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ORIGINAL ARTICLE

Investigation of bacteremia after debonding procedures

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ABSTRACT

Objective: The purpose of this study is to investigate the effect of debonding procedures after completion of orthodontic treatments on bacteremia.

Materials and methods: Twenty-eight patients who were treated with fixed orthodontic treatment at the Faculty of Dentistry's Department of Orthodontics at Gaziantep University and who had an indication of debonding were selected for this study, and blood samples were taken from these patients at different times and examined for bacteremia. Blood culture samples were taken from the antecubital veins of the patients prior to debonding (T_0), immediately after removing the bracket (T_1), and immediately after cleaning the composite residues and plaque deposits on the enamel surface (T_2). The blood samples were then inoculated in blood culture bottles and investigated for bacterial growth.

Results: The results showed that there was no bacterial growth in the blood samples taken at T_0 and T_1, whereas 10 of the blood culture samples taken at T_2 showed bacterial growth including the following bacteria; *Streptococcus viridans*, *Streptococcus mitis*, *Streptococcus parasanguinis*, *Streptococcus salivarius*, *Streptococcus oralis*, *Staphylococcus aureus*, *Actinomyces oris*, *Actinomyces naeslundii* and *Klebsiella pneumoniae*.

Conclusion: It was concluded that patients in the risk group could develop bacteremia during debonding procedures. The presence of these bacteria in sterile blood suggested the possibility of bacterial endocarditis.

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Introduction

Bacteremia is a condition in which a small number of bacteria, whose numbers are generally less than 10 CFU/mL, enter the body through an entryway into the sterile systemic bloodstream and remain in circulation for up to 30 minutes [1,2]. Transient bacteremia may occur due to minor trauma or bleeding following medical procedures in mucous membranes containing a large number of bacteria, such as the oral cavity, urogenital system or gastrointestinal tract. While the microorganisms entering the systemic circulation are cleared by the reticuloendothelial system in healthy individuals, some individuals with heart disease are likely to develop bacterial endocarditis [3].

Poor oral hygiene has been shown to be the most significant cause of infective endocarditis [4]. Investigators have shown that a significant proportion of bacterial endocarditis cases arise as a result of dental procedures [5,6]. In a study, the incidence of bacteremia was found to be 51% for single tooth extraction, 68–100% for multiple tooth extraction, 0–31% for root canal therapies where the canal instruments do not exceed the root apex, 0–54% for root canal therapies where the canal instruments exceed the root apex, 36–88% for periodontal flap lifting procedures, 83% for gingivectomy, 8–88% for scaling and root planing procedures, 0–40% for periodontal prophylaxis, 0–26% for toothbrushing, 20–58% for use of dental floss, 20–40% for interproximal toothbrushing, 7–50% for dentogingival irrigation and 17–51% for chewing [7]. Besides, for orthodontic stripping, mini-screw insertion and removal procedures, fixed treatments were reported to produce the bacteremia [8,9]. However, bacteremia was detected even after dental procedures such as the application of a rubber dam and matrix band that are not associated with bleeding [10,11] and it has been suggested that bleeding is not absolutely necessary for bacteremia to occur [12].

Dajani et al. [13] and Er [14] reported that prophylaxis is necessary in dental procedures that can cause severe bleeding in intraoral soft and hard tissues, tooth extraction, implant placement, intraligamentary anesthesia, subgingival procedures, endodontic treatments that may exceed the apex, all periodontal treatments including descaling, curettage, root planing, periodontal pocket measurement, and insertion and removal of orthodontic bands. In contrast, they state that prophylaxis is not necessary in restorative treatments where bleeding is not expected, endodontic treatments in the canal, dental post placement, dental impression, postoperative suturing, topical fluoride application, administration of local anesthesia (except for intraligamentary anesthesia), radiographic applications, application of rubber dam, placement of mobile orthodontic and prosthetic

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devices, and insertion and removal of orthodontic apparatus, molar tubes and brackets.

Studies in the literature on orthodontics have shown that bacteremia can occur during the insertion and removal of molar bands [15–18]. Nevertheless, debonding procedures are currently not among the dental procedures for which prophylaxis is recommended [13,19,20]. The American Heart Association (AHA) suggests antibiotic prophylaxis only during band placement in high and moderate risk groups [21]. This study was planned because of the lack of any studies in the literature on bacteremia in debonding procedures for patients who are treated only with brackets and molar tubes.

The purpose of this study is to investigate the effect of debonding procedures at the end of orthodontic treatments on bacteremia.

Materials and methods

Patients who had completed fixed orthodontic treatments at the Faculty of Dentistry's Department of Orthodontics at Gaziantep University and were found to be eligible for debonding procedures were selected for this study.

Inclusion criteria

The study included patients who were systemically healthy, who had not used any medication, especially antibiotics, for one month before debonding, whose orthodontic treatment was carried out only with brackets and molar tube, who had not eaten food or brushed their teeth for two hours prior to the appointment for the debonding procedure, who had not undergone any dental procedure, including examination, who agreed to fulfill the instructions given, and who were compatible for the study.

Exclusion criteria

The study excluded patients with any cardiac disease, type-I diabetes, who had received chemotherapy and radiotherapy, who had a disease causing immunosuppression, who were using immunosuppressive drugs, who had joint prosthesis, hemophilia and coronary stenting, and any dialysis patients with permanent vascular catheters.

Twenty-eight patients (18 female and 10 male) were selected. The randomization of patients who meet the inclusion criteria, provided with coin toss. All the patients were scheduled for debonding at 10 am. 10 ml of blood samples were collected from the antecubital veins of the patients under aseptic conditions at three different times: prior to debonding (T_0), immediately after removing the bracket and molar tubes (T_1) and immediately after cleaning the composite residues and plaque deposits on the enamel surface (T_2).

In our study, BACTEC 9240 blood culture system (Becton Dickinson, Diagnostic Instrument Systems, Sparks, MD) and BD BACTEC Plus blood culture bottles (Becton Dickinson, Diagnostic Instrument Systems, Sparks, MD) were used (Figure 1). During the collection of blood samples, we complied with the rules of asepsis and antisepsis.

Before the debonding procedure (T_0), the blood sample was taken. After the T_0 blood sample was cultured in the blood culture bottles, the debonding procedure was started and the patient's brackets and molar tubes were removed.

After removing the bracket and molar tubes, the T_1 blood sample was taken and blood was cultured in the culture bottle. No composite residue or plaque deposit was cleaned at T_1. Thirty minutes after taking T_1, the composite residues and plaque deposits on the surface of the teeth were cleaned and the T_2 blood sample was taken and cultured in the blood culture bottle.

Patient and group codes were written on the blood samples and these samples were incubated in the laboratory of

Figure 1. Blood culture bottles with (B) and without (A) blood culture.

the Faculty of Medicine's Department of Clinical Microbiology at Gaziantep University.

Blood culture bottles from the patients sent to the Microbiology Laboratory were placed in BD BACTEC 9240 device after registration. The incubation period of the device was determined to be seven days and blood cultures were maintained at 37 °C throughout the incubation period.

After the growth signal, the bottles were removed from the device and the plastic caps were wiped with alcohol. 2–3 ml of blood was then drawn from the bottle with a sterile injector. This blood sample was subcultured in sheep blood agar, chocolate agar and EMB agar in a biosafety cabinet near a Bunsen flame and placed on the incubator 24–48 hour. After bacterial growth was achieved, instant identification of bacteria was performed using a MALDI-TOF MS device (Bruker Daltonik GmbH, Bremen, Germany).

Statistical analysis

Statistical analyses of the results were performed using IBM SPSS for Windows (Statistical Package for Social Sciences, version: 24.0, Chicago, IL) package software. The Shapiro Wilk test was used to check the normal distribution of the numerical variables. The Mann–Whitney *U* Test was used to compare two independent groups in non-normally distributed variables. The relationship between categorical variables was determined using the Chi-Square Test. The Cochran *Q* Test was used to compare categorical variables at the three dependent time points, and the *Z*-Test was used to compare two independent rates. The results were within the 95% confidence interval and $p < .05$ was considered statistically significant.

Results

The mean age of 28 patients included in the study was 17.61 ± 5.34 years. The minimum and maximum values of the treatment duration were 1.16 and 3.25 years, respectively, and the mean treatment duration was 1.98 ± 0.60 years. There was no statistically significant difference in the number of isolated microorganisms in terms of age ($p = .308$) and treatment duration ($p = .555$) (Table 1).

Of the 28 patients included in the study, 18 (64.3%) were female and 10 (35.7%) were male. There was no significant relationship between gender and bacterial growth ($p = .636$) (Table 2).

No bacteremia was observed at T_0 and T_1 in the 28 patients included in the study. Bacteremia occurred in 10 (35.7%) of the patients at T_2, whereas no microorganisms were found in the blood of 18 (64.3%) patients (Table 3). In our study, the results of blood cultures detected bacteremia in 10 patients. *Streptococcus viridans* was isolated in one patient, *Streptococcus mitis* was isolated in one patient, *Streptococcus parasanguinis* was isolated in one patient, *Streptococcus salivarius* was isolated in one patient, *Staphylococcus aureus* was isolated in one patient, *Actinomyces oris* was isolated in one patient, *Actinomyces naeslundii* and *Klebsiella pneumoniae* were isolated in one patient; whereas *Streptococcus oralis* was isolated in 3 different patients. In one patient, *S. oralis* and *S. aureus* were both isolated (Table 4).

There was no statistically significant difference between the prevalence of *S. oralis* and other microorganisms ($p = .576$).

Multiple comparisons showed that there was a statistically significant difference between T_2 and the other two time points (T_0 and T_1) ($p = .001$), but that there was no statistically significant difference between the T_1 and T_0 time points ($p = 1.000$) (Table 5).

Discussion

The relationship between orthodontic practices and bacteremia has been a matter of curiosity for investigators. The literature review showed that investigators mostly focused on orthodontic banding and orthodontic band removal in their studies, but that there was no study on the effect of bracket and molar tube removal on bacteremia [15–18,22,23]. Therefore, in this study, it was aimed to investigate the effect of the extraction of orthodontic brackets and molar tubes with removal of residual composite and plaque deposits on bacteremia.

Although molecular tests are quick and promising method, especially for hard-breeding organisms, in diagnosis of bacteremia, it is still not first choice because of the inability to investigate all agents with one test, the lack of antibiotic susceptibility test and the cost [24]. Today, blood culture is the gold standard for bacteremia and is the most commonly used method in microbiology laboratories [25]. Despite improvements in diagnostic methods, blood cultures are still the only practical and reliable method for diagnosing bacteremia and fungemia [26]. Therefore, it was used that blood culture systems in our study.

In the literature, it is not recommended to draw the blood directly into blood culture bottles. This is because the vacuum effect of negative pressure in the blood culture bottles causes more blood to be drawn than recommended. The required blood should first be drawn from the patient and then cultured in the blood culture bottle or transport tube after the needle tip has been changed [27]. Therefore, direct blood collection had not been chosen in the method of in our dissertation study.

In this study, the bacteremia was investigated by collecting blood at different times in completely healthy volunteers with no systemic diseases. In this study, patients with no history of a recent systemic disease, drug use (especially antibiotics) or even a minor intra-oral procedure that could cause bacteremia were preferred. Patients were instructed not to eat anything or brush their teeth for two hours before the appointment time. With these instructions, it was aimed to eliminate the effect of other factors as much as possible while investigating the effects on bacteremia. Prior to performing any procedure, the first blood samples (T_0) were obtained to detect any possible bacteremia not associated with our study. Then only the brackets and molar tubes were removed and second blood samples (T_1) were taken. At this

Table 1. The relationship between the likelihood of bacteremia and age and duration of treatment in the volunteers involved in the study.

	Bacteremia	Number	Average	Standard deviation	p^*
Duration of treatment (year)	Negative	18	1.95	0.68	.308
	Positive	10	2.05	0.47	
Age	Negative	18	16.27	2.41	.555
	Positive	10	20.01	8.06	

*Mann–Whitney *U* test.

Table 2. The relationship between the incidence of bacteremia and the genders of volunteers participating in the study.

		T_2 Bacteremia		
		Negative	Positive	Total
Gender				
Female	*N* (%)	11 (61.1)	7 (70)	18 (64.3)
Male	*N* (%)	7 (38.9)	3 (30.0)	10 (35.7)
Total	*N* (%)	18 (100)	10 (100)	28 (100)

point, it was aimed to determine whether there was any bacteremia due to the removal of the brackets and molar tubes alone, or the movement of the teeth during these procedures. After waiting 30 minutes, the third and final blood sample was taken immediately after cleaning the composite residues and plaque deposits on the surface of the teeth (T_2). The 30-minute waiting period was implemented to prevent the interference of any possible bacteremia at T_1 with a possible bacteremia at T_2. This is because a healthy person's reticuloendothelial system cells will fight the bacteria and destroy them in 20 minutes [28], and this can sometimes last up to 30 minutes [1,2]. Our goal here was to ensure complete sterility of the blood. In this study, the bacteremia was investigated in all of the debonding procedures, as well as trying to determine at what stage of the debonding process the potential bacteremia occurred. The purpose of sampling blood immediately after the procedure was to allow the detection of bacteremia before it was destroyed by the body's defense cells [1,2].

The blood cultures showed no bacteremia in blood samples taken at T_0 and T_1, while bacteremia was seen in 36% (10 patients) of the blood samples taken at T_2. The majority of these bacteria are streptococci. In particular, the identification of *S. viridans* in our study is an important issue to be addressed. This is due to the fact that *S. viridans* is the primary and most common cause of bacterial endocarditis [6,29–31]. In our study, *S. viridans*, *S. mitis*, *S. parasanguinis*, *S. salivarius*, *S. aureus*, *A. oris*, *A. naeslundii* and *K. pneumoniae* were isolated in one patient, whereas *S. oralis* was isolated in three patients. In one patient, *S. oralis* and S. *aureus* were both isolated. Similar results have been reported in similar studies on bacteremia. In their studies, *S. viridans* was isolated by Lucas et al. [22], *S. parasanguinis, S. mitis* and *Actinomyces* by Burden et al. [18], *S. salivarius*, *S. parasanguinis* and *S. mitis* by Erverdi et al. [16], *S. parasanguinis* and *S. aureus* by Erverdi et al. in another study [17], *S. parasanguinis* and *S. aureus* by Gurel et al. [32], *S. sanguinis* by Uysal et al. [8] and *S. sanguinis* by Yagci et al. [9]. These results showed that the bacteria which caused bacteremia after the insertion and removal of bands, removal of rapid maxillary expansion appliances, after insertion of orthodontic mini-implants and after the orthodontic stripping procedure were similar to those which caused bacteremia after the debonding procedures in our study. This similarity suggests that not only do the insertion and removal of bands and removal of rapid maxillary expansion appliances require prophylaxis but also debonding procedures.

Table 3. The number and rate of bacteremia according to the time of blood sampling.

	Bacteremia	Number	%
T_0	Positive	0	0
	Negative	28	100
T_1	Positive	0	0
	Negative	28	100
T_2	Positive	10	35.7
	Negative	18	64.3

Table 4. Percent distribution of bacterium obtained from blood cultures and their proportion within the total number of patients.

Microorganism	Positive culture (*n*, %)
Streptococcus viridans	1 (3.57)
Streptococcus oralis	3 (10.71)
Streptococcus mitis	1 (3.57)
Streptococcus sanguinis	1 (3.57)
Streptococcus salivarius	1 (3.57)
Staphylococcus aereus	1 (3.57)
Actinomyces oris	1 (3.57)
Actinomyces naeslundii	1 (3.57)
Klebsiella pneumoniae	1 (3.57)

Table 5. Multiple comparison of bacteremia according to the time of blood sampling.

	T_0	T_1	T_2	p^*	Multiple comparison	
Bacteremia *N* (%)	0 (%0)	0 (%0)	10 (%35.7)	<.001	T_0–T_2	T_1–T_2

*Cochran *Q* test.

Lucas et al. investigated bacteremia before orthodontic banding in 2002 [23] and after the removal of orthodontic bands in 2007 [22] and found no significant relationship between the procedures and bacteremia in either study. However, in our study, bacteremia in the blood samples (T_2) after the debonding procedure was found to be statistically significant. These results can be attributed to today's advanced microbiological diagnostic methods, or to blood collection without phagocytosis of the bacteria by reticuloendothelial cells.

In their studies conducted in 1996, McLaughlin et al. [15] investigated bacteremia in 30 patients before and after orthodontic banding. They collected two different blood samples from patients just before and 60 seconds after the orthodontic banding. Bacteria were found in one sample taken before and three samples taken after the orthodontic banding. In both cases, *S. parasanguinis* and *S. mitis* were detected. Bacteremia was also detected before orthodontic banding, but in our study, no bacteremia was detected in the blood collected before the debonding procedure and immediately after removal of the bracket and molar tubes. The bacteria detected after orthodontic banding in this study and bacteria detected after debonding in our study were similar in terms of characterization. These microorganisms

(*S. parasanguinis and S. mitis*) are of importance as they are among the most frequent cause of bacterial endocarditis.

In their study on 30 patients in 2004, Burden et al. [18] investigated bacteremia after banding and bracket removal. In this study, they collected two blood samples before removal and after the cleaning process after removal. These blood samples showed bacteremia before removal in one patient and after removal in four patients. They found *Streptococcus viridans* predominantly in 4 patients, and the genera *Actinomyces* and *Veillonella* in 1 patient. Among these bacteria, the genera *S. viridans* and *Actinomyces* were also found in our study, even though no band removal was performed. In this study, the bacteremia that occurred was considered to have resulted from band removal, as band removal was performed in this study in addition to brackets. This study differs from our dissertation study in this respect. Furthermore, as the second blood sample was collected not immediately after removing the fixed appliances but after all cleaning procedures, it cannot be clearly distinguished whether bacteremia was caused by the removal of the fixed appliances or by cleaning of composites, cement residue, plaques deposits, etc. on the teeth. In this case, bacteremia was caused by the accumulated composites, cement residues and plaque deposits revealed after the removal of the fixed appliances. The absence of any microorganisms in the first samples in our study has made our study results more valuable, as well as directly associating the bacteremia with our procedure. Molar tubes are now widely used with the growing bonding agents and increased entrapment. For this reason, the use of the band is reduced. When the literature is examined, there are no studies investigating bacteremia after debonding in patients who only use brackets and tubes. This is one of the original aspects of the study.

In their study conducted on 30 patients in 2000, Erverdi et al. [16] investigated bacteremia before and after the removal of bands and the debonding procedure. In this study, bacteremia was detected in blood samples collected both before and after debonding and band removal procedures. *S. salivarius* and *S. parasanguinis* were detected in the first blood samples, whereas *S. parasanguinis* and *S. mitis* were detected in the blood samples after debonding and band removal procedures. There were similarities between the bacteria detected here and the bacteria detected in our study. In the light of results in the literature indicating the necessity of prophylaxis in band removal procedures as these bacteria were detected after the removal of bands, it was concluded that prophylaxis may be required before debonding procedures as similar bacteria have been detected in our dissertation study.

Conclusion

In our study, it was investigated whether the procedure of removing brackets and molar tubes, cleaning composite residues and removing plaque deposits lead to bacteremia and the following results were obtained:

1. Debonding procedures may cause bacterial contamination of the bloodstream, thus causing bacteremia.
2. There was no significant association between bacteremia and age, gender or duration of treatment in our study.
3. For prophylaxis candidates, prophylaxis may be needed before debonding procedures are carried out.
4. It has been concluded that further studies with clinically larger patient groups are needed to determine the effect of orthodontic debonding procedures on the incidence of bacteremia that leads to bacterial endocarditis.

Disclosure statement

No conflict of interest was declared by the authors.

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