing and buffering capacity, increasing plaque and bacterial accumulation and facilitating the production of malodor-associated metabolites by bacteria.

2.2 Extraoral Causes (Non-oral)

Although extraoral etiologies in halitosis are seen less frequently, they constitute a significant minority of cases (10–20%) (Memon et al., 2022). For the diagnosis of halitosis due to extraoral causes, intraoral causes should first be carefully excluded. After all intraoral causes are eliminated, a diagnosis of halitosis due to extraoral causes can be made. Such cases may require interdisciplinary medical cooperation.

2.2.1 Systemic Diseases

Volatile compounds that arise as a result of metabolic processes in the body or certain organ disorders enter the bloodstream; these compounds are exhaled through the lungs, leading to oral malodor. This is part of genuine halitosis that cannot be resolved by oral hygiene measures and requires a comprehensive medical evaluation (Yaegaki & Coil, 2000; Tangerman, 2002).

Diabetes (Diabetes Mellitus): Especially in uncontrolled diabetes patients or in diabetic ketoacidosis, it is perceived as a sweetish acetone odor in the breath. This odor originates from ketone bodies formed as a result of the body burning fatty acids instead of glucose for energy (Aylikci et al., 2013).

Renal Failure: Disorders in kidney function affect the urea cycle, leading to increased ammonia levels in the breath. This condition is generally characterized by a "fishy odor" or an ammonia-like odor (Wang et al., 2013).

Liver Disorders: Liver diseases also affect metabolic processes, leading to the accumulation of volatile compounds such as ammonia in the blood and breath (Shin et al., 2021).

2.2.2 Airway-Related Conditions

Pathologies occurring in the upper or lower respiratory tract lead to the formation of biomarkers that change the odor profiles detectable in the breath. If the patient does not have dominant intraoral factors such as tongue coating or periodontal inflammation, the focus should be shifted to extraoral airway sources (Kumbargere Nagraj et al., 2019).

Pulmonary Infections and Cancer: Pneumonia (pneumonia), tuberculosis and lung tumors directly change the odor profile in the breath. Metabolic activities or tissue damage in the lungs affect the structure of volatile organic compounds (VOC) exhaled with the breath (Broek et al., 2007).

Upper Respiratory Tract Disorders: Infections in the ear-nose-throat (ENT) region, nasal or pharyngeal infections are common causes of extraoral malodor (Yaegaki et al., 200).

2.2.3 Digestive System (Gastrointestinal) Disorders

Stomach and Esophageal Disorders: Gastritis, gastric ulcers (especially associated with H. pylori infection), gastric cancer and Barrett's esophagus may cause oral malodor. H. pylori bacteria can release ammonia and hydrogen sulfide gas during its metabolic processes (Shin et al., 2021).

Intestinal Diseases: Inflammatory bowel diseases (IBD), Crohn's disease, ulcerative colitis and bacterial overgrowth in the small intestine (SIBO) create distinct odor profiles detectable in the breath (Yu et al., 2024).

3. Microbiological Mechanisms and VSC Production

Halitosis is largely the release of volatile sulfur compounds (VSC) following proteolysis by anaerobic bacteria. This biochemical pathway links protein-rich substrates to malodor via microbial metabolism (Tonzetich, 1977). Persson et al. (1990) reinforced the fundamental driving role of anaerobic proteolytic activity in halitosis by showing that, under appropriate conditions, multiple oral microorganisms can produce hydrogen sulfide and methyl mercaptan.

4. Diagnostic Methods

In the clinic, diagnosis primarily begins with a detailed medical history and intraoral examination.

4.1 Organoleptic Assessment

Despite advances in instrumental tests in the diagnosis of halitosis, organoleptic assessment (sniff test) is still a method used practically in the clinic and accepted as a reference point. Its strength comes from being low-cost, not requiring a device, and being easy to apply in the clinical setting, and the reason it is one of the most commonly used methods is that it reflects real odor perception; however, the biggest drawback is that the scores given in the test depend on the examiner and environmental conditions, that is, the test is subjective.

4.2 Gas Chromatography and VSC Measurement

Gas chromatography (GC) provides a valuable chemical profile for the differential diagnosis of halitosis by quantifying H_2S, CH_3SH and $(CH_3)_2S$ compounds separately. Handheld devices such as Halimeter® offer ease of chairside use, The biggest drawback in these tests is that the devices have limited sensitivity to certain sulfur types. This may cause genuine halitosis to appear milder than it is in some cases.

4.3 Cysteine Challenge Test (Cysteine Challenge Test)

It is recommended for situations where routine evaluation for halitosis does not fully explain the patient's complaint. Cysteine is an amino acid that bacteria easily metabolize. By comparing VSC changes before and after the cysteine mouth rinse, it helps distinguish the intraoral factors of halitosis (Aydın, 2022).

4.4 Nanomaterial-Based Chemiresistive (Electronic Nose) Sensors

These systems mimic the human olfactory mechanism. The sensor surface consists of gold nanoparticles coated with organic ligands or carbon nanotubes. When volatile organic compounds (VOC) in the breath bind to these ligands, the electrical resistance between the nanoparticles changes. These resulting signal patterns are analyzed with machine learning algorithms and are used in the diagnosis of halitosis (Kim et al., 2021).

4.5 Smart Ingestible Capsule Sensors

Developed for monitoring the gastrointestinal system, these capsules measure the levels of pH, temperature, pressure and gases in the intestine. Using a combination of semiconductor and thermal conductivity sensors, these devices transmit data wirelessly, providing real-time information about intestinal health and microbial activity. We can think of these sensors as advanced-technology “interpreters” that decode chemical messages coming from inside the body (Yu et al. 2024).

4.6 Colorimetric Sensors Based on Phage Litmus

Genetically modified M13 bacteriophages are made sensitive to specific volatile organic compounds (VOC). Structures formed by these phages undergo structural changes when exposed to external stimuli such as gases in the breath, i.e., volatile organic compounds, and scatter light differently, resulting in a color change (Kim et al., 2021). This technology is called “phage litmus”

4.7 Autofluorescence Imaging (QLF-D)

• This method is based on the principle that endogenous porphyrins produced by oral bacteria emit red fluorescence under 405 nm blue light. The quantitative light-induced fluorescence digital (QLF-D) system images bacterial accumulation (tongue coating) on the tongue and visualizes and scores the severity of the associated oral malodor (halitosis) in a non-invasive manner (Lee et al., 2015).

5. Findings Obtained from Treatment Studies

The basic principle of management is to first find the source. If intraoral causes are dominant, the first step is mechanical plaque control.

Mechanical Approaches: Mechanical plaque control and tongue cleaning are first-step strategies in preventing halitosis. Reducing the bacterial coating on the tongue surface with tongue scrapers provides measurable improvement in VSC levels (Wu et al., 2020).

Chemical Agents: Chlorhexidine, zinc salts, cetylpyridinium chloride, chlorine dioxide and essential oils have been reported to reduce VSC levels (Froum et al., 2013). However, side effects such as changes in taste perception and staining of teeth with long-term use should not be overlooked.

Stannous Fluoride (SnF_2): SnF_2-containing toothpastes have been shown to reduce morning breath odor (Zsiska et al., 2021). Basically, its mechanism of action is based on stannous fluoride suppressing bacterial activity in the oral cavity and preventing the formation of compounds that cause odor.

Laser Therapies: Although Wiench (2025) reported potential benefits in selected cases due to a reduction in bacterial load, the evidence is still limited and heterogeneous. In particular, the fact that lasers are not widely available in clinics is an important limiting factor in developing them as a treatment option.

Probiotic approaches: Prebiotics and microbiota-modulating strategies are attracting increasing interest in halitosis. However, questions such as which strains will be effective, in which duration and doses, and in which patient groups more meaningful results will be obtained are still unclear (Briceag et al., 2023).

6. Psychosocial Effects

One of the most important possible psychological outcomes caused by halitosis is that patients may experience withdrawal in social life and loss of self-confidence. Genuine halitosis may overlap with anxiety-related perceptions (pseudohalitosis) (Zaitsu et al., 2011). These effects should be considered not as a secondary element of treatment, but as a central part (Briceag et al., 2023).

7. Classification Systems

The classification system proposed by Aylikci et al. (2013) and dividing halitosis into three main categories is also widely used in the current literature

• Genuine Halitosis (Genuine Halitosis)
• Pseudohalitosis (Pseudohalitosis)
• Halitophobia (Halitophobia)

This framework is accepted as the basis for accurate differential diagnosis and the clinical decision-making process.

Discussion

Halitosis, oral malador or bad breathe, is a common clinical condition shaped by the interaction of biological and psychosocial factors, creating serious biological and psychological stress in the patient. Studies on the subject and evidence in the current literature show that the cause of halitosis is intraoral in origin in the vast majority of cases; in particular, tongue coating and periodontal factors are at the center of this condition. Studies reveal that, although halitosis is a biological phenomenon, it is an important condition that affects a person's social life. Therefore, the diagnostic and treatment processes of halitosis should not be reduced solely to a physical odor removal procedure; a holistic approach that also includes the patient's level of perception and psychology should be adopted.

The fundamental mechanism of oral malodor is the anaerobic proteolysis process carried out by intraoral microorganisms. In this process, sulfur-containing volatile compounds (VSC) such as hydrogen sulfide and methyl mercaptan that emerge with the breakdown of proteins constitute the main source of the odor. Therefore, selecting methods that limit the accumulation of protein substrates and reduce anaerobic bacterial load in treatment strategies is the most rational way for permanent improvement.

In terms of diagnostic methods, organoleptic assessment (the clinician directly evaluating the odor) is still accepted as the gold standard because it reflects social perception. However, in order to reduce inter-clinician variability, standardization and measurements supported by next-generation sensor technologies have the potential to increase objectivity. Nevertheless, instead of relying only on device data in the diagnostic process; evaluating the triad of history, clinical examination and measurement together is the safest approach.

In clinical management, the most critical distinction is determining the difference between genuine halitosis that can be objectively detected and pseudohalitosis or halitophobia that is based only on the patient's own perception. When an objective odor is not detected, instead of only recommending mechanical or chemical cleaning methods, providing education and supportive counseling to the patient, and when necessary referring to the relevant specialists, will increase treatment success and patient compliance.

Treatment approaches should follow a stepwise system customized to each patient's needs: management of factors contributing to halitosis such as mechanical cleaning, chemical supports and management of risk factors is essential for long-term outcomes.

Conclusion

In conclusion, halitosis management cannot be carried out with a “single factor – single treatment” understanding. An effective approach requires a holistic strategy that takes into account standardized diagnostic tools, mechanical and chemical methods aimed at etiology and the patient's psychosocial status.
We can liken halitosis management to a detective story. Without examining the crime scene (the oral cavity), making a decision only by looking at the presence of the smoke (the odor) is incomplete. To find the real culprit (anaerobic bacteria and proteins or extraoral factors), both eyewitnesses (the organoleptic test) and technological evidence (sensors) are needed; however, sometimes it may also be necessary to face the fact that the crime is not physical, but only an illusion (halitophobia).

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