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Research Article

Clinical Aspects of Combination of Aesthetic Fixed Prosthetic Appliances

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Abstract

The objective of the research was to study the peculiarities of the combination of zirconia and ceramic occlusal surfaces when constructing aesthetic fixed prosthetic appliances.

Materials and methods. The study included 70 patients with zirconia and ceramic occlusal surfaces of aesthetic fixed dental prostheses. Group I included 24 patients with a combination of zirconia and ceramic occlusal surfaces. Group II included 30 patients with a combination of ceramic occlusal surfaces. Group III included 16 patients with a combination of zirconia occlusal surfaces. All the patients were observed 12 and 24 months after prosthetic repair.

Results. 12 and 24 months after prosthetic repair, the occlusal contact surface area was the largest in Group II (8.18±0.16 mm2 and 9.17±0.1 mm^2, respectively). In Group I, where only one occlusive surface was made of zirconium dioxide, significantly reduced levels of abrasion were observed as compared to Group II – 8.07±0.21 mm^2 and 8.65±0.23 mm^2, respectively. 36 months after denture wearing, in Group III, the smallest contact surface area – 7.84±0.15 mm^2 as well as the lowest growth of the surface area was observed – 8.07±0.13 mm^2.

Conclusions. Dental prostheses with at least one ceramic occlusal surface exhibit a strong tendency to abrasion and, consequently, to an increase in the occlusal surface area resulting in an excessive load on prosthetic appliance. Moreover, functional and aesthetic values of prosthetic prosthesis sharply decrease. Therefore, we recommend to produce zirconia occlusal surface or at least to combine the same materials, as it will increase the longevity of prosthetic appliance.

Keywords

prosthetic appliances; occlusal surfaces; ceramics; zirconium dioxide

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Problem statement and analysis of the recent research

At the current stage of its development prosthetic dentistry uses a wide range of construction materials - both modern and those that have been known for a long time [1].

The combination of modern and traditional techniques and materials allows using many variants of prosthetic appliances; however, the number of complications including ceramic chipping and occlusal surface abrasion increases and, consequently, aesthetic, functional and anatomic values of the prosthesis reduce [2].

It is due to the combination of prosthetic appliances being different from each other in construction materials, design as well as the methods of manufacturing – metal, combined ceramic (low-temperature ceramics, high-temperature ceramics, feldspathic ceramics, alumina-based ceramics) and metal-free prosthetic appliances [2], which is contrary to basic principles of tribology.

A high degree of the aggression of ceramics towards the antagonistic teeth as well as its low abrasion resistance remains the problem being difficult to solve. This fact is explained by several factors.

Ceramics has a much rougher surface in comparison with zirconium dioxide. During the early months of denture wearing this difference is almost imperceptible due to polishing of ceramics at the final stage. However, the glazed layer disappears in 18-20 months exposing the underlying ceramic layers the roughness of which is much higher [3]. This phenomenon is not observed in zirconia dentures as zirconium dioxide has a uniform thickness.

Zirconia surface is polished much better than the surface of ceramics as zirconium dioxide is homogenous while ceramics consists of fine particles of various sizes. Moreover, ceramics contains surface and subsurface pores which greatly reduce the abrasion resistance of the material.

In addition, the combination of various materials when constructing the occlusal surfaces always negatively affects the longevity of the prostheses due to their different physical and chemical properties [2].

All these factors indicate the need for developing the methods of the combination of aesthetic dental prostheses made of different construction materials in the oral cavity.

The objective of the research was to study the peculiarities of the combination of zirconia and ceramic occlusal surfaces when constructing aesthetic fixed prosthetic appliances.

1. Materials and methods

The study included 70 patients with zirconia and ceramic occlusal surfaces of aesthetic fixed dental prostheses.

Group I included 24 patients with a combination of zirconia and ceramic occlusal surfaces.

Group II included 30 patients with a combination of ceramic occlusal surfaces. Group III included 16 patients with a combination of zirconia occlusal surfaces.

All the patients were observed 12 and 24 months after prosthetic repair.

The reason for forming such groups was the fact that the abrasion of ceramic occlusal surfaces sharply increases 18 months after prosthetic repair [4].

The state of the occlusal surface of prosthetic appliances was studied on the basis of history taking (complaints, physical character of food, state of the gastrointestinal tract), the data of physical examination, X-ray results and the determination of the occlusal contact surface area using 3Shape TRIOS Dental System.

We have used 3Shape TRIOS® 3D scanner to determine the occlusal contact surface area since at this stage computer occlusiography provides the most accurate results (Fig. 1). We have not used any other computer methods because in contract to 3Shape TRIOS they are difficult to use [5]. The accuracy of 3Shape TRIOS® 3D scanner is proven to be one of the highest [6] and the margin of error does not exceed 7 mcm. Therefore, we consider the use of this scanner to be justified.

To determine the surface area of occlusal contacts we have used the following method. At first, using 3Shape TRIOS® 3D scanner in the TRIOS Cart configuration the upper jaw was scanned, and then, the lower one was scanned. Next, dentitions in occlusion were scanned. Then, using computer software of 3Shape TRIOS Dental System the surface area of the occlusal surface was determined.

Figure 1. 3Shape TRIOS® 3D scanner

Raigrodski AJ, Chiche GJ, Potiket N, et al [7] state that in patients with intact teeth the mean occlusal contact surface area of the 36th tooth is 7.044 mm^2 and the mean occlusal contact surface area of the 46th tooth is 7.62 mm^2.

The results were statistically processed using Student-Fisher's t distribution; the results were considered statistically significant at $p<0.05$.

2. Results and discussion

The determination of the occlusal contact surface area using 3Shape TRIOS® 3D scanner provided the following results (Table 1).

12 and 24 months after prosthetic repair, the occlusal contact surface area was the largest in Group II (8.18 ± 0.16 mm^2 and 9.17 ± 0.1 mm^2, respectively) (Table 1). It was due to physical and mechanical properties of ceramics, i.e. its aggression and relatively poor abrasion resistance compared to zirconium dioxide.

In Group II, both occlusal surfaces were made of ceramics and, consequently, the abrasion of ceramic surfaces doubled resulting in larger occlusal contact area, especially after prolonged period of denture wearing – 9.17 ± 0.1 $mm^2$2.

The glazed layer disappears from the surfaces being exposed to constant mastication load about 18-20 months after denture placement negatively affecting the abrasion degree and, accordingly, ceramic occlusal surface. As a result, the underlying ceramic layer being much more aggressive toward the antagonistic teeth is exposed. Therefore, prosthetic appliances with ceramic occlusal surfaces are characterized by the increase in the occlusal contact area as well as an accelerated abrasion with increasing duration of denture wearing.

Zirconium dioxide having a very high abrasion resistance and a low degree of aggression helps preserve the initial surface area of occlusal surfaces almost unchanged. It was proven by the results of Group III (Table 1).

12 and 24 months after prosthetic repair, in Group I, where only one occlusive surface was made of zirconium dioxide, significantly reduced levels of abrasion were observed as compared to Group II – 8.07 ± 0.21 mm^2 and 8.65 ± 0.23 mm^2, respectively (Table 1).

24 months after denture wearing, in Group III, the smallest contact surface area – 7.84 ± 0.15 mm^2 as well as the lowest growth of the surface area was observed – 8.07 ± 0.13 mm^2.

In our opinion, the smallest contact surface area is explained by the fact that, at current stage, modelling of zirconia prosthetic appliances is carried out using computer program and milling is performed in automated milling machines reducing the impact of human factor. The lowest growth of the occlusal contact surface area is also explained by the surface structure of zirconium dioxide making it abrasion resistant not only during the early months of denture wearing but during a prolonged period of time.

In our opinion, the difference between the obtained data on the occlusal contact surface area and those obtained by Raigrodski AJ, Chiche GJ, Potiket N, et al is explained by the fact that the method of determining the surface area differed

Table 1. Occlusal contact surface area of the 36th tooth

	Group I, mm^2			Group II, mm^2			Group III, mm^2		
	1 day after prosthetic repair	12 months after prosthetic repair	24 months after prosthetic repair	1 day after prosthetic repair	12 months after prosthetic repair	24 months after prosthetic repair	1 day after prosthetic repair	12 months after prosthetic repair	24 months after prosthetic repair
1	7.88	8.01	8.5	7.82	8.52	9.23	7.57	7.78	7.9
2	7.65	7.94	8.45	7.76	8.22	9.2	7.59	7.8	8.03
3	7.8	8.1	8.49	7.88	8.35	9.11	7.52	7.81	8.11
4	7.75	8.05	8.6	7.79	8.84	9.25	7.77	7.92	8.15
5	7.78	8	8.59	7.72	8.07	9.26	7.52	7.83	8.16
6	7.74	7.95	8.78	7.74	8.12	9.33	7.63	7.83	8.04
7	7.86	8.15	8.67	7.97	8.01	9.34	7.69	7.81	8.06
8	7.71	8.03	8.57	7.97	8.05	9.02	7.1	7.35	7.68
9	7.94	8.2	8.79	7.88	8.14	9.01	7.7	8.01	8.04
10	7.73	8	8.53	7.91	8.19	9.07	7.72	7.94	8.09
11	7.8	8.1	8.64	7.81	8.2	9.08	7.75	7.99	8.18
12	7.79	8.15	8.78	7.72	8.14	9.22	7.69	7.94	8.15
13	7.38	7.65	8.2	7.69	8.04	9.24	7.59	7.89	8.19
14	7.6	7.92	8.56	7.93	8.1	8.99	7.63	7.84	8.06
15	7.78	8.02	8.6	7.84	8.23	9.14	7.65	7.89	8.11
16	7.72	7.98	8.52	7.89	8.19	9.16	7.68	7.82	8.12
17	7.75	8.09	8.62	7.79	8.21	9.22			
18	7.77	8.07	8.74	7.9	8.24	9.32			
19	7.75	8.9	9.55	7.81	8.24	9.21			
20	7.79	8.03	8.71	7.78	8.14	9.18			
21	7.73	8.04	8.67	7.98	8.19	9.18			
22	7.8	8.14	8.73	7.68	8.02	9.05			
23	7.7	8.13	8.66	7.68	8.14	9.18			
24	7.72	8.09	8.62	7.53	8.11	9.23			
25				7.97	8.06	9.31			
26				7.94	8.07	9.07			
27				7.75	8.09	9.08			
28				7.78	8.09	9.15			
29				7.83	8.19	9.12			
30				7.81	8.22	9.22			
σ	7.75±0.11	8.07±0.21	8.65±0.23	7.82±0.06	8.18±0.16	9.17±0.1	7.61±0.16	7.84±0.15	8.07±0.13

Notes:

1 day after prosthetic repair: 1-2 – $p<0.05$. 1-3 – $p<0.05$. 2-3 – $p<0.05$

12 months after prosthetic repair: 1-2 – $p<0.05$. 1-3 – $p<0.05$. 2-3 – $p<0.05$

24 months after prosthetic repair: 1-2 – $p<0.05$. 1-3 – $p<0.05$. 2-3 – $p<0.05$

from that used by the authors. The fact that they observed young persons with intact teeth should also be considered.

3. Conclusions

Dental prostheses with at least one ceramic occlusal surface exhibit a strong tendency to abrasion and, consequently, to an increase in the occlusal surface area resulting in an excessive load on prosthetic appliance. Moreover, functional and aesthetic values of prosthetic prosthesis sharply decrease.

Therefore, we recommend to produce zirconia occlusal surface or at least to combine the same materials, as it will increase the longevity of prosthetic appliance.

4. Prospects for further research

Written informed consent was obtained from the patient who participated in this case. The study indicated the need for

further investigation of the combination of different materials when constructing the occlusal surfaces of the antagonistic teeth to provide the highest quality of prosthetic care.

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