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ORIGINAL RESEARCH

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Comparative assessment of the adhesion of *Streptococcus mutans* and *Lactobacillus* to pedodontic crowns made of metal and zirconium.

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Abstract
Introduction: The microbial flora in children's oral cavities is diverse, with *Streptococcus mutans* (*S. mutans*) and *Lactobacillus* playing key roles in the development of dental caries and periodontal inflammation. Resin restorations, commonly used for carious lesions, may lead to secondary decay and complications over time, making dental crowns a preferred option in pediatric dentistry. Metal crowns are effective for multiple surface lesions, while zirconium crowns offer superior aesthetics and biocompatibility. However, crown placement can promote bacterial adhesion, particularly by *S. Mutans* on enamel and cementum, and *Lactobacillus* on dentin, potentially affecting long-term restoration success. Bacterial adhesion can be assessed through plaque samples to evaluate restoration durability. **Aim of the study:** The purpose of the study is to evaluate the microbial adhesion of *S. mutans* and *Lactobacillus* on pedodontic crown surfaces. **Material and methods:** 60 patients with metal and zirconium pedodontic crowns were included in the study. We analyzed the bacterial load with KariesScreenTests. **Conclusion:** Metal pedodontic crowns have higher microbial adhesion, with *S. mutans* outnumbering *Lactobacillus*. Zirconium crowns show lower microbial adhesion, with fewer bacteria overall. *S. mutans* is present in higher quantities than *Lactobacillus*, but still less than in metal crowns. Zirconium crowns are a better option for restoring primary teeth, as they reduce plaque buildup and bacterial growth, offering improved long-term oral health benefits.
Keywords: pedodontic crowns, bacterial adhesion, KariesScreenTest.

Introduction

The microbial flora in children's buccal cavity is diverse. Bacteria are transmitted vertically from the mother during the first moments of life. Carious processes and gum inflammation are caused by *S. mutans*, the main bacterium. It is able to adhere to surfaces and generate significant amounts of acid. A low pH is a favorable environment for this, which leads to an increase in the production of glucan from food residues. Oral biofilm – together with other host-related factors – has been repeatedly associated with the development of dental caries and periodontitis [1-6].

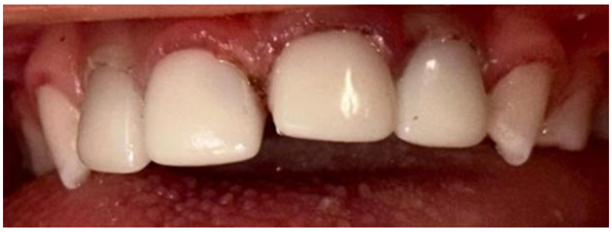
The carious lesion needs to be removed, and to fill the cavity, the most commonly used material is resin. However, the resin restoration technique can lead to secondary decay, fracture, postoperative sensitivity, and discoloration after long-term follow-up. That's why dental crowns are often used in children [7-8].

Pedodontic metal crowns have passed the test of time, proving to be the most appropriate treatment for carious lesions on multiple surfaces. The studies have shown that the incidence of gingivitis is higher when crowns exhibit poor marginal adaptation. To minimize bacterial accumulation and gingival inflammation, the use of crampon pliers is recommended for precise trimming and adjustment of concavity, ensuring optimal marginal fit. Good mechanical properties, biocompatibility and superior aesthetics, are achieved by zirconium pedodontic crowns, which are indicated for the restoration of teeth with significant structural loss. Through the smooth surface minimizes microbial adhesion and implicitly the accumulation of bacterial plaque [7 ,9-11].

The placement of dental crowns in the oral cavity creates an environment conducive to bacterial adhesion, thereby promoting the development of secondary caries or periodontal inflammation. Specifically, *S. mutans* colonizes both the enamel and cementum, while *Lactobacillus* predominates in the dentin, potentially compromising the long-term stability and functionality of the restoration. The adherence of these bacteria can be isolated from plaque samples, allowing for the assessment of restoration longevity by evaluating the impact of bacterial adhesion on the crown surface [2-4 ,12-14].

The aim of the research is to evaluate and quantify the microbial adhesion of *S. mutans* and *Lactobacillus* from the surfaces of pedodontic crowns and to assess the degree of risk in the occurrence of inflammation by determining the level of microorganisms in the bacterial plaque at the surface of the crowns. The importance of analyzing the plaque microbiome on pediatric crowns is highlighted by the limited number of studies available in the specialized literature on this topic.

Material and methods
A number of 60 patients aged between 3 and 11 years old were included in the clinic study (deciduous dentition and mixed dentition). The patients were divided into 2 patient cohorts as follows: the first cohort of 37 patients with a pedodontic metal crown cemented in the oral cavity, and in the second cohort participated 23 patients with zirconium pedodontic crown. They come from clinics in both Targu Mures and Reghin. We performed the clinical examination of patients (Figure 1,2) and took samples from the level gingival and on the surface of the crown. For this study, we received the agreement through the decision of the ethics committee of scientific research no. 3141b and obtained the informed consent of the patients.



Figures 1,2 – Intraoral photographs of two patients, one presenting with metal crowns cemented on the molars, and the other with zirconia crowns placed on the anterior teeth

The tests used are the "KariesScreenTest," which contains 10 tubes, each with 2 culture media, one for *S. mutans* and the other for *Lactobacillus* (they are protected from the external environment by a sealed foil on their surface), sodium bicarbonate tablets, paraffin, and pipettes.

In our study, we did not use the pipette, as we did not perform saliva tests, nor the paraffin. These were stored at a temperature of 4 degrees Celsius to preserve their integrity, according to the manufacturer's specifications (Figure 3).

Figure 3 – Sampling kit - KariesScreenTest

The next step was inoculating the sample onto the culture medium for *S. mutans* and *Lactobacillus*. A sodium bicarbonate tablet was added inside the container (Figure 4) to create a favorable environment for bacterial growth. On the lids of the tests, we marked the type of crown with M or Z, corresponding to the material of the crown (metal or zirconium), the number corresponding to the crowns investigated, the date when the culture medium was inoculated, and the time the sample was placed in the incubator to track how long each test needed to remain.

We used the Cultura mini-incubator from Ivoclar Vivadent, located within the Pedodontics department of the Faculty of Dental Medicine at the George Emil Palade University of Medicine, Pharmacy, Science, and Technology in Târgu Mureș. The tests remained in the incubator for 48 hours at a temperature between 25 and 55 degrees Celsius.After 48 hours, we removed the samples from the incubator, identified the bacterial colonies grown on the culture media, and compared the microbial load on the tests based on their number, according to the standard chart in (Figure 5).

Figure 4 – The sodium bicarbonate tablet inserted into the tube to create an environment conducive to bacterial growth

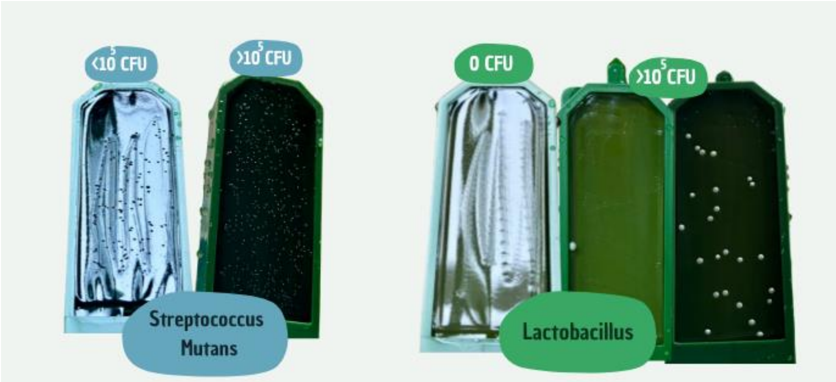


Figure 5 – The method of counting bacterial cultures

Results

Microbiological Tests

In the figures below one can see the microbial load of the tests after they have been removed from the incubator. Tests performed on pedodontic metal crowns (Figure 6) and zirconium (Figure 7).

In the table we introduced the bacterial load data, following the interpretation of the standard scheme for both metal materials and zirconium (Table 1).

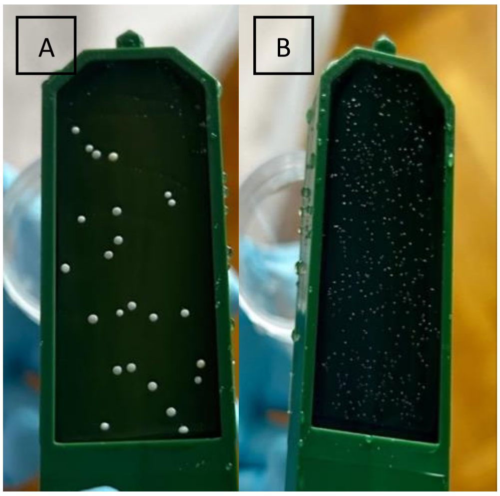


Figure 6 – Metal crown tests, after removal from the incubator, show the presence of microbial colonies on the culture medium
A – *Lactobacillus*,
B – *S. mutans*

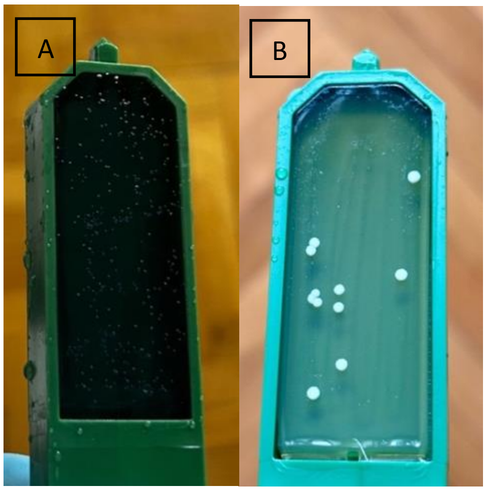


Figure 7 – Zirconium crown tests, after removal from the incubator, show the presence of microbial colonies on the culture medium
A – *Lactobacillus*,
B – *S. mutans*

Table 1. Bacterial values – metal and zirconium pediatric crowns.

No.	Metal		Zirconium	
	S. mutans **(CFU)**	***Lactobacillus*** **(CFU)**	***S. mutans*** **(CFU)**	***Lactobacillus*** **(CFU)**
1.	$\geq 10^5$	$<10^5$	0	0
2.	$\geq 10^5$	0	$<10^5$	$<10^5$
3.	$\geq 10^5$	$<10^5$	$\geq 10^5$	0
4.	$\geq 10^5$	$<10^5$	$\geq 10^5$	0
5.	$<10^5$	$<10^5$	$<10^5$	0
6.	$<10^5$	0	$<10^5$	0
7.	0	0	$<10^5$	0
8.	0	0	0	0
9.	$<10^5$	$<10^5$	$\geq 10^5$	0
10.	$\geq 10^5$	$<10^5$	$\geq 10^5$	0
11.	$<10^5$	$<10^5$	$\geq 10^5$	0
12.	$\geq 10^5$	$<10^5$	$\geq 10^5$	0
13.	$<10^5$	$<10^5$	$\geq 10^5$	0
14.	$<10^5$	$<10^5$	$\geq 10^5$	$<10^5$
15.	$\geq 10^5$	0	$\geq 10^5$	$<10^5$
16.	$\geq 10^5$	$<10^5$	$\geq 10^5$	0
17.	$\geq 10^5$	$<10^5$	$<10^5$	0
18.	$\geq 10^5$	$<10^5$	$\geq 10^5$	$<10^5$
19.	$<10^5$	$<10^5$	$\geq 10^5$	0
20.	$<10^5$	0	$<10^5$	0
21.	$<10^5$	$<10^5$	$\geq 10^5$	$<10^5$
22.	$\geq 10^5$	$<10^5$	$<10^5$	0
23.	$\geq 10^5$	$<10^5$	$<10^5$	$<10^5$
24.	$\geq 10^5$	$<10^5$		
25.	$\geq 10^5$	0		
26.	$<10^5$	0		
27.	$\geq 10^5$	$<10^5$		
28.	$\geq 10^5$	$<10^5$		
29.	$\geq 10^5$	0		
30.	$\geq 10^5$	$<10^5$		
31.	$\geq 10^5$	$<10^5$		
32.	$<10^5$	$<10^5$		
33.	$<10^5$	$<10^5$		
34.	$<10^5$	$<10^5$		
35.	$\geq 10^5$	0		
36.	$<10^5$	$<10^5$		
37.	$\geq 10^5$	$<10^5$		

Note: CFU - Colony-Forming Unit

Descriptive statistical analysis

Restorative material

The study sample includes 60 people who have restoration works with pedodontic crowns, 37 of them (61.7%) with metal pedodontic crowns and 23 (38.3%) with zirconium pedodontic crowns (Figure 8).

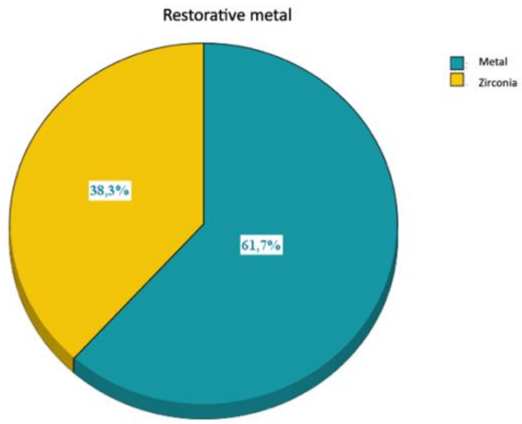


Figure 8 - Distribution of the study sample according to the type of pedodontic crown material used

S. mutans

After assessing the amount of *S. mutans* present in pedodontic crowns, we observed a level 0 in 4 of the subjects (6.7%), a low standard density in 22 of the subjects (36.7%) and high standard density in 34 of the subjects (56.7%) (Figure 9).

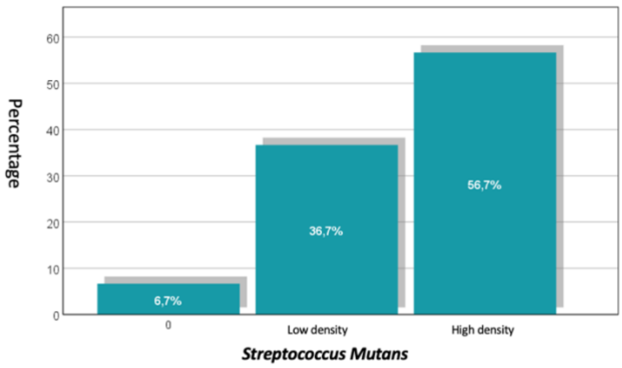


Figure 9 – Distribution of *S. mutans* density levels among subjects with pedodontic crowns

Lactobacillus

Regarding the amount of *Lactobacillus* present in pedodontic crowns, 45% of subjects were not found to have *Lactobacillus*, while 55% there was a low standard density (Figure 10).

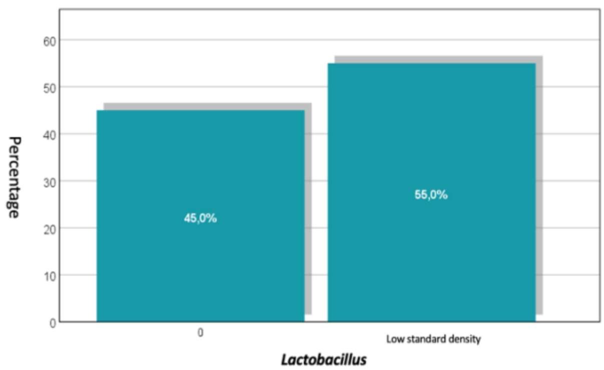


Figure 10 - Distribution of *Lactobacillus* density levels among subjects with pedodontic crowns

Comparison of the two restoration materials on microbial adhesion of S. mutans

To test the relationship between the restoration material and the amount of *S. mutans* present in the pedodontic crowns, we used the chi-square test.

There is no significant association between the two variables (p=0,875). More specifically, the weights of the different amounts of *S. mutans* present at the level of pedodontic crowns are similar on the two restoration materials, as can be seen in Figure 11. We can conclude that the two restoration materials do not differ significantly in terms of adhesion of *S. mutans*.

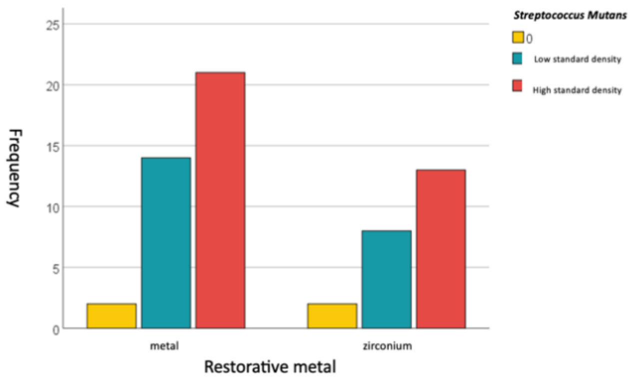


Figure 11 – Chi-square test – Comparison of *S. mutans* adhesion distribution on metal versus zirconium pedodontic crowns

Comparison of the two restoration materials on microbial adhesion of Lactobacillus

However, in the case of the relationship between the restoration material and the quantity of *Lactobacillus* present at the level of the pedodontic crowns, a statistically significant association ($p<0.001$) is found.

We observe a significantly higher share (73%) of the presence of a low standard density at the level of pedodontic metal crowns, compared to zirconium pedodontic crowns, where a low standard density of *Lactobacillus* is found only in 26,1% of subjects (figure 12). We appreciate that the two restoration materials differ significantly in terms of adhesion of *Lactobacillus*, zirconium being a more effective material in terms of periodontal health.

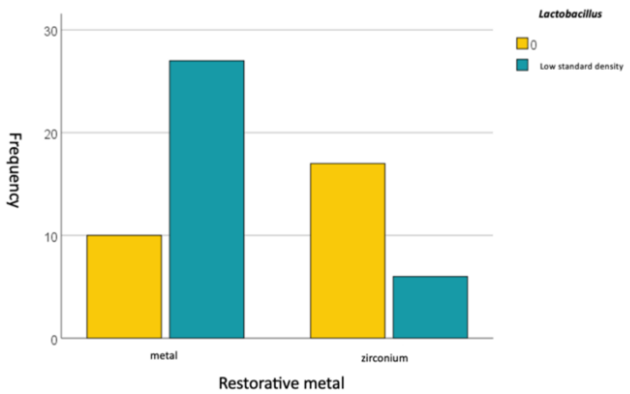


Figure 12 – Chi-square test – comparison of *Lactobacillus* adhesion distribution on metal versus zirconium pedodontic crowns

Discussions

Microbial adhesion to pedodontic crowns refers to the accumulation of dental plaque at the level of the coronal surface and in the cervical area, it can reduce the marginal adaptation of the restoration, which can lead to the formation of caries at this level. An increased amount of these bacteria can cause oral disease by the appearance of gingivitis or periodontitis. In assessing the success of treatment using these coronary restorations, it is essential to evaluate the amount of bacteria present on the coronary surface [15].

The results obtained from this study refer to the microbial adhesion of pedodontic crowns, and by comparing them we can highlight which of them has a lower microbial adhesion. Thus, when assessing the adhesion of *S. mutans* the values vary between a low and high density, a predominant high standard density was observed. As for the adhesion of *Lactobacillus*, the values are relatively close between the value of 0 and the low standard density [3].

Comparing the bacterial levels of *S. mutans* between the materials of the crowns, similar values were observed, in parallel with the presence of *Lactobacillus*, the standard bacterial density is low at zirconium crowns. The latter demonstrated the lowest microbial amount, showing a much higher efficiency in maintaining periodontal health [3].

Our research confirms that at the level of metal crowns there is an increased bacterial adhesion compared to zirconium crowns. Chemicals used in materials may be an important factor in promoting bacterial colonization. The chemical stability and biocompatibility of the components of zirconium products have a negligible rate, which may influence the results when referring to microbial adhesion in zirconium pedodontic crowns. Compared to other studies, where also the biofilm formed on zirconium crowns is significantly lower, compared to metal crowns, account shall also be taken of the adaptation at the level of these crowns with regard to plaque buildup. Instead, the preparation of the abutment for the cementation of both types of crowns is aimed at a similar level of subgingival placement. However, gingival inflammation and plaque buildup around zirconia crowns were lower compared to metal ones. [4,14,16,17].

The colonization ability of oral bacteria increases when the enamel is covered by saliva. This is scientifically researched, and it can be said that this aspect also applies to pedodontic crowns, which are exposed in the oral environment, where constant environmental changes occur and form the biofilm [9,18].

As for the presence of *Lactobacillus*, they are able to inhibit the growth of carious pathogens and those that produce periodontal damage. At the same time, they are involved in the emergence and evolution of dental caries, being opportunistic colonizers that gather and multiply in restrictive niches (such as the marginal level of dental crowns) [19,20].

Scientific research has obtained values similar to those already found in the specialized literature. Drawing a parallel between the present study and one conducted on an Egyptian population, the results were comparable. This study concludes that bacterial accumulation was initially similar for both crown types. Over time, zirconia crowns showed lower bacterial adhesion, with stainless steel crowns exhibiting significantly higher accumulation after three months. This suggests zirconia is more effective in preventing bacterial adherence and promoting better oral hygiene. Thus, we can state that both studies indicate that zirconia pediatric crowns are more effective in preventing bacterial accumulation compared to metal crowns, contributing to better oral health [7, 16].

Suggestions that could improve this study could be to make a larger group of patients that have more selection criteria, so they can be divided into age groups, sex, the tooth on which the work was cemented. The study can be done on the same commercial types of pedodontic crowns, referring to both metal and zirconium. Samples can be periodontal health assessments over a longer period of time, by taking samples at regular intervals to see if the microbial amount over time intervals increases [21].

Conclusions

This clinical research has shown increased microbial adhesion on the surface of metal pedodontic crowns, with *S. mutans* being more prevalent than *Lactobacillus*. In comparison, zirconium pedodontic crowns exhibit significantly lower microbial adhesion, with *Lactobacillus* present in the lowest amount and *S. mutans* detected in higher quantities.

Compared to metal crowns, zirconium crowns demonstrate reduced microbial adhesion, making them advantageous in preventing plaque accumulation. Therefore, zirconium pedodontic crowns represent an optimal choice for the restoration of primary teeth, contributing to improved oral hygiene and a lower risk of periodontal disease.

Conflict of interest: None to declare.

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