Are there any Specific Bacteria Involved in Malodor Associated with the Dental Implant System?

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Abstract

Currently, studies focusing on specific causes of malodor associated with dental implants are scarce. The purpose of this clinical study was to compare clinical parameters and bacterial growth in a healing phase of implant systems and their relation with malodor.

60 oral samples were collected from the site of the healing abutment of 27 patients for microbial tests. Individuals were classified as those with and without malodor (31 oral samples had malodor and 29 samples were without the bad smell). The type of bacterial colony was evaluated regarding the growth of both aerobic and anaerobic bacteria. The two positive and negative groups of malodor were compared regarding baseline and clinical characteristics

About half of the patients had positive odor (51.7%) on assessment. The prominent bacteria in the group with malodor was Streptococcus viridans (90.3% vs. 24.1% in the group without malodor; p<0.001. Regarding implant systems, BioHorizon (48.4%), Intra-Lock (29%), and Medentika (22.6%) had the highest rates of malodor, respectively (p=0.245). Streptococcus viridans had a 9.33 times higher chance of positive odor compared to other groups (OR: 9.33, p=0.00). Although not statistically significant, BioHorizon and Intralock systems of the implant had 2.85 and 1.92 higher chances of malodor compared to Medentika (as reference) (p=0.099 & p=0.334, respectively).

Based on the results of this study, Streptococcus viridans was the most common bacteria associated with malodor in participants with two-stage implant system. This bacterium showed 9 times higher risk factor for malodor when compared to other existing strains of bacteria.

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Introduction

Based on bone conditions and site of the tooth, in today's dental practice, primarily two types of dental implant systems exist, the one-stage and the two-stage systems [1]. The main goal of these two systems is to achieve osseointegration at the site of the bone-implant [2]. Although studies have shown both systems to render promising results regarding osseointegration, each system is associated with some complications. These complications include fractures, peri-implantitis, and associated soft tissue complications, bone loss, etc. [3].

The malodor is mainly considered to be caused by periodontal anaerobic bacteria [4]. These bacteria turn the protein in the mouth into amino acids, which are then metabolized into sulfur and malodorous-causing metabolites [4-6] Two weeks after the second surgery, when the prosthodontist opens the healing abutment, bad odor emits [4] which is also noticed by the patient. Studies have shown that microleakage between the inner parts of the implant cause periimplantitis and marginal bone loss due to bacteria growth [7, 8]. Clinical observations have brought on a theory among researchers that microorganism growth and their metabolites may

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be the cause of the malodor [9-11].

However, to date, studies focusing on the specific cause of the malodor associated with dental implants are scarce.

This study compared clinical parameters and bacterial growth related to the inner part of the healing abutment among individuals who either showed malodor or didn't show any malodor, to define the cause of the malodor associated with the two pieces implant system.

Materials and methods

Study settings and patient selection

The study population consisted of 32 patients (17 females and 15 males). 60 oral samples were collected from the site of the healing abutment of the study participants. These individuals had one of three implant systems: BioHorizon (BioHorizons®, Laser-Lok, USA), Medentika (MEDENTiKA ® GmbH Hammweg, Hügelsheim, Germany), Intra-Lock (Intra-Lock International, USA).

The patients selected exhibited healthy periodontal conditions and had <10% bleeding on probing. Those individuals, who were either smoker or had used antibiotics during the past 4 weeks of their visit, were excluded from the study. The study protocol was following the guidelines of the Declaration of Helsinki. All patients gave their written and informed consent to enter the study. Overall, 60 oral samples were collected from the site of the healing abutment from a total of 27 patients. Samples taken from the patients were transferred to a thioglycolate media (Thioglycollate with Indicator, 16x125mm Tube, 10ml).

Microbial assessment

The healing abutments were opened without contacting the tongue or cheeks of the patients. The sampling of the internal compartment of the implant-abutment interface was collected using sterile swabs. The internal surface of the implant fixture at the implant-abutment interface (coronal) was circumferentially wiped with the paper point (JOMI). Samples were later placed in a thioglycollate medium and were incubated for 3 to 5 days in an incubator at 37°C. When bacterial growth was seen in the incubator a sub-culture was transferred to blood agar, EMB agar, and chocolate agar medium. The plates were then incubated at 37°C for 24 to 48 hours, type of bacterial colony was evaluated for the growth of both aerobic and anaerobic bacteria.

Study measurements and variables

All measurements were done two weeks after the second stage of the implant surgery. Gingival height (GH) evaluation was done using a periodontal probe (Color Coded Michigan Williams) and the maximum depth was recorded. The Gingival height was between 1mm to 3mm. Other measurements included subjective odor score which was performed by a single independent observer. Odor emitting from the healing abutment was scored as followed: 0 = odorless; 1 =odor. Individuals were classified into two groups of those with positive odor and those without odor. The two groups were then compared regarding baseline and clinical characteristics.

Statistical analysis

Data was analyzed SPSS 24 (SPSS, Chicago, IL, USA). (SPSS Inc., Chicago, IL, USA). For comparison of normally distributed quantitative data between two groups the Independent T-test and for comparison of qualitative data between groups, the Chi-square test was used. For comparison of the risk of malodor between 125 implant systems and type of bacteria, odds ratio (OR) was calculated. Data are presented as descriptive statistics where appropriate. A value of $P < 0.05$ was indicated as statistically significant.

Results

Baseline and clinical characteristics of the patients are reported in Table 1. In total, 31 samples were collected from males and 29 were collected from females. The majority of bacterial growth included *Streptococcus viridans* (58.3%), followed by *nonEnterococcus* species (15%) and *Staphylococcus epidermidis* (10%). Overall, 40% of patients had Biohorizon system of implant, 31.4% had Medentika and 28.3% had Intralock. Almost half of the patients were positive odor (51.7%) on assessment, among which 31 specimens were positive malodor (Table 1).

As shown in Table2, 54.8% of malodor positive samples were obtained from male patients and 45.2% of malodor positive samples were obtained from female patients (p=0.611).

To evaluated the association between the type of bacteria and malodor, the samples were cultured in different media. The prominent

bacteria in the group with malodor was *Streptococcus viridans* which was present in 90.3% of samples (vs. 24.1% in the group without malodor; p < 0.001).
Regarding implant systems, BioHorizon (48.4% vs. 31%), Intra-Lock (29% vs. 27.6%), and Medentika (22.6% vs. 41.4%) had the highest rates of malodor samples, respectively, although the difference was not statistically significant between the two groups (p = 0.245).
Gingival height was not different between the two groups (p = 0.310) (Table 2).

Variables		N (%)
Sex - no.*	Male	13 (48.2)
	Female	14 (51.8)
Type of bacteria growth- no.†	*Streptococcus viridans*	35 (58.3)
	Staphylococcus epidermidis	6 (10)
	Non-Enterococcus	9 (15)
	Others	10 (16.7)
Implant system- no.	BioHorizon	24 (40)
	Intra-lock	17 (28.3)
	Medentika	19 (31.7)
Gingival height- no.	1mm	4 (6.7)
	2mm	41 (68.3)
	3mm	15 (25)
Odor- no.	Negative	29 (48.3)
	Positive	31 (51.7)

*From a total of 27 patients, 60 sample were obtained.
†One positive represent mild malodor, two plus moderate, and three plus positive represents severe malodor.

Table 1. Baseline and clinical characteristics of patients.

Variables		Odor		
		Positive	Negative	P-value
Sex*	Male	17 (54.8)	14 (48.3)	0.611
	Female	14 (45.2)	15 (51.7)	
Type of bacteria†	*Streptococcus viridans*	28 (90.3)	7 (24.1)	<0.001
	Staphylococcus epidermidis	0	6 (20.7)	
	Non- Enterococcus	0	9 (31)	
	Others	3 (9.7)	7 (24.1)	
Implant system	BioHorizon	15 (48.4)	9 (31)	0.245
	Intra-lock	9 (29)	8 (27.6)	
	Medentika	7 (22.6)	12 (41.4)	
Gingival height	1mm	1 (3.2)	3 (10.3)	0.310
	2mm	20 (64.5)	21 (72.4)	
	3mm	10 (32.3)	5 (17.2)	

*Number of sample has been considered for distribution of sex.
†Other types of bacteria that were involved in malodor included: Staphylococcus epidermidis + Non-Enterococcus and Non-Enterococcus + yeast.

Table 2. Comparison of individuals with odor and those without odor (Chi-square test).

According to the type of bacteria, odds ratio showed that *Streptococcus viridans* had a 9.33 times higher chance of positive odor compared to other groups (OR: 9.33, p = 0.006). Moreover, regarding the system of implant, although not statistically significant, BioHorizon and Intralock systems of the implant compared to Medentika (as reference), had 2.85 and 1.92 higher chances of acquiring malodor (p = 0.099 & p = 0.334, respectively) (Table 3).

Variables		Odds ratio	P-value
Implant system	BioHorizon	2.85	0.099
	Intra-lock	1.92	0.334
	Medentika	ref	-
Type of bacteria	*Streptococcus viridans*	9.33	0.006
	Staphylococcus epidermidis	-	>0.99
	Non- Enterococcus	-	>0.99
	Others	Ref	-

Table 3. Odds ratio of oral odor according to type of bacteria and implant system (Ref: refrence).

Discussion

In this study, we aimed to test our hypothesis that a special type of bacteria may be involved in the malodor seen two weeks after the second stage of surgery in patients with dental implants. Our findings showed a statistically significant connection between the growth of *Streptococcus viridans* bacteria and malodor. Moreover, *Streptococcus viridans* positive patients showed a 9 times higher chance of malodor than other groups. Furthermore, malodor was more prevalent in the BioHorizon implant system (48.4%) in comparison to the other two systems, though it was not statistically significant. Unlike the other two implant systems, due to the lack of Morse taper quality within the BioHorizon implant system, the growth of malodorous bacteria was made possible. Thus, the malodor from this implant system was much stronger than the other two. This could be validated based on research by Resende et al. who documented that micro gaps within the implants may be susceptible to bacteria and saliva infiltration which may cause inflammation and malodor [12].

The patients in our study had very good periodontal conditions, likely, the source of the bacterial growth in the healing abutment and fixture abutment originated from the back of the tongue. Other researchers have shown that the anaerobic bacteria that are located in the back of the tongue, considering this region is not cleaned properly and can easily harbor bacteria, play an important role in the production of malodor[13-15]. Sterer et al. were not able to identify the source of malodor around the implants among anaerobic

bacteria, due to the material and method utilized in their study[6], however other researchers were able to show that the source of the malodor was *Fusobacterium nucleatum* and *Porphyromonas gingivalis* [16-18]. However, the question of how and why does malodor exists around the healing abutment after it is opened remains to be answered.

In a study by Naveen et al. in a randomized clinical trial, authors attempted to reduce the *Streptococcus viridans* count in the oral cavity by using different cleansing techniques[19]. Consist with our study, the researchers have demonstrated that this bacteria strain was an important factor when it comes to malodor. They also reported that all the cleansing techniques (tongue scraping, mouthwash, and combination technique) had been proven useful, though the results were considered to be "short-term effects of the intervention" [19]. This shows that their results may be applicable among our patients as well. Scarano et al. aimed to evaluate the sealing capabilities of two different dental implant connections. They concluded that the micro gap within the "implant-screw healing junction" may be a cause for bacteria colonization and malodor[20]. A correlation was also seen between the severity of malodor in the two-stage implant and the size of the actual micro gap. In other words, the larger micro gaps, the more bacterial growth, which results in more severe malodor[20].

The findings of our study may offer further validation to a probable hypothesis from the mentioned study, as that considering the gap between fixture abutment and the healing abutment, bacteria can grow and malodor is emitted (more commonly seen in the BioHorizon implant system). Our findings significantly aid in a better understanding of one of the most common issues with dental implant systems. To the best of our knowledge, for the first time, we found that *Streptococcus viridans* was involved in malodor of patients after their dental implants. This opens a wide field of investigation for the eradication and probable therapy for the condition. As a drawback to this study, we had limited number of patients and it did not allow us to include the severity of odor in our analysis. Moreover, perhaps a larger population may have rendered different results regarding the statistical difference between implant systems. Assessment of odor was done through a subjective measurement tool which may include some bias, although we did have one observer to minimize any existing bias.

Conclusions

In this study we found *Streptococcus viridans* was the most common bacteria associated with malodor in participants with two-stage implant system. This bacterium showed 9 times higher risk factor for malodor when compared to other existing strains of bacteria.

Declaration of Interest

The authors report no conflict of interest.

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