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A MICROSCOPY EVALUATION OF THE PROSTHETIC RESTORATIONS OUTER SURFACES MADE FROM FOUR DENTAL MATERIALS

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Abstract

The aim of this study was the microscopy evaluation of the outer prosthetic surfaces in the case of four restorative dental materials: two metal alloys, one noble and one non-noble, and two dental ceramics, one based on lithium disilicate, the other based on zirconia. The samples were made as anatomical crowns in dental laboratory using the specific protocol for each analysed material. The general appearance of the occlusal and buccal surfaces is shown at several magnifications and the results are discussed in relation to the data from the literature and their clinical importance. Among the metallic materials, the noble alloys offered more homogeneous images with smaller cavities, while the final layer of glaze offer a glossier surface for the ceramics materials, in which other small particles may be incorporated, depending on the analysed ceramics . The use of an optical microscope for the final evaluation of the prosthetic structure may bring important details leading to an improvement of the obtained prosthetic structures.

Keywords: prosthetic surfaces, microscopy analysis, dental alloys, dental ceramics

1. Introduction

The outer surfaces of the dental prostheses must have a perfectly smooth appearance, chemically resistant and non-retentive for food and bacterial plaque as a direct relationship exists between surface roughness and plaque accumulation [1].

Metal alloys are materials used for 2000 years for dental restorations due to their mechanical strength but also due to the possibility of obtaining perfect polished surfaces [2]. Dental ceramics tend to replace metal materials in the modern period, due to the aesthetic aspect of the prosthetic restorations, maintaining the possibility of obtaining glossy surfaces [3], but also due to the extensive involvement of computer-assisted manufacturing in the dental prosthetics [4].

The aim of this study was the microscopy evaluation of the prosthetic surfaces appearance in the case of four restorative dental materials used in the current dental practice of the authors. We chose two metal alloys, one noble and one non-noble, and two dental ceramics, one based on lithium disilicate, the other based on zirconia. Molar occlusal surfaces were evaluated due to their

rugged relief, more difficult to process and polish, but also vestibular surfaces with a convex surface.

2. Materials And Methods

In this study we analysed the surface of two types of prosthetic materials, dental alloys and dental ceramics, evaluating for each of them 2 subtypes of prosthetic materials: noble alloys and non-noble alloys, glass ceramics and zirconia ceramics respectively Thus for the tested materials in this study we made 4 study groups, each one containing 4 samples:

Group I – Noble Alloy- comprised 4 crowns made of Argenco Bio, a noble alloy containing 71,9% Au produced by Argen Edelmatelle Dusseldorf, Germany

Group II – Non- Noble Alloy- comprised 4 crowns made of Remanium Star MD II, a non-noble alloy containing 60,5% Co and 28% Cr produced by Dentaurum Ispringen, Germany

Group III – Glass Ceramic - comprised 4 crowns made of IPS E.Max Press, a glass ceramic containing lithium disilicate produced by IvoClar Vivadent, Liechtenstein

Group IV – Zirconia Ceramic - comprised 4 crowns made of Cercon , a zirconia ceramic containing 91% zirconium dioxide produced by DeguDent, Germany.

The samples were made in the dental laboratory DM Dentaltechnik, Essen, Germany using the specific protocol for each analysed material. The samples consisted of anatomical crowns made at the level of the first lower molar on a standard model, which was duplicated to ensure the reproducibility of the situation for each sample performed.

The evaluation of the prosthetic crowns surfaces appearance was made at the level of the occlusal surface and buccal surface. The microscopy analyse was made using a Nikon SMZ745T stereomicroscope (Fig.1) with a magnification of 75X and a working distance of 115 mm, which allows an optimal viewing of the surface of the studied samples. Also, this stereomicroscope allows the acquisition of 2D and 3 D images. The acquisition of 2D images was done through the optical system, they were saved and then processed with the help of NIS-A-AMEAS software that allows the processing of the obtained images.

Fig.1 The Nikon SMZ745T stereomicroscope

3. Results

Noble alloys are known as easy-to-finish materials. The general appearance of the surface of such a crown is a glossy-yellow, specific to this category of materials. A magnification of 30x and more can still highlight fine traces on the occlusal surface such as scratches on the surface produced by the rotary processing tools, but also small cavities with dimensions of a few microns (Fig.2).

Non-noble alloys give a silver-gloss general appearance to the prosthetic crown, specific to this category of materials. However, a magnification of 30x and more on the occlusal suface offers a less homogeneous

image, highlighting cavities or even grooves with dimensions of the order of hundreds of microns (Fig3).

The glass ceramics offers a glossy exterior surface due to the final layer of glaze, an aspect that is maintained at higher magnifications, where we also can see embedded in the final layer the details of make-up used for the occlusal grooves marbles, from which small particles can migrate to neighbouring surfaces (Fig.4).

Zirconia crowns offer the same glossy appearance specific to ceramic materials, but has a higher frequency of embedding in the surface layer impurities from final processing or even from the combustion furnace (fig.5).

The buccal surfaces of the crowns through their convex relief offer the possibility of achieving a superior final processing. This makes the irregularities observed on the buccal surface of the metal crowns to be smaller in size and visible at higher magnifications (Fig.6 & Fig.7).

The buccal surfaces of the ceramic crowns offers the same glossy appearence, with a higher frequency, with a however wider diffusion of make-up particles in the case of zirconia crowns. (Fig.8&Fig.9).

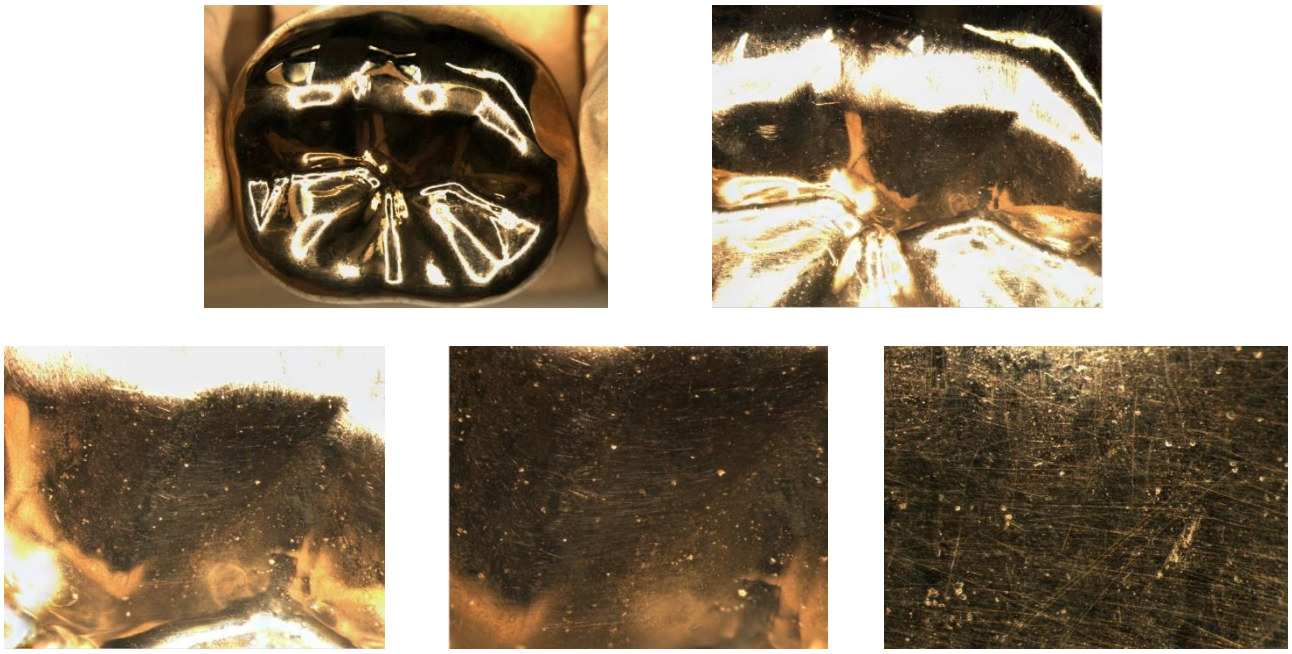

Figure 2 Microscopy aspects of the occlusal surface for the gold alloy crown at following magnifications: a. 10x, b. 15x, c. 30x, d. 45x, e.60 x

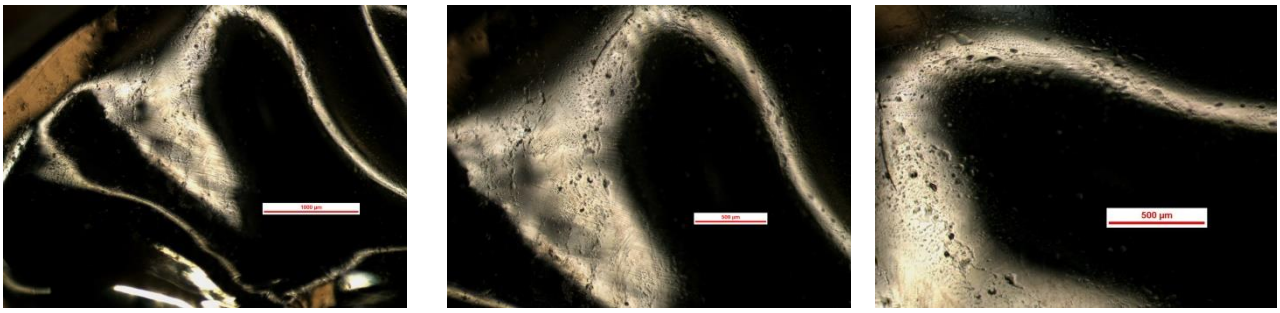

Figure 3 Microscopy aspects of the occlusal surface for the Co-Cr alloy crown at following magnifications: a. 10x, b. 15x, c. 30x, d. 45x, e.60 x

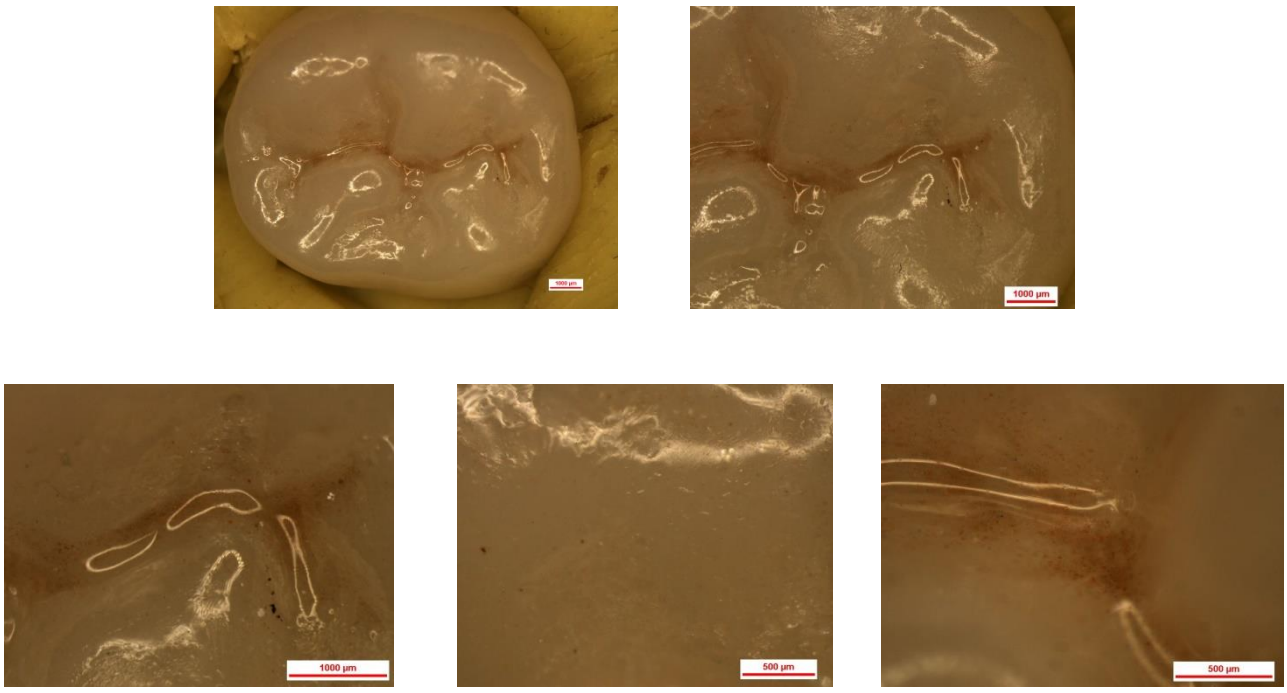

Figure 4 Microscopy aspects of the occlusal surface for the glass ceramic crown at following magnifications: a. 10x, b. 15x, c. 30x, d. 45x, e.60 x

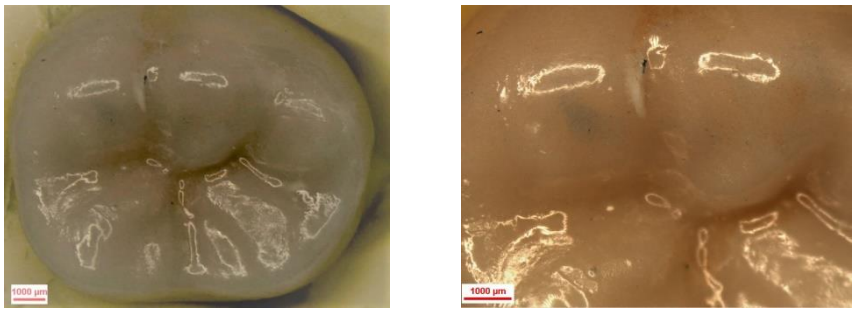

Figure 5 Microscopy aspects of the occlusal surface for the zirconia ceramic crown at following magnifications: a. 10x, b. 15x, c. 30x, d. 45x, e.60 x

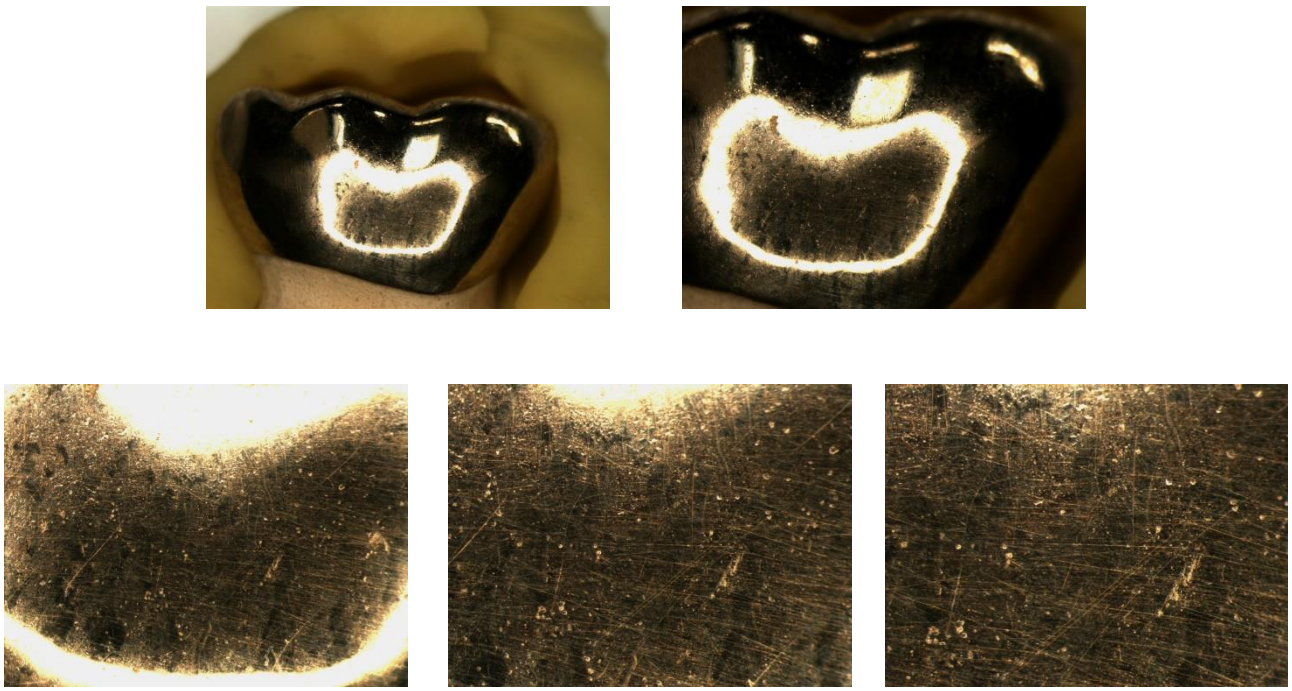

Figure 6 Microscopy aspects of the buccal surface for the gold alloy crown at following magnifications: a. 10x, b. 15x, c. 30x, d. 45x, e.60 x

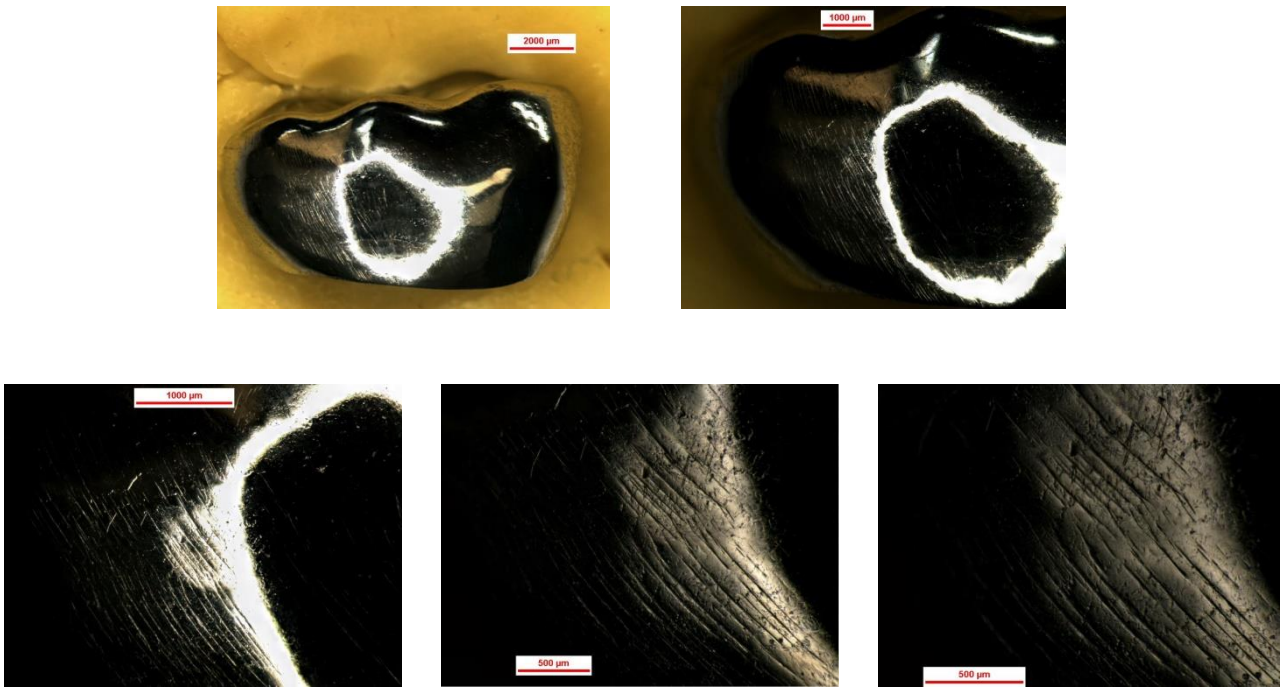

Figure 7 Microscopy aspects of the buccal surface for the Co-Cr alloy crown at following magnifications: a. 10x, b. 15x, c. 30x, d. 45x, e.60 x

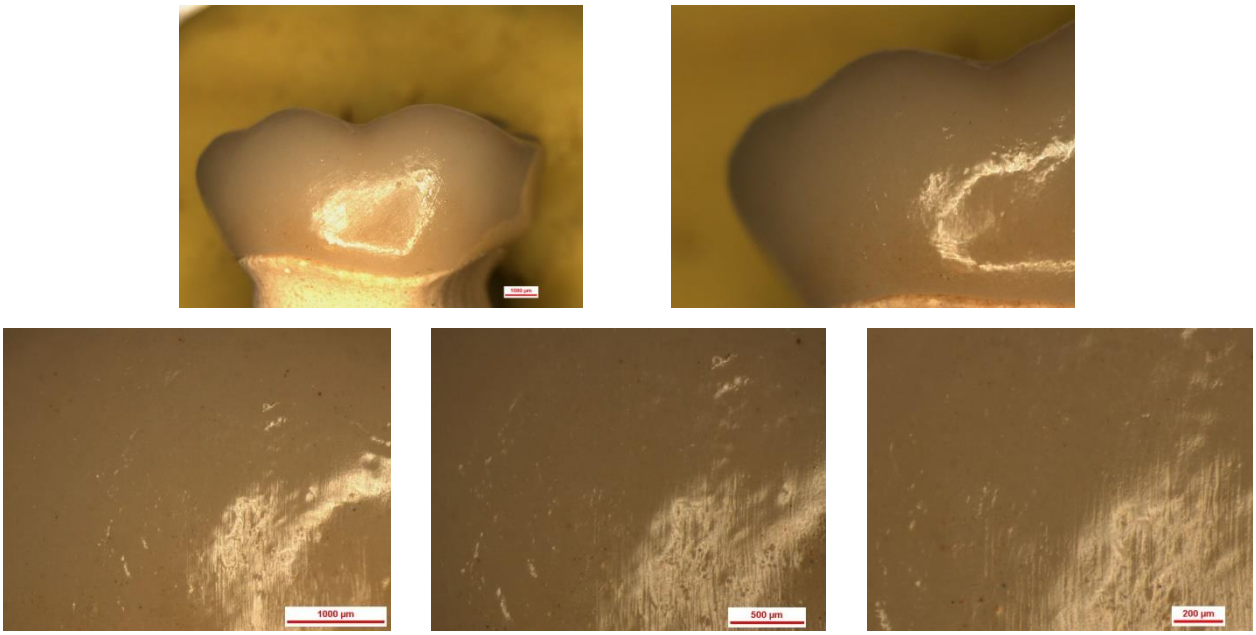

Figure 8 Microscopy aspects of the buccal surface for the glass ceramic crown at following magnifications: a. 10x, b. 15x, c. 30x, d. 45x, e.60 x

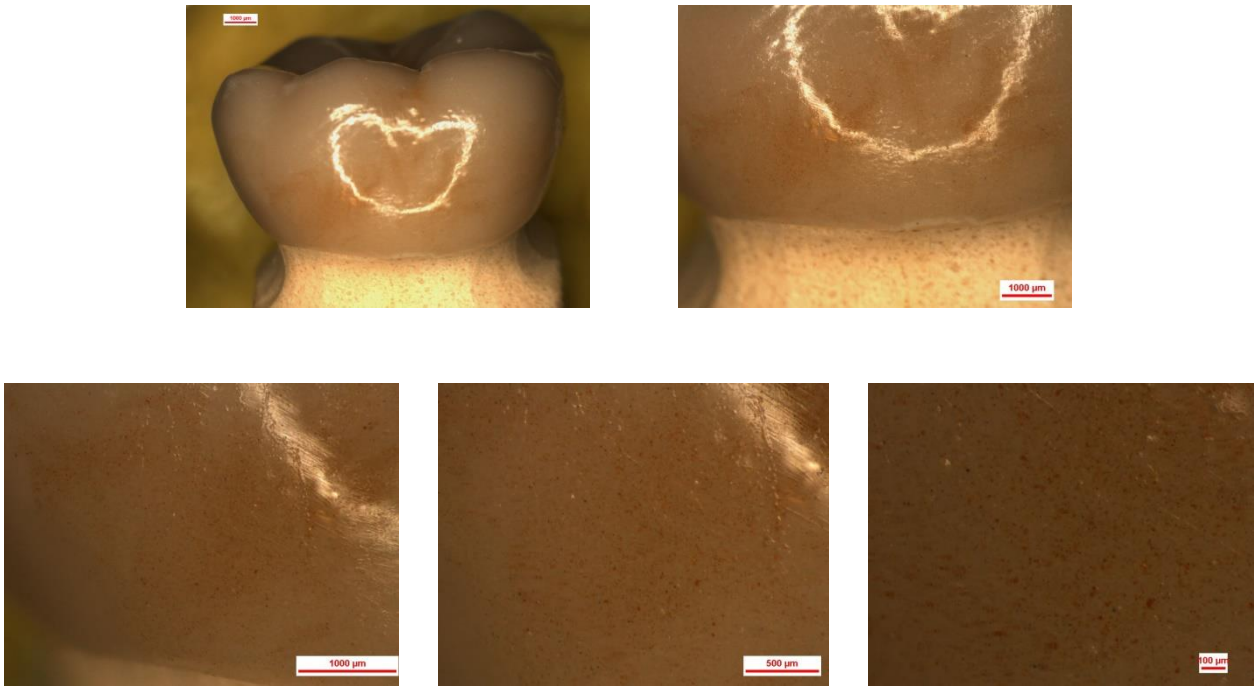

Figure 9 Microscopy aspects of the buccal surface for the zirconia ceramic crown at following magnifications: a. 10x, b. 15x, c. 30x, d. 45x, e.60 x

4. Discussions

The noble alloys are well known for their glossy-yellow general appearance. A scanning electron microscopy study made on six dental alloys showed that all alloys had fine-grain microstructures, even there may be differences in the microstructures at the grain boundary areas [5].

In our study, non-noble alloys gave a silver-gloss general appearance to the prosthetic crown but a less homogeneous image at higher magnifications. Bortun et al. showed also that after grinding, the Co-Cr materials surface it is covered by rough parallel treads and polishing does not provide a perfectly flat surface [6].The higher hardness and casting difficulties of the Co-Cr alloys often require an extra chair side time for finishing and polishing [7]. More over different manufacturing methods can alter the alloy morphologies and change the nature of the surface [8]; emerging techniques of manufacturing such as selective laser sintering allows obtaining prosthetic elements with a higher dimensional precision [9].

In this study we observed the glossy exterior surface offered by the ceramics materials due to the final layer of glaze, even in the case of zirconia samples we may observe a higher frequency of embedding in the surface layer impurities from final processing .

Glass-ceramics are broadly used material nowadays in dentistry due to their good aesthetics, but their indications is traditionally limited up to 3 elements bridges [10]. On this type of materials, when glaze is not applied or the restoration requires additional adjustment in a patient's oral cavity after the finishing procedure, faster plaque

accumulation may occur [11].

On the other hand, the monolithic zirconia restorations are able to overcome the facture problem which frequently appears in the traditional multi-layered ceramic restorations [12]. Glazing monolithic zirconia materials leads to a reduction of the surface roughness [13]. However, this type of restorations requires a good surface finishing also for not wearing the antagonist surfaces [14]. Polished zirconia determine abrasion surfaces with a different pattern and significantly smaller dimensions compared to glazed zirconia at the level of the hard dental tissues of the antagonist teeth [15]. In the clinical practice the use of coarse diamond burs to adjust the occlusal surface may also lead to a crack initiation, even usually it remain in the outer structure and it is not leading necessarily to a fracture [16], but a special attention should always be paid to respect the optimal cross-section dimension mainly at the level of connectors [17].

In the analysis of these data we must keep in mind, however, that in the oral environment, the materials are being subject to a process of degradation, due to the physical-chemical processes, as well as to the masticatory pressures [18]. From a series of studies, it may be concluded that both an increase in surface roughness above the threshold of 0.2 urn mean surface roughness and/or of the surface-free energy promote the bacterial adhesion on prosthetic materials [19], however with a greater influence of the surface roughness [20] .

Obtaining a quality prosthetic surface requires accuracy in all stages of the preparation and not only in the polishing stage. Thus a good quality assessment requires a non-invasive identification of the defects [21] and a defectoscopic analysis by non-destructive methods will prevent the occurrence of errors and will lead to dental prostheses with optimal biomechanical and clinical behaviour [22]. This is why we promote the use of an optical microscope for the final evaluation of the prosthetic structure before its final placement in the oral cavity.

5. Conclusions

The evaluation of the prosthetic restorations outer surfaces it is important to ensure the realization of dental prostheses of good quality with a perfectly smooth appearance on which the bacterial plaque does not adhere.

Even the macroscopic appearance looks glossy, an evaluation performed at increased magnifications will allow the observation of details and areas that can be improved, therefore the use of an optical microscope for the final evaluation of the prosthetic structure may bring important details.

Among the metallic materials, the noble alloys offered more homogeneous images with smaller cavities, while the final layer of glaze offer a glossier surface for the ceramics materials, in which other small particles may be incorporated, depending on the analysed ceramics .

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