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EXPERIMENTAL ANALYSIS OF PECULIARITIES OF THE METAL-CERAMIC SAMPLES SURFACE RELIEF MORPHOLOGY DEPENDING ON THE ABRASIVE PROCESSION METHODS

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Summary: One of the most frequent complications during the use of metal-ceramic prostheses is destruction of facing ceramic layer. Its restoration depends on many factors, among them its roughness parameters. In order to study the influence of surface treatment of metal samples on its morphology two processing methods were used in experiment – abrasive head («Komet», Gebr. Brasseler, Germany) and intraoral sandblastering (Danville MicroEtcher IIA, Danville Materials, USA). It was found that the degree of roughness depends on the preparation of metal surfaces, in particular,intraoral sandblasting forms a smooth,regular and more expressed microrelief of the metal surface, while the use of abrasive head creates heterogeneous relief due to uncontrolled pressure. This can lead to unwanted tense areas and adversely affect the subsequent reliability of composite restorations.

Key words: metal-ceramic dentures, composite materials, morphology.

Background. Foreign and domestic clinical practice shows that one of the most common complications in the use of metal-ceramic prosthesis is violation of the integrity of the lining ceramic layer [1]. Ceramic chips may occur in the enamel, dentine, opaque, as well as on the level of the metal and oxide layer. The quality of chips restoration depends on many factors, including the nature of the coated surface, its modification and roughness parameters [2, 3].

Objective. The aim of the research was to study the peculiarities of metal-ceramic samples relief morphology depending on the methods and techniques of their abrasive processing.

Materials and methods: Experimental studies were conducted on samples made of cobalt-chromium alloy (10x10x0,5 mm), which were processed using two methods.

In the first group the metal surface of samples was treated using two methods - by abrasive head «Komet» (Gebr. Brasseler, Germany) (10 samples) and by intraoral sandblaster Danville MicroEtcher IIA (Danville Materials, USA) (10 samples).

In the second group the surface of samples in a form of cobalt-chromium alloy plates with size 10x10x0,5 mm were covered with priming (10 samples) and dentine (10 samples) in the technical laboratory with subsequent baking in the oven. Then the samples in both cases were treated using two processing methods according to the instructions of the manufacturer: abrasive head - 10 samples and intraoral sandblaster - 10 samples. A mixture of air and corundum sand with particles size of 25 microns was directed on the surface of samples at a distance of 5 mm from the nozzle. The samples surface treatment by abrasive head was carried out without use of force pressure with the rotation speed of 6,000 rpm. The resulting samples of all series were used to study the effect of processing methods on the

At the beginning of the laboratory experiment in order to study the surface morphology of the samples we have determined the optimal duration of the abrasive treatment of the surface of the experimental samples at different time intervals - 5, 10 and 15 seconds.

The morphology of samples surface was studied sequentially by means of diagnostic complex «Micro Measure 3D Non contact Profilometry».

Results and discussion: The study of roughness parameters (Ra, microns) of the surfaces of metal and metal-ceramic samples, depending on the duration of procession using intraoral sandblast and abrasive head revealed that the value of Ra for metal, priming and dentine did not differ significantly ($p>0.05$) in subgroups of samples for 5, 10 and 15 seconds, These data are presented in the Table 1, where Ra - average of ten measurements of the surface roughness. These results indicate the adequacy of the time of abrasive preparation of samples surface ranging from 5 to 10 seconds.

The received results concerning the study of the dependence of the degree of roughness of metal surface in the first group upon the method of treatment are presented in the Table 2, where Ra – the average of ten measurements of surface roughness. These data suggest that processing by intraoral sandblasters creates more deep roughness of the relief.

It was found that just this way of processing creates optimal surface topography, as evidenced by the least variation range of Ra values (Table 2, sample 2). Processing by abrasive head polishes the surface and creates roughness (reducing the average Ra to 1,14±0,02 µm), at the same time the relative heterogeneity of the relief increases and the characteristics of the relief.

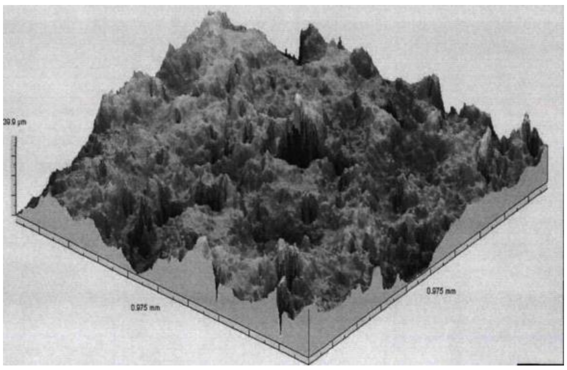
range of deviation of the average Ra values of the depth of the relief depressions is increased up to 71%.

Processing by intraoral sandblaster creates more expressed surface roughness in the metal surface compared with processing by abrasive head (increase in the average Ra to 1,26±0,02 µm), while the relative heterogeneity of the relief is reduced, and the range of deviation of the average values of the depths of depressions in the relief is reduced to 12,12%.

The results of investigations of the influence of the processing method on the degree of roughness of metal surfaces of the second group of samples are presented in the Table 3, where Ra - average of ten measurements of surface roughness.

It is seen from the data presented in the Table 3 and figure 1 that the maximum depths of the relief irregularities were observed in samples of metal covered with laboratory priming. Microscopic relief roughness is important to enhance the adhesion between the priming surface and subsequent layers.

Figure 1.



Three-dimensional image of metal-ceramic composition (metal covered with laboratory priming)

Table 1

Parameters of surface roughness of samples depending on the procession duration using abrasive head and intraoral sandblaster

№ of samples series	Method of surface processing	The surface of samples	Time of abrasive treatment, seconds	Average value of roughness R_a, μm
1	Abrasive head	Metal	5	1,11±0,01
			10	1,12±0,02
			15	1,14±0,02
		Priming	5	2,32±0,02
			10	2,31±0,02
			15	2,30±0,01
		Dentine	5	2,07±0,03
			10	2,09±0,01
			15	2,10±0,02
2	Intraoral sandblaster	Metal	5	1,21±0,01
			10	1,23±0,02
			15	1,22±0,02
		Priming	5	3,15±0,03
			10	3,13±0,02
			15	3,17±0,02
		Dentine	5	2,75±0,03
			10	2,74±0,02
			15	2,77±0,02

Table 2

Roughness parameters of the metal surfaces in the first group of samples

№ of samples series	Method of the metal processing	Average value of roughness R_a, μm	Range of data deviations (R-a max ~ min) / R_a min %
1	Abrasive head	1,14±0,02	71,07
2	Intraoral sandblaster	1,26±0,02	12,12

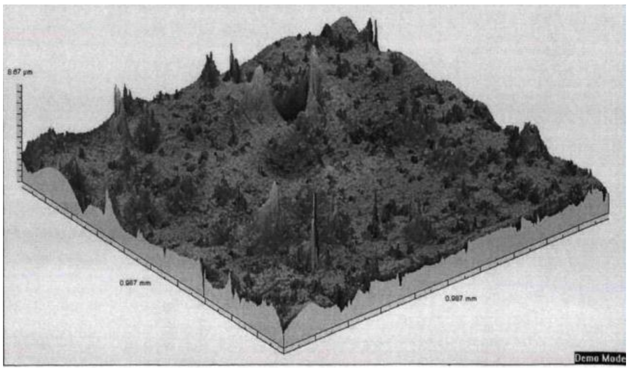
Table 3

Characteristics of the microrelief of the metal-ceramic samples surface

№ of samples series	Method of the metal-ceramic composition processing	Average value of roughness R_a, μm	Range of data deviations (R-a max ~ min) / R_a min %
1	Metal covered with laboratory priming	4,26±0,09	27,19
	Metal covered with laboratory priming and dentine	1,10±0,14	39,43
2	Metal covered with laboratory priming treated by abrasive head	2,34±0,05	29,87
	Metal covered with laboratory priming and dentine treated by abrasive head	2,17±0,05	31,15
3	Metal covered with laboratory priming treated by intraoral sandblaster	3,15±0,08	57,18
	Metal covered with laboratory priming and dentine treated by intraoral sandblaster	3,02±0,06	23,58

Coating the metal-priming surface with a layer of dentine in the laboratory smoothes the surface of metal-ceramic composition as the roughness of dentine layer is less expressed compared to the priming. Visually its surface is smooth enough with few micropores on the surface of the dentine, which improves the fixing of the final enamel layer (Figure 2).

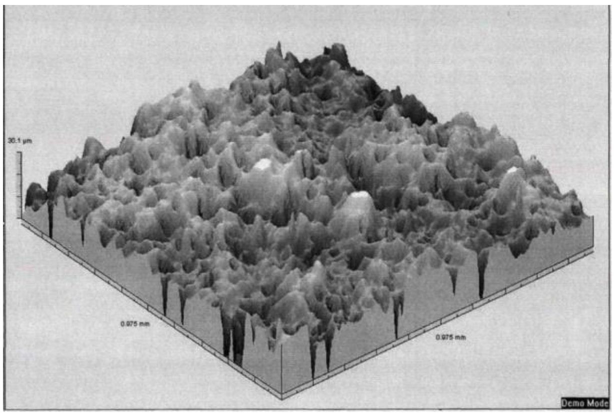
Figure 2



Three-dimensional image of metal-ceramic composition (metal with laboratory priming and dentine coating)

Processing of laboratory priming with dentine using intraoral sandblaster creates an expressed surface roughness on the metal-ceramic compositions (Figure 3) compared with processing by abrasive head (increase in the average Ra up to 3,02±0,06 μm), but the value of roughness (Ra) of the metal surface coated with laboratory priming is higher, because on its surface there is a high depth of relief irregularities without additional processing.

Figure 3



Three-dimensional image of metal-ceramic composition (metal with laboratory priming and dentine coating) treated by intraoral sandblaster

Processing by abrasive head, most likely, results in smoothing the surface, but not creating roughness (reduce in the average Ra to 2,17±0,05 μm), while the relative heterogeneity of the relief is reduced, and the range of deviation of average values of the relief depressions depths Ra decrease to 31,15 %.

Conclusion. Studies have shown that laboratory priming coating initially has a relatively more pronounced roughness and greate porosity compared to the glasseous dentine layer. Sandblasting slightly reduces porosity, possibly opens pores or "hammering" them. Ceramic laboratory dentine compared with the priming layer is more smooth, almost without pores surface, so it is important in the restoration of this layer to increase the roughness of its surface for a strong fixation of the following restoration materials.

Analysis of the investigation of the sequential changes in the micro-relief of metal samples surface after abrasive treatment revealed that intraoral sandblasting forms a smooth, regular and more expressed microrelief of the metal surface with average values of depressions depths up to 12,12 % as opposed to the use of abrasive head, which creates heterogeneous relief due to uncontrolled pressure with increasing mean values of depressions depths to 71,07 %, that can lead to unwanted tense areas and adversely affect the subsequent reliability of composite restorations.

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