

THE MICROLEAKAGE BETWEEN TITANIUM AND VENEERING MATERIALS

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REZUMAT

Objective: Studiarea microscurgerilor cervicale între titan și 3 sisteme de porțelan.

Material și metodă: Titanium ul folosit în acest studiu comercializat, pur

Results: The least microleakage at the interface was produced by Ti22 porcelain (0 ± 0.0), followed by Triceram (0.25 ± 0.5) and Vitatitankeramik (0.75 ± 0.957). Nevertheless, the differences between porcelain systems were not statistically significant ($p > 0.05$).

Conclusions: Within the limitations of this in vitro study, there was no significant microleakage between titanium coping and the porcelain veneer, regardless of the porcelain system.

Key Words: titanium, porcelain, interface, microleakage

ABSTRACT

Objective: This study investigated the cervical microleakage between titanium and three porcelain systems.

Material and Methods: The titanium used in this study (commercially pure, grade 2, IMNR Bucharest, Romania) was veneered with three porcelain systems specially designed for fusing on titanium: Ti22 (Noritake, Nishikamogun, Aichi, Japan), Triceram (Esprident, Ispringen, Germany) and Vitatitankeramik (Vita, Bad Säckingen, Germany).

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INTRODUCTION

The marginal adaptation and resistance to microleakage are among the most important factors for clinical success in fixed prosthodontics. The microleakage that occurs in the cervical area between a veneer and the subjacent coping results in cervical stain, bad taste or even failure of the interface.

It was hypothesized that the absence of a chemical adhesive system might result in microleakage because of the differences between alloy and polymeric material regarding thermal expansion.¹ Regarding titanium-

porcelain interface, strong chemical and physical compatibility exists between the two different materials provided that a proper technology is used.²

Microleakage may be defined as passage of bacteria, fluids, molecules or ions between two restorative materials^{3,4} or between a restorative material and hard dental tissues.⁵ This phenomenon occurs when adhesion at the interface is lost as a result either of thermal and mechanical stresses or lack of accuracy during the laboratory procedures.

The purpose of this study was to investigate the cervical microleakage at the titanium-porcelain interface.

MATERIALS AND METHODS

The specimens consisted of 12 veneer crowns manufactured under similar and reproducible conditions as described below.

Commercially pure titanium grade 2 was used to obtain 12 metallic frameworks (copings).

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The wax pattern of each coping was constructed on the same cast using 0.6 mm calibrated wax (Bego, Bremen, Germany). The margin of the preparation had a 1.4-mm-deep chamfer finish line (Fig. 1). The entire technological process for producing the copings was accomplished by using the same laboratory routine in order to obtain a similar design for all specimens.

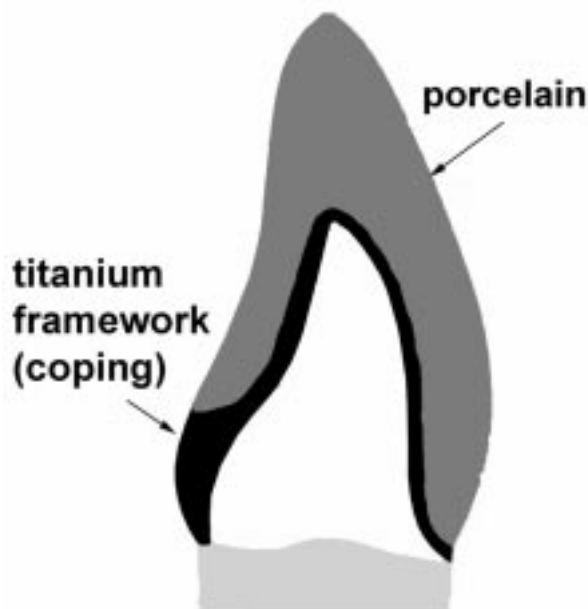


Figure 1. Aspect of the titanium-porcelain specimens

Three porcelain systems specially conceived for titanium were chosen for veneering: Ti22 (Noritake, Nishikamogun, Aichi, Japan), Triceram (Esprident, Ispringen, Germany) and Vitatitankeramik (Vita, Bad Säckingen, Germany). Specimens to be veneered with Ti22 were sandblasted with 50 µm alumina at a 4-bar pressure, and then ultrasonically cleaned in acetone solution for 10 minutes. After cleaning, copings were fired at 500°C to 800°C with a heat rate of 50°C/min, and a hold time of 3 minutes under vacuum of 74cm/Hg for the oxidation treatment of pure titanium. The adhesive (BP, Ti22), opaque, dentine and enamel layers were applied, built-up and fired according to manufacturer's indications. Glazing was carried out in the absence of vacuum. A total number of 4 firings were made for each specimen.

Specimens to be veneered with Vitatitankeramik and Triceram were sandblasted with 150 µm alumina at a 2 bar pressure. After sandblasting, the copings were passivated for approximately 10 minutes. Adhesives (Bonder Vitatitankeramik and Bonder Triceram), opaque, dentine and enamel layers were applied, built-up and fired according to manufacturer's instructions. Glazing was carried out under vacuum for Vitatitankeramik specimens, and in air for Triceram. A total number of 4 firings were made for each specimen.

Four veneer crowns of each titanium-veneering

material combination were obtained, resulting in 12 completed specimens. Proximal interfaces of each crown were insulated with nail varnish in order to prevent the microleakage at these levels, which could have resulted in false scores for the cervical microleakage. All specimens were stored in distilled water at 37°C for 2 weeks in order to simulate the thermal conditions in the oral environment. The specimens were then thermocycled 2000 cycles between 5-55°C with a dwell time of 25 seconds and a transit time of 5 seconds between baths. Thermocycled specimens were then immersed in basic fuchsin 0.5% at 37°C for 24 hours, rinsed and dried.

All specimens were then sectioned through a central cervical-incisal plane through the middle of the cervical collar using fine diamond discs grit 514 (MDT Micro Diamond Tools Ltd., Afula, Israel) under water-cooling. The sectioned surfaces were then polished using Hardie Brown FL2-shaped silicone polishers (Shofu, Kyoto, Japan) and Composite Polishing Paste (Shofu, Kyoto, Japan), a submicron aluminium oxide abrasive particles paste.

The cervical accuracy of fit was assessed by the dye-penetration within the interface and the mechanical integrity of the interface as well as using an optical microscope (Euromex FT MIC 2665, Holland) at magnification x 40-400. The microscope was equipped with an ocular grid calibrated with a stage micrometer (one division = 0.01 mm) so that partitioning the analyzed surfaces was standardized for each specimen. The depth of the coping chamfer was considered to be 0.8 mm; axial wall continues the chamfer beyond this depth (Fig. 2).

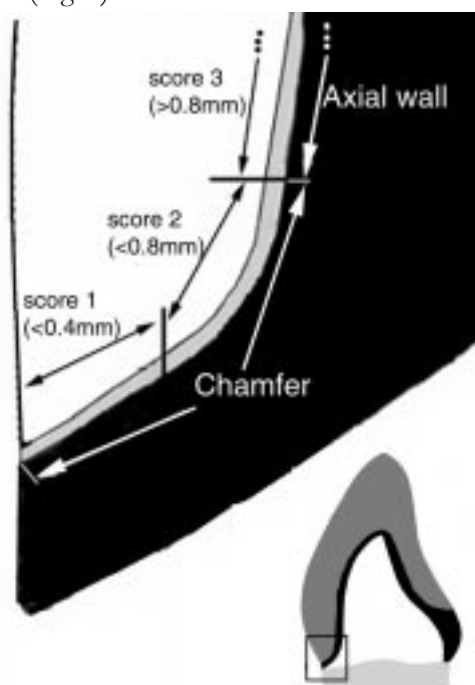


Figure 2. Microleakage scoring system

Leakage scores were established by the authors (Fig. 2): 0 = no microleakage; 1 = dye penetration up to or less than one half of the chamfer depth (the external part of the chamfer curvature; $d < 0.4$ mm); 2 = dye penetration up to but not including the axial wall ($0.4 < d < 0.8$ mm); 3 = dye penetration along the axial wall ($d > 0.8$ mm); and 4 = interface failure (such as gaps or detachment of the material) combined with any score of microleakage. Two independent evaluators scored the coded specimens, and any discrepancies were discussed. A final agreement was always reached, so no third-party opinion was needed or sought. Because each tooth was sectioned into 2 parts, 2 readings were obtained for each specimen. The 2 sections were approximately 0.6 mm apart because of the thickness of the diamond disc. After analyzing each of the two halves for every specimen, the highest microleakage value was recorded and the specimens were compared.

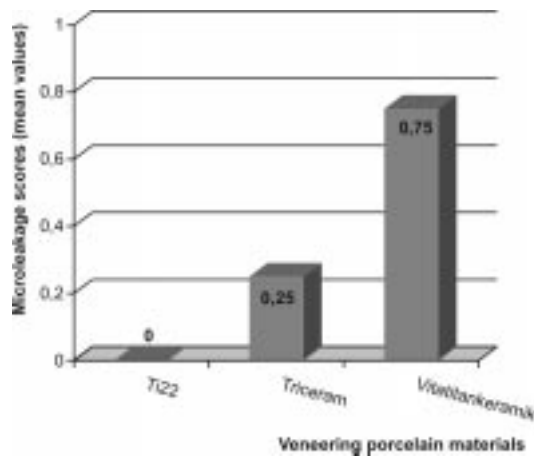


Figure 3. Cervical microleakage scores (mean values)

Statistical analysis was performed with one-way analysis of variance (ANOVA) to determine significant differences between the groups.

RESULTS

Only microleakage scores of 0, 1 and 2 were observed in the study (Table 1 and Fig. 3). Some specimens exhibited different scores on the two halves (Table 2). The lowest scores were observed with Ti22 (0 ± 0.0), followed by Triceram (0.25 ± 0.5). The

highest scores were observed with Vitatitankeramik (0.75 ± 0.957).

One-way ANOVA for the three types of porcelain revealed no statistical difference between the groups at a level of significance of $\alpha = 95\%$ ($p = 0.274016$) (Table 3).

Table 1. The scores of the cervical microleakage (considered values).

	Veneering porcelain		
	Ti22	Triceram	Vitatitankeramik
Specimen 1	0	0	1
Specimen 2	0	1	0
Specimen 3	0	0	0
Specimen 4	0	0	2
Mean	0	0.25	0.75
Std dev	0.0	0.5	0.957

Table 2. The scores of the cervical microleakage - values of microleakage exhibited by mesial and distal halves of each specimen (depth of leakage in brackets).

		Veneering porcelain		
		Ti22	Triceram	Vitatitankeramik
Specimen 1	Mesial	0	0	1 (150 m)
	Distal	0	0	1 (100 m)
Specimen 2	Mesial	0	1 (100 m)	0
	Distal	0	1 (100 m)	0
Specimen 3	Mesial	0	0	0
	Distal	0	0	0
Specimen 4	Mesial	0	0	2 (500 m)
	Distal	0	0	2 (750 m)

DISCUSSIONS

Regardless the porcelain system, not significant microleakage was found at titanium-porcelain interface. Moreover, Ti22 system exhibited no microleakage at all. Porcelain specimens with microleakage degrees exhibited some cast deficiencies of the titanium copings (gaps) too. Such gaps in the cervical part of the coping could have been the promoters for microleakage.

The microleakage at the titanium-porcelain interface was statistically not significant. The occurrence of leakage in porcelain samples could be assigned to technological deficiencies in titanium casting process, which is suggested by the microscopic imperfections of the copings.

Table 3. Results of analysis of variance

Source of variance	df	SS	MS	F	p
Veneering material	2	1.166667	0.583333	1.500000	0.274016
Residual	9	3.500000	0.388889		

Specimen 1 and specimen 4 of Vitatitankeramik sample showed different depths of microleakage on the two halves. This is because of the diamond disc's thickness.

Resins have a higher coefficient of thermal expansion than metal alloys and this is likely to induce stress at the metal-resin interface following temperature changes.⁶ In addition, when polymeric materials are used for veneering, the interface failure may occur as a result of polymerization shrinkage.⁷ Thus, it is normal to observe a degree of microleakage after storage in water and thermocycling.^{8,9}

Regarding porcelain materials, there are different aspects of the subject. Provided that a-case layer is thoroughly removed,² strong chemical and physical compatibility exists between titanium and porcelain, which results in tight interfaces that prevent microleakage. Nevertheless, some authors suggest that microleakage can occur between base metal and porcelain as a result of the chemical bonding.¹⁰ A surprisingly large amount of microleakage at the metal-porcelain interface of ceramometal restorations has been reported.^{3,11} Significant microleakage was found even at the titanium-porcelain interface,⁴ which is discordant with the results of the present study.

Stresses in the oral environment are complex. Nevertheless, simulated thermocycling is commonly used in microleakage studies.^{3,12} Although there is no general agreement about the significance of thermocycling in relation to thermal changes in an oral environment, it has been shown that the major effects of thermocycling on a heterogeneous interface appear after the first 100-200 cycles between 5-55°C.¹³⁻¹⁵ In this study 2000 cycles between 5-55°C were performed for a more appropriate simulation of the thermal stress of a long-term prosthetic restoration in an oral environment. According to some studies this represents more than required for a proper thermal simulation.^{16,17}

The microleakage can be assessed using either dye or radioactive isotopes.¹³ When using isotopes, the results are significantly influenced by isotope power, distance between radiation source and target, time of exposure and redundant isotope removal process;¹⁸ thus, the isotope technique is very sensitive and more qualitative than quantitative.¹⁹ Because of the limitations of the isotope-technique, the most usual method of assessing the quantitative aspect of microleakage is through the use of dye.²⁰⁻²² The present study used basic fuchsin 0.5% for revealing and assessing the microleakage.

In vitro evaluation is the first step for testing any technique or material, and to determine the properties and potential that it possesses. Although the design of the specimens must simulate clinically usable veneer

crowns, a clinical test should be considered for a more relevant evaluation.

CONCLUSIONS

Within the limits of this study, the following conclusions were drawn:

1. There was no significant microleakage between titanium and porcelain, regardless the porcelain system used.
2. Microleakage that occurs at the titanium-porcelain interface is related to the sensitive technology of titanium casting.

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