Polishing of zirconia reinforced lithium silicate press ceramics. An in vitro study

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Abstract

The aim of the study is to evaluate the possibilities for polishing of zirconia reinforced lithium silicate ceramics after making corrections on the glazed ceramic surface. The studied subjects were 20 test samples made of lithium silicate press ceramics. They were divided into 4 groups according to the method of processing and polishing (different grit size of the diamond burs and type of polishing materials). The samples were examined with an atomic force microscope. After polishing with diamond paste, the surface became smoother compared to the treatment of the surface with a polishing kit alone.

There was a difference in the topography of the ceramic surface before and after treatment. Despite the existence of various polishing protocols, maximum smoothness can only be achieved by re-glazing.

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Introduction

The glass-ceramic materials processed by pressing have extremely high aesthetic qualities, good mechanical properties and wear resistance[1]. The glazed process helps to achieve a smooth surface and retains high luster for a long period of time. After adjustment, the restoration is returned to the laboratory for final glazing. Sometimes may be necessary to adjust the construction after cementation. Unpolished ceramics can subsequently lead to many undesirable complications: wear of antagonists, staining, plaque retention, inflammation of the gingiva and reduction of fracture resistance[2,3,4]. To avoid these complications and to achieve a smoother surface polishing the ceramic surface is required[5].

Different techniques for polishing each type of ceramic materials are described in the literature. Their effect on the grinded with burs ceramic surface is of interest to the dentist and has been the subject of number of studies[5-11].

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Each polishing protocol contain combinations of diamond burs, abrasive rubbers, felts and diamond polishing paste[3]. The occlusal adjustments in all-ceramic restorations shall be made in advance in the laboratory or after their cementation if necessary. If a larger correction on the ceramic surface is required, the restoration can be sent back to the dental lab for re-glazing[2,3].

Crystals with a size of 100 – 1400nm are observed in the structure of the pressed zirconia reinforced lithium silicate ceramics. Its homogeneous fine crystalline structure is important for the polishing properties of this ceramic material in particular. The smaller size of the crystals in the structure of the press ceramics requires better polishing potentialities[1].

The aim of this study is to show the possibilities for polishing press ceramics with a crystalline phase of lithium silicate reinforced with zirconia. It is proven that the proper polishing allows better esthetic, mechanical and prophylactic effect of every ceramic construction.

Materials and methods

The objects of the study were the surfaces of 20 test samples with a rectangular shape: 20mm in length of, 8mm in width and 2mm in thickness made of zirconia reinforced lithium silicate press ceramics (Celtra Press, Dentsply Sirona, USA). The test samples were invested using investment powder and liquid (Celtra® Press investment, Dentsply Sirona, USA). The process of pressing was performed in Programat EP 3000 (Ivoclar Vivadent, Schaan, Lichtenstein) according to the manufacturer's instructions. All samples were cleaned from the investment material, polished and glazed in the dental laboratory.

Half of the test samples were grinded chairside with red diamond bur and the other half with green diamond bur. From all the twenty surfaces one was not treated with any burs, nor polishing materials, this surface was used as a control (C0).

The polished samples were divided into groups according to the grinding and the polishing protocol. The specimens from the Group 1 (C1) and Group 3 (C3) were polished with two-step polishing system for press ceramics (Vita Enamic Polishing set clinical, Vita Zahnfabric). The set contains six rubbers divided into two groups, each one with three members according to their roughness (with pink and grey coding).

All test samples from Group 1 and Group 3 (C1 - grinded with red bur; C3 - grinded with green bur) were polished for six minutes - with every type of rubber for 1 minute. Polishing was performed without the use of diamond polishing paste.

The test samples from Group 2 (C2) and Group 4 (C4) - (C2 grinded with red bur; C4 grinded with green bur) were polished with the same set of rubbers in the exact same manner but in this case was used diamond polishing paste.

The measurements and the recordings after grinding and polishing were made using atomic force microscope (Easyscan 2 Nanosurf - Switzerland). This type of microscopy is based on the mechanical contact of a working tip with the tested surface, as a result a computer image of the surface profile is generated.

The images were made under the following conditions:

- working area of the image – square field with linear size of 49.5μm
- resolution – the surface was divided into 256 dots for a single line with 256 lines in total. The recording speed was from 5 to 10 second per line.

The analysis and the evaluation of the test sample's surface included the following roughness parameters:

Sa - arithmetic mean: It is defined as the arithmetic mean value of the moduli of the length of all vectors from a single line and from all the lines.

Sm – mean value: It is defined as the mean values of the lengths (considering their positive or negative sign) of all vectors from a single line and from all the lines.

Sv – depth: This is the value of the lowest compared to the baseline (the longest negative vector)

Sp – peak This is the highest point value compared to the baseline (the longest positive vector)

Sy – this is the total amount if the space between the highest and the lowest point.

$$Sy=Sp-Sv$$

Results

After making measurements with the force microscopy method, on the surface of the specimen (glazed, polished with a polishing kit with the use of diamond polishing paste and without paste) was found that compered to all types of polishing after grinding, the glazing without additional treatment provided the smoothest surfaces. The values of the surface roughness of the samples that were glazed without grinding and subsequent polishing were significantly lower than the values of the other samples. Using the atomic force microscopy method, data on the displacement of the needle in the vertical direction for each measured point on the surface were recorded. This displacement had vector properties in a direction perpendicular to the surface. The reference point of all vectors begins from the base (middle) line in a horizontal direction[12].

From the comparison of the values of the surface roughness parameters it was evident that when using red diamond burs and subsequent polishing with a set of rubbers and diamond paste, the obtained values were significantly lower compared to the values of polishing only with rubbers. While when using green diamond burs and polishing only with a set of rubbers, the obtained values were lower (Table 1).

	Groups				
Test samples	C0	C1	C2	C3	C4
Area	2.462^2	2.462^2	2.462^2	2.462^2	2.462^2
Sa	12.947	114.61	48.666	293.43	388.48
Sm	-0,00014	0,212	0,199	0,212	0,212
Sv	-96.59	-610.11	-452.28	-2361.8	-1911.7
Sp	46.583	456.27	305.75	892.53	1216.1
Sy	143.13	1075.4	758.03	2361.8	3127.7

Table 1. Measurements of the roughness parameters (nm). Sa – arithmetic mean, Sm – mean value, Sv – depth, Sp – peak, Sy – this is the total amount if the space between the highest and the lowest point.

The colour coding of the diamond bur affects the values of the roughness parameters. When using a red diamond bur and subsequent polishing (test samples C1 and C2), it results in a smother surface compared to the use of a green diamond bur (test samples C3 and C4).

The biggest difference was measured among the test samples of lithium silicate ceramic treated with green diamond burs and polished with set of rubbers and diamond paste.
Regardless of the used polishing protocol, the values obtained from the treated surfaces are many times higher than those reported on the glazed ceramic surface. Closest to the values of the control group are the values reported by the press ceramics treated with red diamond burs and polished with rubbers and diamond paste (Fig. 1).

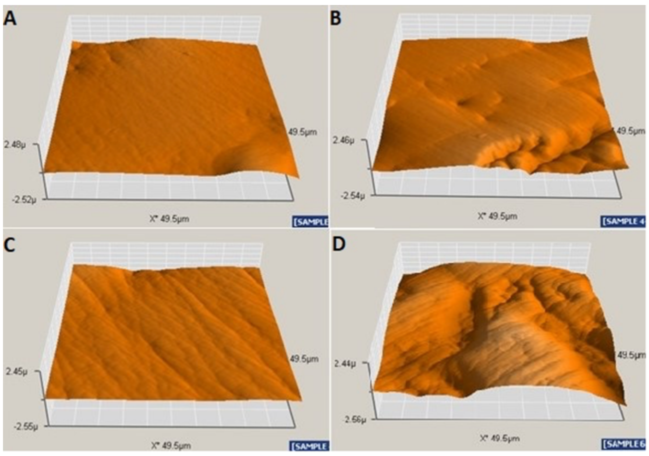

Figure 1. Test samples A. Group C0: glazed lithium silicate press ceramics; B. Group C1: lithium silicate press ceramics treated with red diamond burs and polished with rubbers; C. Group C2: lithium silicate press ceramics treated with red diamond burs and polished with rubbers and diamond paste; D. Group C3: lithium silicate press ceramics treated with green diamond burs and polished with rubbers only.

Discussion

The efficiency of ceramic polishing systems is a controversial issue in the literature[6-11]. Zirconia reinforced lithium silicate press ceramics is a relatively new product on the market and research on this material is still limited. Its predecessor, lithium disilicate glass-ceramics, is much better studied. Alhabdan and Hejazi, 2015[6], when studying restorations made of lithium disilicate press ceramics, claimed that polishing this type of ceramics with a certain type of discs results in a smoother surface than the glazed surface. Several studies reported that the final result after polishing can not match with the result after re-glazing[4,8]. This study confirmed the results from the studies claiming that polishing after corrections on the ceramic surface can not achieve the smoothness of the glazed ceramics.

There are various alternative techniques for polishing of ceramics, each of which involves a particular type of polishing rotational instruments used in a particular sequence. There are several sets on the market specially designed for polishing of ceramic restorations and each company producing ceramic materials also offers its own polishing system[1]. For better results, polishing with diamond paste is recommended[7,8,11].

The protocol used in this study included a six-step system of polishing rubbers with three different shapes and two different grain sizes diamond burs with or without the use of diamond polishing paste and each rubber is used for the duration of one minute. The manufacturers of the lithium silicate press ceramics (Dentsply Sirona) used in this study, claimed in the product description that in clinical conditions it can be achieved perfect polishing. The better polishing properties of Celtra ceramics are due to the size of the crystals of the ceramic material after pressing[1].

Despite the time spent for polishing, in this study it was not achieved the smoothness of glazed ceramics. The glazed ceramic surface is the gold standard for comparison when corrections are made on the surface of the ceramic restorations[2,3].

Conclusions

It is important for the dentist to be aware of the condition of to the surface on which the corrections are made and whether these corrections could lead to further complications if no measures are taken. There is a difference in the smoothness of the ceramic samples before and after clinical corrections. The use of diamond polishing paste in combination with a polishing kit contributes making the ceramic surface smoother after the correction. Despite the existence of various polishing protocols, maximum smoothness can only be achieved by re-glazing. However, this is not an option after cementation of the restorations.

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Declaration of Interest

The authors report no conflict of interest.

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