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## **Clinical Aspects of Combination of Aesthetic Fixed Orthopedic Appliances**

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**Keywords:**

orthopedic appliances; occlusal surfaces; ceramics; zirconium dioxide

**Abstract.**

The article presents the results of examination of 80 patients with aesthetic fixed orthopedic appliances. The state of the occlusal surface of fixed orthopedic appliances as well as the occlusal contact surface area was studied. The occlusal surfaces were made of ceramics and zirconium dioxide. The surface area of occlusal contacts was studied using 3Shape Dental System since computer occlusiography provides the most accurate results. Physical examination indicated a higher level of ceramic occlusal surface abrasion compared to zirconia occlusal surfaces.



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### ***Problem statement and analysis of the recent research***

At the current stage of its development orthopedic dentistry has the ability to use a variety of materials both modern and those that have been known for centuries as constructive ones [1].

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

It is due to the combination of orthopedic appliances made of various materials as well as those being of different design and having different methods of manufacturing – metal, combined ceramic (low-temperature ceramics, high-temperature ceramics, feldspathic ceramics, alumina-based ceramics) and metal-free orthopedic appliances [2], which is contrary to basic principles of tribology.

Excessive ceramic abrasion and aggressivity of ceramics toward antagonists compared to zirconium dioxide remains the problem which is 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 glaze 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 and ceramic materials consist of particles of various sizes. Moreover, ceramics contains surface and subsurface pores which greatly reduce the abrasion resistance of material.

In addition, the combination of different constructive materials on the occlusal surfaces always has a negative impact on the durability of prostheses due to their physical and mechanical properties [2].

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

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

### ***Materials and methods***

The study included 80 patients with aesthetic fixed orthopedic appliances including zirconia and ceramic occlusal surfaces. Group I included 24 patients with combination of zirconia and ceramic occlusal surfaces. Group II included 40 patients with combination of ceramic occlusal surfaces. Group III included 16 patients with combination of zirconia occlusal surfaces.

Patients were observed 18 and 36 months after placement of the denture.

The reason for forming such groups was the fact that the abrasion of ceramic occlusal surfaces sharply increases 18 months after placement of the denture [14].

The state of the occlusal surface of orthopedic appliances was studied on the basis of history taking (complaints, physical character of food, state of the gastrointestinal tract), data of physical examination, X-ray results and 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 contrast 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.



Fig. 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 36<sup>th</sup> tooth is 7.044 mm<sup>2</sup> and the mean occlusal contact surface area of 46<sup>th</sup> tooth is 7.62 mm<sup>2</sup>.

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

### **Results and discussion**

The occlusal contact surface area 18 and 36 months after placement of the denture was the largest in Group II (10.09±0.12 mm<sup>2</sup> and 11.16±0.1 mm<sup>2</sup>, respectively) (Table 1). It was due to physical and mechanical properties of ceramics, i.e. its aggressivity and relatively poor abrasion resistance compared to zirconium dioxide.

In Group II both occlusal surfaces were made of ceramics and, consequently, abrasion of ceramic surfaces doubled resulting in larger occlusal contact area, especially after prolonged period of denture wearing – 11.16±0.1 mm<sup>2</sup>.

The glaze 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 antagonist is exposed. This is precisely why orthopedic 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 low degree of aggressivity helps preserve the initial surface area of occlusal surfaces almost unchanged. It was proven by the results of Group III (Table 1).

18 and 36 months after denture placement in Group I where only one occlusive surface was made of zirconium dioxide significantly reduced levels of abrasion were observed compared to Group II –  $9.39 \pm 0.19 \text{ mm}^2$  and  $10.35 \pm 0.15 \text{ mm}^2$ , respectively (Table 1).

In Group III the smallest contact surface area –  $8.05 \pm 0.07 \text{ mm}^2$  as well as the lowest growth of the surface area 36 months after denture wearing was observed –  $8.13 \pm 0.09 \text{ mm}^2$ .

In our opinion, the smallest contact surface area is explained by the fact that at current stage modelling of zirconia orthopedic 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.

Table 1

Occlusal contact surface area of 36<sup>th</sup> tooth

Group	Occlusal surface area
I (18 months)	$9.39 \pm 0.19 \text{ mm}^2$
II (18 months)	$10.09 \pm 0.12 \text{ mm}^2$
III (18 months)	$8.05 \pm 0.07 \text{ mm}^2$
I (36 months)	$10.35 \pm 0.15 \text{ mm}^2$
II (36 months)	$11.16 \pm 0.1 \text{ mm}^2$
III (36 months)	$8.13 \pm 0.09 \text{ mm}^2$

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

### 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 excessive load on orthopedic appliance. Moreover, functional and aesthetic value of orthopedic prosthesis sharply decreases.

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

### References

1. Zholudev DS. Ceramic materials in orthopedic dentistry. Problemy stomatologii. 2012;5.
2. Bida VI. Principles of orthopedic treatment of dentofacial pathology in reduced vertical dimension of occlusion, its prognosis and prevention. [extended abstract of dissertation for Doctor of Medical Science]. Kyiv. 2003;31.
3. Etman MK, Woolford MJ. Three-year clinical evaluation of two ceramic crown systems: a preliminary study. J Prosthet Dent. 2010;103(2):80-90. doi: 10.1016/S0022-3913(10)60010-8.
4. Mitin NE, Nabatchikova LP, Vasilyeva TA. Analysis of modern methods for estimation and registration of occlusion at stages of dental treatment. Ros. mediko-biol. vestn. im. akad. IP Pavlova. 2015;3:134-139.

5. Yang X, Sun YF, Tian L, et al. Precision of digital impressions with TRIOS under simulated intraoral impression taking conditions. *Beijing Da Xue Xue Bao*. 2015;47(1):85-9.
6. Brahareva NV. Control methods in restoring occlusion when consulting an orthopedist. *Problemy stomatologiyi*. 2013;5.
7. Raigrodski AJ, Chiche GJ, N. Potiket N, et al. The efficacy of posterior three-unit zirconium-oxide-based ceramic fixed partial dental prostheses: A prospective clinical pilot study. *The Journal of prosthetic dentistry*. 2006;96(4):237-244.