ABSTRACT

Dental ceramic is a highly aesthetic material and its surface properties can affect its roughness, bonding properties as well as strength and wear. The aim of the work is to analyze the surface properties by determining the roughness parameters of the three dental ceramics used in the CAD/CAM technique: lithium disilicate (LS_2), lithium silicate reinforced with zirconium oxide (ZLS) and zirconia (ZrO_2) before and after brushing. They were prepared using two different processing techniques, polishing and glazing with three different glazes. Both pre-crystallized LS_2 and fully crystallized ZLS were cut into discs and the surface was ground and polished. Crystallization was carried out for LS_2 samples, while ZrO_2 samples were prepared by CAD/CAM and then sintered. The glaze was then applied and the samples reheated according to the manufacturer's instructions. Before and after brushing with pastes, the surface topography of the tested ceramics was measured by atomic force microscope (AFM) and the roughness parameters were evaluated: mean square roughness (Rq), mean surface roughness (Ra) and surface area difference (SAD). Changes in the morphological characteristics of the tested ceramics were examined using an optical metallographic microscope (OMM) and a scanning electron microscope (SEM). The chemical composition of the surface was determined by Fourier transform infrared spectroscopy (FT-IR) with attenuated reflection (ATR). In the spectroscopic analysis, a characteristic signal for ZrO_2 was obtained for the ZLS samples.

The next step was brushing of the raw surface of LS_2, ZLS, ZrO_2 and glazed CC, IC and IIG samples. Brushing lasted 2 minutes under the pressure of 2 N and each time the paste was applied. Pastes of different RDAs, such as elmex® Sensitive (RDA = 30) and Colgate® Whitening (RDA = 140) were used in the tests. When the surface brushing step was completed, the surface topography was also assessed and compared using OMM, SEM, AFM. The chemical composition using FT-IR was determined as well.

AFM data collected show that the surface of the raw ceramic samples are moderate irregular, while the glazed samples had relatively smooth surfaces with visible glaze crystallites. On the base of the received results it can be concluded that the values of roughness parameters significantly differed depending on the type of the samples. The Wilcoxon ranking test for two related samples revealed a significant difference in the surface roughness (Rq, Ra and SAD) between the tested materials ($\alpha < 0.05$).

In the case of ceramic samples brushed with elmex® Sensitive and Colgate® Whitening pastes, a slight reduction of the roughness parameters was observed (compared to unbrushed samples). There is an upward trend of the roughness parameters values with an increase in the number of brushing cycles. It was noticed a downward trend of the maximum value and increasing the minimum value in a given data set. However, roughness parameter values vary more when a paste with a higher RDA, i.e. Colgate® Whitening Paste is used. Despite the appearance of microcracks, the surface of the tested ceramics after successive brushings becomes smooth in a small percentage, and the range of data narrows. The Wilcoxon ranking test revealed a significant difference in the surface roughness (Rq, Ra and SAD) between the tested materials before and after successive brushing cycles with both low and high RDA toothpaste ($\alpha < 0.05$).

To sum up, it can be concluded that glazing reduces the roughness coefficients, and thus significantly smoothes the surface of the tested materials. For aesthetic and healthy reasons, this effect is desirable in dentistry. Brushing the surface of ceramics also causes smoothing of the surface in a small percentage, despite the appearance of micro-scratches on the surface.