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THE DIFFERENCE BETWEEN ZIRCONIUM CROWNS AND STAINLESS STEEL CROWNS IN THE PROSTHETICS OF PREMOLARS

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A B S T R A C T	K E Y W O R D S
One of the reasons for the refusal to use CAD/CAM technologies in dentistry are reports of the insolvency of all-ceramic frame restorations made of polycrystalline ceramics based on zirconium dioxide and the chipping of veneers [1, 2]. The discrepancy in the recommendations for the manufacture of frame all-ceramic restorations raises a number of questions. Sandblasting is still widely used to improve surface roughness, strengthen the bond between the veneer and the frame and increase the strength of the joint during cementing.	

Introduction

According to the theory, the resulting microcracks cause a phase transition from a metastable tetragonal lattice structure to a monoclinic lattice structure. This is accompanied by an increase in volume by 4-5%. This makes it possible to block cracks by creating compressive stresses, but at the same time the phase ratio changes. After shot blasting of the surface, the so-called recovery firing is recommended. High-temperature exposure can contribute to reverse phase transitions. However , high - temperature exposure can lead to the removal of expansion blocks and further crack propagation . The analysis of special literature in order to clarify the chemical elements of this problem has led to diametrically opposite opinions about the qualitative effect of abrasive and temperature treatment on tetragonal zirconium dioxide. Therefore, it is necessary to find out the nature and degree of influence of sandblasting and diamond tool processing on the strength properties and phase state of YTZP samples, as well as the advantages of "regenerative" firing to restore the initial properties of the material and the phase state of YTZP. The study of this issue can solve many problems associated with the violation of the integrity of all-ceramic dentures. Our clinical studies have demonstrated excellent strength and functional properties of ceramics based on zirconium dioxide. 100% of the manufactured bridges, regardless of the manufacturing system, preserved the integrity of the restoration for more than two years of observation. At the same time, some patients complained of a violation of the integrity of previously manufactured frame prostheses made of zirconium dioxide and chipped ceramic veneers. The existence of this problem is also confirmed by numerous literature data. A comprehensive analysis of the failures of previous treatment showed that in most cases they were due to the negligence of technical or clinical treatment protocols. The frame manufacturing process includes elements of polishing and heat treatment. A detailed study of the manufacturing process revealed discrepancies in the recommendations for the treatment of ceramics based on zirconium dioxide. Therefore, the study was undertaken to determine the nature and degree of influence of sandblasting and diamond tool processing on the strength properties and phase state of ceramic samples based on zirconium dioxide (YTZP), as well as the possibility of "regenerative" firing to restore the initial properties of the material and the phase state of zirconium dioxide.

The purpose of the study: to determine the nature and degree of influence of sandblasting and diamond tool processing on the strength properties and phase state of zirconium dioxide.

Materials and Methods:
As a test material, standard blocks of pre-synthesized ceramics based on zirconium dioxide (VITA InCeram YZ Cubes for in Lab, Vita) were used for the automated manufacture of frames of fixed prostheses using the CEREC in Lab system (Sirona, Switzerland). Zahnfabri was used as a test material. All samples were finally synthesized in the Zyrcomat T furnace (Vita Zahnfabrik, Germany) at a temperature of 1500 ° C for 8 hours in accordance with the manufacturer's recommendations. Samples of a beam shape with a rectangular cross-section were subjected to tests. The samples of the first series (control (K)) were subjected to additional mechanical and temperature treatment. Samples of the second series (P) were sandblasted for 10 seconds at a distance of 10 mm from the surface using Al2 O3 particles with a size of 50 microns in a sandblasting machine. The samples of the third series (PO) were subjected to a similar sandblasting in a sandblasting machine, followed by "recovery" firing at 1000 °C for 15 minutes. Samples of the fourth series (A) were subjected to grinding of turbine tips under intensive water cooling using fine-grained diamond bores Red Code ZR8850.314.016 (Komet, Germany). The fifth series (AO) consisted of samples treated with diamond borons and further synthesized according to the scheme described above. The total number of samples was 100 (20 from each series). All samples were subjected to destruction on a universal testing machine Instron 5581 (Instron Limited, High Wycombe, UK), equipped with a load sensor 2000 N, to study the strength at three-point bending. The study was conducted at the A.A. Baykov Institute of Metallurgy and Materials Science of the Russian Academy of Sciences in accordance with the requirements of ISO 6872:2008 (Dentistry - Ceramic materials). The strength was calculated from the length and width of the sample, the distance between the loading points and the maximum load at which the fracture occurs at temperature. The loading speed during the tests was 0.5 mm/min. The distance between the beams was 10 mm.
The maximum stress in the sample was calculated by the equation: σizg = 3PL/2BW2, where σizg is the bending strength, MPa; P is the maximum load, H; L is the distance between the supports, B is the width of the sample, W is the height of the sample, mm Numerical data were statistically processed. A Tescan VEGA II microscope (Czech Republic) was used for visual analysis of experimental objects and scanning electron microscopy (SEM) methods were used at magnification up to 1000x. To study the morphology of particles in raster mode, samples were glued to copper substrates using conductive carbon glue and sprayed with a layer of gold (Univex 300 spraying unit - "Leybold", Germany; Fine Coat - "JEOL", Japan). All received photos were registered. To identify qualitative and quantitative phase changes on the surface of the treated samples, the method of X-ray phase analysis (XFA) for polycrystalline samples was used. This method allows you to conduct research without scraping the

material in a mortar used in powder analysis. This is very important for the objectivity of this study, since any mechanical impact can affect the data obtained. The research and analysis of the obtained results were carried out at the Institute of Crystallography of the Russian Academy of Sciences and the Kurchatov Center for Synchrotron Radiation and Nanotechnology on a MarResearch diffractometer at the Belok research Station (Germany).Five series of flat samples of zirconium dioxide were placed in the beam, polished surfaces were studied in the P, PO, A and AO series. The diffractometer was focused from the sample using the Bragg-Brentano method. The content of the crystalline phase on the sample surface was estimated by integral maxima in the range of angles 2° - 40° 2θ. The amount of crystal phase in the sample was determined by the relative integral activity, which is proportional to the first. The peak with the highest integral activity was selected for analysis. After selecting the largest peak, the relative intensity was calculated as a percentage of it. At least three studies were conducted with each sample. All data was recorded and analyzed. RESULTS AND DISCUSSION Evaluation of the strength of samples of metastable zirconium dioxide under three-point bending. The research results have shown that both abrasive mechanical action and sintering of additives on zirconium dioxide samples affect their strength characteristics. A comparison of the average results of studies by series (see the table) shows that there is a certain dynamics in the bending strength of ceramics made of zirconium dioxide. In both cases, when polishing the surface, the strength tends to change upwards, and further heat treatment reduces the strength, although its values remain higher than those of the controls. Statistical processing of the results of the study was carried out using ANOVA analysis of variance by checking the significance of differences between the mean values by comparing variations. Based on the data obtained and their statistical processing, a diagram was constructed showing the relationship between the mean and median values and the stability of the properties of the material samples in the series (Fig. 1). Average values are represented by squares in squares, median values are represented by horizontal lines in squares, maximum and minimum values are represented by dotted lines above and below. The sample with the highest average bending strength value belongs to the P series (1326.26 ± 174 MPa). However, as in the case of the A series (1110.73 ± 152 MPa), the samples of this series, despite the high strength values, also show the maximum spread of values, which are so-called emissions, i.e. indicate instability: 869.00 ± 100 MPa for the PO series and 1043.95 ± 84 MPa. However, both values remain high compared to the K control, the average value of which is 824.95 ± 91.9 MPa; the difference between the K-P, P-PO, K-A and K-AO groups is significant (Fig. 2). Thus, sandblasting significantly increases the bending strength values of ceramic samples based on zirconium dioxide compared to the control. A similar pattern is observed in the case of zirconium dioxide samples exposed to a diamond tool: in comparison with control K, the bending strength in group A significantly increases. Compared with the control K, the values of the P, A and AO series have significantly increased. The K series is the most stable in the analysis of variance. The spread of the values of groups P and A indicates relative instability in comparison with the groups PO, AO and K.

Conclusion:

The local inclusion of the monoclinic phase on the skeleton surface leads to an inverse ratio of the coefficients of thermal expansion. This can negatively affect the adhesion of the ceramic lining to the frame. Subsequent reduction firing reduces the strength of the material, but not below the initial value. This is due to the partial removal of blocking "distracting pillows" at the edges of the cracks formed.

However, additional firing normalizes the phase composition, CTLR of the frame surface and its interaction with the ceramic lining, which ultimately contributes to the normal functioning of the prosthesis in the oral cavity. This is due to the fact that the presence of compressive stresses on the inner surface of the frame in this case has a positive effect.

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