

HALITOSIS WITH FIXED ORTHODONTIC APPLIANCE VS REMOVABLE ORTHODONTIC ALIGNERS: A PILOT STUDY

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ABSTRACT

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Introduction: Halitosis is a widespread condition and is a big handicap for the patients. Most adults suffer from bad breath, an estimated 10-30 percent of the USA population, and this may lead to personal discomfort and social disagreement. Furthermore, some authors estimate that approximately 50% of the middle-aged and older individuals emit socially unacceptable breath, especially in the morning, which can be attributed to physiological causes.

Methodology: For the purposes of this study 10 patients with aligners (aligners group - AG) and 10 patients with fixed orthodontic appliance (fixed group - FG) were selected. This experiment aims to detect the presence of halitosis with a gaschromatograph (OralChroma™). The machine analyzes the air sample and provides results in 8 minutes by creating a graphic that shows the amount of 3 volatile sulfur compounds.

Results: The values measured by the gaschromatograph show a significant difference between the two groups. We also considered the average values of both groups. The averages confirm the difference between AG and FG group (FG average > AG average) in all three values.

Conclusion: This study is only a pilot study and should be expanded in order to produce more consistent results, but we can already assert that the possibility to remove the oral device certainly provides a better outcome for oral hygiene procedures and, consequently, improves the halitosis condition. In conclusion we can consider oral hygiene and halitosis as important factors in order to decide what kind of orthodontic device is better suited for the single patient.

Keywords: halitosis, orthodontic appliance, clear aligners, volatile sulfur compounds (VSC), gaschromatograph.

1. Introduction

Halitosis is a widespread condition and is a big handicap for the patients. Most adults suffer from bad breath, an estimated 10-30 percent of the USA population, and this may lead to personal discomfort and social disagreement¹. Furthermore, some authors estimate that approximately 50% of the middle-aged and older individuals emit socially unacceptable breath, especially in the morning; this can be attributed to physiological causes². Halitosis, which means foul breath, might be related to physiologic and/or pathologic

reasons³ such as ear nose-throat diseases (chronic sinusitis, tonsillitis), gastrointestinal system diseases, diabetes mellitus, and acute rheumatic fever. Also, more frequently, halitosis can be related to intraoral factors, including especially gram-negative anaerobic microorganisms on the dental plaque, in the periodontal pockets, in the saliva, and on the dorsum of the tongue⁴. Besides these causes we should consider orthodontic treatment too. With the presence of fixed orthodontic appliances, efficiency when performing dental hygiene procedures decreased

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in a statistically significant way ($p=0,003$), which led to a statistically significant increase of the plaque and tongue coating indexes, and confirmed the suspected positive correlation between halitosis and fixed orthodontic appliances⁵. The brackets and ligatures have a negative effect on natural cleaning by creating retention areas for plaque, making the mechanical cleaning of the teeth and gingiva by the tongue and lips more difficult, and increasing the viscosity of the saliva⁶⁻⁸. It has been stated that the accumulation of plaque and the increase in bacterial count⁹ and tongue coating¹⁰ are clearly also involved in the formation of halitosis. There are also plenty of studies about the effect of orthodontic treatment on the periodontium^{11,12}. Determining the bracket system that causes the less destructive biologic effect has gained importance today. In this perspective, studies have been conducted on self-ligating brackets (SLB), with conflicting opinions. The absence of ligatures should provide fewer retentive sites than other bracket ligation types¹³ but, on the other hand, this theoretical advantage may be eliminated in reality because SLB consist in opening and closing mechanisms that may provide additional plaque retention sites^{14,15}. Instead, with aligner devices, oral hygiene habits were very good¹⁶. The use of removable orthodontic appliances, particularly invisible aligners, allows adequate oral hygiene and can reduce the risk of dental and periodontal complications such as white spot lesions, caries and periodontitis¹⁷. About the correlation between halitosis and orthodontic aligner treatment, it has been shown that this kind of treatment (Invisalign®) is characterized by only minimal impairment of overall oral health and the associated quality of life. Neither halitosis, nor oral dryness, nor high plaque or gingival index measurements were observed⁴. This is a very interesting study but it does not compare orthodontic aligners and fixed orthodontic appliances, as predisposing conditions to halitosis. The aim of the present study is to evaluate the presence of volatile sulfur compounds (VSCs) in patients with orthodontic aligner compared to patients with orthodontic fixed appliance. The VSC consisting of hydrogen sulfide, dimethyl sulfide, and especially methyl mercaptan released through the proteolytic degradation of saliva, exfoliated epithelium, food debris, gingival crevicular fluid, plaque, postnasal drip, sulfur-containing amino acids, and peptides in the blood by the anaerobic microorganisms found in the oral cavity are effective on the formation of halitosis¹⁸. The null hypothesis is that there are no differences in oral volatile sulfur compounds (VSC) emissions between patients with fixed orthodontic appliances and orthodontic aligners.

2. Materials and Methods

2.1. Study Sample

Fixed Orthodontic and Invisalign® patients were selected consecutively with the following characteristics: age between 18 and 39 years old,

good general health, non-smokers, absence of systemic diseases, absence of gastro esophageal reflux, no eating disorders (DAC) and not pregnant. The fixed orthodontic treatment we intended was a superior and inferior multi-brackets system at least from first molar to first molar, instead, the Invisalign treatment consisted of superior and inferior aligner devices. Both treatments have to be started since, at least, three months subjects were involved in the study. We considered the following characteristics as exclusion criteria: individuals with systemic diseases, medical treatments, cuts, sores, lesions of the mucosa and wounds, bearers of crowns, veneers or bridges on the upper incisors and active carious lesions. We also left out individuals who declared to not brush their teeth at least three times a day, to not use dental floss and/or dental picks and, in Invisalign® cases, to not clean aligners with their personal toothbrush and toothpaste (with RDA less than 100) at least two times a week and to not put them in immersion solution of sodium sulfate carbonate at least once a week^{19,20}. Among these patients 10 patients with aligners (aligners group - AG) and - 10 patients with fixed orthodontic appliance (fixed group - FG) were selected. The study was carried out in accordance with the principles of the Declaration of Helsinki and in compliance with Good Clinical Practice. The study protocol was reviewed and approved by the University of Insubria Research Centre Cranio Facial Disease and Medicine Institutional Ethical Committee. Before taking part in the study each patient was required to sign an informed consent form to which a detailed description of the study protocol was attached. These individuals were asked to come for the orthodontic control, at least an hour after performing the oral hygiene procedures, and for VSC measurements.

2.2. Methodology

This experiment aims to detect the presence of halitosis with a gaschromatograph OralChroma™ (Fig. 1).

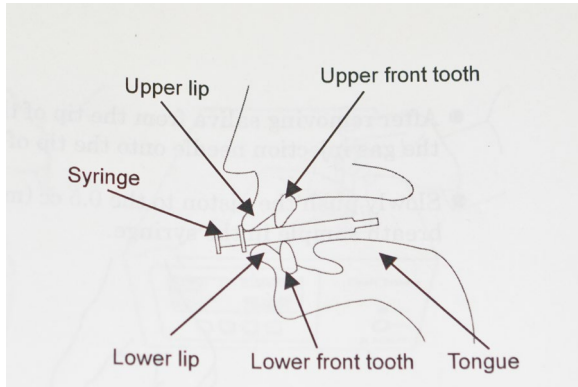


Figure 1. Gaschromatograph OralChroma™

The patient must keep a sterile disposable 1 ml syringe in the oral cavity for 60 seconds, with his mouth closed and without contaminating it with saliva (Fig. 2 a-c). After 60 seconds, the patient must open and close the syringe plunger 2 times,

without letting saliva inside (Fig. 3). After this operation, the clinician takes the syringe with the plunger open, empties it up to 0.5 ml, mounts the needle (supplied with the OralChroma™) and quickly inserts it into the machine's slot and pushes the piston of the syringe to put the air into the

machine that starts analyzing the sample of breath. The volatile sulfur compounds that are analyzed to identify the presence or absence of halitosis are: hydrogen sulphide H_2S , methyl mercaptan CH_3SH and dimethylsulfide $(CH_3)_2S$ (Fig. 4).



2a.



2b.



2c.

Figure 2 a-c. The patient must keep a sterile disposable 1 ml syringe in the oral cavity for 60 seconds

The machine analyzes the air sample and provides results in 8 minutes by creating a graphic that shows the amount of 3 volatile sulfur compounds. The results are reported in ppb or ng / 10ml. The unit chosen to present the results of this study is the ppb. To make a diagnosis of halitosis it is sufficient to have one of the three volatile sulfur compounds at a level higher than the threshold, that is different for each of the three gases. In particular: 112 ppb/10 ml H_2S Hydrogen sulfide, 26 ppb/10 ml CH_3SH methyl mercaptan and 8 ppb $(CH_3)_2S$ dimethylsulfide.

2.3. Data Evaluation

The data obtained were collected in Excel sheets and analyzed by an analysis software. A statistical test for independent samples, Mann-Whitney test, and a statistical significance test used in the analysis of contingency tables, Fisher's exact test, was used to compare the two groups, a value difference of $p < 0.05$ was considered statistically significant. The graphic system chosen to show the data is a box plot.



Figure 3. After 60 seconds, the patient must open and close the syringe plunger 2 times, without letting saliva inside

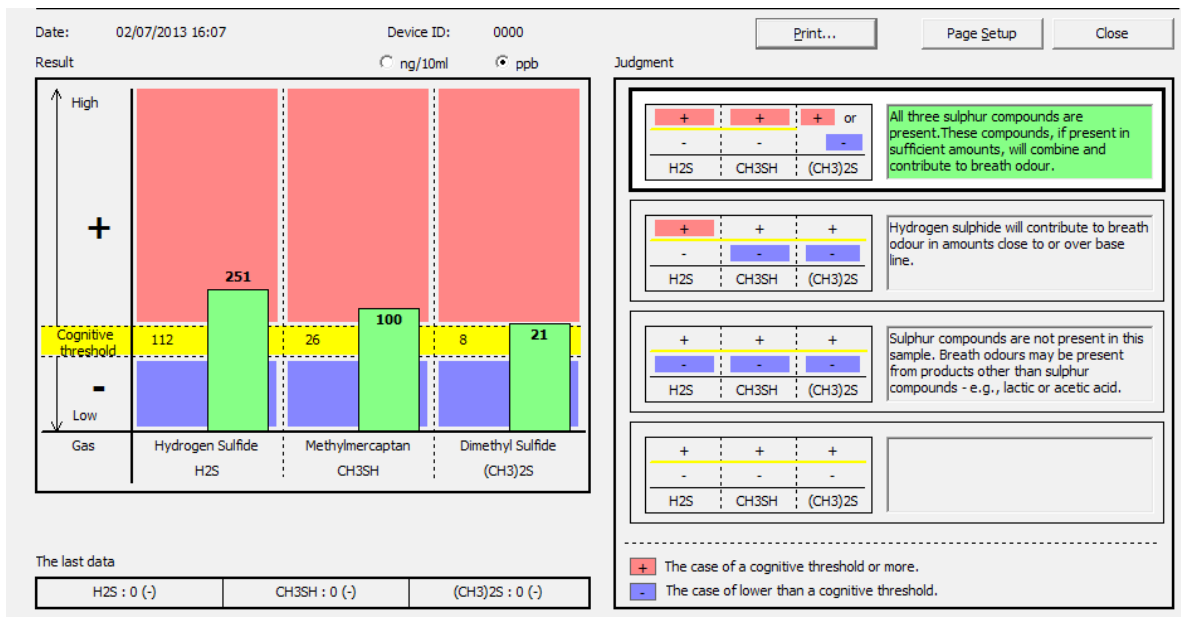


Figure 4. Example of chart showing the levels of the three VSC

3. Results

The values measured by the gas chromatograph show a significant difference between the two groups. The minimum value for each gas in both groups is 0, while the maximum values are:

- AG group: 76 (H₂S), 17 (CH₃SH) and 3 ((CH₃)₂S). They are all under the threshold.
- FG group: 491 (H₂S), 45 (CH₃SH) and 44

((CH₃)₂S). In this case all the values are over the threshold. We also considered the mean of both groups. Means confirm the difference between AG and FG group (FG mean > AG mean) in all three values (Tab. 1). The standard deviation study shows that AG values are nearer to average than FG values (Tab. 2).

Table 1. Mean for each gas

AG			FG		
H ₂ S	CH ₃ SH	(CH ₃) ₂ S	H ₂ S	CH ₃ SH	(CH ₃) ₂ S
11,2	1,7	0,3	123,7	7	7,7

Table 2. Standard deviation for each gas

AG			FG		
H ₂ S	CH ₃ SH	(CH ₃) ₂ S	H ₂ S	CH ₃ SH	(CH ₃) ₂ S
24,0	5,4	0,9	179,2	14,5	14,2

4. Discussion

This study evaluates the presence of volatile sulfur compounds (VSCs) in patients with orthodontic aligners compared to patients with orthodontic fixed appliances. In the aligner group, the three gases evaluated by OralChroma were below the threshold in the 10 patients participating in this study. Instead, in the fixed orthodontics appliance group, there were considerable differences between the patients. Five subjects in this group were over the threshold for at least one gas value and this is sufficient to consider these individuals as halitosis carriers, but two of this group were over the threshold for two gas values. The other five subjects, instead, were under the threshold for all of the three gas values measured in this study. The literature is poor on studies that compare the presence of halitosis between two types of orthodontic appliances, but they treat separately the halitosis problem and the two appliances considered in this study. The Rosenberg's study² shows that approximately 50% of the middle-aged and older individuals emit socially unacceptable

breath. Zurfluh et al., instead, studied halitosis in the presence of fixed orthodontic appliances and in this case the percentage increases. One of the causes must be sought in the decrease of dental hygiene performance that leads to an increase of the plaque and tongue coating indexes. Lara-Carillo et al. demonstrated that brackets and ligatures have a negative effect on natural cleaning because they create retention areas for plaque and increase the viscosity of the saliva. For the same reason they make the mechanical cleaning of the teeth and the gingiva, performed by tongue and lips, also more difficult. Furthermore, for Pellegrini et al. an increase of plaque index causes an increase in the bacterial count, which clearly is involved in the formation of halitosis⁹. Starting from these considerations, many studies have been conducted by several authors^{6,7,13} about self-ligating brackets (SLB), because the absence of ligatures was supposed to provide fewer retention areas than in other bracket ligation types, but the opening/closing mechanisms may provide, on the contrary, additional plaque retention

areas^{11,14}. Alternatively, Schaefer et al. showed that removable orthodontic appliances, particularly invisible aligners, allow a more adequate oral hygiene¹⁶. About the correlation between halitosis and orthodontic aligners treatment it is shown that this kind of treatment did not lead to an increase of plaque and bacterial count, thus neither halitosis, nor oral dryness, nor high plaque or gingival index measurements were observed.

5. Conclusion

The study shows similar results in both groups, but the aligners group shows better results because none of the subjects have high level of volatile sulfur compounds or, better yet, they are all below the threshold for the three values considered. In the second group, instead, there are some differences among the patients because of their different level of oral hygiene, which can cause important changes in the VSC analysis. The presence of brackets, ligatures and archwires is

a big increasing factor for halitosis. Indeed, they cannot be removed by the subject during oral hygiene procedures therefore plaque retention is surely higher than in the aligners group, where the appliance can be removed and oral hygiene can be performed as any subject without orthodontic appliances would do¹⁷. This study is only a pilot study and should be expanded in order to produce more consistent results, but we can already assert that the possibility to remove the oral device certainly provides a better outcome for oral hygiene procedures and, consequently, improves the halitosis condition. In conclusion we can consider oral hygiene and halitosis as important factors in order to decide what kind of orthodontic device is better suited for the single patient.

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Questions

Which are the VSC?

- a. VSC (volatile sulfur compounds) are hydrogen sulphide H₂S, methyl mercaptan CH₃SH and dimethylsulfide (CH₃)₂S;
- b. VSC are sulfur dioxide SO₂, methyl mercaptan CH₃SH and dimethylsulfide (CH₃)₂S;
- c. VSC are hydrogen sulphide H₂S, dimethyl mercaptan (CH₃)₂SH and dimethylsulfide (CH₃)₂S;
- d. VSC are hydrogen sulphide H₂S, methyl mercaptan CH₃SH and methylsulfide CH₃S.

Which kind of instrument was used to measure the VSC?

- a. A gas chromatograph was used to measure the VSC;
- b. A halimeter was used to measure the VSC;
- c. A spectrophotometer was used to measure the VSC;
- d. Salivar strips were used to measure the VSC.

Are VSC levels higher in the orthodontic fixed group (FG) or in the aligner group (AG)?

- a. The FG shows higher level of VSC;
- b. The AG shows higher level of VSC;
- c. FG and AG show the same VSC level;
- d. The FG shows lower level of VSC.

How can the measurement of halitosis be useful in orthodontic treatment?

- a. The measurement of halitosis cannot be used for making an appropriate orthodontic treatment choice;
- b. Halitosis is an important factor in order to decide what kind of orthodontic device is better suited for a single patient;
- c. The measurement of halitosis is useful to improve the oral hygiene of the patient;
- d. Halitosis does not appear during orthodontic treatment.